

Summary Report
WATERSHED REHABILITATION UNITS 95-1 and 95-2
AH PAH ROAD COMPLEX

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Redwood National Park
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INTRODUCTION

Background

Public Law 95-250 (March 27, 1978) directed that a rehabilitation program be developed for lands that had been timber harvested prior to becoming part of Redwood National Park. Before these lands were added to the park, timber harvesting and related road construction had adversely influenced erosion rates, sediment deposition, and water quality within the entire basin. These problems are being addressed in the rehabilitation program. The purpose of the rehabilitation program is to minimize man-induced erosion within Redwood National and State Parks, encourage the return of a natural pattern of vegetation, and protect redwood groves and aquatic communities. Ultimately, these efforts should result in the restoration of natural ecosystems to conditions similar to what would have existed without disturbance by man. (Redwood National Park, Watershed Rehabilitation Plan, 1981)

Redwood National Park and the California Department of Parks and Recreation (CDPR) entered into a management agreement in 1994 for cooperative management of Redwood National Park, Prairie Creek Redwoods State Park, Del Norte Coast Redwoods State Park, and Jedediah Smith Redwoods State Park (now known as Redwood National and State Parks, RNSP). Within units 95-1 and 95-2, 0.3 mile of Ah Pah Road is in Prairie Creek Redwoods State Park, while the remainder of the project area is in Redwood National Park.

Watershed rehabilitation work for Units 95-1 and 95-2 was performed in conjunction with construction of the U.S. Highway 101 Bypass. The roads encompassed by these units were used by the California Department of Transportation (Caltrans) during construction of the bypass in 1984 through 1990. These roads were segments that dead ended or were completely isolated as a result of the bypass construction. The Special Use Permit issued to Caltrans to construct and operate the bypass, stated that Caltrans would restore all areas disturbed as part of the bypass construction to National Park Service Standards. The Redwood National Park standard for abandoned roads is to remove the roads by restoring the topography and hydrology to conditions that existed prior to man's influence.

The National Park Service, Caltrans, and CDPR entered into an agreement (Memorandum of Agreement #8480-3-9002) for Caltrans to reimburse RNSP for expenses incurred to remove National and State Park roads which were used by Caltrans during construction of the U.S. Highway 101 Bypass. Units 95-1 and 95-2 were completed under this agreement.

This project was split into two contracts so that two sections of the project could be worked on at the same time. This was necessary because of the late start date in September due to threatened and endangered species concerns. The southern loop of the B-Line is unit 95-2, while the rest of the project area is unit 95-1.

Site Description

The project area is located approximately ten miles north of Orick between Newton B. Drury Scenic Parkway and the U.S. Highway 101 Bypass (Figures 1 and 2). The section of Ah Pah Road in the project area ran from the Newton B. Drury Scenic Parkway to the bypass. The spur roads which were treated were portions of East Ridge Road, S-Line and B-Line. Ah Pah Road was 1.2 miles long and had nine stream crossings. Three-tenths of a mile of Ah Pah Road and one stream crossing were in Prairie Creek Redwoods State Park, while the remainder of the project area was in Redwood National Park. The portion of the East Ridge Road which was treated was 0.13 mile long and contained one small stream crossing. The S-Line was 0.2 mile long with two adjacent stream crossings. The B-Line was composed of two loops, each 0.2 mile long with two stream crossings on each loop.

Unit 95-1 occupies the upper hillslope regions of the Ah Pah and McGarvey Creek drainages, both tributary to the Klamath River. Unit 95-2 is located in the upper hillslope region of the Ah Pah Creek drainage, tributary to the Klamath River. Total relief for both units is 500 feet, with elevations ranging from 640 feet to 1140 feet. Hillslope gradients range from 20% to 100%. Stream valleys are often narrow and deep with steep (50% - 100%) side slopes. Drainage areas range from 0.5 to 17 acres. Stream crossing RX-B3 had impounded water behind the road fill covering 0.3 acre.

Geology

The project area is underlain by Pleistocene fluvial deposits of the Prairie Creek Formation overlying the Franciscan Complex sandstones. The contact is exposed in the Highway 101 Bypass cutbank between the B-Line north loop and Ah Pah Road. The Prairie Creek Formation is composed of Pliocene/Pleistocene cobbles, sands, and silts that are thought to have been deposited in a river delta laid down by the Klamath River more than two million years ago. This formation lacks competent material and is prone to both surface and deep-seated erosional processes. The cutbank between the B-Line North and Ah Pah Road is a good example of the Prairie Creek Formation which has failed in large slump blocks. In contrast, the Franciscan Formation contains relatively competent material.

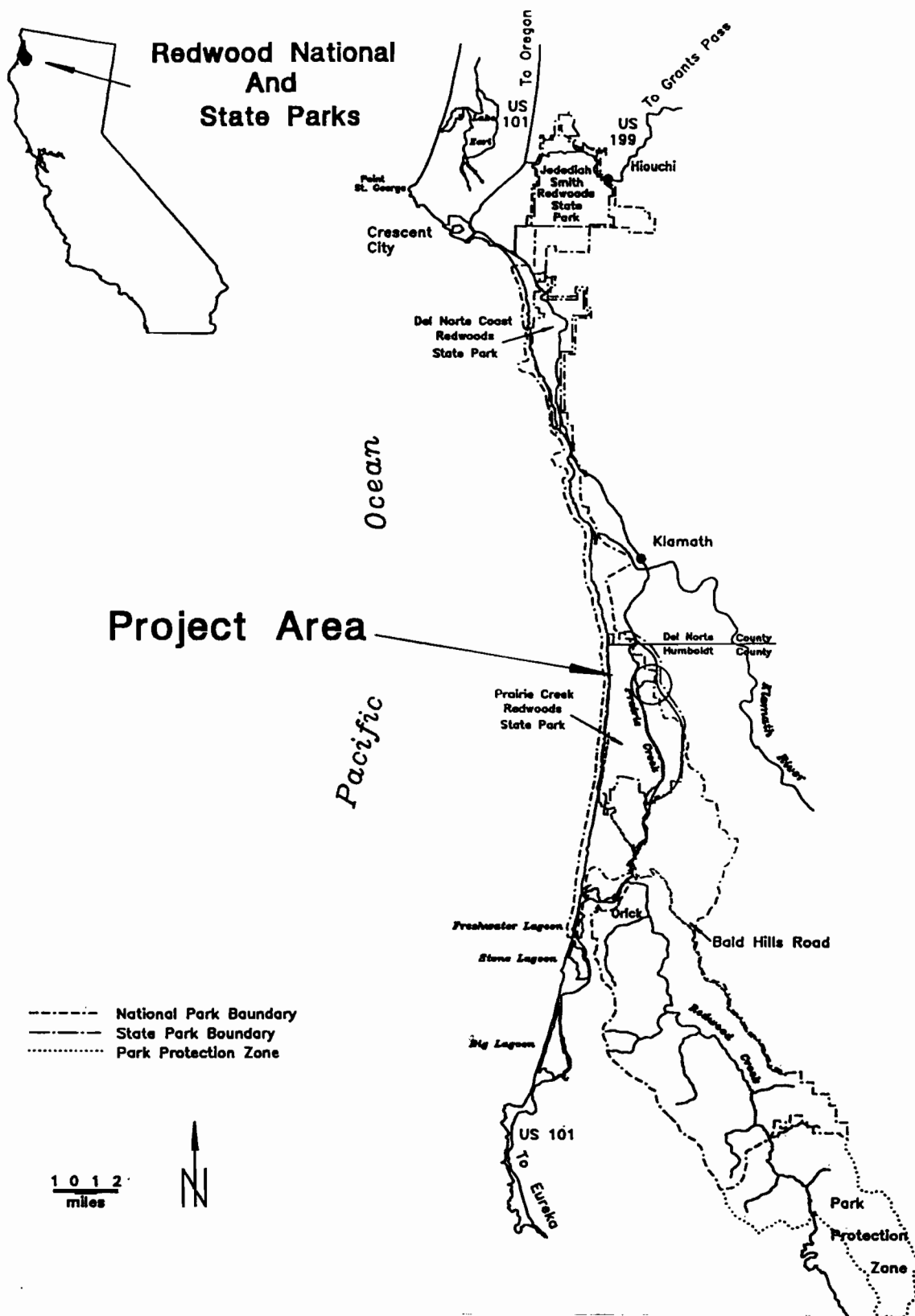


Figure 1. Location of Project Area in Redwood National and State Parks

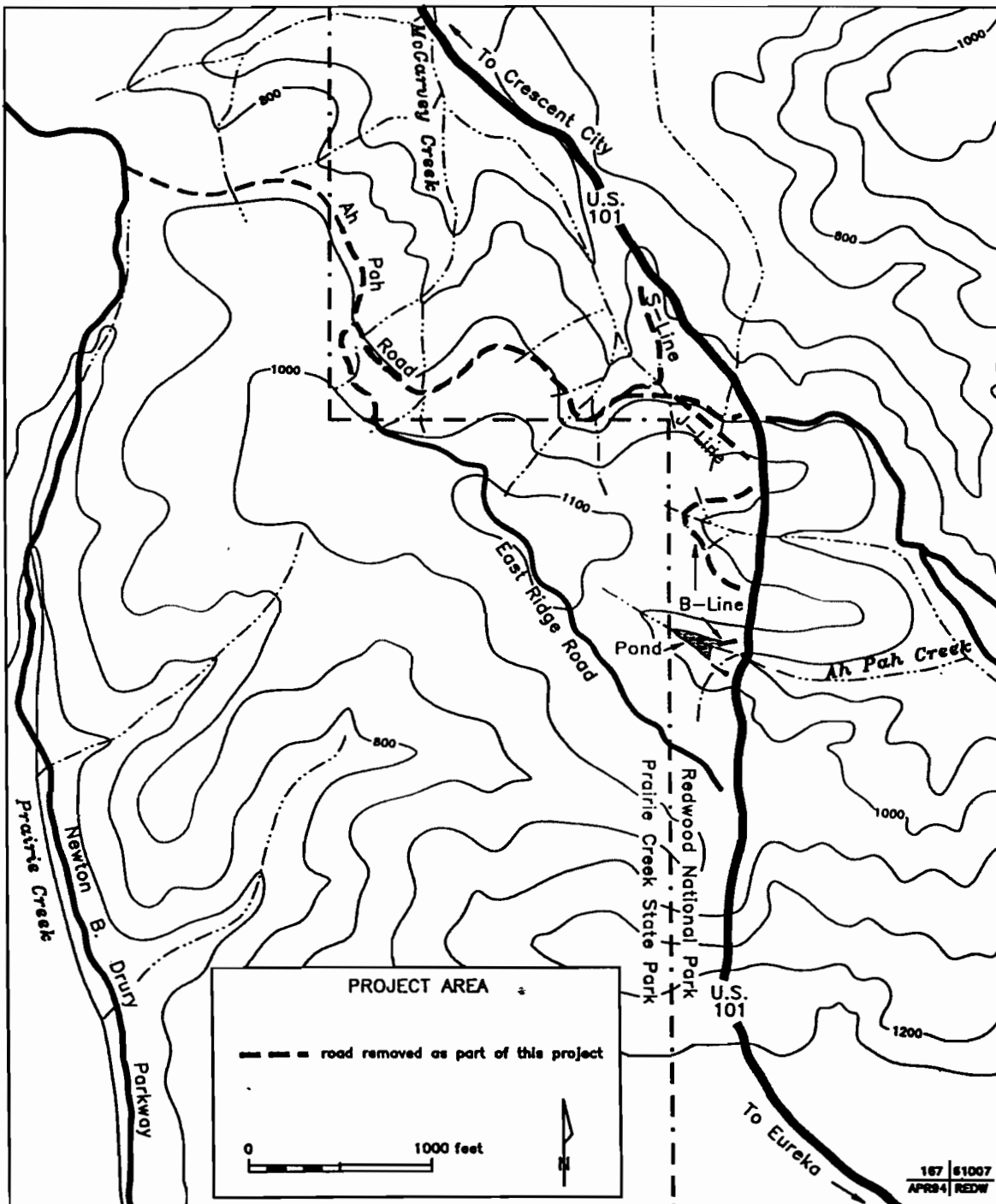


Figure 2. Location of Road Segments Removed in the Project Area

Timber Harvest History

The 1936 air photos covering the project area show that neither Ah Pah Road nor any of the spurs had been constructed and that timber harvest had not begun. East Ridge Road may have been constructed by the Civilian Conservation Corps in the 1930s, but it is not visible in the air photos through the old growth canopy. By 1948, Ah Pah Road, S-Line and B-Line north had been constructed and the entire project area outside of the protected Prairie Creek State Park had been select cut or clear cut with seed trees left (Figure 3). The height of timber harvest and road building in the project area probably occurred in the early 1940's. The majority of the area was cable logged so few skid roads are present. B-Line south was constructed between 1954 and 1962. The area around the B-Line south had been selectively harvested prior to road construction. Areas along Ah Pah Road, B-line north, and B-Line south continued to be selectively harvested between 1948 and 1962. Tractor yarding was dominate during this later period adjacent to the B-Line. The landing on Ah Pah Road at station 34+00 was constructed between 1948 and 1954. The reservoir was also constructed between 1948 and 1954 and it was enlarged before 1962. No additional road construction or timber harvest is apparent in the air photos after 1962. Redwood National Park acquired the lands in this project area between Prairie Creek State Park and the U.S. 101 Highway Bypass when the bypass was constructed in the 1980s.

Threatened and Endangered Species Concerns and Work Schedule

Two species that are listed as threatened under the Endangered Species Act occupy the project area: the northern spotted owl and the marbled murrelet. Because old growth forests serve as critical habitat for these species, Redwood National and State Parks is considered a critical conservation area for their survival.

The U.S. Fish & Wildlife Service (USFWS), as administrator of the Endangered Species Act, has set noise and habitat modification restriction guidelines designed to reduce human impact, especially to nesting sites during the breeding season. Surveys for owls and murrelets were conducted in 1993. A pair of owls were found, but nesting status was undetermined. Murrelets displayed occupying behaviors, which is currently the best indication that they are nesting in the area. Consultation with USFWS resulted in heavy equipment work being permitted only after September 1. Due to the Labor Day Holiday weekend, heavy equipment work began on September 5. Work between September 5 and September 15 was restricted to between two hours after sunrise to two hours before sunset and to within 500' of the bypass. Work after September 15 had no restrictions.

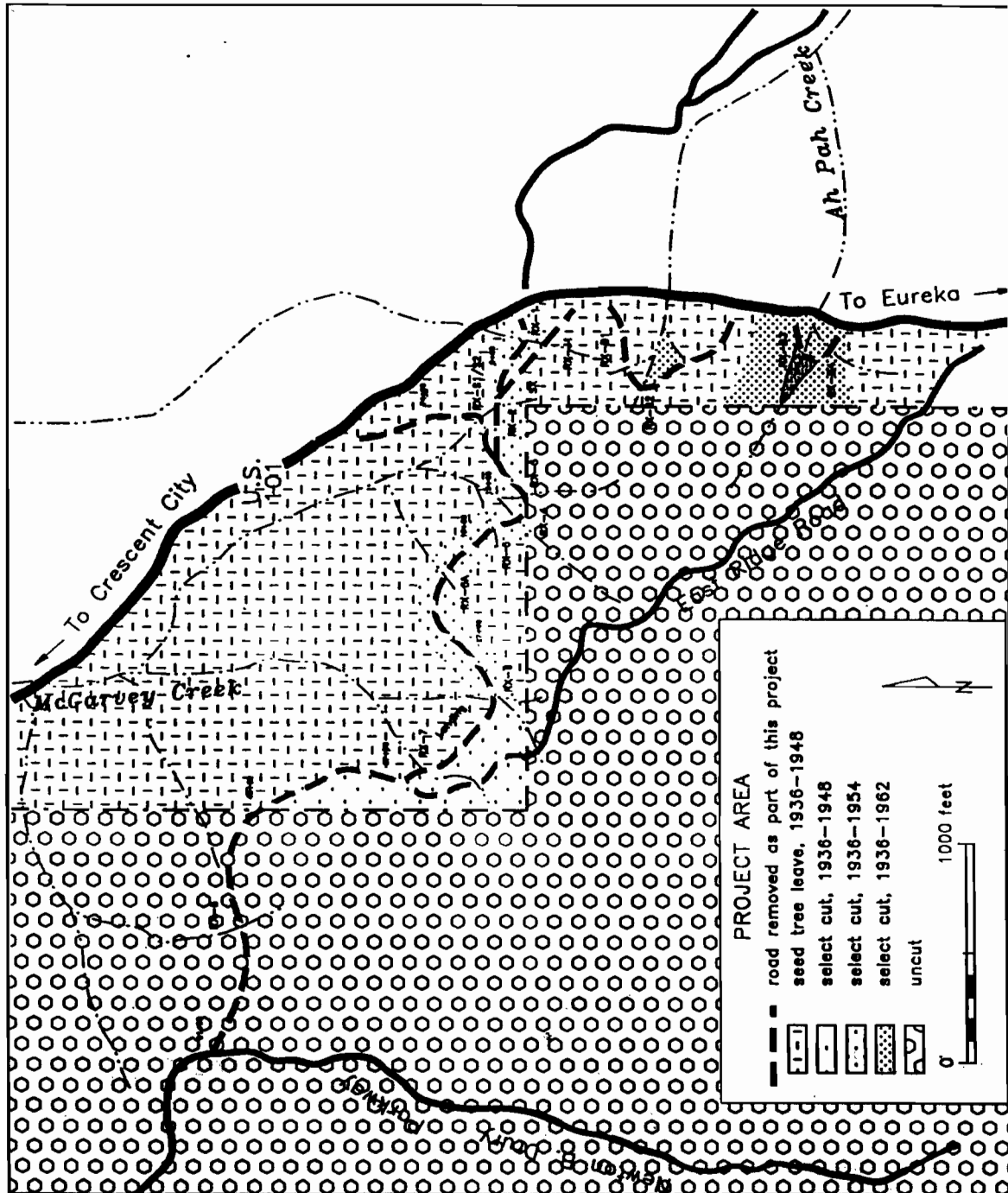


Figure 3. Timber Harvest History of the Project Area

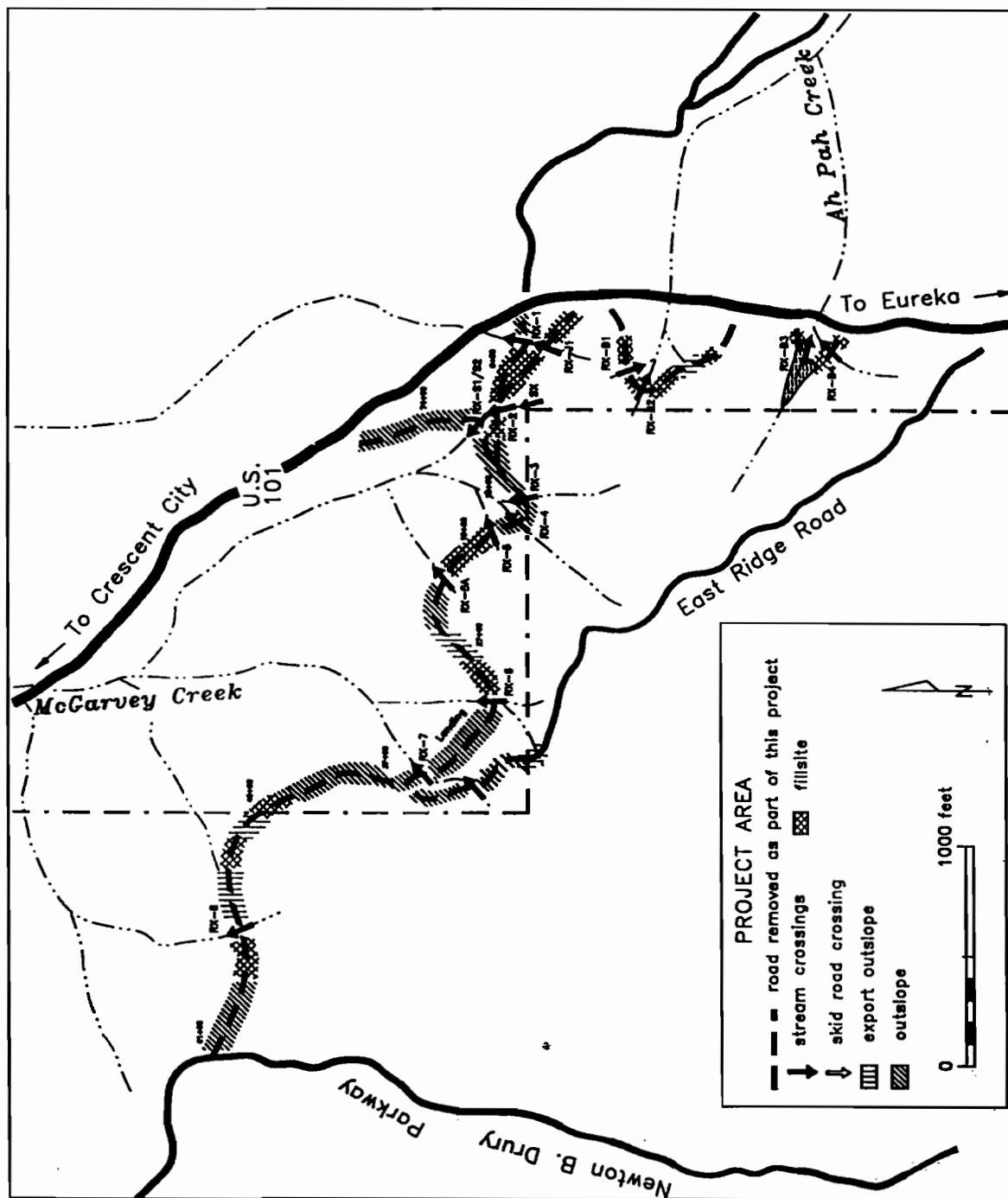


Figure 4. Location of Treatment Types in the Project Area

REHABILITATION WORK

Project Implementation

Rehabilitation work focused on restoring the land to a condition similar to what would have existed without disturbance by man. This included complete excavation of road fill out of stream crossings and swales, complete rebuilding of ridges, and complete outslipping of the road, resulting in the road fill being shaped to mimic the natural hillslope topography above and below the road (Figure 4). Complete recontouring provides a solid, beneficial foundation morphologically, hydrologically, and aesthetically for landscape evolution. The westernmost 0.3 mile of Ah Pah Road was located in an old growth redwood forest which contains memorial groves. The remainder of Ah Pah road had numerous old growth trees within 50' of the road. Proximity to the Newton B. Drury Parkway and the Ten Tapo Trail, as well as the construction of an interpretive and memorial grove trail along the westernmost 0.3 mile of the treated Ah Pah Road make this a visitor use area. The hillslopes in the project area were less disturbed by timber harvest activities (i.e. fewer skid roads) than most areas of Redwood National and State Parks which were logged. These conditions made this area ideal for complete recontouring and restoration.

Redwood National Park's watershed rehabilitation program is divided into four work phases: 1) evaluation; 2) heavy equipment; 3) labor intensive; and 4) documentation. Redwood National Park was responsible for the evaluation work, supervising the heavy equipment work in the field, and documentation. California Department of Parks and Recreation (CDPR) was responsible for administration of the contract and trail construction following treatment.

Evaluation Phase

The evaluation phase included mapping of geomorphic and hydrologic features, prescribing rehabilitation treatments, surveying the volumes of all proposed worksites, and preparing the contract. A summary of project costs is shown in Table 1.

Mapping and treatment prescriptions were begun by D. Short in early 1994 and were continued by B. Smith in 1995. Surveying was done in 1995 by B. Smith, D. Short and numerous assistants. The contract was prepared and administered in 1995 by C. Blomstrom of CDPR, B. Smith, D. Short, and T. Spreiter.

The contracts were hourly equipment rentals so volumetric surveys were not necessary for payment purposes. However, surveys were conducted in order to determine production rates, the cost effectiveness of the project, and to ensure adequate fill space since there were few skid roads that could serve as fillsites. Layout of most crossings for surveying was more straight forward than many areas of

TABLE 1
REHABILITATION WORK COST SUMMARY FOR UNITS 95-1 AND 95-2,
AH PAH ROAD, B-LINE SOUTH AND SPURS

TREATMENT	QUANTITY	# OF JOBS	TOTAL COSTS	% OF GRAND TOTAL	AVERAGE UNIT COSTS
HEAVY EQUIPMENT					
Stream Crossings	55,565 yds ³	15	\$125,827.09	44	\$2.26/yds ³
Exported Outslope	6,057 yds ³	4	\$13,512.75	5	\$1.01/yds ³
Outslope	24,706 yds ³	9	\$25,039.70	9	\$2.23/yds ³
Additional Work Sites	unknown	4	\$4,870.00	2	---
Misc. Excavation Items	---	18	\$21,313.69	7	---
Misc. Non-excavation Items	---	8	\$35,302.30	12	---
Supplies and Materials	---	---	\$816.13	0	---
Sub-total:	86,328 yds ³	58	\$226,681.66	79	---
PROJECT IMPLEMENTATION					
Planning	88.00 hrs	---	\$1,917.24	1	
Mapping	152.00 hrs	---	\$2,851.44	1	
Prescribe	168.50 hrs	---	\$2,992.17	1	
Survey	471.50 hrs	---	\$8,330.58	3	
Environmental Compliance	339.50 hrs	---	\$7,627.11	3	
Archeological Study	NA	---	\$2,200.00	1	
T & E Studies	214.00 hrs	---	\$3,819.25	1	
Contract Preparation	150.00 hrs	---	\$3,210.00	1	
Contract Supervision	1,107.00 hrs	---	\$21,815.81	8	
Photo Documentation	135.50 hrs	---	\$3,091.08	1	
Budget	25.50 hrs	---	\$460.09	0	
Report Writing	56.00 hrs	---	\$1,067.96	0	
Sub-total:	2,907.50 hrs	---	\$59,382.73	21	
GRAND TOTAL			\$286,064.39		

RNSP because the stream channels and hillslopes above and below the roads were less disturbed due to fewer skid roads.

Heavy Equipment Phase

The heavy equipment phase included completion of all primary rehabilitation and erosion control treatments. A total of 1.2 miles of Ah Pah Road and 0.73 miles of spur roads were rehabilitated for a total heavy equipment cost of \$226,682. A total of 86,328 surveyed yds³ of material was excavated from 0.55 miles of outslowing (24,706 yds³), 0.2 miles of export outslowing (6,057 yds³), and 15 stream crossings (55,565 yds³).

The heavy equipment phase was done through the CDPR under two hourly rental equipment contracts. Each contract specified that equipment operators must have a minimum of 1200 hours of experience operating similar heavy equipment performing road removal and landform restoration work in steep, mountainous terrain. It was hoped that this would ensure efficient and high quality work. Listed below is a summary of the bids which were received:

95-1 Ah Pah Road and spurs

Lambert's Excavating Service	\$217,000
Figas Construction	\$221,580
Carl M. Kjer and Sons	\$233,500

95-2 B-Line South

Figas Construction	\$ 30,360
Carl M. Kjer and Sons	\$ 36,000

The 95-1 contract was awarded to the lowest, responsive bidder, Lambert's Excavating Service, for 500 hours on each of three pieces of equipment: 1) a track mounted excavator with a minimum of 2.5 yds³ bucket, 38 ft. horizontal reach, and 235 horsepower; 2) a D8H or equivalent bulldozer with winch; and 3) a D8H or equivalent bulldozer with rippers. The bid price was greater than the amount that had been received from Caltrans for the entire project, so the number of hours for each piece of equipment was reduced as follows: 330 hours excavator; 290 hours dozer with winch; and 330 hours dozer with rippers. Although these reduced equipment hours were inadequate to complete the entire project, it was felt that it would be unlikely that the project could be completed before the winter rains began. However, the fall of 1995 was unusually dry, so heavy equipment was able to continue to completion. In order for the project to be completed in the most cost effective, least resource damaging, and highest quality manner, the contract was amended and the

additional expense was paid for by Redwood National Park. RNP is currently requesting reimbursement from Caltrans.

The heavy equipment work for 95-1 began on September 21, 1995 and was completed on November 22, 1995. The equipment which was delivered to the site was a Case 220 excavator (operated by Larry Lambert, \$150/hr), a D8H Caterpillar bulldozer with winch (operated primarily by Wendall Larkin and occasionally by Ernie Larkin, \$137/hr), and a D8H Caterpillar bulldozer with rippers (operated primarily by Ernie Larkin and occasionally by Wendall Larkin, \$137/hr). The Case 220 broke down on October 10 and was replaced on October 14 by a John Deere 892E excavator, also operated by Larry Lambert. The Case 220 and the D8H with rippers worked alone until October 4 when the D8H with winch began working. It was quickly apparent that two dozers were too many for the one excavator to work efficiently with and that there would be a lot of idle and standby time. On October 13, an agreement was made with the contractor to provide a Hitachi 200 excavator (operated by Wendall Larkin) which would be paid the same rate as the dozers (\$137/hour). This excavator was used interchangeably with one of the dozers. Therefore, only three of the four pieces of equipment were in use at a time. Standby was not paid for the piece which was not being used. This small excavator was an excellent addition. It did nearly all the finish work and was able to get around and sit on slopes much steeper and work in smaller spaces (i.e. the bottoms of stream crossings and between old growth trees) than the larger excavator.

The 95-2 contract was awarded to the lowest, responsive bidder, Carl M. Kjer and Sons for 100 hours on each of two pieces of equipment: 1) a track mounted excavator with a minimum of 2.5 yds³ bucket, 38 ft. horizontal reach, and 235 horsepower; and 2) a D8H or equivalent bulldozer with winch.

The heavy equipment work for 95-2 began on September 5, 1995 and was completed on September 25, 1995. The equipment which was delivered to the site was a Bucyrus Erie 350 excavator (operated by Ernie Kjer, \$185/hr) and a D8H Caterpillar bulldozer with winch (operated by Paul Johnson, \$135/hr). Due to inefficient equipment operation and the very wet condition of the fill, the heavy equipment work was not completed within the contract budget. The project was completed in the most cost effective and least resource damaging manner through a Federal sole-source contract funded by Redwood National Park. Redwood National Park is currently requesting reimbursement from Caltrans.

Photographs of selected areas before and after heavy equipment work are in Appendix A.

TABLE 2 STREAM CROSSING EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 95-1, AH PAH ROAD AND SPURS									
WORKSITE	VOLUME (yds ³)	HEAVY EQUIPMENT HOURS				TOTAL COSTS	UNIT COSTS (\$/yds ³)	EXCAV. RATE (yds ³ /hr)	
		CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200				
RX-1	3115	24.50	25.75	3.25	6.00	\$8,470.00	\$2.72	52	
RX-2/S1/S2	9894	37.00	41.50	27.75	22.50	\$18,119.75	\$1.83	77	
RX-3	4307	22.75	8.25	0.50	13.00	\$7,924.20	\$1.84	55	
RX-4	5108 ^a	30.00	16.75	2.75	11.50	\$11,267.75	\$2.21	45	
RX-5	2112	12.25	8.00	2.75	2.25	\$3,618.50	\$1.71	84	
RX-5A	1500 ^b	9.00	9.25	1.00	0.50	\$2,822.75	\$1.88	76	
RX-6	3565	28.25	22.50	10.50	20.00	\$11,498.50	\$3.23	44	
RX-7	4501	1.00	27.75	4.75	30.00	\$8,712.50	\$1.94	71	
RX-8	7325	59.00	0	9.00	19.25	\$16,960.89	\$2.32	41	
RX-B1/RX-B2/ Swale	600 ^b	4.25	3.25	0	0	\$1,082.75	\$1.80	80	
RX-J1	5372	12.00	27.00	1.25	1.50	\$5,875.75	\$1.09	129	
SX above RX-2	200 ^b	4.00	0	0	0	\$600.00	\$3.00	50	
TOTALS	47,599	244.00	190.00	63.50	126.50	\$96,953.34	\$2.04	59	

^a This is an average of two different post excavation surveys.

^b Volume is estimated. Surveys were not conducted.

Stream Crossings: 95-1

A summary of stream crossing excavation costs and production rates for 95-1 is shown in Table 2.

RX-1

This crossing was fairly steep and narrow. The dozer built a push road down toward the bottom and the excavator bailed dirt to the dozer to push up the road. This worked for awhile until the road became too steep for the dozer to be able to work efficiently. At this point the excavator double bailed the dirt to the dozer. A lot of large logs were buried in the bottom. Good top soil horizons were uncovered on the lower right and left banks. A layer of greenish-gray muck was uncovered above a layer of black soil containing small pieces of wood. These layers were used to determine the channel bottom. When the Hitachi 200 arrived, it was able to go all the way into the bottom, clean it out, and do superb finish work.

A bedrock (sandstone) ledge was uncovered underneath the road at the upper end of the crossing. This in-place rock produced a convex drop in the channel. One old growth redwood was scarred by the excavator bucket.

Light rain fell periodically during excavation of this crossing. The top few inches of exposed dirt became wet, but underneath this, the dirt was dry and excavation was not slowed.

RX-J1

This was an old skid road which Caltrans upgraded and used during construction of the 101 Bypass. Because Caltrans had re-engineered this road, original landform indicators were very difficult to discern.

This was the broadest crossing of the project and had no old growth trees on the edges. Because of this, the dozer was able to dish out a significant amount of the crossing volume before the excavator was needed to finish the work.

The upper portion of the crossing contained a very thick (approximately 6-8') layer of black soil with small wood chunks and some charcoal. Most of this must have been pushed in here at some point. Perhaps this was an area where stumps were pushed in and burned. This material was black and contained small wood chunks which made it look like top soil. We excavated the channel down to what appeared original ground, but when Wendall arrived on site, he felt the excavation should be deeper. He dug down along the whole channel about 8 more feet which appeared closer to the original channel bed.

An apparent cutbank and large (approximately 42" dbh) second growth redwood between RX-1 and RX-J1 was thought to be original ground. However, as the bottom of RX-J1 was excavated, topsoil went underneath the second growth redwood, indicating that this tree was growing in fill. This tree was removed and the bottom was excavated below design and tied into the top of RX-1

Light rain fell periodically during excavation of this crossing. The top few inches of exposed dirt became wet, but underneath this, the dirt was dry and excavation was not slowed.

RX-2

The dozer dished down the crossing until the push road started getting mucky and it was becoming inefficient for the dozer to work without the excavator. At this point the excavator bailed material to the dozer that pushed it to the fillsite.

Old growth trees on the OBR were uncovered 10-15' until the swell of the rootbole was re-exposed. Part of the bark of one old growth redwood was pulled away from the tree, but not broken off, as the excavator dug around its secondary roots. Another old growth redwood was scarred by the excavator bucket.

RX-S1/S2

There was an old growth snag which was leaning over the road at this crossing. There was concern that this snag could fall during excavation of the crossing as a result of the equipment vibrating the ground and digging dirt from around the snag's base. The snag was felled by state park personnel after consultation with the U.S. Fish and Wildlife Service and before excavation began.

Twenty to thirty logs were buried in the bottom of the crossing. We dug beyond the LES a little into a pile of wood and dirt in the channel. A 6' hole under a log was discovered at the level of the LES. We excavated out the fill in front of this hole causing the excavation to extend about 10' beyond and 8' below the LES.

The excavator was broken down for three days while the dozer dished down RX-2. The dozer got too far ahead of the excavator to be efficient and had to be put on down time until the excavator was fixed.

There was some flow in the bottom of this channel and the fill was very wet. It was too wet to push up to the fillsite and we were running out of fill space so a small amount of wet muck was left in the bottom of the channel with lots of large organics to hopefully stabilize it.

We were running out of fill space so a skid road was opened up near the right bank. This provided more space but it was a steep push for the dozer.

An old growth stump on the OBR was uncovered about 15'. A stump sprout had been growing out of the top of this stump, but it fell over when the stump was fully exposed.

RX-3

The Case 220 excavator had broken down just before work on RX-3 began. This excavator was replaced with a John Deere 892E which was used during the remainder of the project.

Very few skid roads were available for use as fillsites, so essentially all of the fill had to be spread on the road. This necessitated trucking some of the fill from RX-3, RX-4, and RX-8. The fill was moist, sticky, and contained wood chunks which was not ideal for the trucks to dump - wood got stuck in the tailgates and mud stuck to the beds. Larry separated the wood out of the fill as best he could while waiting for the trucks and periodically scraped mud out of the truck beds. Also the sticky fill had to be spread out on the fillsite frequently with a dozer so the trucks could back up the ramps and dump. Approximately 1500 yd³ of fill were trucked from RX-3 to the landing at station 34+00 in two days. We only had two trucks during these two days which was not enough - the excavator had to wait for the trucks to come back.

Top soil was very difficult to find in this crossing. Channel configuration was primarily determined by channel grade and bedrock outcrop on the left bank. The bedrock resulted in the channel having a slightly convex profile. There were a lot of large wood chunks and root wads on the OBR which took some time to get out. A small amount of fill appears to have been left on the right bank near the top.

One stump sprout redwood was scarred by the excavator bucket.

RX-4

Approximately 2700 yd³ of fill were trucked from RX-4 to the landing at station 34+00 in two days using four trucks each day. This was more efficient than RX-3 where only two trucks were used each day. The John Deere 892E excavator broke down and the Hitachi 200 excavator had to be used to load the trucks for a little over half a day.

Water was flowing down the culvert and channel throughout excavation, however this did not create too much of a problem because excavation proceeded from the bottom up with the culvert gradually removed. Well defined top soil layers were uncovered

on both banks in the lower part of the crossing. Grey muck and top soil defined the channel bottom which was wider than designed.

The road across the upper part of the crossing was gradually narrowed, eventually to the point that it was too narrow for the equipment to work safely. This caused the upper right bank to be roughly completed, leaving some fill along the right bank and a hole along the cutbank in the adjacent fillsite.

The bark of one old growth redwood was minimally scarred by the excavator bucket.

RX-5

Some water was flowing through this crossing throughout excavation. Patchy topsoil was uncovered which guided the boundaries of the crossing. A small amount of fill may have been left on the right bank. In general, the crossing ended up looking very good.

RX-5A

This appeared to be a shallow, gentle, swale crossing. The topsoil layer was very thin. Topsoil uncovered was patchy and there was a lot of wood buried in the fill.

RX-6

This crossing became mucky fairly high up in the fill. The dozers could only push two excavator bucket scoops of fill at a time and the push distance was fairly long because we were trying to get as much fill as possible downstation to fill the entire, long throughout between RX-5A and RX-6. Therefore, excavation of this crossing was slow.

The left bank was steep. We were unable to completely fill the cutbank on this side because of the steep slope and wet fill.

RX-7

A concrete and wood pump house was located in the upper portion of this crossing. This structure was removed and buried in the fill on the adjacent landing.

This crossing was very dry in comparison to RX-6. There were a lot of wood chunks, root wads, tires, and metal debris on the right bank which must have been pushed off the edge of the adjacent landing.

As the OBR was dished down, water began flowing out across the unfinished lower part of the crossing. We pushed some wood into this wet portion of the crossing and

covered it with a little bit of fill to make a relatively dry push road out of the bottom. This worked pretty well.

This crossing ended up looking very good, especially compared to how it looked before with all the wood and trash that had been pushed off the landing into the crossing.

RX-8

According to Ernie Larkin, RX-8 used to be a bridge which was later filled in and a culvert installed. Most of the fill came from the cutbank at station 39+00. Because the fill was imported to RX-8 there was very little fill space locally. Approximately 4750 yd³ of fill was trucked from RX-8 to either the cutbank at station 39+00 or the throughcut at station 45+00 over six days using two trucks some days and three trucks other days. As the excavation progressed, the loaded trucks were having a hard time getting up the ramp out of the crossing.

Because the fillsites for the material that was trucked were downstation, RX-8 had to be partially excavated before the intervening road could be treated. After trucking was completed, the crossing had to be left about two thirds excavated while the intervening road bench was treated. We finished the very bottom of the crossing and smoothed and compacted the remaining fill with the excavator bucket so that any rain water would drain over it and hopefully not erode much. This was successful because it did rain while we had this crossing open, but erosion was minimal. The rain did make the ground wet and difficult for the dozers to work. This crossing was completed with the two excavators. The last fill had to be bailed three to four times to get it to the upstation throughcut fillsite.

Black soil was encountered in the channel bottom. We dug through it because it was causing the channel gradient to be convex, and found cut wood. This was similar to the situation in RX-J1 but this black layer was not as thick in RX-8. It is probably the remains of topsoil and organic debris that was pushed in when the crossing was constructed.

Topsoil defined a hump on the lower left bank which looked somewhat strange, but an old growth root from a nearby stump confirmed that this was the original morphology.

Stream Crossings: 95-2

A summary of stream crossing excavation costs and production rates for 95-2 is shown in Table 3.

RX-B3

RX-B3 had substantial water ponded behind the road fill. RNP rented a pump and drained the pond as much as possible in the weeks prior to heavy equipment work. The water was piped through PVC pipe over the road fill and discharged near the bottom of the excavation. The road fill was able to dry to some extent but the majority of it was saturated throughout excavation. A small amount of flow continued to flow into the pond during excavation so intermittent pumping was necessary. One of the first things the excavator did when it arrived on site was to dig a trench along the right edge of the crossing and bury the water line so that pumping could continue for as long as possible while allowing the equipment to walk across the water line without damaging it.

TABLE 3 STREAM CROSSING EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 95-2, B-LINE SOUTH						
WORKSITE	VOLUME (yds³)	HEAVY EQUIPMENT HOURS		TOTAL COSTS	UNIT COSTS (\$/yds³)	EXCAV. RATE (yds³/hr)
		BE 350	D8 WINCH			
RX-B3 (pond)	4617	50.00	39.50	\$14,582.50	\$3.16	52
RX-B4	3349	36.75	55.50	\$14,291.25	\$4.27	36
TOTALS	7,966	86.75	95.00	\$28,873.75	\$3.62	44

Because of the unusually wet nature of the fill, RX-B3 was a challenge to excavate. The dozer had a difficult time pushing the wet fill to the north fillsite. The excavator waited until the dozer backed by him before dumping a bucket full of mud in front of the dozer. This was to reduce the mud getting worked into the road when the dozer backed over the pile. The road frequently got too wet to push over so the dozer had to periodically spend time improving the road while the excavator waited. The excavator also tried mixing or alternating wet and dry fill so that the road wouldn't get muddy as quickly.

As the excavator pulled back the left bank, wood was exposed, indicating that we had not yet reached original ground. As excavation continued, the wood turned out to be the top of a stump. The stump indicated that the excavator needed to lay the left bank back more. The excavator exposed the stump but could no longer reach the top of the left bank, so the resulting slope was quite steep and underexcavated. A portion of this slope subsequently failed.

RX-B4

Excavation of the top of RX-B4 began before excavation of RX-B3 in order to move approximately 1000 yd³ of the fill to the north fillsite on the other side of RX-B3. The original channel was determined by a grey layer containing some small rocks. Due to the lack of channel armor, wood uncovered in the fill was placed in the channel to reduce erosion. Fill was placed against the cutbank along the right bank of the channel before the channel bottom was reached. This resulted in the right bank being oversteepened. As the excavation continued, the right bank was pulled back, but it remained steep and slightly convex.

As the excavation of this crossing was nearing completion, the banks were becoming steep. The excavator operator felt that the slopes were too steep to work on. When the last part of the channel was being cleaned out, a hole was dug into original ground on the right bank near the channel to put the last bit of mud which the excavator operator felt was too difficult to get up to the fillsites. The fill which was put into this hole subsequently failed.

Outsloping: 95-1

A summary of outslope excavation costs and production rates for 95-1 is shown in Table 4.

S-Line

The S-Line east of RX-S1/S2 was the first large outsloping reach excavated. Due to the technical representative's inexperience, excavation was not necessarily down to topsoil and the finished slope was not smooth. However, this outsloping was completed quickly with only the Case 220 excavator.

The S-Line west of RX-S1/S2 was done later in the project by both the John Deere 892E and the Hitachi 200. This section was much smoother when finished.

Landing at station 34+00

This was a very large landing which was used primarily as a fillsite. The outboard edge was outsloped. A lot of trash (wood, car bodies, tires, cables, metal) had been dumped over the edge. This material was retrieved and buried in the landing. There was a fair amount of alders and second growth redwoods growing on the OBR which were removed and scattered over the finished fillsite. The live trees got in the way of the dirt moving. We tried to clear an area, finish outsloping it, and then fall trees from the next section to be outsloped on the finished area. Larry got better at this as we moved around the landing.

TABLE 4 OUTSLOPING COSTS AND PRODUCTION RATES FOR UNIT 95-1, AH PAH ROAD AND SPURS									
WORKSITE	VOLUME* (yds ³)	HEAVY EQUIPMENT HOURS					TOTAL COSTS	UNIT COSTS (\$/yds ³)	EXCAV. RATE (yds ³ /hr)
		CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200	DUMP TRUCKS			
OS 2+00	1,317	5.50	0	0	0	0	\$825.00	\$0.63	239.45
OS 17+00	1,047	4.25	0	0.25	2.75	3.50	\$1,213.38	\$1.16	97.40
OS 34+00	3,788	15.75	12.50	1.50	6.00	0	\$5,102.50	\$1.35	105.96
OS 38+50	8,279	12.00	10.00	1.50	16.75	0	\$5,670.25	\$0.68	205.69
OS 43+00	1,120	4.25	6.00	1.25	4.50	0	\$2,247.25	\$2.01	70.00
OS 55+50	702	9.25	0	0	2.75	21.50	\$2,749.25	\$3.92	20.96
OS 58+00	1,618	8.50	0	0	3.25	14.50	\$2,342.31	\$1.45	61.64
OS 60+00	1,135	5.25	0	1.75	3.75	0	\$1,541.00	\$1.36	105.58
OS S-LINE	5,700 ^a	11.50	0	0	8.25	10.75	\$3,348.76	\$0.59	186.89
TOTALS	24,706	76.25	28.50	6.25	48.00	50.25	\$25,039.70	\$1.01	118.07

* Volume is the estimated surveyed volume before excavation. Post excavation surveys were not conducted.

^b Volume is estimated. Surveys were not conducted.

A small reservoir which was above the landing was filled in and the slope shaped to be free draining.

Stations 38+50 and 43+00

When excavation of this reach began, the large excavator was busy loading trucks at RX-8, so brushing was done by the dozer winching the trees over and pushing the wood aside. This was not very efficient, but the dozer didn't have much else to do until the excavators were freed up to work on this outslope. When the dozer pushed the wood around, it broke up and dirt got mixed in with it which made it more difficult for the excavators to later spread it on the finished surfaces.

The dozer also dished down the OBR and pushed the fill toward the cutbank. A berm was left on the OBR which the excavators later pulled back. The excavators also fell the remaining trees from the OBR onto the finished surfaces as they moved along. This worked pretty well.

Stations 55+50 and 58+00

Approximately 1800 yd³ of fill from the OBR of these outslopes was trucked as the fill from RX-8 was trucked. This was because the fill that is easiest to truck is on the OBR where the excavator can sit on the road and dig over the edge and load the trucks on the road. Trucking this fill allowed the last fill from RX-8 to be stored against the cutbanks adjacent to the crossing.

Outsloping: 95-2

No outsloping was performed on this unit. Fill placed on road benches was sloped to form a free draining surface which blended into the surrounding morphology.

Export Outsloping: 95-1

A summary of export outslope excavation costs and production rates for 95-1 is shown in Table 5.

Stations 23+50 and 26+80

These were two small swales where the fill was excavated and stored against adjacent cutbanks.

Station 48+00

This was a large EOS which was excavated during periodic episodes of rain. In the middle of the excavation, work had to be stopped for a few days in order for the fill to dry out enough to be able to work with it. The dozers became increasingly inefficient as the fill became wetter because they were not able to push as much fill as quickly and got stuck more often.

This excavation was deeper than designed and turned out to be a swale which had not been recognized earlier. Fill space was limited so we pushed as much fill as possible into the throughput immediately downstation. This resulted in the fillsite having a very steep slope. A portion of this slope subsequently failed.

Station 51+50

Prior to treatment, the road was cracked at this location. As the fill was excavated, it became apparent that this section of road was a pile of logs with some fill over the top of them. The fill was excavated and the logs scattered on the finished surface.

Export Outsloping: 95-2

No export outsloping was performed on this unit.

Labor Intensive Phase

Labor intensive rehabilitation and erosion control work usually includes all secondary treatments for surface erosion which, in the past, have typically involved the application of straw mulch to critical areas on finished rehabilitation worksites. Straw mulch was not applied on units 95-1 and 95-2 for several reasons. The majority of the project area is surrounded by old growth forest canopy. Logs and topsoil were placed on the surface wherever possible. After rehabilitation work was completed, redwood fronds were naturally dropped on the surface which helped protect it from surface erosion. Natural revegetation is expected to be excellent. Previous studies indicate that straw may not be good in forest settings since it alters the soil to be more like that of a grassland and it also introduces exotic species. The winter of 1995-1996 was moderately wet and erosion over the project area was minimal. Plants were already beginning to grow in December of 1995.

The labor intensive work that was completed on 95-1 was the construction of an interpretative and memorial grove trail from the Newton B. Drury Scenic Parkway along the removed road to the state and national park boundary. The trail was constructed in April, 1997 by the California Conservation Corps supervised by state park personnel.

No labor intensive work was completed on 95-2.

Documentation Phase

The final rehabilitation phase is the documentation process which includes post heavy equipment volumetric surveys, photo point documentation, cost data compilation, and writing the rehabilitation project report. This work was done by B. Smith, D. Short and numerous assistants, and was completed in June, 1997.

TABLE 5 EXPORT OUTSLOPING COSTS AND PRODUCTION RATES FOR UNIT 95-1, AH PAH ROAD AND SPURS								
WORKSITE	VOLUME* (yds ³)	HEAVY EQUIPMENT HOURS				TOTAL COSTS	UNIT COSTS (\$/yds ³)	EXCAV. RATE (yds ³ /hr)
		CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200			
EOS 23+50	1,284	0	0	0	4.25	\$582.25	\$0.45	302
EOS 26+80	167	0	0	0.50	0.50	\$137.00	\$0.82	167
EOS 48+00	2,817	19.50	16.25	14.50	12.75	\$8,884.50	\$3.15	45
EOS 51+50	1,789	8.25	2.00	9.00	8.50	\$3,909.00	\$2.19	64
TOTALS	6,057	27.75	18.25	24.00	26.00	\$13,512.75	\$2.23	63

* Volume is the estimated surveyed volume before excavation. Post excavation surveys were not conducted.

TABLE 6 ADDITIONAL WORK SITES FOR UNIT 95-1, AH PAH ROAD AND SPURS						
JOB	HEAVY EQUIPMENT HOURS				TOTAL COSTS	
	CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200	DUMP TRUCKS	
Reservoir and channel above landing	0	0	4.25	2.25	0	\$890.50
Finish fillsite on landing	0	14.00	0	8.75	0	\$3,116.75
East Ridge Road	0	0	1.00	3.00	0	\$548.00
Memorial Grove Road	0.50	0	0	1.75	0	\$314.75
TOTALS	0.50	14.00	5.25	15.75	0	\$4,870.00

TABLE 7 MISCELLANEOUS EXCAVATION COSTS FOR UNIT 95-1, AH PAH ROAD AND SPURS						
JOB	HEAVY EQUIPMENT HOURS				TOTAL COSTS	
	CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200	DUMP TRUCKS	
Open access roads	0	0.50	0	0	0	\$68.50
Walking equipment	8.00	2.00	0.25	6.00	1.50	\$2,400.19
Rip roads	0	7.75	0	0	0	\$1,061.75
Brushing and moving logs	1.00	2.25	1.50	0	0	\$663.75
Moving logs for RNSP salvage	0.75	3.25	1.50	0.25	0	\$797.50
Moving cables	0.50	0.75	0	0	0	\$177.75
Moving support equipment	0.75	2.00	0	1.00	0	\$523.50
Building ramps for trucks	0.50	3.50	0.25	0	0	\$588.75
Cleaning truck beds	0.25	0	0	0	0	\$37.50
Smoothing fillsites for trucks	0	11.75	4.75	0	0	\$2,260.50
Burying cars	0	1.25	0	1.00	0	\$308.25
Taking out gate	0	0	0	0.50	0	\$68.50
Winterize site	0.75	0	0	1.75	0	\$352.25
Move in/out	--	--	--	--	--	\$5,180.00
TOTALS	12.50	35.00	8.25	10.50	1.50	\$14,488.69

TABLE 8
MISCELLANEOUS EXCAVATION COSTS FOR UNIT 95-2, B-LINE SOUTH

JOB	HEAVY EQUIPMENT HOURS		TOTAL COSTS
	BE 350	D8 WINCH	
Open access roads	1.00	1.75	\$421.25
Brushing	6.25	5.25	\$1,865.00
Moving logs for RNP salvage	0.25	1.00	\$181.25
Water line and pump excavations	1.75	0.25	\$357.50
Move in/out	---	---	\$4,000.00
TOTALS	9.25	8.25	\$6,825.00

TABLE 9 MISCELLANEOUS NON-EXCAVATION COSTS FOR UNIT 95-1, AH PAH ROAD AND SPURS						
JOB	HEAVY EQUIPMENT HOURS				TOTAL COSTS	
	CASE 220/ JD 892	D8 RIPPER	D8 WINCH	HITACHI 200	DUMP TRUCKS	
Discussion	25.00	19.00	9.50	20.50	1.25	\$10,519.54
Idle	7.25	11.25	2.75	4.50	12.50	\$4,237.23
Walking from worksite to vehicles	5.75	7.50	2.00	5.25	0	\$2,883.25
Paid breaks	19.50	16.00	5.25	13.25	0.75	\$7,683.64
Paid down time	0	1.00	0.25	2.00	0	\$445.25
Equipment stuck "	6.25	6.50	1.50	1.50	0.75	\$2,269.64
Standby with operator	0	1.00	2.25	0.75	0	\$621.50
Standby without operator	0	13.75	19.75	0	0	\$1,708.50
TOTALS	63.75	76.00	43.25	47.75	15.25	\$30,368.55

TABLE 10 MISCELLANEOUS NON-EXCAVATION COSTS FOR UNIT 95-2, B-LINE SOUTH			
JOB	HEAVY EQUIPMENT HOURS		TOTAL COSTS
	BE 350	D8 WINCH	
Discussion	8.75	5.25	\$2,327.50
Idle	3.50	1.75	\$883.75
Paid breaks	3.25	4.00	\$1,141.25
Equipment stuck	1.50	2.25	\$581.25
TOTALS	17.00	13.25	\$4,933.75

DISCUSSION

Summary

Projects 95-1 and 95-2 met the goals of the watershed rehabilitation program by minimizing human-caused potential erosion and sedimentation into creeks and on hillslopes. Road fill was removed from stream crossings, swales, and road benches and natural topography and hydrology were restored. Topsoil was recovered where possible and spread on the finished surface, providing a nutrient-rich seed bed for revegetation. Woody debris was also spread on the finished slopes.

Ah Pah Road had old growth trees growing along it for its entire length in the project area. The restored Ah Pah Road corridor is also easily assessable to visitors because it takes off from Newton B. Drury Scenic Parkway and the Ten Tapo Trail runs within 500' of the restored portion of the East Ridge Road corridor. For these reasons, complete recontouring was deemed the appropriate level of treatment for this project. The old growth trees within and surrounding the completed restoration area add a very scenic quality to the work.

A total of 86,328 surveyed yds³ were excavated from potentially unstable areas and moved to stable fillsites at a total project cost of \$286,064 which equates to an overall average of \$3.31/yds³. The equipment operators for 95-1 were very experienced with this type of restoration work and did an excellent job overall. Wendall Larkin was very skilled at operating the Hitachi 200 and was able to work on steep slopes in

narrow areas in order to get all the fill out of the bottoms of the stream crossings. Wendall was also able to leave the finished slopes very smooth.

Contracting Through the State Park System

Because part of the project was within Prairie Creek State Park, this project was accomplished through a cooperative agreement with California Department of Parks and Recreation. The most significant result of this agreement was that the heavy equipment was contracted through the state park system. Equipment was hired by the hour and equipment operators were required to have 1200 hours of previous experience doing similar restoration work.

One primary benefit of this type of rental agreement was that the technical representative had substantial control in directing the equipment. This was useful because we could ask the operators to do various, small, odd jobs that came up, such as moving logs for salvage by RNP or burying cars or obliterating the reservoir above the landing, without having detailed contract specifications (Tables 6, 7, and 8). Excavations could be modified to conform to original ground as it was uncovered without contract modifications. Contract preparation time was substantially reduced because plan sheets did not have to be written up. However, total equipment hours had to be estimated. The entire project area was surveyed, although this is not necessary for an hourly contract, in order to assure that there was enough fill space and to determine volumes actually excavated for documentation purposes. A disadvantage to the equipment being under the direction of the technical representative was that the technical representative had no prior experience in watershed restoration or equipment operation. This may have resulted in additional discussion time with the operators.

The other primary benefit of this rental agreement was that the equipment operators were very experienced in watershed restoration work. In general, on 95-1, the operators provided helpful suggestions to keep the equipment working efficiently. They also had experience in looking for original channel and valley elements. However, the operators often did not work very well together. They became annoyed with each other and would not listen to each other. The technical representative often had to talk to each operator separately to get their opinions, then decide what to do, and then tell each operator. This was time consuming.

Another problem developed over time keeping. The technical representative was required to keep track of the time worked for payment purposes. Certain activities were not paid such as fueling, equipment down, and lunch. The operators objected to how the time was being recorded which evolved into a dispute. This was resolved a few hours later, but not until after the operators threatened to stop using the Hitachi 200 and the government threatened to terminate the contract. The government has no leverage to resolve these types of problems that cannot be resolved through discussion

except by terminating the contract. Termination of a contract prior to completion may not be the best thing for the resources, especially late in the season when there may not be time to hire another contractor to complete the project before winter rains begin. This is a disadvantage to hourly rental contracts.

The contract for 95-2 involved a different contractor and different operators. The excavator operator seemed to have the attitude that he was being paid by the hour so he didn't have to think about how to improve efficiency. We encouraged the operators to provide input on how to improve equipment efficiency since they have much more equipment operation experience than the government representatives. This operator was reluctant to provide suggestions. It often appeared that the excavator was swinging slower than it could and that dirt was not being dug and dropped as efficiently as possible. Other than repeatedly asking the operator to work differently, the government has no leverage, other than terminating the contract, to prevent an operator from working slowly and inefficiently under an hourly rental contract. There is no profit motive for the operators or contractors to work as efficiently as possible under a rental agreement.

Because the contractor is being paid by the hour, all discussion, idle, breaks, and stuck time is paid by the government at the equipment rate (Tables 9 and 10). When there is not enough work for all pieces of equipment, standby must be paid.

Post Heavy Equipment Monitoring

The winter of 1995-96 had about average rainfall and provided a good indicator of how much erosion can be expected from these rehabilitated units.

95-1

After one year, adjustments were very minor over most of the project area with one exception. Downcutting within the channels was less than one foot. However, about 100 yd³ slumped off the steep fill slope adjacent to the EOS at station 48+00. There was a three foot scarp at the top of the slump and rills going down the slope. A fan of sediment deposited at the base of the slope and just below the bottom of the excavation. Two small (< 5 yd³) debris torrents occurred on the right banks of RX-1 and RX-2 and flowed into the excavated channels.

Within months of completion of the project, a few plants were sprouting from the soil all over the site. After one year, volunteer vegetation regrowth is excellent. Ferns, berries, and other shrubs are numerous. A few redwoods are sprouting from logs and rootwads. Some alders and firs are beginning to grow.

The winter of 1996-97 had above average rainfall. No significant adjustments occurred on either 95-1 or 95-2 with the exception of RX-J1 on 95-1. A portion of

the lower right bank of the crossing failed, leaving a vertical scarp approximately 20' high and 50' long. A black line which looked like topsoil was visible in the scarp 4' to 8' below the ground surface. Material was transported through the crossing and deposited at the bottom of RX-1 and at the inlet to the culvert under the bypass at MP 135.62. This culvert was temporarily plugged by this material.

95-2

Channel adjustments have been minor on this site. About 25 yd³ has slumped into the channel of RX-B3 from the upper left bank which was very steep and slightly under excavated. The channel may also be slightly under excavated also as it appears that buried logs are becoming uncovered in the bottom of it.

Two small debris torrents (5 yd³ each) have occurred on the right bank of RX-B4. One of them is where a hole was dug out of the bank to store the fill from the bottom of the excavation. Digging into original ground to store fill appears not to have been a good idea here. A spring is now emerging from this location.

Within months of completion of the project, numerous plants were sprouting from the soil all over the site. After one year, volunteer vegetation regrowth is good. Grass, lupins, berries, and other shrubs are numerous. A few ferns and sprouting redwoods are present. Moss is growing along the creeks. Several 6" tall alders and tanoaks are growing on the south fillsite, as well as huckleberries, salal and other shrubs.

APPENDIX A

This appendix contains photographs of selected areas of 95-1 before and after heavy equipment work. The photographs are in pairs - one taken of the road before heavy equipment work began and one taken after heavy equipment work was completed. Both photographs in each pair are taken from the same location and looking in the same direction. All of these photographs are taken along Ah Pah Road. The post excavation photographs were taken one year after heavy equipment work was completed and illustrate that there has been virtually no post-excavation erosion at these sites. The vegetation growing on the excavated surfaces following heavy equipment work is volunteer regrowth. None of these plants were planted. Topsoil was spread on the finished surfaces which provided nutrient rich soil, seeds, and root balls. Redwood seedlings have sprouted out of some of the woody debris that was scattered on the finished surfaces.



RX-1, Photo Point 7B, 8/16/95. The cut log is part of a tree that was illegally cut down and a section of the trunk was stolen from the park.



RX-1, Photo Point 7B, 12/23/96. The stump had been completely buried in the road fill and was uncovered during excavation. The U.S. Highway 101 Bypass is in the background through the trees.



RX-4 and RX-3, Photo Point 22, 2/24/94.



RX-4 and RX-3, Photo Point 22, 11/6/96. The stream channels of RX-3 and RX-4 merged at the base of the road fill. This photograph is taken looking across RX-4 with RX-3 coming down the hill behind the old growth tree in the center of the photo.



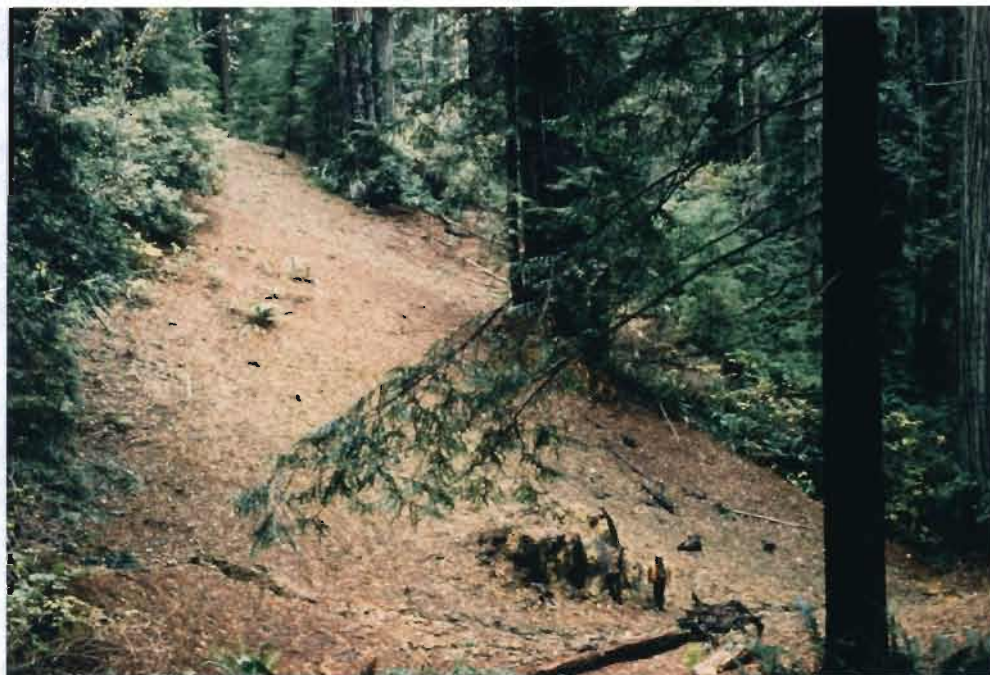
RX-7, Photo Point 35, 3/1/94. This crossing is at the left edge of the large landing on Ah Pah Road.



RX-7, Photo Point 35, 12/2/96. A large amount of wood, root wads, tires, and metal debris that had been pushed off the edge of the landing into the crossing has been removed and the edge of the landing pulled back to recreate the valley slope.



RX-8, Photo Point 43A, 3/1/94. This photograph is taken from the right bank of the crossing on the inboard side of the road fill.



RX-8, Photo Point 43A, 12/2/96. A stump (to the left of the person) was uncovered during excavation. The stream channel is just in front of the person.



RX-8, Photo Point 45, 3/1/94. This photograph is taken from the left side of the crossing on the outboard edge of the road.



RX-8, Photo Point 45, 11/2/95. This photograph was taken during heavy equipment work. The large excavator is excavating fill from the upper end of the crossing and passing it to a bulldozer behind it that pushes the fill to a fillsite.



RX-8, Photo Point 45, 12/2/96. The stream channel runs from the base of the old growth tree in the middle of the photograph to the lower left below the woody debris.



OS 58+00, Photo Point 46, 3/1/94. This is a view downstation taken from the gate.



OS 58+00, Photo Point 46, 12/2/96. Natural revegetation is particularly vigorous in this area.



OS 60+00, Photo Point 46.5A, 10/28/95. This is a view downstation taken from the end of Ah Pah Road at the Newton B. Drury Scenic Parkway.



OS 60+00, Photo Point 46.5A, 12/2/96. This is a view of the restored road corridor that was taken from what is now the parking area and trailhead.