

Summary Report
WATERSHED RESTORATION UNIT 99-6
A-9-7-1 North Road

equipment used on pg. 25

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Job	Equipment Hours				Total H.E.R.E. Costs
	John Deere 330 LC	Cat. D8R	John Deere 850 C with rippers	John Deere 850 C with winch	
Discussion	8	6	5.25	1.75	\$3,124.00
Stuck	2.25	3.50	0.75	0.25	\$1,059.50
Fueling	12.00	7.50	7.00	0.75	\$4,103.00
Service	9.00	6.25	1.75	0.50	\$2,745.75
Culvert removal	0.50	0.00	0.00	0.00	\$80.00
Access improvement	2.25	1.00	0.75	0.00	\$616.50
Subtotal	34.00	24.25	15.50	3.25	\$8,604.75
Idle	4.75	30.25	27.00	2.25	
Lunch/Breaks	43.25	15.25	41.00	5.00	
Down	5.25	0.75	3.00	0.00	
Totals	87.25	70.50	86.50	10.50	

a Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked.
 These rates are: John Deere 330 LC hydraulic excavator @ 160/hr.; John Deere 850C @ 122/hr.; Caterpillar D8R bulldozer @ 165/hr.

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Tables in separate excel files - not in report

#2 John Deere 330 LC - 238.75
 Cat D8R - 101.00 - Dozer
 John Deere 850 C (rip) - 161.50
 John Deere 850 C (win) - 28.75

#3 JD 330 LC - 14.00	#5 90.25
Cat D8R - 11.50	32.50
JD 850 (rip) 14.75	26.25
(win) 1.25	1.00

#6 2.0

#4 206.25	1.50
34.25	1.25
147.00	1.75
23.00	

INTRODUCTION

Background

Redwood Creek drains a 280-square-mile watershed in the mountainous, coastal region of northwestern California. The watershed is characterized by high relief, steep unstable slopes, and narrow valley bottoms. Redwood Creek and its tributary streams are subject to frequent flooding from winter storms, and basin soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions streams swelled by winter rains transport large volumes of sediment. With over 90% of the forests in the basin harvested, and 2/3 of the basin in active timber management, sediment levels in Redwood Creek are twice the mean annual erosion rates for the north coast (U.S. Congress, House Committee on Government Operations 1976). Redwood National Park (RNP) is located in the lower 1/3 of the Redwood Creek watershed.

Public Law 95-250 (March 27, 1978) directed that a watershed restoration program be developed for lands that had been timber harvested prior to becoming part of Redwood National Park. Timber harvesting and road construction that occurred on these lands before they were added to the park had adversely influenced erosion rates, sediment deposition, and water quality within the entire basin. These problems are being addressed in the restoration program. The purpose of the restoration program is to minimize human-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 humans. (Redwood National Park, Watershed Rehabilitation Plan, 1981)

It is National Park Service policy to "actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources..." It is also Park Service policy that "Terrain and plants may be manipulated where necessary to restore natural conditions on lands altered by human activity. Management activities may include, but will not be restricted to, removing constructed features, restoring natural gradients, and revegetating with native park species..." (National Park Service Management Policies, 1988). Management objectives of Redwood National Park are "to restore and/or maintain the natural ecosystems of the park" and "to continue with biological and physical restoration of park lands severely impacted by past land-use practices" (Redwood National Park, Statement for Management, 1992). These policies and objectives provided the guidance and direction for the removal of this portion of the A-9-7-1 North Road.

Site Description

The project area is located approximately one mile south of Orick at an elevation of approximately 700 feet above sea level (Figure 1). The A-9-7-1 was a haul road constructed in approximately 1968. It is located on the eastern side of the McArthur Creek sub-basin, except for its southernmost portion which crosses McArthur Creek to connect up with the West Side Access Road on the west side of the sub-basin (near MP 4.5). A short road connecting the A-9-7-1 Road with the A-9-7 on the west side of McArthur Creek (at approximately the mid-point of the A-9-7-1 Road) marks the point at which the A-9-7-1 Road is informally divided into the A-9-7-1 North and the A-9-7-1 South Roads.

On January 1, 1997, an eleven-year storm hit northern California, including the Redwood Creek basin, after three months of above average precipitation. This storm caused numerous failures, predominately mass movements along the roads in Redwood National Park. Five large debris flows (up to approximately 5,000 cubic yards of material) occurred along and immediately above the A-9-7-1 North Road as a result of this storm event. In addition, tension cracks, and occasional minor slumping of the fill outboard of these cracks, occurred along approximately 2,000 linear feet of the road bench, marking numerous incipient failures of the road sidecast material.

Redwood National Park received \$7.5 million from the Emergency Supplemental Appropriations Act for Recovery from Natural Disasters (PL 105-18) and \$0.5 million from the Federal Highway Administration's Emergency Relief for Federally Owned Roads (ERFO) to remove roads that had been damaged during the storm. Other roads that were public access or long term administrative access roads also received funds for repair. The A-9-7-1 North Road was one of the roads to be removed. Cost of the removal was paid for entirely by the NPS supplemental appropriation bill.

Watershed Restoration Unit 99-6 constitutes the second phase of a two-year strategy to remove the A-9-7-1 North Road. This project removed 7,300 feet of the A-9-7-1 Road and 2,000 feet of skid roads located immediately upslope of the A-9-7-1 North Road. This project involved the excavation of a total of 96,148 yds³ of fill material, including 34,709 yds³ associated with thirteen road stream crossings and two skid road stream crossings.

Restoration focused on the removal of the stream crossing fill and unstable side cast fill, and placement of this fill against the cutbanks on stable road reaches in order to restore more natural hillslope topography and drainage patterns interrupted by the A-9-7-1 North Road. The excavation of the stream crossing fill uncovered the natural channel bed and banks, and excavated fill was used to re-create the natural topography. Buried organic and nutrient rich material was returned to the surface in order to help speed recovery of native vegetation. Trees removed during excavation were stockpiled and dispersed along the finished surface in order to simulate natural forest litter; thereby providing habitat and shade for seedlings, and a reduction in potential surface erosion of the recontoured surfaces by reducing rain splash and retarding surface runoff.

Heavy equipment was used for all excavations. Excavations were executed through a Cooperative Agreement (No. 1443CA848099001) with the Yurok Tribe. Project costs are summarized in Table 1.

Figure 1. Location of Project Area.

TABLE 1
RESTORATION WORK COST SUMMARY FOR UNIT 99-6, A-9-7-1 NORTH ROAD

Treatment	Quantity	No. of jobs	Total Costs		% of Grand Total using Contract	Average Unit Costs	
			Contract	H.E.R.E.		Contract	H.E.R.E.
Heavy Equipment							
Stream Crossings	34,709 yd ³	15	\$137,809	\$78,075	37.7	\$3.97	\$2.25
Export Outslope	2,113 yd ³	3	\$8,027	\$7,810	2.1	\$3.80	\$3.70
Outslope	47,545 yd ³	17	\$135,783	\$59,391	37.1	\$2.86	\$1.25
Skid Roads (EOS)	11,781 yd ³	11	\$45,968	\$23,127	12.6	\$3.90	\$1.96
Misc. Bid Items	NA	3	\$10,000	NA			
Non-Bid Items	-	-	-	-			
Subtotal	96,148 yd ³		\$337,587	\$168,403	92.3		
Project Implementation							
Mapping	0	NA			0.0		
Prescriptions and Layout	103	NA	\$2,153		0.6		
Surveying	175.5	NA	\$3,157		0.9		
Contract Preparation	179.5	NA	\$3,752		1.0		
Heavy Equipment Supervision	792	NA	\$17,834		4.9		
Photo Documentation	38	NA	\$685		0.2		
Report Writing	30	NA	\$639		0.2		
Subtotal	1318	NA	\$28,219		7.7		
Grand Total			\$365,807	\$196,622			

Geology

The Redwood Creek basin is almost entirely underlain by the Jurassic-Cretaceous Franciscan formation. Exposures of these rocks typically shows closely spaced fractures and/or pervasive shearing. Fractures seem to have resulted from deformation from tectonic emplacement, likely in association with subduction, and from brecciation along high angle faults. The intensity and style of this disruption seems to be the rock characteristic that most influences differences in the erosion rates and landforms (Janda, et al., 1975). The Grogan fault, which has a surface trace roughly coincident with the valley of Redwood Creek, separates the Franciscan formation into two major lithologies. In general, rocks on the west side of the basin consist of quartz-mica schist whereas unmetamorphosed sedimentary rocks are found on the east side. The Grogan fault is more linear than other major NNW trending faults in the region which suggests a near vertical dip (Harden et al., 1982).

Restoration Unit 99-6 is situated on the west side of the Redwood Creek basin, and is underlain by tightly folded and sheared Schist of Redwood Creek (Harden, et al., 1982), a quartz-albite-white mica- chlorite schist. The most common rock type within this unit is metamorphosed mudstone. Metamorphosed sandstones which locally display graded bedding are also present. Another

major lithologic component is metamorphosed basalt and tuff. Large metabasalt outcrops form prominent knobs on the landscape. Considerable variations in mineralogy, texture, lithology, and structure are evident but intense shearing and complex folding and faulting preclude mapping subunits. Metamorphosed sandstone exposures are present in the project area, but no metabasalt outcrops or exposures have been observed.

Timber Harvest History

A timber harvest history (Figure 2) of the McArthur Creek sub-basin was compiled through the comparison of historical aerial photographs. Prior to the start of logging, a continuous cover of old-growth Redwood and Douglas Fir was present over the eastern McArthur Creek sub-basin, with scattered Hemlock and Spruce occurring within and proximal to the floodplain. The first logging operations occurred in 1966. This logging was confined to the upper hillslopes, above the L-2-2 Road. Logging on these ridges continued into 1972. Following the construction of the A-9-7-1 Road in 1968, timber harvesting began on the lower hillslopes. Clear-cutting of the slopes from the edge of the floodplain up to the L-2-2 Road began in 1969. Cutting generally progressed in a northerly manner from 1969 until 1976, at which time logging on the slopes was completed. Harvesting within the McArthur Creek floodplain by cable yarding and minor amounts of tractor yarding occurred from 1975 until 1978. Redwood National Park acquired the land in 1978.

Except for the cable-harvested areas within the floodplain of McArthur Creek, all timber harvesting was done by tractor logging. Two other haul roads, the L-2-2-1 and the L-2-2, were constructed above the A-9-7-1 Road at the mid-slope and upper-slope positions respectively. In addition, an intensive network of skid roads was constructed during the logging operations. Little of the original ground surface on the entire eastern slope of the McArthur Creek sub-basin was left undisturbed by roads or their associated fill material.

Erosional Features

Erosional features include several debris flows, slumps, and incipient failures of sidecast fill material that occurred during the Jan. 1, 1997 storm event. Slightly older, but still recent (during and post-timber harvesting) debris flows and slumps are also present, and surface water diversions and interception of ground water flow have been present since the construction of the A-9-7-1 Road.

The Jan. 1, 1997 storm event caused a large debris flow, originating from the L-2-2-1 Road, to deposit approximately 3,000 cubic yards of sediment and large logs on the A-9-7-1 North Road and in the floodplain of McArthur Creek immediately below the road. This debris flow originated as a failure of the sidecast material in the L-2-2-1 Road. Another debris flow, originating from the L-2-2 Road deposited approximately 5,000 cubic yards of sediment and large logs into a swale immediately above the A-9-7-1 North Road. Many cubic yards of fine sediment from this debris flow were carried down onto the A-9-7-1 North Road by surface flow. Failure of sidecast material caused a slump of approximately 1,000 cubic yards on the outboard edge of the A-9-7-1 North Road, with the material being deposited onto the McArthur Creek floodplain. Another slump occurred adjacent to the previous slump. The cause of this slump was the failure of a saturated, over-steepened cut bank of the A-9-7-1 North Road overlain by sidecast fill material from an upslope skid road. The material from this slump was also

Fig 2. Timber harvest history of project area.

deposited onto the floodplain of McArthur Creek. A similarly-caused slump occurred in another location along the A-9-7-1 North Road, with material from this slump being deposited onto the A-9-7-1 North Road bench and the banks immediately adjacent to the McArthur Creek floodplain. Approximately 2,000 linear feet of tension cracks were present along the A-9-7-1 North Road following the Jan. 1, 1997 storm, marking incipient failure of sidecast fill material. In many cases, the road bench outboard of these cracks dropped up to eighteen inches. Failure of this amount of sidecast material would have deposited thousands of cubic yards of sediment onto the McArthur Creek floodplain and into the creek itself.

An approximately 5-year old debris flow, originating from failure of sidecast material on the L-2-2-1 Road deposited approximately 2,000 cubic yards of sediment and large logs onto the A-9-7-1 North Road bench and the banks immediately adjacent to the floodplain of McArthur Creek. Disruption of an upslope skid road stream-crossing by this debris flow caused a diversion of surface water out of the natural channel, onto skid roads and the A-9-7-1 North Road.

Throughout the hillslope area above the A-9-7-1 North, skid roads have caused diversion of surface flow and interception of ground water flow. This flow is often deposited onto road fill material which has insufficient drainage. This fill has the potential of becoming saturated and failing, causing further debris flows and slumps.

Threatened and Endangered Species Concerns and Work Schedule

Two bird species that are listed as threatened under the Endangered Species Act occupy areas in or near the project area: the Northern Spotted Owl and the Marbled Murrelet. On May 6, 1997, Coho Salmon were also listed as a threatened species. 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 for Northern Spotted Owl and Marbled Murrelet, has set noise and habitat modification restriction guidelines designed to reduce human impact, especially to nesting sites during the breeding season. In May, 1998, a Biological Assessment (BA) to determine the effects of the proposed restoration projects on threatened and endangered species and their critical habitat was completed by RNSP (RNSP, 1998). The purpose of the BA was to meet the criteria for formal consultation with the USFWS and National Marine Fisheries Service (NMFS) as required under Section 7 of the Endangered Species Act of 1973, as amended. The BA determined that work could proceed as of July 10, 1999, and continue until November 1, with the possibility of an extension of the ending date contingent upon approval by NMFS. Suitable habitat (residual old-growth trees) was present within ¼ mile of the project area, mostly on the floodplain of McArthur Creek. An "incidental take" of 99 acres was determined in the BA to account for the possible detrimental effects to this habitat from noise and other disturbances during the heavy equipment phase of the project.

RESTORATION WORK

Project Implementation

Restoration work focused on restoring the land to a condition similar to what would have existed without disturbance by humans. This included complete excavation of road fill out of stream crossings and swales, complete outslowing of the A-9-7-1 North Road and skid roads with high erosion potential, and rebuilding of interfluvial ridges; resulting in the road fill being shaped to mimic the natural hillslope topography above and below the road. Recontouring provides a solid, beneficial foundation morphologically, hydrologically, and aesthetically for landscape evolution. Figure 3 summarizes the types and locations of treatments performed during the heavy equipment phase of project 99-6

The project geologist, Phil Freiberg, mapped geomorphic and hydrologic features, prescribed restoration treatments, surveyed the volumes of all worksites before and after excavation, prepared the contract, oversaw heavy equipment operations as the contracting officer's technical representative (COTR), photo documented the work, and wrote the final report.

Heavy Equipment Phase

The heavy equipment phase included completion of all primary restoration treatments. A total of 7,300 feet of the A-9-7-1 North Road, and 2,000 feet of skid roads were removed at a total heavy equipment cost of \$337,587.45. A total of 96,148 yds³ of material was excavated from 13 haul road stream crossings (33,557 yds³), 420 feet of haul road export outslope (2,113 yds³), 5,116 feet of haul road outslope (47,545 yds³), 1,700 feet of skid-road export outslope (11,781 yds³), and two skid-road stream crossings (1,152 yds³). The haul road surface was ripped prior to placement of fill on fillsites.

The heavy equipment phase was done by a Cooperative Agreement between RNP and the Yurok tribe. The operators worked for the Tribe's Watershed Restoration Program. Prior to the signing of the Cooperative Agreement, unit prices for the work were negotiated between the tribe and RNP. The equipment operators had been trained the previous year in both heavy equipment operations and watershed restoration processes through the Tribe's Watershed Restoration Program. This was the first time either the operators or the Tribe's Watershed Restoration Program had worked on a project in the Park.

Figure 3(a). Treatment prescriptions and fill sites.

Figure 3(b). Treatment prescriptions and fill sites.

Figure 3(c). Treatment prescriptions and fill sites.

Figure 3(d). Treatment prescriptions and fill sites.

Figure 3(e). Treatment prescriptions and fill sites.

Figure 3(f). Treatment prescriptions and fill sites.

Figure 3(g). Treatment prescriptions and fill sites.

The heavy equipment work was scheduled to begin on July 10, 1999. Move-in of the equipment occurred on July 11, and actual dirt moving began on July 12, 1999. Work was completed on October 10, 1999. The equipment used was a ~~John Deere 320 LC excavator~~ with a thumb (operated by Richard Nelson), a ~~Caterpillar D8R~~ (operated by Walter Lara III and occasionally Rocky McKinnon), and two ~~John Deere 850 Cs~~, one with a winch and one with rippers, (operated by Walter Lara III and occasionally Roger Boulby and Darrell Maybry). The Tribe originally planned to use the D8R (with rippers) for the length of the project, but after four weeks it was determined that it was too heavy for the wet conditions of the project area, so it was replaced with an 850 C with a winch. For a period of eight days (during a period of time in which many large excavations were being carried out) a second 850 C, this one with rippers, was also used on the project. Both 850 Cs were used concurrently during this time, in order to excavate out the bulk of the material ahead of the excavator on these large excavations. The original 850 C was then taken off of the project, and the 850 C with rippers remained until the project finish.

Improvements to the A-9-7-1 North Road to allow access included brushing of young alder and fir trees for most of the 7,000 foot length, grading of the road surface, pioneering of short road segments through several debris flows on the road bench, and installation of culverts and cross road drains, had been completed the previous year as part of project 98-6. Occasional work (more culvert installations, grading) on the A-9-7-1 North Road for access purposes was performed throughout the heavy equipment phase of the project.

Heavy Equipment Rental Equivalent (H.E.R.E.) rates are included in the excavation cost and production rate tables in order to normalize equipment costs for comparison of these costs with other restoration projects. H.E.R.E. rates for this project were calculated by adding 40% (profit) to the sum of the equipment rental rates and operator wages. Equipment rental rates (\$73.86/hour for the excavator, \$78.98/hour for the D8R, and \$48.30/hour for the 850s) were determined from personal communication with Steve Namitz of the Tribe's Watershed restoration Program. Wages (excavator operator \$40.35/hour; bulldozer operators \$38.97/hour) were determined from Davis-Bacon wage determination guidelines.

Stream Crossings

A summary of stream crossing excavation costs and production rates is shown in Table 2 (Appendix). A narrative of atypical procedures during excavation, or atypical characteristics of each of the crossings follows.

RX-4

This crossing consisted of a shallow, sediment- and debris-filled channel. Some water was flowing through the crossing at the time of excavation. The excavation top was contiguous with the bottom of the excavation of Skid 320. Degraded schist was encountered in the lower portion of the excavation, on both the right and left sides. No distinct channel was found. Because of the lack of an obvious organic horizon, excavation proceeded down to this schist in most places. The excavator operator reported the material as being much harder to dig than would be expected of loose schist fill material, so the degraded schist was determined to be a regolithic bedrock, as opposed to fill

material.

RX-5

This was a narrow channel crossing, with minor amounts of water flowing through it at the time of excavation. The steepness of the channel restricted the movements of the excavator, and during the excavation a fair amount (10 cubic yards?) of ravel ended up in the lowest portion of the completed stream channel. The relative inexperience of the excavator operator at this early time in the project also contributed to this problem. He eventually did learn to carry out his excavations to avoid loose material falling into completed areas that were out of his reach.

RX-6

This channel crossing was designed as a continuous excavation from the haul road to a skid road immediately upstream from the road, with only one stream channel present. Water was believed to be diverted (as indicated by gulying) onto the skid road to the left of the stream crossing. It was believed that slopework above the crossing site would alleviate this diversion. Upon excavation, however, it was discovered that there had originally been a swale at the site of the "diverted" water. Apparently, not all the water was diverted, and at least some portion of it originally flowed in this channel. It is difficult to say whether all the diverted water was corrected by the slopework upstream. In any case that diversion is minor, and causes a temporary diversion of only a few hundred feet of probably only minor flow. Both channels confluence in the middle of the excavation, then a bedrock knob forces the channel slightly to the left. The left bank turns out to be very steep, with evidence that a former bedrock ridge ran from the fillsite down to the lower left bank of the excavation.

RX-7

The road bench across this shallow stream crossing was partially buried by logs and sediment contained in a debris flow that had originated in sidecast material on the L-2-2-1 Road above. Much of the material was saturated from the small surface flow that was present. Most of this excess material was placed to the left of the crossing, where a large, natural "bowl" allowed for it. A small portion of the road fill material that crossed the lowest portion of this bowl was left in place, probably to a depth of no more than ten feet. This was necessary to provide sufficient fillsite space to place the approximately 3,000 cubic yards of debris that was imported to this site by the debris flow. It was felt that this natural bowl would provide a very stable fillsite.

A gentle bedrock knob, that apparently had been partially sheared off during road construction, caused the stream channel to bend slightly to the left within the excavation.

RX-8

This was a narrow crossing excavation, with water flowing through the crossing at the time of excavation. Directly upstream of the crossing are three skid road excavations (SX-1, SX-2, and Skid 500 EOS). Sediment appears to have accumulated in the stream channel, perhaps to a depth of several feet. This sediment between the skid work and the stream crossing excavation was not removed, being too difficult to reach and not of sufficient volume to be worth the effort, so it

may be possible that some incision in this portion of the channel may occur following the crossing excavation.

RX-9

This was also a very narrow stream channel excavation, with water running through it at the time of excavation. There is a very large old-growth windfall which ran into the crossing fill material and which was exposed during the excavation. This large log made it impossible to thoroughly clean out the fill material from the narrow channel, as the log occupied much of the channel.

RX-10

The excavation of the top 40 feet of this small crossing went slightly too deep, ending in regolithic schist. A gentle flattening out of the excavation grade brought it back to what is believed to be original ground. No definitive channel was found at the bottom of the excavation. This is due, it is believed, to a slight alluvial buildup as this tributary meets the floodplain of McArthur Creek. This alluvium allows most flow within this tributary to go subsurface, discouraging formation of a distinctive surface flow channel. The top of the excavation is bordered by several large old-growth logs lying perpendicular to the channel. These logs prevented removal of the sediment underneath them. In order to taper the excavation to this somewhat artificial top, some fill material was left on the top left bank. No more than thirty cubic yards of fill material remains in these locations. Much large, woody debris was placed in the channel immediately below the top of the excavation in order to check any sediment which may move down from these locations.

RX-11

This excavation consisted of a very shallow stream crossing located on a broad, alluvial apron at the transition from the tributary valley to the floodplain of McArthur Creek. At the time of the excavation, water was flowing through an 18" culvert. The original channel was well-defined below the designed excavation. Above the designed excavation a well-defined channel was present, but it was not known whether the channel location had been disturbed by the building of skid roads and a landing. Bedrock was encountered after only shallow digging throughout most of the excavation, and no former channels were exposed during the excavation. Though this area was highly disturbed by tractor skidding and truck loading, that activity appears to have occurred on a naturally broad, flat, stable area, with minimal disturbance of the tributary channel.

RX-12

Included in this stream crossing excavation were two skid roads located on the left bank of the tributary immediately above the excavation. Some of the flow of the tributary was being diverted down these skid roads. The entire channel from the bottom of the road crossing to the top of these skid roads was excavated, having been filled with sediment and logs during logging activities.

RX-13

This excavation consisted of a very shallow stream crossing located on a broad, alluvial apron at the transition from the tributary valley to the floodplain of McArthur Creek. A large debris flow (3,000 cubic yards?) originating from the L-2-2 Road in January of 1997 terminated just several hundred feet above the crossing excavation. Due to the low gradient of the alluvial apron upon which the sediment was deposited, and the gentle to flat gradient of the apron and floodplain of McArthur Creek below the sediment, it was decided to leave the debris flow sediment in place. Some of the sediment filled the channel between the top of the crossing excavation and the toe of the debris flow. With the intent of minimizing incision in the debris flow sediment following the excavation of the crossing, most of this in-channel sediment was left in place, to produce a constant, gentle final channel gradient between the top of the excavation and the debris flow. The final top of the crossing excavation was, therefore, placed at the location of large logs that would act as local base levels for potential downcutting of this sediment.

Excavation of the channel in the crossing itself found the channel to be an eight foot-deep, V-shaped incision across the alluvial apron. A very thin organic layer was seen on the left bank of the channel during excavation, but because of the steepness (approx. 70-80 degrees) of the bank, the layer was mostly destroyed during excavation. A yellowish-tan subsoil was exposed, and the left bank gradient was decreased to 50 to 60 degrees to leave a more stable bank. The organic layer was able to be preserved in most places on the more gentle right bank of the channel.

RX-14

This was another crossing with sediment and logs from a debris flow that originated on the L-2-2-1 Road. Most of the debris, however, ended up below the crossing, on the floodplain of McArthur Creek. Above the crossing, the original topsoil and some subsoil were scoured away by the debris flow. No distinct channel above the crossing is present, with minor flow expected in this small swale. Several hundred cubic yards of sediment and woody debris had piled up against the four old-growth redwoods below the crossing. This debris was carefully removed by the excavator in addition to excavation of the crossing

Because of the scouring away of the original surface above the crossing, a shallow channel was constructed in the exposed subsoil in order to confine and direct water towards its original location in the lower portions of the excavation.

Below the former road bench, only a slight, shallow channel was found as the excavation proceeded. No distinct channel was found on the floodplain of McArthur Creek, so excavation proceeded down to original ground over a broad area, allowing for several possible routes of surface water flow.

RX-16

This excavation consisted of a very shallow stream crossing located on a broad, alluvial apron at the transition from the tributary valley to the floodplain of McArthur Creek. Much of the original tributary channel had been obliterated by skid road and landing development during logging

activities. It is believed that the channel above the excavation site was altered by the building of a skid road up the channel. Because of the low gradient of the area, the large amount of potential damage caused by attempting to reconstruct this portion of the channel, with successful reconstruction highly unlikely due to the amount of disturbance, the channel configuration was left as-is during the crossing excavation. Because construction of the former road bench had also obliterated some of the original channel, it was necessary to artificially construct a small portion of the channel in the exposed subsoil. A broad, shallow channel was constructed in order to confine and direct surface flow into what was believed to be the former channel below the excavation. It is not certain whether this was the former channel or not, although no other possible channel was obvious. This site was an alluvial apron at the mouth of the tributary valley and it is likely that this allowed for a higher percentage of subsurface flow than surface flow, thereby minimizing channel development.

Export Outsloping

A summary of export outslope excavation costs and production rates is shown in Table 3 (Appendix). Export outslope treatment was done on three road reaches where there was not sufficient space against the cutbank, nor on immediately adjacent skid roads, to store all the material, or where the presence of moisture precluded the placement of fill material into the cutbank. The fill was pushed to other fill sites with the bulldozer.

EOS 32+78

This EOS excavation was in an unstable area with high moisture content. Two slumps of approximately 300 to 400 cubic yards each were present in the excavation site. One slump had originated in the sidecast fill material of the A-9-7-1 North Road, the other had originated in the sidecast fill material of a skid road located immediately above the A-9-7-1 North Road. Both slumps occurred in January, 1997. The slumped material ended up largely on the edge of the floodplain of McArthur Creek. Most of the material was too dispersed to be removed, or had already been removed by natural processes.

The EOS excavation involved re-exposing two separate swales, both with minor amounts of flow at the time of excavation. Above the road, the swales had been filled and obliterated by skid road construction. These skid roads were removed and the swales re-exposed prior to the EOS excavation. In some spots, the original organic layer had been scoured away during the slumping of the fill material, exposing regolithic schist bedrock. No distinct channels were observed or constructed in the re-exposed swales.

Outsloping

A summary of outslope excavation costs and production rates is shown in Table 4 (Appendix). In general, outsloping proceeded rapidly, with original ground surface being determined by soil and organic horizons, or by geometry. Most outsloping excavation was done by the excavator, with some sidecast material being removed by the bulldozer by benching down parallel to the road

bench.

Skid Roads

Skid road work involved a combination of outsloping and export outsloping. In most cases, the wet material and the confined work space precluded use of the bulldozer for moving material. Production rates were generally slow, but the volumes of the skid work were quite small. A summary of outslope excavation costs and production rates is shown in Table 5 (Appendix).

400 SKIDS

This area of skid work was comprised of three short skid roads (the 400, 420, and 440 Skids), one above the other, that also joined with each other. The skid roads occupied an area of two separate swales, and the road material placed into these swales to construct the skid roads was continuous down to the A-9-7-1 North Road bench below. The excavations, therefore, were contiguous from one skid road to another, and a large area was excavated to re-expose the broad, shallow swales originally present.

Miscellaneous Work items

A summary of miscellaneous work item costs is shown in Table 6 (Appendix). All miscellaneous work items were lump sum or unit price (each) items.

Move-in and move-out costs involved only those related to moving of the equipment to and from the work site. Culvert installation, brushing of the A-9-7-1 North Road, clearing of sediment from several debris flows that originated above the A-9-7-1 North Road, cross-road drains, and rolling dips had all been completed the year before, as part of project 98-6. This large amount of work was deemed necessary by the contractor in order to use the A-9-7-1 North Road for continual access by equipment and service vehicles for both the work done on the A-9-7-1 North Road and the L-2-2-1 road.

Ripping was done to decompact the remaining road bench and inboard ditch underneath fillsites. This was carried out by the D8R with rippers, and with the 850 C with rippers. Two passes along the road bench was generally sufficient to decompact the road.

Non-Work items

Non-work items are categorized as jobs that result in non-recoverable costs on the part of the Tribe. These items are distinguished by requiring time that is generally not directly attributable to any specific work item. Non-work item times were recorded to compare the costs of the contract with that of an hourly rental. Table 7 (Appendix) provides a cost breakdown for non-work items.

“Discussion time” is defined as periods of time where equipment operations were interrupted by discussions lasting 15 minutes or more. Several shorter discussion periods were sometimes combined into one when they added up to approximately 15 minutes (time was recorded in 15 minute intervals). Typically the operator would stop to discuss the progress of a particular phase of a work item or develop a strategy for the work with the other operators or COTR. On occasion, the COTR or site inspector would interrupt the operators to make sure that the specifications of the contract were understood and would be met.

“Stuck” refers to a piece of equipment getting stuck in the mud and needing to be pulled out with another piece of equipment, or when the equipment was stuck by a fallen tree. This includes both the time one piece was stuck and the time another piece spent assisting in rescuing the stuck equipment.

“Idle time” for equipment was recorded as a non-work item but is markedly different than the previous items. Idle time represents the time a piece of equipment was inactive while work proceeded. Idle time differs from down time in that the equipment was able to be used but the Tribe or operator choose not to use it. For this project, there were often times when the excavator had more work to do than the bulldozer (sometimes due to the morphology of the excavation, sometimes due to the inexperience of the bulldozer operator limiting his ability to work on the site), so the bulldozer was idle during these times.

“Down time” occurred when equipment was unable to perform at its expected capacity. Down time was most often the result of mechanical failure.

Labor Intensive Phase

Labor intensive restoration 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 restoration worksites. Straw mulch was not applied on unit 99-6 for several reasons. Logs and topsoil were placed on the surface wherever possible. After restoration work was completed, redwood fronds and alder leaves naturally dropped from the surrounding second-growth forest onto the finished surface, which helped protect it from surface erosion. Natural revegetation, especially alder growth, 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 may also introduce exotic species.

No labor intensive work was done on this project.

Documentation Phase

The final restoration phase is the documentation process. This includes post-heavy equipment volumetric surveys, photo point documentation, cost data compilation, and writing the restoration project report. This work was done by Phil Freiberg, with assistance from Aileen Stuart and Steven Tillinghast, and was completed in January, 2000.

DISCUSSION

Project 99-6 met the goals of the watershed restoration program by minimizing human-caused potential erosion and sedimentation from roads 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 uncovered where possible. Woody debris was also spread on the finished slopes. A total of 96,148 surveyed yds³ were excavated from potentially unstable areas and moved to stable fillsites at a total heavy equipment cost of \$337,587 which equates to an overall average of \$3.51/yd³. Much of the work involved small and partly-saturated stream crossings, a narrow road prism, confined work spaces, and wet slopework.

All excavations were carried out approximately as designed, or with a slightly greater extent to the excavation than designed. Reconnaissance of the project area after several moderate rainfall events had hit the area showed only slight incision (up to 6" deep) within excavation sites, with no other major adjustments to either the excavations or the fill sites.

The carrying out of this project through a Cooperative Agreement with the Yurok tribe worked well. The fact that both RNP and Tribal administrators wanted the agreement to work helped speed the negotiation of the agreement specifics along, allowing for a timely start to the heavy equipment work.

This was the first project by the Tribe's Watershed Restoration program that was a full-scale project involving fully-recontoured excavations. This was the program's second year of operation, with the first year having been largely training sessions on private industry land doing partial channel excavations to designed grades. In general, the Tribe's employees did an excellent job. The equipment operators had been trained well in the basic concepts of hydrology and geomorphology so that they were able to envision the predicted morphology of excavations. They quickly learned to identify the indicators of original ground and, although they were relatively inexperienced at heavy equipment operations, they quickly learned to operate the equipment skillfully and efficiently to complete the excavations to the original ground surface. The moist, saturated condition of several of the first channel crossings excavated presented conditions with which they were unfamiliar in operating equipment in, causing them great frustration and slowing their progress considerably. However, once they learned the equipment's limitations in dealing with this type of material, they could plan their equipment operations more realistically and accurately, thereby decreasing their frustration and increasing their efficiency. Throughout the remainder of the project the operators displayed an efficiency and quality of work that was only slightly less than that displayed by the best of the contractors doing rehab

work in RNP. The work was completed 25 days ahead of the planned completion date in the work schedule, allowing for the entire project to be completed before the rainy season began, and allowing the operators to work on another RNP rehab project (the 230 Road) for two weeks until the threat of rainy weather shut that project down for the season.

Several problems did arise, however - caused mostly by the newness of the Tribe's program and its infrastructure. Fueling and routine maintenance of the equipment was done by an individual who was responsible for fueling and maintenance of all of the Tribe's five concurrently-operated teams of equipment. This made for erratic and untimely fueling of the equipment, often during work hours at unexpected times. One of the operators often had family matters to attend to, and the lack of a coordinated operator substitution plan caused an unpredictable, inconsistent appearance of equipment operators at times. In some cases this jeopardized the quality of an excavation, but in most cases it just caused extra work for the COTR in having to explain the background and history of a particular excavation to several operators. Finally, although a tribal representative was supposed to be on site, none ever was. Tribal representatives (other than the equipment operators) visited the site only four times during the entire project. This was not a problem, as no conflicts arose between the Park and the Tribe's operators during the project. If, however, a conflict had arisen, the equipment operators would have been the only persons in a position to represent the Tribe's position in any negotiations. This would have been less than ideal, both for the Park and for the Tribe, as the operators are often too involved in the specific actions of a site excavation to be able to deal with the broader aspects of a contract or agreement.

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APPENDIX

Excavation Costs and Production Rates