

Summary Report
Watershed Rehabilitation Unit 03-03
Y zone and B540 Roads

Portion of road removal work in the Larry Damm Creek watershed
(Lost Man Creek)
Completed with Line Item Construction Funds
Package #277

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Redwood National and State Parks
December 2003

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Introduction

Redwood National Park was established "in order to preserve significant examples of the primeval coastal redwood (*Sequoia sempervirens*) forests and the streams and seashores with which they are associated for purposes of public inspiration, enjoyment, and scientific study" (Public Law 90-545).

Original park boundaries (1968) protected a ½ mile wide corridor of forest along the lower ⅓ of Redwood Creek, while lands located upslope and upstream of this corridor remained in private ownership. Prior to the establishment of the park, much of these lands were forested with old growth mix conifer forests. Subsequent to the park's establishment, these lands were subject to aggressive timber harvesting. This timber harvesting and the related road construction adversely influenced erosion rates, sediment deposition and water quality within the entire basin. The existence of several hundred miles of major haul roads and thousands of miles of tractor trails creates severe erosion problems. Studies indicate these activities cause unnatural and excessive erosion that result in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Narver, 1971). The cut and fill construction of logging roads on steep slopes often results in massive slope failures, causing sediment to be delivered directly into perennial and intermittent stream channels. Surface runoff can be intercepted and concentrated by inboard ditches along these roads, and often discharged onto slopes that have no natural drainage channels, resulting in severe gullying. With the absence of road maintenance, even annual storms can cause culverts and inboard ditches become overwhelmed by debris, resulting in water diverting onto road surfaces, causing new gullies and saturating road fills, which increases the risk of fillslope failures. The altering of drainage patterns, the resulting loss of top soil, soil compaction, and destruction of ground cover, combined with increased runoff rates are among the widespread results of logging activities in the Redwood Creek basin. These factors lead to increased sedimentation, increased streamside slope failures, greater bank erosion, and loss of anadromous fish-spawning habitat. Further, these events lead to a general degradation of the watershed, including damage to the aquatic and riparian environments in the Redwood Creek basin.

Project Background

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..." (National Park Service Management Policies, 2001). It is also Park Service policy that "Landscape and vegetation conditions altered by human activity may be manipulated where the park management plan provides for restoring the lands to a natural condition. Management activities to restore human-altered landscapes may include, but are not restricted to: removing constructed features, restoring natural topographic gradients, and revegetating with native park species..." (National Park Service Management Policies, 2001). Management objectives of Redwood National Park are "to restore and maintain the RNSP ecosystems as they would have evolved without human influences since 1850 and perpetuate ongoing natural processes" (RNSP, Final General Management Plan/General EIS/EIR, 1999). These are among the policies and objectives that provide guidance and direction for the road removal program.

Redwood National Park (RNP) is located in the lower ⅓ of the 280 square mile Redwood Creek watershed, in the mountainous, coastal region of northwestern California (Figure 1). The basin is characterized by high relief, steep, unstable slopes, and narrow valley bottoms with the mainstem controlled by the Grogan Fault. 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 in the basin, 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 ⅔ 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).

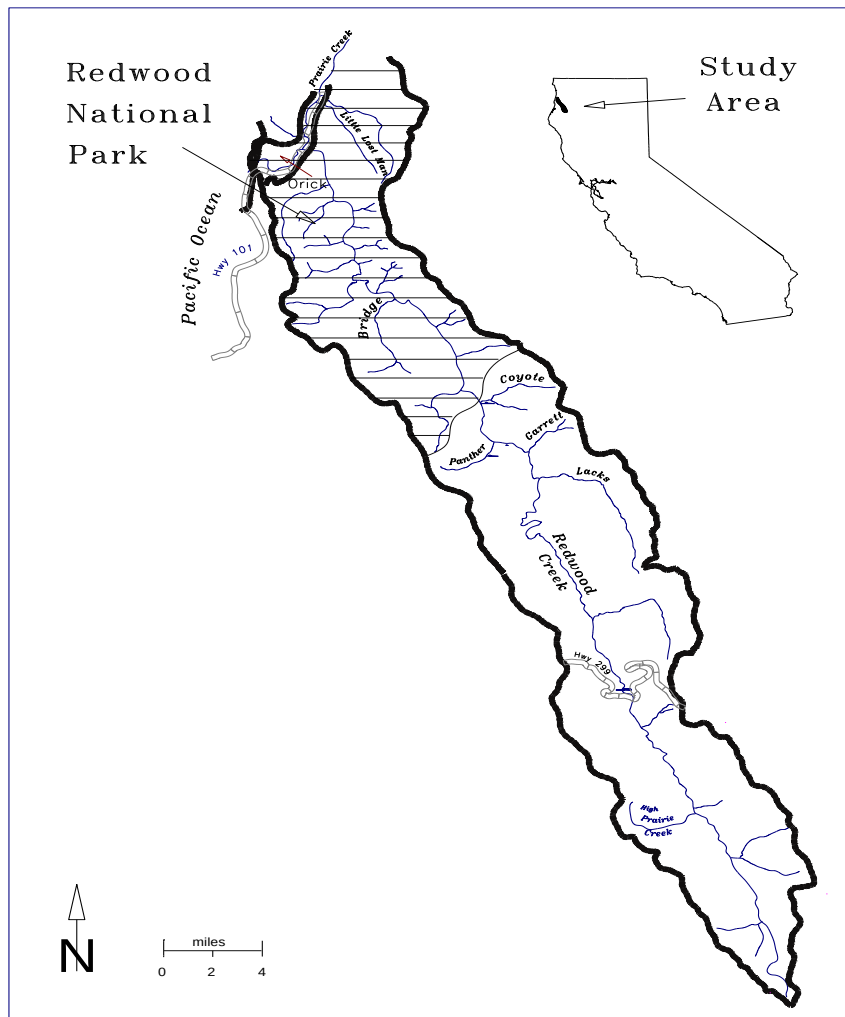


Figure 1. Map of Redwood National Park and the Redwood Creek basin.

In 1978, Congress enacted the expansion legislation of 1978 (Public Law 95-250, "In order to protect existing irreplaceable Redwood National Park resources from damaging upslope and upstream land uses, to provide a land base sufficient to insure preservation of significant examples of the coastal redwood in accordance with the original intent of Congress, and to establish a more meaningful Redwood National Park for the use and enjoyment of visitors". The boundaries of Redwood National Park were expanded by approximately 48,000 acres, and Congress directed the National Park Service to undertake a watershed rehabilitation program. The primary goals of the rehabilitation program are to minimize man-induced erosion and speed the natural re-vegetation process by restoring the hillslope hydrology to conditions that existed prior to human influence. The expansion legislation directed the Park Service to develop techniques for reducing the impacts of landscape disturbance that had never been attempted on such a scale as found here at Redwood. The techniques and philosophies have evolved over the years, and will continue to do so, as more is learned about geomorphic processes, and the relative relationship of these processes to the life histories of the native plants and animals.

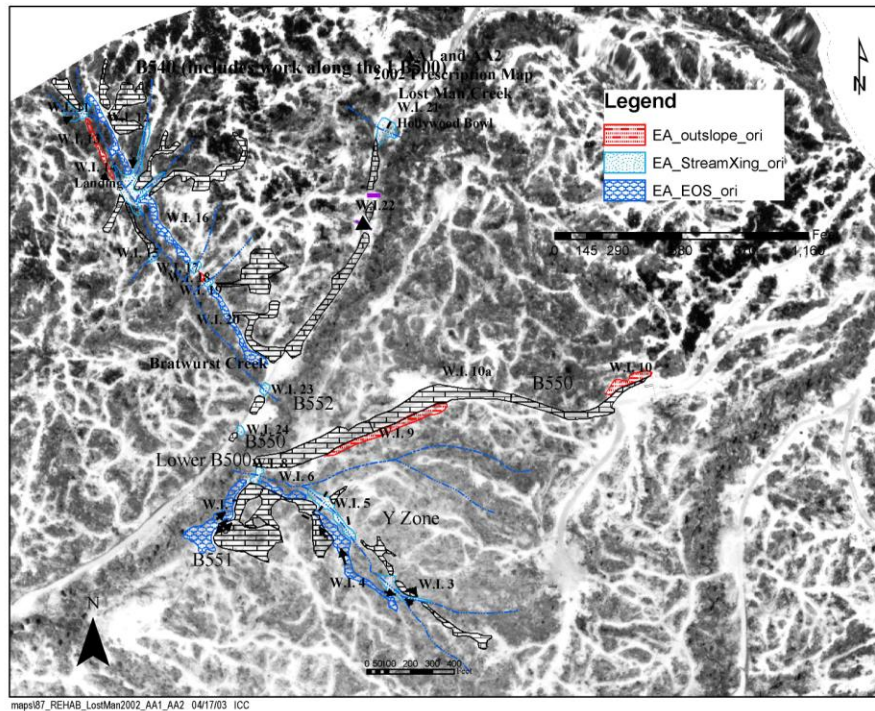


Figure 2. Map of Watershed Restoration Project 03-03, Y zone and B540 locations.

Geology

The 03-03 project area includes the Y Zone and B540 roads, located on the mid-basin portion of Larry Damm Creek. While there is no specific information about geology in the exact area of the project site, conditions found here were similar to those reported by Kelsey and Trexler (1989), who describe the northern portion of Larry Damm Creek watershed as predominantly underlain by the Gold Bluffs Unit of the Prairie Creek Formation. The Prairie Creek Formation represents the onshore and nearshore portion of an extensive sedimentary sequence deposited near the mouth of the Klamath River. It is dominantly composed of fluvial sediments but also includes nearshore marine, beach, and estuarine deposits. Macro faunal fossils constrain the maximum age of the Prairie Creek Formation to 2-4 Ma. (Kelsey and Trexler, 1989).

Kelsey and Trexler (1989) described three sections through the Prairie Creek Formation, one of which is in Larry Damm Creek, near the 560 and 540 roads, and south west of the 03-03 project area. Here, the first 60 meters of sediments deposited on the Franciscan graywacke are medium to fine-grained sands. Above this, the section is dominated by sandstone and mudstone, with some intervals rich in clay and others consisting of massive conglomerate. Above 175 meters, the section becomes more conglomeratic and generally coarser.

Prairie Creek sediments were deposited with angular unconformity on the Jurassic-Cretaceous Franciscan Assemblage. In the project area, the Franciscan is designated as the coherent unit of Lack's Creek (Harden et al., 1982). Harden et al (1982) describes the predominant rock types of the unit as coherent sandstone and interbedded sandstone and mudstone with rhythmic bedding and internal sedimentary structures typical of turbidites. Sandstone occurs as massive beds up to 10 meters thick, but most beds are between 0.1 and 3

meters thick with thinner mudstone interbeds; individual beds cannot be traced laterally for more than 100 meters due to complex folding and faulting (Harden et al., 1982).

The Prairie Creek Formation and the coherent unit of Lack's Creek are juxtaposed along the Lost Man Fault, a high angle fault trending north-northwest to south-southeast near the south and southwest portion of the project area (Kelsey and Trexler, 1989). According to Kelsey and Trexler (1989), the Lost Man Fault displaces the Franciscan basement upward along its east-side, exposing it near the headwaters of Larry Damm Creek. Activity of the Lost Man Fault during the late Pleistocene to Holocene is not known (Kelsey and Trexler, 1989).

Threatened and Endangered Species Concerns and Project Work Schedule

Redwood National and State Parks are home to five species listed as threatened under the Endangered Species Act and that are potentially effected by watershed restoration projects; marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), Southern Oregon/Northern California Coasts coho salmon (*Oncorhynchus kisutch*), California Coastal chinook salmon (*Oncorhynchus tshawytscha*), and Northern California steelhead trout (*Oncorhynchus mykiss*).

With respect to terrestrial species, the U.S. Fish & Wildlife Service (FWS), as administrator of the Endangered Species Act, set noise restriction guidelines for management projects that do not remove or degrade suitable habitat for both the northern spotted owl and the marbled murrelet. These noise restrictions are designed to reduce human impact to nesting sites during the breeding season and apply to management projects that are located within a ¼ mile radius of suitable habitat. Additionally, FWS may impose restrictions due to impacts to foraging habitat. Unit 03-03 was located entirely outside of the ¼ mile radius for suitable habitat and therefore was excluded from the noise restrictions.

With respect to aquatic species, the National Marine Fisheries service (NMFS), as administrator of the Endangered Species Act, set restrictions and guidelines for management projects requirements to minimize short-term adverse effects to aquatic habitat and listed, proposed or candidate species of Pacific salmonids (coho, chinook, and steelhead). These restrictions and guidelines include the implementation of erosion control methods such as the distribution of woody debris along and in stream channels, and minimizing the disturbance to existing riparian cover along non-fish bearing and fish bearing streams. They also define the work season as June 15 to October 15 of each year. For a complete list of the required measures to be taken to minimize impacts to threatened fish species, see Appendix 2.

Heavy equipment typically operated 10 hours per day, 50 hours per week. Heavy equipment operations on Unit 03-03 began August 19 and were completed October 30, 2003. The NMFS authorized the extension work season past October 15 due to favorable weather in the later part of October.

Rationale for Assessment and Prescription

The methodology for defining landscape disturbance and related impacts often appears to be somewhat subjective. In an effort to address multiple resource concerns, a variety of factors are used to analyze the disturbance and subsequent impact relative to present day park priorities on a site by site basis. As these sites are identified and a project plan evolves, an informal cumulative assessment of projected work areas is considered. While cost is always included in the equation, there are situations that dictate an added expense to provide a more favorable outcome when some of the peripheral concerns are taken into account.

Priorities for watershed restoration in the park include (but are not limited to) reducing human induced sediment, improving water quality (temperature and turbidity) for fisheries and improving forest stand health. While road removal has a direct benefit to mass reduction of potential sediment, short-term impacts to fish and wildlife habitat is a concern. Some erosion is anticipated from excavation sites and reduction of canopy along restored stream channels may allow for elevated stream temperatures. While nearly all of the second growth forest associated with this project's efforts are dense thickets of poor quality habitat, there

remains concerns for the fragmentation of what will likely become more suitable forest habitat in the coming years.

An understanding of interdisciplinary issues and incorporating appropriate mitigation measures on a site by site basis are a significant component of the project geologists job. Consultations (both formal and informal) provide the geologist with up to date information and concerns for habitat requirements of the various listed species. Often, project implementation may require modification, or prescribed treatments to be altered in order to minimize potential impacts to a sensitive area. On a more regular basis the project geologist will adjust the excavation boundaries or finished landscape features to achieve a desired goal, such as retaining maximum shade elements near perennial streams.



Figure 3. Riparian trees left in large woody fills on the flood plain of Larry Damm Creek.

An example of shade tree retention can be seen in the latter portion of work item 7 where a landing had been constructed downstream of the confluence of the Y Zone stream and Larry Damm Creek. Anticipating that a large proportion of riparian vegetation could potentially be removed in the surrounding area due to the adjacent B550 bridge removal and the B551 stream crossing of Y Zone Creek just north of the landing, we elected to leave a row of trees growing in the outboard fill (figure 3). The trees and associated fill that were retained had large concentrations of wood chunks or rootwads. The rationale for this was that when Larry Damm Creek floods to that level, there will be more woody material than sediment remaining in the floodplain susceptible to erosion. This decision was made on the premise that the life span of the retained vegetation will be somewhat less than it may have been when growing in the unstable fill prism, but it would provide a transition period for the next generation of riparian canopy.

Photo Points:

Photo Points are used to document road removal work through time. A protocol and archive of past projects is located in the RNSP archive / museum at the South Operations Center, Orick CA. A detailed map(s) is attached as Appendix 1, showing the locations of photo points for project 03-03. Photo points are chosen at locations that will have a good representative depiction of ground conditions before and after road removal. Photos may be taken at the designated photo point during excavation, providing a glimpse as to how the road feature was de-constructed.

Each photo point begins with the project number 0303 to indicate that it belongs with this project. The two-digit work item number as presented in the task order for contract follows the project number. Each work item may have multiple photo points, designated by a seventh digit. The work item photo point number may have a letter following that reference number, indicating multiple directions of photos taken at

a single point. An example would be at work item 7, where there are two photo's shot from photo point 2 (0303072a & 0303072b) (Figure 4). The bearing is given on the photo point map (figure 5) and labeled on the flagging marking the photo point site location.



Photo point 0303072a_8_21_03, before.



Photo point 03030702a_9_17_03, after.

Figure 4. Photo point 0303072a showing before and after photos on the B551, looking downstream or south along road alignment.

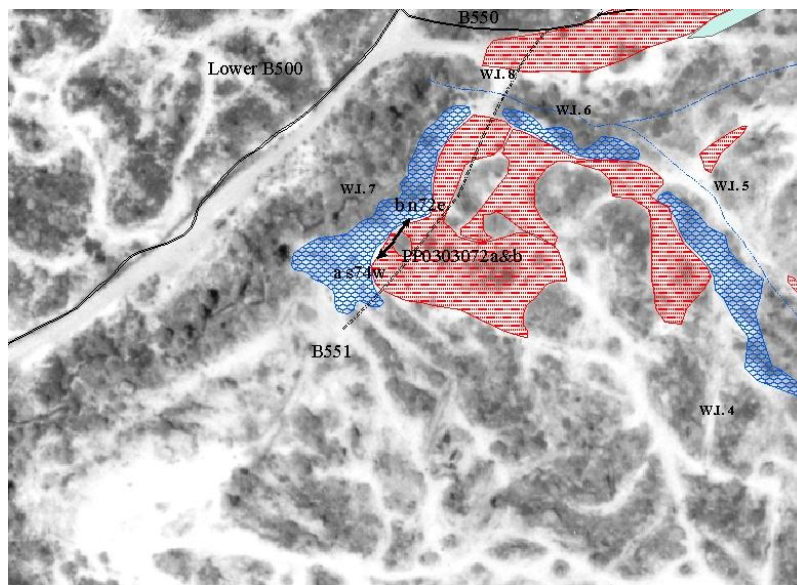


Figure 5. Location of Photo point 0303072a&b

Geomorphology

The geomorphic processes acting within the project area are a direct result of the physical characteristics of the existing bedrock units, high rainfall, and recent disturbance by intensive logging and road building activities. The unconsolidated sediments of the Prairie Creek Formation are readily mobilized by surface runoff, especially where the landscape has been cut and sidecast to construct roads and lay-outs, and where natural drainage patterns have been obliterated by logging disturbances. These sediments are also susceptible to natural and disturbance-induced mass wasting processes.

The 03-03 project area is close to the contact boundary between the Franciscan bedrock and the Prairie Creek Formation, and both these sediments effect the geomorphology of the area. The tributary streams exhibit the steep slopes, narrow, confined canyons, and high energy streams flow associated with the relatively resistant

Franciscan bedrock found in the upper reaches of Larry Damm Creek. Other locations in the project area exhibit the gentler terrain and less confined stream reaches of the Prairie Creek Formation, and act as sediment accumulation zones. The eastern contact between the Prairie Creek Formation and the Franciscan is a probable hydrologic boundary and a potential zone of instability; groundwater that accumulates in the porous Prairie Creek “cap-rock” is likely to accumulate and move along the buried valleys of the ancient surface of the Franciscan Assemblage, and come to the surface where the fault exposes the contact. The steep slopes of Franciscan graywacke below tend to facilitate the formation of debris flows along this contact.

Timber Harvest History

Timber harvesting in Unit 03-03 occurred between 1962 and 1966, prior to the establishment of the California Forest Practice Rules. The area was clear-cut logged and heavily tractor-yarded by Arcata Redwood Company. The Arcata Redwood Company lands suffered extreme ground disturbance due to a combination of factors including the recently increased power developments in large bulldozers; old growth logging and tractor-yarding methods of the period; construction of large haul roads and landings with little regard for preserving natural drainage networks; and highly remoldable unconsolidated substrate. Imminent park expansion also influenced the rampant logging activities in the Larry Damm watershed (Franke and others, personal communications, 2002). These land use practices caused major disruptions to the natural hydrologic conditions including the formation of large gullies in stream crossing and sidecast fills, slope failures due to diversions of surface and stream flows, and chronic road slumping of sections of the LB500, B540 and B551 roads along Larry Damm Creek. These conditions have led to increased sedimentation in Larry Damm Creek and its associated tributaries. This area was prioritized for watershed rehabilitation efforts due to the extensive upslope resource threats, damage from the 1997 storm and relatively high quality of downstream terrestrial and anadromous fish habitat of threatened and endangered species.

Erosional Features

The most dominant erosional problems identified in Unit 03-03 were associated with stream crossings and unstable fills along Larry Damm Creek or in high energy tributaries. Most of the landings on the B540 and the Y zone were located in stream channels, burying the stream courses in up to 35 ft. of fill and organic debris. Also, many prominent stream courses were utilized as skidding corridors, destroying the natural stream course form and function. A combination of the high level of ground disturbance from harvest practices with storm events in 1964, 1972, and 1975 resulted in accelerated erosion and the entrainment and deposition of large quantities of sediment in stream systems. Many of the tributary stream crossings conducted subsurface flow, as evidenced by the lack of surface channels, and by numerous sink holes in landing fills. Surface flow that did occur, occurred during high flow periods, cutting large gullies through the landings. Post harvest influxes of sediment from landing failures and gullying caused the channels downstream of these tributary stream crossings to aggrade, and delivered large amounts of sediment to Larry Damm Creek.

Due to the stepped nature of the road features within the channel network, sediment from an upstream crossing or landing would often be deposited at the top of a lower road structure. This subsequent deposition from upstream sediment sources is notably different, by nature, than the fill material used to construct the crossing or landing. The sediment deposit is much higher in silts and clay, consisting of a fine “muck”. Excavation of the muck deposits often require some modification of techniques typically used to relocate road fills, such as mixing dry dirt with the muck to achieve a manageable consistency.

Project Objectives

The project unit 03-03 includes three distinct groups of work items. The Y Zone is the culmination of residual roads left by the previous project 02-01. The predominate segments being the remaining portion of the B551 – perched along Larry Damm Creek, the ridge road that accessed the B550 complex in the north fork of Lost Man Creek and a set of spur roads labeled B551a and B551b (“Y” proper). The second phase of the 2003 season was the B540 road system with a portion of the Lower B500 mainline. The B540 was a short haul road up a tributary on the west side of Larry Damm Creek. The Creek in the B540 basin was named Bratwurst during the course of the season (see narrative segment). The portion of Lower B500 assigned to this project stretched from the terminal end of rehab project 03-01 at the access road to PT Creek (station 83+50) to the B550 bridge (station 104+75). The remaining downstream portion of the Lower B500 was addressed by project 03-02.

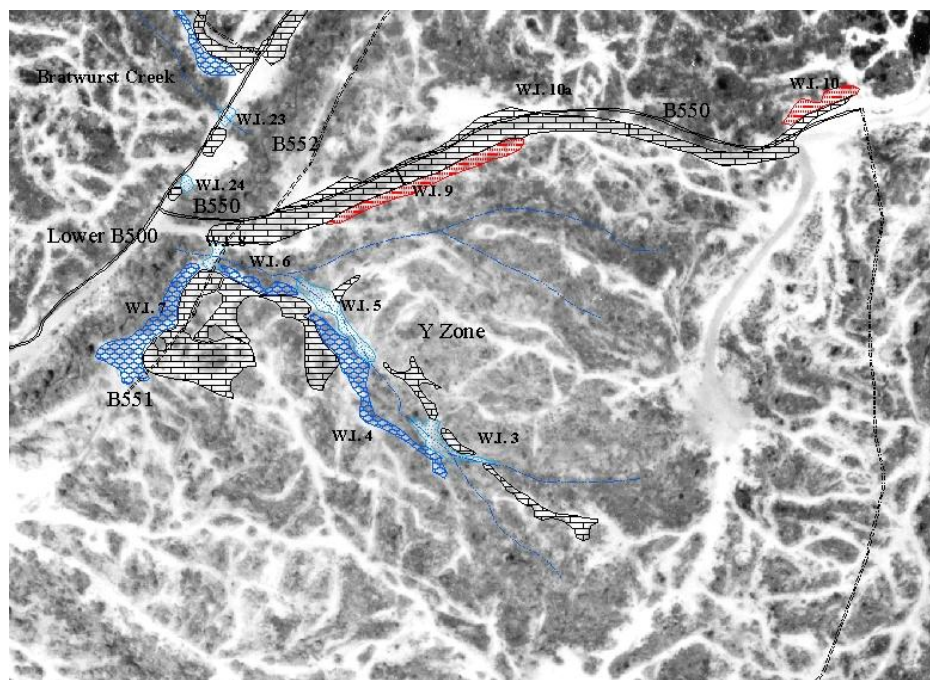


Figure 6. Project map (as built) showing the Y Zone with associated work items.

The Y zone included two road stream crossings on a mid basin tributary (work items 3 and 5), that were constructed without drainage structures. The lower crossing (work item 5) was an intersection of the main road and various skid roads. The channels morphology maintained an inner gorge shape through this area, with moderate hillslopes dropping into a steep walled channel, often deeper than the channel width. This road system cut over a small ridge to the east of the confluence with Larry Damm Creek, connecting with the remaining B551. The intent of the road removal work at these sites was to remove the bulk of the potential sediment source, while minimizing the linear disturbance to the channel habitat elements.

The B551 had been targeted in the 2002 work season. Due to seasonal time restrictions, the last portion of the B551 had to left for the 2003 season. This section had a relatively well developed swale crossing and a large landing built out onto the flood plain of Larry Damm Creek. The objectives for this section of road was to remove road fill placed in fluvially accessible locations (i.e. in the swale or on the flood plain) to stable up slope fillsites. The remaining section of the B550 was one of the main targets for the relocated fill.

The B550 was the first road system targeted for removal in the Larry Damm and North Fork Lost Man Creek project. Begun in 2000, the B550 retained only a half mile of steep ridge road constructed to access the north fork basin. The objective of using the B550 as a fillsite allowed for a reconstruction of some the ridge features that would restore natural drainage patterns and eliminate diverted surface flows.

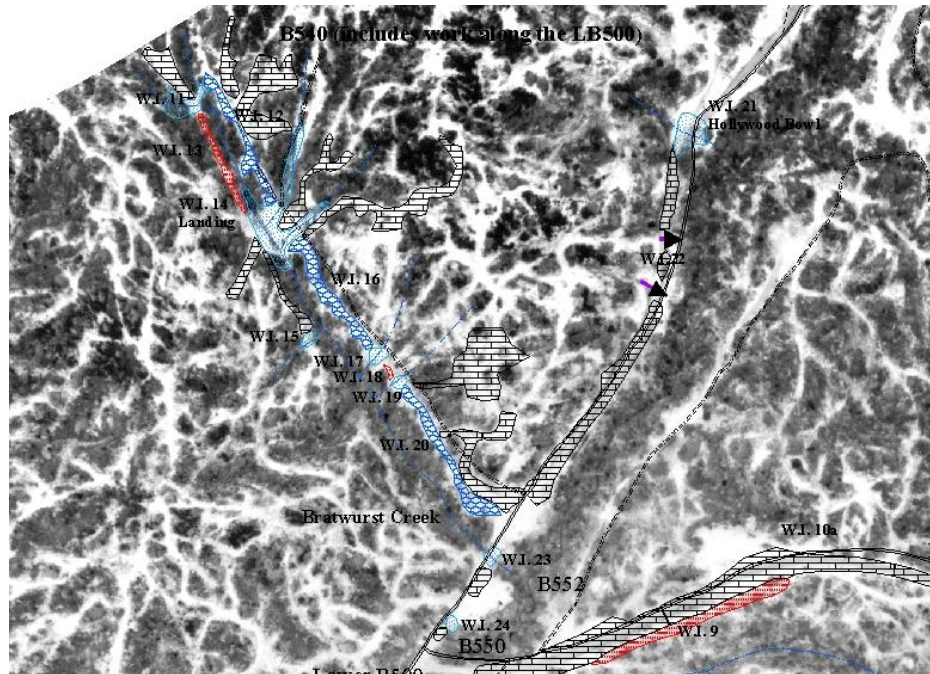


Figure 7. Project map (as built) for B540 and Lower B500 road work.

The B540 or Bratwurst Creek area was a terminal haul road built along the north side of Bratwurst Creek. The terminal landing, constructed in the confluence of three channels, was the main objective for treatment in the drainage. Once again, the main objective was to remove or reduce the large sediment sources while minimizing channel disturbance.

The final portion of the project was a segment of the Lower B500. The segment began from the north, at Hollywood Bowl, where Project 03-01 ended. The end of the 03-03 segment was the Wee Draw site, just upstream from the B550 log string bridge, removed by Project 03-02. Due to the relative close vicinity of Larry Damm Creek and the extensive amount of road removal work done over the past few years in this area, the objective for the Lower B500 scaled back the amount of upslope, or bank disturbance along the mainstem. Tributary crossings were targeted for “stable excavations”, which does not necessarily mean complete restoration of the channel form. If a channel bottom was found to have a stabilizing element such as a large wood control, the elevation would be used as the final configuration for the excavation.

Summary and Overview of Volumes and Costs

Project 03-03 was awarded under Contract Number 848 03 0127, Task order T83560-0020-036, to Z Logging, LLC of Orick, California. Under this Task Order, the Contractor excavated 77,938 yd³s of road fill at a total contract cost of \$546,655.07. The Contractor moved in a John Deere 330LC excavator, a Cat D8L and a Cat D8K. As the season progressed, the Contractor also moved in two other D8's as back up dozers to maintain production during breakdowns or increase production during long pushes. Daily operations saw Jim Potts as lead Catskiner and Chris Mills on the excavator. Albert Zuber ran the second dozer on an ‘as needed’ basis, unless a full-time second dozer was needed. During periods of a “two cat” show, either Pat Williams or Steve Maples ran second cat (a guest appearance by Jay Franke occurred one day, as fill in for Pat).

Table 1 GENERAL SUMMARY EXCAVATION COSTS FOR UNIT 03-03: REMOVAL OF A PORTION OF THE Y ZONE AND B540 ROADS					
Treatment	Quantity (cubic yards)	Number of Sites	Total Costs (\$)	Percent of Grand Total	Average Unit Costs (\$)
Heavy Equipment					
Stream Crossing	47,032	11	\$386,776.65	70.8%	\$8.22
Export Outslope	24,697	6	\$123,082.20	22.5%	\$4.98
Outslope	6,209	5	\$18,868.98	3.5%	\$3.04
Rolling Dips	1 job	2	\$370.00	0.1%	\$185.00
Move In	1 job	---	\$1,000.00	0.2%	---
Brushing and Rebuilding	1 job	---	\$13,225.00	2.4%	---
Move Out	1 job	---	\$1,500.00	0.3%	---
Adjustments	1 job	---	\$1,641.31	0.3%	---
interest paid			190.93		
Subtotal	77,938		\$546,655.07		\$7.01

GENERAL PROJECT FIGURES FOR ROAD REMOVAL	
Overall average yd ³ s per mile	45313 yd ³ s/mi
average cost per mile	\$7.01 /mi
total miles	1.72 mi
length of road removed for:	
stream crossing	2698 ft
export outslope	2394 ft
outslope	4015 ft

Overall numbers for project are provided in appendix 3. The following tables provide numbers for Stream Crossing (RX), Export Outslope (EOS) and Outslope prescriptions. Production rate values are discussed in the narrative portion to allow for a more detailed explanation of factors that may influence efficiency during any particular work item.

Stream Crossing Summary Data for Project 03-03

Item Number	Item Title	Excavated Volume	Subdivided* Volume	Actual		length RX	Overall Unit Cost Per Bid Item	Actual Costs		
				Station begin	Number end			\$/CY	Total Cost	
Y zone (includes B551 / B550 roads)										
3	RX1	upper Y	4358	4358	0000	0300	300	\$6.15	\$5.50	\$23,969.00
3a	push	push (100')		3000			0		\$0.95	\$2,850.00
5	RX2	lower Y	4189	4189	0000	0200	200	\$9.47	\$5.50	\$23,039.50
5a	push	push (500')		3500			0		\$4.75	\$16,625.00
8	RX3	B551 RX@16+25	319	319	1650	1750	100	\$4.95	\$4.95	\$1,579.05
11	RX4	B540 upper landing	1912	1912	0000	0100	100	\$5.69	\$4.70	\$8,986.40
11a	push	push (200')		1000			0		\$1.90	\$1,900.00
14	RX5	B540 landing	23578	23578	0000	0219	219	\$9.65	\$6.25	\$147,362.50
14a	push	push (600')		4610			0		\$5.70	\$26,277.00
14b	push	push (300')		15085					\$2.85	\$42,992.25
14c	push	push (500')		2300					\$4.75	\$10,925.00
15	RX6	adjacent skid	2893	2893	0000	0500	500	\$7.82	\$4.70	\$13,597.10
15a	push	push (200')		1000					\$4.75	\$4,750.00
15b	push	push (300')		1500					\$2.85	\$4,275.00
17	RX7	B540 RX@6+25	1501	1501	0588	0670	82	\$4.70	\$4.70	\$7,054.70
19	RX8	B540 RX@8+00	1190	1190	0752	0835	83	\$4.70	\$4.70	\$5,593.00
21	RX9	LB500, Hollywood Bowl	4604	4604	8350	8700	350	\$7.18	\$4.70	\$21,638.80
21a	push	push (200')		4000	8700	9711			\$2.85	\$11,400.00
23	RX10	LB500, Bratwurst	1413	1413	9711	10075	364	\$4.70	\$4.70	\$6,641.10
24	RX11	LB500, WeeDraw	1075	1075	10075	10475	400	\$4.95	\$4.95	\$5,321.25

Item Number	Item Title	Actual Volume	Actual Volume	Total Project Length	RX	Overall Unit Cost \$/CY	Actual Costs \$/CY	Total Cost
Totals	push (200')	47032			2698	\$8.22	\$8.22	\$386,776.65

* Subdivided volume denotes proportions of excavated fill that were pushed to various fillsites requiring additional push differentials for a particular work item.

Overall RX Unit Cost = \$8.22
Overall Cost Per Mile = \$756,923.91

2698 feet removed as RX
5280 feet per mile
0.51 miles removed as RX

Over the past three years of road removal in the Prairie Creek Formation bedrock, a number of post excavation adjustment processes have been noted. Shallow earth flows (typically 1 foot deep by 100 square feet in area) were observed on fillsites where material had been placed, but not compacted. In the 2003 season, fill placement procedures attempted to minimize the placement of fill near excavated channels and utilize 'safer fillsites'. Typically, the change meant pushing fill further from the excavation site. The increased unit cost of stream crossing excavations through time is a by-product of the evolution and implementation of BMP's.

Export Outslope Summary Data for Project 03-03

Item Number	Item Title	Actual Volume	Subdivided* Volume	Station begin	Number end	EOS	Overall Unit Cost Per Bid Item	Actual Costs		
								\$/CY	Total Cost	
4	EOS	B551b 00+00 to 04+00	2569	2569	0000	0400	400	\$4.05	\$4.05	\$10,404.45
6	EOS	B551a 06+00 to 09+00	1511	1511	0600	0900	300	\$4.05	\$4.05	\$6,119.55
7	EOS	B551 10+50 to 16+50	10847	10847	1050	1625	575	\$5.71	\$4.05	\$43,930.35
7a	push	push (300')		6300					\$2.85	\$17,955.00
12	EOS	00+00 to 03+85	1504	1504	0000	0385	385	\$4.05	\$4.05	\$6,091.20
16	EOS	02+19 to 05+88	2023	2023	0219	0588	369	\$4.05	\$4.05	\$8,193.15
20	EOS	08+35 to 12+00	6243	6243	0835	1200	365	\$4.05	\$4.05	\$25,284.15
Item Number	Item Title	Actual Volume		total length			Overall Unit Cost	Actual Costs		
							\$/CY	\$/CY	Total Cost	
Totals		24697		2394			average \$4.78	average \$4.78	\$117,977.85	

* Subdivided volume denotes proportions of excavated fill that were pushed to various fillsites requiring additional push differentials for a particular work item.

Overall EOS Unit Cost = \$4.78
Overall Cost Per EOS Mile = \$260,201.77

2394 feet Export Outslped
5280 feet per mile
0.45 miles EOS

The EOS prescriptions for the Y Zone and B540 roads typically addressed road segments that had variable depths of fill requiring relocation to sites up to 300 feet away from source excavation. Work item 7, on the

B551 road, was a landing that doubled from the estimated volume due to a buried swale. The additional volume had to be pushed out to, and up the B550 ridge road. The additional work is shown as a new work item, labeled 7a.

Outslope Summary Data for Project

Item Number	Item Title	Actual Volume	Subdivided Volume	Station Number begin	Station Number end	Length OS	Overall Unit Cost Per Bid Item	Actual Costs	
								\$/CY	Total Cost
9	OS B550s 00+00 to 09+82	1256	1256	0000	0982	982	\$3.00	\$3.00	\$3,768.00
10	OS B550 81+55 to 84+00	939	939	8155	8400	245	\$3.06	\$3.06	\$2,873.34
10a	OS B550 ridge	2775	2775	8400	9800	1400	\$3.06	\$3.06	\$8,491.50
13	OS 00+00 to 02+95	920	920	0000	0295	295	\$3.00	\$3.00	\$2,760.00
18	OS 06+70 to 07+52	319	319	0670	0752	82	\$3.06	\$3.06	\$976.14
Item Number	Item Title	Actual Volume		Total Project Length	Length OS *		Overall Unit Cost \$/CY	Actual Costs \$/CY Total Cost	
Totals		6209			4015		average \$3.04	average \$3.04	\$18,868.98

*additional 1011 feet of outslope included for the Lower B500 fillsite

Overall OS Unit Cost = \$3.04
Overall Cost Per OS Mile = \$24,814.00

4015 feet Outsloped
5280 feet per mile
0.76 miles Outsloped

Outslope segments of road were typically boring endeavors. The use of outsloping focused on either defining adjacent excavation boundaries to insure critical fills were completed, or connected, along a reach of road or to provide integrity to restored slopes that had less subtle disturbance issues.

Chronological narrative

Y Zone: B550 and B551 roads, work items 3 through 10

The Y zone portion of project 03-03 began on August 18, 2003. During this phase of the project, 3440 feet of haul road was either excavated or recontoured to a level that would adequately convey fluvial activity so as to restore natural drainage patterns and prevent anthropomorphic erosion, or render the site “hydrologically transparent” An additional 2343 feet of skid road was extirpated from the project area in the course of storing excavated fill from the problem road segments. Based on survey, a cumulative volume of 26951 yd³ of road fill was excavated from the combined work items in the Y Zone. Three stream crossings were excavated as part of the Y Zone phase with a total of 8866 yd³ of fill being removed from the associated stream channels.

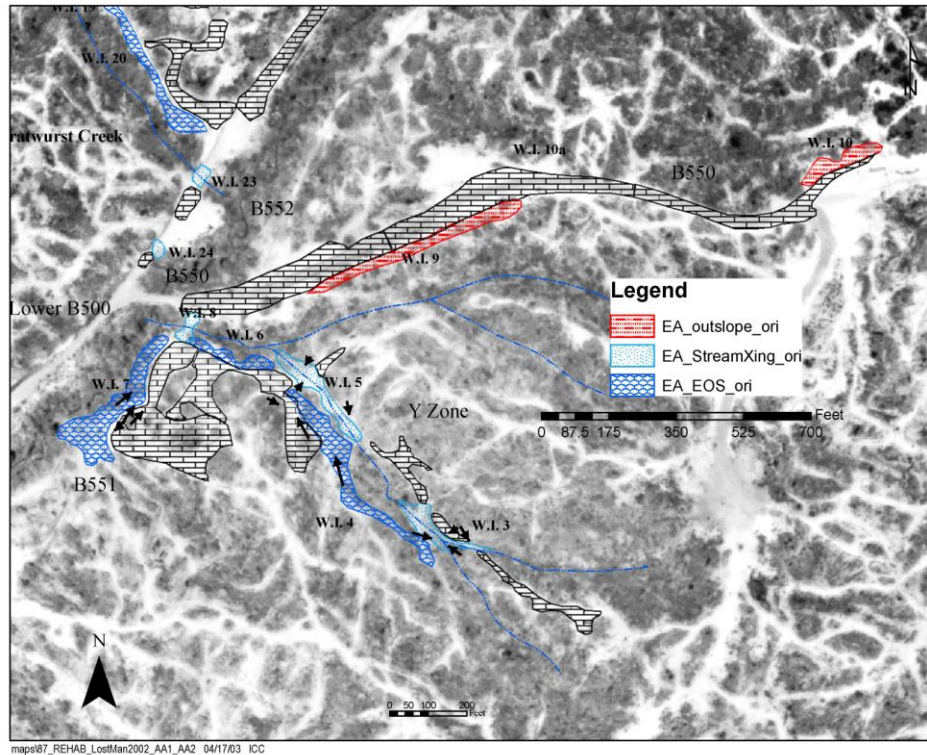


Figure 8. The Y zone includes remaining portions of the B550, B551 and a critical segment of skid road to the southeast of the B550 / B551 junction.

Work Item 3, Upper Y, RX1

The Upper Y stream crossing was constructed in / adjacent to a confluence of two mid-basin perennial stream channels. Road fill had been placed predominantly in the east fork providing access to a skid network along the ridge separating the two channels.

The crossing was actively eroding through internal decay, or “metering” as can be seen in figure 9. Large holes had collapsed as buried organic debris decomposed and settled following construction. The holes, or voids, were on the order of 5 to 50 yd³ of where fill material had eroded.



Figure 9. Sediment deposit in a hole at Upper Y derived from internal decay of crossing fill (field book for scale). Deposition is located approximately 3 feet above active flow at time of photo.

Excavation of the channel fill began on August 21, following a day and a half of brushing and fillsite preparation by the dozer. The ridge skid, which was used as the main fillsite, can be seen in the back ground of figure 10, above the excavator boom. The south fork had been laid out for excavation, but was found to be unwarranted as restoration of the lower portion of channel exhumed the confluence (to the immediate right of the excavator in figure 10).



Figure 10, Looking upstream at the confluence of east and south forks at Upper Y crossing. Minimal fill in the south fork (to the right of the excavator) reduced the cost benefit ratio resulting in leaving the fill to adjust through runoff processes.

The restoration work on the upper crossing was completed on August 26. Nearly all of the restored slopes were left with a 100% veg/mulch cover except for a small portion of steep inner gorge channel (less than 50ft²). A trickle of surface flow was occurring during the morning hours, but was noticed to disappear on hotter days.

Due to the logistical setup of crossing fill, access to fillsites, and the ability of the operators to prepare push roads, fillsites and brush stockpiles, the production rate for this crossing was high. The channel was narrow and steep, but the relative closeness of the push road added to their ability to achieve an average of 58 yd³ per hour.

Work Item 4; B551b, EOS along the west bank between Upper and Lower Y Crossings

The EOS treatment prescribed along the B551b was intended to treat four portions of road fill that were perched steeply above the channel between Upper and Lower Y Crossings. The roads, collectively referred to as the B551b, were a series of connected skid roads the weave between the stumps along the break in slope on the west bank.



Figure 11. Looking down stream at the west bank (left bank of Upper Y) where a portion of the B551b was removed during the Upper Y excavation. Additional brush mulch was applied during the removal of the remaining B551b, covering the bare slope seen in this photograph. Photo location PP0303031b.

Removal of the B551b began on August 26, following almost a full day of prep by the dozer. The restoration of the west slope was completed on August 28. Due to the abundance of vegetation in this particular area, the site received nearly 100% ground cover with native mulch.

Work Item 5; Lower Y Crossing, RX2

The stream crossing at Lower Y may have been a small landing or major intersection of numerous skid roads constructed in a narrow stream channel. The crossing was failing by internal decay as subsurface or piping flows carried away eroded material. Large holes were present during initial reconnaissance.

The estimated plan called for hauling most of the channel fill out to the B550 for dispersal along the ridge. As preparations for trucking began, it became dubious as to the ability of highway trucks to access the crossing location. The B551a road from the B551 was too steep, considering the unconsolidated road material (loose sand) and working space too close for efficient logistics of loading and turning around. Fill was subsequently pushed up and around the ridge to the west (above work item 7) where it was placed in a number of skid roads and blended into the ridge.



Figure 12a, Photo point 030305-1 as the lower Y crossing (Work Item 5) was being cleared prior to excavation.



Figure 12b. Photo point 030305-1 following restoration of the channel through Work Item 5.

The contractual classification of the channel type for the Lower Y excavation changed following excavation. The side slopes were found to be steeper than 60% and narrower than 75 feet, reclassifying the work item from Item Number 16 to Item Number 19. The transportation of fill also changed from a 1900 foot haul to and 800 foot push. All remaining aspects of the excavation went without incident or excitement.

The steep inner gorge morphology of the site required numerous push roads as the excavation moved upstream. This excavation generated a production rate of 26 yd³ per hour. In addition, the roundabout steep push, which was further burdened by mud, likely reduced the production rate.

Work item 6, B551a, EOS

Work item 6 consisted of 300 feet of outsloping along the B551a connecting the interior Y Creek road network to the B551. Targeted fill for the EOS was a series of lobes of fill perched above Y Creek located between several stumps along the outboard edge of the road.

With the exception of the first 75 feet of the treatment prescription, the excavator worked solo with occasional help completing the excavation. The first 75 feet of the EOS treatment was indirectly usurped with the Lower Y crossing removal as fill was transported out to the lower left bank. Some fill was left in the region of station 08+00 in an effort to retain riparian canopy along the left bank of Y Creek just above RX3 (the B551 crossing of Y Creek).

A production rate of 163 yd³ per hour was calculated for work item 6. It is likely that the down station portion of the EOS that was moved during the Lower Y excavation may not have been adequately represented in accounting of hours. The low production rate for work item 5 would also support such an argument. Yet, another reason to be careful of blindly applying production rates with out some level of scrutiny.

Work Item 7, B551, EOS

Work Item 7 encompassed the remaining portion of the B551, left over from the 2002 project. The Export Outslope was anticipated to contain a small swale and outboard perched fill directly adjacent to Larry Damm Creek.



Figure 13a. Photo point 0303072a, looking back towards swale.



Figure 13b. Photo point 0303072b, looking up road towards the B550.

The treatment prescription anticipated a relatively gentle slope of 30 to 60 % grade rolling down to the left bank flood plain of Larry Damm Creek.

Targeted fill for excavation focused on road fill in the swale at station 12+45 and perched fill along Larry Damm Creek. Some slumping was noted along the outboard edge of the B551. The swale location showed subsidence and developing holes, typical of the North Fork Lost Man and Larry Damm Creek erosion processes seen throughout associated road networks.

An additional swale was encountered at station 14+95. Due to the additional depth of the anticipated swale and the exhumation of the additional unanticipated swale, the volume of this EOS almost doubled. The added fill had to be pushed out the B551 and then up the remaining portion of the B550. The extended push added 300 feet of distance beyond the provided standard for an EOS specification.

The up station, or northern portion of work item 7 was a landing or staging area. The outboard edge of the landing was constructed of predominately large chunks and rootwads set along the left bank of Larry Damm Creek. In an effort to retain canopy, especially along streamside, riparian corridors, we decided to leave a fragmented berm of large woody material next to the creek.

A relatively low production rate of 48 yd³ per hour was generated during work item 7. In part, one factor may have been the sensitivity of crossing Y Creek at work item 8. In an effort to prevent fill from slipping into the creek, only the D8K was used to push fill across the work item 8, since the D8K had a narrower blade.

Work Item 8; RX3, B551 crossing of Y Creek

The crossing excavation of RX3 was intended to remove only the fill associated with the B551, regardless of original morphology. Since portions of the outboard fill from the landing on the B551 were being retained, it was prudent to blend the crossing bank into the residual material. As it happened, the original channel was narrow, making it possible to restore the natural banks while blending into the previous excavation.

The removal of 319 yd³ of fill required 4.75 hours, resulting in a 68 yd³ per hour rate. Similar excavations done later in the season on the Lower B500 produced higher rates. It is likely that the additional effort required to keep turbidity level down (progressive check dams) added time to the small scale excavation.

Work Item 9; OS, the B550 frontage road

A parallel road was constructed along the lower half of the B550 as it climbed the hill towards the North Fork of Lost Man Creek. This work item was intended to remove the frontage road and a lower portion of

side cast material perched directly above Y Creek. After further consideration, following the opening of the interior Y Zone, developing additional fillsites, and reconfiguring the B550 as a fillsite, the lowest portion of this work item was dropped to retain canopy and stream cover. The perched fill that was left is comprised mostly of large woody debris and appears to be relatively stable. Surface runoff from the B550 ridge road has been mitigated by the addition of work item 10a.

A production rate for work item 9 was not obtained. The transport of road fill from the frontage road was mixed considerably with incoming fill from work item 7 and the overall reshaping described in work item 10a.

Work Item 10; OS, B550, Camp Larkin

The prescription for work item 10 was intended to provide a sound boundary for the reshaping of the B550 ridge. The hilltop landing / junction is where the B553 and the B554 left the B550, headed south and north respectively. As the previous year's excavation approached the landing, they followed a swale that ended up heading into a throughcut at the summit of the divide. The excavation terminated just shy of following the swale to its logical end. A strip of fill was also left along the northern edge of the landing, perched above the headwaters to a channel crossing the B552. Work item 10 focused on the northern strip of fill.

The OS treatment held a dual purpose. The perched fill was constructed of mixed wood debris and earth left at a 60 to 90% slope. When this fill failed it would have had direct access to a swale being treated as part of project 03-02 (B552). In addition, fill from other work items in the Y Zone had been anticipated to be hauled up the B550 for spoilage. By excavating the remaining fill along the landing, we could be assured that no fill would be placed atop an unstable location as has been done in the past, causing significant failures and avoidable resource impacts.

The excavator completed this work item exclusive of help from dozers. Even while double-bailing the excavator was able to achieve a production rate of 65 yd³ per hour.

Work Item 10a; OS, B550 ridge

Work item 10a was added following the abandonment of end hauling to the B550 ridge. The removal of the ridge road had been intended to be accomplished through fill placement from offsite sources and shaping of the imported fill. The ridge road as it was, represented a significant source of misplaced, concentrated surface flows. In order to restore natural drainage patterns and eliminate the concentrated flows being diverted on to fragile slopes, it was imperative to reshape the ridge to mimic original flow morphology.

Work item 10a was prescribed to utilize any local fill on an "as needed" basis to reshape the ridge. Complete restoration of the original ridge morphology was not a priority as long as surface flow patterns could be replicated to an undisturbed condition.

Using the "hydrologically transparent" approach, the dozer was able to efficiently regrade the road fill to accomplish a corrected surface flow pattern, allowing water to gain access to its appropriate drainage basin.

B540 road: work items 11 through 20

The B540 (Bratwurst Creek) portion of the project began on September 19 and was completed on October 17. The B540 road consisted of a 1200 feet of haul road to a main landing. An additional 2000 feet of skid that was removed by either fillsite utilization or excavation. The survey volume totaled 42083 yd³ removed from the Bratwurst channels (a small portion of that was associated with adjacent fill slopes within 50 feet of the main channel).

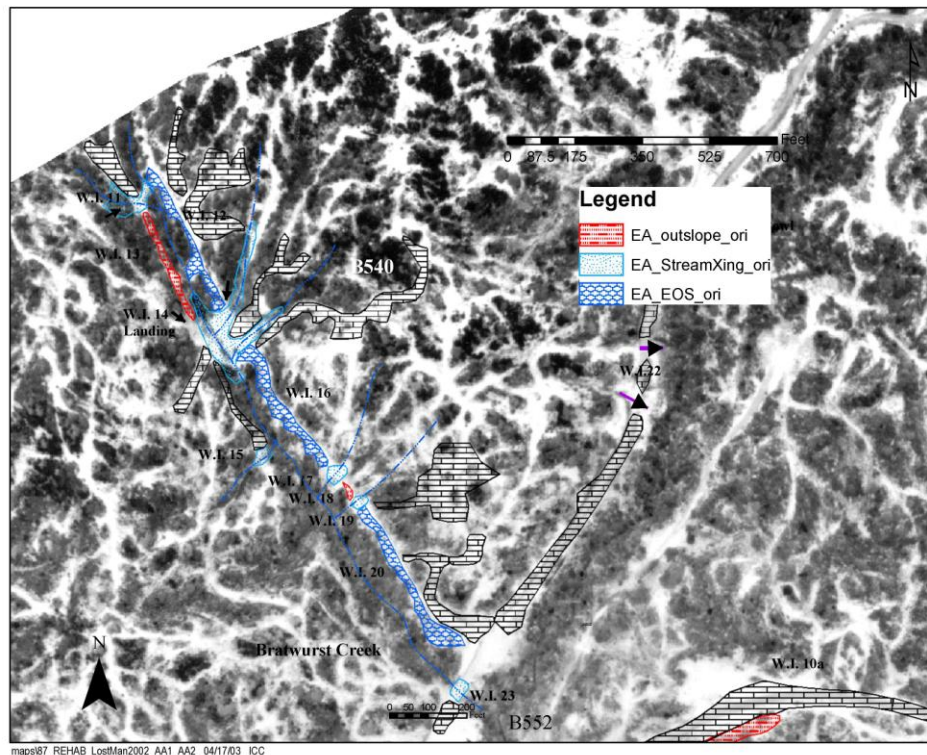


Figure 14. The B540 constructed along the left bank of Bratwurst Creek. All excavated fill from this work area remained upslope of the Lower B500.

The Geomorphology, logging style and road construction was similar to that found in PT Creek and the AA2 (road removal projects 03-01 and 02-04 respectively). The terminal landing was constructed at the confluence of three channels, burying the streams without drainage structure or means of fluvial conveyance. This landing overshadowed all aspects of project 03-03 in time, volume and cost.

Work item 11; RX4, upstream of B540 Landing

Work item 11 was a small stream crossing / skid road intersection located a few hundred feet up stream of the terminal B540 landing. The main portion of fill targeted for excavation was constructed in a southern tributary joining with the mainstem of the Bratwurst creek. The left and right banks are steep with a gentle ridge rising to the west in the confluence.

Fill had been slowly failing in the form of internal collapse within the channel. General subsidence and voids were present throughout the buried tributary. A large wad of perched fill existed above the road on the right bank. This fill was also included in the excavation due to its potential failure in to live flow following the crossing removal.



Figure 15a. Push road that was rebuilt to transport fill across mainstem, through RX4.



Figure 15b. Excavation of last portion of fill from mainstem channel at RX4.

A skid road that had crossed the main channel, but had subsequently partially failed, was rebuilt to provide access to a fillsite on the northern side on the creek. The upper portion of channel fill associated with the B540 landing was pushed up stream along the right bank (through work item 13), across the creek at RX4, and then pushed back down stream along the left bank (through work item 12) to the ridge fillsite just north of the B540 landing. This strategy was required due to soupy nature of the channel fill and the relative elevation of the fillsite (i.e. mud is difficult to push uphill).

The production rate of 75 yd³ per hour is reasonable but may be artificially high. As the soupy fill was pushed over this crossing, any dry fill may have been picked up to make the wet fill more pushable. This volume would easily be missed during the accounting process.

Work Item 12; EOS, road on north or left bank between RX4 and B540 Landing

A large lens of fill, associated with a gentle swale, was perched above the mainstem of B540 creek, tapering back to RX4. Several other small lobes of fill were included in the prescription. The road was constructed approximately 50 feet above the channel, running on contour to the B540 landing.

A large segment of fill had failed, likely in the 1997 storm. Remaining fill showed stress cracks and subsidence along most of the length included in this work item.

This upstream portion of road was used in the transport route for fill from the upper channel excavation of the B540 Landing. During the pushing of fill, much of the road was accreted by dozer blades and relocated in the northwest ridge and the west swale fill sites. Production rates (80 yd³/hr) for this work item are suspect due to the inability to differentiate volumes being picked up with the push dirt from work item 14.

Work Item 13; OS, road on south or right bank between RX4 and B540 Landing

Minimal amounts of perched fill existed along the right bank of B540 creek between RX4 and the terminal landing of the B540. The fill was prescribed for straight outsliping as part of work item 13.

As with work item 12, a majority fill from this work item was incorporated with the push dirt (mud) from the upper portion of the B540 landing / channel fill. As with the scenario at work item 12, the final action undertaken along the reach was to merely pull back the berm with an occasional extra scoop of original road fill. Again, as with work item 12, the production figure appears to be reasonable (80 yd³/hr), but it should be viewed with a fair degree of suspicion.

Work Item 14: B540 Landing

The B540 landing was the main hub for log transfer in the Bratwurst basin. The landing was constructed by filling in the main creek and two tributaries near the central point in the basin. The nose of the ridge separating the two smaller tributaries was scalped to fill in the channels. Skid roads leading up the tributaries likely provided additional sources of fill for the landing.

As with most landings constructed by filling in stream channels in the North Fork and Larry Damm drainages, subsidence was occurring on an annual basis. No drainage structures were used in construction of the landing unless you define large chunks of wood randomly buried in fill as “structure”. The down stream portion of the landing had already failed into the creek. Numerous holes and depressions were evident prior to brushing of the landing surface.



Figure 16a. Uncovering large ‘jackpot’ of woody debris in lower portion of B540



Figure 16b. Windthrow (14' BDH) exhumed in mid portion of B540 landing.

Production figures for the landing excavation were 47 yd³ per hour. The steep channel banks, saturated fill and “jackpot” of large wood debris made fill removal a slow and tedious process. The upper reach of channel, above the landing, had accumulated a large volume of sediment. This material was very wet and located in a place that made it difficult to access the fill site close to the landing. A plan was conceived early in the landing removal to transport the mud up the road along the right bank, across the creek at the upstream road crossing (work item 11), and then to bring it back down the road on the left bank to a ridge fillsite. Essentially this created a loop that resulted in the fill being placed a couple hundred feet from its origin. Alternative pathways for the fill transport would have required either cutting through the ridge to gain a manageable grade, which would reduce the holding capacity of the fillsite by more than 50%, or to build a ramp up to the fillsite (which would have to be placed over yet to be excavated fill). Since the alternative routes either limited much needed fillsite volume or hindered productive excavation, the added push distance was justified to maintain acceptable production rates.



Figure 17a. B540 Landing during early excavation.



Figure 17b. B540 Landing with main channel excavated.

Work item 15: RX6

RX 6 was a small skid road crossing 300 feet down stream along the right bank (or southern side) below the terminal landing of the B540 unit. The crossing filled in a swale less than 200 feet above the mainstem of Bratwurst Creek.

The skid road that was used to access RX6 had not been prescribed (in whole) as a work item. During the excavation of the left bank, enough perched fill became apparent to warrant continued removal of fill. The additional volume was lumped in with work item 15. Nearly all fill was pushed an additional 200 to 300 feet beyond the anticipated 300 foot allowance, upstream to a full cut skid. The final production rate was 56 yd³ per hour.

Work Item 16: EOS, B540 2+19 to 5+88

Road fill along the reach between stations 2+19 and 5+88 was perched steeply above Bratwurst Creek. A portion of this fill had previously failed, delivering approximately 1000 yd³ to the creek. Arcuate cracks and outboard slumping was occurring, requiring minor rebuilding of the site for access to the B540 landing.

The final portion of B540 landing fill was pushed through this work item to a fillsite located above and to the east of RX8 at station 8+00. Due to the moisture content (basically 'mud') of the fill being pushed through this EOS, a thin layer of dry dirt typically disappeared with each pass. By the time we attacked the EOS, most of the volume to be excavated had been taken to the fillsite with the landing mud. What remained was just enough to provide a minimal outslope. Some material had to be brought back in for the final shaping.

A production rate 406 yd³ per hour was recorded for work item 16. It should be apparent that this is an abnormally high figure. First thought is that the regular accretion of dry fill to maintain traction while pushing wet fill through this work item was not incorporated, there by missing a majority of the fill removal assigned to the site.

Work Item 17: RX7, B540 @ 06+25

This crossing was the first of two deep swales that were crossed by the B540. Road fill in the swale reached to the flood plain on the left bank of Bratwurst Creek. Minor subsidence was noted prior to opening the B540.

Most all of the 1501 yd³ of fill from RX7 went to the fillsite located above and to the east of RX8 at station 8+00. Little in the way of moisture was encountered during the excavation. The final morphology

produced a broad swale, as anticipated. Good residual topsoil was uncovered on the banks of the swale, below the road.

Even though mud from the B540 landing was pushed through RX7, the accretion factor was not perceived to be as impactful. A production rate of 57 yd³ per hour was achieved during the RX7 excavation.

Work Item 18: OS, B540 6+70 to 7+52

The outslope was a small lobe of fill perched above both Bratwurst Creek and the right bank of RX8. The intent of the prescription was to define the boundary of the right bank of RX8 and to ensure that no perched fill was left that may have the potential to fail into Bratwurst Creek.

While this was one of the few work items that surveyed out under the original estimate, the exhumed morphology was as anticipated. The lobe of fill, small as it was, would have been perched directly above the confluence of the swale and Bratwurst creeks. The fill associated with this excavation was replaced into the cutbank “onsite”, providing an authentic restoration of the ridge feature.

A whopping 160 yd³ per hour is likely, quite close to real. This site represented the ultimate in efficient excavation, providing a fillsite that was easily within reach of the excavation site.

Work Item 19: RX8, B540 @ 08+00

The crossing at station 8+00 along the B540 road was a slightly smaller version of RX7. The estimated volume of road fill was 952 yd³. Constructed through the swale and extending to the main channel below. As with the up station swale (RX7), some subsidence was occurring prior to road opening.

Excavation of the swale found sufficient evidence of topsoil above the floodplain for Bratwurst Creek. The resulting morphology appears as a perched cavity in the slope (perched approximately 4 feet above bank full for the small channel). Final excavation volume was 1190 yd³, with the swale being slightly broader, but not as deep as the design estimate.

A production rate of 82 yd³ per hour may be slightly higher than it actually was. A large prism of fill was placed on RX8 in order to access the 8+00 fillsite. Subsequent excavation of the added prism could likely have incorporated crossing fill that should have been attributed to production rate for RX8.

Work Item 20: EOS, B540 8+35 to 12+00

The targeted fill along this Exported Outslope was steeply perched material, directly above Bratwurst Creek. Some minor subsidence was expressing itself, but no obvious signs had formed prior to road removal. The design estimate showed 4711 yd³ of fill with an anticipated 300 feet of additional push for fill placement.

Two minor swales were encountered during excavation, increasing the volume and validating the fill removal due to the proximity to the creek. A local fillsite was opened and exploited, allowing the additional push to be eliminated.

Another relatively high production rate of 133 yd³ per hour was achieved for work item 20. The dry conditions and close proximity to the fillsite are likely contributing factors to the high rate.

Lower B500: work items 21 through 24

The lower B500 portion of project 03-03 treated 2125 feet of the mainline haul road. A survey volume of 7092 yd³ of fill was excavated from three stream crossings in this segment of road. Two landings at the down station end of the segment were ripped and mulched to preserve as much of the riparian shade vegetation as possible.

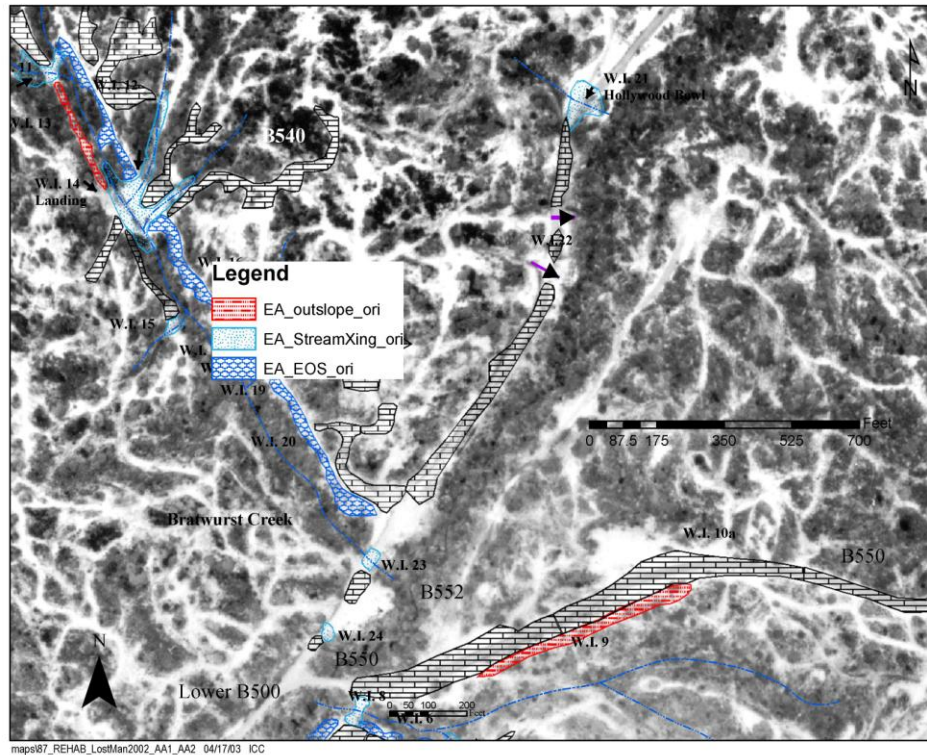


Figure 18. The portion of the Lower B500 road treated in project 03-03 along the west bank of Larry Damm Creek. Most of this segment of road was used as a fillsite.

A ponded location of the inboard ditch, to the downstream side of Hollywood Bowl was retained for a population of salamanders that have been breeding there for a number of years. This site was relatively stable and does not pose a significant resource risk by the remnant road bench.

Work Item 21: RX9, Lower B500, Hollywood Bowl

Hollywood Bowl consisted of the Lower B500 skirting around the upper portion of a bowl morphology for the confluence of three small channel forms. The road bench was comprised of predominantly clean fill. The lower portion of the bowl had been filled in with large wood and earthen material, possibly used as a staging area or disposal site.



Figure 19a. Hollywood Bowl, partially excavated, dozer on B500 road elevation.



Figure 19b. Final excavated surface of southern portion of Hollywood Bowl.

The main channel or middle branch of the confluence at the Hollywood Bowl site had been surveyed for anticipated excavation. As the exhumation to the channel forms proceeded, the original bottom began to rise abruptly under the Lower B500. A large stump that was determined to be “in place” provided a constriction to the upper portion of the middle tributary. The remaining fill above the former road location was found to be minimal, and left in place due to the reduced threat of failure and reduced perceived impact.

Even with the relative ease of access to a fillsite (as can be seen in the ramp to the left of figure 19a), the production figure for work item 21 was only 33 yd³ per hour. The most likely contributing factor for the lower than expected rate was the logistical necessity to maintain an open road surface for another contract in operation on the upstream portion of this site. The fillsite for this excavation was the Lower B500 road bench, which had to be bladed open every time a vehicle required trespass.

Work Items 22, 23 and 24: Lower B500, Rolling Dips and Culvert Removals

The remaining work items were four locations where the road fill was excavated only to the extent as to provide stable conveyance of flow courses across the Lower B500. No production figures were calculated for these work items.

Concluding Summary: Lessons Learned

The overall goals and objectives of the Y zone, B540 and Lower B500 road removal project were achieved with little stress or complication. Unforeseen circumstances happened as is typical for road removal. Much of the efficiency and smooth operation is due to the contractor’s ability to be flexible, anticipate potential changes in strategy and proactively prepare for those changes.

The final portion of the project had the three projects all converging on the Lower B500 road. This was anticipated to be a bottleneck, requiring a higher degree of flexibility. Due to working with an extension of the season, the final work items were opened one at a time to allow for a quick shut down and winterization if rain was forecast. While it may be obvious to most, and even though work was completed to a satisfactory level, stacking multiple contractors on a linear piece of road should be avoided.

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Appendix 1: Photo points

Photo points for project 03-03 are referenced by project and work item number. Not all work items have photo points, although many sites have action photos that may not have been taken from a monumented point. The nomenclature used for the photo point is unique to this project and is not intended to supercede the photo documentation process of chronological photo points.

The Photo Documentation procedure is found in the archival “Photo Point” files at Redwood National Park, South Operations Center, in care of the Archivist. A series of thumbnail photos taken during project 03-03 is provided on the following pages of this appendix. Digital copies of these photos are archived at the South Operations Center. The photos are filed by work item, in a digital format at a 28mm frame.

Appendix 2: NOAA Fisheries Biological Assessment

From: A Biological Assessment of Impacts to Aquatic Threatened Species from the Watershed Restoration Program in the Northern Portion of Lost Man Creek Watershed, Redwood National and State Parks, 2002. Post Excavation Monitoring

All completed projects are visited a number of times during the first winter, and photo-points established prior to excavation are re-photographed. The distribution of woody debris and rock in the excavated channel may be rearranged using hand tools, to minimize post-excavation erosion. Additional on- and off-site monitoring is described in the Post-excavation Erosion Control Plan in the appendix.

Measures Taken to Minimize Impacts to Threatened Species

- 1.) RNSP geologists will continue to plan and design all excavation work. The geologist that planned and designed the work will continue to directly oversee all excavation work on the ground as it proceeds and follows the Post-Excavation Erosion Control Guidelines as written in Appendix 2.
- 2.) A detailed, final project summary report, similar to those normally prepared by the parks, will be submitted to NMFS by the end of the July following project completion.
- 3) RNSP will ensure that erosion control measures are used to minimize short-term adverse effects to aquatic habitat and listed, proposed, or candidate species of Pacific salmonids.
- 4.) Woody debris will be concentrated on finished slopes adjacent to stream crossings to reduce surface erosion, contribute to amounts of organic debris in the soil, encourage fungi, provide immediate cover for small terrestrial species and to speed recovery of native forest vegetation.
- 5.) Large woody debris will be placed in the streams when completing crossing excavations. This will provide storage locations for trapping sediment that moves through the channel from natural upstream and post-excavation erosion, and provide immediate cover for aquatic/riparian species.
- 6.) Riparian cover on fish-bearing streams and non fish-bearing (where non-fish bearing streams lead immediately into fish-bearing waters) will be protected wherever reasonably feasible, balancing quality and benefits of the riparian cover against risks of sediment delivery. Proposed treatments in riparian areas will be reviewed by an interdisciplinary team prior to implementation; the team will include a park restoration geologist and a park fishery biologist.
- 7) All non-emergency project work will be completed during the normal operating season (NOS), that is, between June 15 and October 15 of each year. If more than 0.5 inches of rain is forecast during the dry season, project operations will temporarily cease and sites will be winterized. If periods of dry weather are predicted outside of the NOS, additional small work items may be done, if they can be completed within the window of predicted dry weather. Only those repairs needed to reduce risks from active erosion will be undertaken outside of the NOS, in coordination with NMFS.
- 8) Work sites will be winterized at the end of each day when significant rains are forecast that may cause unfinished excavations to erode. Winterization procedures are supervised at all times by RNSP geologists and involve taking measures necessary to minimize erosion on unfinished work surfaces. Winterization includes the following: smoothing unfinished surfaces to allow water to freely drain across them without concentrating or ponding; compacting unfinished surfaces where concentrated runoff may flow with an excavator bucket or similar to minimize surface erosion and the formation of rills; and installation of culverts, silt fences and other erosion control devices where necessary to convey concentrated water across unfinished surfaces, and trap eroded sediment before it leaves the work site.
- 9.) Equipment, both hand tools and heavy equipment, will be inspected daily to check for leaks. Equipment that may leak lubricants or fuels into drainage will not be used until leaks are repaired. All equipment will be stored, serviced and fueled outside of riparian areas and away from stream crossings.

Heavy equipment will be cleaned (e.g., power washed, steam cleaned) prior to use below the ordinary high water mark.

10.) A spill plan and materials for spill containment will be available to onsite personnel and all personnel shall know how to use them. In the event of a spill, work shall be stopped immediately, clean up shall begin and the appropriate authorities will be notified.

11.) Petroleum products, chemicals, fresh cement, deleterious materials, or water contaminated by the aforementioned shall not be allowed to enter flowing waters.

12.) Disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flows, shall be minimized during excavation.

13.) Adequate erosion control supplies (gravel, straw bales, shovels, etc.) shall be kept at all restoration sites to ensure materials are kept out of water bodies.

14.) Water drafting from fish-bearing streams will be conducted only at sites approved by a park fishery biologist, and shall be done in accordance with NMFS's "Water Drafting Specifications" (attached in Appendix 4)

15.) Any disturbed ground must receive appropriate erosion control treatment prior to the beginning of the wet season. (See Appendix 2)

16.) Streams with significant surface flow capable of sediment transport off-site must be diverted around excavation areas. The diverted flows shall be returned to their natural streamcourse as soon as restoration is complete and prior to the rainy season. Any turbid wastewater from project activities and de-watering is disposed of off-site in a location that will not drain directly into a stream channel or carry sediment laden water into a stream channel.

17.) Listed salmonids that would be in the area shall be removed prior to and during stream flow diversion and de-watering. Listed salmonids will be relocated to a suitable instream location immediately up or down stream of the work area. This will be done by qualified fishery biologists using nets to capture and relocate listed salmonids when practical. When it is necessary to use electroshockers, the Park will follow and be consistent with NMFS guidelines. The Parks' section 10 permit does not cover the capture and relocation of listed salmonids during culvert replacement and installations activities, therefore take coverage is necessary. All efforts shall be taken to neither exhaust nor kill listed salmonids during the capture and relocation process.

18.) Effective erosion control measures shall be in place at all times during restoration activities. Activities within the 5-year floodplain will not begin until all temporary erosion controls (e.g., straw bales, silt fences that are effectively keyed in) are in place, downslope of project activities within the riparian area. Erosion control structures shall be maintained throughout, and possibly after, activities. Erosion control devices such as check dams, silt fences, and other acceptable techniques, shall be used when the potential exists to have sediment or other materials entering water bodies. Note: The maintenance of all roads used to access work sites for the North Fork of Lost Man and Larry Damm Creeks are listed and covered in the current Routine/Non-Routine Road Maintenance BA.

POST-EXCAVATION EROSION CONTROL GUIDELINES

INTRODUCTION

Studies have shown that erosion from roads is a primary cause of the decline in salmonids throughout the Pacific Northwest. In Redwood National and State Parks (RNSP), the erosion and resultant sedimentation downstream is also threatening streamside ancient redwoods by increased bank erosion and flooding. The parks are actively involved in watershed restoration work, with the goals of reducing unnaturally accelerated erosion, restoring natural geomorphic and hydrologic processes, and speeding the recovery of native forest vegetation in areas disturbed by the logging and road building that occurred before park acquisition.

These goals are achieved by:

- completely excavating stream crossing fills,
- excavating potentially unstable sidecast road fills,
- uncovering buried topsoil where reasonably feasible,
- placing native vegetative debris and large woody debris on the finished surfaces, and
- transplanting native plant species on finished slopes where a boost to re-establishment of vegetation is needed.

During the restoration process, large volumes of road fill are excavated using heavy equipment, and re-distributed to stable locations. The potential exists for post-excavation erosional adjustments to occur, particularly if the excavations do not uncover the original channel beds and banks, or where roads are located on unstable slopes. Generally the total volume of post-excavation erosion is small in comparison to the volumes being prevented from eroding by moving road fill from removed stream systems. However, new information on the effects of turbidity and suspended sediment on the survival of young salmonids has raised concerns about the surface erosion that may occur during the first winter post-excavation. This document describes measures that will be taken to control this erosion, and minimize management-related contributions to downstream turbidity and suspended sediment.

BACKGROUND

The watershed restoration program goals of erosion control and restoring geomorphic/hydrologic processes focus on removing road fill from stream crossings, minimizing failure of sidecast road fill into streams, and reducing driving forces on management-related mass movements. Initial adjustments and potential for continued post-treatment erosion were generally most pronounced in the early years of the watershed restoration program before more effective excavation techniques were developed. Myriad combinations of ground cover and vegetation were used to reduce surface erosion from treated areas. Various methods were tried to reduce fluvial erosion following the stream channel treatments, including building check dams and placing rock armor in the flow courses. As heavy equipment techniques were improved, more complete excavations became cost-effective, and the need for secondary erosion control treatments declined. Extensive monitoring and cost-effectiveness analyses were undertaken during this period, providing feedback to the restoration project leaders. This information is described in RNSP's technical report series and numerous other papers.

SURFACE EROSION CONTROL

In the early years of the restoration program, the park relied on imported mulch and other surface erosion control blankets reduce post-excavation surface erosion. At that time, there was little vegetation that had to be removed in order to do the work, or to spread on finished surfaces, and there was little choice but to import mulch or other blanket materials. In the late 1980's, approximately \$50,000, or 10% of the erosion control and watershed restoration implementation budget, was being invested in straw mulch (includes purchase, delivery and spreading costs).

In 1989, the cost-effectiveness of controlling surface erosion was reviewed, particularly in light of the improving efficiency of heavy equipment excavation techniques. The \$50,000 spent on straw would also move 25,000 cubic yards of sediment from the stream system, or completely recontour 5 miles of road. Minimizing the small volume of sediment generated from surface erosion post-excavation was not viewed as cost-effective in addressing the large-scale problems associated with abandoned logging roads. The decision was made to greatly reduce straw mulching, and concentrate on more complete excavations of stream channels and sidecast road fills (Spreiter, personal communications).

Aside from the benefit of removing more sediment from the stream system, other restoration goals were addressed by the additional earthmoving. Natural hillslope drainage patterns were restored, potentially unstable sidecast fills were stabilized, and buried topsoil was uncovered beneath the fill. Native forest species quickly re-established on the organic and nutrient rich soil. Meanwhile, the heavy applications of straw most effective at controlling surface erosion were found to slow the re-establishment of native forest species, and straw, although certified weed-free, generally introduced exotic species. The additional earthmoving also eliminated long term maintenance and potential future failures associated with inboard ditch and cross-road ditch systems that had been constructed along many of the treated roads in the early years.

At the same time, the density and size of vegetation along the road corridors was increasing. On a few projects, large amounts of vegetative debris were buried in fillsites. This practice was quickly discontinued, with the realization that large voids would develop as the debris decayed, potentially affecting slope drainage and stability. Vegetative debris began to be stockpiled and scattered on the finished slopes. Benefits to re-establishment of vegetation were quickly noted, as many of the first successful plants were those protected by the cover of the debris. It was also noted that where shallow slumping occurred on finished slopes, the vegetative debris acted as a "binder", trapping much of the mobilized material. This has been the standard practice for the last 10 years.

New Developments

Recently, concerns have been raised about post-excavation surface erosion potentially contributing to turbidity and suspended sediment in the fish-bearing streams, impacting young salmonids. These concerns have caused RNSP to re-evaluate the importance of surface erosion control measures.

In order to address these new concerns, the parks propose to alter the distribution of the vegetative debris. Rather than random scattering of debris, vegetative material will be collected and concentrated on slopes adjacent to live streams and other locations where fine sediment may be mobilized and enter the stream system. If there is not enough on-site vegetative debris to achieve the desired level of ground cover, additional materials may be imported to the site. Materials will be selected to comply with NPS guidelines to minimize introduction of exotics and interference with re-establishment of native forest species. Shredded redwood bark is the current preferred material.

Guidelines have been established to help determine where surface erosion control materials will be most useful, and in what quantities, based on the factors that affect erosion and transport of fine sediment, described below. Interactions between these factors are often complex and somewhat unpredictable. Best professional judgement will be used in analysis of these factors in the field.

The potential for surface erosion from a completed watershed restoration project is largely a function of:

Material properties (e.g., texture, cohesion, coarse fragment content, etc.) of the soil subject to erosive forces.

Slope length of the finished area (in a downslope direction).

Slope steepness of the of the finished area (in a downslope direction)

Slope form or convergence of the finished slopes.

Surface treatments applied to control erosion following earthmoving activities (ground cover type and degree of cover or rate of application).

The potential for sediment delivery to a stream channel is largely a function of buffer characteristics:

Slope steepness of the hillslope between the treated area and the stream.

Slope length from the treated road segment down to a stream channel

Surface conditions of the intervening slope (e.g., slope form, ground cover) that control the ability of the intervening slope to trap sediment delivered from upslope prior to reaching the channel.

A chart (Figure 1) has been developed to help plan the surface erosion control efforts. The rationale for the chart is that the potential for sediment delivery from finished slopes to streams is largely a function of the ability of the intervening ground to trap eroded sediment as it moves downslope. In general, excavated stream crossing side slopes have the highest risk of sediment delivery if not treated with preventative measures. Adjacent recontoured road segments that approach a stream crossing will have a relatively moderate to high sediment delivery risk, depending on the buffering factors. Road segments that are not near a stream crossing will have relatively low risk of sediment delivery, except: 1) where such segments are crossed by fluvial transport features (rills, gullies, swales), and 2) where such segments are located low on the hillslope, in close proximity to stream channels. Low risk areas may be left bare in order to insure adequate cover at the higher risk locations.

Controlling post-earthmoving erosion and sediment delivery from watershed restoration projects in a cost-effective manner requires balancing erosion and sedimentation risks with treatment costs and site logistics. While the chart provides guidance, site-specific conditions both on the finished slope and within the buffer will affect the amount of ground cover actually needed to achieve the goals of reducing downstream turbidity and suspended sediment. For example, the greater the levels of duff, live vegetation, downed woody debris and micro-topography within the buffer, the greater the natural trapping efficiency, and the less ground cover needed on the finished slope directly above. Where particularly vulnerable species or habitat are located immediately downstream, or where highly erodable soils are found, the guidelines shall be adjusted to favor more complete surface erosion control. Conversely, some areas may allow relaxing of guidelines, for example where buffer zones have atypically high sediment trapping efficiency due to topographic benches or particularly dense understory and litter accumulations or where excavated materials contain large coarse fragment content that would readily form an erosion pavement.

These guidelines will be used and adapted as needed to actual field conditions to insure that fine sediment is prevented from entering the stream systems as much as is reasonably possible. Best professional judgement of an interdisciplinary team including a park geologists and park biologist will be used in analysis of these factors in the field.

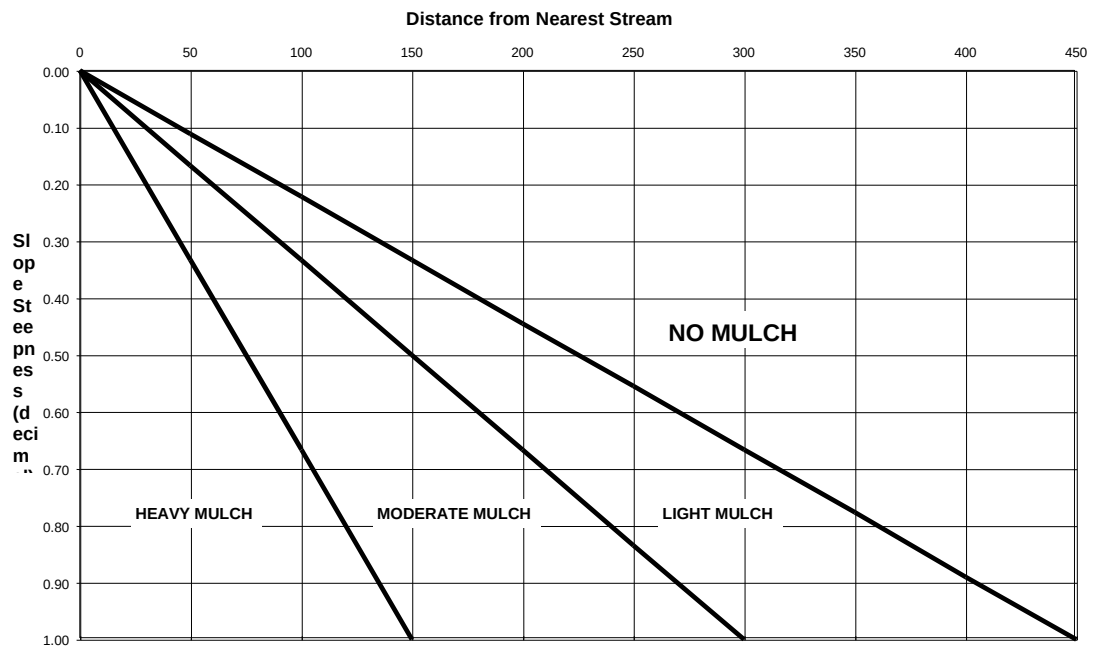


Figure 1. Mulching Guidelines

In planning ground cover needs, the site geologist will estimate the finished slope steepness and length along road segments with potential to contribute surface erosion to streams, and use the guidelines to determine appropriate ground cover rates. Where flow is expected to cross the finished slopes, ground cover will be increased to reduce erosion and trap sediment. Small swales that may not exhibit signs of surface runoff will also be covered with vegetative debris to reduce erosion and sediment delivery. Ground cover in both cases will be done to “moderate” specifications. As excavations proceed, and slopes are finished, final adjustments to ground cover rates will be made to insure the intent of reducing downstream turbidity and suspended sediment is achieved.

There is abundant vegetation that must be disturbed in order to get to the fill that needs to be excavated, and this material provides a good source of on-site, native material that can be used as ground cover. Recently, this material has been spread relatively evenly over all finished slopes, but observations show that this often results in insufficient ground cover to control surface erosion adjacent to streams. Practices are being changed to collect this material and concentrate the vegetative debris on finished slopes leading directly to streams, and on recontoured slopes where the downslope buffer is inadequate to catch mobilized fine sediments.

Where surface erosion control is critical equipment operators will be asked to “mash” the woody debris to increase ground contact. If needed, hand crews will cut and lop debris that is suspended to further increase ground contact, following placement of the debris with the heavy equipment. Woody debris scattering may have to be supplemented with imported mulching material (shredded bark, wood chips, etc.) to achieve the needed ground coverage. This would consist of applying the imported mulch over small bare areas that compose gaps in woody debris application.

From previous monitoring studies, surface erosion from bare areas is greatest the first winter following earthmoving, then declines exponentially in subsequent years as erosion pavements and leaf litter accumulate and revegetation proceeds. To speed re-establishment of vegetation, and provide long-term surface erosion control, seed bearing vegetation may be collected and scattered on the slopes to spread native seed. Similarly, duff, laden with seed, nutrients and fungi may be collected and scattered. Care will be taken not to impact source areas.

Figure 2 represents a hypothetical application of the surface erosion control guidelines to a watershed restoration project to be implemented in 2002 (note that this was a map exercise as would be used in project planning; actual ground-based prescriptions will vary somewhat).

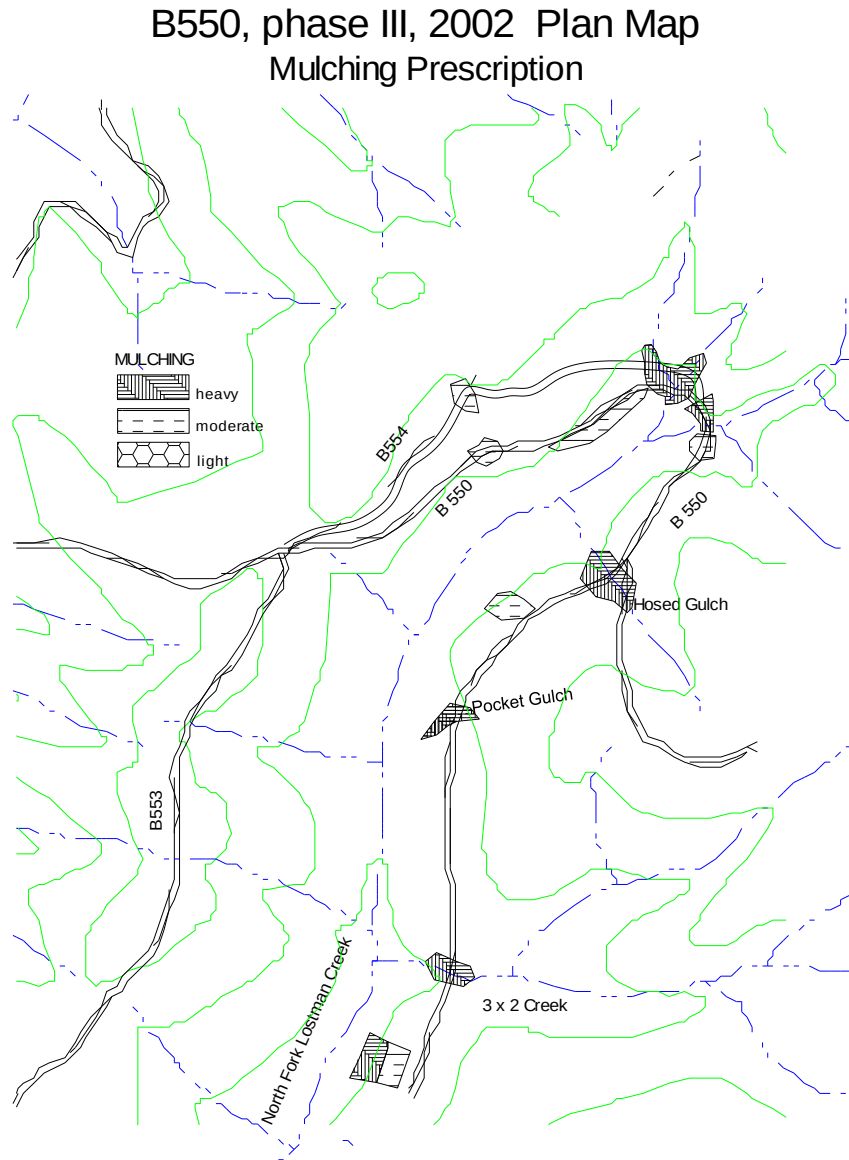


Figure 2. Hypothetical application of surface erosion control guideline to a planned 2002 rehabilitation site. Roads, streams, and contour lines are shown.



Figure 3. Vegetative debris mulching on excavation sideslopes provides for control of surface and fluvial erosion (this depicts a heavy rate of mulch application). Note the excavated stream channel with large woody debris placement in the foreground.

CHANNEL EROSION CONTROL

With the parks' goal of re-exposing the natural channel bed and banks, stream channel adjustments following excavation are generally small in volume (less than 5%), relative to the amount of material removed from the stream system during excavation. Adjustments are most pronounced during the first winter, but the erosional response is also affected by the sequence of high flow events following excavation.

The potential for channel erosion from a completed stream crossing excavation is largely a function of:

Stream power during storm runoff events (proportional to drainage area and channel gradient).

Material properties (e.g., texture, cohesion, coarse fragment content, etc.) of the soil subject to erosive forces.

Length of the excavated channel.

Steepness of the excavated channel.

The degree to which intact **original channel structure** (woody debris, boulders, bedrock) was exhumed upon completion of the excavation.

The type and degree of **treatments** applied to control channel scour following earthmoving activities.

Sediment delivery resulting from scour processes in stream channels is immediate and total. While many types of channel erosion control measures might be considered (and have been used in the past at RNSP), the park relies on finding original channel structure, supplemented by large woody debris placement. Check dams or import rock riprap to armor channels were tried and abandoned primarily due to the high cost, high

maintenance and questionable ecological consequences of using non-native materials and structures. The best case scenario for avoiding significant channel adjustment (scour) is successful excavation of original channel beds and banks. Fortunately this is usually possible. In addition, large woody debris encountered during excavation is placed in arrangements that mimic natural accumulations observed in stream channels. In most cases, abundant woody debris is available for placement in stream crossing excavations. Figure 4 shows a completed stream crossing excavation with extensive woody debris placement as it appeared in spring, 2001, following a relatively mild winter. While channel scour will occur even with woody debris placement, the extent of scour will be minimized, much of the sediment is trapped within the excavated reach, and the channel will have the structural elements needed to re-establish a natural morphology relatively quickly with this approach.



Figure 4. A stream crossing excavation with extensive woody debris placement. This photo was taken after the first winter following excavation.
Adaptive Management

It is anticipated that the guidelines for preventing surface and fluvial erosion included herein will be sufficient for achieving the desired level of protection for downstream resources. However, the monitoring program included in this biological assessment will provide feedback on the performance of these guidelines through time. Insights gained through monitoring will be used to adapt these criteria as may be required to achieve the desired level of protection in a cost-efficient manner.

Appendix 3: Overall summary spreadsheet