

Summary Report

**Erosion Control Work Performed on
The Fortyfour Creek Rehabilitation Unit
84-5**

**by
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Introduction

The Fortyfour Creek Unit, 84-5 is located approximately six miles upstream from Orick, and drains the west side of Redwood Creek. The unit extends downslope from the A-9 and A-9-9 roads to the valley bottom. The unit contains 890 acres and seven miles of logging haul roads, including the C-12-1, C-13, and C-14 roads in their entirety, and that portion of the C-line, downslope from the C-line/C-13 road intersection (map A & B).

Total relief on this unit is 970 feet, and ranges from 320 feet at the valley bottom, to 1,290 feet on the A-9-9 Road. Hillslope steepness varies considerably throughout the unit, but averages 30 percent. Upper hillslope steepness commonly averages 25 percent and are convex in profile. Prominent, well-defined break-in-slopes are found across the mid-slope region where steepness approaches 50 percent. Lower hillslopes commonly exceed 50 percent and steepen in the vicinity of deeply incised streams. As they approach the valley bottom, the lower hillslopes become more concave in profile.

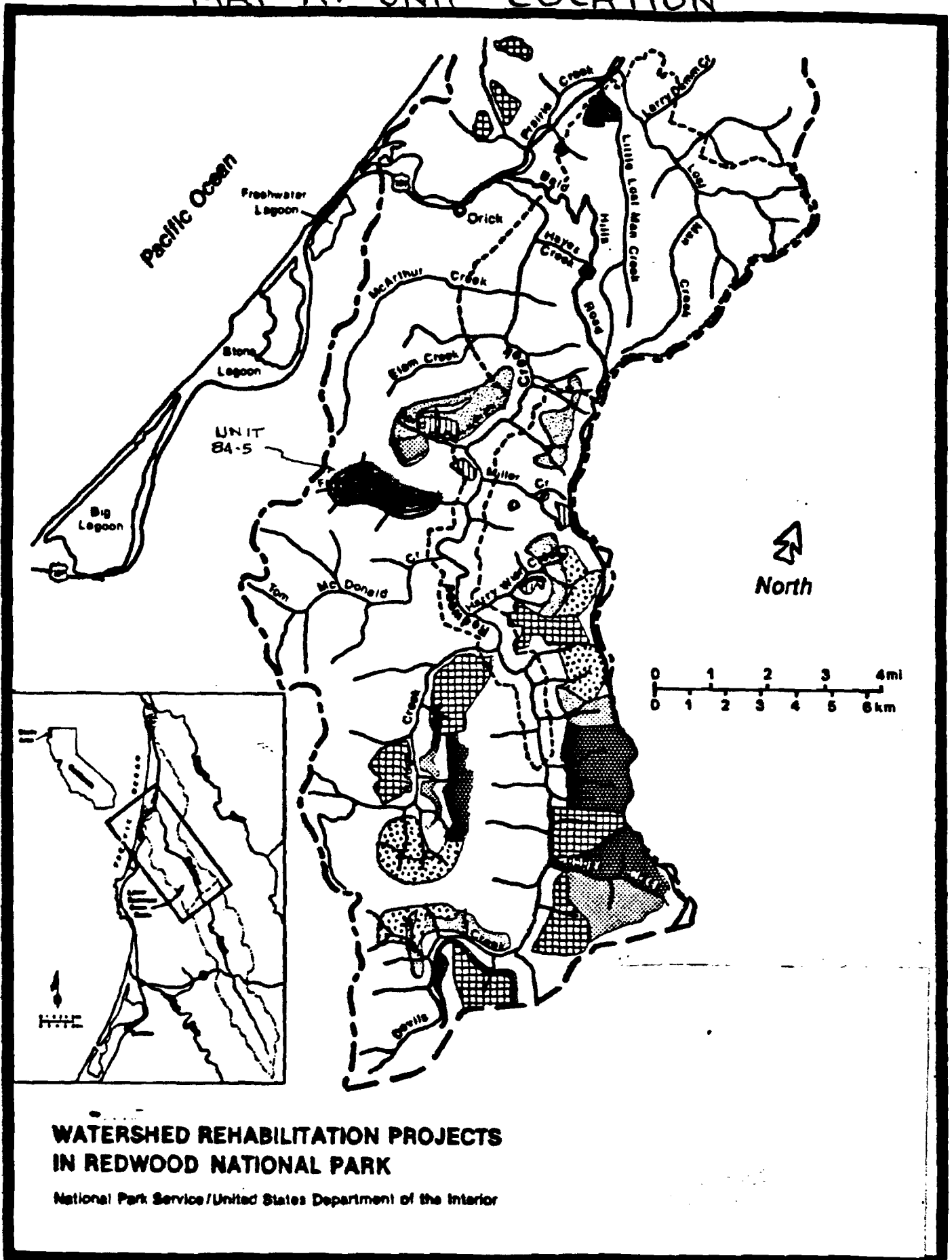
The drainage network in Fortyfour Creek is atypical of tributary drainage patterns in the Redwood Creek basin, and can be described as a palmate, dendritic pattern. Fortyfour Creek contains numerous 1- and 2-order, ephemeral - perennial streams which combine immediately downstream from the C-line to form the 3-order main stem of Fortyfour Creek, draining a total of 2,400 acres. Upper hillslope streams have steep gradients and shallow incisions, but quickly incise as they approach the C-13 Road. At this point, streams become moderately to deeply incised and maintain this character to the valley bottom. Organic debris appears to be the dominant armor in most stream channels.

Typical of west-side tributary basins, this unit lies within the schist unit of Redwood Creek. Few examples of intense shearing, folding or faulting were observed in this unit. Soil types and depths vary throughout the unit. The interested reader is referred to the in-house report by Popenoe, et. al., 1984, "Soils of the Fortyfour Creek Rehabilitation Unit".

An area of geomorphic interest is the hillslope area above the C-13 Road and below the A-9-9 Road which drains the south fork of Fortyfour Creek. These tributary streams are moderately to deeply incised as they approach and pass through the A-9-9 Road. Once below this road, ridgelines are poorly defined and stream incisions become very shallow. An exotic bedrock, in an old-growth setting, is spread throughout this hillslope region. Apparently a metavolcanic, this competent, bedrock unit appears to be checking stream channel incision in this area.

Another interesting feature in Fortyfour Creek is the bedrock control found at its confluence with Redwood Creek. Bedrock and large organic debris form an elevated baselevel at the mouth of Fortyfour Creek which maintains a gentle stream profile throughout its main stem reach.

MAP A. UNIT LOCATION



Appropriately so, Fortyfour Creek is, at times, misfit to its valley bottom. Its profile has been unable to keep pace with the lowering of Redwood Creek, and, concomitantly, maintains a low stream power. The net result appears to have been valley filling in response to tectonism and episodes (natural and man-induced) of excessive hillslope erosion.

In summary, the total rehabilitation costs, including the investigative and planning phases was \$96,770. Of this total, heavy equipment and labor intensive work accounted for 79 percent and seven percent, respectively. A total of seven miles of road were removed: 0.5 mile of the C-12-1; 2.8 miles of the C-13; 1.4 miles of the C-14; and, 2.3 miles of the C-line. A total of 21,000 yd³ of channel fill was excavated from 35 haul road stream crossings (Table 1).

Timber Harvest and Erosion Features

As can be seen from Map C, timber harvest and road construction began in the early 1950's and continued until 1975. A major thrust in timber harvest took place in 1974. Essentially 99 percent of the harvested area was tractor yarded. As evidenced on this unit, tractor use was indiscriminate with little or no concern for soil and/or water resources. Numerous skid trail crossings were constructed on every stream channel, and, in many cases, tractors utilized the actual stream channels as skid trails. The confluence of the north fork tributaries provides a classic example to the indiscriminate tractor use in this basin. In 1975, during a seed-tree harvest, a log landing was constructed in the confluence of these 2- and 3- order perennial streams. Tractors re-shaped the valley bottom to suit their needs. They erased entirely all geomorphic features expressing the stream environments, and completely buried these channels with soil and organic debris. In John Pitlick's study, "Sediment Routing in Tributaries of Redwood Creek", he identifies a disproportionate amount of stored sediment in Fortyfour Creek relative to the amount of sediment contributed by streamside landslides. Based upon our field mapping and observations, the balance (almost 2x) of stored sediment was introduced directly to streams by tractor activity and subsequent fluvial erosion.

Though most haul road crossings were intact at the time of mapping, many crossings showed signs of past failures and were simply waiting for the next flood producing storm to fail again. The C-13 and C-14 road crossings were by far the most unstable crossings on this unit. The main stem crossings of the north fork (Rx1 & 2, C-13) had washed-out (presumably twice) by 1975 and were abandoned. Similarly, the main stem crossings on the north fork (Rx11 & 12, C-13) had also failed by 1975, but had been reconstructed. Three separate culverts were uncovered during the course of excavation at Rx12. Additionally, scarps along the outer edge of the fill prisms were common features to most C-13 and C-14 road crossings.

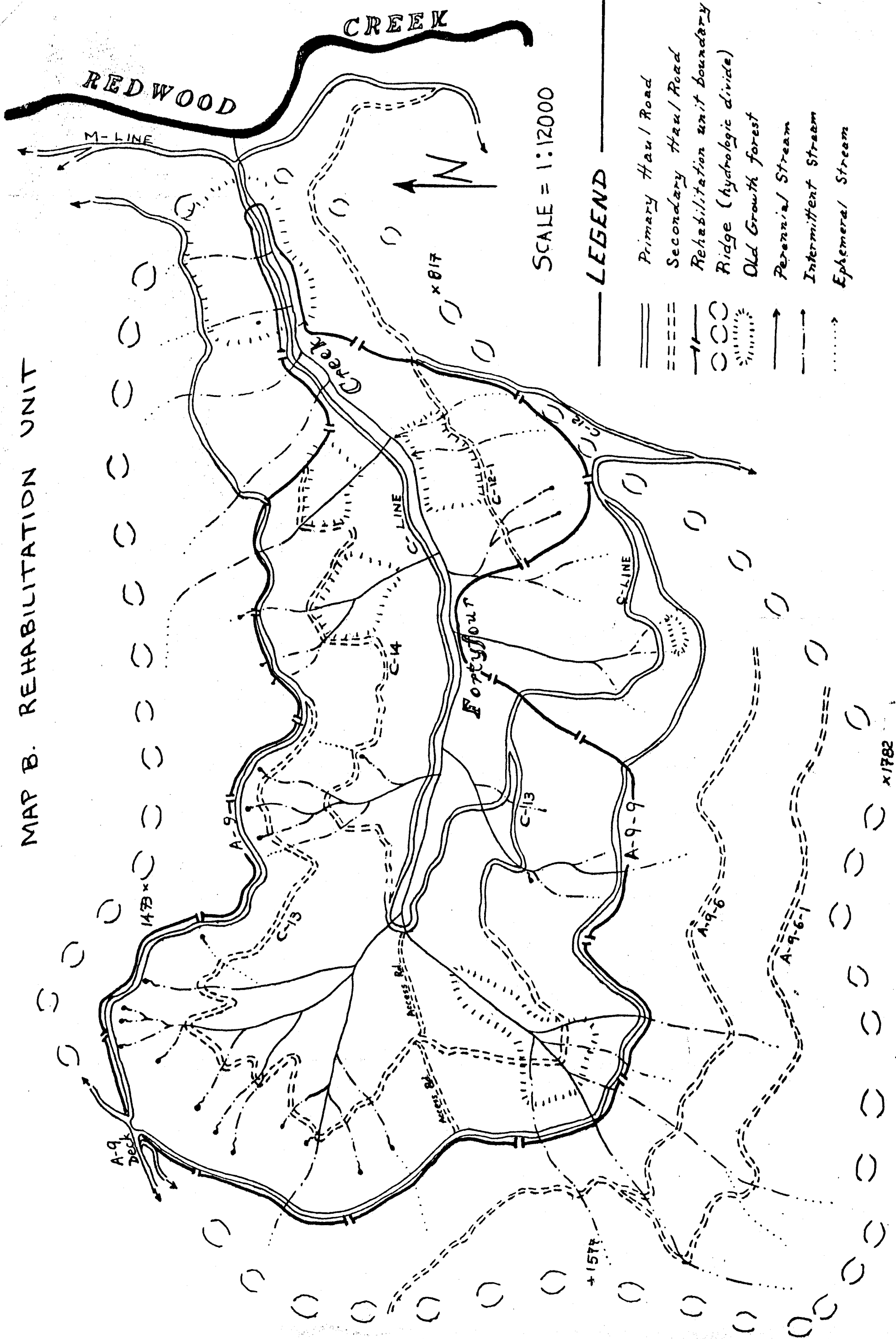
On the C-line, the culvert at the main stem crossing (Rx1) had plugged, diverting its flow down and across the road. With the exception of Rx5, all other C-line, and C-12-1 road crossings were functioning well at the time of mapping. Rx5 had aggraded to the point that rendered its culvert (offset from the stream) useless, allowing its stream to flow over the road, eroding its fill. Neither aerial photos nor ground conditions suggested past failures of the other C-line crossings.

Table 1. SUMMARY OF COSTS OF EROSION CONTROL REHABILITATION WORK: UNIT 84-5

Phase	Task	Hydrologist & P.S. Tech	Laborers	Heavy Equipment Rental	YCC	R.U.	Total Task Costs	% Total Cost	Phase Totals	Phase %
Evaluation Phase	Mapping	\$ 5,308	--	--	--	--	\$5,308	5.5	\$13,564	14
	Prescriptions, Planning & Documentation	8,256	--	--	--	--	8,256	8.5		
Heavy Equipment Phase	Primary Treatments	6,544	--	\$57,737	--	--	64,281	.65	76,371	79
	Secondary Treatments	--	--	369	--	--	369	0.6		
	Access & Relocation Cost	--	--	6,406	--	--	6,406	7.3		
	Miscellaneous Costs	--	--	5,315	--	--	5,315	6.1		
Labor Intensive Phase	Primary Treatments	--	\$ 42	--	--	--	42	0.0	6,835	7
	Secondary Treatments	200	850	--	\$369	\$ 395	1,814	1.9		
	Travel Time	--	1,012	--	94	390	1,496	1.5		
	Brush Roads	--	2,593	--	80	810	3,483	3.6		
		\$20,308	\$4,497	\$69,827	\$543	\$1,595				

GRAND TOTAL = \$96,770

MAP B. REHABILITATION UNIT



Finally, a high erosion potential was identified at a road crossing on the main stem of the north fork on the A-9-9 Road. It appears this crossing had been initially constructed as a humboldt crossing. A culvert, offset from stream alignment, was added at a later date. At the time of mapping, a pipe hole in the upstream end of the crossing was identified which captured approximately .15 cfs of streamflow before entering the culvert. Organics contained within the fill provided a conduit through which the water flowed. In the process, water was lost into the road, saturating much of the road fill and de-stabilizing the outer edge and fill prism.

Because of the types of soils and parent material, large mass movement features are uncommon to these hillslope areas. Mass movement features are, however, found in entisol regions along drainages. Numerous shallow, translational slides resulting from fill failures were common along skid trails traversing steep slopes. Three larger landslides were identified on this unit; two associated directly to tractor use; a third, which preceded timber harvest activities. A shallow, translational slide developed on the hillslope above the C-13 Road as a result of three skid trails constructed across 70-80 percent slopes. The hillslope had essentially been undermined and failed, triggering a similar failure at the C-13. The second shallow, translational slide occurred around 1980, below the C-14 Road as a result of a stream diversion at Rx1, C-14. Its sediment was delivered directly to Fortyfour Creek. The third slide was a deep-seated translational slide which had been reactivated and/or accelerated by a stream diversion at Rx6, C-14. It appears this stream defined the right, lateral scarp to the entire feature.

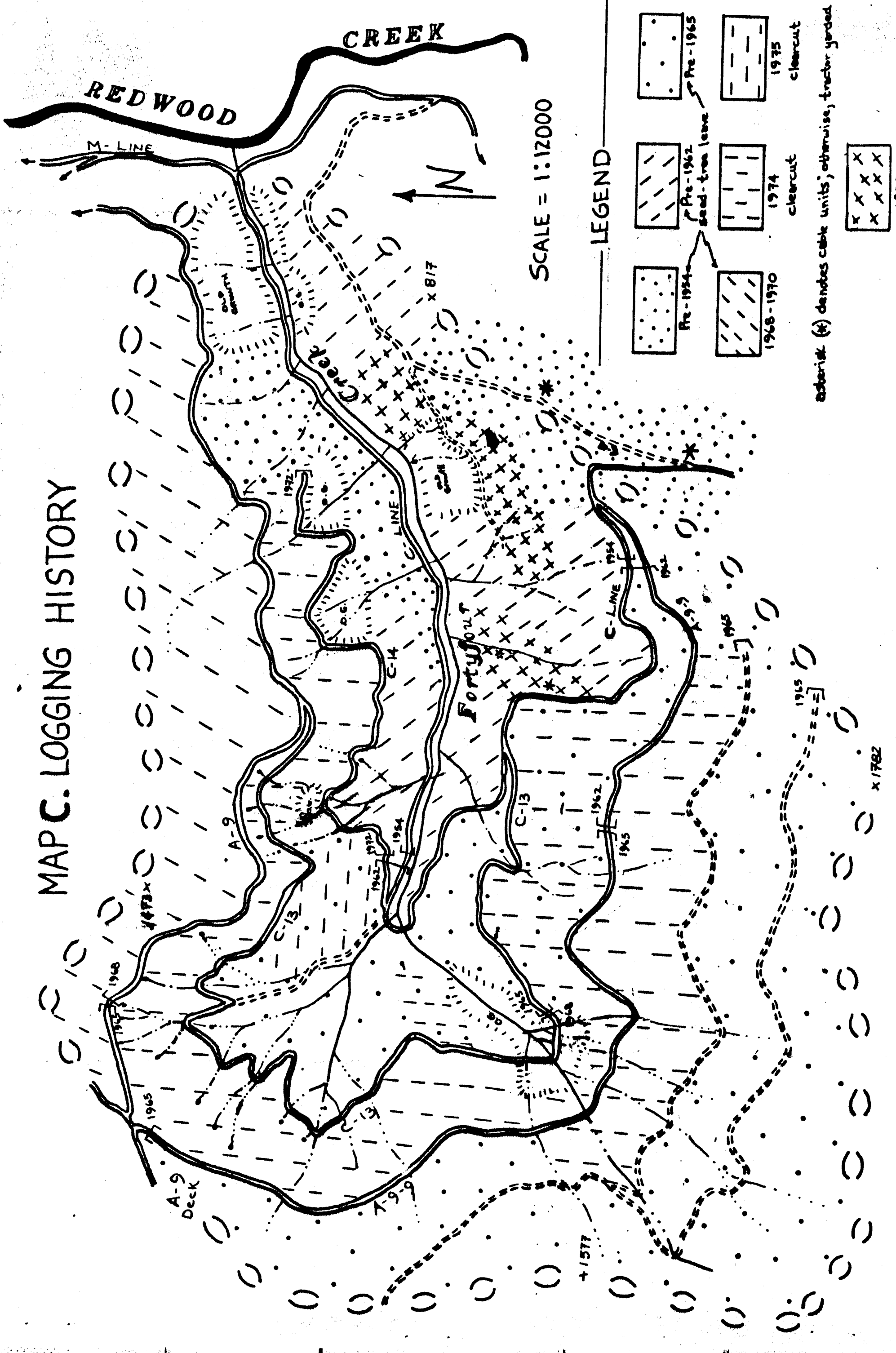
Erosion Control Rehabilitation Work

The rehabilitation unit contains 890 acres. Approximately 725 acres were mapped in detail, requiring 56 person-days to complete. Prescriptions, planning, and documentation required an additional 95 person-days to complete. Heavy equipment performed its work between July 16 and September 21, 1984.

Erosion control treatments focused only on features capable of delivering sediment directly to streams. For example, skid trail crossings varied considerably in age and most had experienced at least one flood producing storm event since construction. As a result, most skid trail crossings had eroded beyond cost-effective treatment. Therefore, only those skid trail crossings capable of diverting streamflow or exhibiting debris torrent potentials were treated. All worksites are located on Map D, with unit costs listed in Table 2.

Road crossings were excavated as close as possible to their original channel geometries. No secondary treatments in the form of channel armor were performed. Organic debris, exposed during the excavation, was left in place and undisturbed to provide a stabilizing effect. Rx1, 1 1/2, and 2 on the C-13, and Rx8 on the C-line were not treated. They had already eroded to varying degrees and were beyond cost-effective treatment.

MAP C. LOGGING HISTORY



LEGEND

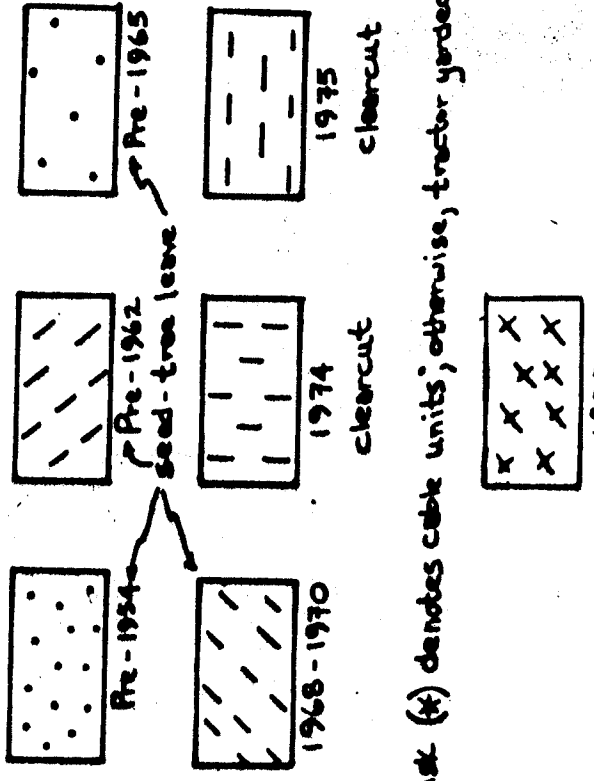


Table 2. SUMMARY OF AVERAGE HEAVY EQUIPMENT COSTS: UNIT 84-5

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Treatment	# of Work-Sites	Total Quantity	Total Cost	Avg. Cost Worksite	Avg. Cost Quantity	Range Cost/Quantity
<u>Primary Treatments</u>						
Landing Outslope	4	1,795 yd ³	\$ 3,356	\$ 839	\$1.87/yd ³	<u>\$0.83-2.61</u> yd ³
Road outslope, in place	10	1,960 yd ³	2,469	247	1.26/yd ³	<u>0.77-2.08</u> yd ³
Road outslope, push-endhaul	5	2,015 yd ³	3,350	670	1.66/yd ³	<u>1.24-3.75</u> yd ³
Deep dishes	9	1,060 yd ³	1,063	118	1.00/yd ³	<u>0.58-2.62</u> yd ³
Cross-road drains (<20yd ³)	77	77	3,737	48	48/ea.	--
Cross-road drains (>20yd ³)	23	23	906	39	39/ea.	--
Skid trail crossings	12	995 yd ³	2,425	202	2.44/yd ³	<u>0.83-4.91</u> yd ³
Skid trail crossing, A-9-9	1	350 yd ³	2,406	--	6.87/yd ³	--
Haul road crossings	35	21,000 yd ³	38,025	1,067	1.78/yd ³	<u>0.76-5.62</u> yd ³

TOTAL PRIMARY TREATMENT = \$57,737

Secondary Treatment

Straw placement	15	195 bales	\$369	\$25	\$1.89/bale	--
TOTAL SECONDARY TREATMENT			=	<u>\$369</u>		

Access Costs

Open roads	6	--	\$2,631	--	--	--
Travel (major relocations on unit)			4,494			
TOTAL ACCESS			=	<u>\$7,125</u>		

Treatment	# of Work- Sites	Total Quantity	Total Cost	Avg. Cost Worksite	Avg. Cost Quantity	Range Cost/Quantity
<u>Miscellaneous</u>						
Standby with operator (excavator breakdowns)		--	\$ 696	--	--	--
Standby without operator (excavator breakdowns)		--	2,438	--	--	--
Culvert installation		1	700	--	--	--
Tree removal	--	--	450	--	--	--
Open roads for winter access	3	3 mi.	1,031	--	--	--
TOTAL MISCELLANEOUS			= \$5,315			
TOTAL HEAVY EQUIPMENT COST			= <u>\$70,546</u>			

Unstable road reaches and landings were outsloped when in close proximity to streams. Along wet road reaches to be outsloped, bench outsloping was used to preserve inboard ditches and control discharged groundwater. Cross-road drains were constructed across the bench to drain inboard ditches onto the most stable area. Additionally, "deep dishes" were performed to remove road fill from filled-in swales; i.e., incised headwater regions, which displayed torrent potentials.

The majority of road and landing surfaces were cross-road drained. Since the C-line was the only road containing a rocked surface, none of the roads were ripped. Unusually deep cross-road drains were constructed along excessively wet road reaches where water would be discharged over steep road fill. With the exception of drains constructed on the C-line, side-casting was allowed during standard (<20yd) cross-road drain construction.

Labor crews performed both primary and secondary treatments. Primary treatments took the form of debris removal from skid trail crossings to prevent stream diversions. Secondary treatments consisted entirely of straw application to treated road crossings, and selected road reaches and landings. Table 5 lists labor intensive treatments and costs.

Equipment Application

The heavy equipment used on this unit were well suited for the work. We were extremely fortunate to have had two very experienced tractor operators, with whom we had worked last year, return for their second season. From the very beginning, they understood our goals and job specificating. Though our excavator operator was essentially inexperienced at the beginning of the season, he came to us with a good command of his machine's basic functions. Within only a few days, he proved to be an effective and versatile operator. The machine, however, was plagued throughout the season with breakdowns which resulted in extended periods of standby time for the other equipment. Table 2a lists the owners, operators, and types of equipment used on this unit.

Table 2a Equipment and Operators

Owner	Operator	Equipment	Rate
Paul Johnson	same	Cat D8 w/winch	\$75.00
Wendell Larkin	same	Cat D7E w/winch	\$75.00
Robert Flowers	Bob French	Case 980 B	\$100.00

Every road crossing was flowing at the time of excavation. Fortunately, road conditions permitted temporary diversions of streamflow down inboard ditches, thereby maintaining a dry excavation. Problems developed, however, when saturated fill was encountered during the course of an excavation. This condition prevented full utilization of tractors to excavate fill and required the hydraulic excavator to remove more than its share of the volume. Additionally, equipment often times got stuck in the saturated fill which, in some instances, cost a great deal of time. Poor worksite conditions, compounded by buried logs and root wads, are reflected in the crossings with highest unit costs. Road crossings are categorized

and described in a general sense in Table 3. Table 4 provides a complete summary of road crossing information for each road crossing treated on this unit.

The skid trail crossing on the A-9-9 is listed separately in Table 2. The worksite conditions, limitations and approach to this crossing were unlike any other skid trail crossing treated on this unit. This skid trail was, in reality, the original pioneered A-9-9 Road, and, like the present day crossing, was constructed as a humboldt crossing. Its unit cost was disproportionately high because of: 1) an extremely high concentration of logs in the crossing fill, and 2) difficulty in identifying the original stream gradient. Because of the latter point, the excavation of this crossing was actually completed three times until we were satisfied with the end product. Rather than being totally concerned with the complete removal of the fill, it was more imperative to obliterate the piping mechanism which allowed streamflow to saturate the A-9-9 Road crossing located immediately downstream.

Table 3. HAUL ROAD CROSSING COSTS: UNIT 84-5

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
Small	10	1-200 yds ³	D7 HE D8	0-4 3/4 1/2-3 3/4 0- 1/2	\$ 330	\$106-731	\$2.29	\$1.23-5.62
Medium	10	200-500 yd ³	D7 HE D8	1-6 1/2 1 1/2-6 1/2 0-6 1/2	652	243-1,350	1.78	0.76-3.05
Large	14	500-1,500 yd ³	D7 HE D8	3-21 3 1/2-16 3/4-12 1/2	1,776	600-3,393	1.81	1.19-3.97
Extra Lg.	1	1,900 yd ³	D7 HE D8	13 3/4 14 6 3/4	2,938	--	1.54	--

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5

Crossing	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (\$/yd ³)	Average Push Distance (ft)
<u>C-13 Road</u>						
Rx0 @ STA 132+00 ²	D7 HE D8	13 3/4 14 6 3/4	\$2,937	1,900	\$1.54	150
Rx1	No Treatment					
Rx2	No Treatment					
Rx3 @ STA 103+70 ^{2,3}	D7 HE	3 1/4 3 1/4	569	220	2.55	50
Rx4 @ STA 78+20 ^{2,3}	D7 HE D8	6 1/2 7 1/2 1 1/2	1,350	440	3.05	100
Rx5 @ STA 73+70	D7 HE	3/4 1/2	106	90	1.23	50
Rx6 @ STA 72+80 ⁴	D7 HE D8	11 1/2 10 7 1/4	2,406	1,020	2.35	200
Rx7 @ STA 71+80	D7 HE D8	1 1/4 1 1/2 3 3/4	525	340	1.54	350
Rx8 @ STA 59+00	D7 HE D8	6 1/4 5 1/4 6 3/4	1,500	1,200	1.25	80

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5
(continued)

Crossing ¹	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (\$/yd ³)	Average Push Distance (ft)
<u>C-13 Road (cont.)</u>						
Rx9 @ STA 57+80 ⁴	D7	8 1/4	\$1,837	1,015	\$1.81	200
	HE	8 1/4				
	D8	5 1/4				
Rx10 @ STA 54+85 ⁴	D7	12 1/2	2,725	1,250	2.18	100
	HE	8 1/2				
	D8	12 1/2				
Rx11 @ STA 48+50	D7	4	1,250	770	1.62	150
	HE	3 1/2				
	D8	8				
Rx12 @ STA 40+00 ⁴	D7	21 1/4	3,394	1,280	2.65	200
	HE	16 1/2				
	D8	2				
Rx13 @ STA 18+50	D7	2	250	190	1.29	50
	HE	1				
Rx14 @ STA 12+00	D7	3/4	206	120	1.75	30
	HE	1 1/2				
<u>C-13 Road Totals =</u>			<u>\$18,662</u>	<u>9,843 yd³</u>	<u>\$1.90 /yd³</u>	

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5
(continued)

Crossing ¹	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (\$/yd ³)	Average Push Distance (ft)
<u>C-14 Road</u>						
Rx1 @ STA 16+50 ^{2,3,4}	D7	8 1/2	\$1,825	1,030	\$1.78	100
	HE	7				
	D8	6 1/2				
Rx2 @ STA 18+20 ^{2,3,4}	D7	1	450	120	3.66	200
	HE	3 3/4				
Rx3 @ STA 19+00	HE	2	237	160	1.46	250
	D8	1/2				
Rx4 @ STA 25+00	D7	2 1/4	219	175 ⁵	1.25	50
	HE	1/2				
Rx5 @ STA 44+90 ^{2,4}	D7	6	1,262	500	2.53	100
	HE	6 1/4				
	D8	2 1/2				
Rx6 @ STA 49+40	D7	1 3/4	394	225	1.75	70
	HE	1 1/2				
	D8	1 1/2				
Rx7 @ STA 66+90 ^{2,3,4}	D7	13	2,225	560	3.97	250
	HE	11				
	D8	2				
<u>C-14 Road Totals =</u>			<u>\$6,612</u>	<u>3,071 yd³</u>	<u>\$2.15/yd³</u>	

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5
(continued)

Crossing	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (\$/yd ³)	Average Push Distance (ft)
<u>C-Line</u>						
Rx-2 @ STA -22+20 ^{2,3,4}	D7 HE	4 3/4 3 3/4	\$ 731	130 ⁵	\$5.62	50
Rx-1 @ STA -19+00	D7 HE	2 1/2 1 1/2	337	150 ⁵	2.25	50
Rx0 @ STA -14+00	D7 HE	1 1/2 2 1/2	362	100 ⁵	3.62	50
Rx1 @ STA 3+00 ^{2,4}	D7 HE D8	12 12 4 1/4	2,419	1,480	1.63	120
Rx2 @ STA 4+50	D7 HE D8	6 6 3/4 5	1,500	1,160	1.29	100
Rx3 @ STA 19+00	D7 HE D8	1 1 1/2 2	375	490	0.76	60
Rx4 @ STA 48+15	D7 HE D8	1 1/2 1 1/4 2 1/2	425	480	0.88	100
Rx5 @ STA 62+00 ³	D7 HE D8	8 1/2 11 1	1,812	990	1.83	125

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5
(continued)

Crossing ¹	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost ³ (\$/yd ³)	Average Push Distance (ft)
<u>C-Line (cont.)</u>						
Rx6 @ STA 72+10 ⁶	D7	4 1/2	\$ 962	445	2.16	75
	HE	4 3/4				
	D8	2				
Rx7 @ STA 76+00	D7	3 1/4	419	200	2.08	60
	HE	1 3/4				
Rx8 @ STA 82+00	No Treatment					
Rx9 @ STA 88+00	D7	3	400	200	2.00	60
	HE	1 3/4				
C-Line Totals =			\$9,744	5,834 yd ³	\$1.67/yd ³	

Table 4. HAUL ROAD CROSSINGS: UNIT 84-5
(continued)

Crossing ¹	Equipment	Hours	Cost	Volume (yd ³)	Unit Cost (\$/yd ³)	Average Push Distance (ft)
<u>C-12-1 Road</u>						
Rx1	D7	1/2	\$ 244	310	.80	70
	HE	3/4				
	D8	1 3/4				
Rx2	D7	3	881	740	1.19	70
	HE	6				
	D8	3/4				
Rx3	D7	3	600	500	1.19	100
	HE	3				
	D8	1				
Rx4 @ end of rd.	D7	4	887	710	1.26	100
	HE	4				
	D8	2 1/2				
C-12-1 Road Totals			\$ 2,612	2,253 yd ³	\$1.16 /yd ³	
Grand Total Road Crossings =			\$37,631	21,001 yd ³	\$1.79 /yd ³	

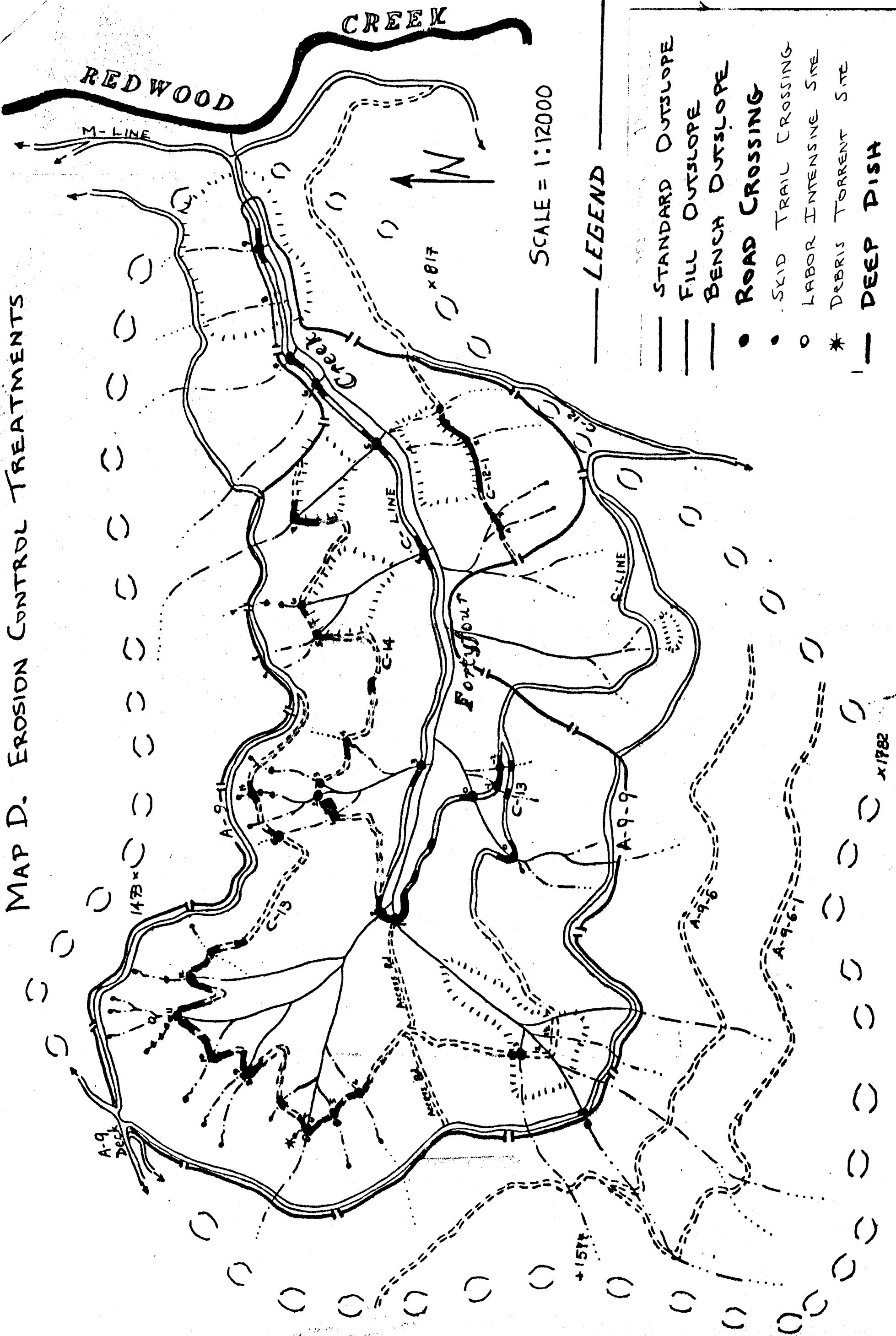
1. Streams at all haul road crossings were flowing at the time of excavation.
2. Crossing contained saturated fill.
3. Because of worksite conditions, equipment became stuck in mud.
4. Fill in crossing contained high concentration of logs and/or root wads.
5. Estimated volume; no pre-treatment survey.
6. Excavation performed entirely by hydraulic excavator because of worksite conditions.

Table 5. SUMMARY OF AVERAGE LABOR COSTS: UNIT 84-5

Treatment	Type of Labor	Total Person Hours	Avg. Cost Per Hour	Total Cost	Quantity	Avg. Cost Quantity
<u>Primary Treatments</u>						
Site #1	RNP	3	\$8.50	\$25.50	Job	--
Site #2	RNP	2	8.50	17.00	Job	--
Total Primary Treatment =				<u>\$42.50</u>		
<u>Secondary Treatments</u>						
Deliver Straw	RNP	45	8.50	633.30	360 Bales	\$1.76/Bale ¹
	RU	18	5.00			
	YCC	48	3.35			
Spread Straw	RNP	55	8.50	980.20	360 Bales	2.72/Bale
	RU	61	5.00			
	YCC	62	3.35			
Total Secondary Treatments =				<u>\$1,613.50</u>		
<u>Travel Costs</u>						
	RNP	119	8.50	1,495.30	--	--
	RU	78	5.00			
	YCC	28	3.35			
Total Travel Cost =				<u>\$1,495.30</u>		
<u>Miscellaneous Treatments</u>						
Brush Removal	RNP	305	8.50	3,482.90	Job	--
	RU	162	5.00			
	YCC	24	3.35			
Total Miscellaneous =				<u>\$3,482.90</u>		
Total Labor Costs =				<u><u>\$6,634.20</u></u>		

1) Each straw bale cost \$2.90. Therefore, the total unit cost including material, distribution, and application was \$7.38/bale.

MAP D. EROSION CONTROL TREATMENTS





Unit: 84-5 Date: 8-13-1985, PP5 SOC (NLD)



Unit: 84-5 Date: 6-16-1984, PP44 SOC (WDB)



Unit: 84-5 Date: 10-11-1984, PP44 SOC (WDB)



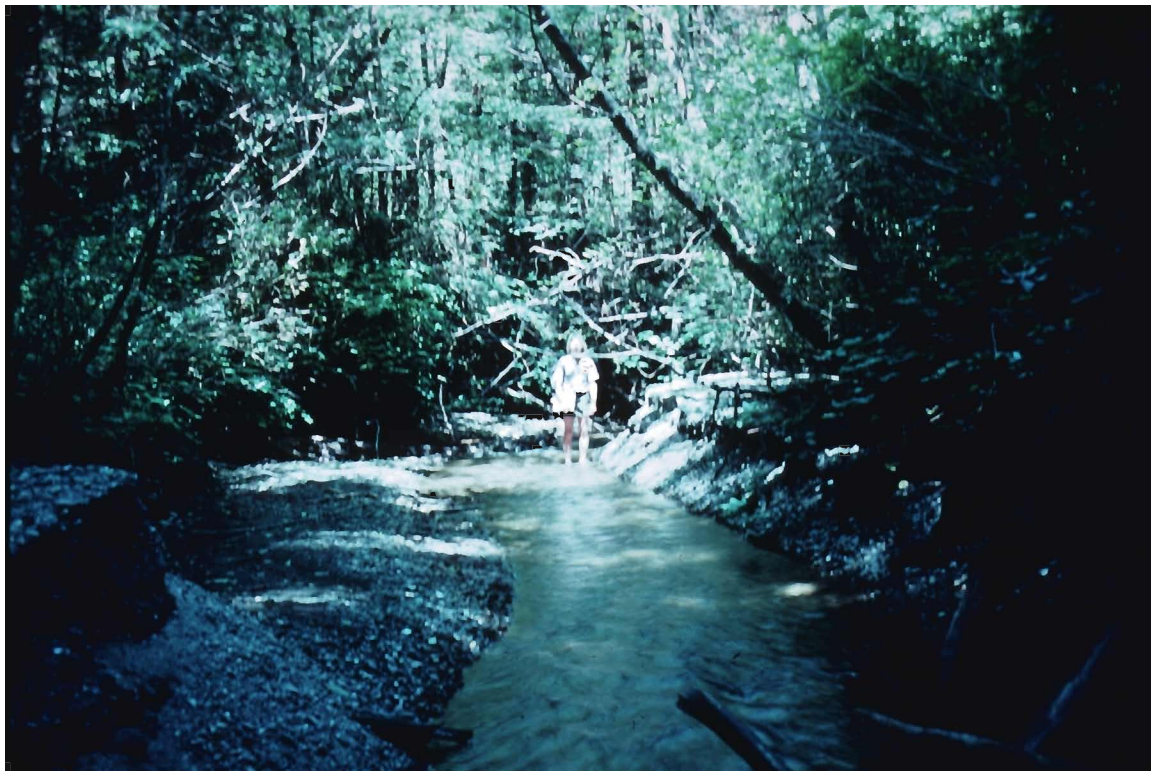
Unit: 84-5 Date: 7-28-1984, PP44 SOC (NLD)



Unit: 84-5 Date: 5-28-1984, PP60 SOC (WDB)



Unit: 84-5 Date: 10-15-1984, PP60 SOC (WDB)



Unit: 84-5 Date: Fall 1984, PP44 Creek SOC