

SUMMARY REPORT

EROSION CONTROL WORK PERFORMED ON
THE BOND CREEK REHABILITATION UNIT
SITE 82-4

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REDWOOD N. P.
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¹Appendixes are on file at the Arcata and Orick offices.

INTRODUCTION

Unit Description

The Bond Creek Rehabilitation Unit, Site 82-4, is located on the west side of the Redwood Creek basin, approximately five miles upstream from Orick. Specifically, this unit encompasses the south-facing-half of the Bond Creek watershed and the adjacent southeast-facing slopes above Redwood Creek, totaling 560 acres. This unit is bordered to the north by the Elam Creek-Bond Creek divide, to the south by the L-1-5 Road, and to the west by the 1979 Bond Creek unit. (Map A).

In addition to the area described above, another 500 acres was eliminated from the rehabilitation schedule by virtue of a single road crossing excavation which isolated the northern extension of the L-1 Road leading from Bond Creek to Elam Creek. This area was not mapped in detail, but instead, was inspected by a review team. A consensus was reached to isolate this road segment and perform no erosion-control treatments. Additionally, 150 acres was removed from the rehabilitation schedule by the elimination of the M-11-1-1 Road. Located above the M-11-1-1 and the 1979 Bond Creek Rehabilitation Unit, a field reconnaissance was made of this area but it was not mapped in detail.

Mass movement and surficial processes have both contributed significantly to the sculpting process of hillslopes in this unit. Unlike most areas in the Bond Creek basin, geomorphic expressions of past erosion processes vary greatly across the unit. Parallel, first-order, shallow to moderately incised streams appear to be a combination of fluvial erosion and debris avalanching. Interfluvies are convex in profile, well-rounded, and commonly contain steep (50-90 percent) southwest facing slopes which descend to valley bottoms and are prone to debris avalanching. In contrast, the northeast-facing slopes are less steep (30-45 percent), more uniform, and less prone to mass movement. Hillslope amphitheatres are found in a number of locations, but are most common in the western-half of the unit. Bowl shaped with steep cirque-like rims, these areas are probably a result of one or more episodes of mass movement.

Hillslope gradients vary from straight to gently convex in profile to straight to greatly concave in profile. Hillslope gradients average 35 percent with slopes exceeding 70 percent common within drainages. Relief ranges from approximately 700 feet at the L-1-5 Road to 1320 feet at the Elam-Bond divide.

The L-1 Road provided access to a haul road network totaling 4.0 miles. The upper hillslopes contained 1.7 miles of road which included in the M-11-1-1, L-1-3, and L-1-4 roads. The M-11-1-1 was stable and unrocked, and its drainage was improved during the 1979 rehabilitation season. The L-1-3 and L-1-4 roads were stable, rock roads designed for one time use. With the exception of a road-caused stream diversion on the L-1-3, both roads were in stable condition. The L-1-5 Road crossed the lower hillslopes of this unit, and was 2.3 miles long. This road was only partially rock and contained a number of stability and drainage problems.

[illegible]

—————	Perennial Stream
——— ·····	Intermittent Stream
·····	Ephemeral Stream
=====	Haul Road
(—)(—)(—)	Drainage Divide
———	Culvert
-----	Unit Boundary



In summary, the total rehabilitation cost for the Bond Creek Unit was \$76,761. Of the total cost, primary treatments accounted for \$55,822 (73 percent) while secondary treatments accounted for \$2,804 (4 percent). Heavy equipment and manual-labor costs accounted for 86 percent and 6 percent, respectively, of the total cost. A total of 4.0 miles of logging haul roads were removed; 0.3 miles were outsloped while the remaining 3.7 miles were ripped and cross-road drained. A total of 17,850 yd³ of fill was excavated from 26 road crossings; 465 yd³ from 3 skid trail crossings.

Land Use History

Within the Bond Creek Unit, all 560 acres had been logged in a nine year period between 1966 and 1975 (see map B). Seed-tree removal continued for another two years through 1977. With the exception of two cable units clearcut in 1977, all timber had been tractor-yarded. Roughly 230 acres - the northeastern-half of this unit - was logged in 1966. Another 40 acres in the headwaters of Bond Creek was also clearcut during this year. The remaining hillslopes (300 acres) above the M-11-1-1 and north to the 1966 block, were clearcut between 1970-1972. The final, major entry was initiated in 1975. Roughly 200 acres between the L-1 and L-1-5 roads were logged by seed-tree-leave cutting methods. Seed trees were harvested in 1977.

Haul road construction followed a similar scenario, beginning with the construction of the L-1 Road from Elam Creek and the M-11-1-1 Road. Both roads pre-date 1966. The L-1 provided access to timber above Redwood Creek, between Bond and Elam creeks. The M-11-1-1 at this time, appeared to be a secondary road and/or a fire break. The L-1-3 and L-1-4 roads were constructed around 1966. During the 1966 harvest a skid road was constructed across the base of the block, following the present day alignment of the L-1-5 Road. Only portions of this alignment, however, were used to construct the L-1-5 Road. The skid road was replaced by the L-1-5 in 1972. In many cases, the L-1-5 crossed stream channels at locations just downstream from the "humboldt crossings" constructed in 1966. The L-1-5 was extended to RX6 between 1972-73, and was completed during 1974-75.

EROSION FEATURES

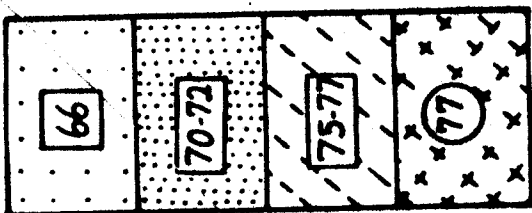
This discussion will summarize the major erosion features found on this unit. The reader is referred to Map C for the precise locations of these features. For a more complete and detailed description, erosion inventory maps (1:1200) are on file in Orick.

The four major types of erosion features found on this unit were: 1) skid trail and haul road stream crossings; 2) unstable road reaches; 3) debris torrents and an earthflow; and 4) shallow, translational slides caused by the overburden from skid trails constructed across steep hillslopes. With the exception of the earthflow, these erosion features were either active or potential sediment sources to stream channels.

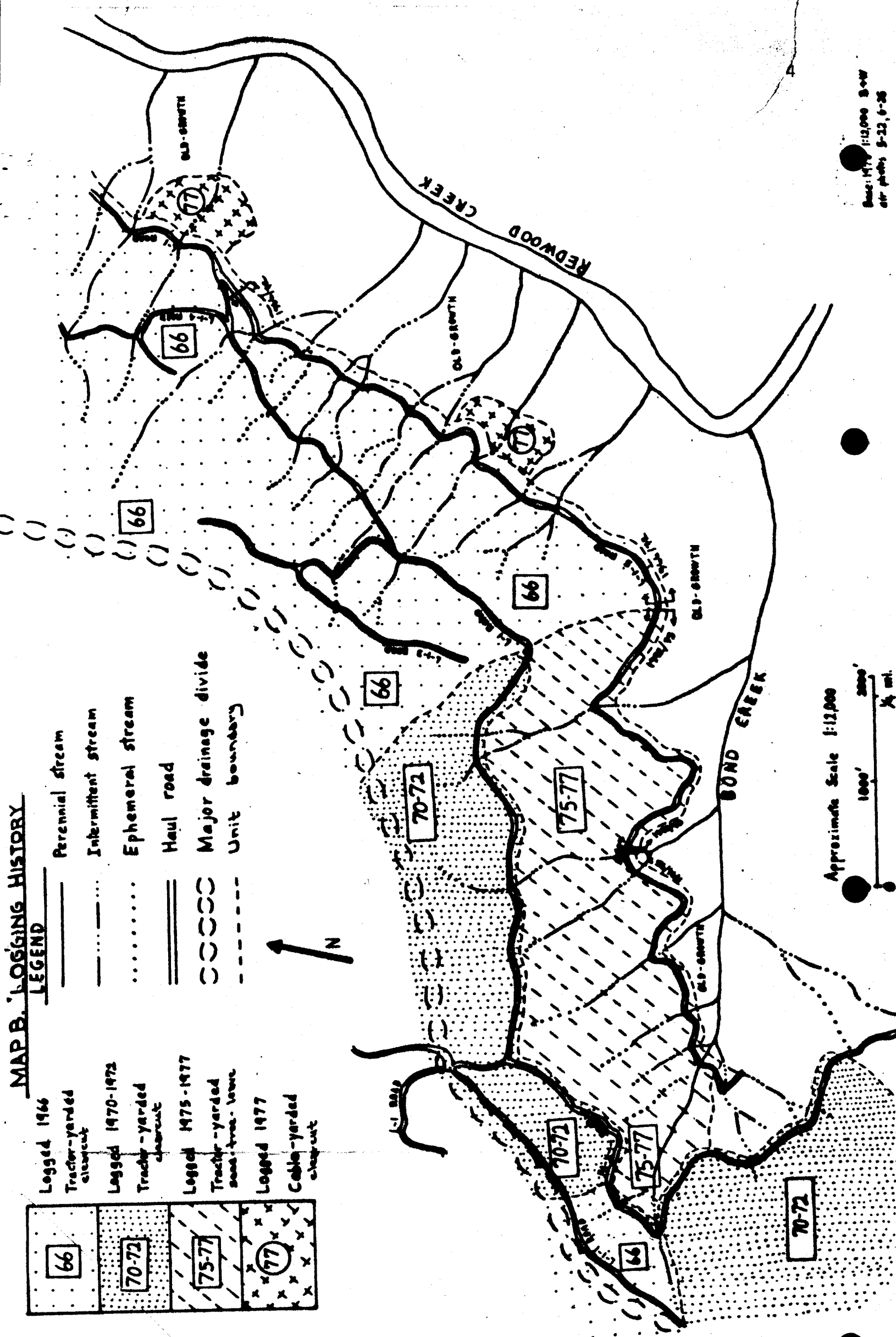
MAP B. LOGGING HISTORY

LEGEND

Logged 1966
 Tractor-yarded
 clearcut
 Logged 1970-1972
 Tractor-yarded
 clearcut
 Logged 1975-1977
 Tractor-yarded
 seed-tree forest
 Logged 1977
 Cable-yarded
 clearcut



Perennial stream
 Intermittent stream
 Ephemeral stream
 Haul road
 Major drainage divide
 Unit boundary



Approximate Scale 1:12,000
 1000' 2000' 1/4 mi.

Date: 11/19/12, 000 3:47
 air photo: 5-12, 6-26

A total of 118 crossings (L-1 Road not included) were identified on this unit, of which 86 were skid trail crossings and 32 were haul road crossings. As can be seen from Map B, the age of logging fell into three time periods. The eastern-half of the unit, from the L-1-5 Road to the divide, was logged in 1966. Skid trail crossings constructed during this period drained small areas, and were constructed at points of shallow incision (contained 100-200 yd³ of fill) where stream gradients were commonly low-moderate. Since their construction, these crossings have experienced three major storm events. Most have adjusted to hydrologic conditions by releasing the greater portion of their fill, rendering them inactive features. Other have remained entirely intact, displaying a very low erosion potential. At the time of mapping, SX 3 was still intact and had diverted stream flow out of its drainage. SX 4 was actively eroding, and SX 5 had diverted its streamflow, initiating a landing failure. Skid trail crossings constructed during 1970-1972 occupy the upper, western one-third to one-half of the unit. Because of their hillslope position and small drainage areas, these crossings have also displayed a low erosion potential. Finally, the 1975-1977 skid trail crossings were originally mapped and treated under the supervision of Bill Weaver in 1978. These crossings were quickly inventoried during the 1982 mapping season. Few changes were observed in almost all of the crossings, and this may be due to the fact that these crossings have never experienced a major storm event. The one exception, however, was at SX 1 where streamflow, previously mapped as piping through the crossing fill, had initiated the collapse of the crossings, creating a sediment source and a potential stream diversion at RX 2 located immediately downstream.

In general, haul road crossings were more a potential sediment source than an active sediment source to stream channels. Of the 19 major road crossings, only 4 (RX 2, 4, 26, 31) were actively eroding. Another five crossings (RX 1, 6, 10, 11, 17) had very high erosion potentials due to the debris loading in steep, upstream reaches and poorly functioning culverts. And, RX 33 contained no culvert and had diverted its streamflow down the L-1-3 Road, causing gully erosion on the road and the failure at SX 4. As a result of aerial photo interpretation and field study, it appears that RX 1 and RX 10 had completely failed during the 1975 storm event.

Perhaps the largest and most active erosion features found on this unit were debris torrents and failing road segments along the L-1-5 Road. Three debris torrents occurred during the March 1982 storm, delivering an estimated 1800-2000 yd³ of material directly to stream channels. Characteristics common to these features were: slope steepness ($\geq 70\%$), southwesterly aspects, points of groundwater discharge, and severe ground disturbance caused by multiple skid trail cuts. Two of the three torrents occupied identical hill-slope (topographic) position as well. A probable scenario to their failure mechanism combined structural controls of underlying bedrock with oversteepened sidecast material which had saturated and failed.

Whether a coincidence or another implication of structural controls, unstable road segments along the L-1-5 Road contained similar morphologic characteristics as the debris torrents. Within the inner valley gorge of Bond Creek, four road segments crossing steep headwall regions slumped during the 1982 mapping season. Vertical displacement of up to seven feet was observed.

Unique to the Bond Creek Unit is the hillslope morphology found in the lower (relative to the unit) reaches of the mainstem. Situated between the L-1-5 and M-11-1-1 roads, opposing valley walls are fairly straight in profile and uniformly steep, exceeding 90 percent in many locations. Timber from these slopes had been tractor-yarded, and because of the slope steepness, skid trail cuts were commonly tall (8-14 ft.) and large volumes of fill had been sidecasted onto naturally steep slopes. Though this area of the unit has not been subjected to a major storm event since harvest, numerous translational slides have occurred as a result of fill failures from these skid trails. These features have delivered sediment directly to the mainstem of Bond Creek.

EROSION-CONTROL REHABILITATION WORK

As the first phase of rehabilitation, the Bond Creek Unit was inventoried to identify all erosion processes and sediment sources to stream channels. Aerial photographs were interpreted to generate logging history data and to facilitate detailed field mapping. As a final product, an erosion feature map (1:1200) was compiled, providing a complete scenario of sediment source areas on this unit. Field mapping began in early March and continued through May, requiring 32 person-days to map approximately 560 acres. Next, the planning phase began and continued into June. During this time the entire unit was assessed, sediment sources prioritized, peak discharge estimates computed, treatments prescribed, and equipment scheduled. This phase required 16 person-days to complete. Pre-rehabilitation work site conditions were then documented. Through the month of June, photo points were established and stream channels were surveyed, requiring 16 person-days to complete. As can be seen in Figure 1, heavy equipment work began on July 6 and continued through August 23.

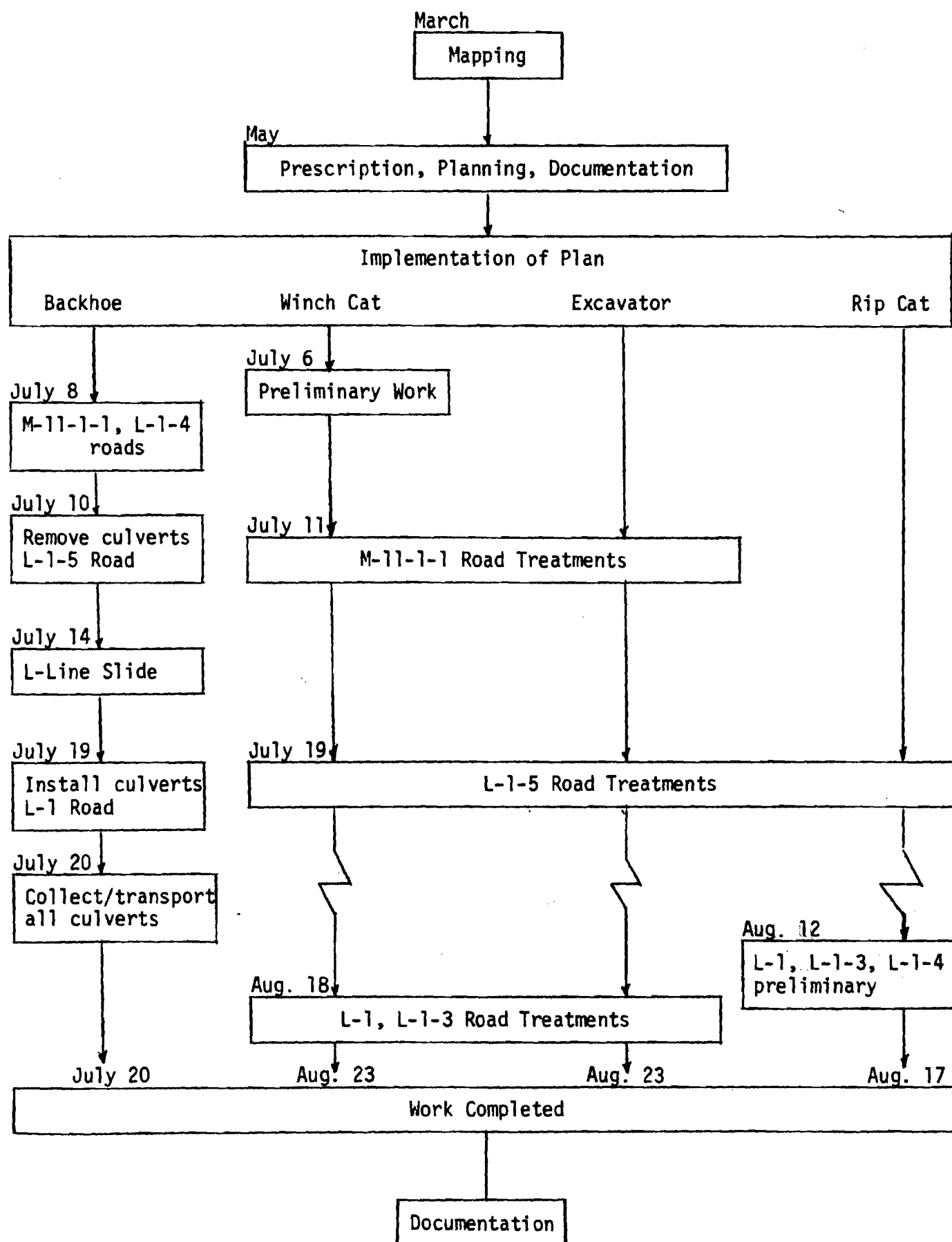
This project was supervised by Gregory Bundros and Matt Horns. Park laborers included William Quinn and Arnie Nova. Labor intensive work was also performed by Redwoods United.

Objectives, Methods, and Summary Costs

The objectives of rehabilitation were to remove active and potential sediment sources to stream channels and to encourage revegetation as the ultimate form of erosion-control. The aesthetic appearance of our work played a secondary role to its effectiveness. Because of budget constraints, manicure work was not performed. Additionally, erosion features which would store their eroded material as slope deposits were not a concern. The reader is referred to Map C which locates all work sites on this unit.

The Bond Creek Unit contained 4.0 miles of logging haul roads which included the L-1-5, L-1-4, L-1-3, and M-11-1-1 roads. With the exception of six unstable road segments on the L-1-5, these roads were in stable condition. Stable roads were treated to encourage revegetation and infiltration and to disperse concentrated surface runoff. To achieve these goals, road surfaces were simply ripped and cross-road drained. Unstable road segments, however, were completely outsloped because of their close proximity to streams and high debris torrent potentials.

Figure 1. REHABILITATION PHASES AND WORK SEQUENCE



Haul road crossings on the L-1-5 Road were considered to be the largest potential sediment sources on this unit. Sixteen crossings were completely excavated on this lowermost road to their approximate pre-road channel geometries. A single crossing - RX 15 - was only partially excavated because of the lack of channel development upstream. A total of 15,240 yd³ were removed from these crossings. Higher on the hillslopes, road crossings were also excavated from the L-1-4, L-1-3, and M-11-1-1 roads, but not to the same extent as those on the L-1-5. These crossings typically drained less than ten acres and because of this, did not warrant complete excavation. Excavations proceeded to a sufficient depth and provided adequate channel capacity to eliminate any diversion potential. A total of eight crossings were treated on these upper roads, removing a total of 2600 yd³ of fill from the channels.

Of the 86 skid trail crossings identified on this unit, only four crossings were treated. SX 1 was identified in 1978 but was not treated. As a result of this past winter, this crossing and the road crossing (RX 2) immediately below it, started to collapse. SX 1 was excavated concurrently with RX 2. Since its drainage area approximated only five acres, the excavation resulted in more of a channelization effort than a total erosion-control measure; i.e., a complete excavation was not performed because of the site conditions and the high cost to perform a complete excavation. Similarly, the crossing at SX 4 was also actively eroding due to gully erosion from the L-1-3 Road. This stream had diverted higher on the hillslope at RX 33 and had been directed down the L-1-3 Road until intercepted by a skid trail which directed the stream/gully flow onto SX 4. This crossing had only partially eroded (approximately 20 percent), and contained a large ponded area behind the crossing, approaching six feet in depth. The channel fill remained saturated during the excavation which precluded a complete excavation of the upstream channel reach.

Landing surfaces along all roads were typically ripped to encourage revegetation and infiltration. Two landings along the L-1-5 Road, however, displayed fill failure/debris torrent potential and were outsloped to varying degrees. Located above the left bank of RX 2, landing #1 (L1) was completely outsloped. In contrast, only the westernmost-half of L4 was outsloped. No volume estimates are available for either landing.

Drainage improvements utilizing waterbars, cross-road drains, and culverts were the final treatment performed on this unit. To disperse concentrated runoff, waterbars were constructed on the skid road connecting the L-1-1 to the M-11-1-1 roads. The L-Line, though not a portion of this unit, was cross-road drained to the north and south of the debris torrent that developed this winter. And, two culverts were installed on the L-1 Road that crosses the upper hillslopes of this unit. Culverts were placed in natural drainages to redirect streamflow and reduce the runoff received by a single stream channel. This stream, the easternmost to two streams, had carried streamflow from the adjacent stream along with road runoff generated from approximately 1500 feet of road. Incipient slope failures were identified in this drainage, extending up to the L-1 Road. It is hoped that these hillslope and channel features, a blend of fluvial and mass movement processes, will stabilize with more appropriate flow distribution and regimes.

Erosion features not treated during our erosion-control efforts were the shallow, translational slides, originating from oversteepened skid trail fill and the three debris torrents. As a result of peer review, it was decided that work site conditions would be too hazardous to effectively outslope these skid trails, and should these skid trails continue to fail, the majority of sediment would be stored as valley deposits, and would not be transported to Redwood Creek. Regarding the debris torrents, their headcuts had retreated sufficiently upslope to capture and contain ground-water discharge areas. These areas can no longer be drained. A small bench, however, was constructed on the left bank of RX 4 to catch debris released from the torrent outslope.

The total cost of rehabilitation, including supervision cost was \$76,761. Of this total, heavy equipment and labor costs accounted for 87 and 6 percent, respectively. Evaluation costs accounted for the remaining 7 percent (refer to Table 1). Secondary treatments were not performed by heavy equipment. Primary treatments were not performed by labor crews. Primary treatments accounted for 73 percent and secondary treatments accounted for 4 percent of the total cost of erosion-control rehabilitation work on this unit.

Heavy Equipment Phase

Heavy equipment work was performed by five pieces of equipment. Work began on July 6 and ended August 23 (refer to Figure 1). The D6, D7, and hydraulic excavator were the core of the equipment package. A backhoe and dump truck combination worked only a brief time to remove culverts from the roads and performed miscellaneous jobs. Table 2 lists equipment owners, operators, and describes the equipment used on this unit.

The backhoe and D6 were the first two pieces to begin work. The backhoe excavated two small road crossings and removed culverts from the M-11-1-1 Road. Next, it excavated RX 32 and performed preliminary excavations on the L-1-4 Road cross-road drains. It then moved down to the L-1-5, removing all culverts from the road and road crossings. When all culverts had been removed, the backhoe performed a small excavation at SX 5, installed two culverts in the L-1 Road, and cross-road drained the L-Line, north and south of the debris torrent.

During this time, the D6 upgraded the L-1-1 Road, cleared the L-1-5 Road of slide debris, and excavated culvert "toppings" so as to minimize excavations for the backhoe. It completed the preparatory work on the L-1-5 by winching large logs from road crossings, and draining ponds from behind crossings scheduled for excavation. The D6 moved the L-1-4 Road where it completed the cross-road drains initiated by the backhoe, and proceeded to the M-11-1-1 Road where it performed preliminary excavations on the remaining road crossings.

The hydraulic excavator was the next piece to begin work. The excavator and D6 then excavated road crossings, ripped (blade mounted chisel) road and landing surfaces, and cross-road drained the M-11-1-1 Road. Once the M-11-1-1 Road had been completed, the D6 and excavator moved to the L-1-5 Road. The D7 was then delivered. For the remaining time on the L-1-5, the D6, D7, and hydraulic excavator worked as a team. The D7 performed preliminary

Table 1. SUMMARY COSTS OF EROSION-CONTROL REHABILITATION WORK: SITE 82-4

Phase	Task	--RNP Employees--		Heavy Equipment Rental	Redwoods United	Total Task Costs	% Total Cost	Phase Totals	Phase %
		Geologist & P.S. Tech.	Laborers						
Evaluation Phase	Mapping	\$2,200	--	--	--	\$2,200	3	\$5,175 ✓	7
	Prescriptions, Planning, & Documentation	2,912	\$63	--	--	2,975	4		
Heavy Equipment Phase	Primary Treatments	4,942	--	\$50,880	--	55,822	73	67,234	87
	Secondary Treatments	--	--	--	--	--	--		
	Access Costs	--	--	2,872	--	2,872	4		
	Miscellaneous Costs	--	2,046	6,494	--	8,540	11		
Labor Intensive Phase	Primary Treatments	--	--	--	--	--	--	~~4,352~~ 7029	6
	Secondary Treatments	568	~~2,015~~ 2476 ✓	--	\$221 ✓	~~2,804~~ 3265	4		
	Travel Time	--	1,173 ✓	--	111 ✓	1,284	1		
	Miscellaneous	--	~~264~~ 2480	--	--	~~264~~ 2480	0		
		\$10,622	\$5,561	\$60,246	\$332				

GRAND TOTAL ~~\$76,761~~

79438

1343

Table 2. EQUIPMENT AND OPERATORS

Owner	Operator	Equipment	Rate/Hr.
Keith Parker	Steve Hoopes	680 C extendahoe	\$40.50
		10 yd ³ dump truck	\$34.32
Robert Chambers	Jim Morgan	D7G tractor with rippers	\$68.50
Diamond R Logging	Tim Renner	D6D tractor with winch	\$56.05
Lawrence Lambert	same	JD690 with "thumb"	\$85.00

excavations at every road crossing, removing an average of approximately 50-60 percent of the fill volume. The D6 and hydraulic excavator would then complete the excavation while the D7 ripped roads and landings, and moved onto the next crossing. In many cases, the D7 would complete a preliminary excavation and return to assist the D6 with long pushes or in really wet soil conditions. Towards the end of the L-1-5 work, the D7 left the D6 and excavator, and completed preliminary excavations at RX 31 and RX 33, ripped the L-1-4 Road, and cross-road drained the L-1-3. The L-1-3 Road was not ripped because of worn ripper teeth.

The total heavy equipment cost (less supervision) was \$60,246, or 78 percent of the total rehabilitation cost. Heavy equipment performed only primary treatments and accounted for 84 percent of the total equipment costs. Miscellaneous and access costs accounted for 11 percent and 5 percent (refer to Table 1).

Average heavy equipment costs summarized in Table 3. A summary of all equipment costs, providing an hourly breakdown for each piece of equipment and for all tasks performed, is included in Appendix A. Miscellaneous costs include preliminary jobs, non-productive time, administrative time, and paid standby. Non-productive time represents the break time taken by operators, averaging one-half hour per day. Administrative time is that time spent discussing work schedules and safety. Since 67 percent of heavy equipment costs involved stream crossing excavations, only this treatment will be discussed in detail. Road outslowing will be discussed briefly to point out the method used.

-Haul road stream crossings (Tables 4-6) -- 26 road crossings were excavated at an average unit cost of \$2.20/yd³. Unit costs ranged from \$1.42-3.56/yd³. Unit costs greater than \$3.00/yd³ resulted at RX 2, RX 5, and RX 28 1/2. RX 2 contained a skid trail crossing and a haul road crossing. The area in which equipment had to operate was extremely limited and steep. As a result, the excavator performed the skid trail excavation on its own, resulting in a high unit cost. At RX 5 there was no surface water flowing in the channel, yet the fill contained within the crossing was completely saturated. Both tractors were needed to push mud during the entire excavation; the excavator kept sinking. RX 28 1/2 was the first excavation performed by the tractor-excavator team. The unit cost of \$3.23/yd³ reflects their lack of team work and inexperience.

Table 3. SUMMARY OF AVERAGE HEAVY EQUIPMENT COSTS: SITE 82-4

Treatment	# of Work-sites	Total Quantity	Total Cost	Avg. Cost Worksite	Avg. Cost Quantity	Range Cost/Quant.
<u>Primary Treatments</u>						
Haul road crossings	26	17,850 yd ³	\$39,222	\$661	\$2.20/yd ³	<u>\$1.42-3.56</u> yd ³
Skid trail crossings	3	465 yd ³	1,340	447	2.88/yd ³	<u>2.20-3.36</u> yd ³
Ripping roads	3	3.6 mi. ✓	1,184	395	3.29/mi.	<u>267-357</u> mi.
Outsloping roads	6	1,320 ft. ✓	2,572	429	1.95/ft.	<u>0.52-2.93</u> ft.
Cross-road drains	5	119 ✓	2,034	407	17/ea.	<u>10.00-39.20</u> ea.
Waterbars	2	12	70	35	5.83/ea.	<u>4.67-6.22</u> ea.
Outslope landings	3	3	2,001	667	667/ea	<u>170-955</u> ea.
Culvert removal and transport	--	11	1,969	--	179/ea.	--
Culvert placement	--	2	304	--	152/ea	--
Perched slash	1	--	184	--	--	--
Total Primary Treatment Cost		=	\$50,880			
<u>Secondary Treatments - None</u>						
<u>Access Costs</u>						
Lowboy		7 trips	\$1,505 ✓	\$215	\$215	<u>\$85-306</u> trip
Travel			\$1,367 ✓			
Total Access Cost =			\$2,872			

Table 3. - cont.d SUMMARY OF AVERAGE HEAVY EQUIPMENT COSTS: SITE 82-4

Treatment	# of Work- sites	Total Quantity	Total Cost	Avg. Cost Worksite	Avg. Cost Quantity	Range Cost/Quant.
<u>Miscellaneous Costs</u>						
Preliminary jobs	--	--	\$1,647	--	--	--
Non-productive time	--	--	3,152	--	--	--
Administrative time	--	--	835	--	--	--
Paid standby	--	--	860	--	--	--
Total Miscellaneous Costs		=	\$6,494			
TOTAL HEAVY EQUIPMENT COST		=	\$60,247			

Table 4. SUMMARY OF HAUL ROAD CROSSINGS COST: SITE 82-4

Type of Worksite	# of Sites	Range Volume of Fill	Equip.	Range Hours	Avg. Cost Worksite	Range Cost	Avg. Cost yd ³	Range Cost/yd ³
Extra Small (0-100 yd ³)	4	15-50 yd ³	B.H. D6 HE	1 - 2 1/4 1 1/2 1/4	\$74.25	\$40-105	\$2.20/yd ³	\$1.74-2.67 yd ³
Small (100-400 yd ³)	4	225-400 yd ³	D7 D6 HE	1 1/4 - 3 1/2 3 - 7 3/4 3 - 7	827.00	509-1269	2.61	1.76-3.23 yd ³
Medium (400-800 yd ³)	7	430-750 yd ³	D7 D6 HE	3 - 11 1 1/4 - 14 1/2 4 1/2 - 12	1319.00	756-2530	2.23	1.42-3.56 yd ³
Large (800-2000 yd ³)	11	820-1800 yd ³	D7 D6 HE	4 1/2 - 17 1/2 4 - 20 1/2 6 - 20	2398.00	1200-3977	2.19	1.43-2.75 yd ³

Table 5. SKID TRAIL CROSSING COSTS: SITE 82-4

Type of Worksite	# of Sites	Range Volume of Fill	Equip.	Range Hours	Avg. Cost Worksite	Range Cost	Avg. Cost yd ³	Range Cost/yd ³
Extra Small (0-100 yd ³)	1	15 yd ³	B.H.	1 1/4	\$50.63	--	\$3.36/yd ³	--
Small (100-400 yd ³)	2	200-250	D6 HE	3 3/4 - 7 1/2 3 3/4 - 4	664.00	\$550-739	2.86	\$2.20-3.70 yd ³

Table 6. HAUL ROAD CROSSINGS: SITE 82-4

Crossing	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (yd ³)	Erosion Potential (yd ³)	Cost Effectiveness (yd ³)
RX1 ¹	D7	8 1/4	\$2158	1100 ²⁵	\$1.96	615	\$3.51
	D6	13 1/4					
	HE	10					
RX2/SX1 ²	D7	3 1/2	1269	400 ²²	3.17	280	4.53
	D6	7 3/4					
	HE	7					
RX3	D7	3	756	400 ²³	1.76	220	3.44
	D6	3					
	HE	4 1/2					
RX4 ¹	D7	14	2419	1300 ³⁸	1.86	366	6.61
	D6	9 3/4					
	HE	10 3/4					
RX5 ³	D7	11	2530	710 ¹⁹	3.56	360	7.23
	D6	13 1/2					
	HE	12					
RX6 ¹	D7	16 3/4	2179	990 ²³	2.20	460	4.74
	D6	4					
	HE	9 1/2					
RX7 ¹	D7	9 1/4	1065	580 ²²	1.84	400	2.66
	D6	1 1/4					
	HE	4 1/4					
RX8 ^{1,2,3}	D7	17 1/2	3977	1520 ²²	2.62	--	--
	D6	20					
	HE	19 1/2					

Table 6. - cont'd HAUL ROAD CROSSINGS: SITE 82-4

Crossing	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (yd ³)	Erosion Potential (yd ³)	Cost Effectiveness (yd ³)
RX9	D7 D6 HE	1 1/4 3 3	\$509	290	\$1.76	290	\$1.76
RX10	D7 D6 HE	5 3/4 11 1/4 10	1874	820	2.29	377	4.97
RX11	D7 D6 HE	4 1/2 11 1/2 11 3/4	1952	980	1.99	832	2.35
RX12	D7 D6 HE	4 3/4 6 1/2 6	1200	841	1.43	377	3.18
RX13	D7 D6 HE	5 1/4 6 1/2 6 1/2	1276	470	2.71	380	3.36
RX14	D7 D6 HE	7 1/4 16 16	2753	1000	2.75	774	3.56
RX15	D6 HE	1 1/2 1/4	105	50	2.10	50	2.10
RX16	D7 D6 HE	4 1/2 11 1/4 12 1/4	1980	850	2.33	581	3.41
RX17 ¹	D7 D6 HE	9 1/4 11 1/4 11	2199	860	2.56	504	4.36

Table 6. - cont'd HAUL ROAD CROSSINGS: SITE 82-4

Crossing	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (yd ³)	Erosion Potential (yd ³)	Cost Effectiveness (yd ³)
RX26 (M-11-1-1)	D6 HE	9 8	\$1184	580	\$2.04	--	--
RX27	D6 HE	6 3/4 5	803	350	2.29	--	--
RX28	D6 HE	14 1/4 8 3/4	1542	750	2.06	--	--
RX28 1/2	D6 HE	5 3/4 4 3/4	726	225	3.23	--	--
RX29	BH	1	41	15	2.70	--	--
RX30	BH	2 1/4	91	35	2.60	--	--
RX31 (L-1)	D7 D6 HE	12 1/4 20 1/2 20	3688	1800	2.05	800	4.61
RX32 (L-1-4)	BH	1 1/2	61	35	1.73	--	--
RX33 (L-1-3)	D7 D6 HE	3 4 1/2 5	883	620	1.42	--	--

¹The D7 performed preliminary excavation, and returned later to assist the D6 push material away from the worksite.

²This excavation included a skid trail crossing excavation which was extremely difficult to perform. Its high unit cost, relative to others on this unit, reflects tight work space and limited access.

³This crossing contained saturated fill within the crossing material. Its high unit cost reflects extremely poor work conditions; i.e., mud.

-Road outsloping (Table 3) -- Approximately 1320 feet of road was outsloped at an average unit cost \$1.95/ft. Unit costs ranged from \$0.52-2.93/ft. The degree of the outsloping also varied. In general, the excavator retrieved over-steepened road fill, excavating entirely through the scarps that had developed on the road. The D6 did not remain at these worksites the entire time. Instead, it was brought to the road reach being outsloped just before the excavator completed its work. The D6 smoothed and outsloped piles of fill while the excavator completed the last segment of the road reach. Low unit costs (\$0.52-0.94/ft) were associated with mild outsloping of short road reaches (<100 ft.) performed entirely by the hydraulic excavator. Major outsloping averaged \$2.13/ft and required both D6 and hydraulic excavator.

Evaluation of Heavy Equipment Application

All five pieces of equipment hired for this rehabilitation project were well suited for the work. Once familiar with our goals and their work, the operators utilized their equipment effectively and completed each work task to prescription. All work performed was well within the capabilities of the equipment, though the D6 may have been the one exception. Once in mud, the D6 lost its ability to push up any significant slope and, without the D7, the excavations proceeded at a much slower rate.

The D7 (opposed to a D8) was chosen particularly because of its blade size - 10 feet 8 inches. This tractor was a work horse and because of its relatively short blade was able to work along side the excavator when needed. Because of its size and the nature of work sites, this would not have been possible with a D8. The D7 was originally scheduled to assist the D6 at most major crossings, realizing that at some point the D6 would not be able to keep up with the excavator because of long, steep pushes. The D7 always had enough time to complete road work and perform a preliminary excavation at one crossing, and return to the previous crossing to assist the D6 and hydraulic excavator. Once together, the D6 and D7 would relay the fill away from the work site. The D7 was also hired on a four day work week. This always allowed one day per week for the D6 and excavator to catch up with the D7.

With the exception of three culverts, all pipes were salvaged from this unit. The backhoe-dump truck combination was hired specifically to remove culverts and to perform minor excavations. The D6 made one sweep across the unit, removing the "toppings" from each culvert. Then, the backhoe removed, stockpiled, and loaded all culverts into the dump trucks which transported them to the A-9 deck. This equipment application worked extremely well because the right sized equipment was performing the work, and culverts never interfered with the routine of road crossing excavations or road work. Culverts were salvaged and handled only once.

Channel excavations across the lower hillslope were thoroughly excavated with low gradient stream profiles. Channel capacity was estimated using the rational formula and assumed no rock armor. Appendix B contains runoff estimates and drainage areas for most stream crossings on the lower hillslope. Rock armor was not prescribed as a secondary treatment because of the lack of a close supply. Instead, buried organics were left in the channel bottom as much as possible to provide a form of channel protection. At the time of this writing, there have been minor channel adjustments to this season's initial runoff events.

Channel excavations, though complete, left steep streambanks as a finished product. Based on the surrounding slope morphologies, these streambanks were naturally steep before road construction. Prescriptions focused on maximizing the cost-effectiveness (opposed to production; i.e., unit cost) of our work by excavating only the fill volume in any particular crossing. Original ground was seldomly excavated. Table 6 lists both the unit cost to perform an excavation and the cost-effectiveness of the excavation. Cost-effectiveness is based upon the estimated volume of fill that would erode should the crossing fail.

A flaw in the prescription of treatments for this unit was the decision to not endhaul material away from RX 1 to the nearest landing. Instead, all of this fill was stored on Road Reach #1 after the road had been outsloped. The expansion ration of excavated soil was overlooked during the planning phase, and this resulted in a storage pile - albeit outsloped - that is much too tall and steep to be located above the mainstem of Bond Creek. At least one-half of the fill should have been endhailed to L1, less than a quarter-mile away.

A personal bias of mine remains regarding the skid trails in the headwater region of Bond Creek. Though it was the opinion of most who attended the "show-me" not to proceed with the treatment, I still feel that outsloping those skid trails, along with the M-11-1-1 Road located above, would deter future translational slides and cumulative downstream impacts to Bond Creek.

Labor Intensive Phase

Labor intensive work was performed primarily by Redwood National Park laborers. William Quinn and Arnie Nova were the park laborers assigned to this rehabilitation unit, and they performed a variety of tasks. They brushed work sites, distributed needed materials, and performed miscellaneous tasks from May 5 to August 25. Matt Horns provided the laborers with his assistance when necessary. Redwoods United provided five workers on August 16 to spread straw on stream banks.

The total cost of labor intensive work (less supervision) was \$6,461.06 or 8 percent of the total rehabilitation cost. Manual-labor crews performed only secondary treatments. Travel time and miscellaneous costs accounted for 58 percent of the total labor costs.

Average labor costs are summarized in Table 7. Appendix A contains a summary breakdown of all hours spent on the rehabilitation unit by labor crews. This discussion will now turn to the most significant labor treatments and costs.

-Straw application -- Straw was applied only at haul road crossing excavations on the lower hillslope. Twenty bales of straw were delivered to each crossing and applied at approximately 6,000 lbs/ac. A total of 320 bales were spread.

-Check dams -- Check dams were constructed at RX 5 to protect a reach of check dams constructed in 1978. Bank supports in the form of wood-board walls were also constructed on the right bank. All stake and splash board materials were split wood products from onsite logs. A total of 10 dams were constructed at a unit cost of \$89. Site conditions were extremely poor for the installation of check dams. Soils were saturated and the upper channel reach was poorly defined. This high unit cost also reflects laborer's inexperience in check dam construction.

Table 7. SUMMARY OF AVERAGE LABOR COSTS: SITE 82-4

Treatment	Type of Labor	Total Person Hours	Avg. Cost Per Hour	Total Cost	Quantity	Avg. Cost Quantity
<u>Primary Treatments - None</u>						
<u>Secondary Treatments</u>						
Check dams	RNP ¹	113 1/2	\$7.81	\$886.76	10 dams	\$89/dam
Channel work	RNP ²	39 1/2	8.32	328.62	5 sites	\$66/site
Distribute straw	RNP ¹	82	7.86	644.46	unit	--
Spread straw	RNP ¹	78 1/2	7.85	837.99	16 sites	\$52/site
	R.U.	30	7.38			
Total Secondary Treatment Cost =				\$2697.83		
<u>Travel Time</u>						
	RNP	149	7.87	1283.33	--	--
	R.U.	15	7.38			
Total Travel Cost =				\$1283.33		
<u>Miscellaneous</u>						
Brush xings	RNP ¹	236	7.87	1856.44	20 sites	\$93/site
Diversion dams	RNP ¹	24	7.82	187.56	2 dams	\$94/dam
Dismantle culverts	RNP	10	7.87	78.70	11 culverts	\$7/culvert
Survey xing	RNP ¹	12	7.80	93.56	1 xing	--
Administrative	RNP	33 1/2	7.87	263.64	--	--
Total Miscellaneous Cost =				\$2479.90		
TOTAL LABOR COST =				\$6461.06		

¹Performed by labor crew and Physical Science Technician.²Performed by labor crew, Physical Science Technician, and Hydrologist.

-Brush crossings -- neither a primary nor secondary treatment and the most expensive labor treatment, twenty crossings were brushed in May to facilitate the documentation (survey and photos) of the larger work sites. The total cost was \$1,856, or \$93/crossing.

Evaluation of Labor Treatments

Labor crews performed secondary treatments and miscellaneous tasks. Secondary treatments consisted of check dam construction, channel work, and the spreading of straw. The most important miscellaneous task included brush removal from road crossings, and the construction of diversion dams prior to road crossing excavations.

Check dam construction was a necessary treatment at RX 5. Because of the highly sheared and saturated material exposed during the excavation, some form of channel protection was necessary to prevent downcutting and earthflow potentials. A local rock source was not available, nor was any substantial amount and/or size of rock exposed during the excavation. Additionally, check dams had been constructed in the channel reach upstream from RX 5 in 1978. This skid trail crossing was under-excavated and headcut erosion at RX 5 would have undermined those dams, releasing the fill from the upstream crossing.

Channel work consisted of clearing mudflow debris which had accumulated during the excavation of a few road crossings. If this material had not been removed, streamflow would have been encouraged to flow around the deposits, encouraging lateral erosion and the undermining of streambanks. Flow deposits were simply raked against the base of each bank to encourage downcutting in the center of the channel.

At this point, straw mulch is an accepted secondary treatment aimed at preventing rill-gully formation on freshly disturbed soils. From the advice of the vegetation staff, straw was not prescribed for road surfaces, owing to the abundant seed source from surrounding areas. From an erosion-control standpoint, however, I lacked the foresight to recognize the need for a protective cover on Road Reach #1 which stores all of the excavated fill from RX 1. This fill-outsloped road reach should have received a generous cover of straw mulch.

Brush removal from the major haul road crossings was an extremely beneficial application of our laborer's talents. With the brush removed, volume and profile surveys were more precise and safe to perform, photographs captured more detail of pre-treatment conditions, and work instruction were more easily communicated to equipment operators.

Finally, diversion dams were constructed upstream from RX 1 and RX 6 prior to excavation. Streamflow was diverted around and out of these sites to maintain dry work conditions. They were cheap, easy to install, and very effective.

In general, we received very good support from the labor crew this year. The quality of work was good, and everyone arrived at the worksite on a punctual basis.

DISCUSSION

Unit Costs

In general, I was very pleased with the quality of work performed by the equipment operators and the resultant unit costs, especially those associated with stream crossing excavations. Fair unit costs were attributed to the following: 1) high drainage density along road networks, 2) good communication, 3) proper equipment for the job, and 4) enthusiastic and competent equipment operators. Because the drainage density along the roads was so high, road and/or skid trail crossing excavations were almost a daily work task. Even though each posed its own unique challenge, crossing excavations were so frequent that they almost became routine. Good communication helped instill a sense of teamwork and purpose in equipment operators. Along with daily instruction and close supervision, they received a weekly briefing to discuss progress; i.e., where we stood in relation to our proposed schedule, and were given goals to shoot for. What was the incentive to accomplish these goals? I do not know, but they did accomplish them, as a team.

The equipment used on this unit was ideal for the site conditions. Road crossings were deep and narrow, defining limits to the amount of fill that could be excavated by a single tractor without over-excavating and undermining adjacent slopes. These limits precluded the use of a D8 to perform preliminary excavations, the D7 excavated and disposed of the spoil at a rate of 40-90 yd³/hr., depending on site conditions. An added advantage was the length of its blade (10 ft.-8 in.). It was short enough to allow the tractor to work with the hydraulic excavator in limited work space. When together, the D6 and D7 were powerful enough to never let the excavator sit idle, even when pushing spoil in excess of 200 feet. The computed excavation rate for the hydraulic excavator and D6 combination ranged from 40-70 yd³/hr. and averaged 50 yd³/hr.

Finally, unit costs were low because of enthusiastic, honest, and competent equipment operators. It has been stated that there is no incentive for operators to maintain a high production level while working at an hourly rate. Albeit the logic follows, but there exists an underlying assumption in the logic that everyone will take advantage of a government job. Assuming competent operators, it is my opinion that we will continue to get our money's worth if our proposed treatments are thought-thru and well planned, and communication is kept open, setting goals and encouraging team efforts.

Volume Estimates

For the purpose of estimating equipment hours, most road crossings along the lower hillslopes of this unit were surveyed to derive an estimated volume of fill contained within each crossing. A longitudinal profile was surveyed using the tape-clinometer method. Beginning and end points of the survey were marked with flagging. Excavation limits; e.g., cutbanks that should not be undermined, were also noted and recorded at this time. Fourteen road crossings were surveyed, requiring approximately 3 person-hours, or 1 1/2 hours per crossing (2 people). The data was then reduced and plotted, producing a long profile showing the upstream reach, road prism, and the downstream extents of excavation. A straight line was used to connect points denoting both upstream and downstream extents of excavation. This line represented the uniform stream profile for the planned excavation. Where possible, cross-sections

were then assumed with 50 percent sideslope steepness. Using the programmable calculator, the double-ended formula was used to compute the estimated volume to be excavated from each crossing. Approximately 1 1/2 person-hours were required to reduce, plot, and design a road crossing excavation, and generate an estimated excavation volume.

Following the equipment work, these crossings were surveyed once again, measuring longitudinal profile and cross-sections. This information was used to compute the actual volume removed at each excavation. Where treatments followed the prescribed channel design, an average variability of +7 percent (0%-14%) was observed between estimated volumes and actual volumes. In general, most crossings were excavated deeper with shallower gradients than the prescribed straight line profile, and accounted for the observed variability in volume estimates. If anything, the excavated volumes presented in this report are conservative values.

A simple summary sheet containing the depths of excavation at the inboard and outboard edge of each crossings was compiled from the initial survey data. This proved very useful in delineating the extent and depth of excavation to the operators.

Stream Crossing Excavations

A total of 24 crossings were excavated on this unit and were left entirely unprotected with no channel armor. Rock was not prescribed as a secondary treatment because of the lack of close rock supply. Rock transportation costs would have been exorbitant. Instead, buried organics were left in the channel bottom as much as possible to provide a form of channel protection. Special care was taken at every crossing to prevent overexcavating and undermining sideslopes, and to develop a gentle, concave profile.

Following treatment, erosion-potentials remained the highest at crossings 1, 4-7, and 10. Highly sheared schist was exposed in the left banks of crossings 1, 4, 5, and 6. The erosion-potential at RX 7 remained high by virtue of its drainage area, approximately 51 acres. At RX 10, the stream gradient is very steep at its upstream end, and, unless rock and/or buried debris is encountered, headcut erosion is expected to develop.

Each stream profile on the L-1-5 Road was resurveyed following treatment. Permanent reference points were reset upstream and downstream from the surveyed profile. Following the 1982-83 winter, these profiles will be resurveyed to note and document channel adjustments.

Road Outsloping

As a result of peer review on all 1982 rehabilitation units, it was decided that road outsloping would be an erosion-control measure and not a cosmetic one. Of course, roads in prairies and those highly visible to the public were exceptions to this decision. Because of the consensus reached, roads on the Bond Creek Rehabilitation Unit were outsloped to prevent mass wasting of road prisms, located in close proximity to stream channels. No cosmetic work was performed. Upon reviewing other rehabilitation units following the equipment season, I was disturbed by the amount of road outsloping that had been performed in spite of the consensus to outslope only when/where necessary. What good is the peer review process if we, as project leaders, do not adhere to the

decisions (policy?) made by collective opinion? In the wake of budget cuts, we need to spread our money as far as possible by performing only those treatments necessary to accomplish our mission. If there is money to burn, that is fine. Lets all share it so that every unit can benefit by some cosmetic treatments.

Proposed Horse Trail

During the planning phase of this rehabilitation unit, our Trail Planner, Steve Lau, pointed out that portions of the L-1-5 and northern extension of the L-1 were being developed into a horse trail. He requested that these road segments be treated so as to accommodate the trail alignment and horse traffic. He suggested that roads be ripped only one-half their width, and that road crossing excavations, when completed, permit the crossing to be executed (crossed) by horses.

These plans were implemented with the ripping of Road Reach #9. The tractor operator was instructed that from this point, only the outer-half of the road could be ripped, leaving the compacted road surface for the proposed horse trail. Initially, the tractor operator followed these instructions, but as work progressed, he forgot and proceeded to rip the entire road width. Another problem developed as a result of the size/depth of crossing excavations and the amount of fill generated. Humboldt crossings were encountered unexpectedly at the upstream end of a number of crossings which required the excavations to extend farther upstream with greater depth. Also, the road crossings were so close to each other that entire road segments between crossings were buried and outslopped with fill from crossing excavations.

In summary, there appears to be conflicting goals between trails and rehabilitation. From a trail planner's perspective, trail surfaces are flat or gently sloping, compacted (inhibits revegetation, thereby eliminates maintenance costs for brush/tree removal), and low gradient. From an erosion-control perspective, flat surfaces can be unstable, but more often are poorly drained and may require outslipping. Compacted surfaces are ripped to encourage revegetation - the ultimate form of erosion-control. Ideally, the sideslopes of stream channels seldomly exceed 50 percent, but site conditions may require even steeper slopes. And, once stream channels are treated, they should be left undisturbed to revegetate and stabilize, and should not be impacted by foot and/or horse traffic. The latter point must not be constructed as an absolute statement, because the natural morphology at some stream channel excavations can accommodate a stable foot and/or horse trail with minimal impact to the site. The deep, narrow channels on the L-1-5 Road, however, do not fall into this category. If the proposed trail becomes a reality, its alignment can utilize the old roadbed as much as necessary; however, it should circumvent the steep and potentially unstable stream crossing excavation sites located on the L-1-5 Road.



SOWN WITH
RYE, VETCH
WILLOW SAMPLES

✦ AREA #1 ✦
16 ROWS
760 L.F.
WATTLES
ON CONTOUR
3' VERTICAL
SPACING
MOSTLY ALDER
SOME WILLOW
IN BUNDLES

VEGETATED

AREA

Big leaf
maple
Site

7/22/87
(A)

80 L. F. Wattles

500 L.F. Wattles

OVERALL MAP
for
SLIDE AREA

Map Prepared by:
Mark Gary
10/4/77

BUNNIE
RESOURCE
AREA
W/ Wood Resource
80 L.F. PLANTER BOXES

- - - Supply Area
40 L.F. WATER BARS

VEGETATED
GULLY
ALDERS, HORSE
BERRIES, TAIL

Planted with
260 Willow &
7 MAPLES

→ AREA # 2 ←

16 ROWS
360 L.F. WATTLES
MOST WILLOW SOME
ALDER IN BUNDLES

STEEP
SCHIST
EXISTING
VEGETATION, ALDER,
RYE, HORSE TAIL, BERRIES
RE SOWN WITH
VETCH, RYE
✓ 6 CHECK DAMS
8 1 BRUSH BUNDLE
12 6 F. WATER
LADDER

REDWOOD
TREE CLUMP

16-51
TAGS

STUMP

5 ROWS
120 L.F. WHORTLES
MOSTLY WILLOW
YETCH SOWN
20 WILLOWS, 5 MAPLES

FLAT SPOT

STEEP
BARE
SCHIST

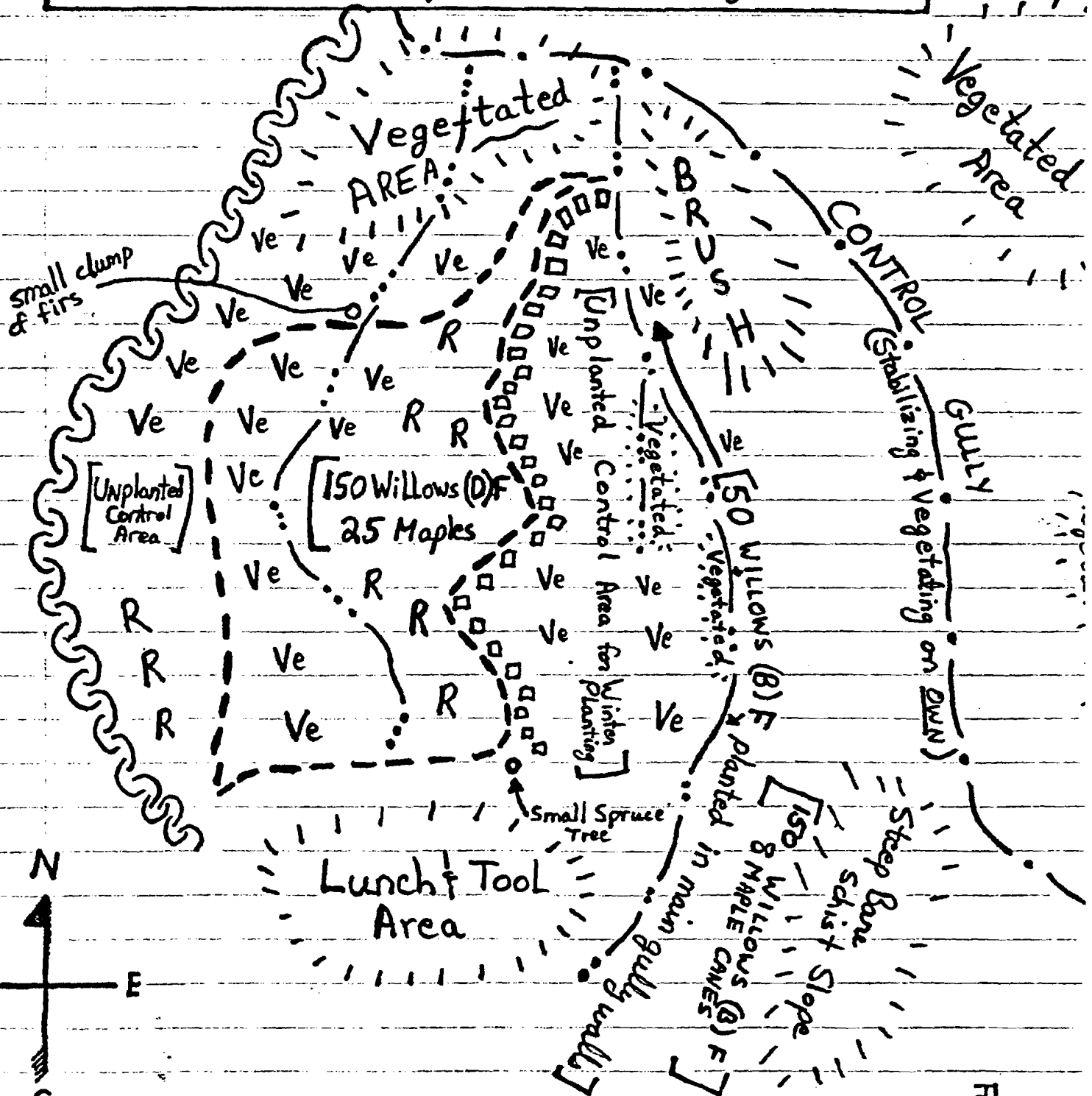
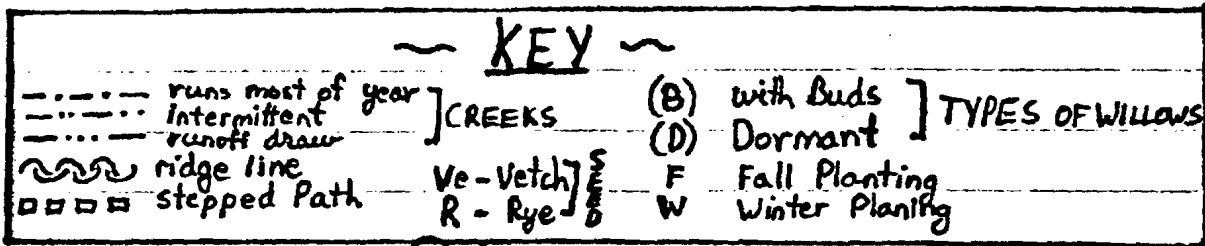
GUL
 WEAR
 ↓
 ALD
 TREE
 HORS
 TAIL

GOLLY HEAD
6
8-1
TR
OWN

TREE
GULLY
8-10
YR
OLD
SPRUCE
PINE
CUT
FOR
BUNDLES
CLUMP
TERRACE

P.O. Box 61
UKIAH, CALIFORNIA 95482

Seeding & Planting Map[®] - Lower Slide: AREA 4



Man Processed by: Stephen M. Brewer 10/8/77

VEGETATION TREATMENTS ON BOND CREEK REHABILITATION UNIT 1982 -4

Neil SUGIHARA

INTRODUCTION

Site Description

The Bond Creek drainage is located on the west side of the Redwood Creek basin, relatively close to the ocean and mostly below 1,200 feet. The cool moist summer air and fog along with abundant winter rainfall resulted in stands heavily dominated by redwood, even on the steep south facing slopes. The slopes on the north side of Bond Creek were clearcut between 1971 and 1976.

Post logging vegetation includes large quantities of Ceanothus thyrsiflorus and Baccharis pilularis var. consanguinea with Alnus oregona becoming dominant in wetter areas. In all cases Pseudotsuga menziesii (Douglas-fir) is the dominant conifer with Sequoia sempervirens (redwood) and Tsuga heterophylla (western hemlock) present in moister areas. Portions of this area were rehabilitated in 1978 and 1979. During summer of 1982 ^{portions} ~~part~~ of the main haul roads L-1-5 and M-11-1 were ripped and/or partially outslowed and stream crossings excavated. The attached map shows the location of stream crossings and roads treated.

PLANTS USED IN 1982 BOND CREEK REHABILITATION

Species	Common Name	Method of Propagation
<u>Alnus oregona</u>	Red Alder	seedlings
<u>Sequoia sempervirens</u>	Coast Redwood	seedlings
<u>Whipplea modesta</u>	Yerba de Selva	rooted cuttings

Revegetation Objectives

The long-term objective of vegetation management in this area is to hasten re-establishment of redwood dominance. To accomplish this, successional processes must be utilized. Redwood dominance is naturally established under a canopy in moist shaded areas. In this case stream crossings are the main area of concern. Without management Red alder will dominate these sites in dense pure stands initially ~~excluding~~ ^{inhibiting} but eventually favoring redwood over Douglas-fir. However, planting redwood seedlings as initial colonizers enables the simultaneous planting of Red alder. The immediate result is a rapidly growing stand of planted alder with slower growing redwood seedlings below. The planting of alder accomplishes three primary goals: 1) rapid establishment of vegetative cover, stabilizing sidebanks and initiating the healing process; 2) enhancing conditions for redwood seedlings by providing partial shade and canopy cover, nitrogen and humus; 3) the shade canopy will select for redwood and gainst dense Douglas-fir establishment while being short lived and yielding to established conifers in a relatively short period of time.

Redwood was planted along road surfaces adjacent to the old growth stands. This was in effort to establish a larger proportion of redwood than would be present if untreated. Both road and stream bank dominance of redwood are important because of their natural adaptiveness to these habitats. Dominance of the more aggressively colonizing Douglas-fir will eventually yield to ~~the more shade~~ ^{tolerant} redwood if left undisturbed for hundreds of years, but in these areas redwood dominance may be ^{artificially} accomplished in the first conifer canopy established.

GENERALIZED PRESCRIPTIONS

Crossing side slopes were planted at close spacings (2-4 feet) starting 3 to 5 feet from the channel and generally extending to the break in slope.

Red alder and/or whipplea were interplanted with redwood. Planting was done placing individual plants in the areas which would give good slope coverage but maximize survival. This resulted in planting which is not totally uniform or in rows, but fairly random over the treated area. Most crossings were planted with alder but part of RX 16, 17, 31, 32, and 33, were planted with whipplea. RX 2, 9, 14 (left bank), and 32 (right bank) were left as controls.

Road reaches along the L-1-5 were planted with redwood with the exception of the stretch from RX 7 to RX 10 which was a control. The last 300 feet of the M-11-1 were planted with redwood and the remaining roads were not.

TEST PLOTS

Test plots were located in two areas to monitor seedling survival. Both areas have plots of ten seedling rows at spacing of one foot. One ~~plot~~ ^{plot} is located above the L-1 ~~and consists of two plots, one of 200 redwood~~ ^{South of RX 32 and consists of seedlings}. The other area is south of RX 31 on the L-1 and consists of two plots, one of 200 redwoods and the other 100 redwoods. Both are planted in fill from crossing excavations on rehabilitated roads. Further treatment of these plots may be performed.

MONITORING RECOMMENDATIONS

The vegetation treatments on this unit were set up for visual qualitative monitoring. The treatment variables used and monitoring recommendations are as follows:

- 1) Alder spacing on stream crossing banks was varied from 2 to 5 feet. The resulting stand density should be monitored as should the success of early redwood regeneration under these stands.

2) The relative effectiveness of revegetation with alder, whippiea, and control treatments as well as their influence on succession.

3) Survival of conifer seedlings as well as their relative vigor.

Survival Data is needed for
~~Refer to the attached data~~ road planting of redwood excluding grass seeding.

4) Browsing intensity and its effect on survival.

5) Quantitative redwood ^{some} ^{data} survival can be obtained from test plots.

COST ANALYSIS

The 1982 Bond Creek unit was planted by Redwoods United crew and park personnel during the period from January 10 to January 31, 1983. Redwood seedlings were purchased from Simpson Timber Company's nursery. Alder seedlings and whippiea rooted cuttings were purchased from Randy Stemler. Both redwood and alders were in 6-inch leach tubes and grown at the Simpson nursery in Korbel, California. Rooted whippiea cuttings were grown in *Petalia, Ca by Randall Stemler.*

MATERIALS COST

Species	Number	Cost/ #	Total Cost
<i>Alnus oregona</i>	9,577	\$.30 ea.	\$2,873.10
<i>Sequoia sempervifens</i>	8,030	\$.15 ea.	1,204.50
<i>Whippiea modesta</i>	1,360	\$.28 ea.	652.80
TOTAL	18,967	Avg. = \$.249	\$4,730.40

RR 17- ⁶ / ₈	1/25	7500	300(5)	0	0				
L-1 forward RX 26	1/27	2600	260(10)	0	0				
RX 26	1/24	600	25(5)	150(2)	0	600	25(5)	150(2)	0
RR 26/ ₂₇	control	0	0	0	0				
RX 27	1/24	600	25(5)	150(2)	0	600	25(5)	150(2)	0
RR 27/ ₂₈	control	0	0	0	0				
RX 28	1/25	1700	60(5)	430(2)	0	300	50(5)	300(2)	0
RR 28/ ₂₉	control	0	0	0	0				
RX 28 ₂₉	1/25	900	25(6)	230(2)	0	1100	40(5)	280(2)	0
RX 31	1/10	1300	70(5)	320(2)	0	2550	102(5)	0	320(3)
RX 32	1/31	1100	80(4)	0	270(2)	1100	70(4)	0	0
RX 33	1/27	600	25(5)	0	150(2)	600	25(5)	25(5)	150(2)
SX 3	control	0	0	0	0	control	0	0	0

TEST PLOTS

- 1) L-1 (Past RX 31) 300 Redwoods (one foot spacings)
- 2) Near RX 32 200 Redwoods (one foot spacings)

Totals

Redwood 8030

Alder 9577

Whipplea 1360

Total planted 18927

Total Area Planted 434000 Square feet (9.96 Acres)

Revegetation Treatments on the 1982 Bond Creek Rehabilitation Unit

Area in square feet
numbers in parentheses = spacings

Site	Date treated	Left Bank (or Road Rough)				RIGHT BANK			
		Est. Area Treated	Redwood	Alder	Whipplea	Est. Area Treated	Redwood	Alder	Whipplea
RX1	1/10	1600	100 (4)	380 (2)	0	2400	100 (5)	600 (2)	0
RR 1/5	1/12	96000	1500 (8)	0	0				
RX2	control	0	0	0	0	control	0	0	0
RX3	1/10	600	20 (5)	70 (3)	0	600	20 (5)	72 (3)	0
RX4	1/10	1900	70 (5)	480 (2)	0	1800	110 (4)	460 (2)	0
RX5	1/11	1400	60 (5)	350 (2)	0	1400	60 (5)	350 (2)	0
RR 5/7	1/17	91000	1425 (8)	0	0				
RX6	1/11	1600	60 (5)	400 (2)	0	900	20 (7)	220 (2)	0
RX7	1/11	1000	40 (5)	110 (3)	0	1000	40 (5)	110 (3)	0
RR 7/10	control	0	0	0	0				
RX8	1/12	2000	100 (4)	500 (2)	0	2000	100 (4)	500 (2)	0
RX9	1/13	600	25 (5)	0	0	600	25 (5)	0	0
RX10	1/13	1000	50 (4)	250 (2)	0	1200	50 (5)	300 (2)	0
RR 10/11	1/25	36800	575 (8)	0	0				
RX11	1/13	1500	60 (5)	360 (2)	0	2000	80 (5)	80 (5)	0
RR 11/12	1/25	17300	270 (8)	0	0				
RX12	1/13	1500	60 (5)	375 (2)	0	900	40 (5)	225 (2)	0
RR 12/14	1/25	25600	400 (8)	0	0				
RX13	1/13	400	10 (6)	90 (2)	0	800	32 (5)	200 (4)	0
RX14	1/17	2000	80 (5)	0	0	2000	80 (5)	500 (2)	0
RR 14/16	1/25	15400	240 (8)	0	0				
RX16	1/11	1200	50 (5)	300 (2)	0	1200	90 (4)	0	300 (2)
RR 14/17	1/25	12800	200 (8)	0	0				

LABOR COSTS

1) Redwoods United

Wages	\$1,570.42
Transportation	600.00
Overhead (18%)	390.68
Total Billed	\$2,561.10

2) Park Personnel (include 6% benefits)

GS-7	\$562.39
WG-3	689.83
Total	\$1,252.22

Vehicle G62-09121

$$(9 \text{ days} \times 4.29/\text{day}) + (18 \text{ mi}/\text{day} \times .21/\text{mi} \times 9 \text{ days}) = \$72.63$$

TOTAL COSTS

Total Labor Costs	\$3,885.94
Total Materials Cost	4,730.40
Total Cost	8,616.35
Total Plantings	18,967.00
Labor Cost/Plant	\$.205
Material Cost/Plant	\$.249
Total Cost/Plant	\$.454

MAP C. EROSIONAL FEATURES AND TREATMENTS

APPROXIMATE SCALE

1:6,000

ONE INCH EQUALS FIVE HUNDRED FEET

MILES 0 1/2 1
FEET 0 500 1000



drainage divide



haul road/landing



perennial stream



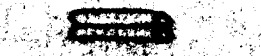
intermittent stream



ephemeral stream



culvert

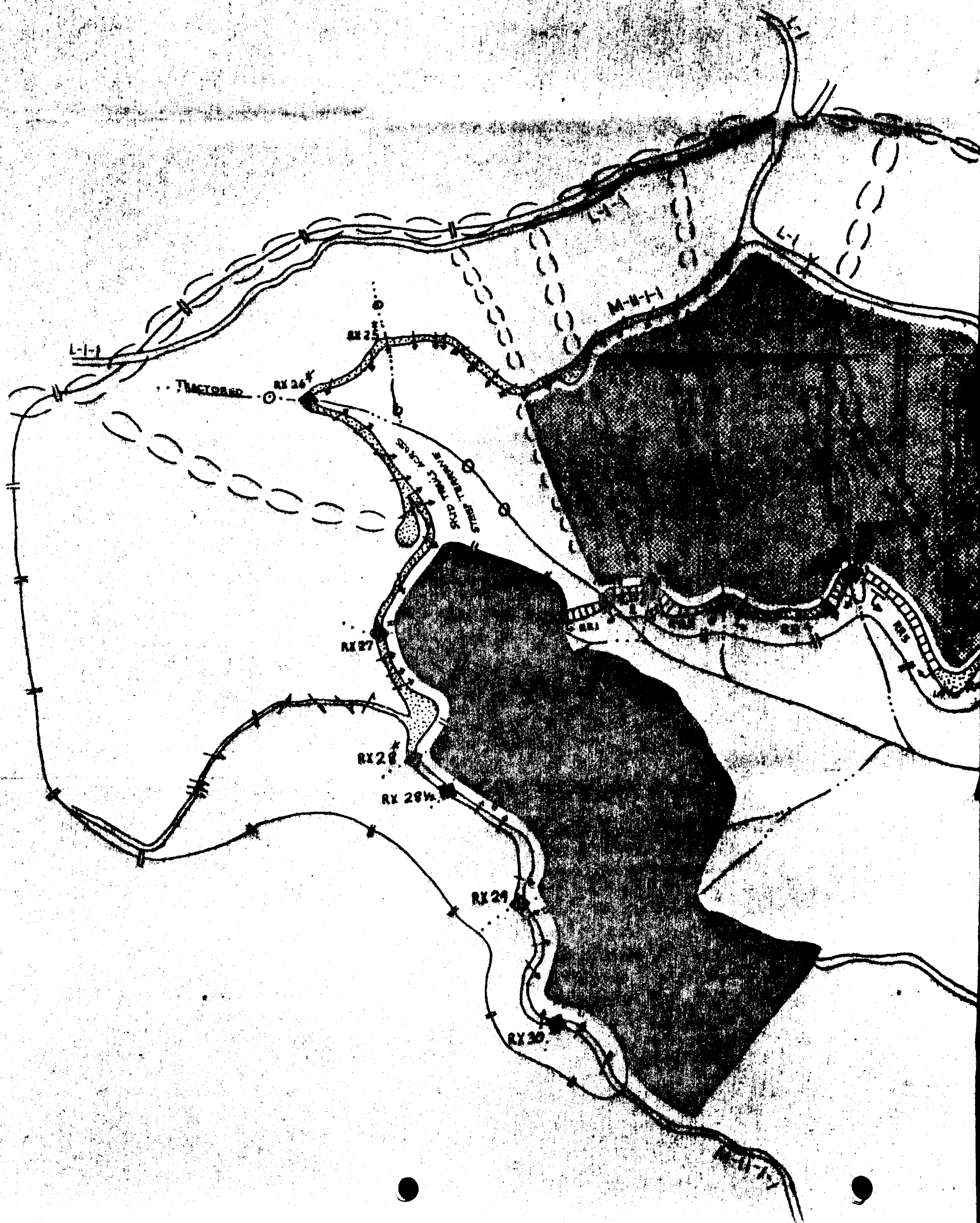


Humboldt crossing
stream channel used as
tractor trail during
commercial yarding

TRACTORED



directed flowcourse



LEGEND

100

site 79-1

slide(head scarp/deposit)

DT

EF

FF

road reach boundary

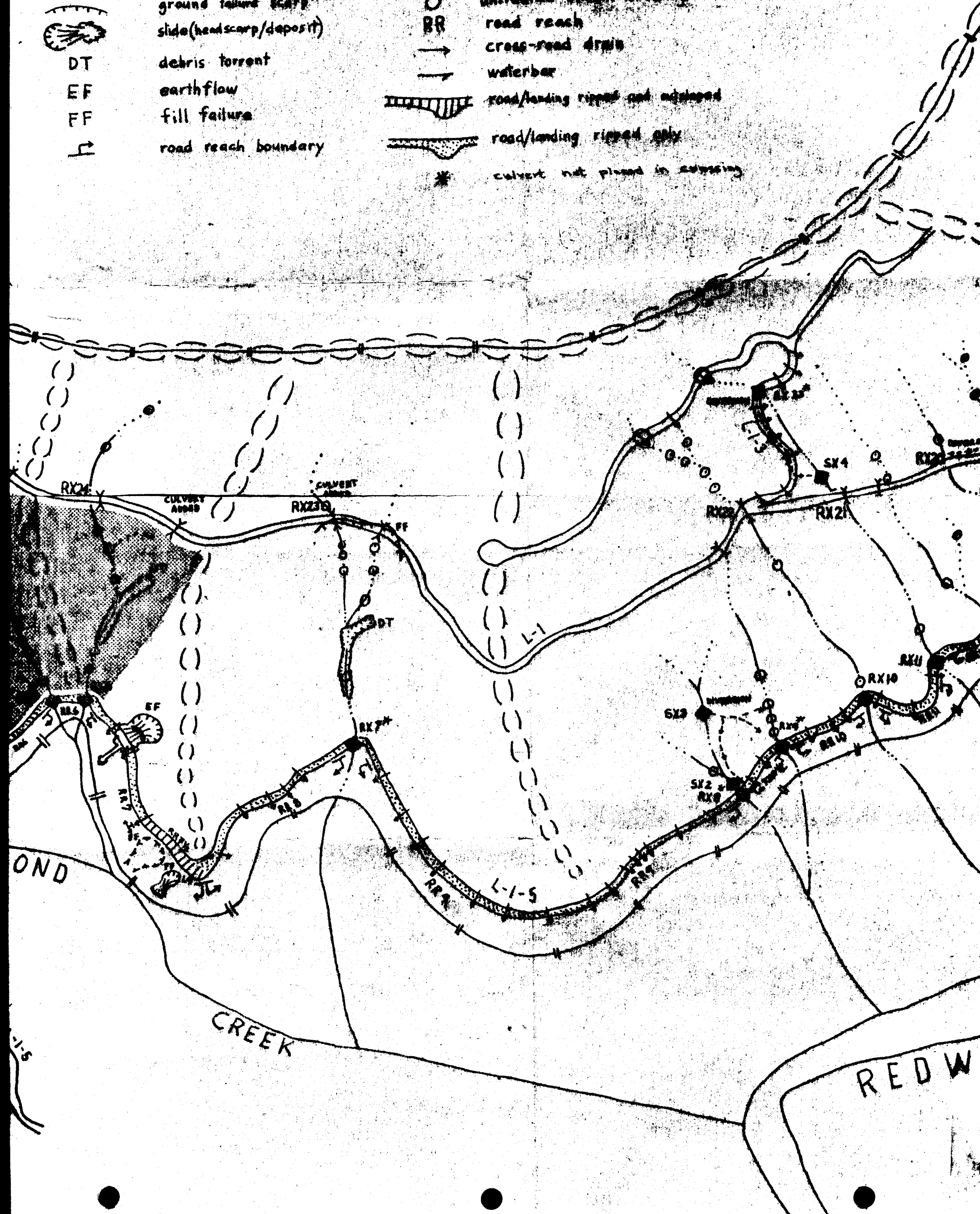
RX

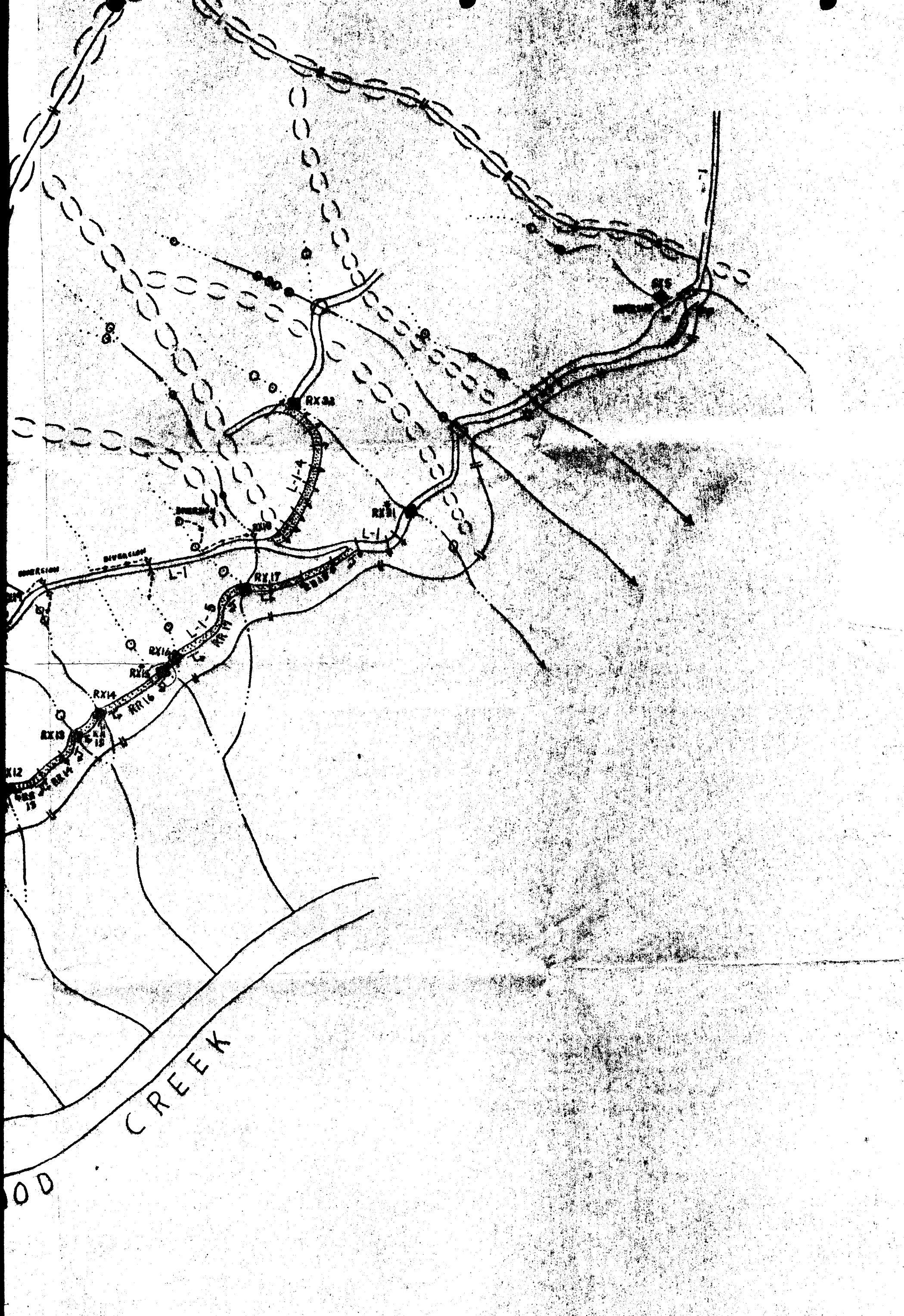
SY

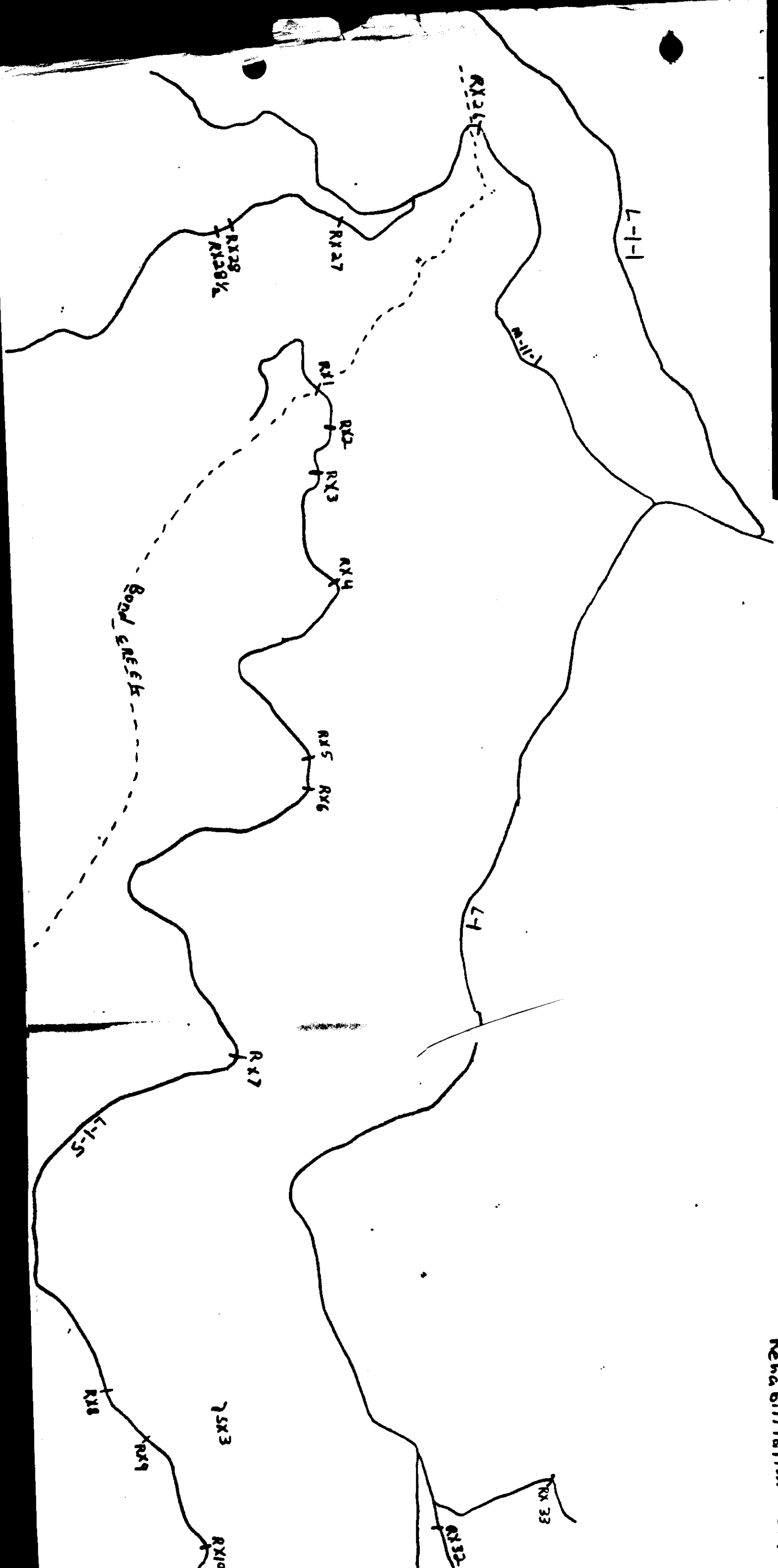
RR

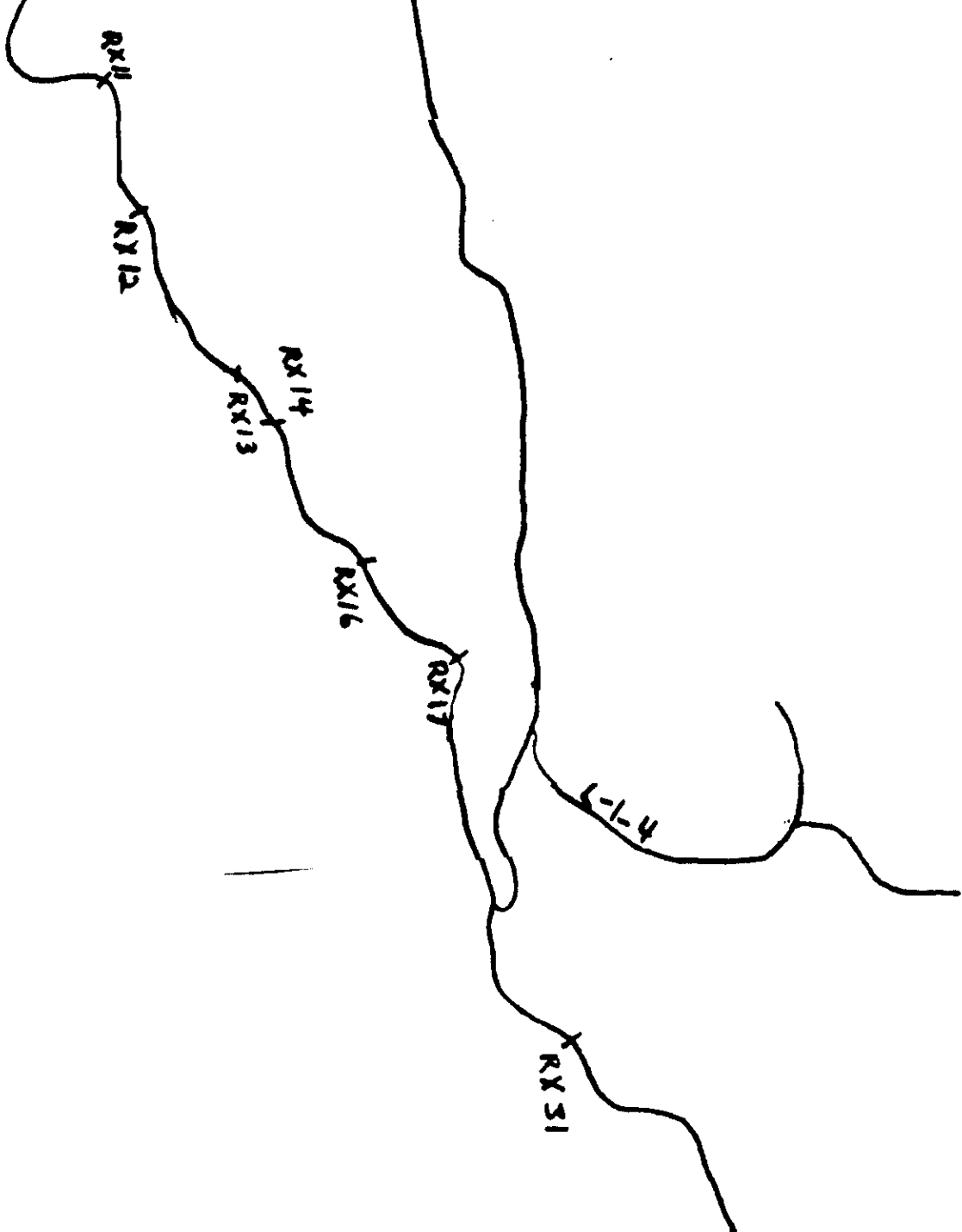
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current not placed in crossing









Redwood creek

L-1



Unit: 82-4 Ref. 1-A 6/82 PP#11 RX-4 G.B.



Unit: 82-4 Ref. 1-B 8/82 PP#11 RX-4 G.B.



Unit: 82-4 Ref. 1-C 7/9/84 PP#11 L.T.



Unit: 82-4 Ref. 2-A 6/16/82 PP#34 Fill Slope RX 14 G.B.



Unit: 82-4 Ref. 2-B 8/82 PP#34 RX 14 G.B.