

Upper Redwood Creek Watershed Road Assessment Summary Report - March 2009 Update

Road Assessment Project
Contract # P0610549

Prepared for participating landowners in the
Redwood Creek watershed, Pacific Coast Fish,
Wildlife and Wetlands Restoration Association
and California Department of Fish and Game

By Redwood National and State Parks
March 10, 2009



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EXECUTIVE SUMMARY

There are about 1,120 miles of road in the upper Redwood Creek watershed. Since 1996, eleven assessment projects have been completed, evaluating 783 miles, or about 70% of all roads in the upper watershed. The assessments were funded primarily by grants administered by California Department of Fish and Game, Redwood National and State Parks and U.S. Fish and Wildlife Service. Contributions were also made by the Resources Legacy Fund Foundation and private landowners.

There were 60 miles of roads with 524 sites recently assessed in the Minor Creek. The total potential sediment yield from these roads is about 118,000 yds³. About 74 percent of the potential yield is attributed to fluvial sites and about 26 percent to landslide sites.

Four road assessments have been completed in Minor Creek in the past 10 years. The first assessment was implemented in 1999-2000 by Natural Resources Management Corp (NRM) and assessed about 48 miles of roads. In 2000, the Five Counties Salmonid Conservation Program completed an assessment of Bair Road, which is owned and maintained by Humboldt County. In 2003, Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA) assessed six miles of road in Minor Creek. These six miles had been previously assessed by NRM. The fourth project (this current project) was implemented in 2007-2008 by PCFWWRA. It targeted the remaining roads in Minor Creek and roads previously assessed in 1999-2000.

Of the 71 miles of privately owned roads in Minor Creek, PCFWWRA assessed about 66 miles (92%) in their 2003 and 2008 assessments combined. Of these roads, about 38 miles were drivable and about 28 miles were not driveable. About 33 miles of road were maintained and about 33 miles were not maintained. A total of 631 sites were evaluated in the field with an estimated potential sediment yield of about 139,000 yds³.

There are reliable sediment yield data for about 667 miles of roads (about 60% of all roads) in the upper watershed. The total potential sediment yield from these roads is about 1,338,000 yds³.

The estimated cost to treat the 386 miles of roads in upper Redwood Creek watershed for which cost data were estimated is about \$25 million, averaging about \$132,000 per mile of road.

A substantial amount of work has been completed in upper Redwood Creek since 1996 through the cooperative erosion control program. Potential sediment yield was reduced by over 20,000 yds³ per square mile in sub-watersheds or interfluvial areas where potential sediment yield ranked highest in 2004. Of the 4,431 sites initially assessed as of 2004, 926 sites (21%) have been treated. More than 12% of all sites were decommissioned and about 8% of all sites were upgraded. Combined, all treatments reduced the potential sediment yield by over 405,000 yds³. The reduction is about 25% of the original estimated volume of 1,647,000 yds³. Of the approximately 755 miles of assessed roads for which we have data about 170 miles (22%) have been treated. About 110 miles have been upgraded and about 61 miles have been decommissioned.

ACKNOWLEDGEMENTS

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Upper Redwood Creek Watershed
Road Assessment Summary Report
- March 2009 Update

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INTRODUCTION

This report presents the results of the Minor Creek Watershed Inventory and Restoration Planning Project and an update to the 2004 Upper Redwood Creek Watershed Road Assessment Report (Bundros, et al 2004).

The project was funded by California Department of Fish and Game (CDFG) Fisheries Restoration Grant Program under grant agreement number P0610549 dated September 4, 2007. The grant was awarded to Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA) for \$92,292. The Resources Legacy Fund Foundation provided additional funding. Redwood National and State Parks (RNSP) contributed in-kind services, including maps and aerial photographs, geologists for GIS and database development, GIS technical support, data analysis and report preparation.

The primary purpose of this update is to describe the results of the Minor Creek road assessment. It presents summary statistics for the project, integrates the new data with data for all of upper redwood creek, establishes a priority of roads to be treated, and highlights the accomplishments of cooperative erosion control in the upper Redwood Creek watershed for the period of 1996-2008. Another report, currently being prepared, will fully integrate all assessment data with additional analyses of completed work and will supplant this report.

Both spatial and numeric data have been refined since the 2004 report. More data have been collected through verification of timber harvest plan (THP) road treatments and the completion of cooperative erosion control projects. GIS layers have been edited. Watershed and project areas have been more accurately defined. Data errors also have been corrected. Thus, variation in some numbers such as watershed areas and/or road length can be expected between this and the 2004 report.

Background

Redwood Creek is listed as sediment and water temperature impaired by the U.S. Environmental Protection Agency (EPA). Impairment was caused by past timber harvest activities and erosion during large floods. The watershed analysis for Redwood Creek (RNSP, 1997) identifies erosion and sedimentation from roads on private lands in the upper two-thirds of the watershed (upper watershed) as major causes of the loss of aquatic and riparian habitats, and the decline of salmonid populations. The Total Maximum Daily Load for Redwood Creek (EPA, 1998), the Redwood Creek Watershed Analysis and the Draft Redwood Creek Water Quality Attainment Strategy for Sediment (California North Coast Regional Water Quality Control Board, 1998) all recommend road assessments that identify potential sediment sources, and plans that contain prioritized erosion control and prevention treatments.

In 1995 and 2000, Memorandums of Understanding (MOUs) between the National Park Service (NPS) and individual private landowners were signed and state that the NPS and private landowners will "...voluntarily cooperate to identify, prioritize, and correct, where economically

feasible, potential sediment sources in the Redwood Creek basin.” These MOUs have provided a framework for successful cooperative erosion control and prevention work on private lands in the upper watershed.

Since 1996, eleven road assessments in upper Redwood Creek have been completed (Table 1 and Figure 1). A total of about 783 miles of roads have been assessed or about 70% of the 1,120 miles of road in upper Redwood Creek. The remaining 30 percent of roads are owned by landowners who have chosen to not participate. For data management, the assessments were assigned project numbers by RNSP.

Table 1. Project names and description.

Project	Sub-watersheds	Field Crew	Year(s)	Acres	Total road miles in project	Miles evaluated
Project 96	Garrett Creek	RNSP	1996	1,816	15.8	11.7
Project 97	Bradford Creek., etc	NRM	1996	10,439	84.0	32.1
Project 0	Lake Prairie Ck. and Headwaters	RNSP	1996	8,227	93.0	84.4
Project 1	Park Protection Zone (PPZ)	PCFWWRA	1999 - 00	23,828	218.7	189.3
Project 2	Dolly Varden Ck. to Lupton Ck.	PCFWWRA	2001 - 02	16,957	192.8	145.4
Project 3	Noisy Ck. to Smokehouse Ck.	PCFWWRA	2000 - 01	12,056	155.7	115.5
Project 4	Roaring Gulch Ck. to Minor Ck.	NRM	1999 - 00	8,429	86.4	55.1 ¹
Project 5	Stover Creek	PCFWWRA	2001	1,592	15.3	6.2
Project 6	County Roads	Five Counties Salmonid Conservation Prog.	2000	Note 2	34.9	28.1
Project 7	Captain Ck. to Simon, High Pr.	PCFWWRA	2003	13,304	150.7	53
Project 8	Minor Creek	PCFWWRA	2007-2008	7,892	73.0	62
Totals				104,540	1,120.3	782.9³

Table notes:

- 1 Project 4 assessed about 97.4 miles of road. About 42.3 miles of these roads were re-assessed in Project 8 and as part of Project 7. Project 4 mileage shown is for the length where the original assessment data are still used in the most current database version.
- 2 No project acreage was assigned to County roads because they cross through other project areas.
- 3 RNSP GIS currently contains information and data for about 723 miles. It does not include data for the county road assessment of 28 miles or Project 97 assessment of 32 miles.
- 4 Mileages shown differ from those reported in 2003 and 2004 due to: Project 8 reassessment of Minor Creek 'replacing' the data for part of Project 4, new road construction associated with THPs (many which are temporary roads), assessment of roads subsequent to previous assessments and, to a lesser extent, clean-up/editing of minor GIS errors.
- 5 Totals may differ slightly from those shown in other tables in this report due to rounding.

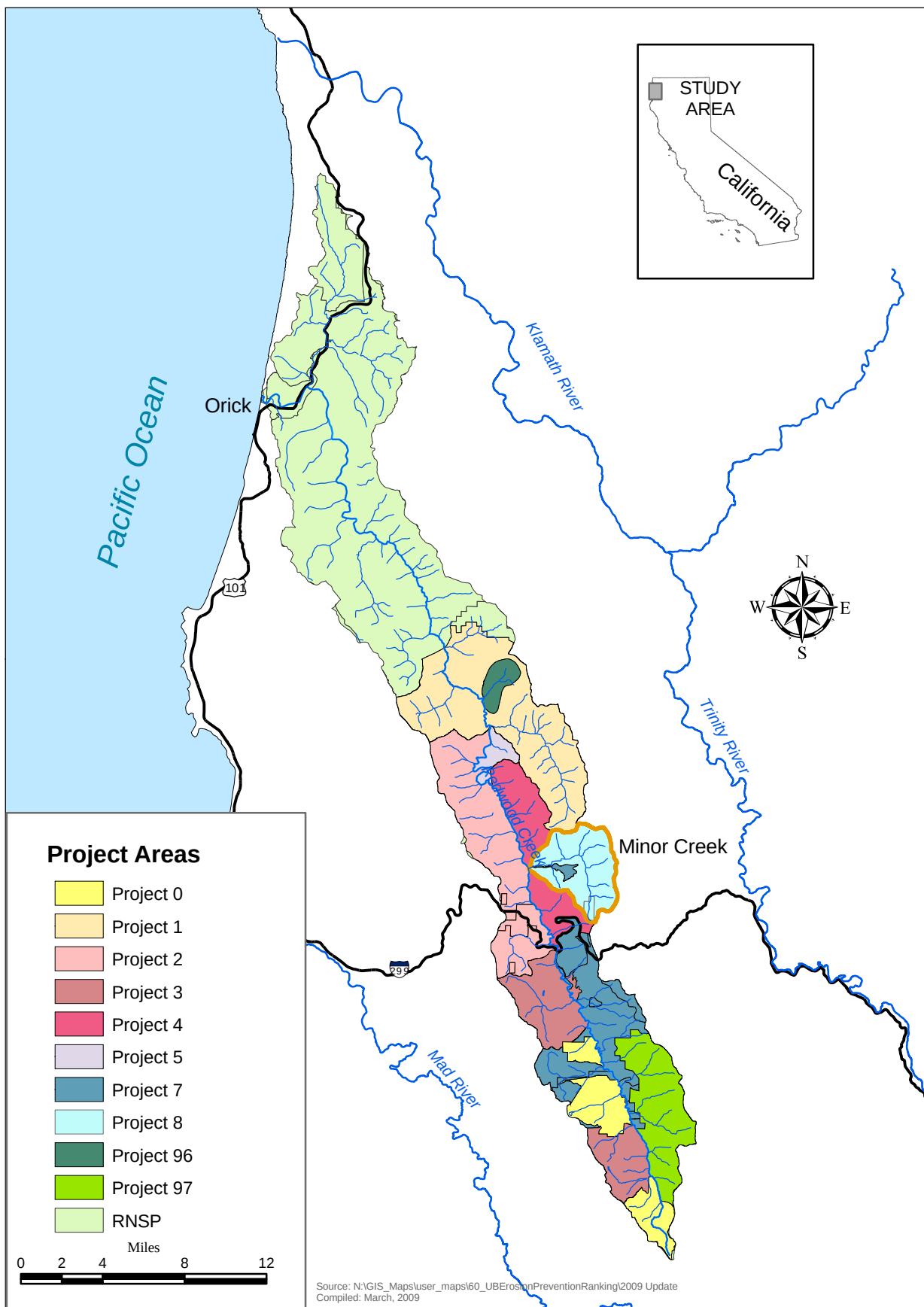


Figure 1. Location of the Redwood Creek watershed and road assessment project areas.

Project Area Description

Watershed Description

Redwood Creek drains a 285 square mile watershed located in the Coast Range of Northern California. The watershed is steep and mountainous, located within a tectonically active area with relatively rapid uplift. Weak, pervasively sheared rocks underlie the watershed. Mean annual watershed-wide precipitation averages about 80 inches. The combination of steep terrain, weak underlying geology and soils, and moderately high precipitation contribute to naturally high erosion rates and susceptibility to accelerated erosion.

The watershed is unusually long and narrow, and has a very large number of small tributary sub-watersheds. There are no major tributary forks to Redwood Creek above Prairie Creek. Most tributaries are characteristically low-order and high gradient streams. Their channels are, in general, deeply incised, and steep hillslopes adjacent to channels are particularly landslide prone (Pitlick, 1982).

Land use

The major land use in the watershed during the past 60 years has been ranching and timber production. Historically, roughly 82 percent of the Redwood Creek watershed supported old-growth coniferous forests. Harvesting of the coastal redwood forests in portions of the lower Redwood Creek watershed began in the latter half of the 1800s. Mechanized timber harvesting established throughout the watershed by the late 1930s. Timber harvesting and associated road construction accelerated in the watershed in the late 1940s to 1950s in the Douglas-fir dominated upper watershed. During the 1960s, timber harvest became most concentrated in the lower watershed, and logging continued steadily there until the expansion of Redwood National Park in 1978. By 1978, about 81 percent of the original forest in the watershed had been logged (Best, 1984).

Road construction history

The earliest roads in the Redwood Creek watershed coincided with settlement in the mid-1800s. New roads were built as settlement and ranching expanded. A rapid rise in road construction occurred along with increased timber harvest activities in the mid-1900s.

Road construction history for the Redwood Creek watershed was researched by RNSP in 1992-1993 using stereo aerial photography. Photos were analyzed for photo years 1958, 1962, 1970, 1978 and 1992. Subsequently, photo year 1998 has been interpreted from digital orthophoto coverage. Road construction information after 1998 is from approved THPs. Some of these roads were verified by field crews during road assessments. Road construction history maps are in Appendix A.

There are about 1,120 miles of roads in the upper watershed of which 1,033 miles are on private lands. About 61 percent of the road mileage was constructed before 1962, 88 percent was constructed before 1978, and 95 percent was constructed by 1992.

The California Department of Forestry and Fire Protection (CDF) regulates forest practices on private lands. Timber harvest regulation by the state began in 1945, but was not fully implemented until the passage of the Z'berg-Nejedly Forest Practice Act of 1973. The first substantive erosion control rules for logging roads appeared in 1983.

The early history of forest practice rules is important to keep in mind when considering the road construction history in the Redwood Creek watershed. By 1983, more than 1,000 miles of roads in the upper watershed had been built to inadequate standards. More than 88 percent of the roads in existence today were built before forest practice rules had been fully implemented. This, in part, explains the legacy road conditions present in the watershed today.

ROAD ASSESSMENT METHODS

All road assessments were comprised of field work to locate and evaluate potential sites for likelihood of erosion, the volume expected to deliver to a stream in the event of erosion and to prescribe corrective treatments. Additional information describing estimated equipment and labor needed to implement treatments was recorded for all sites in Projects 1, 2, 3, 5, 7 and 8. Data were compiled on field forms and sites located on airphoto mylar overlays. Various forms were used over the span of the eleven assessment projects. The form used by PCFWWRA is shown in Appendix B. All field data were entered into a database that contains data for all assessment projects as shown in Table 1. Site locations and other characteristics of each site were entered into a GIS. Both database and GIS coverages are maintained by RNSP.

The details of road assessment methods are described in Appendix C.

MINOR CREEK ROAD ASSESSMENT

Project Area Description

The Minor Creek watershed drains about 8,250 acres (12.9 square miles) and is the third largest tributary to Redwood Creek (Figure 1). The elevations range from 720 feet at the confluence with Redwood Creek to about 4,075 feet on the eastern watershed divide. The watershed is underlain by predominantly mudstones and sandstones of Franciscan Assemblage with schist bedrock along the eastern side of the watershed.

The watershed has been managed for timber production and ranching since the mid-1900s. The watershed contains about 76.6 miles of roads. About 71.2 miles of roads are privately owned. A county maintained road (Bair Road) traverses the northern side of the watershed for 5.4 miles from near Redwood Creek to the watershed divide with Trinity River on the east side. These data are shown in Table 3.

Table 2. Public and private roads in Minor Creek.

Road ownership	Road miles
County	5.4
Private	71.2
Total	76.6

The watershed is presently owned by ten different landowners. Two larger landowners, combined, own approximately 82% of the watershed. Six smaller landowners that participated in this road assessment collectively own about 13% of the watershed. Two smaller landowners that did not participate own about 5% of the watershed.

Four road assessments have been completed in Minor Creek in the past 10 years and are shown in Table 2. The first assessment was implemented in 1999-2000 by Natural Resources Management Corp. (NRM) as part of a larger project in Redwood Creek and assessed about 48 miles of privately owned roads in Minor Creek (Project 4). In 2000, the Five Counties Salmonid Conservation Program (SCP) completed an assessment of Bair Road, which is owned and maintained by Humboldt County (Project 6). In 2003, PCFWWRA assessed six miles of road in Minor Creek watershed as part of a larger project in Redwood Creek (Project 7). These six miles had been previously assessed by NRM. The fourth project was implemented in 2007-2008 by PCFWWRA (Project 8) and targeted the roads assessed in 1999-2000 and the remainder of all privately owned roads in Minor Creek.

The most recent Minor Creek assessment evaluated potential erosion sites on 65.6 miles of roads (Figure 2). Road assessment fieldwork began in July 2007 and concluded in August 2008. Bair Road was previously assessed as part of the Five Counties SCP in 2000 and was not re-assessed as part of this project.

Table 3. Completed road assessments in Minor Creek watershed.

Project Name	Investigator	Assessment Dates	Miles Assessed	Number of Sites
Project 4 (portion of)	NRM	1999-2000	48.0	251
Project 6 (portion of)	Five Counties SCP	2000	5.4	40
Project 7 (portion of)	PCFWWRA	2003	6.0	107
Project 8 (this project)	PCFWWRA	2007-2008	59.6	524

Table note: Projects 4, 6 and 7 covered larger areas of Redwood Creek watershed. Data shown are for only the Minor Creek portion of each project.

The 2003 PCFWWRA assessment was implemented when landowners in an adjacent project in Redwood Creek changed their minds about participating and decided to not allow access to their roads after the grant had been awarded. CDFG allowed the unspent funds from the adjacent project to be expended on a small portion of Minor Creek roads. This allowed for an objective comparison of road assessment results on the same six miles of roads by two different assessment groups. The comparison revealed a substantial difference in the number of potential erosion sites identified and the estimated erosion volumes at each site. The differences are described in Bundros, et al 2004.

The NRM data were not included in analyses for all upper Redwood Creek watershed assessments in previous reports because the results of the two assessments differed significantly and the later assessment was considered more consistent with existing data. Field observations and the results of the 2003 PCFWWRA assessment in Minor Creek suggested that treatable sediment sites in Minor Creek were numerous and should be prioritized along with all other areas within the upper watershed. For this reason we pursued funding for a full re-assessment of Minor Creek.

Current Road Assessment – Project 8 Results

The current Minor Creek road assessment, Project 8, assessed approximately 66 miles of roads, with 524 erosion sites. Field crews spent 120 days (240 person-days) in the field. Additional time was spent in the field by a geologist to review the sites and in the office to calculate survey volumes and organize field products. Park staff entered data into the Redwood Creek roads database and into GIS.

Table 4 is a summary of data for Project 8 (this assessment) which does not encompass the entire Minor Creek watershed. Other data for Minor Creek collected by Project 7 is combined with Project 8 in later discussions. All data were collected by the same field crews using the same field forms and methods with the only difference between the assessments being the separation in time from 2003 to 2007-08.

Table 4. Potential sediment yield for Project 8 road assessment.

	No. of Sites	Erosion Volume ¹ (yds ³)	Site Potential Yield (yds ³)	Extreme Potential Yield (yds ³)	Potential Sediment Yield ² (yds ³)	% of No. of Sites	% of Pot. Sediment Yield
Sites Inventoried ³	524	208,866	107,387	18,250	118,032	100%	100%
All Sites with no yield	22	0	0	0	0	4%	0%
All Sites, Yield > 0	502	208,866	107,387	18,250	118,032	96%	100%
M-H Sites, Yield > 0	136	55,847	35,505	12,750	41,960	26%	36%
All Fluvial Sites	373	84,145	83,909	5,500	87,405	71%	74%
All Landslide Sites	151	124,721	23,478	12,750	30,627	29%	26%
Field Prescriptions							
Decommission	193	104,564	50,702	10,000	56,136	37%	47%
Upgrade	303	99,722	54,756	8,250	59,967	58%	51%
Maintain	28	4,580	1,929	0	1,929	5%	2%

Table notes:

¹ Erosion Volume is that amount of sediment that can potentially erode from a site. Not all sediment eroded will always be delivered to a stream.

² Potential Sediment Yield is the greater of the site potential yield and the extreme potential yield for each site then summed for all sites. It is not the sum of the two columns "Site Potential Yield" and "Extreme Potential Yield".

³ All sites, including DRCs with no potential sediment yield.

Results for Minor Creek Watershed Project 7 and Project 8

Project 7 (2003), and Project 8 (2007-08) together provide a nearly complete assessment of potential road-related erosion and sediment delivery in Minor Creek. Combined, the two projects identified and assessed 631 sites including ditch relief culverts (DRCs) with no potential sediment yield. The location of all sites is shown in Figure 2.

About 77 miles of roads have been identified in Minor Creek through analysis of historic aerial photography and field verification. For the recent assessment, permission to assess roads was granted by all but two landowners which excluded assessment of about 6 miles of road (7.9% of Minor Creek privately owned roads or about 5% of watershed area). These data are shown in Table 5.

Table 5. Status of roads assessed in Minor Creek.

Assessment status	Miles	% of all road length in watershed	% of private road length in watershed
Assessed private roads (Projects 7 and 8)	65.6	85.7	92.1
Non-assessed private roads	5.6	7.3	7.9
Assessed county road (Bair Road) (Project 6)	5.4	7.0	-
Total length of road	76.6	100.0	-

Driveability and maintenance status

Crews recorded the driveability of road reaches while assessing roads. Of the 66 miles of roads assessed, about 38 miles of road were found to be driveable by a standard 4WD vehicle and about 28 miles were not driveable. Road driveability is summarized in Table 6.

Table 6. Driveability of all assessed roads in Minor Creek Projects 7 and 8.

Driveability	Miles	% of Total Assessed Miles
Driveable	37.5	57%
Not Driveable	28.1	43%
Total Assessed in Projects 7 and 8	65.6	100%

Table notes: Driveability is listed as documented at the time of the assessment.

Figure 2. Map of Minor Creek watershed showing all sites assessed in Projects 7 and 8.

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The maintenance status of each road was also documented during the assessment. Field crews described roads as maintained, unmaintained, or decommissioned. Maintained roads showed evidence of recent maintenance, including cleaning of culvert inlets, trash racks, and inboard ditches; grading; rolling dip or waterbar reconstruction; brushing; culvert replacement; or reconstruction of fills. Roads identified as unmaintained lacked obvious maintenance to culverts and ditches, and vegetation was encroaching on the road and road surface. The road may or may not have been driveable. There were about 33 miles of maintained roads and about 33 miles of unmaintained roads. The status was not documented for about 0.5-mile of road. Table 7 summarizes these data.

Table 7. Maintenance status of all assessed roads in Minor Creek Projects 7 and 8.

Maintenance Status	Miles	% of Total Assessed Miles
Maintained	32.6	49.7%
Unmaintained	32.5	49.5%
Unknown Status	0.5	0.8%
Total assessed Projects 7 and 8	65.6	100%

Prescribed road treatments

Field crews prescribed treatments for each site, based largely on the stability, erosional condition and maintenance status of the road. Site prescriptions were either: decommission, upgrade or maintain. Decommission was typically prescribed for sites where the field conditions clearly showed the road was on unstable terrain, the sites were highly prone to erosion and the road was abandoned. Approximately 18 miles of road were prescribed for decommissioning, about 41 miles for upgrading and about 4 miles prescribed for maintenance. Table 8 summarizes these data.

Table 8. Road treatments prescribed for Minor Creek Projects 7 and 8.

Prescribed Treatment	Miles Prescribed for Treatment	% of Total
Decommission	18.0	28.4
Upgrade	41.4	65.4
Maintain	3.9	6.2
Unassigned ¹	2.2	3.5
Totals	65.6	100%

Table Note:

¹ Field crews failed to identify prescribed treatment for 2.2 miles of roads.

The treatment prescribed by the field crews was purely an educated ‘call’ that guided the type of information collected at the site. It was not meant to reflect a commitment or obligation by the landowner to treat the road as prescribed. While we encourage road decommissioning to reduce the road density in the upper Redwood Creek watershed, the landowner will ultimately decide how a road will be treated.

Regardless of the prescription assigned at the time of the assessment, the basic information gathered during the assessment can still be used if prescriptions change. For example, if the landowner decides they would like to upgrade a road that had been prescribed as decommission, the basic information gathered during the assessment can be adjusted to provide an estimate of the needed work and project costs. Similarly, for roads that had been prescribed as upgrade, the data can be re-worked for decommission treatments. This second scenario requires additional time in the field to determine such things as: where to store spoils, how to move spoils, what are estimated equipment production rates for more complex excavations, etc. In both cases, the information from the original road assessment must be ground-truthed and a budget developed for the specific project.

Potential sediment yield

In this report, *potential sediment yield* is always the larger of *site potential yield* or the *extreme potential yield* for each site. The site potential yield was measured for each site in the field during the assessment. It is the volume of material that can potentially erode and be delivered to a stream during a large storm. An extreme potential yield was also estimated in the field, but only where the potential for an extreme erosional event (e.g., a debris torrent initiating at a stream crossing) was clearly identified at a site. Sites with extreme potential yields were not common and they are sometimes difficult to identify.

A total of 631 sites were evaluated in the field. Sites were categorized into two groups based on the dominant erosional process at the site. Fluvial sites generally include stream crossings on either haul roads or skid trails, DRCs, road reaches, springs and swales. Landslide sites generally include debris slides and deep-seated features related to the road system. There were 456 fluvial erosion sites and 175 potential landslide sites. Site locations are shown in Figure 2 and potential sediment yield information is summarized in Table 9.

Table 9. Potential sediment yield for Minor Creek watershed Projects 7 and 8.

	No. of Sites	Erosion Volume ¹ (yds ³)	Site Potential Yield (yds ³)	Extreme Potential Yield (yds ³)	Potential Sediment Yield ² (yds ³)	% of No. of Sites	% of Pot. Sediment Yield
Sites Inventoried	631	241,538	127,609	19,750	138,847	100%	100%
All Sites with no yield	30	0	0	0	0	5%	0%
All Sites, Yield > 0	601	241,538	127,609	19,750	138,847	95%	100%
M-H Sites, Yield > 0	193	73,447	48,156	14,250	55,204	31%	40%
All Fluvial Sites	456	101,554	101,318	7,000	105,407	72%	76%
All Landslide Sites	175	139,984	26,291	12,750	33,440	28%	24%
Field Prescriptions							
Decommission	202	105,563	51,653	10,500	57,159	32%	41%
Upgrade	37	4,605	1,954	0	1,954	6%	1%
Maintain	392	131,370	74,002	9,250	79,734	62%	57%

Fluvial erosion sites

Of the 456 fluvial erosion sites identified by the road assessment, 332 were haul road stream crossings. Of these, 130 had treatment urgencies of medium or higher with the potential to yield about 39,898 yds³ of sediment. This is about 94% of the potential sediment yield of all medium and higher urgency fluvial erosion sites. Skid trail crossings accounted for the next largest volume of potential sediment yield with an estimated 1,915 yds³ possible sediment delivery from 13 sites with medium or higher treatment urgency. Selected data for fluvial erosion sites in Minor Creek are shown in Table 10.

Table 10. Selected information for fluvial erosion sites in Minor Creek Projects 7 and 8.

Fluvial Features Yield>0	All Urgency Sites		Medium to High Urgency Sites			
	No. of Sites	Potential Sediment Yield (yds ³)	No. of Sites	Potential Sediment Yield (yds ³)	% of No. of Medium + Sites	% of Pot. Sediment Yield
Stream Crossings on haul roads	332	96,042	130	39,898	87%	94%
DRC	29	322	5	114	1%	0%
DRC, no sediment delivery	28	0	0	0	0%	0%
Road Reaches	22	1,058	2	504	3%	1%
Stream Crossings on skid trails	43	7,917	13	1,915	9%	5%
Swales	2	68	0	0	0	0
Totals	456	105,407	150	42,431	100%	100%

Fish passage at stream crossings - In Projects 7 and 8 there were three Class I (fish bearing) stream crossings identified. None of the crossings appeared to be barriers to fish at any life stage. Two of the crossings were on the TP1300 Road which was built sometime before 1958 in very steep terrain. Both crossings had washed-out long ago. The third crossing is a flat car bridge on a main access road into the watershed that crosses the mainstem of Minor Creek. Improvements prescribed at the crossings for erosion control are low to low-medium urgency. These data are summarized in Table 11.

Table 11. Status of Class I stream crossings in Minor Creek Projects 7 and 8.

Site ID	Road	Type	Urgency	Comment
3059046.3	MC1000	Flat car bridge	Low	Mainstem Minor Ck crossing
3165007	TP1300	Washed out	Low	On large tributary, ~ 650 feet from mainstem
3165009	TP1300	Washed out	Low-Medium	On large tributary, ~ 500 feet from mainstem

Landslide sites

There were 175 landslide sites identified in the assessment. Of these, 137 sites were associated with road reaches with 33 having treatment urgencies of medium or higher and potential sediment yield of about 7,360 yds³. This was about 58% of total potential sediment yield from landslide sites. Selected data for landslide sites in Minor Creek are shown in Table 12.

Table 12. Selected information for landslide sites in Minor Creek Projects 7 and 8.

Landslide Features, Yield>0	All-Urgency Sites		Medium to-High Urgency Sites			
	No. of Sites	Potential Sediment Yield (yds ³)	No. of Sites	Potential Sediment Yield (yds ³)	% of No. of Sites	% of Potential Sediment Yield
Road	137	21,851	33	7,358	77	58
Landing	22	4,586	4	2,198	9	17
Hillslope	1	750	0	0	0	0
Road-Landing	11	3,531	5	2,717	12	21
Road-Hillslope	3	1,222	1	500	2	4
Landing-Hillslope	1	1,500	0	0	0	0
Totals	175	33,440	43	12,773	100%	100%

Costs for implementing treatments

Costs were calculated for all work prescribed by PCFWRA during the field assessments in Minor Creek (Table 13). Costs have been determined separately for road decommission and upgrade treatments. Costs represent a preliminary estimate; final cost estimates will vary based upon a detailed field evaluation at the project level when projects are planned, and the landowner's decision to upgrade or decommission a road is finalized. Of the 65.6 miles assessed, treatments were prescribed for 63.3 miles. Eighteen miles were prescribed for decommission and about 41 miles prescribed for upgrade. About 6.1 miles were prescribed for maintenance needs and those costs are not shown in the table below. Treatments were not identified for 2.2 miles of road.

Table 13. Estimated road treatment costs for all evaluated sites in Minor Creek Projects 7 and 8 (Bair Road not included).

Item	Decommission	Upgrade	Totals
Miles prescribed for treatment	18.0	41.4	59.4 ¹
Site specific treatments	\$ 265,920	\$ 661,637	\$ 927,557
Equipment and labor logistics	\$ 132,960	\$ 330,819	\$ 463,778
Road opening and rebuilding	\$ 279,216	\$ 668,253	\$ 947,469
Road drainage	\$ 25,247	\$ 96,893	\$ 122,140
Culvert materials	0	\$ 256,473	\$ 256,473
Mulch	\$ 14,626	\$ 13,233	\$ 27,858
Mobilization	\$ 10,637	\$ 26,465	\$ 37,102
Layout, coordination, supervision and reporting (30% of above costs)	\$ 218,582	\$ 616,132	\$ 834,714
Totals	\$ 947,187	\$ 2,669,905	\$ 3,617,092
Average treatment cost per mile	\$ 52,622	\$ 64,490	\$ 57,142

Table note:

¹ A total of 59.4 miles of roads were prescribed for Decommission or upgrade treatments and the estimated costs for those roads are shown in the table. Estimated costs were not calculated for an additional 6.1 miles prescribed for maintenance work where site specific road treatment was not identified.

Site specific treatment costs were calculated first for each evaluated site based on equipment and labor needs recorded on the field form. Other costs associated with treatments, such as equipment mobilization, road opening and rebuilding, road drainage treatments, culvert materials, and mulching were summed for the entire assessment area. Additional costs for equipment and labor logistics, and layout, coordinating, supervision and reporting were added as an aggregate amount to the total project cost.

The specific details and assumptions for calculating costs are shown in Appendix D.

Excluding routine road maintenance, the total estimated cost to decommission roads identified as such in Minor Creek is about \$947,187, averaging about \$52,622 per mile of road (Table 13). For decommission roads, costs are calculated for all sites and all treatment urgency levels. It is assumed that all sites along a road to be decommissioned would be treated, because the road would be inaccessible after treatment, and untreated sites could not be maintained.

For roads prescribed as upgrade, the total estimated treatment cost is about \$2.7 million, averaging about \$64,490 per mile of road (Table 13). Costs for upgrade sites are only calculated for medium to high urgency sites. Treatments at lower urgency sites are likely not critical, so limited funds would be spent most effectively treating higher urgency sites. Landowners would be expected to treat the low urgency sites during routine maintenance operations.

Treatment Priorities for Minor Creek watershed assessed areas (Minor Creek Watershed Restoration Action Plan)

Establishing treatment priorities is important, because erosion control and prevention treatments are expensive and the funds available for this type of work are limited. Establishing priorities helps determine where the greatest benefit can be achieved so that limited funds are spent wisely.

A road treatment prioritization is presented in Table 14 based upon data for all named road in Minor Creek. Roads that contained medium to high treatment urgency sites were ranked separately on three criteria: 1) potential yield (volume of sediment that can enter a stream) from the entire road; 2) potential yield per mile of road evaluated, and; 3) treatment cost-effectiveness (the cost per cubic yard to prevent sediment from entering a stream). Of the 52 named roads assessed in Minor Creek, the table lists the 13 roads that rank the highest when the top 13 roads (25%) ranked by each criterion are considered. Thirteen roads ranked high in at least two criteria. Six roads ranked the highest because they ranked high in all three criteria. They are shown with bold fonts in Table 14.

The 3C2010 is a mid-slope spur road on industrial timber lands and is recommended for decommissioning. The 3C2500 and TP1321 are mid-slope roads that cross various ownerships and are recommended for upgrading. The 3C2512 is a mid-slope road on a smaller ownership and is recommended for upgrading. The 3C2800 and MC1330 roads are mid-slope roads on industrial timber lands and are recommended for upgrading.

Table 14. Treatment priority for roads based on potential sediment yield, yield per mile and/or treatment cost-effectiveness. Roads are listed in alphabetical order. Bolded names are roads that ranked high in all three criteria.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield All Sites (yds ³)	Medium to High Urgency Sites			
					Total Cost	Potential Sediment Yield (yds ³)	Potential Sediment Yield per Mile (yds ³ /mi)	Cost/Yard "saved"
3C2002	0.1	1	1	1,050	\$7,458	1,050	8,007	\$7.10
3C2002	0.1	1	1	1,050	\$7,458	1,050	8,007	\$7.10
3C2010	0.2	6	5	4,000	\$49,559	3,500	16,972	\$14.16
3C2500	1.9	18	7	5,881	\$47,799	3,554	1,830	\$13.45
3C2501	0.3	5	2	2,279	\$22,130	1,101	4,200	\$20.10
3C2512	0.3	6	1	3,066	\$3,729	1,500	5,349	\$2.49
3C2800	0.8	20	11	4,742	\$48,288	3,429	4,501	\$14.08
CP1000	1.9	28	7	6,248	\$51,917	3,293	1,704	\$15.77
MC1210	0.5	14	4	6,605	\$32,945	1,146	2,400	\$28.75
MC1330	1.1	16	5	4,062	\$31,983	2,401	2,177	\$13.32
TP1000	2.4	30	4	4,527	\$24,815	1,094	462	\$22.68
TP1300	2.3	14	3	7,110	\$9,630	847	375	\$11.37
TP1321	1.1	12	7	5,365	\$39,362	4,258	3,713	\$9.24

Note: costs shown are only for equipment and labor needs identified for each site on the road. They do not include project costs for permitting, project layout, equipment mobilization, oversight and other costs.

UPPER REDWOOD CREEK WATERSHED ROAD ASSESSMENTS – CURRENT CONDITIONS

This section describes the current watershed conditions in Redwood Creek based on road assessment data.

Initial road assessment results were reported in previous reports for Redwood Creek (Bundros, et al 2003, Bundros, et al 2004). Since the initial assessments, road improvements have been made through cooperative erosion control projects with public grant and landowner funds and through THP road work. RNSP has reviewed all reports of cooperative projects completed 1996 through 2008 and all THPs filed with CDF through 2006. Nearly all sites treated have been field reviewed by RNSP geologists to evaluate completed treatments. Some decommissioned roads were not field reviewed by RNSP, but were described in completion reports prepared by Pacific Watershed Associates. THPSs on ownerships outside the cooperative erosion control program were not reviewed.

As shown in Table 15, about 783 miles of roads (70%) of the 1,120 miles of roads in upper Redwood Creek watershed have been evaluated. However, our database contains data for only

723 miles. We do not have data for 32 miles of roads in Project 97. We have the data for the 28 miles of Humboldt County roads assessed by the Five Counties SCP, but have not yet verified consistency of those data with data from the other assessments.

Table 15. Project, road miles and data use for assessment projects in upper Redwood Creek.

Project	Total	Public	Private	Evaluated	% Evaluated	Data in Database	Volume Data Used in Report	Cost Data Used in Report
Project 96	15.8	0.0	15.8	11.7	74%	Yes	Yes	No
Project 97	84.0	12.8	71.1	32.1	38%	No	Not Avail	No
Project 0	96.3	9.1	87.2	84.4	88%	Yes	Yes	No
Project 1	218.7	14.1	204.6	189.3	87%	Yes	Yes	Yes
Project 2	199.0	10.4	188.5	145.4	73%	Yes	Yes	Yes
Project 3	158.7	4.0	154.7	115.5	73%	Yes	Yes	Yes
Project 4	95.6	14.7	80.9	55.1	58%	Yes	No	No
Project 5	17.4	2.4	15.0	6.2	35%	Yes	Yes	Yes
Project 6				28.1		Yes	Not Avail	No
Project 7	156.6	13.5	143.1	53.0	34%	Yes	Yes	Yes
Project 8	78.3	6.0	72.3	62.0	79%	Yes	Yes	Yes
TOTALS	1,120.3	87.1	1,033.2	782.9	70%			

Throughout this chapter we use project data that are reliable for the specific summary statistics or analysis. During each assessment, some projects recorded all data used in all tables and analyses in this report. Other projects did not record estimated treatments costs or used volumetric surveys that were inconsistent with most other assessments in the watershed. Table 16 shows the projects from which data are used, the summary statistic and analysis that uses the data, and total road miles for those projects.

Table 16. List of projects from which data are used in summary statistics and data analysis.

Projects with Reliable Data	Summary Statistic or Data Analysis	Total Road Miles	% of all roads in upper Redwood Creek
1, 2, 3, 5, 7 and 8	All cost tables and prioritizing roads	571	51%
0, 1, 2, 3, 5, 7, 8 and 96	Sediment yield and road surface drainage	667	60%
0, 1, 2, 3, 4, 5, 7, 8 and 96	Driveability and maintenance status	723	65%

Driveability and maintenance status

Road work completed since initial assessments has been subsequently recorded in the database. Of the 783 miles of roads assessed, about 401 miles of road were found to be driveable by a standard 4WD vehicle and about 326 miles were not driveable. Driveability was not documented for about 56 miles of roads. Road driveability is summarized in Table 17.

Table 17. Driveability of all assessed roads.

Driveability	Miles	% of Total Assessed Miles
Driveable	400.9	51%
Not Driveable	259.9	33%
Decommissioned / part decommissioned	66.3	9%
Not documented	55.6	7%
Total Assessed in Projects 0,1,2,3,4,5,7,8, and 96	782.8	100%

Table notes: Driveability is as documented at the time of the most recent field review or implementation project report.

The road maintenance status was documented during the assessment and updated after completion of subsequent road treatments. Roads were described as maintained, unmaintained, or decommissioned. Maintained and unmaintained are described above in the section Results for Minor Creek Watershed.

Decommissioned roads were roads blocked to vehicular access. Fills and culverts had been removed from stream crossings, unstable fills pulled-back, and permanent road drainage provided by outsloping, rolling dips or cross-road drains. Partially decommissioned roads are THP roads that were ‘abandoned’ under earlier forest practice rules. On these roads, not all of the crossing fill had been removed from stream crossings, culverts remained, and potential sediment yield was documented. There were about 306 miles of maintained roads and about 339 miles of unmaintained roads. About 66 miles of roads were decommissioned or partially decommissioned. The status was not documented for about 72 miles of road. Table 18 summarizes these data.

Table 18. Maintenance status of all assessed roads through 2008.

Maintenance Status	Miles	% of Total Assessed Miles
Maintained	305.9	39%
Unmaintained	338.5	43%
Decommissioned	60.8	8%
Partially decommissioned	5.5	1%
Unknown Status	72.1	9%
Total Assessed	782.8	100%

Table note: Totals may differ slightly from those shown in other tables due to rounding.

Potential sediment yield

A total of 5,057 sites were evaluated in the field. There were 4,000 fluvial erosion sites and 1,057 landslide sites. Potential sediment yield is summarized in Table 19.

Table 19. Potential sediment yield with proposed treatments for Projects 0, 96, 2, 3, 5, 7, and 8 road assessments.

	No. of Sites	Erosion Volume ¹ (yds ³)	Site Potential Yield (yds ³)	Extreme Potential Yield (yds ³)	Potential Sediment Yield ² (yds ³)	% of No. of Sites	% of Potential Sediment Yield
Sites inventoried	5,057	1,785,880	1,025,566	510,750	1,337,607	100%	100%
All Sites with No Yield	1,155	32,965	0	0	0	23%	0%
All Sites, Yield >0	3,902	1,752,915	1,025,566	510,750	1,337,607	77%	100%
M-H Sites, Yield >0	2,100	1,066,834	680,440	392,250	923,321	42%	69%
All Fluvial Sites	4,000	743,262	732,415	121,750	799,081	79%	60%
All Landslide Sites	1,057	1,042,618	293,151	389,000	538,526	21%	40%
Field Call for Treatment							
Decommission	1,484	902,255	403,945	297,250	588,380	29%	44%
Upgrade	2,074	774,601	546,369	172,750	643,422	41%	48%
Maintain	883	81,899	73,704	37,250	101,039	17%	8%
None ³	616	27,125	1,549	3,500	4,766	12%	0%
Totals all Sites	5,057	1,785,880	1,025,566	510,750	1,337,607	100%	100%

Fluvial erosion sites

Of the 4,000 fluvial erosion sites identified in the road assessments, 2,606 were haul road stream crossings. Of these, 1,328 had treatment urgencies of medium or higher with the potential to yield about 501,000 yds³ of sediment to streams. This is about 94% of the potential sediment yield of all medium and higher urgency fluvial erosion sites. Skid trail crossings accounted for the next largest volume of potential sediment yield with an estimated 14,900 yds³ possible sediment delivery from 80 sites with medium or higher treatment urgency. Selected data for fluvial erosion sites are shown in Table 20.

Table 20. Selected information for fluvial erosion sites.

Fluvial Features	All Urgency Sites		Medium to High Urgency Sites			
	No. of Sites	Potential Sediment Yield	No. of Sites	Potential Sediment Yield	% of No. of Medium + Sites	% of Pot. Sediment Yield
Road Crossings	2,606	749,998	1,326	501,253	82.9%	93.9%
DRC	359	13,903	126	9,089	7.9%	1.7%
DRC, no sediment delivery	578	0	0	0	0.0%	0.0%
DRC, Road Reaches	5	115	0	0	0.0%	0.0%
Road reach	169	6,289	59	3,626	3.7%	0.8%
Skid Trail Crossings	159	25,695	80	14,861	5.0%	3.2%
Swales	124	3,082	9	878	0.6%	0.4%
Totals	4,000	799,081	1,600	529,707	100.0%	100.0%

Fish passage at stream crossings – There were 21 Class I stream crossings identified during field assessments. Subsequent to initial assessments, two sites have been decommissioned, one upgraded and one found not treatable as part of an adjacent road decommissioning project. Table 21 shows the current status of Class I streams identified in assessments. One of the crossings shown is identified as a possible barrier to fish.

There are additional Class I stream crossings in Redwood Creek along roads managed by Humboldt County and Caltrans that are not reported here. Areas not assessed as part of the cooperative erosion control program are also not included in Table 21.

Table 21. Class I stream crossings with medium and higher urgency in bold font.

Site ID	Road Name	Location	Type	Urgency	Comment
2017021	O-LINE	Mainstem Panther Creek	Bridge	LOW	Landowner replaced undersized culvert with bridge in 2003.
2052028	1300	Mainstem Panther at Redwood Creek	Removed bridge	LOW	Landowner removed bridge. Abutments and sill remain.
2053025	1305	Mainstem Joplin	Washed out	LOW	Culvert blown-out to original grade.
2064050	LC4000	Tributary to Lacks	Washed out	MED	"King's Crossing" mostly washed-out. About 100 yds³ remain within mainstem.
2073007	RC-1	Mainstem Lacks	Bridge	LOW	Bridge
2078004	LC-11	Mainstem Lacks	Ford	LOW	Ford immediately above bridge.
3059046.3	MC1000	Minor	Bridge	LOW	Mainstem minor Creek crossing
3165007	TP1300	Minor Creek	Washed out	LOW	On large tributary, ~ 650 feet from mainstem.
3165009	TP1300	Minor Creek	Washed out	LOW-MED	On large tributary, ~ 500 feet from mainstem.
4032107	L2010	Lupton Creek	Washed out skid crossing	LOW-MED	Crosses mainstem Lupton. Many logs and 20 yds ³ remain
4036001	K&K West	Redwood Creek	Removed bridge	LOW	Landowner removed bridge across Redwood Creek.
4037223	Dolly Varden	Cashmere	Old Log bridge	MED-HIGH	Failing -bridge may be barrier. Need to replace or remove.
4037269	Dolly Varden	Mainstem N>F. Dolly Varden	Decommis- sioned in 2003.	LOW	Previously failed log bridge that may have been barrier.
5031006	480-1	Pardee	Bridge	LOW	Crosses mainstem Pardee
5038016	UPR-10	Mainstem Windy	Bridge	MED-HIGH	Bridge seriously constricting channel. Need to replace. ~400 yards of pot. yield.
5044018	L2000-CN	Noisy	Bridge	MED	Bridge condition is OK. Road drainage treatments are medium urgency.
5101003	N950	Noisy	Fill crossing	LOW	Low volume, low gradient fill crossing.
7032006	AM-5	Windy	Bridge	LOW-MED	Left abutment needs minor stabilizing.
7042001	HP-51	High Prairie	Washed out	LOW	Minor fill remaining.
7061001	UBR	Negro Joe	Washed out	LOW-MED	Some fill remaining
7078002	M-1	Minon Creek at Redwood Creek	Ford	LOW	Good low flow crossing.

Landslide sites

There were 1,057 landslide sites identified in the assessment. Of these, 500 sites had medium or higher treatment urgencies and potential sediment yield of about 394,000 yds³. This was about 73% of total potential sediment yield from all landslide sites. Selected information for landslide sites are shown in Table 22.

Table 22. Selected information for landslide sites.

Landslide Features	All Urgency Sites		Medium to High Urgency Sites			
	No. of Sites	Potential Sediment Yield	No. of Sites	Potential Sediment Yield	% of No. of Medium + Sites	% of Pot. Sediment Yield
Road	745	259,337	352	197,674	70.4%	48.2%
Landing	119	51,146	54	42,125	10.8%	9.5%
Hillslope	14	27,295	4	4,684	0.0%	0.0%
Road, Hillslope	92	115,821	36	77,116	0.0%	21.5%
Road, Landing	41	37,224	27	33,087	5.4%	6.9%
Road, Swale	35	23,482	22	21,232	4.4%	4.4%
Landing, Hillslope, Swale	11	24,220	5	17,696	1.0%	4.5%
Totals	1,057	538,526	500	393,615	100.0%	100.0%

Costs for implementing treatments

Costs have been calculated for treating all sites assessed where site specific cost data were determined (Projects 1, 2, 3, 5, 7 and 8). Sites that have been decommissioned, upgraded or maintained are not included in the costs shown below. Costs have been determined separately for roads that have been prescribed for decommission and upgrade treatments (Table 23) and are strictly an estimate. Actual costs will vary based upon a final field evaluation at the project level when projects are planned, and the landowner's decision to upgrade or decommission a road is finalized.

Excluding routine road maintenance, the total estimated cost to decommission roads identified as such is about \$10,989,000, averaging about \$72,700 per mile of road. For roads prescribed as upgrade, the total estimated treatment cost is about \$13,961,000, averaging about \$59,400 per mile of road.

Table 23. Estimated road treatment costs for sites evaluated and not yet treated in Projects 1, 2, 3, 5, 7 and 8 in Redwood Creek.

Item	Decommission	Upgrade	Maintain	Totals
Miles prescribed for treatment	151.2	234.9	76.3	462.4
Prescribed Treatment % of Total	33%	51%	16%	100%
Site specific treatments	\$ 5,748,780	\$ 5,649,405		\$ 11,398,185
Equipment and labor logistics	\$ 1,724,186	\$ 1,668,244		\$ 3,392,430
Road opening and rebuilding	\$ 287,439	\$ 56,494		\$ 343,933
Road drainage	\$ 244,188	\$ 1,087,143		\$ 1,331,331
Culvert materials	\$0	\$ 2,035,347		\$ 2,035,347
Mulch	\$ 316,183	\$ 112,988		\$ 429,171
Mobilization	\$ 132,222	\$ 129,936		\$ 262,158
Layout	\$ 2,535,899	\$ 3,221,867		\$ 5,757,766
Totals	\$ 10,988,897	\$ 13,961,423		\$ 24,950,321
Average treatment cost per mile	\$ 72,673	\$ 59,438		\$ 132,111

Treatment Priorities for all upper Redwood Creek watershed assessed areas

There are about 584 miles of assessed roads in upper Redwood Creek yet to be treated. The following discussions and tables provide various prioritizations for treating the remaining roads based upon threats or cost-effectiveness.

Treatment priorities for individual roads were established using database queries and data from Projects 1, 2, 3, 5, 7 and 8. Other projects were omitted because field crews did not prescribe detailed treatments nor estimate treatment costs. Roads that contained sites with medium to high treatment urgencies were ranked based on three criteria: 1) potential yield (volume of sediment that can enter a stream) from the entire road; 2) potential yield per mile of road evaluated, and; 3) treatment cost-effectiveness (the cost per cubic yard to prevent sediment from entering a stream). Road treatment priority was based on the ranking of each criterion for each road. Tables E-1, E-2, and E-3 (Appendix E) show how each road ranks by each criterion.

The results of each table from the above analysis were combined and analyzed together. Of the 370 named roads, Table 24 lists the 22 roads that rank the highest when the top 37 roads (10% of all roads) ranked by each criterion are considered. Twenty two roads ranked high in at least two criteria. Eight roads ranked the highest because they ranked high in all three criteria. They are shown with bold fonts in Table 24.

Table 24. Treatment priority for roads based on potential sediment yield, yield per mile and/or treatment cost-effectiveness. The eight roads with bolded names rank high in all three criteria.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield ALL Sites (yds ³)	Medium to High Urgency Sites			
					Total Cost	Potential Sediment Yield (yds ³)	Potential Sediment Yield per Mile (yds ³ /mi)	Cost/Yard "saved"
1020	1.7	18	12	8,059	36,317	7,544	4,465	4.81
1140	0.8	15	7	12,616	23,856	7,144	9,516	3.34
1410	1.9	23	12	8,125	33,660	7,602	3,994	4.43
1433	0.5	7	7	3,978	12,109	3,978	7,835	3.04
1440	1.5	18	15	15,155	31,314	14,588	9,657	2.15
800G	0.3	2	2	3,726	12,236	3,726	12,298	3.28
809	1.8	15	13	16,032	156,745	12,510	7,032	12.53
831	2.1	13	7	7,699	14,821	7,338	3,578	2.02
BO1666	0.1	7	7	5,139	19,795	5,139	35,597	3.85
Dolly Varden	14.8	191	114	109,890	1,234,068	103,954	7,035	11.87
DVA	1.3	18	15	7,480	112,964	7,292	5,640	15.49
LC5000	2.3	26	21	23,659	59,360	23,089	10,176	2.57
N500A	0.2	3	3	1,697	8,348	1,697	7,318	4.92
O-10	0.1	4	2	8,000	3,210	5,000	46,450	0.64
Old Hwy 299	2.5	52	39	16,040	233,836	15,064	6,074	15.52
PP1110	0.5	8	5	9,346	22,131	7,061	14,002	3.13
PR1106	0.6	5	5	10,417	31,477	10,417	17,639	3.02
R1000	2.1	21	13	8,914	33,653	8,775	4,164	3.84
R3351	0.1	1	1	750	1,017	750	6,544	1.36
R3800	0.9	11	10	9,796	57,576	9,774	11,364	5.89
R3810	0.1	2	1	5,000	10,165	3,500	43,126	2.90
RC-2	1.5	25	14	10,122	134,682	9,120	6,168	14.77

The 1020 Road is recommended for upgrade and crosses through George Creek in the upper-midslope. The 1410 is recommended for upgrade and is in a lower slope position between Coyote and Johnson Prairie Creeks. The 1440 is recommended for decommission and is in a midslope position on Coyote Creek. The 831 is recommended for decommission and is in a mid-slope position in Lee Creek. The LC5000, the PP1100, and the PR1106 are all recommended for decommission and are in low-slope positions in Lacks Creek. The lower portion of the R1000 Road is recommended for decommission and is in a low-slope position in Powerline Creek.

ACCOMPLISHMENTS OF COOPERATIVE EROSION CONTROL PROGRAM 1996-2008

Assessments

Since 1996, eleven road assessments have been completed by the cooperative erosion control program in Redwood Creek. The assessments have been possible because of unique opportunities of trust relationships and available funding. The first assessment in 1996 was implemented by RNSP staff on lands owned by the Stover family and was soon followed by an assessment on Sierra Pacific Industries lands. The U.S. Fish and Wildlife Service, Jobs-in-the-Woods program funded the implementation of the assessment findings.

Soon after, CDFG's Fisheries Restoration Grant Program (SB271) provided funding for additional assessments. NRM used the SB271 funds to complete assessments in two areas of the watershed. A partnership between PCFWWRA, RNSP and numerous landowners allowed for the furtherance of the assessments into what ultimately included about 783 miles of the 1,120 miles of roads in upper Redwood Creek

All available data from the assessments are maintained by RNSP.

Implementation

Projects to address the potential erosion identified at assessed sites have been implemented since 1996. The road assessment database and GIS coverages were updated to reflect treatments at sites that occurred as a result of grant-funded erosion control projects and road improvements associated with approved THPs. Work that was implemented by the landowner outside of grant projects or THPs has not been captured in the database.

Table 25 shows selected data for sites that have been treated. Treated sites are those that were completed through grant projects through 2008 and THPs through 2006. Of the 4,431 sites initially assessed as of 2004, 926 sites (21%) have been treated. More than 12% of all assessed sites were decommissioned and about 8% of all assessed sites were upgraded. Combined, all treatments reduced the potential sediment yield by over 414,000 yds³. Figure 3 shows these data graphically.

Table 25. Potential sediment yield removed from delivery for Projects 0, 1, 2, 3, 5, 7, 8 and 96.

	No. of sites	Potential Sediment Yield (yds ³)	% of Count of all of Sites	% of Potential Sediment Yield
Sites inventoried as of 2004	4,431	1,647,186	100.0%	100.0%
Potential sediment yield removed from delivery				
Decommissioned sites	556	369,959	12.5%	22.5%
Upgraded sites	365	44,083	8.2%	2.7%
Maintained sites	5	227	0.1%	0.0%
Sites treated under THPs	151	8,870	3.4%	0.5%
Sites treated under cooperative erosion control program	775	405,401	17.5%	24.6%
All sites treated as of 2006/2008	926	414,269	20.9%	25.2%
<u>Medium and higher urgency only</u> ¹				
2004 summary report	2,370	1,239,786	100%	100%
Decommissioned sites	348	304,661	15%	24.6%
Upgraded sites	173	38,526	7%	3.1%
Maintained sites	2	146	0%	0.0%
Treated sites as of 2006/2008 ²	523	343,333	22%	27.7%

Note: Small differences are due to rounding.

¹ Urgency is 2004 urgency.

² All THPs filed through 2006, all cooperative projects through 2008.

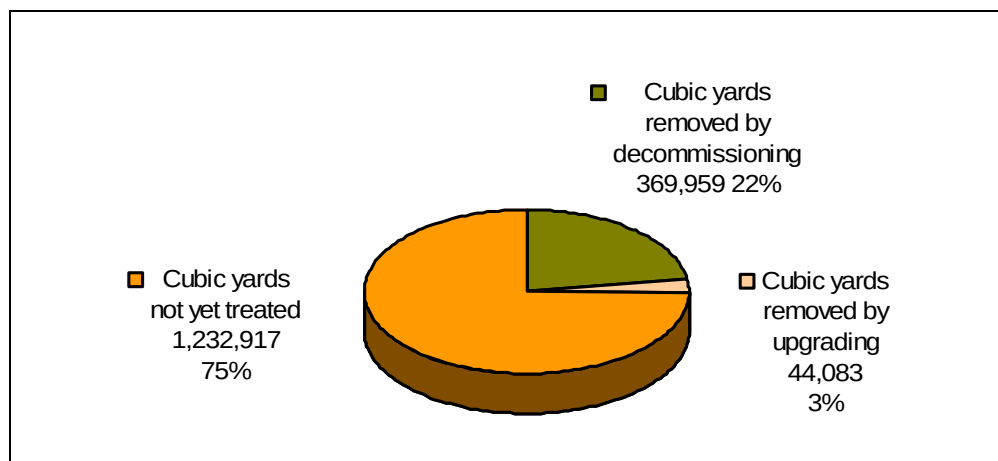


Figure 3. Reduction of potential sediment yield by decommission and upgrade treatments in upper Redwood Creek.

Another way to look at treatment accomplishments is by road miles. Of the approximately 755 miles of assessed roads for which we have data about 170 miles have been treated. About 110 miles have been upgraded and about 61 miles have been decommissioned. Table 26 shows selected data for that have been treated. Treated roads are those that were treated by grant projects through 2008 and THPs through 2006. Figure 4 shows these data graphically.

Table 26. Miles of road treated in project areas 0, 1, 2, 3, 5, 7, 8 and 96. Treatments were implemented by cooperative erosion control projects and under THPs.

Treatment type	miles	% of all assessed roads
Not yet treated	584.0	77.4%
Upgraded	109.7	14.5%
Decommissioned	60.7	8.0%
Not treatable	0.4	0.1%
All assessed roads	754.8	100.0%

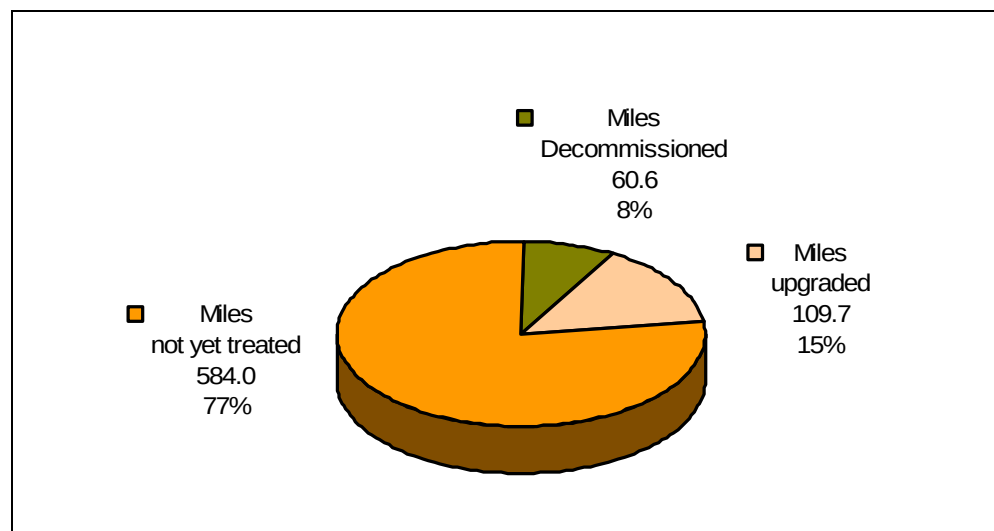
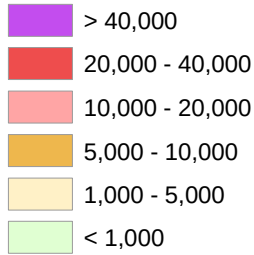


Figure 4. Miles of roads treated in upper Redwood Creek.

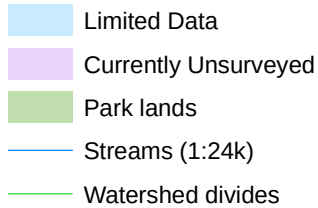
A third way to look at treatment accomplishments is spatially. Figure 5 shows the potential sediment yield in upper Redwood Creek as reported by Bundros, et al in 2004. Figure 6 shows where reduction of potential sediment yield has occurred in the upper watershed. By 2004, most of the major assessments had been completed, but databases, intentionally, had not yet been updated to reflect the implementation work that had been completed since 1996. By retaining the original assessment data until 2004, a snap shot of watershed conditions at the completion of road assessments could be developed. The volumes were based on all sites that had at least a medium erosion potential. Potential sediment yield was normalized on drainage area for each sub-watershed and interfluvial area. Areas of limited data were not used in the analysis. Treatments have been focused on areas with willing landowners, where potential sediment delivery is concentrated and where treatments are cost-effective.

Potential Sediment Yield 2004 Upper Redwood Creek Watershed

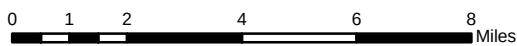
Potential Sediment Yield per Square Mile (yds3/mi2)*



Status of Inventory Data



*This map shows the potential sediment yield per square mile in upper Redwood Creek as report in Bundros et al 2004. In 2004, most of the assessments had been completed, but databases had not yet been updated with the actual work completed since 1996. Potential sediment yield was normalized on drainage area for each sub-watershed and interfluvial area. The analysis considers all sites that had at least a medium erosion potential. Areas of limited data were not used in this analysis.



Source: RNSP GIS - N:\GIS_Maps\user_maps\60_UB\ErosionPreventionRanking\2009\Updates
Compiled: March, 2009

Figure 5. Potential sediment yield in upper Redwood Creek 2004.

Reduction of Potential Sediment Yield 1996 - 2008

Upper Redwood Creek Watershed

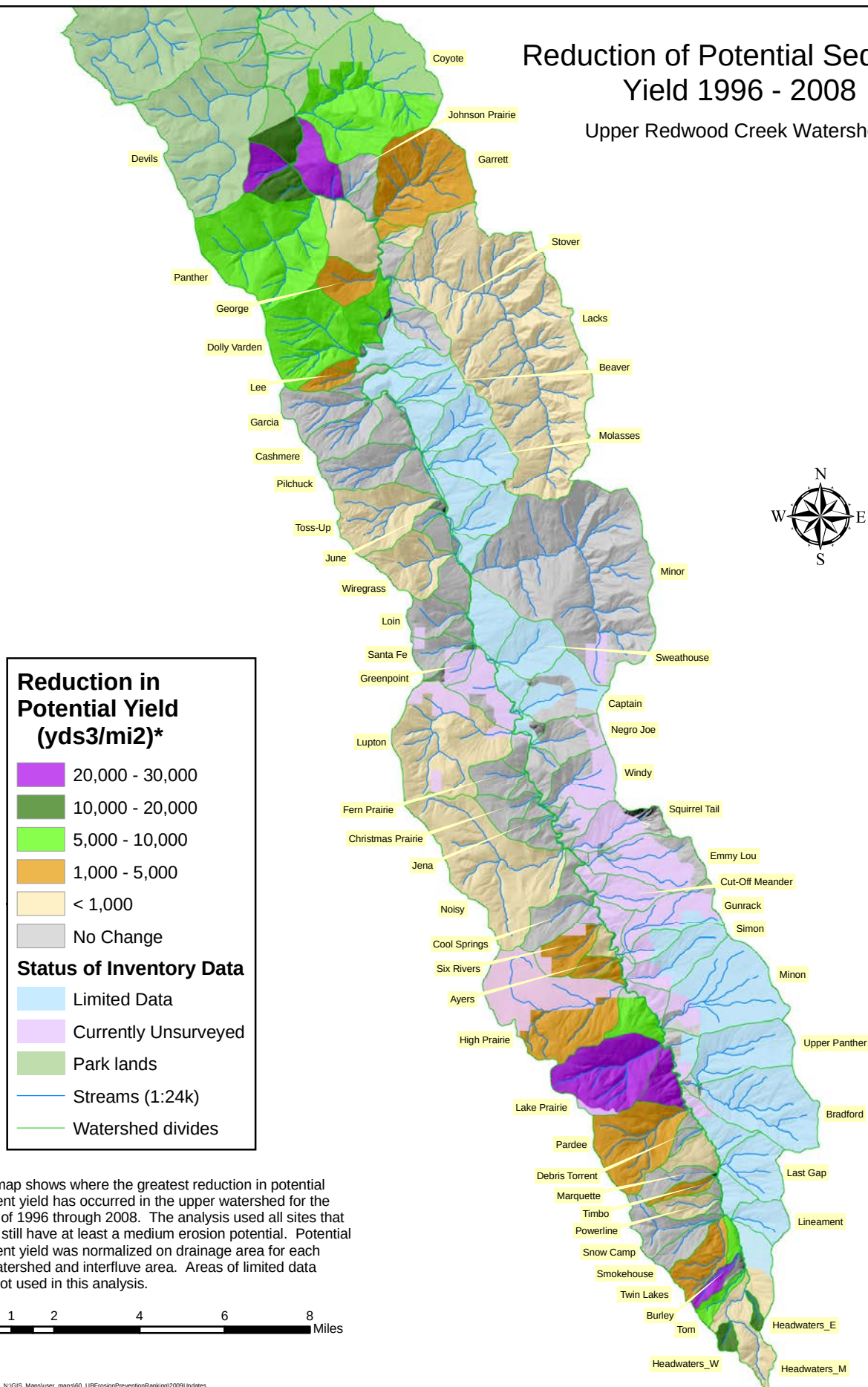


Figure 6. Reduction of potential sediment yield in upper Redwood Creek.

Lee, Dolly Varden, Lake Prairie, Timbo and Burley creeks, along with several interfluvial areas were ranked the highest in 2004 for potential sediment yield (Figure 5). Potential sediment yield ranged from 20,000 yds³ to more than 40,000 yds³ per square mile. Projects were implemented in most of these areas between 1996 and 2008 through cooperative erosion control. The greatest reduction of potential yield occurred through cooperative projects in Coyote, Panther, Dolly Varden, Lake Prairie and Burley creeks, and in most of the interfluvial areas that ranked high in 2004 (Figure 6). In these sub-watersheds and interfluvial areas, potential sediment yield was reduced by 5,000 – 30,000 yds³ per square mile.

CONCLUSIONS

A substantial amount of work has been completed in upper Redwood Creek through the cooperative erosion control program from 1996 through 2008 and through approved THPs filed between 1999 and 2006. Potential sediment yield was reduced by over 20,000 yds³ per square mile in sub-watersheds or interfluvial areas where potential sediment yield ranked highest in 2004. Of the 4,431 sites initially assessed as of 2004, 926 sites (21%) have been treated. More than 12% of all sites were decommissioned and about 8% of all sites were upgraded. Combined, all treatments reduced the potential sediment yield by over 405,000 yards³. The reduction is about 25% of the original assessed volume of 1,647,000 yards³. Of the approximately 755 miles of assessed roads for which we have data about 170 miles (22%) have been treated. About 110 miles have been upgraded and about 61 miles have been decommissioned.

The 25% reduction of assessed potential sediment yield in upper Redwood Creek over the past 12 years is a remarkable accomplishment that has been made possible by the cooperative efforts of the private landowners, RNSP, PCFWRA and the funding agencies that have supported projects in Redwood Creek. Redwood Creek watershed is unique from other north coastal California watersheds with its relatively small size and with a national and state park in the lower-third of the watershed. Most of the land upstream of the park is used almost exclusively for ranching and forest products, and is mostly owned by a relatively small number of large landowners which make watershed-scale planning feasible. This unique situation allows for continued successful watershed improvement through landowner initiatives and programmatic projects supported with grant funding.

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APPENDIX A.

ROAD CONSTRUCTION HISTORY MAPS

(maps can be found on the enclosed CD)

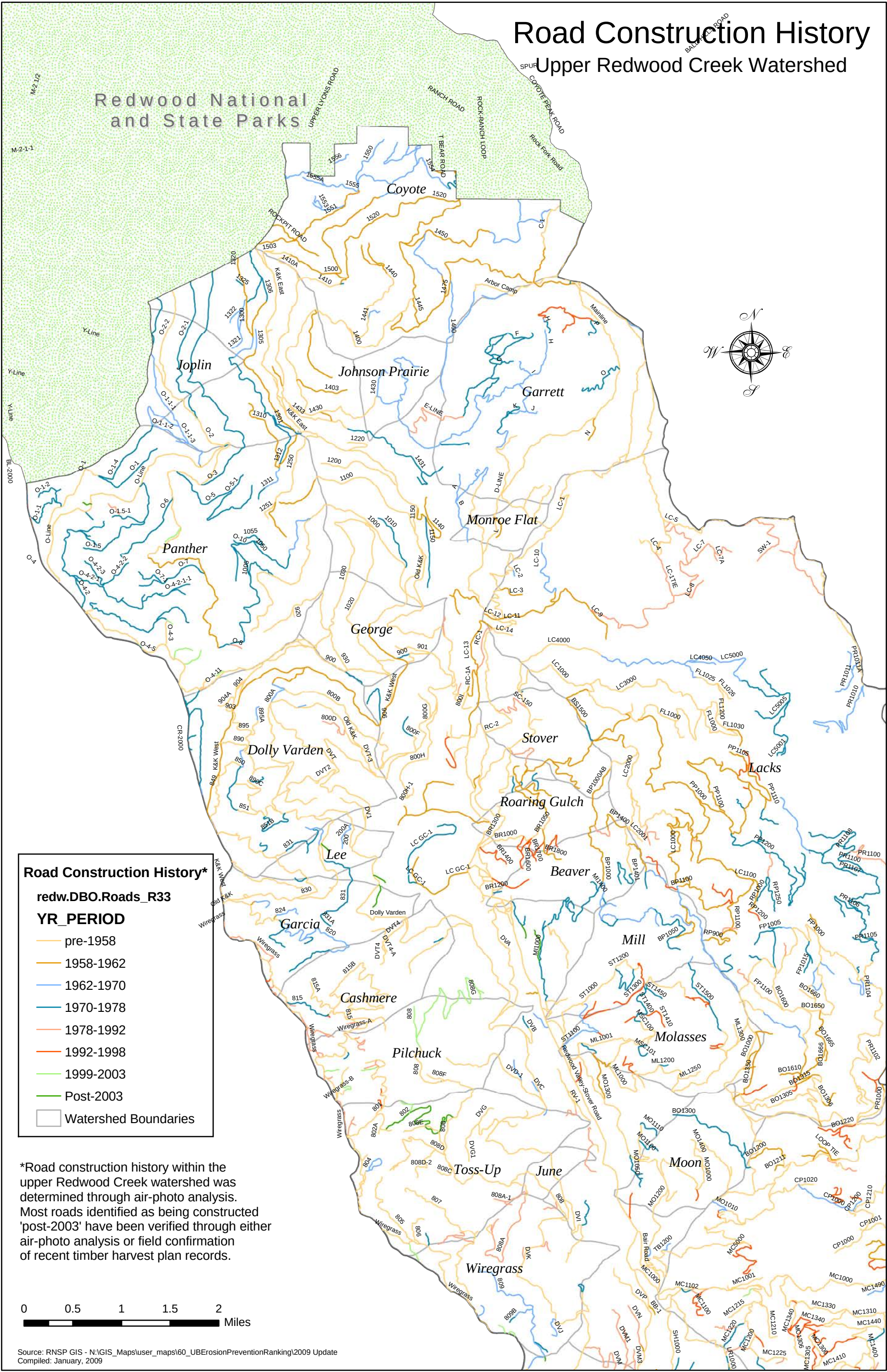


Figure A-1. Road construction history

Road Construction History

Upper Redwood Creek Watershed

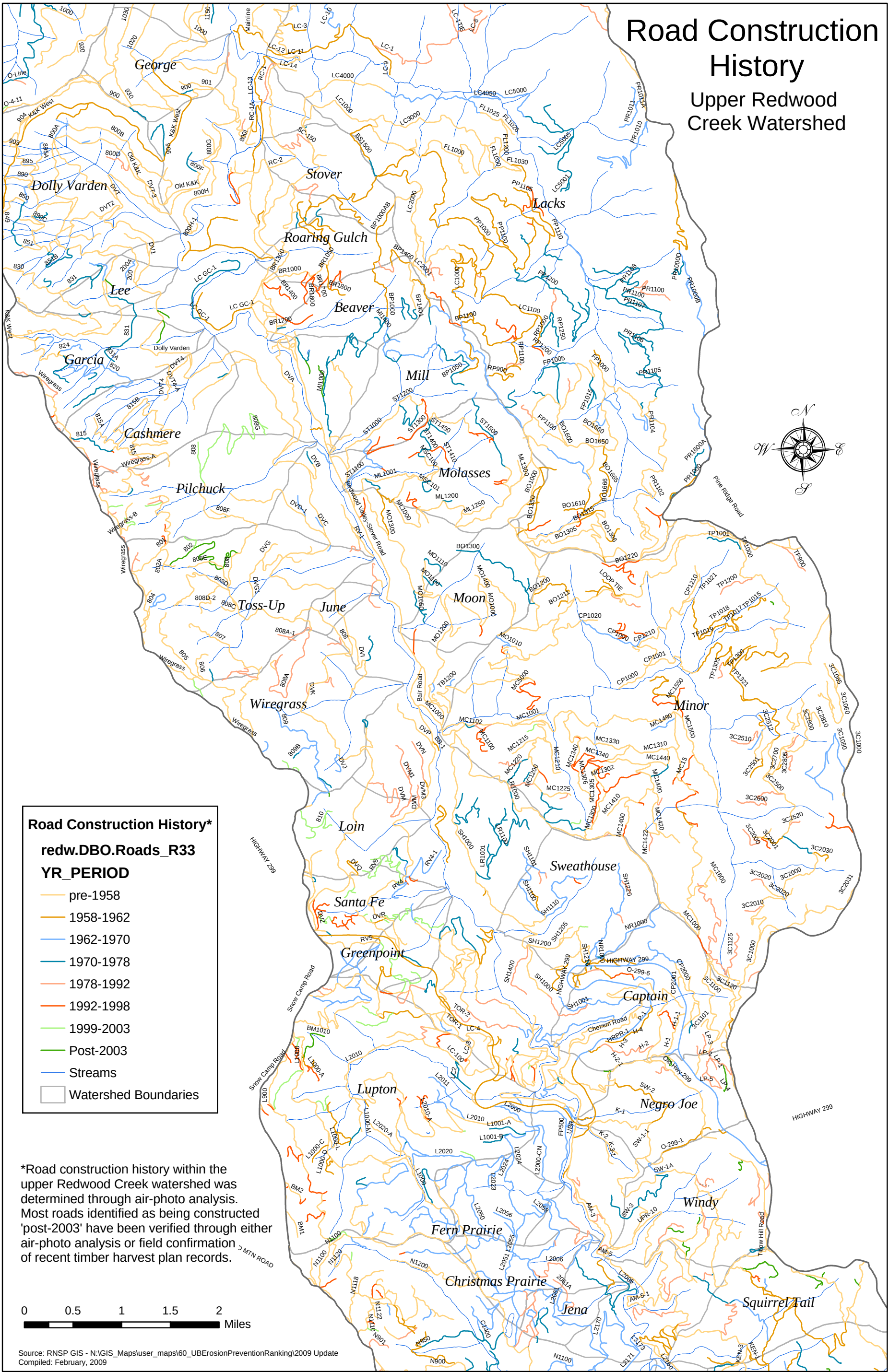


Figure A-2. Road construction history

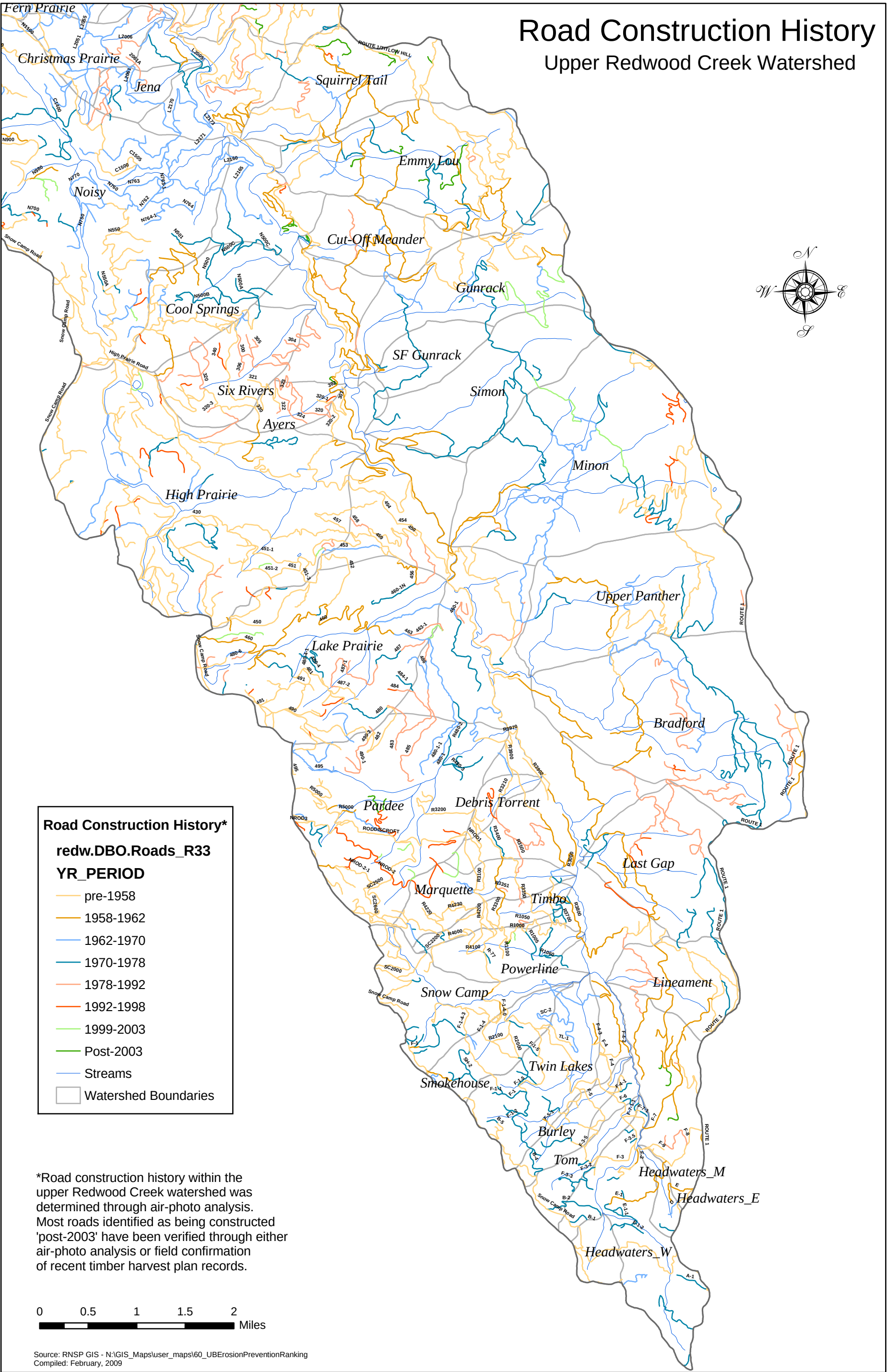


Figure A-3. Road construction history

APPENDIX B.

ROAD ASSESSMENT FIELD FORM USED BY PCFWWRA IN REDWOOD CREEK

Reviewed by : _____

REDWOOD CREEK BASIN ROAD INVENTORY FORM

Check _____

ID No.: _____

Redwood National and State Parks

ASAP _____

Version 4/9/03

SECTION I: GENERAL SITE INFORMATION

Road Name: _____ Site # _____ Date: _____ By: _____.

Watershed: _____ Ownership _____ Year built: _____.

Quad ID: _____ Photo# _____ Photo date: _____.

Current road condition: Drivable [Maintained Abandoned Decommissioned]

The road surface is: [Native Rocked Paved]

Proposed Treatment: [Maintain Upgrade Decommission]

SECTION II: FLUVIAL SITE (CROSSINGS, RELIEF CULVERTS, GULLY, ETC.)

FEATURE: [RXing STXing Swale *Ditch/road relief Road reach] Spring

PROCESS: None Gully Streambnk/channel eros. Collapsing Fill failure

Will it debris torrent? **Y N M**

DRAINAGE STRUCTURE: Bridge *Culvert: *metal *concrete *plastic

Humboldt Fill Ford Armored fill None

Critical dip@xing? **Y N** Left ditch/road length _____ft. Right ditch/road length _____ft.

DIVERSION POTENTIAL: DP? **Y N** Now diverted Past diverted Rd grade _____%

CONDITION OF FILL: Intact removed _____% washed-out _____%

CULVERT INLET INFORMATION: *Diameter _____in. Headwall height _____in.

Rust line: width _____in. depth _____in. Upstream chan: width _____ft; depth _____ft grade _____%

Stream class: **I, II, III, or IV** Sediment transport: **H M L**

Does culvert look undersized? **Y M N** Plug potential: **H M L**

*Inlet condition: OK Rust/holes Band separation Trash rack Drop inlet

*crushed _____% *plugged _____%

CULVERT OUTLET INFORMATION:

*Condition: OK Rust/holes Functional downspout %crushed _____% Shotgun

Fish-outlet drop: now _____ft. @bankfull _____ft. Culvert grade _____%

Pool dim.: length _____ft. depth _____ft. @bankfull: length _____ft. depth _____ft.

Comments:

SECTION III: LANDSLIDE SITE

FEATURE: Road reach Landing Cutbank Hillslope

PROCESS: [Slow, deep seated Fast, shallow debris slide] Will it debris torrent? **Y M N**

SETTING: Streamside: <55% or >55% Swale Headwall Break-in-slope Hillslope

Distance to stream _____ft. Slope _____%

ACTIVITY: Failed in past? **Y N** %failed _____%

ASSOCIATION(S): Road related Water onto feature Spring Stream undercutting

SECTION IV: TREATMENTS (Circle all that apply)

Critical dip@xing Install culvert Replace culvert New culv: dia. _____in. len _____ft.

Drop inlet Flared inlet Trash rack Remove sed@CMP inlet Brush inlet

Reconstruct fill Excavate fill Ford Bridge Other None

Armor fillslope: @inlet _____ft²; Downstream face _____ft² Downspout _____ft.

Armored fill: sill height _____ft. sill width _____ft. Check culvert size

***** URGENCY: **H M L** COMPLEXITY: **H M L** *****

ROAD REACH TREATMENTS

Clear/est. IBD _____ft. Remove IBD _____ft. Rock road _____ft². Remove berm _____ft.

Rolling dips: # _____ OS w/out IBD _____ft. OS w/IBD _____ft. Inslope road _____ft.

Cross-road drains # _____ Ditch relief culvert # _____, _____ft.

SECTION V: FILL AND FUTURE EROSION VOLUMES

Dimensions of landslide or gully: length: _____ft. width: _____ft. depth: _____ft.
(Use Comment Section below to record dimensions of complex features)

Potential erosion vol: _____yd³ %delivery: _____% Site potential yield: _____yds³

Erosion Potential: **H M L** Potential for Extreme Erosion? **Y N**

Is the treatment likely to control or prevent erosion?: **Y M N**

Extreme potential yield (yds³): [<500, 500-1000, 1K-2K, 2K-5K, >5K]

EXCAVATION VOLUMES		EQUIPMENT HOURS	COMMENT ON TREATMENT:
Total excavated (yds ³):		Excavator (hrs):	
Vol. put back in (yds ³):		Dozer (hrs):	
Vol. removed (yds ³):		Dump truck (hrs):	
Vol. stockpiled (yds ³):		Grader (hrs):	
Vol. endhauling (yds ³):		Backhoe (hrs):	
Dist. endhauling (ft):		Labor (hrs):	
Exca. prod. rate (yds ³ /hr):		Other:	

Stream Profile through Crossing			Xing type: 1, 2, 3, 4
(begin at top of crossing)			(circle one)
Angle (deg) (up+, dn-)	Distance (feet)	Code (UES, TOP, IBR, OBR, BOT, XS1, XS2 LES)	Comments
0	0	UES, TRN	in natural channel

Cross Section(s)				
(begin on left side of crossing)				
XS#	Angle (deg)	Distance (feet)	Code (LRP, LEC, CLP, REC, RRP)	Comments
1	0	0	LRP, TRN	Base of cutbank

Site sketch - Site No. : _____.

Design Results	
Decommission vol. (2:1)	
Erosion vol. (1:1)	
Culvert add/repl. vol. (1:1)	
Humboldt crossing (1:1)	
Culvert length needed	

APPENDIX C.

ROAD ASSESSMENT METHODS USED IN REDWOOD CREEK

Assessment Fieldwork

Field crews, in teams of two, evaluated each road for existing and potential erosion sites. Sites included all stream crossings, over-steep landings and other sites where sediment would likely be delivered to a stream channel. All ditch relief culverts (DRC) were mapped and assessed including those that would not deliver sediment to a channel.

A data form was completed for each site and the site was located and mapped on 1:6,000, 1997 aerial photography on a mylar overlay. Each site was flagged and marked with an aluminum tag for locating in the future.

The field form (Appendix B), when completed, contains basic information about the type, nature, and location of each potential erosion site on a road. A form was also completed for each DRC along a road, even if the DRC had no potential erosion. The form is organized in such a way that it guides the field crew as they record the critical information needed to describe the potential erosion site. The crew then prescribes needed erosion control or prevention treatments, and surveys the sites to quantify volumes.

The assessment method includes a tape and clinometer survey of each site that is being evaluated. The survey is used to estimate potential erosion volumes and excavation volumes necessary for treatments (e.g., excavation volumes for decommissions, culvert replacements, etc.). Recommended treatments, equipment, labor and material needs are also recorded. The crew also provides a written description and simple sketch of each site on each form.

All field crew members were previously trained by Pacific Watershed Associates (PWA) and had completed numerous road assessments in Redwood Creek prior to starting this assessment. Two crews worked in Minor Creek in teams of two. For quality control, each assessment site was field reviewed by an experienced geologist from PWA.

All field forms and mylar overlays are stored at RNSP office in Arcata.

Volume Calculations and Limitations

As used in this report, “site potential yield” and “site potential erosion” are synonymous with “future yield” and “future erosion” (respectively) found on the assessment form. Site potential yield is the amount of sediment that is reasonably expected to be delivered to a watercourse if site failure occurs.

Terminology – Yield vs. Delivery

Yield has been used by others to describe sediment in the channel that passes a specific point, such as a gage. We use the term in this and other assessment reports for Redwood Creek to describe sediment that is delivered to a stream.

Fluvial sites

Site potential yield at a stream crossing is estimated from tape and clinometer surveys of the crossing fill. The field crew surveys a profile through the stream crossing that follows a straight line and approximates the center of the stream valley. The profile begins in undisturbed or stable channel above the crossing, extends downstream across the roadway and down the fillslope to the channel below the crossing. When plotted, an accurate profile survey reveals the original channel grade through the crossing. The site potential yield is estimated by assuming that, on average, a stream will eventually erode the crossing to its original channel depth, grade and width, and will erode sideslopes to a 1:1 (100%) slope.

For stream crossings where decommission is proposed, the profile is used in combination with cross-section surveys to determine the fill volume in the crossing. The estimated excavation volume is the fill volume that would be removed from the crossing to expose the original or near original stream bed, with a channel width similar to the channel and valley width above and below the crossing. The default design uses 2:1 sideslopes (50%) for calculating the estimated volume. The actual crossing excavation will be influenced by bedrock and stumps, which guide the final excavation and reveal original, pre-road conditions.

For stream crossings where upgrade is proposed, the surveyed profile provides a means for determining proper culvert placement on channel grade, length of culvert needed and, where appropriate, the length of downspout needed. The volume of fill that must be excavated and replaced during a culvert upgrade can also be determined from the surveys.

Fluvial erosion at ditch relief culvert outlets, springs and along road reaches is estimated by assuming reasonable dimensions of a gully that could potentially form or enlarge at the site.

Stream diversions – Site potential yield from stream diversions was not estimated during the assessments. Stream diversions can cause substantial erosion and sedimentation, but estimating the potential yield from future, hillslope gully erosion would be speculative and most likely incorrect.

Landslide sites

Estimates for site potential yield at a landslide site was determined by delineating the boundaries of the future landslide, calculating the volume of the material and then estimating the percent of the volume that was expected to reach a stream. The site potential yield generally includes only the erosion volume directly associated with the road prism. For most landslide sites, the yield does not include the volume of material that can erode downslope from a road when road failures occur, nor the volume associated with larger landslide features that can extend far upslope or downslope from the road. Field crews measured only that portion of the landslide mass that could be directly associated with the road prism. There were two situations where the yield included more than just the road prism. These sites were: 1) deep seated landslides where the road mass likely initiated a failure that is incorporating native ground, and; 2) landslide sites where ‘extreme erosion’ had been identified and quantified. Other than these two exceptions, the total volume associated with a large landslide that may or may not be exacerbated by a road was not quantified as part of this assessment. Because volume calculations for most landslide sites

are based only on the road prism, volume and yield estimates for potential landslide erosion are likely conservative.

Culvert Diameter Sizing

Recommended culvert diameters were sized using two methods and choosing the larger of the two results. The first method used field evidence including natural channel cross-sectional area and existing culvert rust line. The second method used standard published runoff equations.

In the first method, channel cross-sectional area (average channel width x average channel depth) for the 100-year storm was estimated in the field as part of the assessment and was reported on the assessment form. The crew then made a field decision on the adequacy of the existing culvert diameter by comparing the channel cross-sectional area to the existing culvert inlet area. If determined undersized, the field crew recommended a larger culvert diameter equal to the channel cross-sectional area. The culvert rust line was also used to determine proper culvert diameter. A rust line that exceeded 50 percent of the circumference was used as a criterion indicating an undersized culvert.

The second culvert sizing method was an office exercise that estimated 100-year discharge based on Waanenen and Crippen (1977) for drainage areas 80 acres and greater, and the Rational Method (Dunne and Leopold, 1978) for drainage areas less than 80 acres.

There are inherent errors in both the field methods and the office methods when sizing culvert diameters. In the field, errors occur when estimating the channel dimensions of the 100-year storm discharge. In the office, errors occur when delineating drainage areas from topographic maps. A 10-meter digital elevation model (DEM) produced by RNSP was used as a base for delineating drainage areas.

During project level planning, the recommended culvert diameter should be evaluated in the field prior to finalizing a culvert replacement. Results from both the initial field call and the office determination should be used in combination with other field evidence to correctly determine culvert size.

Database and GIS

All data collected as part of the Minor Creek road assessment are contained in a relational database using Microsoft Access™. The database contains the data from all assessments performed in Redwood Creek for which data are available. All GIS data are maintained in ESRI ArcInfo™ coverages and geodatabases.

APPENDIX D

DETAILS AND ASSUMPTIONS FOR CALCULATING COSTS.

As part of the road assessment in Project 8, information necessary to estimate treatments costs were recorded on the field forms. These data were used as described below to calculate overall treatment costs.

Site specific treatment costs

Site specific costs are calculated in the database using formulas that assign specific equipment and labor hourly rates multiplied by the equipment and labor times recorded on the field form. Equipment and labor hours were estimated by first calculating volume of fill to be moved, production rate of equipment (yds³ moved per hour), the need for support equipment such as dump trucks to endhaul fill to stable sites, and labor needs for installing culverts, downspouts, trash racks or other labor treatments. For upgrade sites, we use only the medium to high urgency sites, since those are the sites that must be treated. Low urgency sites are sites that have deficiencies but would likely survive a large storm. For decommission sites, we use the costs to treat all sites because after decommissioning a road, potential erosion sites along the road would remain inaccessible. Therefore, all sites on decommission roads should be treated unless it is shown it would not be cost-effective to do so.

Equipment and labor logistics

The costs for site specific treatments do not include logistical costs. Logistical costs include equipment travel between specific work sites, discussion time between the equipment operators and the project geologist regarding treatment prescription and approach, and labor time for travel and set up at project sites. Our experience with road treatment projects has shown that equipment costs are generally 20 percent of the site specific treatment costs and labor costs are about 30 percent of the site specific treatment costs.

Road opening and rebuilding costs

Many roads proposed for treatments in Redwood Creek require equipment to re-open roads before the equipment can begin decommissioning or upgrading a road. Many roads are abandoned (unmaintained) and overgrown with dense vegetation and trees. Some may have blown-out crossings and failed road prisms. Road opening and rebuilding costs can be a substantial part of road decommissioning projects, but are usually less for road upgrade projects. Generally, roads targeted for decommission are in substantially poor condition requiring more work. Roads targeted for upgrade are often currently driveable requiring less work to open.

While recognizing costs to open and rebuild roads are highly variable, we calculate a rough estimate based on past projects in the region. Generally, decommission projects can incur road opening and rebuilding costs that average about 5 percent of total equipment costs for the project. Upgrade projects have road opening and rebuilding costs that average about 1 percent of

equipment costs. Again, these costs will vary from project to project, but our estimates provide a ‘ball park’ cost for all work identified in the project.

Road drainage treatment costs

Road drainage treatment costs were not calculated for each individual site. These costs are generally best calculated at the project level when a scale of economy can be realized by prescribing treatments for a whole project or road reach. Road drainage treatment costs that are calculated at the project level are: install rolling dips, cross-road drains (XRD), and ditch relief culverts (DRC); road outsloping or insloping; inboard-ditch treatments (IBD); removing outboard berms, and; road rocking.

During the field assessment, sites not requiring treatments were identified as “maintain” sites. However, when an adjacent road reach required treatment, those treatments were noted and described on the field form for the nearest site along the road, which in some places was a maintain site.

Culvert materials costs for medium to high urgency stream crossings

Culvert materials costs have been calculated for all medium to high urgency stream crossings where either the field or database culvert analysis called for replacing or installing new culverts.

Mulching costs

Straw mulch is recommended at all treated stream crossings at a rate of about 4,000 pounds per acre. Mulch is prescribed for all bare soil slopes within crossing excavations and adjacent fillslopes draining directly to a stream. Mulch is also prescribed for all upgraded stream crossings of medium to high urgency. This includes culvert replacements and other treatments that would leave bare soil draining to the stream. Mulching generally occurs on the upstream and downstream face of upgraded crossings. Tree planting is required on stream crossing excavations for all projects funded by CDFG. These costs have not been included in our estimates, but are a very small portion of the total overall costs of projects. Mulching costs were estimated using cost ratios in past road assessment reports for Redwood Creek where mulching costs were calculated in detail. For decommission sites mulching costs averaged 5.5% of site specific treatments and for upgrade sites mulching costs averaged 2.0% of site specific treatment.

Equipment mobilization costs

Equipment mobilization costs can be highly variable depending on the project. For this discussion, we assume that a typical one-season project completed with two pieces of equipment will cost about \$250,000. We also assumed that mobilization costs for each project would be about \$10,000 for all equipment.

Total costs for all prescribed road treatments

All costs are summed in the final table to calculate the total estimated cost for treating sites identified in Minor Creek (Project 8 and a portion of Project 7).

For the cost tables note that the following roads have cost data for only a portion of the road because a portion of these roads cross project areas (Project0, Project4 and Project96) where cost data were not collected.

Snow Camp Road

Roddiscroft Road

TP1000

430

480-1

480-3

3C1120

BO1000

D-Line

E-Line

F-1

F-1-4

APPENDIX E.

TREATMENT PRIORITIES FOR ROADS

Table E-1. Roads in Projects 1, 2, 3, 5, 7 and 8 prioritized by potential sediment yield from medium to high treatment urgency sites.

Table E-2. Roads in Projects 1, 2, 3, 5, 7 and 8 prioritized by potential sediment yield per mile of road from medium to high treatment urgency sites.

Table E-3. Roads in Projects 1, 2, 3, 5, 7 and 8 prioritized by site specific cost per yard “saved” from medium to high treatment urgency sites.

Note for all tables in this appendix:

We truncated the table to show only the top 70 roads on each list in the interest of saving paper. The entire lists are available at RNSP

Potential Sediment Yield is the greater of the site potential yield and the extreme potential yield for each site then summed for all sites. It is not the sum of the two columns “Site Potential Yield” and “Extreme Potential Yield”.

Costs shown include only heavy equipment costs for site specific treatments and laborers for culvert installations. Costs do not include permitting, equipment mobilization, road opening, heavy equipment requirements for road drainage treatments, culvert materials costs, mulch and seeding costs, project layout, coordination, oversight, report preparation, or overhead. Roads lacking medium, medium-high and high urgency sites are not ranked.

Table E-1: Roads in Project Areas 1, 2, 3, 5, 7 and 8 ranked by potential sediment yield for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
Dolly Varden	14.8	191	114	109,890	103,954	95%	7,035	\$1,234,068	\$11.87
Old K&K	9.9	133	30	41,513	31,477	76%	3,165	\$297,094	\$9.44
PR1100	5.4	69	52	28,069	24,652	88%	4,539	\$234,505	\$9.51
LC5000	2.3	26	21	23,659	23,089	98%	10,176	\$59,360	\$2.57
K&K West	7.9	79	30	37,375	23,063	62%	2,904	\$263,580	\$11.43
LC1000	6.5	41	27	22,770	20,241	89%	3,134	\$191,878	\$9.48
1400	4.6	47	32	19,382	17,301	89%	3,753	\$96,655	\$5.59
Old HWY 299	2.5	52	39	16,040	15,064	94%	6,074	\$233,836	\$15.52
1440	1.5	18	15	15,155	14,588	96%	9,657	\$31,314	\$2.15
1000	3.9	37	16	14,312	14,050	98%	3,616	\$74,023	\$5.27
809	1.8	15	13	16,032	12,510	78%	7,032	\$156,745	\$12.53
808	4.2	40	22	19,766	11,895	60%	2,840	\$125,299	\$10.53
L2010	4.3	42	27	15,483	11,689	75%	2,750	\$136,646	\$11.69
MC1000	6.4	82	53	15,313	10,897	71%	1,691	\$191,235	\$17.55
Mainline	2.7	33	16	13,611	10,585	78%	3,875	\$145,608	\$13.76
PR1106	0.6	5	5	10,417	10,417	100%	17,639	\$31,477	\$3.02
UPR-10	4.7	38	24	14,685	10,394	71%	2,197	\$126,230	\$12.14
R3800	0.9	11	10	9,796	9,774	100%	11,364	\$57,576	\$5.89
LC4000	2.5	35	24	17,335	9,436	54%	3,849	\$85,283	\$9.04
1431	1.7	29	22	9,479	9,375	99%	5,626	\$95,960	\$10.24
O-LINE	8.9	86	24	21,575	9,155	42%	1,028	\$48,399	\$5.29
RC-2	1.5	25	14	10,122	9,120	90%	6,168	\$134,682	\$14.77
R1000	2.1	21	13	8,914	8,775	98%	4,164	\$33,653	\$3.84
RODDISCROFT	5.3	55	31	9,195	8,308	90%	1,573	\$113,422	\$13.65
1410	1.9	23	12	8,125	7,602	94%	3,994	\$33,660	\$4.43
LC2000	2.6	17	13	8,762	7,591	87%	2,881	\$108,119	\$14.24
1020	1.7	18	12	8,059	7,544	94%	4,465	\$36,317	\$4.81
L2171	1.4	16	12	7,884	7,532	96%	5,446	\$110,514	\$14.67
FP500	1.6	29	18	9,014	7,351	82%	4,733	\$110,692	\$15.06
831	2.1	13	7	7,699	7,338	95%	3,578	\$14,821	\$2.02
DVA	1.3	18	15	7,480	7,292	97%	5,640	\$112,964	\$15.49
1140	0.8	15	7	12,616	7,144	57%	9,516	\$23,856	\$3.34
PP1110	0.5	8	5	9,346	7,061	76%	14,002	\$22,131	\$3.13
DVD-1	1.4	12	11	7,102	7,004	99%	5,162	\$69,224	\$9.88
L1000	3.4	26	15	7,839	6,573	84%	1,954	\$70,951	\$10.79

Table E-1: Roads in Project Areas 1, 2, 3, 5, 7 and 8 ranked by potential sediment yield for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
L2000-CN	5.4	64	29	7,677	5,754	75%	1,070	\$98,520	\$17.12
F-1-4	1.6	20	15	6,023	5,431	90%	3,428	\$28,719	\$5.29
L2011	0.6	10	7	5,822	5,261	90%	8,177	\$83,782	\$15.92
PP1000	2.4	19	12	6,853	5,235	76%	2,137	\$27,173	\$5.19
BO1666	0.1	7	7	5,139	5,139	100%	35,597	\$19,795	\$3.85
O-10	0.1	4	2	8,000	5,000	63%	46,450	\$3,210	\$0.64
800H	1.3	20	16	5,736	4,961	86%	3,775	\$77,114	\$15.54
R3000	3.5	34	17	11,253	4,895	43%	1,379	\$38,446	\$7.85
R3900	1.7	16	6	12,255	4,508	37%	2,706	\$16,304	\$3.62
PP1100	1.6	20	14	8,886	4,372	49%	2,731	\$60,756	\$13.90
BO1665	0.8	19	13	5,181	4,329	84%	5,130	\$42,196	\$9.75
TP1321	1.1	12	7	5,365	4,258	79%	3,713	\$39,362	\$9.24
1450	3.1	24	16	5,224	4,138	79%	1,321	\$45,464	\$10.99
LC1100	1.1	4	3	4,100	4,003	98%	3,633	\$56,894	\$14.21
1433	0.5	7	7	3,978	3,978	100%	7,835	\$12,109	\$3.04
FL1025	0.8	8	7	3,982	3,947	99%	4,671	\$17,178	\$4.35
820	2.8	15	9	5,559	3,937	71%	1,387	\$51,349	\$13.04
BO1306	0.4	4	4	3,789	3,789	100%	10,207	\$46,725	\$12.33
R3500	1.3	14	11	3,755	3,727	99%	2,838	\$24,725	\$6.63
800G	0.3	2	2	3,726	3,726	100%	12,298	\$12,236	\$3.28
1150	1.0	15	8	4,640	3,608	78%	3,616	\$25,735	\$7.13
3C2500	1.9	18	7	5,881	3,554	60%	1,830	\$47,799	\$13.45
LC5005	0.5	3	1	7,074	3,500	49%	7,405	\$9,095	\$2.60
PR1107	0.7	3	3	3,500	3,500	100%	4,690	\$9,900	\$2.83
R3810	0.1	2	1	5,000	3,500	70%	43,126	\$10,165	\$2.90
3C2010	0.2	6	5	4,000	3,500	88%	16,972	\$49,559	\$14.16
3C2800	0.8	20	11	4,742	3,429	72%	4,501	\$48,288	\$14.08
LC-1	8.7	50	18	4,862	3,391	70%	389	\$51,327	\$15.14
L2010-B	0.1	1	1	3,334	3,334	100%	44,387	\$35,350	\$10.60
CP1000	1.9	28	7	6,248	3,293	53%	1,704	\$51,917	\$15.77
D-Line	1.7	22	17	3,445	3,286	95%	1,953	\$59,704	\$18.17
DVG	0.7	16	16	3,141	3,141	100%	4,658	\$42,714	\$13.60
BO1315	1.0	8	4	4,084	3,131	77%	3,198	\$40,509	\$12.94
807	2.0	19	10	4,769	3,094	65%	1,573	\$25,297	\$8.18
SW-1A	3.0	17	11	3,669	3,003	82%	996	\$54,248	\$18.07

Table E-2: Roads in Project Areas, 1, 2, 3, 5, 7 and 8 ranked by potential sediment yield per mile for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
O-10	0.1	4	2	8,000	5,000	63%	46,450	\$3,210	\$0.64
L2010-B	0.1	1	1	3,334	3,334	100%	44,387	\$35,350	\$10.60
R3810	0.1	2	1	5,000	3,500	70%	43,126	\$10,165	\$2.90
BO1666	0.1	7	7	5,139	5,139	100%	35,597	\$19,795	\$3.85
L2061	0.1	6	4	1,954	1,815	93%	25,638	\$44,137	\$24.32
HP-22	0.0	3	2	1,204	804	67%	25,588	\$23,005	\$28.60
PR1106	0.6	5	5	10,417	10,417	100%	17,639	\$31,477	\$3.02
3C2010	0.2	6	5	4,000	3,500	88%	16,972	\$49,559	\$14.16
HP-21	0.1	1	1	1,014	1,014	100%	15,504	\$13,523	\$13.34
PP1110	0.5	8	5	9,346	7,061	76%	14,002	\$22,131	\$3.13
800G	0.3	2	2	3,726	3,726	100%	12,298	\$12,236	\$3.28
R3800	0.9	11	10	9,796	9,774	100%	11,364	\$57,576	\$5.89
BO1306	0.4	4	4	3,789	3,789	100%	10,207	\$46,725	\$12.33
LC5000	2.3	26	21	23,659	23,089	98%	10,176	\$59,360	\$2.57
L2173	0.2	3	3	1,845	1,845	100%	9,979	\$11,595	\$6.28
1440	1.5	18	15	15,155	14,588	96%	9,657	\$31,314	\$2.15
1140	0.8	15	7	12,616	7,144	57%	9,516	\$23,856	\$3.34
R1050	0.2	2	1	1,829	1,778	97%	9,405	\$11,362	\$6.39
AM-4-1	0.1	1	1	500	500	100%	8,438	\$2,712	\$5.42
UBR	0.2	3	2	1,775	1,723	97%	8,402	\$27,722	\$16.09
L2011	0.6	10	7	5,822	5,261	90%	8,177	\$83,782	\$15.92
L1000-E	0.1	2	2	961	961	100%	8,082	\$16,272	\$16.93
R4250	0.1	2	2	625	625	100%	8,031	\$8,981	\$14.38
3C2002	0.1	1	1	1,050	1,050	100%	8,007	\$7,458	\$7.10
DVJ	0.3	4	2	2,792	2,269	81%	7,882	\$16,272	\$7.17
1433	0.5	7	7	3,978	3,978	100%	7,835	\$12,109	\$3.04
LC5005	0.5	3	1	7,074	3,500	49%	7,405	\$9,095	\$2.60
R2100	0.2	2	2	1,557	1,557	100%	7,402	\$4,746	\$3.05
N500A	0.2	3	3	1,697	1,697	100%	7,318	\$8,348	\$4.92
Dolly Varden	14.8	191	114	109,890	103,954	95%	7,035	\$1,234,068	\$11.87
809	1.8	15	13	16,032	12,510	78%	7,032	\$156,745	\$12.53
R3351	0.1	1	1	750	750	100%	6,544	\$1,017	\$1.36
RC-2	1.5	25	14	10,122	9,120	90%	6,168	\$134,682	\$14.77
Old HWY 299	2.5	52	39	16,040	15,064	94%	6,074	\$233,836	\$15.52
MC1300	0.1	17	3	1,816	636	35%	5,956	\$11,829	\$18.60

Table E-2: Roads in Project Areas, 1, 2, 3, 5, 7 and 8 ranked by potential sediment yield per mile for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
DVA	1.3	18	15	7,480	7,292	97%	5,640	\$112,964	\$15.49
831A	0.2	3	3	1,237	1,237	100%	5,633	\$29,838	\$24.12
1431	1.7	29	22	9,479	9,375	99%	5,626	\$95,960	\$10.24
1220	0.4	6	5	15,170	2,281	15%	5,541	\$18,958	\$8.31
PP1010	0.1	1	1	323	323	100%	5,477	\$3,729	\$11.54
L2171	1.4	16	12	7,884	7,532	96%	5,446	\$110,514	\$14.67
3C2512	0.3	6	1	3,066	1,500	49%	5,349	\$3,729	\$2.49
200A	0.3	3	1	1,827	1,689	92%	5,294	\$27,120	\$16.06
RV4	0.4	6	6	2,068	2,068	100%	5,257	\$30,236	\$14.62
LC5001	0.1	1	1	750	750	100%	5,246	\$2,622	\$3.50
DVD-1	1.4	12	11	7,102	7,004	99%	5,162	\$69,224	\$9.88
BO1665	0.8	19	13	5,181	4,329	84%	5,130	\$42,196	\$9.75
LPC-PC-1	0.1	3	1	935	750	80%	5,052	\$3,390	\$4.52
F-1-4-0	0.2	3	3	1,191	1,191	100%	4,942	\$17,930	\$15.05
FP500	1.6	29	18	9,014	7,351	82%	4,733	\$110,692	\$15.06
RP1200	0.3	6	3	1,622	1,413	87%	4,699	\$13,560	\$9.60
PR1107	0.7	3	3	3,500	3,500	100%	4,690	\$9,900	\$2.83
FL1025	0.8	8	7	3,982	3,947	99%	4,671	\$17,178	\$4.35
DVG	0.7	16	16	3,141	3,141	100%	4,658	\$42,714	\$13.60
PR1100	5.4	69	52	28,069	24,652	88%	4,539	\$234,505	\$9.51
3C2800	0.8	20	11	4,742	3,429	72%	4,501	\$48,288	\$14.08
1020	1.7	18	12	8,059	7,544	94%	4,465	\$36,317	\$4.81
800F	0.5	2	2	1,945	1,945	100%	4,294	\$44,810	\$23.04
808D-1	0.1	1	1	295	295	100%	4,260	\$5,085	\$17.24
3C2501	0.3	5	2	2,279	1,101	48%	4,200	\$22,130	\$20.10
R1000	2.1	21	13	8,914	8,775	98%	4,164	\$33,653	\$3.84
HRPR-1	0.2	3	2	840	807	96%	4,086	\$3,390	\$4.20
1410	1.9	23	12	8,125	7,602	94%	3,994	\$33,660	\$4.43
UPC-BC-2	0.2	1	1	778	778	100%	3,921	\$10,848	\$13.95
Mainline	2.7	33	16	13,611	10,585	78%	3,875	\$145,608	\$13.76
LC4000	2.5	35	24	17,335	9,436	54%	3,849	\$85,283	\$9.04
890C	0.8	7	6	3,508	2,963	84%	3,839	\$66,185	\$22.34
895	0.6	5	5	2,437	2,437	100%	3,838	\$47,405	\$19.45
802A	0.1	2	2	247	247	100%	3,833	\$2,094	\$8.48
800H	1.3	20	16	5,736	4,961	86%	3,775	\$77,114	\$15.54

Table E-3: Roads in Project Areas, 1, 2, 3, 5, 7 and 8 ranked by cost-effectiveness for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
O-10	0.1	4	2	8,000	5,000	63%	46,450	\$3,210	\$0.64
UPC-BC	0.6	4	3	2,194	1,694	77%	2,609	\$2,034	\$1.20
R3351	0.1	1	1	750	750	100%	6,544	\$1,017	\$1.36
930	1.7	4	1	750	750	100%	434	\$1,119	\$1.49
N550A	0.2	1	1	750	750	100%	3,276	\$1,356	\$1.81
O-8	0.1	1	1	95	95	100%	728	\$177	\$1.86
O-4-2-3	0.4	5	2	1,468	451	31%	1,169	\$908	\$2.01
831	2.1	13	7	7,699	7,338	95%	3,578	\$14,821	\$2.02
1440	1.5	18	15	15,155	14,588	96%	9,657	\$31,314	\$2.15
800I	0.8	2	2	1,517	1,517	100%	1,913	\$3,745	\$2.47
3C2512	0.3	6	1	3,066	1,500	49%	5,349	\$3,729	\$2.49
LC5000	2.3	26	21	23,659	23,089	98%	10,176	\$59,360	\$2.57
LC5005	0.5	3	1	7,074	3,500	49%	7,405	\$9,095	\$2.60
R3970	0.2	2	2	910	910	100%	3,741	\$2,569	\$2.82
PR1107	0.7	3	3	3,500	3,500	100%	4,690	\$9,900	\$2.83
R3810	0.1	2	1	5,000	3,500	70%	43,126	\$10,165	\$2.90
PR1106	0.6	5	5	10,417	10,417	100%	17,639	\$31,477	\$3.02
1433	0.5	7	7	3,978	3,978	100%	7,835	\$12,109	\$3.04
R2100	0.2	2	2	1,557	1,557	100%	7,402	\$4,746	\$3.05
PP1110	0.5	8	5	9,346	7,061	76%	14,002	\$22,131	\$3.13
800G	0.3	2	2	3,726	3,726	100%	12,298	\$12,236	\$3.28
1140	0.8	15	7	12,616	7,144	57%	9,516	\$23,856	\$3.34
LC5001	0.1	1	1	750	750	100%	5,246	\$2,622	\$3.50
R3900	1.7	16	6	12,255	4,508	37%	2,706	\$16,304	\$3.62
1055	0.3	1	1	89	89	100%	263	\$339	\$3.81
R1000	2.1	21	13	8,914	8,775	98%	4,164	\$33,653	\$3.84
BO1666	0.1	7	7	5,139	5,139	100%	35,597	\$19,795	\$3.85
RV-1	0.7	3	3	178	178	100%	252	\$708	\$3.98
HRPR-1	0.2	3	2	840	807	96%	4,086	\$3,390	\$4.20
PR1104	0.4	1	1	400	400	100%	920	\$1,695	\$4.24
FL1025	0.8	8	7	3,982	3,947	99%	4,671	\$17,178	\$4.35
1410	1.9	23	12	8,125	7,602	94%	3,994	\$33,660	\$4.43
LPC-PC-1	0.1	3	1	935	750	80%	5,052	\$3,390	\$4.52
N750	0.3	2	1	426	371	87%	1,267	\$1,695	\$4.57
CP1210	1.4	19	1	6,324	686	11%	491	\$3,210	\$4.68

Table E-3: Roads in Project Areas, 1, 2, 3, 5, 7 and 8 ranked by cost-effectiveness for medium to high urgency sites.

Road Name	Length (mi)	Total no. of ALL Sites	Total no. of M to H Sites	Potential Sediment Yield for ALL Sites (yds3)	Potential Sediment Yield for M to H Sites (yds3)	Percent of Potential Sediment Yield Volume for M to H Sites	Potential Sediment Yield per Mile for M to H Sites (yds3/mi)	Total Cost for M to H Sites	Cost/Yard "Saved"
1020	1.7	18	12	8,059	7,544	94%	4,465	\$36,317	\$4.81
N500A	0.2	3	3	1,697	1,697	100%	7,318	\$8,348	\$4.92
LC-7	0.7	6	2	1,611	649	40%	942	\$3,216	\$4.96
R5000	1.4	9	3	1,474	814	55%	569	\$4,168	\$5.12
PP1000	2.4	19	12	6,853	5,235	76%	2,137	\$27,173	\$5.19
L2000	0.5	10	3	1,403	1,293	92%	2,484	\$6,734	\$5.21
1000	3.9	37	16	14,312	14,050	98%	3,616	\$74,023	\$5.27
O-LINE	8.9	86	24	21,575	9,155	42%	1,028	\$48,399	\$5.29
F-1-4	1.6	20	15	6,023	5,431	90%	3,428	\$28,719	\$5.29
801	1.3	4	2	503	497	99%	394	\$2,675	\$5.38
AM-4-1	0.1	1	1	500	500	100%	8,438	\$2,712	\$5.42
N770	0.6	4	4	1,645	1,645	100%	2,726	\$9,079	\$5.52
1400	4.6	47	32	19,382	17,301	89%	3,753	\$96,655	\$5.59
LC2	0.3	4	4	923	923	100%	3,052	\$5,238	\$5.67
N500C	1.3	3	2	69	69	100%	55	\$392	\$5.68
R3800	0.9	11	10	9,796	9,774	100%	11,364	\$57,576	\$5.89
R-77	0.1	1	1	30	30	100%	226	\$177	\$5.90
3C2810	0.5	3	1	783	500	64%	976	\$3,051	\$6.10
L2173	0.2	3	3	1,845	1,845	100%	9,979	\$11,595	\$6.28
R1050	0.2	2	1	1,829	1,778	97%	9,405	\$11,362	\$6.39
RP900	0.7	5	3	1,091	1,082	99%	1,485	\$7,060	\$6.52
R3500	1.3	14	11	3,755	3,727	99%	2,838	\$24,725	\$6.63
808A	1.8	9	9	2,756	2,756	100%	1,530	\$18,350	\$6.66
LC3000	1.5	25	9	2,853	2,764	97%	1,825	\$18,645	\$6.74
R3200	1.3	13	5	1,338	498	37%	382	\$3,412	\$6.85
R3350	0.3	5	3	215	145	67%	548	\$1,017	\$7.03
DVM	1.4	10	8	2,082	2,017	97%	1,435	\$14,249	\$7.06
3C2002	0.1	1	1	1,050	1,050	100%	8,007	\$7,458	\$7.10
1150	1.0	15	8	4,640	3,608	78%	3,616	\$25,735	\$7.13
HP-31	0.3	1	1	306	306	100%	930	\$2,185	\$7.15
DVJ	0.3	4	2	2,792	2,269	81%	7,882	\$16,272	\$7.17
C1400	0.6	1	1	233	233	100%	394	\$1,695	\$7.27
FL1030	0.3	2	1	252	139	55%	495	\$1,070	\$7.70
R3000	3.5	34	17	11,253	4,895	43%	1,379	\$38,446	\$7.85
807	2.0	19	10	4,769	3,094	65%	1,573	\$25,297	\$8.18