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Summary Report

WATERSHED RESTORATION UNIT 01-01

A100 Road (Phase II)

Michael B. Sanders

Redwood National and State Parks

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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 A100 Road .

Project Background and Site Description

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. Large gullies and mass movements (up to approximately 4,000 cubic yards of material) occurred at stream crossings along the A100 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 1,000 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 A100 Road was one of the roads to be removed. Cost of the removal was paid for entirely by the NPS supplemental appropriation bill.

The project area is located approximately six miles east of Orick at an elevation of approximately 1100 feet above sea level (Figure 1). The A100 was a haul road constructed before 1954. It is located on the eastern side of the Lost Man Creek sub-basin, running from Geneva Road on the north end to the A100/A140 connector (approximately one mile from Bald Hills Road) on the south end. This project deals with the remaining portion of the A100 Road that lies between the east fork of the main stem of Lost Man Creek and the A130 Road. After assessment from the 1997 storm, only that portion of the A100 Road that lies between Geneva Road and the A130 Road was identified as a high-priority to be removed, and the portion of the road north of the A120 Road was to be removed as part of another project.

Watershed Restoration Unit 01-01 constitutes the second phase of a two-year strategy to remove the damaged sections of the A100 Road. This project removed 7,100 feet of the A100 Road. This project involved the excavation of a total of 75,066 yds^3 of fill material, including 22,709 yds^3 associated with four road stream crossings and one skid road stream crossing.

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 A100 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 IDIQ contract (No. C8530990005) with the Lambert's Excavating. 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	39,369	5	$175,319	$187,525	52.5	$4.45	$4.76
Export Outslope	10,017	3	$39,087	$18,555	5.6	$3.90	$1.85
Outslope	16,176	6	$48,689	$21,351	14.6	$3.01	$1.32
Skid Road XINGs	6,847	4	$28,380	$17,265		$4.14	$2.52
Skid Roads (EOS)	1,150	2	$2,600	$2,912	0.8	$2.26	$2.53
Misc. Bid Items		3	$3,280	13279.5			
Non-Bid Items	-	-	-	-			
Subtotal	73,559		$297,355	$260,888	89.0		
Project Implementation							
Mapping	69.4	NA	$1,778		0.0		
Prescriptions and Layout	137.8	NA	$3,274		1.0		
Surveying	163.2	NA	$2,926		0.9		
Contract Preparation	95	NA	$2,434		0.7		
Heavy Equipment Supervision	1052	NA	$25,183		7.5		
Photo Documentation	4	NA	$103		0.0		
Report Writing	43.5	NA	$1,115		0.3		
Subtotal	1564.9	NA	$36,813		11.0		
Grand Total			$334,167	$297,700			

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, etal.,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 00-6 is situated on the east side of the Redwood Creek basin, and is underlain by the Coherent unit of Lacks Creek (Hardin et al., 1982). This rock unit consists primarily of coherent sandstone and interbedded sandstone and mudstone with minor amounts of conglomerate, chert, and volcanic rock. The sandstone is predominately lithic graywackes and

quartzofeldspathic graywackes. The rhythmic bedding and internal sedimentary structures of sandstone-mudstone sequences are typical of turbidites. However, individual beds cannot be traced laterally for more than 100m due to complex folding and faulting within this unit. Sandstone occurs as massive beds up to 10m thick, but most beds are between 0.1m and 3m thick with thinner mudstone interbeds. Mudstone comprises a noticeably lower percentage of coherent sedimentary sequence than of the incoherent unit of Coyote Creek. The graywackes within this unit contain abundant fine volcanic detritus, but large blocks of volcanic rocks and chert are not found.

High sandstone content, presence of massive beds, and less intense shearing and fracturing result in steeper, straighter hillslopes in areas underlain by the coherent unit compared to those in the remainder of the basin (Janda, 1979). Uniformly sharp ridge crests, steep slopes, and narrow V-shaped tributary canyons are characteristic of the landscape developed in this unit. (Hardin et al., 1982).

Geomorphological features include large (up to 5 acres in size) block slides, their triggering mechanisms unknown. In most cases, these features can be identified only by hummocky, shallow-gradient topography lying immediately downslope of steeper, more typical topography. Watercourses can be deviated by these features, and some courses change in morphology from mature, well-incised stream channels to immature, gully-like channels as they intercept the slide features. Other geomorphic features include steep, sandstone bedrock-dominated slopes and topographic highs. These slopes seem to have a thin soil and regolith layer developed on them, causing mass movement due to road construction undercutting the regolith layer, or by natural process-caused mass movements within inner gorge morphology found in the larger tributaries. In one section of cutbank (near XING 5), shearing of the normally blocky-fracturing sandstone was observed, along with small-scale folding of the sheared layers, suggesting that faulting may also play a role in the development of the geomorphology of the project area.

Soils within the project area appear to be dominantly Lacks Creek and Copper Creek units. The Lacks Creek unit typically forms a 50- to 100-cm thick B horizon on slopes underlain by competent, steep bedrock. Copper Creek formation occurs where bedrock does not occur as proximal to the surface, and thicker horizons with increased clay content have developed. Both units consist of dunn- to reddish-dunn-colored, friable B horizons with subangular clasts. The generally low clay content and low clast content of these units makes them succeptible to gullying, and the high ratio of gullying to other types of mass movements in this area demonstrates this.

Timber Harvest History

A timber harvest history (Figure 2) of the project area 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 Lost Man Creek sub-basin, with scattered Tan oak and Madrone occurring on the mid slope locations, increasing uplsope. The first logging operations occurred just prior to 1954. Cable yarding was the dominant harvesting method, due to the steep slopes (up to 110%) within the project area. Tractor yarding also occurred, starting prior to 1954. This harvesting method was used on the more moderate slopes, with some reentry into previously cable yarded areas to harvest residuals. Both types of harvesting occurred concurrently from pre-1954 until 1962, at which time harvesting in the area ceased. No further harvesting occurred within the project area, and the land became part of Redwood National Park in 1968.

Fig 2. Timber harvest history of project area.

Because of the dominance of cable yarding harvest method, skid road development was limited to approximately one half of the project area. The skid road networks are moderate to low in intensity.

Erosional Features

Erosional features include several debris flows, significant erosion of crossing fill material, 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) mass movements are also present, and surface water diversions and interception of ground water flow have been present since the construction of the A100 Road and associated skid roads.

The Jan. 1, 1997 storm event caused a total of approximately 3,000 cubic yards to be eroded from stream crossing fill material, and in some natural material. This erosion was caused by failure of the Humboldt-style crossings to handle the volume of water that occurred during the storm. This caused a large portion of the channel flow to run over the road surface, which caused rapid, deep gullying and erosion of the fill material. In XING 4, the overflow was diverted partially onto natural subsoil, which also eroded deeply (up to 10 feet).

Although no large debris flows occurred immediately on the A100 Road, one large (approximately 2,500 cubic yards) debris flow caused by failure of skid road outboard fill material, along with numerous smaller debris flows occurred, mostly in the steeper reaches of the tributaries above XING 4. Aerial photo analysis and field reconnaissance indicate that massive failure of natural slopes immediately above the A100 Road have occurred since the road was constructed, largely due to mass movement of slopes oversteepened by the cutting of the road bench into the slope.

Incipient failure of sidecast material caused slumping of approximately 1,000 linear feet on the outboard edge of the A100 Road. This slumping involved sections of up to 1,000 cubic yards of material, with the slumped portions of fill dropping up to four feet. The cause of these slumps was the failure of saturated, over-steepened fill material on the outboard edge of the A100 Road and associated skid roads.

Throughout the hillslope areas above the A100, skid roads have caused diversion and concentration of surface flow and interception of ground water flow. Concentrated flow has caused gullying of both road fill material and, to a lesser extent, natural soil and subsoil. Most gullies are less than three feet wide and deep, but several gullies, those in fill material, are up to ten feet in diameter and depth. Diverted and concentrated flow is also 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 June 15, 2000, and continue until October 15, 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, around the area of XING 4 and the 300 Skid Road. However, a survey for Marbled Murrelets before the start of the project indicated there were no Marbled Murrelets occupying that area, so work proceeded through that area with no work restrictions and no “incidental take” necessary 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 outsloping of the A100 Road and skid roads with high erosion potential, and rebuilding of interfluve 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 00-6

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 government's technical representative (GTR), 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 5,100 feet of the A100 Road, and 1,700 feet of skid roads was removed at a total heavy equipment cost of $297,355. A total of 73,559 yds^3 of material was excavated from 5 haul road stream crossings (39,369 yds^3), 944 feet of haul road export outslope (10,017 yds^3), 4,116 feet of haul road outslope (16,176 yds^3), 502 feet of skid-road export outslope (1,150 yds^3), and four skid-road stream crossings (6,847 yds^3). 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. However, the primary excavator operator had trained and worked on a bulldozer, and had spent limited time operating an excavator. Additionally, the type of "restoration" that the operators had been trained in was that of "designed" crossing excavations, in which no effort is made to excavate to natural ground but, instead, specific grades for the sideslopes and the channel itself are determined and excavated to. Except for brief periods (less than two weeks total) that several of the operators worked on in-park projects last year, this was the first time any of the operators had worked on a restoration project in the Park.

The heavy equipment work was scheduled to begin on June 15, 2000. Administrative matters, on both the part of the Park and the Tribe, in addition to equipment procurement delays, postponed the start of the project for several weeks. Move-in of the equipment occurred on July 3 and 5, and actual dirt moving began on July 6, 2000. Work was completed on October 28, 2000, and all equipment was walked out and the access road was winterized on October 30. The equipment used for the length of the project was a Hitachi 230 excavator with a thumb (operated by Roger

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.

Boulby), and a John Deere 850C with rippers (operated by Rocky McKinnon, later by Tyke Robbins). A Caterpillar D8R (operated by Rocky McKinnon) was added to the equipment on August 30. A John Deere 330 LC excavator (operated by Richard Nelson) and another John Deere 850C (operated by Walter Lara III) were added to the equipment on October 17, following the completion of the in-park restoration project they were working on.

Because of several washed out stream crossings on the A100 Road between the project area and Geneva Road, heavy equipment and service vehicle access to the site was via Holter Ridge Road, the A120 Road, and the A100 Road. Because the A120 road was to be used for access to the project site, and to a similar project removing the A110 Road, work had been performed in the previous summer (1999) to rebuild washed out or failing portions of the A120 Road surface and to provide better drainage. Therefore, the only work necessary to allow access to the project site in 2000 was the flattening out of several rolling dips and the removal of trees along several sections of road to allow more sunlight penetration in order to promote drying of clay-rich and, therefore, potentially muddy sections of road. Improvements to the A100 Road to allow access included brushing of young alder and fir trees for an approximately 1,000 foot length, grading of the road surface where fill material from the previous years' work had been placed on the road bench and where rolling dip construction had left an undriveable road surface, pioneering of one short road segment through a debris flow on the road bench, and installation of a 24-inch culvert at XING 4 to allow temporary rebuilding of the road to gain access across that portion of XING 4 that had been washed out. Occasional work (mostly grading) on the A100 Road and the A120 Road for access purposes was performed throughout the heavy equipment phase of the project. At one point RNSP's road grader was used to grade the entire surface of the A120 to provide a surface that was less bumpy and therefore would reduce service vehicle (including those used for fueling) travel time up and down that portion of the project access roads.

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 ($60.86/hour for the Hitachi excavator, $66.97/hour for the John Deere excavator, $42.02/hour for the 850 bulldozer, and $110.23/hour for the D8R) were determined from Caltrans rental rate listings. Wages (excavator operator $43.40/hour; bulldozer operators $42.02/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.

<u>XING-1</u>

This crossing consisted of 2,900 cubic yards of road fill material across a narrow, steep-sided swale. Some water was flowing through the crossing at the time of excavation. No culvert existed, and all the surface water in the channel was piping through the humboldt crossing in place in the fill material. A skid road running from above the top of the crossing to the road bench to the left of the

crossing was diverting a small amount of flow onto the road bench at that point. Outsloping of this skid road was included in the crossing excavation, as it was immediately adjacent to the crossing material.

The excavation bottom was contiguous with the top of the excavation of the 500 Skid crossing. A slight bedrock knob was discovered on the left bank as the excavation proceeded.

XING-2

This was a 4,300 cubic yard crossing across a narrow, steep-sided swale. No culvert was present in this crossing, and flow during the 1997 storm had overwhelmed the humboldt-style crossing and water had flowed over the road bench, gullying the outboard edge of the crossing fill material by up to ten feet.

Some water was flowing through the crossing at the time of excavation. The inexperience of the heavy equipment operators in dealing with water in an excavation caused the saturation of more fill material than was necessary, due to insufficient diversion of the flow. This additional amount of saturated fill material slowed production considerably. At one point in the excavation, it was impossible to retrieve approximately 10 cubic yards of fine, saturated material that flowed down into the finished channel, out of reach of the excavator.

Bedrock was present near or at the finished surface of the excavation, on both the left and right bank. The resulting steepness of the excavation restricted the movements of the excavator, another factor that contributed to reduced production rates in this excavation. During the excavation it was difficult to avoid raveling of the angular, cobble-sized fill that occurred near the bedrock surface into the finished 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.

At approximately mid-crossing, excavation of the channel bottom went about three feet too deep, as no good indicators were found until a stump adjacent to the channel on the right was unburied, and the very thin, buried topsoil layer found at the base of the stump was followed toward the channel excavation. It was then realized that excavation through this natural horizon had occurred in the excavation of the channel bottom. This over-excavation, however, occurred over a linear distance of no more than eight feet of the channel.

XING-3

This 1,900 cubic-yard excavation consisted of the crossing of a swale by both the road bench of the A100 Road and a skid road leading uphill from the road. No water was flowing at the time of the excavation. The lower part of this excavation was contiguous with the lower portion of XING 4.

The lowest portion of the crossing material had been eroded away during the 1997 storm. During that event, storm runoff overwhelmed the partially-functioning humboldt crossing in XING 4, flowed over the road bench and eroded the lower fill material from both XING 3 and 4, and eroded portions of the subsoil at the bottom of XING 3. This caused a 15-foot vertical drop

within the natural subsoil at the bottom of XING 3, and elimination of the natural stream channel in the lowest portion of the crossing. During excavation, the vertical drop was layed back to a more natural slope, and a broad channel was created within the subsoil that matched the stream gradient above the eroded area to the gradient of the tributary that occurred below the eroded area.

XING-4

This 26,449 cubic-yard treatment included the excavation of a stream crossing of the A100 Road and a landing that was constructed in the stream channel above the road. Two tributaries joined within the excavation to form the main tributary, and the excavation proceeded up both tributaries for approximately 100 feet. The morphology of the excavation area was dominated by mass movements. Most, if not all, were caused by road construction, as the cutting into the slope to form the road bench caused undercutting of the thin regolith that occurs on the underlying bedrock. The lowest portion of the left bank of the stream channel had been eroded away during the 1997 storm. A wooden box culvert had been in place within the crossing, on the original stream grade, but was no longer functioning. A ditch and berm had been emplaced around the upper and left edges of the landing in order to divert flow from both tributaries around the landing. During the storm event water from the right tributary broke through the berm and flowed across the landing surface. The combined water from both tributaries flowed over the road surface and caused erosion of approximately 1,000 cubic yards of fill material and natural soil and subsoil. The bottom of XING 4 was contiguous with the bottom of XING 3 at this point.

A recent (1972?) mass movement was located immediately below the bottom of the excavation, on the right bank. The toe of the movement reached the stream channel, and the stream has since eroded away some of the material. The debris from the mass movement was left in place, and it will be interesting to see if erosion of the mass movement toe increases due to the stream channel being lowered and moved to the right (to it's original location) by the excavation. Large logs were observed within the mass movement material, and more logs were placed on the bank immediately upstream of the material to armor the material.

As the excavation proceeded on the right side of the landing, it was realized that much of the material that comprised what was thought to be the natural slope above the landing was actually comprised of disturbed material caused by the mass movement of the slope above. Prior to excavation a small fir stump was located on this slope, in an apparent growth position, with subsoil exposed below it. This suggested that this slope was comprised of natural material. However, as excavation of the channel below this slope proceeded, and organic horizons and large woody debris were uncovered, it appeared that the channel right bank was too far to the right and too shallow to match up morphologically with that supposedly natural slope. Further excavation uncovered cut stumps that were now in a sub-horizontal position buried within the "natural subsoil" near the base of the slope, in addition to fragmented and disturbed subsoil and bedrock within that "natural subsoil". The conclusion was then reached that this "natural" slope was actually comprised of material that had collapsed down from the cutbank of a skid road that had previously been located low on the right hand bank , above the landing surface. The fir stump had ridden down on this mass movement and come to rest in a position that made it appear to still be in it's original growth position. This increased the size of the excavation by at least two thousand cubic yards.

As excavation of the lower- to middle-right bank proceeded, it was discovered that a skid road

leading up from the landing had been partially filled with fill material, included at least one log, during the timber harvest operation of the landing and skid roads. Because this skid road was being used as a fillsite for this project, it was decided to leave that older fill material in place, with the fill material from this project already having been placed on it.

Fill space was a problem with this excavation. A road reach that was dominantly export outslope lay immediately downstation of the crossing, and the terrain along the road reach immediately upstation of the crossing was dominated by mass movements. Therefore, most material from the excavation had to be pushed 700 to 1,100 feet downstation and upstation to sufficient fillsites. These fillsites were characterized by high rocky cutbanks and outcrops. It will be interesting to see how these steep, relatively narrow wedges of fill material placed against and on top of near-vertical bedrock will behave erosionally. Some fill material from the excavation was placed immediately adjacent to the excavation, sometimes in former mass movement locations. It was believed that the mass movements were caused by the construction of the road, as cutting of the road bench undercut the regolith layer lying on top of the bedrock. So it was believed that placement of fill material in these areas would not increase the instability of these locations, and that further movement of the slope above and underneath the fill material would not occur, as the filling of the cutbank and reshaping of the slopes with the fill material would help to buttress the slopes.

One other mass movement is located on the left bank of the right tributary near the top of the excavation. This also appears to be a failure of the slope above the cutbank of a skid road leading up from the landing. The total volume of the mass movement debris is approximately 200 cubic yards. It lies just above the extent of the excavation, and seemed stable enough that it was not removed.

XING-5

This was a steep, narrow stream crossing excavation of 3,780 cubic yards. The upper left bank was previously bedrock, so the fill material could not be stacked steep and high enough to completely fill the cutbank. A bedrock knob was unearthed on the right bank. Bedrock outcrops immediately above the top of the excavation, and a several-year-old debris flow lies upstream of the bedrock. No attempt was made to remove any of that debris, as it seemed well –stabilized on the bedrock, and it was well outside the extent of the excavation.

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 28+99

Two dry swales occur within this EOS reach. No significant, discernible swales or channels were found below the road bench during excavation. This was probably due to the change in

morphology, as the excavation locations were at the lower slope/floodplain junction. A skid road occurs below both of these swales, and there was concern that construction of this skid road had filled the swales, that the swales did indeed occur below the A100 Road, and that the excavations were simply incomplete. However, original ground was believed to have been carefully followed in both cases, and the excavations are believed to be complete.

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 subsoil, 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).

200 SKIDS

This area of skid work was comprised of three short skid roads (the 200, 220, and 240 Skids), one above the other, that also joined with each other. Construction of the skid roads had infilled a slight swale that has surface flow during times of heavy precipitation and ground saturation. The uppermost skid road was diverting water out of the swale and causing a large (8 feet wide, 5 feet deep) gully in the outboard fill material of the skid road further downslope. The diverted water was then carried along the lowest skid until it ran off the outboard edge of the skid road downslope of the swale. Excavation of the three sections of skid roads was intended to remove these diversions, allowing surface flow to remain in the appropriate swale, which then flowed into the top of XING 3.

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. This included the flattening out of several rolling dips and the removal of trees along several sections of the A120 Road. Work on the A100 Road included brushing of young trees and brush for an approximately 1,000 foot length, grading of the road surface where fill material from the previous years' work had been placed on the road bench and where rolling dip construction had left an undriveable road surface, pioneering of one short road segment through a debris flow on the road bench, and installation of one culvert.

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. Also included in discussion time were discussions between the operators and Tribal administrators or other visitors.

"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.

"Assisting stuck" refers to the time one piece was used in assisting in the rescue of a stuck piece of equipment.

"Breakdown" refers to when equipment was unable to perform at its expected capacity, most often the result of mechanical failure.

"Assisting breakdown" refers to the time that a piece of equipment was not operating because the operator was helping repair another piece of equipment.

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 00-6 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 moderate to 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 technician Dave Heaton, and was completed in November, 2000.

DISCUSSION

Project 00-6 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 73,559 cubic yards was excavated from potentially unstable areas and moved to stable fillsites at a total heavy equipment cost of $297,355 which equates to an overall average of $4.04/yd^3. Much of the work involved steep-sided, narrow, moderate-sized stream crossings; a steep-sided road fill prism; and steep, bedrock-dominated slopes.

Most stream channels in this area are choked with sediment and logs as a result of the timber harvesting methods. This required a transition from complete excavation of the fill material and logs within the prescribed treatment, to the unexcavated sediment- and log-chocked stream channels. Precise location and length of this transitional regime was determined as the excavation was carried out, and depended largely upon depth of sediment, and amount and location of large logs which could act as nick points within the transition area. Incision is expected in these locations, but will hopefully be checked or slowed by the in-place logs. In most of the excavations, a large amount of woody debris was placed immediately below these locations to created sediment storage sites that might catch and meter out the sediment created by any incision that does occur.

The lower portion of the finished channel in XING 3 was in subsoil, because the original, natural stream channel had been eroded away by storm flows. In most places, excavation proceeded to a depth where many clasts were present, almost appearing regolithic, it will be interesting to see how this channel is affected by high flows. The subsoils in this area appear to be relatively low in clay and clast content, and, therefore, the armoring capability is low.

The fillsites for this project were often characterized by high rocky cutbanks and outcrops. It will be interesting to see how these steep wedges of fill material placed against and on top of near-vertical bedrock will behave erosionally. Additionally, some fill material from the excavations was placed in former mass movement locations. It was believed that the mass movements were caused by the construction of the road, as cutting of the road bench undercut the regolith layer lying on top of the bedrock. So it was believed that placement of fill material in these areas would not increase the instability of these locations, and that further movement of the slope above and underneath the fill material would not occur, as the filling of the cutbank and reshaping of the slopes with the fill material would help to buttress the slopes. It will be interesting to see if these fillsites do remain stable throughout wet years. In particular, the fillsite adjacent to XING 4, at station 39+00, should be monitored. This site had more fill placed in it than was desirable, due to the time constraints of otherwise having to push the material 800 feet to another fillsite. As a result, the fillsite finished slope is steeper than planned. Bedrock does occur beneath the toe of the fillslope, so it is believed that the fill is placed on stable ground. It would not be surprising, however, if a portion of the fill slope fails due to its oversteepness. Numerous “micro debris torrents” were observed after the first rains (less than two inches of rain) at many places on the fresh fill slopes. These features ranged in width up to one foot, in depth up to eight inches, and in

length up to one hundred feet. This suggests that the lower clay content in the soils and subsoils of this area will make the fill material less cohesive and more prone to failure than in other areas in the park.

This project was carried out through a Cooperative Agreement with the Yurok tribe. Although most of the finished work is of good quality, the average production rate for the project was quite low – approximately 4,100 cubic yards per week. Several factors contributed to a less-than-successful project season. Operator inexperience in "RNP-style" restoration and equipment operation, recurring fuel contamination problems, an under-powered excavator, personality conflicts between some of the equipment operators, and the Tribal administration's delay in providing larger equipment when the operators felt it was needed, all contributed to less than average production rates.

None of the equipment operators had worked on "RNP-style" restoration projects before, except for minor (Less than two weeks total) periods of time the previous year. Although they had all gone through the tribal watershed restoration program training, the excavations involved in this program were "designed" excavations with little regard to following natural ground or exposing buried topsoil or natural stream channel armoring. Therefore, it was necessary to spend time training the operators to identify indicators of these natural surfaces, and to plan and carry out their excavations so that these surfaces would be exposed but not disturbed. In addition, the excavator operator had limited time operating an excavator prior to this project. Although he was becoming familiar with the machine by the end of the project, at the beginning of the project he had to become familiar with both operation of the excavator and "RNP-style" restoration. The steepness, narrowness, and rockiness of XINGs 1 and 2 also decreased the efficiency and quality of the first excavations.

Fuel contamination problems, probably caused by the Tribe's fueling system, plagued the excavator and bulldozer early on in the project. Though the problem's cause was eliminated during the first two weeks of operation, clogging of fuel lines, stalling, and under-powered running of the equipment occurred throughout the next two months – occasionally for the excavator, but often for the 850C bulldozer.

Problems arose from the lack of a Tribal representative on site. Tribal representatives (other than the equipment operators) visited the site only four or five times during the entire project. This is 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. Several issues arose during the project that, had a Tribal representative been on site, would have been better and probably more quickly resolved. These included the mechanical problems with the equipment, personality conflicts between the operators, absenteeism and tardiness among the operators, additional equipment needs, and conflicts between the equipment operators and the Park's COTR in relation to excavation logistics.

As of February, 2001, during a somewhat dry winter, one debris flow and one slump had occurred within the finished work. A debris flow of approximately 40 cubic yards originated in the upper right bank of XING 1. Some fill material had been left here to transition from the crossing excavation into the log- and debris-choked stream channel above. The water observed flowing from the failure had not previously been detected. A slump of approximately 30 cubic yards occurred on the left bank of Skid 300 XING 1. A one to two foot-thick veneer of fill material had inadvertently been left during excavation, and the steepness of the finished bank promoted the failure. Both of these failures may expand to up to 100 cubic yards each before

they stabilize.

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APPENDIX

Excavation Costs and Production Rates

As of the time of writing of this report, negotiations between the Park and the Tribe to determine final prices had yet to be finalized. Therefore, all production costs used in this report are based on the original prices agreed upon before project startup. Addenda to this report will be included upon determination of final prices.

Calculation of HERE rates

Heavy Equipment Rental Equivalent (H.E.R.E.) rates were determined using the following rental rates for equipment and operators (determined from Caltrans equipment rental listing and Davis-Bacon wage listing):

Equipment	Hourly Rental Rate	Ripper	Operator Rate	+40%	Total Hourly Rate
JD230	$60.86		$43.40	$41.70	$146
JD330	$66.97		$43.40	$44.15	$155
JD850C	$38.56	$3.84	$42.02	$33.77	$118
CAT D8R	$89.52	$10.71	$42.02	$56.90	$199