

Summary Report

Upper D-Line
Rehabilitation Unit 83-4

Resource Management Division
Redwood National Park

by

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TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Unit Description	1
Land Use History	3
Erosion History	3
Erosion Features: 1962-69	5
Erosion Features: 1970	5
Erosion Features: 1971	5
Erosion Features: 1972	5
Erosion Features: 1973	6
Erosion Features: 1974-82	6
Erosion Features: 1983	6
Erosion Control	6
Introduction	6
Procedures	6
Objectives	7
Cost Summary	9
Heavy Equipment Phase	9
Heavy Equipment Application	9
Heavy Equipment Sequencing	13
Heavy Equipment Treatment Objectives and Costs	13
Evaluation of Heavy Equipment Application	22
Labor Intensive Phase	26
Labor Intensive Application	26
Labor Intensive Costs	27
Summary and Conclusion	30
Appendix	32
Photo Points	32
Archive File List	37
Literature Cited	38

LIST OF ILLUSTRATIONS

	<u>Page</u>
Figure 1 Location and Description Map	2
Figure 2 Erosion Features Map	4
Figure 3 Sequence of Rehabilitation Work	8
Table 1 Summary of Rehabilitation Costs	10, 11
Table 2 Summary of Equipment Specifications	12
Table 3 Summary of Heavy Equipment Costs	14
Table 4 Summary of Haul and Skid Road Stream Crossing Excavation Costs	16
Table 5 Haul Road Crossings	17, 18
Table 6 Summary of Road Removal Cost of Heavy Equipment	20
Table 7 Summary of Costs for Drainage Channel Armor Acquisition and Placement	21
Table 8 Miscellaneous Costs	23
Table 9 Pre-Rehabilitation/Post-Rehabilitation Heavy Equipment Cost Analysis Comparison for Described Treatments	24
Table 10 Pre-Rehabilitation/Post-Rehabilitation Heavy Equipment Cost Analysis Comparison	25
Table 11 Summary of Labor Intensive Treatment Costs	28
Table 12 Analysis of Labor Intensive Costs	29

INTRODUCTION

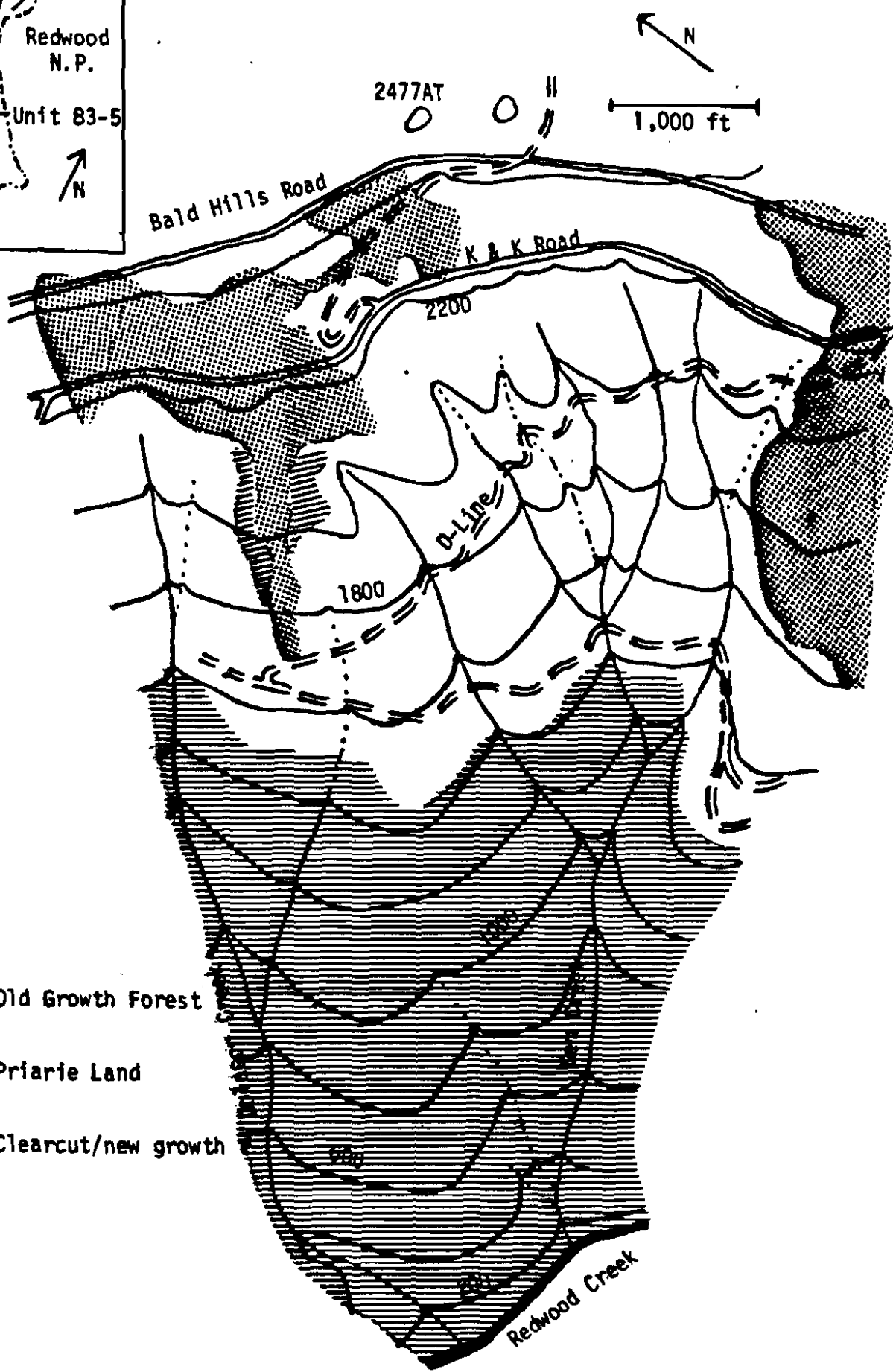
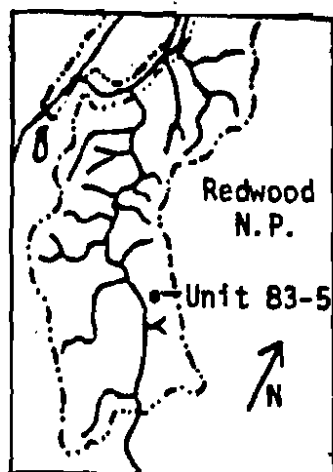
Unit Description

Rehabilitation Unit 83-4 is located in the southeast portion of Redwood National Park between the Bald Hills Road and Redwood Creek (Figure 1). The unit is composed of three subunits: 1) the D-Line haul road; 2) a multiple stream crossing located on site 80-5 (Spreiter and Johnson, 1980) and 3) a road reach which crossed prairie land and connected the K&K Road to the Bald Hills Road. (Henceforth referred to as the "prairie road"). The majority of the rehabilitation unit is encompassed by the Gem Creek watershed (440 acres) which is drained by the third order stream directly into Redwood Creek. Total relief within the Gem Creek watershed is about 2,350 feet from Redwood Creek (140 feet) to Bald Hills Ridge (2,486 feet). Relief within the rehabilitation unit ranges from about 1,400 feet to 2,450 feet. Generally, slopes within the rehabilitation unit are moderately steep (25-40 percent) with a mean slope of about 30 percent. Localized slopes range from very gentle (<5 percent) to very steep (>100 percent). Drainage and hillslope aspect are west southwest.

Geomorphically and vegetatively, the hillslopes are distinguished as prairie or conifer forested land (Figure 1). Prairie is naturally occurring grassland devoid of trees. Topographically the prairies are highly irregular and composed of alternating steep slopes and gentle benches. This staircase-like topography (tread and riser) and hummocky ground indicate some form of mass-movement processes have been active on these areas. Stream channels on the prairies are not well developed. Forested slopes tend to be more stable than prairie slopes and exhibit more developed drainage channels.

Of the 440 acres of land within the Gem Creek drainage, about 12 percent is prairie land with the remainder forested primarily by Douglas-fir and redwood. About 68 percent of the forested land was clearcut during the early 1970's. The remaining forest is primarily lush old growth redwood and is adjacent to Redwood Creek downslope of the cutover land (Figure 1). Vegetation within the cutover land is largely young-growth conifer and brush. As a result of the harsh timber harvest practices, the stream channels within the rehabilitation unit are severely disrupted such that some reaches are well incised and similar to the natural condition while others are inundated with fill and logging debris. Several stream diversions occurred following logging, all of which rejoined their perspective streams after causing fluvial erosion and, in some cases, mass movement features. Local topography of the prairie and old growth tends to be somewhat smooth and consistent compared to that of the cutover land which is harsh and contrasting due to a high density of roadways and erosion features.

Figure 1. Location and Description Map -
Rehabilitation Unit 83-4, D-Line.



The rehabilitation unit is composed entirely of cutover land and prairie. Rehabilitation work involved removal of approximately 2.7 miles of haul and skid road and associated stream crossings. Several areas were treated in order to reduce or avoid mass movements above stream channels. The majority of the rehabilitation unit was geomorphically mapped during the winter of 1982 at a scale of 1:2,200 (Burns, 1982). The area treated on Unit 80-5 was geomorphically mapped during the spring of 1980 at a scale of 1:2,200 (Spreiter and Johnson, 1980). The mapping was verified and supplemented during the spring of 1983.

LAND USE HISTORY

During the late 1950's the K&K road and the prairie road were constructed. Some timber harvest occurred adjacent to the K&K road. Downslope of the K&K, the forest land supported a dense stand of old growth redwood and Douglas-fir. The land was leased out for cattle grazing but probably only involved the prairies. Timber harvest began again in 1970 and was accelerated in 1971 when the entire unit was clearcut. Tractor logging was the primary method of timber harvest and resulted in a dense network of skid trails and the construction of the D-Line haul road. Some isolated cable-yard units occurred on the steeper slopes adjacent to the D-Line.

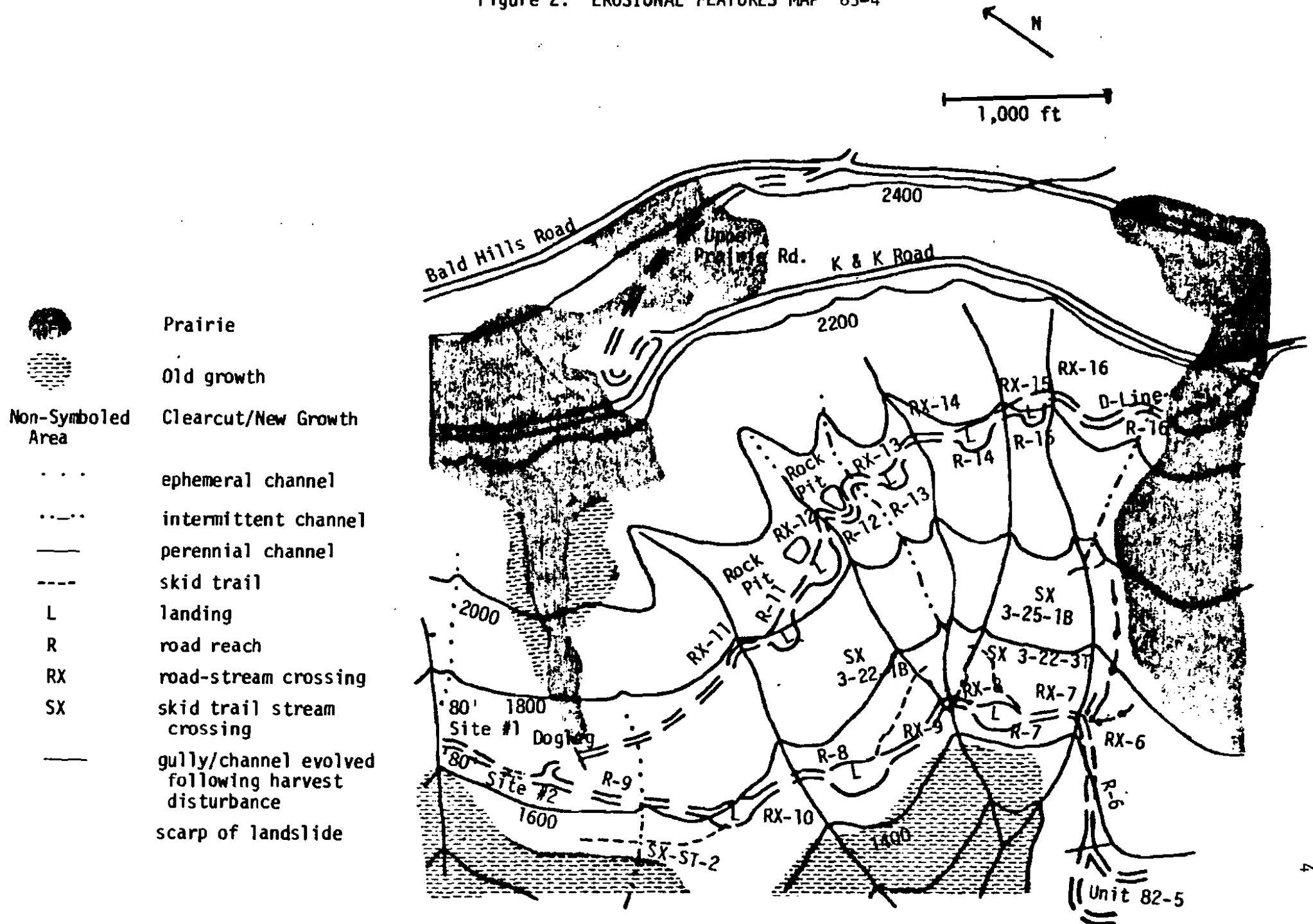
During the 1971-1972 winter considerable surface erosion, stream channel disruption, and water diversions developed. Haul road fill failures also occurred rendering the D-Line impassible. Subsequently the D-Line was reconstructed and access was maintained.

In 1982 the lower portion of D-Line and its surrounding slopes under went rehabilitation treatment (Burns and Routon, 1983). Rehabilitation work was performed on the remainder of D-Line and its associated watershed in 1983.

EROSION HISTORY

The following section describes the recent erosional history of the unit. The information was obtained from aerial photographs taken in 1962, 1966, 1968, 1970, 1970, 1971, 1973, 1975, 1977, 1978, 1979 and 1981. On site mapping occurred during the winter of 1981-1982 (Burns, 1982). A reconnaissance in the 1982-1983 winter was performed to insure the validity of the previous years work and to establish if any new erosional problems were developing. A combination of severe drainage disruption and the occurrence of two major storms during the winter of 1971-1972 played a major role in the erosional evolution of the unit following timber harvest. Refer to Figure 2 for geographical locations described in this section of the report.

Figure 2. EROSIONAL FEATURES MAP 83-4



EROSIONAL FEATURES: 1962-1969

The 1962-1969 photographs indicate that the unit supported a pristine, predominately old growth redwood/Douglas-fir forest. The old growth canopy inhibits analysis of surficial erosion and does not suggest recent mass movement features.

EROSIONAL FEATURES: 1970

The spring of 1970 marked the initial construction of D-Line. In mid-September, when the aerial photographs were taken, road construction had been completed 600 feet beyond the 'dog leg'. Timber harvest, at this time, was limited primarily to a narrow strip adjoining the D-Line that was cut while gaining access. Timber was tractor logged along D-Line, upslope to the K&K haul road, from Rx-14 to the K&K/D-Line intersection. Skid trails were constructed in a criss-cross manner traversing the hillslope. Skid trails constructed near stream channels paralleled the channel courses but rarely crossed the channels in the upper portion of the Rehabilitation Unit. Timber approximately 500 feet downslope of the D-Line, from RX-14 to the K&K/D-Line intersection, was cable-yarded due to steep slopes. Tractor logging was just under progress above R-10 with three landings in the immediate vicinity.

EROSIONAL FEATURES : 1971

During this time period, photo coverage of the rehabilitation unit was extremely limited. Evidence indicates that the D-Line and timber harvest activity had been completed by June. Erosional features cannot be documented, but presumably only harvest disturbances would have been evident.

EROSIONAL FEATURES: 1972

The 1972 aerial photos were taken in March just a few days after the second major storm of that winter.

These photos indicate that the unit had undergone severe channel disruption and fluvial erosion. Stream channel disruption was largely a result of multiple skid trail crossings, and some impact was due to haul road failures, primarily in the lower section of D-Line (Rx-9 and below). In many instances, portions of the channels were used as skid roads and as sites to place excess fill and logging slash. Consequently, multiple water diversions developed and resulted in extensive surface erosion, ponded water, and saturated hillslopes.

Most of the hillslope erosion was directly related to the skid trails. In numerous locations water was diverted directly onto skid trails and/or runoff became concentrated forming gullies that followed the length of the skid trail. Finally, the water re-entered a channel or created its own gully course downslope.

Portions of the D-Line were rendered impassable due to fill failures of the road prism. Diversions associated with the D-Line occurred where culverts plugged or were never placed in problem areas and where inboard ditches became blocked. Ground water intercepted by road cuts added numerous smaller water diversions and fluvial erosion to the unit.

EROSIONAL FEATURES: 1973

The 1973 photos taken in June, indicate that the D-Line had been reconstructed and was once again passable. Many of the water diversions along D-Line that occurred in 1972 had been corrected. Several new diversions had also occurred since 1972. Some involve new water courses and others are associated with previous diversions where corrective work routed water along the inboard ditch and subsequently diverted farther along the road.

For the most part the erosional problems remained the same on the hillslopes with the exception of the three gullies above Rx-6 which had greatly incised, appearing very prominent on the photos.

EROSIONAL FEATURES: 1974-1982

During this time period the drainage pattern within the unit for the most part remained unchanged. Diversion courses remained active and roadways continue to deteriorate. Generally, the vegetation growth was good through this time period except on roadways, active gullies, and on mass movement scars. The principal vegetation was brush, with a lesser amount of Douglas-fir, and very little regeneration of redwood. Following acquisition in 1978, the D-Line was maintained by Redwood National Park for continued access to the area.

EROSIONAL FEATURES: 1983

Channel diversions and gully system routes remained unchanged after 1973, however these features were active and had enlarged due to erosion. The D-Line had continued to deteriorate, especially the lower reach from Rx-9 and below.

EROSION CONTROL

Introduction

Procedures

The rehabilitation work in Redwood National Park can be divided up into five phases. Assessment, prescription, heavy equipment, labor intensive (which includes winter maintenance), and evaluation.

Assessment consists of inventorying erosional problems and locating sediment sources. This is accomplished through aerial photo interpretation, reconnaissance, and detailed geomorphic field mapping.

Prescription entails design of appropriate treatments to reduce erosion, correct disrupted drainage patterns, and remove sediment sources adjacent to stream channels. This phase also includes selecting the types of heavy equipment to be used, surveying the worksites, and generating an overall cost estimate.

The heavy equipment phase involves earth moving equipment used to excavate fill, correct water diversions, and improve the stability of active and potential mass movement features. This work is always performed during the dry months, primarily due to heavy equipment limitations. Heavy equipment is also utilized to distribute and place rock rip-rap intended for armoring stream channels.

The principal task of the labor intensive phase involves distributing and spreading straw. Straw is used as a mulch placed over bare ground in order to reduce surface erosion from raindrop impact and to help retain soil moisture. Additional work includes rock repositioning that is required following the placement with heavy equipment. Winter maintenance, at times, is necessary in stream channels after adjustments occur on the site during the rainy season. A team of laborers is used for these efforts.

The last phase to occur is an evaluation of the rehabilitation work. This is used to appraise the effectiveness of the prescribed work in terms of cost and erosion control. The evaluation is summarized in a report. Figure 3 lists the sequence and time frame of the phases as performed on the 83-4 Rehabilitation Unit.

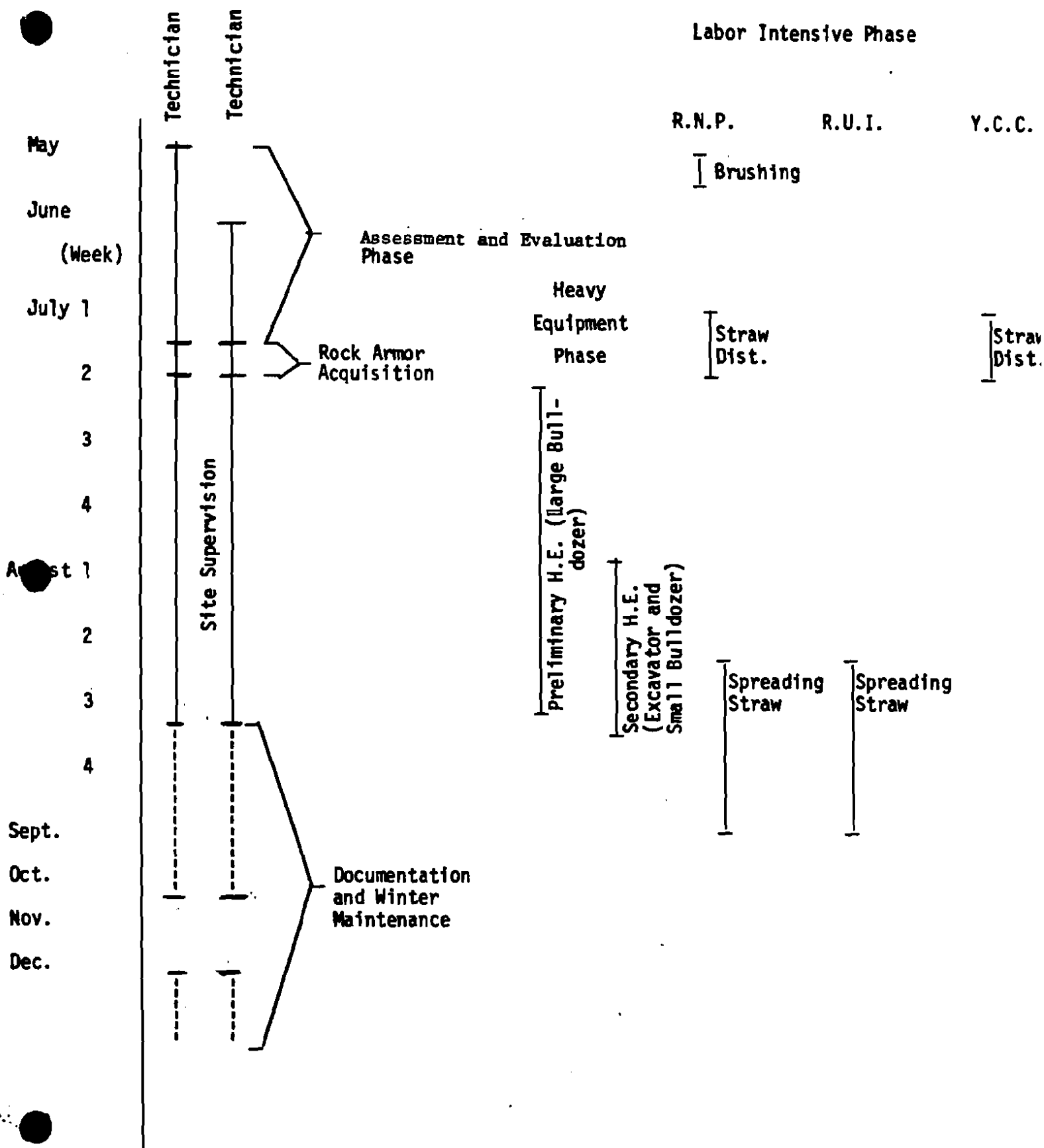
Objectives

The overall objective of rehabilitation work is to mitigate hillslope erosion induced by past land use practices. Logging has greatly accelerated erosion on the slopes of the Redwood Creek Basin, predominately due to haul road and skid trail construction. Primary consideration are, removing active and potential sediment sources (with major emphasis on proximal stream side environments), returning drainage networks to their original configuration, and dispersing water.

The 83-4 Rehabilitation Unit addressed the removal of the D-Line haul road and the 'prairie road' (see Figure 1.). Some minor hillslope work involved the channelization of five skid trail crossings with high erosion and water diversion potential.

Additional work included a stream channel worksite, completed in 1980 (80-5 Rehabilitation Unit), which had to be re-rocked to

Figure 3. Sequence of Rehabilitation Work
Unit 83-4



create a cross-sectional area large enough to meet the estimated runoff requirements for a 25-year return storm event. The upper reach of this stream crossing also had to be re-armored and given toe support on the right bank due to a large active streambank failure.

The prairieland worksites were prescribed applying a different criteria then used for the rest of the unit. Even though the erosional potential was low, the roads traversing the prairies were completely removed for aesthetic reasons. The road prism and the cutbank were eliminated by recontouring the land and blending it into the surrounding landscape.

Except on the 'prairie road', outsloping was prescribed in areas where road fill contributed to overloading and the stability of the hillslope was low to questionable. Outsloping principally involved areas where overburden was perched above stream channels or in locations where a failure would endanger the old growth forest below.

The remainder of the unit that did not exhibit major or treatable erosional problems was ripped and cross-road drained allowing for improved infiltration and deconcentration of surface runoff.

Cost Summary

The costs of erosion control work performed on this unit are summarized on Table 1. The majority of the cost is attributed to heavy equipment (71%). Mapping, prescriptions, supervision, and documentations accounted for 18 percent of the total cost. Labor, which primarily involved secondary treatment such as straw and rock placement, accounted for the remaining 11 percent.

Heavy Equipment Phase

Heavy Equipment Application

Prior to direct heavy equipment work a rock pit operation was initiated for acquisition of armor to be used in stream crossing excavations. A Komatsu D85-E bulldozer with ripper teeth was used to generate, stockpile, and feed rock to a Caterpillar 950 loader. Six 10-yard dump trucks were used to haul the rock to specified work sites. The rock-pit operation was completed on schedule without equipment failure or other logistical problems.

Rehabilitation work on the unit was carried out by two bulldozers and an excavator (Table 2). A Komatsu D85-E bulldozer was used for preliminary excavation of stream crossings and outsloping of unstable road fill or sidecast. The D85-E was also used to rip compacted surfaces to allow for easy excavation or to improve infiltration and aeration through the soil. A Case 980-B excavator and Caterpillar D6-D bulldozer, for the most part, worked as a team completing excavations, outsloping, and placing rock armor in stream crossing excavations. The skid trail

Table 1 Summary of Rehabilitation Costs
83-4

RNP Employees

	Technicians ¹	Laborers	Heavy Equipment	Redwoods United Inc.	YCC	Total Task Cost	Total Phase Cost	Phase % of Total Cost
Mapping ²	496.00					496.00	4,352.00	6%
Prescription ³	3,856.00					3,856.00		
Rock Acquistion			8,202.12			8,202.12		
Primary Treatment	4,412.00 ⁴		27,518.03			31,930.03		
Secondary Treatment			6,605.43			6,605.43		
Miscellaneous			7,982.04			7,982.04		
Secondary Treatment		4,743.01		1,260.78	1,554.40	7,558.19	7,558.19	11%
Cost Analysis ⁵ Documentation	3,980.00					3,980.00	3,980.00	5%
Totals	12,744.00	4,745.01	50,307.62	1,260.78	1,554.40	GRAND TOTAL	70,609.81	
Percent of Costs	18%	7%	71%	2%	2%			

Table 1 (cont.) Summary of Rehabilitation Costs
(Continued)

Footnotes:

¹Estimated cost.

²Original mapping was charged to Site 82-5 (Burns, 1982). The value shown reflects a complete recon of mapping with additional minor mapping.

³Includes all preliminary survey work, flagging for site limits and straw distribution, brush delineation costs estimates, equipment rental, water diversions, photo points, etc...

⁴Includes all heavy equipment and labor intensive supervision.

⁵Includes all post survey work, data analysis, winter maintenance, photo points, and report writing.

REHABILITATION UNIT 83-4 SUMMARY

UNIT NAME: Upper D Line

PROJECT LEADER: ROUTON AND VANN

LOCATION DESCRIPTION: T R S (Map A, pg)

primary with the Com Creek watershed

TOTAL UNIT ACREAGE:

MILE OF ROAD TREATED:

INCLUDES:

TOTAL REHABILITATION PROJECT COST: \$

(Table 1, pg)

GEOLOGY DESCRIPTION:

GEOMORPHIC DESCRIPTION (Map B, pg)

83-4 can be divided into three geomorphic/vegetal units. The first unit is the primary forested area. The second unit is the area that has been cleared by logging. The third unit is the area that has been cleared by logging and is now a grassy field.

SOIL DESCRIPTION:

in the appendix to the report

LAND USE/LOGGING HISTORY (Map C, pg)

The K and K road and prairie road were built through 83-4 some time in the late-1950's. Timber harvest occurred adjacent to the road. Timber throughout the remainder of the unit was clearcut in 1960-71 and mostly tractor yarded. The D-Line haul road was constructed at that time.

EROSION FEATURES (pg) (Map D, pg)

Diversions created gulping and erosion of soil and road crossing fires

TABLE 2: Summary of Equipment Specifications
83-4

<u>Equipment Type</u>	<u>Make/Model</u>	<u>Year</u>	<u>Rate/Hour</u>	<u>Total Hours</u>
Bulldozer	Komatsu D-85E w/13' wide 4 way hydraulic tilt U-blade and 3 30" rippers	1980	\$80.00	235 5 ST/BY W-OP
Excavator	Case 980-B w/standard 1 1/4 yd ³ toother bucket and triple grouser tracks	1980	85.00	159.5
Bulldozer	Caterpillar DG-D w/ 10.5' wide 4 way hydraulic tilt blade winch and one 18" blade attachable ripper	1977	59.00	162.6
Loader	Caterpillar 950 w/3 yd ³ loader bucket	1974	51.00	20.5
Backhoe	Case 580-C Extendahoe w/1yd ³ 4-in-1 loader bucket and 1/3 yd ³ excavator bucket	1980	35.00	87
6-Dump Trucks	10 yd ³ dump truck	1966-1974	*36.00	140

* Average Rate

crossings were more variable than haul road crossings and required a specific piece of equipment for efficient excavation depending on the characteristics of the given crossing. Two skid trail crossings were removed by excavator, two by the D6-D, and one by the D85-E.

In addition, a park-owned backhoe (Case 580-C) proved to be valuable relative to the quality of work and to the cost effectiveness at some sites. The backhoe was involved with preliminary water diversions prior to several of the stream crossing excavations, feeding rock armor to the excavator at several sites, road maintenance during rock delivery by dump trucks, and outsloping of portions of the prairie road. Work performed by the backhoe was of high quality because of the skill and efficiency of the operator.

Heavy Equipment Sequencing

Initially, as described under "Heavy Equipment Application", rock armor was accessed from an off-site rockpit. For on-site work, heavy equipment was scheduled such that the D85-E started work 12 days ahead of the 980-B and D6-D and completed as much of the primary rehabilitation work as was efficiently possible. Work was initiated by the D85-E at the down road extent of the rehabilitation unit and progressed up-road. An access road was left along the up-stream portion of crossings, at the down-slope perimeter of outslope reaches, and through ripped reaches. The D85-E excavated from 50 to 90 percent of each stream crossing and about 90 percent of the outslope work. The 980-B and D6-D completed primary rehabilitation work - outsloping and excavation - and were responsible for the secondary treatment which consisted of rock-armor placement within stream crossing excavations. Besides assisting the excavator by removing spoil, the D6-D was used for touch-up work on outslope areas, feeding rock-armor to the excavator, winch work, and touch-up ripping. Cross-road drains were excavated by different equipment depending on excavation efficiency and/or the logistics of the work schedule.

Heavy Equipment Treatment Objectives and Costs

The average costs of heavy equipment treatments prescribed for Rehabilitation Unit 83-4 are summarized in Table 3. Primary treatment involved excavation of haul and skid-road stream crossings; outsloping of unstable road reaches and landings; ripping the road surface; and cross-road draining of springs and seeps. Secondary treatment involved channel armoring within stream crossing excavations to minimize channel erosion.

Armor may be organic (logs, branches, etc..) or inorganic (rock) depending on availability. Organic armoring usually consist of embedded debris which is left as part of the channel bottom or bank during excavation, or is acquired locally and keyed into the

Table 3 Summary of Heavy Equipment Costs - Site 83-4.

Treatment	# of Worksites	Total quantity	Total cost	Average cost per worksite	Range in cost per worksite	Average cost per quantity	Range in cost per quantity	% of total
Haul road stream crossings	11	8,710 yds ³	\$12,270.80	\$1,115.45	\$86.40- 2,448.10	\$1.41/yd ³	\$0.75- 2.92	24.4
Skid trail crossings	5	500 yds ³	558.75	111.75	40.00- 191.25	1.12/yd ³	0.41- 1.91/yd ³	1.1
Road Reaches: Outsloping	6	3,953 LF (11,924 yds ³) (2,91 acres)	10,490.90 ¹	--	--	2.65/LF 0.88/yd ³ (\$3,605.12/acre)	0.72- 13.74/LF (\$0.72-1.70/yd ³)	20.8
Ripping and cross road draining	--	9,022 LF (12.94 acres)	4,197.58	--	--	0.46/LF (340.16 16/acre)	0.18- 0.63/LF	8.3
Total Primary Treatment			\$27,518.03					54.7
Placement of channel armor	14	776 yds ³	6,605.43 ³	550.45	107.70- 1,596.22	8.51/yd ³	5.38- 31.59	13.1
Armor acquisition	For 13 sites	481.5 yds ³	8,202.12 ⁴	--	341.60 1,878.80	17.08 yd ³	--	16.3
Total Secondary Treatment			\$14,807.08					29.4
Miscellaneous: Itemized			7,277.26					14.5
Non-itemized			704.78					1.4
Total Miscellaneous Cost			7,982.04					15.9
Total Heavy equipment Cost			\$50,307.62					100.0

¹ Does not include work done by a park backhoe which account for 922 yds³ of OS work over a 32 hour period.

² Includes 295 yds³ of rock that was acquired during 1982 and charged to the 82-5 rehabilitation unit and 20 yds³ acquired from local road surfacd.

³ Does not include 15.7 hours of work by a park backhoe.

⁴ Does not include the cost of the rock acquired during 1982.

channel. As such, the organic armor is not specifically accounted for under "Heavy Equipment Costs". Rock armor is often acquired from the spoil of an excavation or locally from the road surface or other source. Rock armor from these sources is usually accounted for under armor placement but not armor acquisition. However, the majority of rock armor used on this site was accessed from off-site rock pits, and both acquisition and armor placement are accounted for from this source.

The stream crossing excavations (Table 3) accounted for approximately 24.4 percent of the heavy equipment cost for this unit. Table 4 summarizes excavation costs of stream crossings. The extra small crossings (<100 cubic yards) were the least expensive excavations relative to average cost per volume. This observation can be attributed to the minimal distance of spoil displacement that was required at these crossings. Four of the five extra small crossings were skid-road crossings. Transport of equipment to and from skid trail crossings is not included in the cost analysis shown on Table 4. Large crossing excavations (<800-2,000 cubic yards) were the next least expensive category on a cost per volume basis. The D85-E, which was the most cost efficient piece of equipment on the site, was able to excavate a relatively large portion of fill due to the size and geometry of the larger crossings.

The medium crossings (400-800 cubic yards) proved to be the most expensive on an average cost per volume basis. Two of the three excavations within the medium size class (Rx-7 and the CRD at the dog leg) presented special circumstances which inflated excavation costs. Data for individual crossings are listed on Table 5. At Rx-7 (424 cubic yards) fill consisted of wet, fine-grained material that was difficult for equipment to work in and the crossing was geometrically constricted by resistant features. Consequently, only about one-half of each excavation could be accomplished with the D85-E as compared to as much as 90 percent at some of the larger crossings. In addition, the 980-B operator was inexperienced, and the 980-B was in poor working order. The 'dog-leg' CRD was not a difficult excavation. However, the prescription was such that the fill, which was relatively good soil, was spread over a 300 foot reach of rocky, ripped road surface to enhance vegetation growth.

The two least expensive crossing excavations involved an extra small crossing (ST-2; 90 cubic yards; \$0.44/cubic yard) and a large crossing (Rx-13: 994 cubic yards; \$0.75/cubic yard). The D85-E accounted for all of the ST-2 excavation and about 98 percent of the Rx-13 excavation. Both crossings were uncomplicated excavations from the aspects of channel morphology and type of spoil material. Rx-13 would probably have been as inexpensive on a cost/volume basis as ST-2, or more so, but the material was spread across the harsh surface of the rock pit (0.75 acres) located between Rx-12 and Rx-13. The push averaged about 170 feet and was justified for revegetation enhancement.

Table 4 Summary of Haul and Skid Road Stream Crossing Excavation Costs
83-4

Size of Excavation	# of Worksites	Equipment	Total Cost	Total yds ³	Average Cost/ Worksite	Average Cost/yd ³	Range: Cost/yd ³
Extra-small 0-100 yd ³	5	980-B, D6-D, D85-E	\$468.15	400	\$93.63	\$1.17	\$0.44 - \$1.91
Small 101-400 yd ³	3	980-B, D6-D, D85-E	1,196.35	718	398.78	1.67	0.88 - 2.98
Medium 401-800 yd ³	3 ¹	980-B, D6-D D85-E	3,396.66	1,571	1,132.22	2.16	1.52 - 2.92
Large 801-2000 yd ³	6	980-B, D6-D	8,867.06	6,971	1,477.84	1.27	0.75 - 1.63
Extra-Large	None	--	--	--	--	--	----
Totals	17		\$13,928.27	9,660		\$1.44	

¹Includes a large CRD (450 yds³) excavated near the dog-leg of the main D-Line.

(Itemized under miscellaneous costs due to its unusual circumstances, see discussion in "Heavy Equipment Treatment Objectives and Costs).

Table 5 Haul Road Crossings: Unit 83-4

Crossing	Equipment	Excavation Hours	Excavation Cost	Volume (yds ³)	Unit Cqst (\$/yds ³)	Average Push Distance (ft.)	Drainage Area (acres)	Volume of Rock, Armor (yds ³)	Cost of Armoring
Rx-6	D85-E 980-B D6	0.9	\$ 363.35	186	\$1.95	100	7.5	61	\$1,468.38
		1.5							
		2.7							
Rx-7	D85-E 980-B D6	2.1	1,239.28	424	\$2.92	220	57.8	166	2,112.50 (640.90)
		5.9							
		9.7							
Rx-8	D85-E 980-B D6	4.7	1,238.13	992	\$1.25	145	100.4	159.5	2,702.31 (490.10)
		6.2							
		5.7							
Rx-9	D85-E 980-B D6	0.7	656.00	332	\$1.98	180	59.9	55	620.57 (414.70)
		4.0							
		4.3							
Rx-10	D85-E 980-B D6	1.1	86.40	100	\$0.86	30	52.7	20	107.70

Rx-11	D85-E 980-B D6	4.9	1,401.60	860	\$1.63	80	42.3	20	191.52 (150.80)
		7.0							
		7.0							
Rx-12	D85-E 980-B D6	4.3	\$1,575.15	1,016	\$1.55	100	41.6	20	\$ 472.60
		9.2							
		7.5							

Table 5 Haul Road Crossings: Unit 83-4 (Cont.)

Crossing	Equipment	Excavation Hours	Excavation Cost	Volume (yds ³)	Unit Cgst (\$/yds ³)	Average Push Distance (ft.)	Drainage Area(acres)	Volume of Rock Armor (yds ³)	Cost of Armor
Rx-13	D85-E 980-B D6	8.0 0.5 1.0	\$ 741.50	994	\$0.75	200	18.3	----	----
Rx-14	D85-E 980-B D6	11.8 11.4 9.0	2,448.10	1,877	\$1.30	125	26.5	30	\$ 322.58 \$ (226.20)
Rx-15	D85-E 980-B D6	7.5 7.1 4.4	1,462.58	1,232	\$1.19	85	19.4	20	\$193.00 \$(150.80)
Rx-16	D85-E 980-B D6	5.2 5.7 2.7	1,058.65	697	\$1.52	75	20.1	20	\$150.50 \$(150.80)
80-S #1	D85-E 980-B D6 580-C	-- -- -- --	---	---	---	---	47.5	95	\$2,668.90
80-S #2	D85-E 980-B D6	-- -- --	---	---	---	---	48	110	\$3,475.02

1) The park-owned Case 580-C backhoe assisted in rock armor placement on several crossings. Backhoe costs are not included under costs of armoring. For detailed data see File #4 of the Archives.

2) Values shown in parenthesis are for rock which was delivered to Unit 83-4 during the 1982 and charged to Unit 82-5 (Burns and Routon, 1982).

The D-Line haul road was surfaced with one and one-half to two feet of compacted rock and presented problems from a revegetation standpoint. Therefore, excavation prescriptions (cross-road drains and stream crossings) emphasized spreading the soil along the ripped road as far as feasible. From the standpoint of equipment cost, the practice of extending the distance of soil displacement is not economically sound. As a result, the cost of excavation work, was higher than would have been the case if the unit has a less harsh road surface.

A summary of road removal costs is shown on Table 6. Outslope work accounted for approximately 30 percent of the road treatment (length), and 71 percent of the cost. Of the 3,953 LF (3.57 acres) of road way outsloped, 1,053 LF (1.25 acres) involved unstable near-stream road and landing fill, and the remainder was associated with prairie land. Prairie road work involved mild outslope work on relatively gentle slopes.

Most of the roadway within the unit was stable and only required surface treatment for revegetation purposes. Road surface treatment included 9,022 LF (7.56 acres) which was ripped and cross road drained. Almost all the ripping was accomplished with the D85-E. This treatment is relatively inexpensive on a cost per area basis and was prescribed where erosional hazards were insignificant.

Rock armoring of haul-road stream crossing excavations accounted for 29.4 percent of the heavy equipment costs (Table 6). Of the 776 yards of rock used as channel armor, 295 yards were acquired during 1982 at a cost of \$2,224.03. The cost of the rock acquired in 1982 was charged to the 82-5 unit (lower D-Line). For comparative purposes, the cost of the 1982 rock is shown on Table 6 as if it were charged to this site.

Prescriptions of rock armor differed markedly between Rx-6 through Rx-9 and the rest of the crossings. Rx-6 through Rx-9 were underlain by highly erodible weathered mudstone locally called "blue goo". Consequently, Rx-6 through Rx-9 were armored with rock one and one-half to two feet thick across the entire stream bed of the excavation, and well above anticipated high water flows. In addition, large rocks (> 4 feet diameter) were keyed along the upstream margins of the excavations at Rx-7 through Rx-9. This was necessary at these locations due to the steepness and unstable appearance of the local slopes upstream and/or downstream of the crossings. The 80-5 stream crossings were also underlain by highly erodible material such that the entire stream bottom had to be rocked within the zone of the excavations and up channel banks well above anticipated high water flows.

Rx-10 through Rx-16, were largely underlain by a relatively stable soil of sandstone derivative. For these crossings, with the exception of Rx-13, two to three rock aprons were placed at strategic locations to create knickpoints and to ensure that water channeled down the middle of the excavation. Rx-13 did not

Table 6 Summary of Road Removal Cost of Heavy Equipment
85-4

Treatment	Equipment	Total Cost	# of Sites	Length (ft)	Range in Average Road Width (ft)	Total yds	Range in yds ³ /LF	# of CRD's	Area (Acres)	Cost Acre	Cost/LF	Cost/yd ³
<u>Outsloping</u>												
Mild 0-3 yds ³ /LF	D85-E	\$3,926.62 ¹	3	3,217	32-56	5,422	0.8-3		2.73	\$1,438.32	\$1.22	\$0.72
	980-B	(\$4,886.62)								(\$1,789.97)	(1.52)	(0.96)
	D6-D											
	580-C											
Medium 3-10 yds ³ /LF	D85-E	3,801.51	2	545	40-56	3,628	6.2-6.8		0.65	\$5,848.48	6.97	1.05
	980-B											
Heavy 10 yds ³ /LF	D85-E	2,762.77	1	191	44	2,874	15		.19			
	980-B											
D6-D												
Subtotal		\$10,490.90 (\$11,450.90)	6	3,953		11,924			3.57	\$555.23	0.46	--
Ripping and CRD's	D85-E	\$4,197.50	13	9,022	24-46	--	--	37	7.56	\$555.23	0.46	--
	980-B											
	D6-D											
Total Road Removal		\$14,696.90 (\$15,656.04)		12,975					11.13			

¹The park owner 580-C backhoe outsloped 1,100 LF of road involving 922 yds³. A hypothetical cost of \$30.00 per hour for the backhoe was added to the actual site cost and is shown in parenthesis. At \$30.00 per hour the backhoe performed mile outsloping work at \$0.96/yd³. The relatively high cost effectiveness for a backhoe is attributed to a high level of work efficiency by the operator.

Table 7 Summary of Costs for Drainage Channel Armor Acquisition and Placement
83-4

Volume of Rock	# of Worksites	Total Quantity	Range in Excavation Size	Cost of Acquisition	Cost of Placement	Average Cost/ Worksite	Average ³ Cost/yd ³	Range in Cost/yd ³
Extra small 20 yds ³	2 ²	20.25 yds ³	30 yds ³ -450 yds ³	\$345.87	\$151.30	\$248.58	\$24.86	\$22.74-\$25.45
Small 20-50 yds ³	6	130 yds ³	100 yds ³ - 1,877 yds ³	\$341.60 ³ (\$1,020.20)	\$1,096.30	\$239.65 (\$352.75)	\$11.06 (\$16.28)	\$5.38-\$23.63
Medium 50-100 yds ³	3	210.75 yds ³	186 yds ³ - ⁴ 332 yds ³	\$2,660.21 (\$3,074.91)	\$2,095.64	\$1,585.28 (\$1,723.51)	\$22.57 (\$24.53)	\$18.82-\$28.09
Large 100-200 yds ³	3	435.5 yds ³	424 yds ³ - ⁵ 992 yds ³	\$4,876.34 (\$6,007.34)	\$3,413.49	\$2,763.28 (\$3,140.28)	\$19.03 (\$21.63)	\$12.73-\$31.59
Totals	14	796.5 yds ³		\$8,204.02 (\$10,428.32)	\$6,756.73		\$18.81 (\$21.60)	

¹ A park-owned backhoe which was used for 15.7 hours of rock placement work is not accounted for in this table.

² These two worksites involved CRD's including the large CRD (450 yds³) located at the dog-leg on the main D-Line.

³ This value is the cost charged to site 83-4. Values shown in parenthesis reflect the cost of rock acquisition during 1983 and charged to site 83-4 plus the cost of rock acquisition during 1982 and charged to site 82-5. Thus, the values shown in parenthesis should be used for comparative purposes and the values not in parenthesis for budgetary cost analysis of site 83-4.

⁴ One of the worksites (site 80-5 #1) did not involve excavation work.

⁵ One of the worksites (site 80-5 #2) did not involve excavation work.

present significant erosion potential and received no armor. Approximately 20 cubic yards of rock were required at crossings where aprons were placed. These crossings were relatively inexpensive to armor compared to crossings requiring more extensive armor protection.

Miscellaneous heavy equipment costs charged to this unit involve various aspects of rehabilitation work which are usually indirectly associated with major tasks. However, for reasons of accurate accountability these costs have been isolated (Table 8).

Tables 9 and 10 compare pre-rehabilitation cost estimates of equipment and treatments with the costs actually incurred on this unit. The D85-E was less expensive than originally appraised because the actual cost/hour was less than estimated, and more significant, the machine proved to be more efficient than was estimated. Both the 980-B and the D6-D were less expensive on a cost/hour basis, however, both were more expensive relative to the estimated budget. This discrepancy was largely due to the inefficiency of the 980-B operator and machine and is discussed under the "Evaluation of Heavy Equipment Application". Since the D6-D worked in tandem with the 980-B, it too incurred the excess of work time and cost. If the 980-B had been in good working order and operated by an experience operator, the equipment cost for this unit could have been reduced by \$5,000 to \$7,000.

Evaluation of Heavy Equipment Application

Of the heavy equipment operators on this project, only the D6-D operator had experience on a rehabilitation site. The D6-D was in good shape and the operator was well skilled. Because of its relatively small size, the D6-D was able to operate in limited work space with the 980-B and was particularly useful due to the machines winching and ripping capabilities. The 980-B and operator presented problems. First, the operator had never worked in rugged terrain with an excavator. The first week served as a training session with the site supervisors spending a good deal of time explaining capabilities and limitations of the 980-B to the operator. Second, the 980-B was in poor working order and operated at about 50 percent of the engine power that is typical for that model excavator. The operator of the 980-B had a good work attitude and became fairly efficient as work progressed. However, at least several work days were lost relative to the work schedule due to the initial inefficiency of the operator and the poor condition of the equipment. The 980-B operator and machine could have been dismissed and replaced as soon as the deficiencies were apparent. But, because of scheduling logistics and the possibility of attaining another inexperienced operator and/or poor running machine, no dismissal action was taken.

The D85-E was operated by three different individuals during the project, none of which were experienced in rehabilitation work. Also, several days of down time and equipment use by another

Table 8 Miscellaneous Costs - Site 83-4

<u>Task</u>	<u>Equipment</u>	<u>Hours</u>	<u>Cost</u>	<u>Subtotal</u>
Non-itemized	D85-E	2.86	\$228.80	
	980-B	.38	32.30	
	D6-D	7.52	443.68	\$704.78
Move-in/move-out	D85-E		479.00	
	980-B		402.00	
	D6-D		550.00	\$1,431.78
Sit Time ²	D85-E	.67	53.60	
	980-B	.83	70.55	
	D6-D	13.09	772.31	\$896.46
Walking and ³ Strategy Talks	D85-E	4.07	325.60	
	980-B	8.16	693.60	
	D6-D	4.33	255.47	\$1,274.67
Standby with ⁴ Operator	D85-E	5.0	243.60	
				243.60
Cross-road drain ⁵ at dog leg	D85-E	6.08	486.40	
	980-B	6.16	523.60	
	D6-D	3.42	201.78	\$1,211.78
Rocking Cross-Road Drain below St-1	980-B	.45		\$38.25
Lunch Break	D85-E	12.5	1,000.00	
	980-B	8.0	680.00	
	D6-D	8.5	501.50	\$2,181.50
Total Cost			\$7,982.04	

1 Includes insignificant tasks such as hauling culvert off the site, road repair, etc.

2 Incurred for short periods of time (10-30 minutes) during tandem equipment operation.

3 Involves equipment transportation on site which takes more than ten minutes of time, and strategy talk at individual worksites.

4 Incurred when D85-E was transported to another rehabilitation unit to perform work in a rockpit.

5 This excavation was a typical in that it was too large (450 yds³) to be considered a cross-road drain, although it was created to drain several springs and seeps.

Table 9 Pre-Rehabilitation/Post-Rehabilitation Heavy Equipment Cost Analysis
Comparison for Described Treatments - Site 83-4.

<u>Treatment</u>	<u>Pre-Rehab. Est.</u>	<u>Actual Cost</u>	<u>Comment</u>
Haul Road Crossing Excavations Road Reaches	\$23,275 \$15,405	\$18,876.23 \$14,688.48	Includes fill excavation and rock armor placement Includes outsloping, ripping, and CRD's.
Skid Trail Crossing Excavations	\$1,168	\$558.75	Less material needed to be excavated than was initially deemed necessary.
Rock Procurement	\$10,000	\$8,202.12	Includes generating rock with ripper cat, loading by front-in loader, and hauling of rock by dump trucks.
Miscellaneous	<u>\$1,500</u>	<u>\$7,982.04</u>	Miscellaneous costs involve indirect tasks associated with described treatments, and move-in/move-out costs (see Table 7).
	\$51,348.00	\$50,307.62	
+ 10% fudge factor=	\$56,418.00		The fudge factor was added to absorb hidden costs such as miscellaneous tasks, breaks, strategy talks, etc...

Table 10 Pre-Rehabilitation/Post Rehabilitation Heavy Equipment Cost Analysis Comparison - Site 83-4.

<u>Equipment</u>	<u>Pre-Rehab. Est. of Rate/hr.</u>	<u>Actual Rate/hr.</u>	<u>Pre-Rehab. Est. of work hrs.</u>	<u>Actual work hrs.</u>	<u>Pre-Rehab. Cost Est.</u>	<u>Actual¹ Cost</u>
D85-E	\$90.00	\$80.00	270.6	221 ²	\$24,854.00	\$18,002.60 ³
980-B	\$90.00	\$85.00	101.6	159.5	9,734.00	13,959.50
D6	\$65.00	\$59.00	103	162.6	6,760.00	10,143.40
Rock Pit					<u>10,000.00</u>	<u>8,202.12</u>
					\$51,348.00	\$50,307.62

¹Includes move-in/move-out costs.

²The "Actual Work Hours" for the D85-E include 5 hours of standby with operator (\$48.72/hour).

³The "Actual Cost" of the D85-E does not include 19 hours (\$1,520.00) of work performed in the rock-pit operation

rehabilitation project occurred. However, all three operators were well versed in bulldozer operation strategy and quickly became efficient after advice from supervisors and some experimentation. The D85-E proved to be the most cost effective and versatile among the equipment used on the project. The machine's U-blade was very efficient for outsloping and road crossing excavations and was able to move relatively large volumes of spoil for long distances (100-300 feet) as compared to a machine with a straight blade. The three ripper teeth allowed the machine to rip a nine foot wide swath with one pass. The rate of ripping was observed to be about 1,350 cubic feet per minute of medially packed road surfaces unimpeded by obstacles. Due to the high level of efficiency of both operator and equipment, the D85-E finished a week ahead of schedule and compensated for budgetary losses incurred by the 980-B operator and machine.

As was discussed, the D85-E started work on the project ahead of the 980-B and D6-D. The lag-time between the D85-E and follow up equipment was determined from prescription estimates of the project and proved to be sufficient. The D85-E worked at a faster rate than was anticipated and at no time did equipment interfere with one another.

The access road which was left intact to allow thoroughfare of service vehicles, etc., worked effectively. The road was easily removed by follow-up equipment since it was essentially a back-bladed path through crossing excavations and over outsloped areas.

Of problems encountered, the most significant concerned feeding rock armor to the excavator. The rock armor was of poor quality, being of smaller diameter than was desirable, and composed of about 25 percent soil. Due to road constrictions, the rock had to be stockpiled a considerable distance from some of the work sites (80-120 feet). The D6-D proved to be inefficient at pushing rock along the road surface due to considerable loss of rock along the push and mixing of soil into the already rock/soil composition. As a result, armor placement at the first two crossings completed was relatively expensive per unit of volume. Procurement of a park-owned backhoe solved the rock transport problem in similar situations. Rock was loaded into the backhoe's loader bucket and cleanly fed to the 980-B for inchannel placement.

Labor Intensive Phase

Labor Intensive Application

The labor intensive work, on this rehabilitation unit, was implemented by three crews: Redwood National Park laborers (R.N.P.), Redwood United, Inc. employees (R.U.I.), and the Youth Conservation Corps (Y.C.C.). The labor intensive personnel were utilized solely for secondary treatments. The principal task was

the spreading of a straw mulch over barren ground disturbed by heavy equipment activities. Other secondary treatments include brushing, straw delivery, straw distribution, and rocking.

Brush removal and straw delivery preceded heavy equipment operations. Straw distributions occurred before and during heavy equipment movement, and was initiated by placing pre-calculated quantities of straw (number of bales) in stockpiles at flagged locations.

After completion of a worksite by heavy equipment the straw was spread out as soon as possible to minimize walk-in distances over completed sections of road impassable by vehicles.

Following the heavy equipment work and the spreading of straw, a crew of R.N.P. laborers walked over the unit repositioning rock armor in locations deemed necessary to insure a greater stability of the channel bottom from erosion.

Labor Intensive Costs

The labor intensive cost for the 83-4 Rehabilitation Unit amounted to \$7,558.19. Distribution and spreading of straw accounted for 88.5% (\$6,686.89) of the total cost. The remainder was absorbed by brush removal and hand rocking. A summary of the costs is shown on Table 11.

The cost effectiveness of the labor intensive treatments was reduced due to a significant portion of paid time spent off the worksite by laborers (Table 12). R.N.P. laborers and the R.U.I. crew averaged 27% and 28% of off-site time, respectively a day. This represents 2 1/2 to 3 hours of nonproductive time out of a 10 hour day. The Y.C.C. crew had the highest percentage with 63% of the paid time being non-productive. These 'lost' hours are contributed to travel time between the duty station and the worksite. The Y.C.C. crew traveled 5 hours out of 8 hours a day being transported to and from the worksite.

Due to the large discrepancy of actual hours spent on the worksite and the variance in hourly wages among the three crews, an average cost per productive hour parameter was generated. This parameter represents the total cost paid out to each group divided by the number of productive on site hours. This will allow a direct comparison of the cost effectiveness between the crews.

Using this criteria, the R.U.I. crew proved to be the most cost effective of the three crews at \$7.30/productive hour. The Y.C.C. was second at \$8.93/productive hour, even though they had the highest non-productive off site hours per day. This is attributed to their low average wage of \$3.35/hour. The RNP Laborers had the Highest cost, \$11.98/Productive Hour, due to their high average wage of \$8.80/hour.

Table 11 SUMMARY OF LABOR INTENSIVE TREATMENT COSTS

Treatment	Crew	Personnel Hours	Average Cost Per Hour	Cost	Total Cost
Brushing	RNP	60	\$8.98	\$539.00	\$539.00
Straw Delivery and Distribution	RNP	80	8.82	705.20	1,938.00
	YCC	368	3.35	1,232.80	
Spreading Straw	RNP	359	8.82	3,166.51	4,748.89
	YCC	96	3.35	321.60	
	RUI	238	5.29	1,260.78	
Rocking	RNP	40	8.30	332.30	332.30
				Total =	\$7,558.19

TABLE 12 ANALYSIS OF LABOR INTENSIVE COSTS

Crew	Total ¹ Personnel Hours	Productive Hours	Non- Productive Hours	Average Wage/Hour	Total Cost	Average Cost Per Productive Hour
RNP	539	396	143	\$8.80	\$4,743.01	\$11.98 ²
YCC	464	174	290	3.35	1,554.40	8.93 ²
RUI	238	172.5	65.5	5.29	1,260.78	7.31 ²
Total = \$7,558.19						

¹Total of all hours for all treatments paid out.

²Transportation and Administration costs not included.

Comparing the three crews in terms of efficiency of job completion or work completed per day and ignoring cost, both the R.U.I. and R.N.P. crews out rank the Y.C.C. crew. The R.U.I. and R.N.P. crews had 7 to 8 hours a day of productive time compared to approximately 3 hours for the Y.C.C. crew. Thus, if a job needed to be completed as soon as possible the R.N.P. or the R.U.I. crew would be preferable.

In conclusion, the overall crew which proved to be the most productive in terms of both cost and efficiency of job completion was the Redwood United, Inc. crew.

SUMMARY AND CONCLUSION

Rehabilitation work on 83-4 began with an analysis of the relationship between drainage features and erosion features based on detailed geomorphic mapping. Minor drainages are observed as complexes composed of interacting elements (slopes, drainage channels, knickpoints, mass movement features, etc.), and as subunits of larger drainages and of the rehabilitation unit as a whole. Based on interpretation of geomorphic mapping and on input from experience rehabilitation geologists, hydrologists, botanists, and soil scientists, treatment priorities were established. The criteria for prioritizing treatments involves the probability of erosion features to affect stream channels, the magnitude and activity of each erosion feature, revegetation of disturbed areas, the cost/benefit, and the potential for successful stabilization. In addition, reaches of prairie road were treated to re-establish natural prairie morphology. The prairie roads were of low priority and were completed after the more critical treatments were accomplished.

On this unit, highest treatment priority was given to Rx-6 through Rx-9, the outslope reach involving R-7, and the multiple stream crossing of the 80-5 unit (Figure 2). Due to the highly erodible soils and unstable banks of the stream crossings mentioned above, intense channel armoring was deemed necessary for successful stabilization. The intense channel armoring involved the keying of large rocks (4 feet diameter) at strategic positions along the excavations to act as toe support for banks and as support mechanisms for smaller rock. The entire excavation of each of these crossings was armored with an average depth of rock of about two feet to a point up the banks which were determined to be well above the largest expected high flows. Baring unforeseen mass movement(s) above or immediately below crossings, the rock armoring should inhibit significant erosion and function in stabilizing the banks and channel bottom to allow for successful revegetation and long-term stabilization.

The outsloping of R-7 was largely carried out to remove weight from the head of a complex mass movement feature located immediately upslope of one of the major drainage channels on the unit. The success of this treatment in inhibiting the activity of this mass movement feature remains to be seen, however, in the

worst case, thousands of cubic yards of potentially unstable fill were moved to a more stable position and morphology (outslope). Other heavy outslope work involved road and landing fill along both banks downstream of Rx-12. This outslope work was carried out because of the excessively steep fill slopes, evidence of instability (scarps and cracks), and proximity to the stream. The heavy outslope work along R-7 and that near Rx-12 largely involved a sandstone derived soil, therefore, the fill outslope has good infiltration and percolation, and consequently low pore pressure.

Road-stream crossings Rx-10 through Rx-16 were treated differently than the lower, more unstable ones. These crossings were filled with fairly fine-grained, highly erodible soil overlain by a compacted rock road surface. However, the banks and slopes local to these crossings were relatively stable and did not present significant erosion problems. With the exception of Rx-10 and Rx-13, these crossings were armored with two to three rock aprons. The aprons consist of about ten cubic yards of rock each and were keyed into the channel banks and bottom to a distance up each bank above expected high flows. Apron widths ranged from four to about eight feet. Apron geometries and spacing varied depending on the characteristics of the given cross-section of channel. As such, the aprons function to channel water down the middle of the excavation and to serve as knickpoints. The cost of armoring by means of rock aprons was relatively inexpensive.

Skid-trail stream crossings that were prescribed for treatment on this unit were done so to avoid potential diversions which could result in significant erosion, and not because of potentially high erosion of the actual crossing fill. Armor was not placed in these crossings, however, organics which were a part of the fill were left intact, keyed into the banks and channel bottom.

A field survey of Unit 83-4, following the 1983-1984 water year, indicates that treatment appear adequate and that only minor hydraulic adjustments have occurred in and near road stream crossing excavations. Fill/outslope areas also appeared stable and with good drainage. At the time of this writing, the only obvious area of concern regarding extensive hillslope stability is the complex mass movement feature downslope of Rx-7 which appears to remain active.

Appendix Unit 83-4

Photo Points
D-Line
Site 83-5

July 28, 1983
Cloudy/foggy

PR
&
DV

Photo Point	Color 35mm (200)	B & W 35mm (400)	Comment
#1 A	1, 2	1	Stake on outside of road 6+00. View down road of ripped section and CRD's.
#1 B	3, 4	2	Up road of CRD's and fill area.
#2	5, 6	3	Stake up channel on left bank view down excavation site of Rx-6.
#3 A	7, 8	4	Stake upslope of road 30' and right of channel 20'. View down excavation site at Rx-7.
#3 B	9, 10	6	View along right bank OS area of Rx-7.
#4 A	11, 12	7	11 + 70 stake 40' up from road prism. View down OS road reach at fir line.
#4 B	13, 14	8	View across OS reach.
#5 A	15, 16	9	Stake up fill slope between Rx-8 & 9. View down road of OS reach and Rx-8.
#5 B	17, 18	10	View across right bank into Rx-8
#5 C	19, 20	11	View across left bank into Rx-9.
#6	21, 22	12	Stake upslope of road prism 35' 8' right of gully from St-1. View of road area with CRD's.
#7	23, 24	13	3 T stake on left bank 20' up from ST. View down Xing.
#8	25, 26	14	3-22 1 + stake on left bank on upper portion of Xing. View down excavation site.

July 28, 1983
Cloudy/foggy

Photo Points
D-Line
Site 83-5

PR
&
DV

Photo Point	Color 35mm (200)	B & W 35mm (400)	Comment
#9	27, 28	15	Stake 100' up road from 3-22-1T. Stake up cut bank 15'. View down OS reach towards 3-22-1T.
#10	29, 30	16	Stake 35' down road and up cutbank 20'. View of Rx-10 across left bank and down excavation.
#11	Omitted	17	CRD over landing. Stake on right bank 30' right of upstream portion of Xing. View down CRD over wide area in road at 31 + 20
#12	Omitted		ST-1 Xing.
#13	Omitted		Dog-leg CRD
*Note: Let Cat knock brush down before taking photos: ST-1 Xing; Dog leg Xing;			
#14	33, 34	18	Upper Xing of '80' site. Stake on right bank at upward extent of excavation beneath <u>very</u> large ceonothus.
#15	35, 36	19	Lower Xing of '80' site. Stake on right bank of upstream extent of Xing. View down channel.
#16 A	1, 2	20	Rx-11 Stake on right bank of lower 20% of excavation just at fir line. View upstream of Xing.
#16 B	3, 4	21	Rx-11 View downslope end of Xing.
#17 A	5, 6	22	Stake on top stump above CB of rock pit (way above OS reach) at 65 + 60. View <u>1</u> to OS
#17 B	7, 8	23	View of fill site in down road direction.

July 28, 1983
Cloudy/foggy

Photo Points
D-Line
Site 83-5

PR
&
DV

Photo Point	Color 35mm (200)	B & W 35mm (400)	Comment
#18 A	9, 10	24	Stake on ST adjacent to rock scarp of rockpit. Left of channel 70' 100' upslope of road. View of Rx-12
#18 B	11, 12	25	View of OS fill area up road of Rx-12
June 29, 1983 Cloudy			
#19 A	13, 14	26	Shot of fill site between Rx-12 & 13. Stake on right bank below Rx-13 75' next to 15' fir.
#19 B	15, 16	27	Rx-13; view up-channel.
#20 A	17, 18	28	Stake up CB 35' 75' down road of Rx-14. View down road of fill area along ridge.
#20 B	19, 20	29	View of Rx-14 over right bank.
#21	21, 22	30	Stake on log which lies across channel at upstream extent of excavation on Rx-15. View down Rx-15.
#22	23, 24	31	Rx-16 and right bank OS. Stake on left bank at fir line. View down Xing.
#23 A	25, 26	32	Stake at 97 + 60 on prairie; nailed to fence post upslope of road. View down prairie OS reach.
#23 B	27, 28	33	View across prairie OS reach.

July 28, 1983
Cloudy/foggy

Photo Points
D-Line
Site 83-5

PR
&
DV

Photo Point	Color 35mm (200)	B & W 35mm (400)	Comment
#24	29, 30	34	Stake on outside of road next to 102 + 00 stake. View down road of OS reach of prairie.
	34		Div. placement of Rx-7 to Rx-6 with flexible plastic hose.
	35		

ARCHIVE FILE LIST

File #1 Summary Report Maps and Mylars.
File #2 Field Notes
File #3 Heavy Equipment Work Schedule; Pre-Rehabilitation
File #4 Post-Rehabilitation Heavy Equipment; Hours and Costs
File #5 Prescription Sheets; Volume Estimates; Pre-Rehabilitation Cost
Estimates for Heavy Equipment
File #6 Profiles and Volume Estimates
File #7 Disturbed Area and Straw Mulch
File #8 Drainage Area/25-year Discharge Estimate
File #9 Labor and Backhoe Work
File #10 Rock Armor Estimates
File #11 Time Sheets for Heavy Equipment
File #12 DI-1's for Heavy Equipment
File #13 Maps

LITERATURE CITED

Burns, David 1982 Geomorphic map of Unit 82-5

Burns, David and Paul Routon, 1983

11

APPENDIX

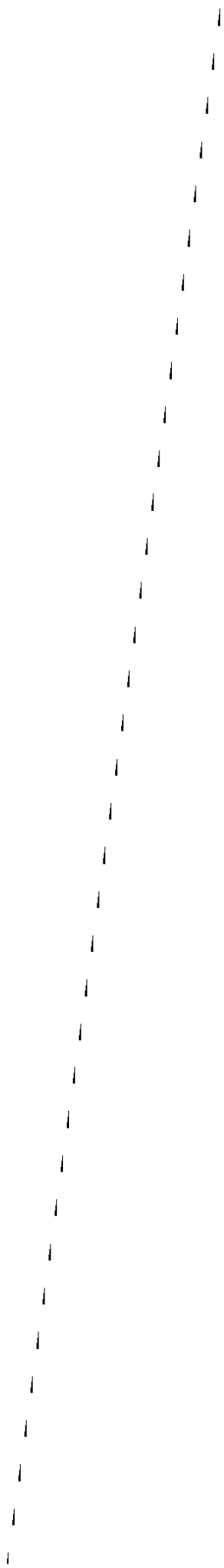


PHOTO POINTS

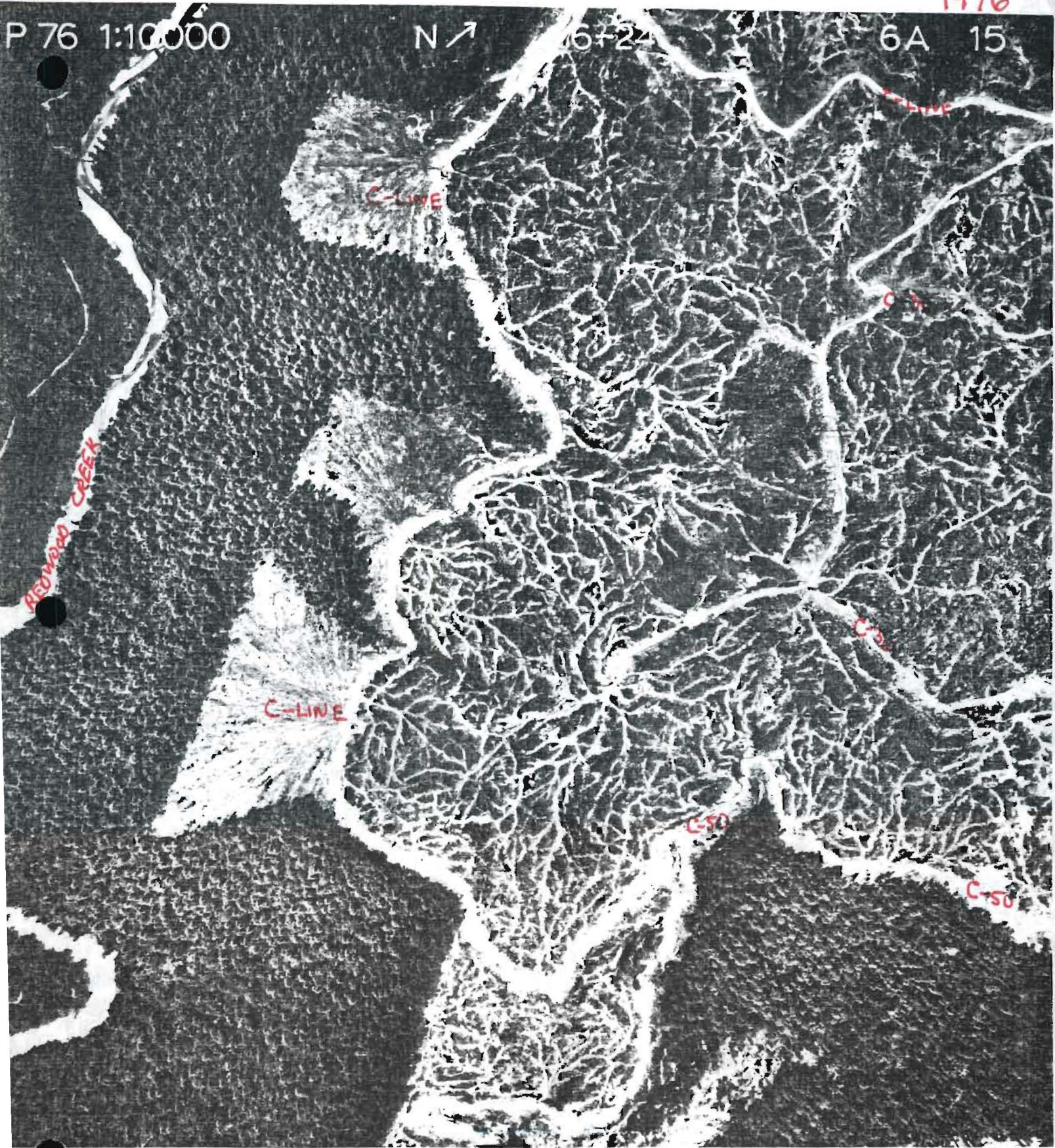
1976

P 76 1:10000

N ↗

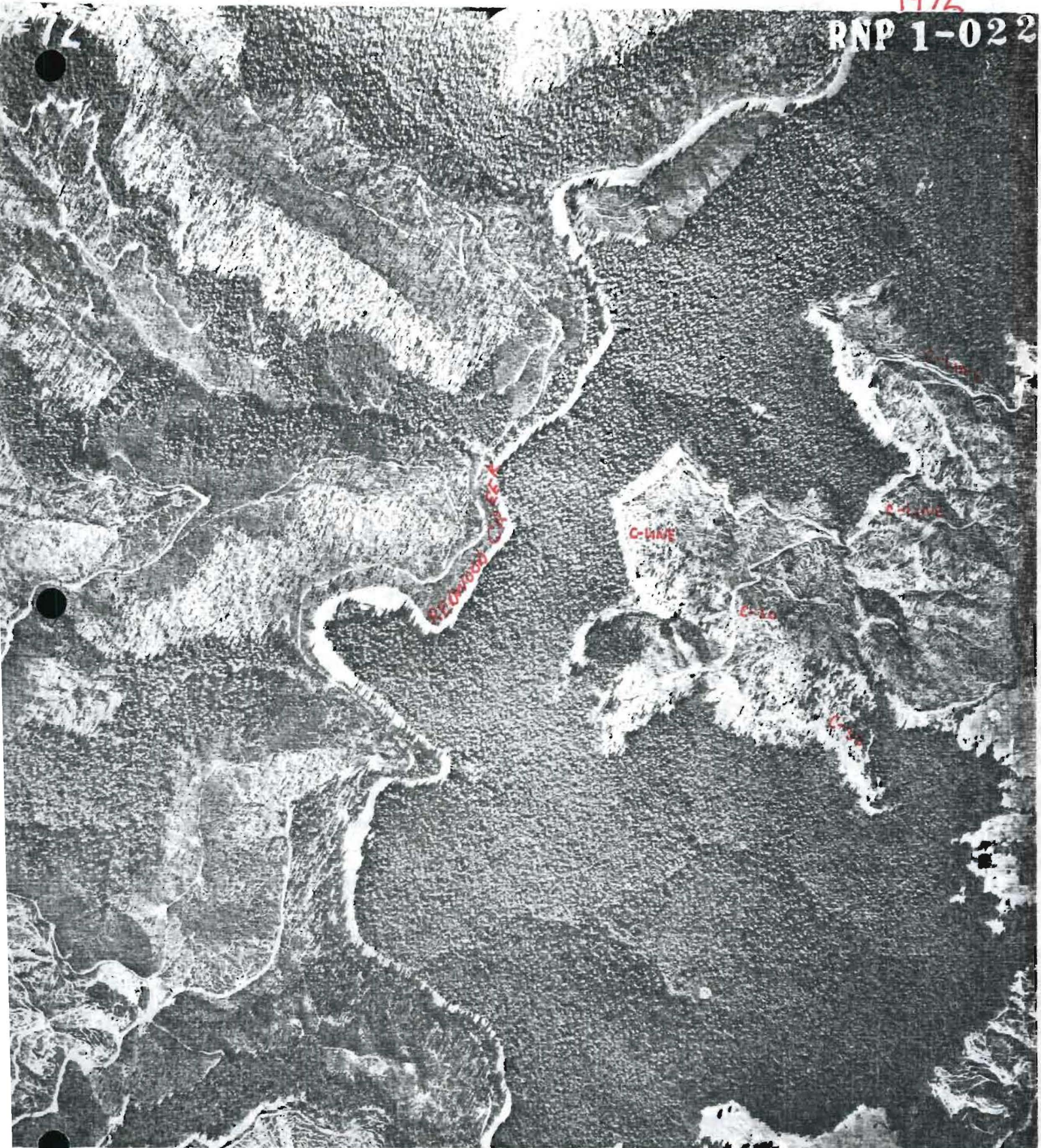
6+22

6A 15



1972

RNP 1-022

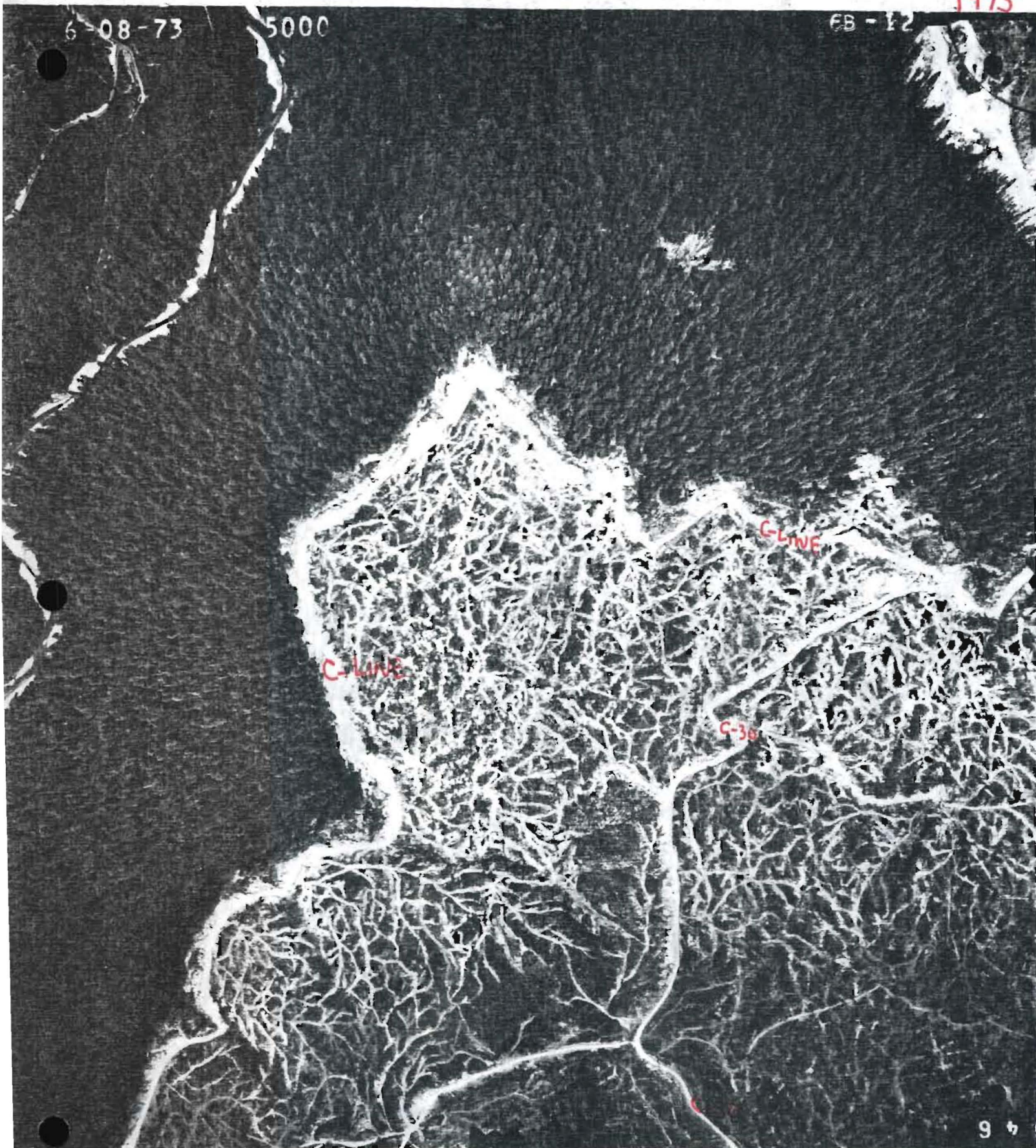


6-08-73

5000

EB-12

1973



1973

6-08-73

5000

65-11

C-LINE

C-30

C-30

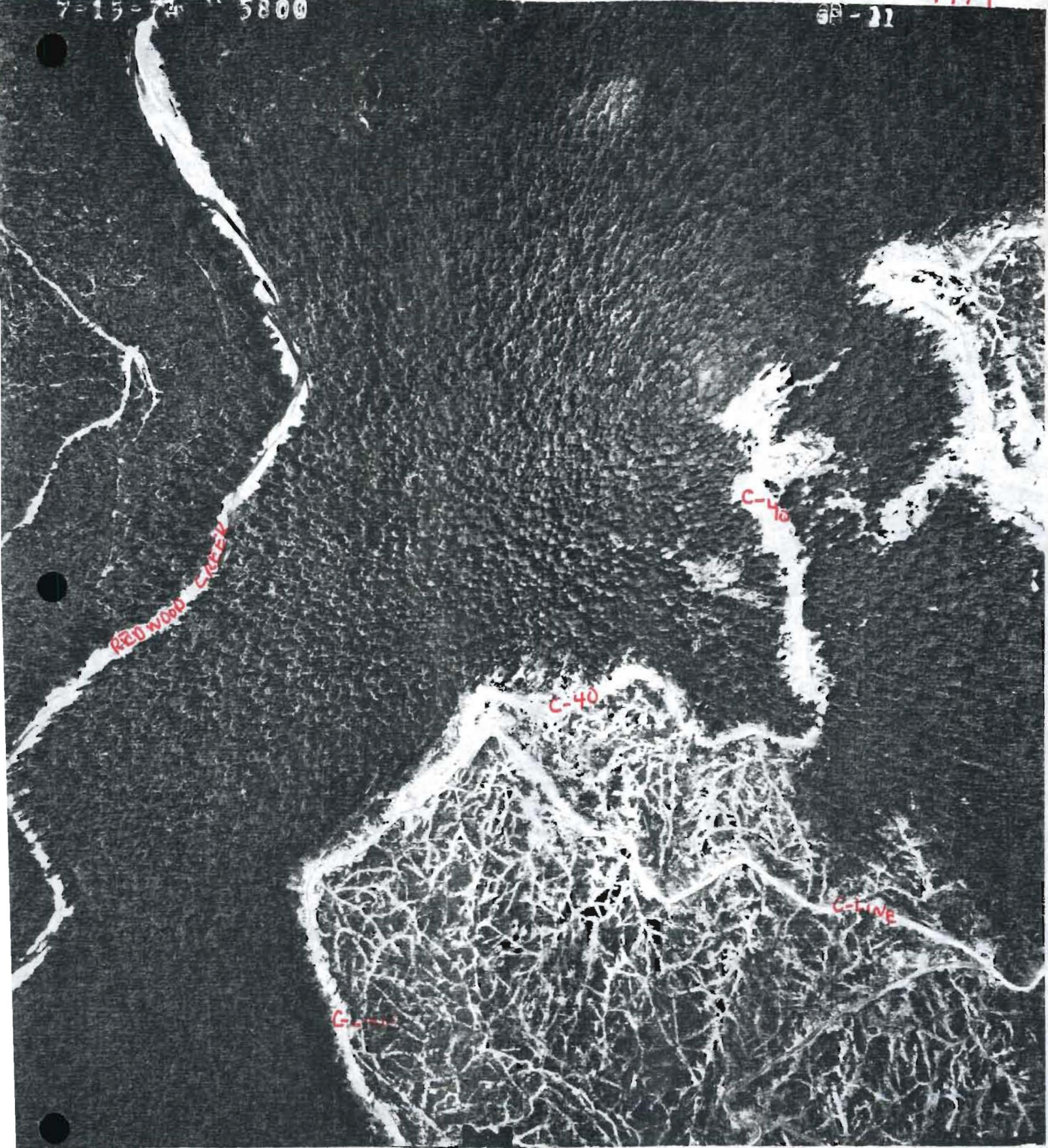
C-50

C-LINE

C-LINE

7-15-74 5800

SP-21 1974

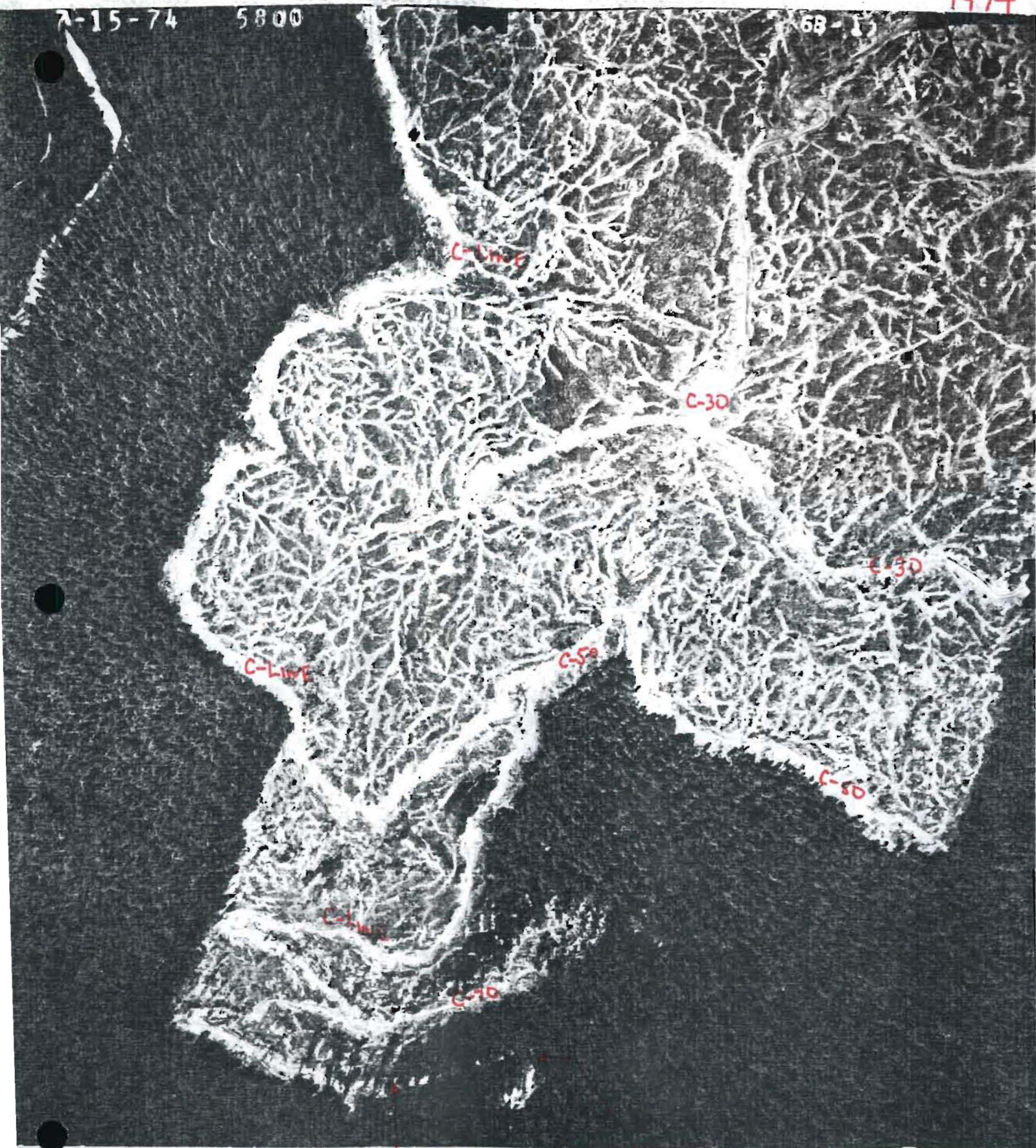


7-15-74

5800

68-1

1974



LOWER C-LINE

EMERALD CREEK BRIDGE

1976

P 75 1:10000

N ↗

6-24

6A 13

REDWOOD CREEK

C-40

C-40

C-40

C-LINE

1976

P 76 1:100 0

N ↗

6-24

6A

14

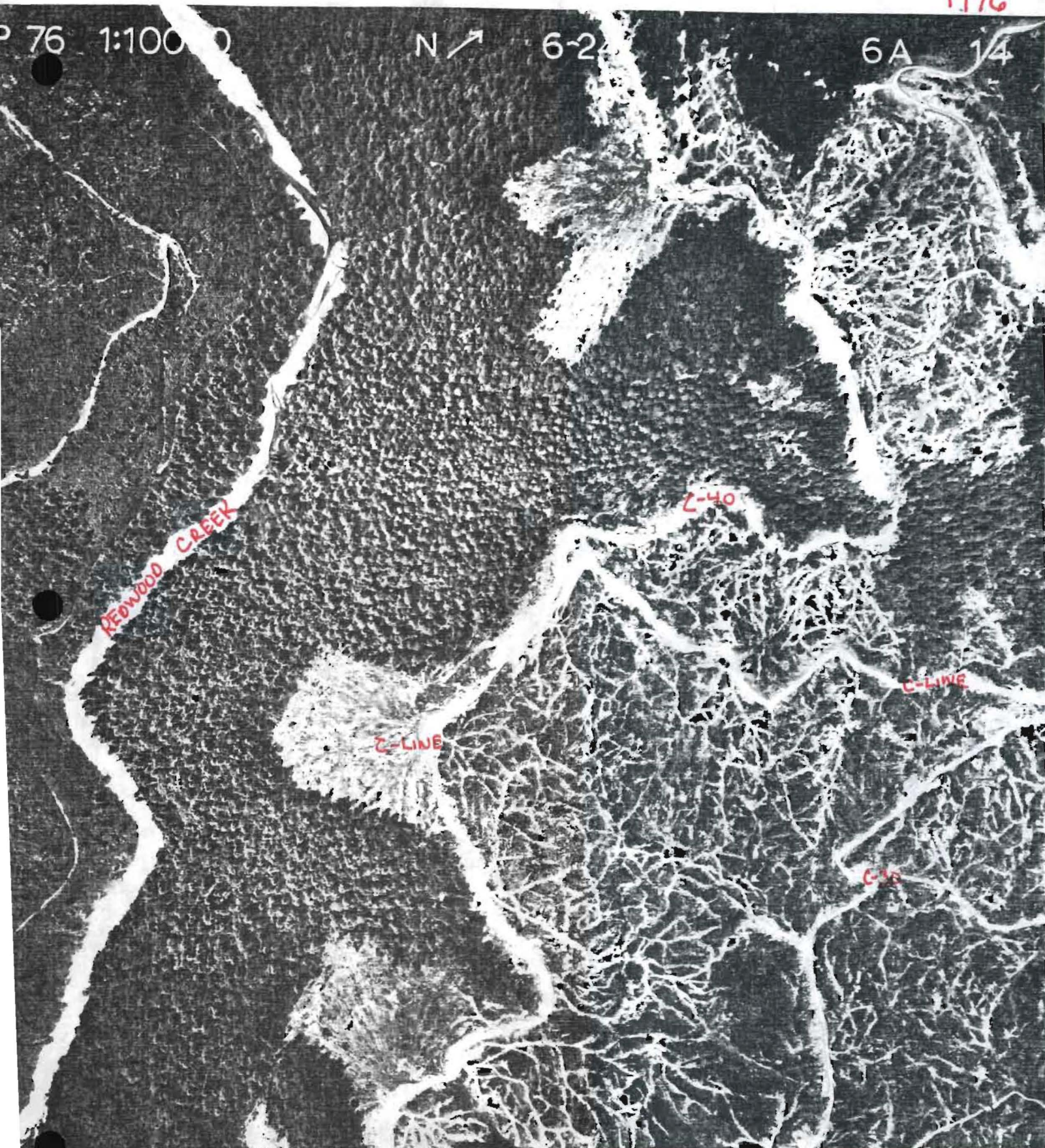
REWOOD CREEK

Z-40

Z-LINE

C-LINE

C-30



1976

P 75 1:100000

6A 17

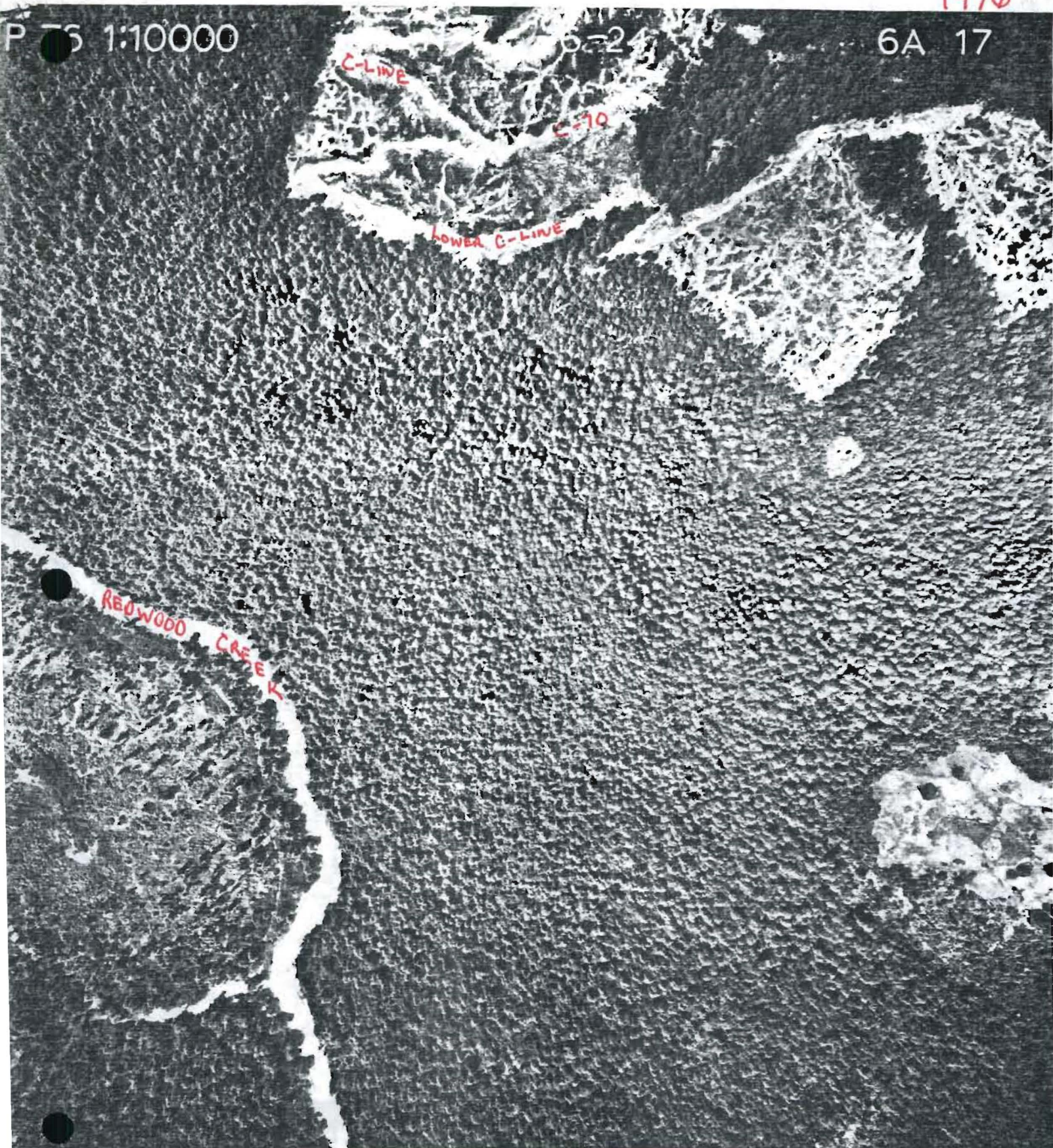
C-LINE

D-24

C-10

LOWER C-LINE

REOWOOD CREEK





Unit: 83-4 Date: 7-11-1984, PP3A, SOC, (DAS)



Unit: 83-4 Date: 11-8-1983, PP3A, SOC, (DV)



Unit: 83-4 Date: 11-8-1983, PP7, SOC, (DV)



Unit: 83-4 Date: 7-17-1984, PP7, SOC, (DAS)



Unit: 83-4 Date: 7-28-1983, PP17A, SOC, (DV)



Unit: 83-4 Date: 11-8-1983, PP17A, SOC, (DV)



Unit: 83-4 Date: 8-1-1985, PP24, SOC