NORTH COAST INTEGRATED REGIONAL WATER MANAGEMENT PLAN

North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

289 - Camp Creek Habitat Protection-Road Decommissioning Implementation Project, Karuk Tribe

- Camp Creek Habitat Protection Road Decommissioning Implementation Project Site Plan
- Treatment Log 11N50.1 Road Decommissioning
- Road Assessment and Restoration Planning in the Camp Creek and Slate Creek Watersheds of the Klamath River Basin
- Karuk Ecosystem Restoration Program Final Report

TREATMENT LOG 11N50.1 ROAD DECOMMISSIONING

TREATMENTS ARE SEGMENTED INTO ROAD REACH, AND SWALE ITEMS. PRESCRIPTIONS VARY ALONG THE ROAD AS THE ROAD TEMPLATE AND SHAPE CHANGES. SWALES ARE BOTH A TREATMENT AND A PRESCRIPTION. THE FOLLOWING SUMMARIES ARE THE PRESCRIPTION SPECIFICATIONS FOR THE 11N50.1 ROAD DECOMMISSIONING.

ITEM 1

CP 369+00 TO CP 0+00 (36,900 FEET OF ROAD TREATED)

TOTAL VOLUME OF RX = 17,300 YD^3
OUTSLOPE VOLUME (.5 YD^3 PER LINEAR FOOT) = 18,450
TOTAL VOLUME = 35,750 YD^3

DOS= DISPOSAL OUTSLOPE
EOS= EXCAVATE OUTSLOPE
RSP= ROCK SLOPE PROTECTION
DS= DISPOSAL SITE
OS= OUTSLOPE
NOTE: TRACTOR COMPACT FILL IN 1-FOOT LIFTS. REMOVE CROSS-DRAIN CULVERT DOWN SPOUTS AND OUTLETS. ALL DISTRUBED AREAS WILL BE SEEDED WITH NATIVE SEED MIX AND MULCHED UTILIZING NATIVE MULCH GATHERED ONSITE.

CP 369+00 BEGIN OS TO CP 367+25 (225 FEET)

CP 367+25 END OS BEGIN EOS **(SWALE # 14)**

CP 367+00 **SWALE #14** (EST. 1,000 YDS^3)

CP 366+75 END EOS BEGIN DOS/OS TO CP 363+25 (262 FEET)

CP 363+25 END DOS/OS BEGIN EOS **(SWALE #13)**

CP 363+00 **SWALE #13** (EST. 500 YDS^3)

CP 362+75 END EOS BEGIN DOS/OS TO CP 354+79 (796 FEET)

CP 354+79 END OS BEGIN EOS **(SWALE # 12)**

CP 354+54 **SWALE #12** (EST. 400 YDS^3)

CP 354+29 END EOS BEGIN DOS/OS TO CP 350+74 (355 FEET)

CP 350+74 END DOS/OS BEGIN EOS **(RX#11)**

CP 350+44 **RX#11** (EST. 400 YD^3) 8′ CHANNEL WIDTH

CP 350+14 END EOS BEGIN DOS/OS TO CP 347+00 (314 FEET)

CP 347+00 END OF BIG SLIDE

CP 344+30 BEGINING OF BIG SLIDE

CP 332+30 END DOS/OS BEGIN EOS **(RX#10)**

CP 332+00 **RX#10** (EST. 1,200 YD^3) CROSSING ALREADY WASHED OUT

CP 331+70 END EOS BEGIN DOS/OS TO CP 257+30 (7,440 FEET)

CP 300+00 INTERSECTION OF (11N55)

CP 257+30 END DOS/OS BEGIN EOS **(RX#9)**

CP 257+00 **RX#9** (EST. 250 YDS^3) 8′ CHANNEL WIDTH

CP 256+70 END EOS BEGIN DOS/OS TO CP 239+00 (1,770 FEET)

CP 255+00 SLIDE IMPASSABLE

CP 245+40 SLIDE IMPASSABLE

CP 243+40 SLIDE IMPASSABLE

CP 239+00 END DOS/OS BEGIN EOS **(RX #8)**

CP 238+70 **RX #8** (EST. 1,000 YD^3) CROSSING ALREADY WASHED OUT
NOTE: 5 CULVERTS 4′ BY 20′ALREADY PULLED

CP 238+40 END EOS BEGIN DOS/OS TO CP 234+42 (398 FEET)

CP 234+42 END DOS/OS BEGIN EOS **(RX #7)**

CP 234+12 **RX #7** (EST. 600 YDS^3) CROSSING ALREADY WASHED OUT

CP 233+82 END EOS BEGIN DOS/OS TO CP 227+33 (649 FEET)

CP 227+33 END OS BEGIN EOS **(SWALE # 11)**

CP 227+08 **SWALE #11** (EST. 250 YDS^3)

CP 226+83 END EOS BEGIN DOS/OS TO CP 226+03 (80 FEET)

CP 226+03 END DOS/OS BEGIN EOS **(SWALE #10)**

CP 225+78 **SWALE #10** (EST. 200 YDS^3) SWALE ALREADY WASHED OUT

CP 225+53 END EOS BEGIN DOS/OS TO CP 216+82 (250 FEET)

CP 222+78 INTERSECTION OF 11N50

CP 216+82 END OS BEGIN EOS **(SWALE # 9)**

CP 216+57 **SWALE #9** (EST. 500 YDS³)

CP 216+32 END EOS BEGIN DOS/OS TO CP 197+56 (355 FEET)

CP 197+56 END OS BEGIN EOS **(SWALE # 8)**

CP 197+31 **SWALE #8** (EST. 400 YDS³)

CP 197+06 END EOS BEGIN DOS/OS TO CP 170+42 (2,664 FEET)

CP 183+50 ROCK SLIDE ENDS

CP 181+00 ROCK SLIDE 250′ LONG COVERING 100% OF ROAD

CP 183+50 ROCK SLIDE ENDS

CP 170+42 END DOS/OS BEGIN EOS **(RX#6)**

CP 170+12 **RX#6** (EST. 3,500 YD³) CHIRSTEN GULCH

CP 169+82 END EOS BEGIN DOS/OS TO CP 150+64 (1,918 FEET)

CP 150+64 END OS BEGIN EOS **(SWALE # 7)**

CP 150+39 **SWALE #7** (EST. 500 YDS³)

CP 150+14 END EOS BEGIN DOS/OS TO CP 133+76 (1,638 FEET)

CP 149+76 INTERSECTION OF SKID RD.

CP 133+76 END OS BEGIN EOS **(SWALE # 6)**

CP 133+51 **SWALE #6** (EST. 400 YDS³)

CP 133+26 END EOS BEGIN DOS/OS TO CP 124+29 (897 FEET)

CP 124+29 END OS BEGIN EOS **(SWALE # 5)**

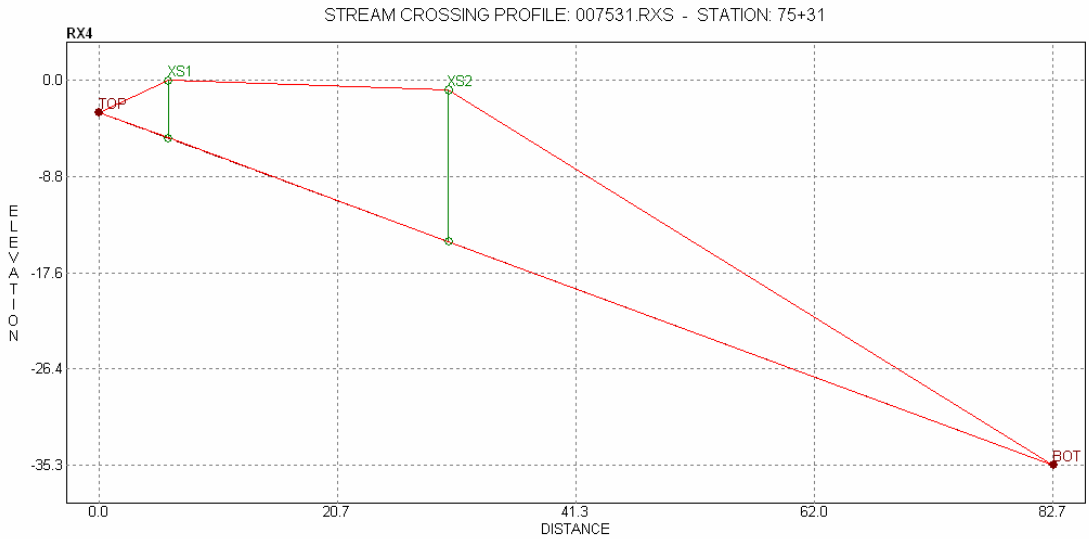
CP 124+04 **SWALE #5** (EST. 300 YDS³)

CP 123+79 END EOS BEGIN DOS/OS TO CP 86+90 (3,689 FEET)

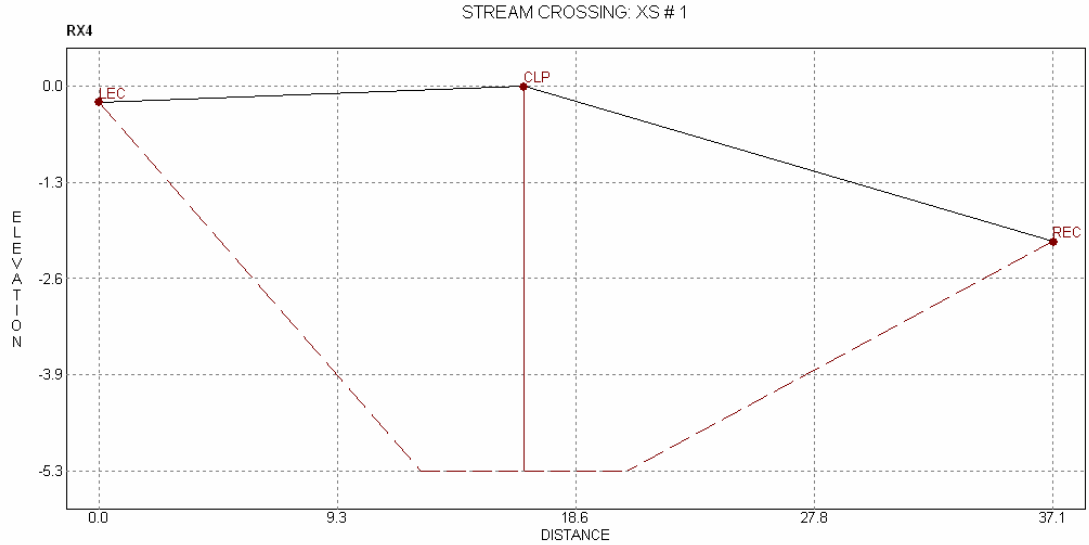
CP 107+36 END OF SLIDE

CP 105+44 BIG WASHOUT AT CEDAR GULCH

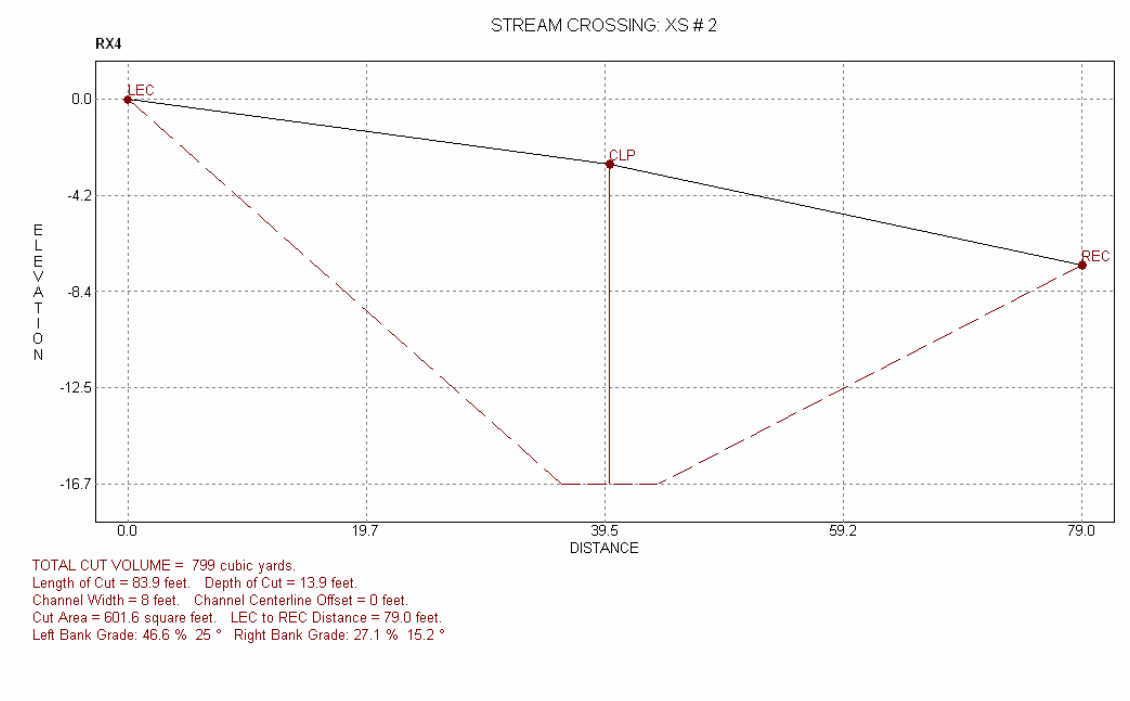
CP 96+40	INTERSECTION OF 11N45A
CP 86+90	END OS BEGIN EOS **(SWALE # 4)**
CP 86+65	**SWALE #4** (EST. 250 YDS^3)
CP 86+40	END EOS BEGIN DOS/OS TO CP 82+55 (385 FEET)
CP 82+55	END OS BEGIN EOS **(SWALE # 3)**
CP 82+30	**SWALE #3** (EST. 150 YDS^3)
CP 82+05	END EOS BEGIN DOS/OS TO CP 79+60 (245 FEET)
CP 79+60	END DOS BEGIN EOS TO CP 79+35
CP 79+35	INSTALL 80 YD^3 SPRING DRAIN
CP 79+10	END EOS (SPRING DRAIN) BEGIN DOS TO CP 78+08 (102 FEET)
CP 78+08	END DOS/OS BEGIN EOS **(SWALE # 2)**
CP 77+83	**SWALE #2** (EST. 200 YDS^3)
CP 77+58	END EOS BEGIN DOS/OS TO CP 76+25 (133 FEET)
CP 76+25	END DOS BEGIN EOS TO CP 76+00
CP 76+00	INSTALL 80 YD^3 SPRING DRAIN
CP 75+75	END EOS (SPRING DRAIN) BEGIN DOS TO CP 75+61
CP 75+61	END DOS/OS BEGIN EOS **(RX#4)**
CP 75+31	**RX#4** (EST. 799 YD^3) EXCAVATE CROSSING TO THE FOLLOWING SPECIFICATIONS



TOTAL CUT VOLUME = 799 cubic yards.
Length of Cut = 88.8 feet.
Grade 1 = 39.1%
Depths of Cut (ft.): XS1 = 5.3 XS2 = 13.9



TOTAL CUT VOLUME = 799 cubic yards.
Length of Cut = 38.4 feet. Depth of Cut = 5.3 feet.
Channel Width = 8 feet. Channel Centerline Offset = 0 feet.
Cut Area = 113.9 square feet. LEC to REC Distance = 37.1 feet.
Left Bank Grade: 40.3 % 22.0 ° Right Bank Grade: 18.9 % 10.7 °



TOTAL VOLUME OF CUT = 799 CUBIC YARDS
EXCAVATION BOTTOM WIDTH = 8 FEET

CP 75+01 END EOS BEGIN DOS/OS TO CP 54+05 (2,096 FEET)

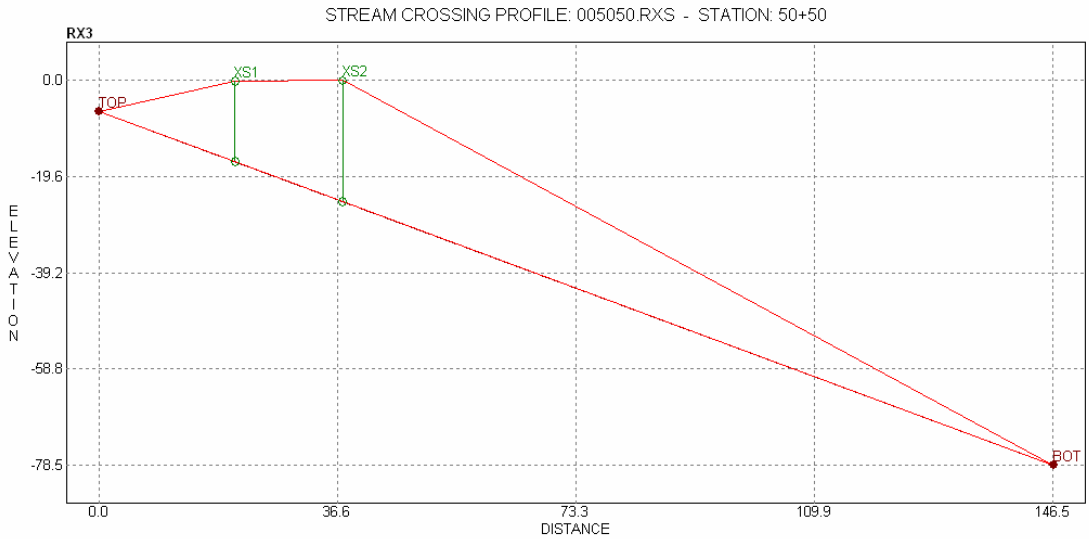
CP 54+05 END DOS BEGIN EOS TO CP 53+80

CP 53+80 INSTALL 80 YD³ SPRING DRAIN

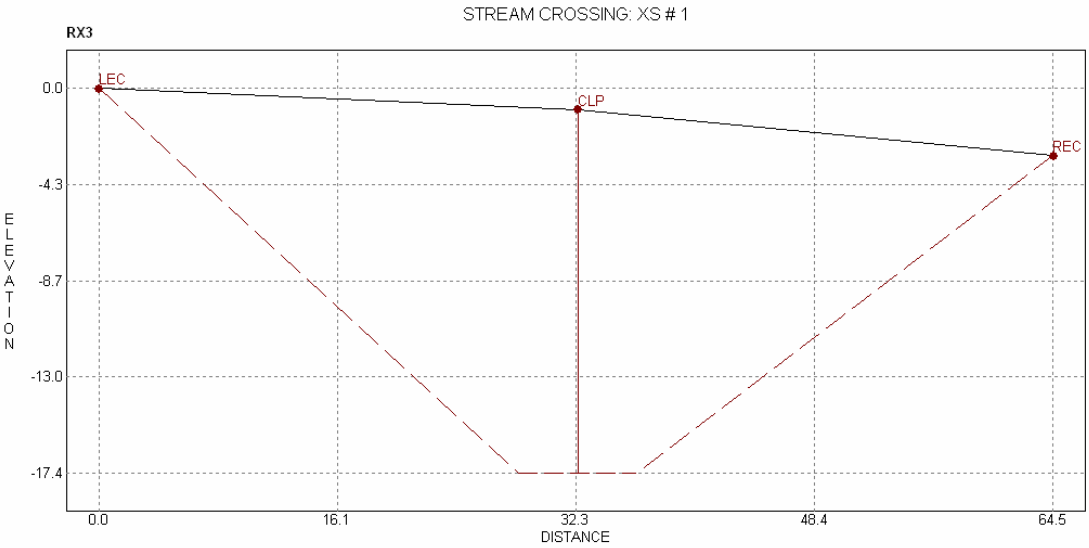
CP 53+55 END EOS (SPRING DRAIN) BEGIN DOS TO CP 50+80

CP 50+80 END DOS/OS BEGIN EOS **(RX#3)**

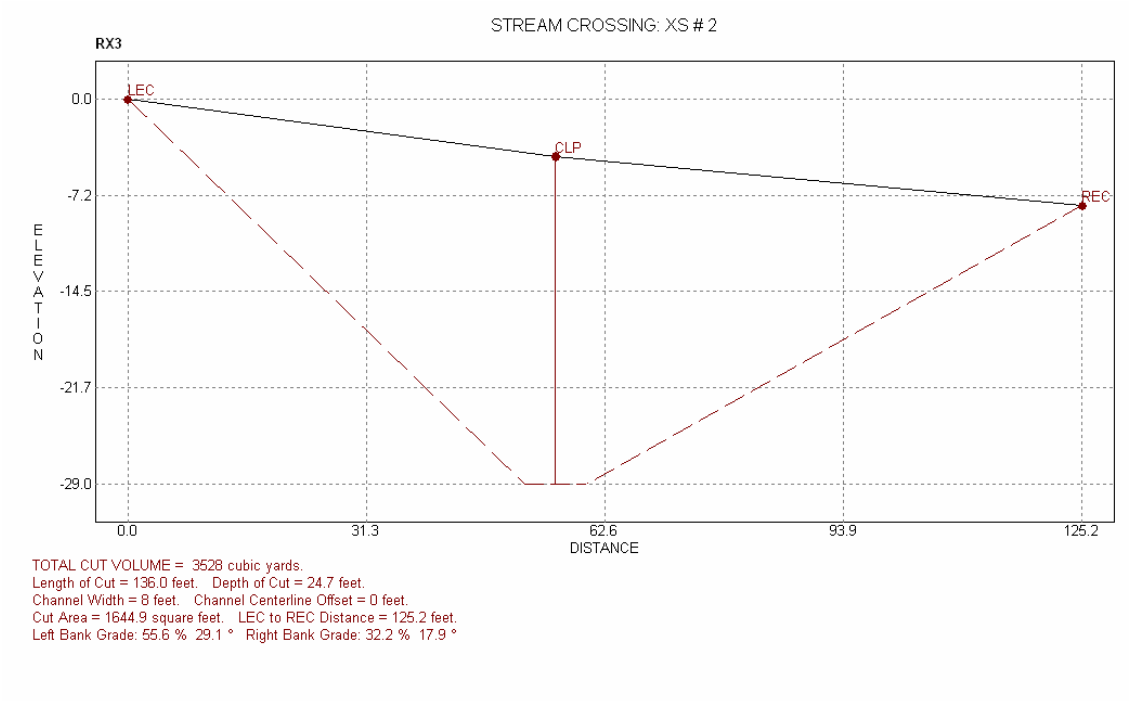
CP 50+50 **RX#3** (EST. 3,528 YD³) EXCAVATE CROSSING TO THE FOLLOWING SPECIFICATIONS



TOTAL CUT VOLUME = 3528 cubic yards.
Length of Cut = 163.4 feet.
Grade 1 = 49.3%
Depths of Cut (ft.): XS1 = 16.4 XS2 = 24.7



TOTAL CUT VOLUME = 3528 cubic yards.
Length of Cut = 72.9 feet. Depth of Cut = 16.4 feet.
Channel Width = 8 feet. Channel Centerline Offset = 0 feet.
Cut Area = 594.0 square feet. LEC to REC Distance = 64.5 feet.
Left Bank Grade: 61.3 % 31.5 ° Right Bank Grade: 51.0 % 27.0 °



TOTAL VOLUME OF CUT = 3,528 CUBIC YARDS
EXCAVATION BOTTOM WIDTH = 8 FEET

CP 50+20 END EOS BEGIN DOS/OS TO CP 44+25 (595 FEET)

CP 45+25 END DOS BEGIN EOS TO CP 45+00

CP 45+00 INSTALL 80 YD³ SPRING DRAIN

CP 44+75 END EOS (SPRING DRAIN) BEGIN DOS TO CP 34+00

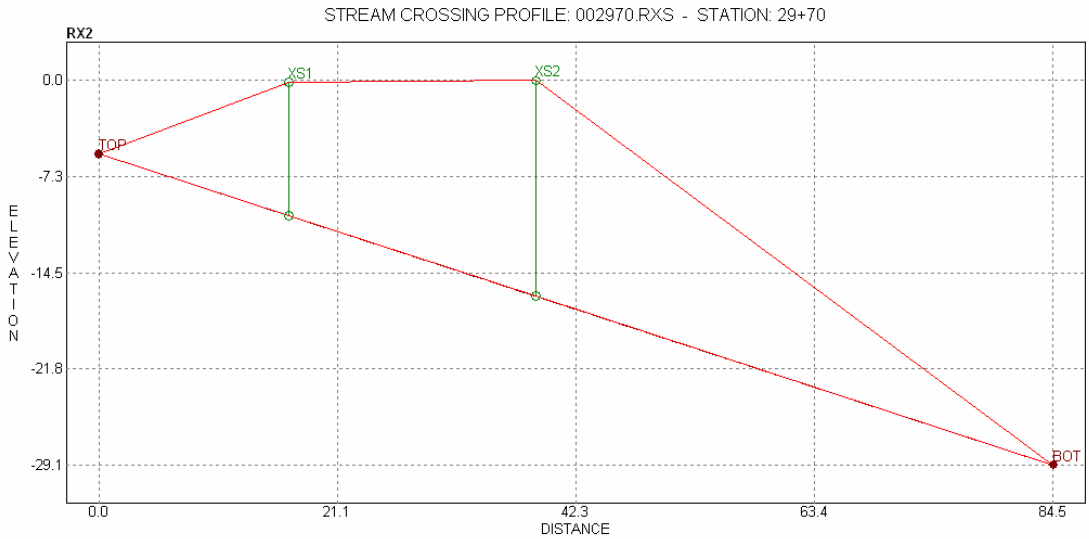
CP 34+00 END DOS/OS BEGIN EOS **(SWALE#1)**

CP 33+75 **SWALE#1** (EST. 600 YD³)

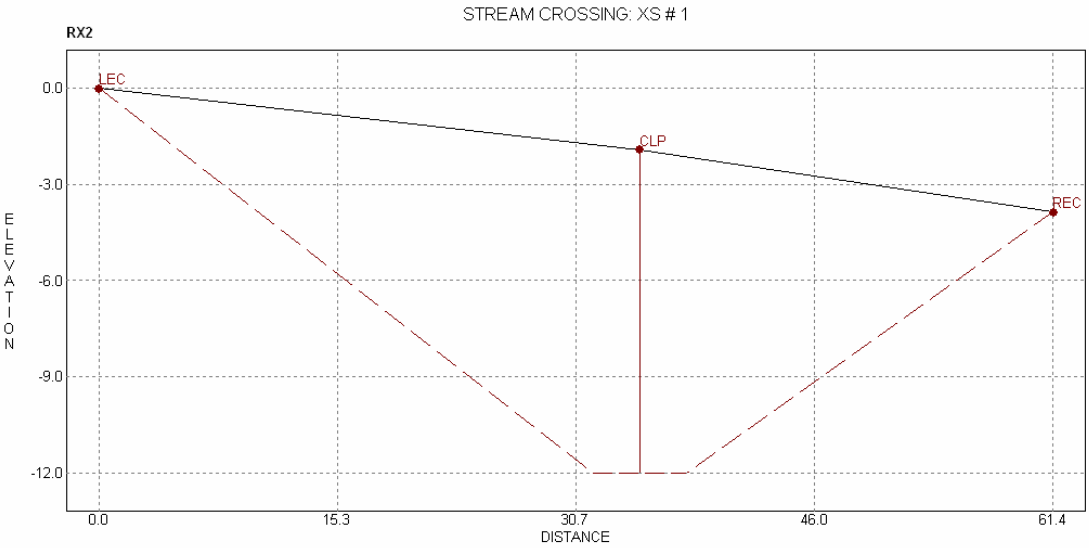
CP 33+50 END EOS BEGIN DOS/OS TO CP 30+00 (350 FEET)

CP 30+00 END DOS/OS BEGIN EOS **(RX#2)**

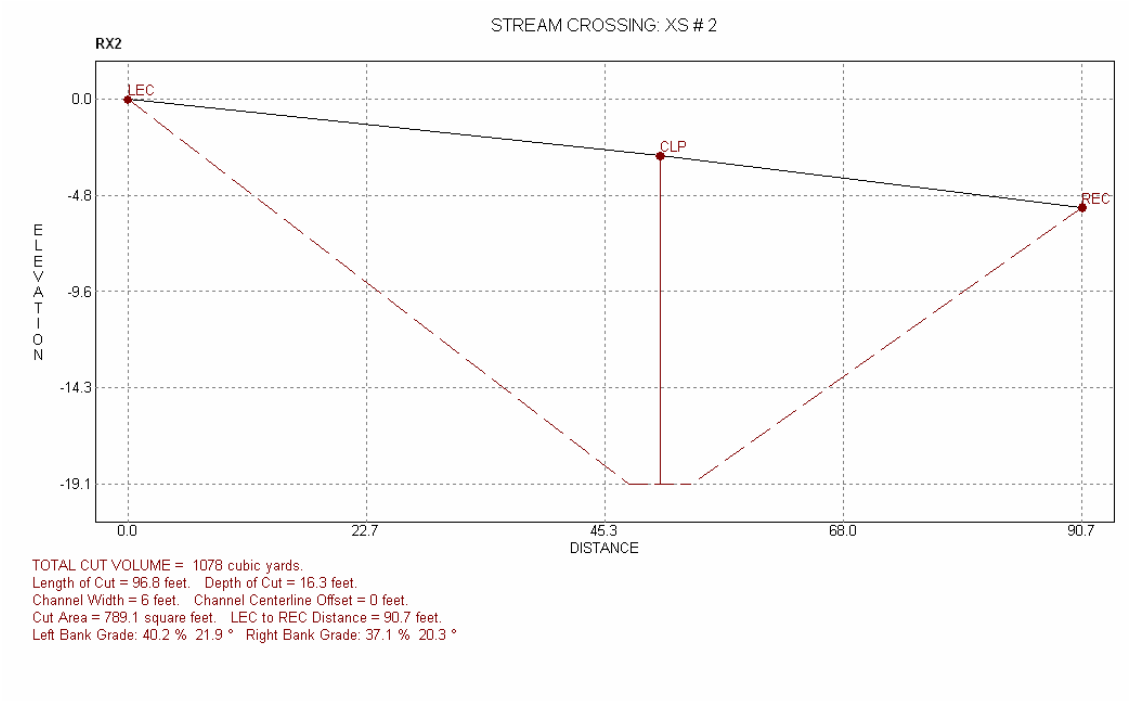
CP 29+70 **RX#2** (EST. 1,078 YD³) EXCAVATE CROSSING TO THE FOLLOWING SPECIFICATIONS



TOTAL CUT VOLUME = 1078 cubic yards.
Length of Cut = 87.7 feet.
Grade 1 = 27.8%
Depths of Cut (ft.): XS1 = 10.1 XS2 = 16.3



TOTAL CUT VOLUME = 1078 cubic yards.
Length of Cut = 64.9 feet. Depth of Cut = 10.1 feet.
Channel Width = 6 feet. Channel Centerline Offset = 0 feet.
Cut Area = 340.2 square feet. LEC to REC Distance = 61.4 feet.
Left Bank Grade: 37.8 % 20.7 ° Right Bank Grade: 34.5 % 19.1 °



TOTAL VOLUME OF CUT = 1078 CUBIC YARDS
EXCAVATION BOTTOM WIDTH = 8 FEET

CP 29+40 END EOS BEGIN DOS/OS TO CP 26+30 (310 FEET)

CP 26+30 END DOS BEGIN EOS TO CP 26+05

CP 26+05 INSTALL 80 YD³ SPRING DRAIN

CP 25+80 END EOS (SPRING DRAIN) BEGIN DOS TO CP 24+57

CP 24+57 END DOS/OS BEGIN EOS **(RX#1)**

CP 26+05 **RX#1** (EST. 250 YD³)

CP 25+75 END EOS BEGIN DOS/OS TO CP 23+07 (268 FEET)

CP 23+07 END DOS BEGIN EOS TO CP 22+82

CP 22+82 INSTALL 80 YD³ SPRING DRAIN

CP 22+57 END EOS (SPRING DRAIN) BEGIN DOS TO CP 13+72

CP 17+08 SLIDE 12′ DEEP

CP 13+72 END DOS/OS BEGIN EOS

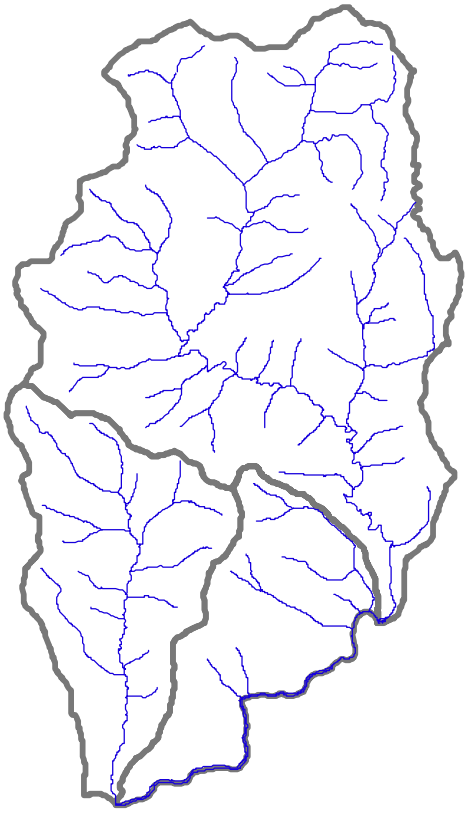
CP 13+47	INSTALL 80 YD^3 SPRING DRAIN
CP 13+22	END EOS (SPRING DRAIN) BEGIN DOS/OS TO CP 10+55
CP 10+55	END DOS BEGIN EOS TO CP 10+30
CP 10+30	INSTALL 80 YD^3 SPRING DRAIN
CP 10+05	END EOS (SPRING DRAIN) BEGIN DOS TO CP 0+00
CP 0+00	END TREATMENT CONSTRUCT VEHICLE BARRIER

ROAD ASSESSMENT AND RESTORATION PLANNING IN THE CAMP CREEK AND SLATE CREEK WATERSHEDS OF THE KLAMATH RIVER BASIN

FINAL REPORT

September 2000

Funded by SB-271
Contract FG 8179 WR



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Background

Camp and Slate Creeks are adjacent tributaries to the Klamath River. Located 12 miles upstream from the confluence with the Trinity River, they are part of the Lower-Middle Klamath River Basin. Camp Creek watershed has an area of 26,994 acres and Slate Creek watershed covers 8,768 acres. Camp and Slate Creeks surround two smaller watersheds, Crawford and Ullathorne, and share a common road system. These two smaller watersheds have an estimated combined area of 5,500 acres. Together, these four watersheds, referred to in this report as the Camp-Slate watersheds, encompass much of the north side drainages in the Lower-Middle Klamath Basin (Figure 1). Approximately 95.5% of the land in the Camp-Slate watersheds is located within and managed by the Orleans Ranger District of Six Rivers National Forest, with 1600 acres privately owned.

The Klamath Basin Assessment has identified the Lower-Middle Klamath Basin as containing some of the best spawning and rearing habitat for anadromous salmonids. Both Camp and Slate Creeks support fall-run chinook salmon, coho salmon, and steelhead trout. Combined, these creeks contain approximately thirteen river miles of anadromous fish habitat. Additionally, Camp Creek has been designated as a "key watershed" by Six Rivers National Forest due to its important role in the recovery of at-risk fish stocks within the Klamath basin.

In the summer of 1999 funding was secured through the California Department of Fish and Game Senate Bill 271 to develop a plan to reduce the delivery of sediment from Forest Service roads to streams within the Camp-Slate watersheds. Tyler Ledwith administered the grant and Michael Love was retained as a sub-contractor.

This summary report describes the road assessment and inventory process and presents an action-plan for preventing future erosion from Forest Service roads within the project area.

Road Inventory

Identification of Non-System Roads

The first phase of the project involved identifying non-system roads from aerial photographs. Currently there exists a GIS layer of Forest roads that consists of all system roads. Additionally, the roads layer contains many, but not all, non-system roads. To identify roads not shown on the GIS layer, the 1990 air photo set (1:16,000 scale) was used. A non-system road was defined as any road not part of the Forest transportation system. Non-system roads can include “temp” roads, abandoned roads, and jeep trails. Most are not maintained, increasing their associated erosion hazard.

Using the Forest Service roads layer and the identified non-systems roads, a project map of the road system was constructed and served as the base map for showing locations of sites with potential future erosion and sediment delivery to streams.

Field Inventory Procedure

From July to September 1999, 250 miles of road (226 miles of system roads and 24 miles of non-system roads) in Camp and Slate Creek watersheds and adjacent frontage drainages were inventoried to identify and assess road-related sediment sources. The inventory focused on collecting information at road-stream crossings, cross drains (ditch relief culverts), and erosional features. The information collected was used to identify active and potential sources of sediment delivery from roads to streams. The location of each feature was recorded with a Global Positioning System (GPS) unit. The attributes of each feature were recorded onto the appropriate field form and then entered into the GPS unit as an attached table (Appendix I). The location and attributes were then converted to an ARC/INFO coverage, which is located in the Six Rivers National Forest computer database at *fs/fsfiles/ref/library/gis/sixrivers/stream_xing*. To ensure accuracy, the hard copies of the completed data forms were used to check the entered data and have subsequently been provided to the Watershed/Hydrology department at the Supervisors Office, Six Rivers National Forest.

Inventory Assessment

Road-Scale

A road-scale approach was used to prioritize roads for treatment based on their sediment delivery potential to the stream network. To aid in developing the erosion reduction action-plan for roads in the Camp-Slate watershed, a matrix was created to rate roads based on their overall need for treatment.

Summary statistics were calculated for each road and placed into the following categories:

1) Proximity of stream crossings to anadromous fish habitat;
2) Risk of stream crossing diversions;
3) Risk of road surface erosion at stream crossings;
4) Adequacy of road drainage between stream crossings, and;
5) Number of sites ranked high for treatment or needing maintenance.

Factors in each category were given weighted scores based on importance. The sum of the weighted scores for each road combined with professional judgment was used to develop the final ranking of roads for treatment. The road-ranking matrix along with the criteria used to score each factor is presented in Appendix II.

Stream Crossings

Analysis of stream crossings was conducted to determine the relative risk each crossing poses to the stream network based on its sediment delivery potential. Stream crossings were ranked for treatment using methodologies outlined in the *Methods for Inventory and Environmental Risk Assessment of Road Drainage Crossings* (Flanagan *et. al*, 1998); *Assessment and Implementation Techniques for Controlling Road-Related Sediment Sources*, (Hagans and Weaver, 1997), and

the Klamath National Forest (personnel comm.). The crossings were analyzed by examining site-specific data organized into four categories:

1) *Culvert Hazard* – the likelihood of culvert capacity being exceeded, referred to as culvert failure;
2) *Fill Hazard* – the likelihood of the stream crossing fill failing;
3) *Consequences* – the erosion effects of culvert failure, and;
4) *Impacts* – the effects of culvert failure on downstream resources.

Factors in each category were given scores that were then weighted based on importance. The sum of the weighted scores gives the Environmental Risk Score (Appendix II). Using the Environmental Risk Score and professional judgment, stream crossing sites were then identified as high, medium, and low priority sites. The volume of potential sediment delivery to streams ("sediment saved") was estimated for all high and medium priority stream crossings. The measured fill volume was used as an estimate of sediment delivery. Stream crossing sites in need of maintenance were also identified and mapped in the field.

Cross Drains

The assessment of cross drain sites was based on the delivery potential to streams and failure potential. Cross drains were considered a "high priority" when the: outlet gully connected to a stream, inlet was plugged or crushed, pipe was damaged by rust, road bed was saturated, excess ravel in ditch, or ditch not routing water properly. Information on contributing ditch and potential diversion distance was collected and used in the analysis of road segments.
Cross drains in need of maintenance were also identified and mapped in the field.

Erosional Features

Erosional features were examined in the field to assess the type of failure (i.e., slump, slide, gully), the location (i.e., cutslope, road bed, fillslope), the volume of the feature, and the potential future yield to the stream network (Appendix I). Only features associated with roads and greater than 20 cubic yards or gullies greater than 20 feet in length were included in the database. Features were given a rating of high, medium and low, based on the potential for future sediment yield to the stream network, proximity to an anadromous fish bearing stream, activity of the feature, and potential risk to the road network.

Results

Watershed Scale

Most roads within the Camp-Slate watershed are positioned near ridgelines and on stable geology. A majority of the inventoried road system was determined to pose little risk to the stream network, with only minor evidence of past sediment delivery to streams.

The areas with the highest erosion potential were found at stream crossings. The most common problem at stream crossings was the potential for stream diversions (Table 1). Since most stream crossings will eventually fail, it is imperative to eliminate diversion potential at all existing crossings as a principal component of any erosion prevention plan within the watershed.

The road system, although relatively stable, suffers from a lack of routine maintenance. Many of the spur and feeder roads are brushy and difficult to access by vehicle. Additionally, nearly 40% of the stream crossings are in need of routine maintenance. With poor access to many of these sites, they are likely to continue being unmaintained and may eventually fail, delivering sediment into adjacent streams.

Table 1. Site classification and future sediment yield from all inventoried road-related sites in the Camp-Slate Creek watersheds.

Site Type	Total number of sites	Number of sites to treat	Number of sites with fill problems	Future yield to streams (cy) [1]	Number of sites that need maintenance	Number of sites currently diverting	Number of sites with diversion potential
Stream Crossings	204	172[2]	31	107,320	80	4	145
Cross Drains	232	27[3]	7	N/A	69	N/A	222
Erosional Features	42	21[4]	30	3,058	N/A	N/A	N/A
Totals	478	220	68	110,378	149	4	367

[1] At stream crossings with diversion potential, future erosion is difficult to predict. A minimum estimate of the stream crossing fill volume was used as a predicted value for this table.
[2] Stream crossings ranked high or medium priority. Sites that need maintenance may be included in this value.
[3] Does not include cross drain sites that need maintenance.
[4] Erosional features ranked high and medium priority are included in this value.

Road Scale

Often it is most cost-effective to treat sites using a road-by-road approach. Individual roads were ranked based on treatment immediacy using the scoring system outlined in the Analysis section and Appendix II. Only roads containing one or more stream crossings, cross drains, or erosional features were examined.

Sixty roads were identified as having features and were ranked, for a total length of 144 miles. Roads needing extensive improvement or decommissioning because of future potential sediment delivery were ranked highest and are listed in Table 2. The remaining roads were identified as either low or medium priority for treatment. A summary of each road along with its assigned treatment immediacy can be found in the Road Log (Appendix IV).

The top seven roads were further divided into two treatment categories: roads needing extensive upgrade and roads recommended for decommissioning. Arterial roads 12N12, 12N20 and 11N05 have relatively high traffic loads, and both have road segments situated adjacent to anadromous stream reaches. Identified in the road assessment as both chronic contributors of sediment to nearby streams and containing a large number of sites with diversion potential, these

three roads would benefit greatly from drainage upgrades. Treatment of these roads would result in potential "sediment savings" of 26,331 cubic yards.

Table 2 – Top road treatment priorities for the Camp-Slate Creek watersheds based on density and severity of sites, risk of diversions, and overall adequacy of road drainage.

Road Number	Length (miles)	Road-Risk Score (max = 66)	No. of high immediacy stream xings	No. of maint. sites	Volume "Saved" (cy)	Overall Road Condition
12N12	23.82	60	12	27	12,847	22 of 29 stream crossings have diversion pot, 28% of the road is connected to streams at crossings, and road contains the most high-immediacy treatment and maintenance sites.
11N38	1.66	30	4	4	1,351	4 high immediacy sites, saturated fills, an active diversion, and 2 erosional features. Unmaintained road (walk-in).
12N38	1.03	23	1	2	180	Long continuous ditch, steep grade, 22% of road connected to streams, gullies on roadbed, active diversions, and intermittent stream in ditch.
12N01.1	0.3	10	0	1	400	Fill is actively failing along the first 0.3 miles of road. Beyond, the road is decommissioned. Close proximity to Camp Creek.
11N46	3.45	33	5	6	3,625	5 high immediacy sites, flow through fill, road crosses 7 perennial streams, long contributing ditches and potential diversion lengths.
12N20	6.22	46	2	16	10,654	33% of road connected to streams, 1 overtopped crossing, 1 site with major flow through fill, 14 of 20 stream crossings w/ diversion potential.
11N05	10.76	51	5	6	2,830	2 previously failed sites, undersized culvert on tributary close to lower Slate Creek. Large erosional feature, all 11 stream crossings have diversion potential.
15N01	17.11	52	3	12	64,747	2 undersized culverts on large perennial streams, cross-drain with large gully to 12N38, 32 of 35 stream crossings w/diversion pot. (paved road).
11N44	1.79	37	2	4	3,683	2 crossings overtopped with one actively diverting, 8 of 8 stream crossings w/ diversion potential, 33% of road connected to streams.
12N01	1.93	35	1	2	291	2 of 4 stream crossings w/ diversion potential, 1 undersized culvert near lower Camp Creek. 2 connected X-drains with long contributing ditch.
10N15A	0.41	23	2	2	565	1 crossing overtopped, 1 plugged inlet. Unmaintained road (walk-in) with 30% of road length connected to streams at crossings
12N19	2.72	23	1	4	1,193	Overtopped perennial stream crossing, 5 of 5 crossings with diversion potential, all crossings undersized. Road close to large perennial stream.
12N36	3.81	21	1	4	1,229	Fill failing at 1 crossing, 4 crossings with partially plugged inlets, and 8 of 9 crossings have diversion potential, with an average diversion length of 300 ft.
12N18	2.05	21	1	4	1,777	Plugged crossing with diversion, slide through road connected to stream, 4 of 5 crossings with diversion potential.
11N48	2.86	18	1	1	587	Inlet plugged with long diversion. Large erosional feature with potential to deliver 350 cy to stream.

Roads 12N38 and 11N46 were identified as needing substantial upgrading of the drainage system. 12N38 is a midslope road possessing a steep unbroken grade for over a mile, ending at a perennial stream. The road was identified as containing numerous failed sites and erosional features requiring treatment. Also a midslope road, 11N46 contains saturated fills while crossing numerous perennial streams, including forks of Ullathorne Creek. Treating these two road would result in sediment savings of 3,805 cubic yards.

Two roads are recommended for decommissioning. Inventory of 11N38 found it to contain an active diversion and saturated fills, with one observed and several impending fill failures with direct delivery to adjacent stream channels. The non-system road, 12N01.1 is an abandoned road upslope of lower Camp Creek. Although the road was decommissioned, the first 0.5 miles requires further treatment. Built on steep, unstable terrain, failing road fill continues to initiate debris slides caught by 12N01 immediately below, with the potential for sediment delivery to Camp Creek. Both roads are neither maintained nor accessible by vehicles. Treating these two roads would result in potential "sediment savings" of 1,751 cubic yards. Due to the difficulty of predicting the size of future catastrophic hillslope failures initiated by these roads, the actual amount of sediment delivered may be substantially greater.

Stream Crossings

A total of 204 stream crossings were inventoried in the Camp-Slate watersheds giving a stream crossing density of 0.8 crossings per mile of road (Figure 2). The low density of stream crossings is attributable to the high proportion of roads on or near ridgelines where streams are fewer.

All of the stream crossings in the watershed were fitted with corrugated metal culverts. No bridges or other alternative crossing types were inventoried. Additionally, there were no crossings on anadromous stream reaches. Stream crossing sites were identified as high, medium, or low priority based on the risk of failure and potential to delivery sediment to streams. Fifty-two sites (25%) were identified as high, 120 (59%) as medium, and 32 (16%) low priority. Problems and treatments have been listed for each high and medium priority stream crossing to prevent an estimated 107,320 yds^3 of sediment from entering the stream network (Table 1 and Appendix III). Treatment options for these sites include preventing diversion, installing larger culverts or end-sections, reconstructing the crossing fill, or decommissioning entire road segments.

All of the crossings were assessed for hydraulic capacity at a headwater to diameter ratio of 1.0. Of the 204 crossings, 134 (66%) of the culverts were identified as being sized for less than the 25-year storm event; 150 (74%) were sized for less than the 50-year storm event; and 165 (81%) were sized for less than the 100-year storm event. Standard and Guidelines for Road Management outlined in the Northwest Forest Plan specify that "stream crossings determined to pose a substantial risk to riparian condition will be improved, to accommodate at least the 100-year flood, including associated bedload and debris." Sites with culverts undersized for the 100-year flood and at risk of direct sediment delivery to anadromous fish habitat were identified as high priority.

Within the Camp-Slate Creek watersheds, 4 sites were identified as currently diverting and 145 having the potential to divert if the stream flow overtopped the crossing fill. (Table 1). Erosion from diversion has been identified as a major source of sediment input into streams. At the watershed scale, potential diversions can be corrected cost-effectively through the installation of diversion dips at stream crossings. Sites with diversion potential can be found in the Road Log (Appendix IV) and in the main database under the heading, "Diverted."

The risk of stream crossing failure can be reduced through routine maintenance. Within the project area 80 sites were identified as benefiting from some form of maintenance (Appendix III). These include sites with plugged or crushed culverts and other problems that can be fixed by hand or a small backhoe. Stream crossing maintenance sites were ranked based on a Maintenance Risk Score. This score accounts for the hazard, consequence, and impacts of the site failing. The list in Appendix III is sorted by road number and mile post to facilitate maintenance planning and implementation.

The maintenance list overlaps with sites identified as high and medium priority in Table 1 and Appendix III to provide options in the timing of maintenance and treatment for these sites. Treating the maintenance needs of high priority sites will reduce the risk of failure and sediment delivery in the short term, while planning, design, and funding decisions for treatment are underway.

Cross Drains

A total of 232 cross drains were inventoried in the project area (Figure 3). Of these 27 (12%) were identified as needing immediate treatment (Appendix III). The most common problem at these pipes was direct delivery of sediment to the stream network through surface flow paths (i.e., rills and gullies). These flow paths can be chronic contributors of fine sediment from the road surface and inboard ditches. The main cause of these flow paths is long sections of uncontrolled flow along the road surface and inboard ditch. In these situations, the most effective treatment is the installation of additional drainage features to reduce the volume of contributing water.

Cross drains in need of maintenance were identified in the field. These included 69 (30%) sites where routine maintenance techniques would be sufficient to treat the problem (Appendix III). The most common problem encountered was sediment plugging of the culvert, which accounted for over 50% of these sites. Other maintenance problems encountered included buried outlets, filled contributing ditches, and broken drop inlet covers. Thirty-eight of these sites need immediate treatment, including all sites with sediment plugging. Sites that plug can divert water either onto the road surface or hillslope causing erosion, or into downroad cross drains or stream crossings possibly causing these sites to fail. Routine maintenance of these sites is a cost-effective way of storm proofing the road system within the watersheds, reducing potential delivery of sediment to the stream network.

Erosional Features

A total of 42 road-related erosional features were field identified in the Camp-Slate watersheds (Figure 4). Types of erosional features included: 19 fillslope failures, 13 cutslope failures, 7 roadbed gullies, and 3 roadbed failures. Of these, 30 (71%) sites were identified as having the potential to deliver an estimated 3,058 cubic yards of sediment into the stream network.

Erosional features were given a rating of high, medium and low priority for treatment, based on the potential for future sediment yield to the stream network, proximity to anadromous fish habitat, activity of the feature, and potential for damage to the road system. Of the 42 features, 11 (26%) sites were considered high priority, 10 (24%) sites medium priority, and 21 (50%) sites low priority (Appendix III). It is recommended that all sites with potential future delivery be treated.

Treatments for erosional features are site specific and should reflect the future use of the road. Cutslope failures and roadbed gullies are usually chronic sediment sources that can be effectively treated through disconnecting the sediment source from the stream network. Material from cutslope failures is often stored on the road prism. This sediment enters inboard ditches and is transported by runoff to cross drains or stream crossings. Rolling dips, cross drains, and waterbars that direct water and sediment away from streams are cost-effective methods for disconnecting sediment sources from the stream network.

Larger mass wasting features associated with fillslope (and hillslope) failures are more difficult to treat. Unstable road segments or fillslopes may have to be excavated and stabilized to keep material from failing and entering the stream network. Some buttressing, revegetation and upslope drainage control may be necessary to prevent further sedimentation and stabilize the erosional feature.

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Personal Communications

Don Elder, Geologist, Klamath National Forest, Yreka, CA

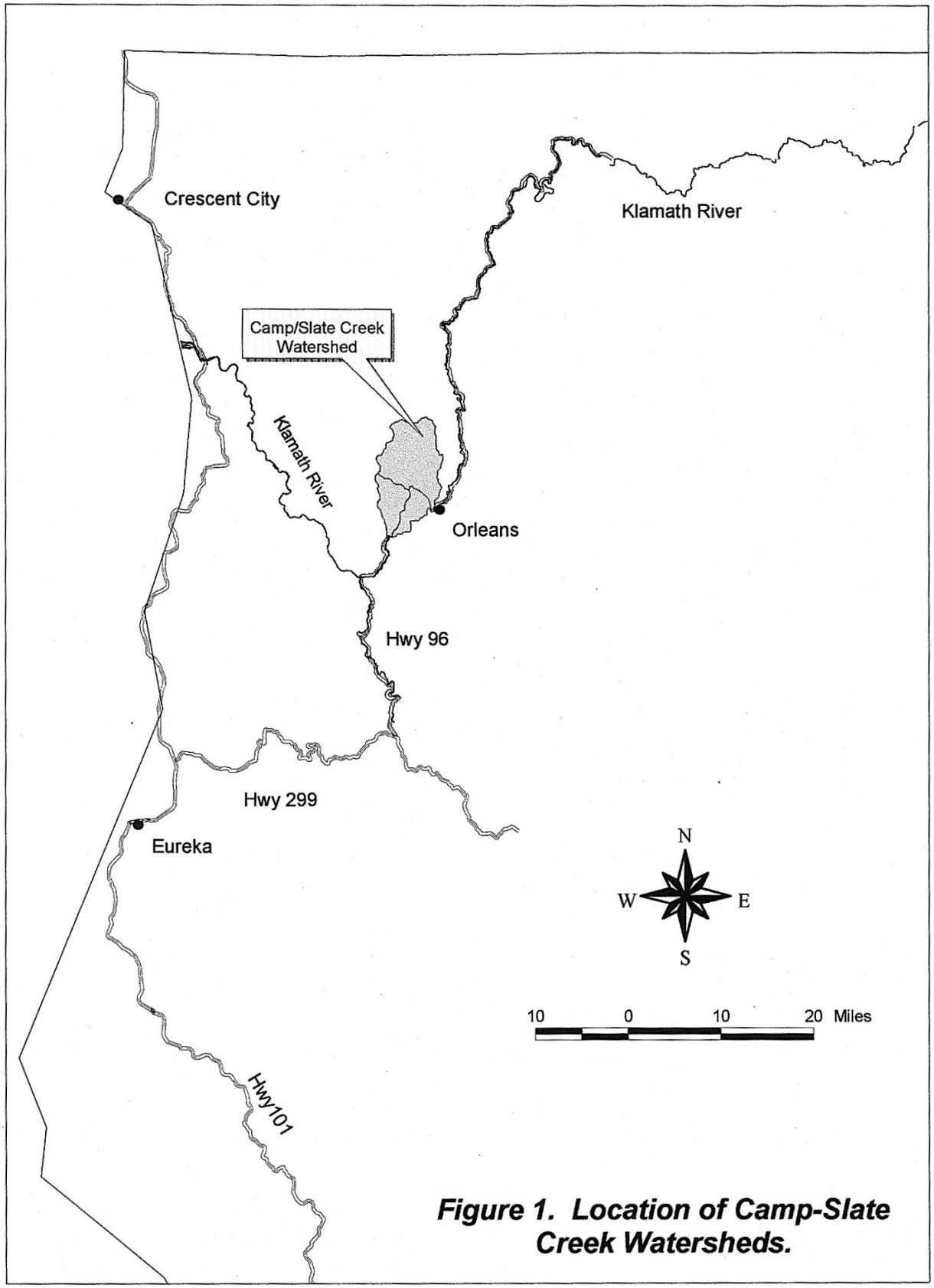


Figure 1. Location of Camp-Slate Creek Watersheds.

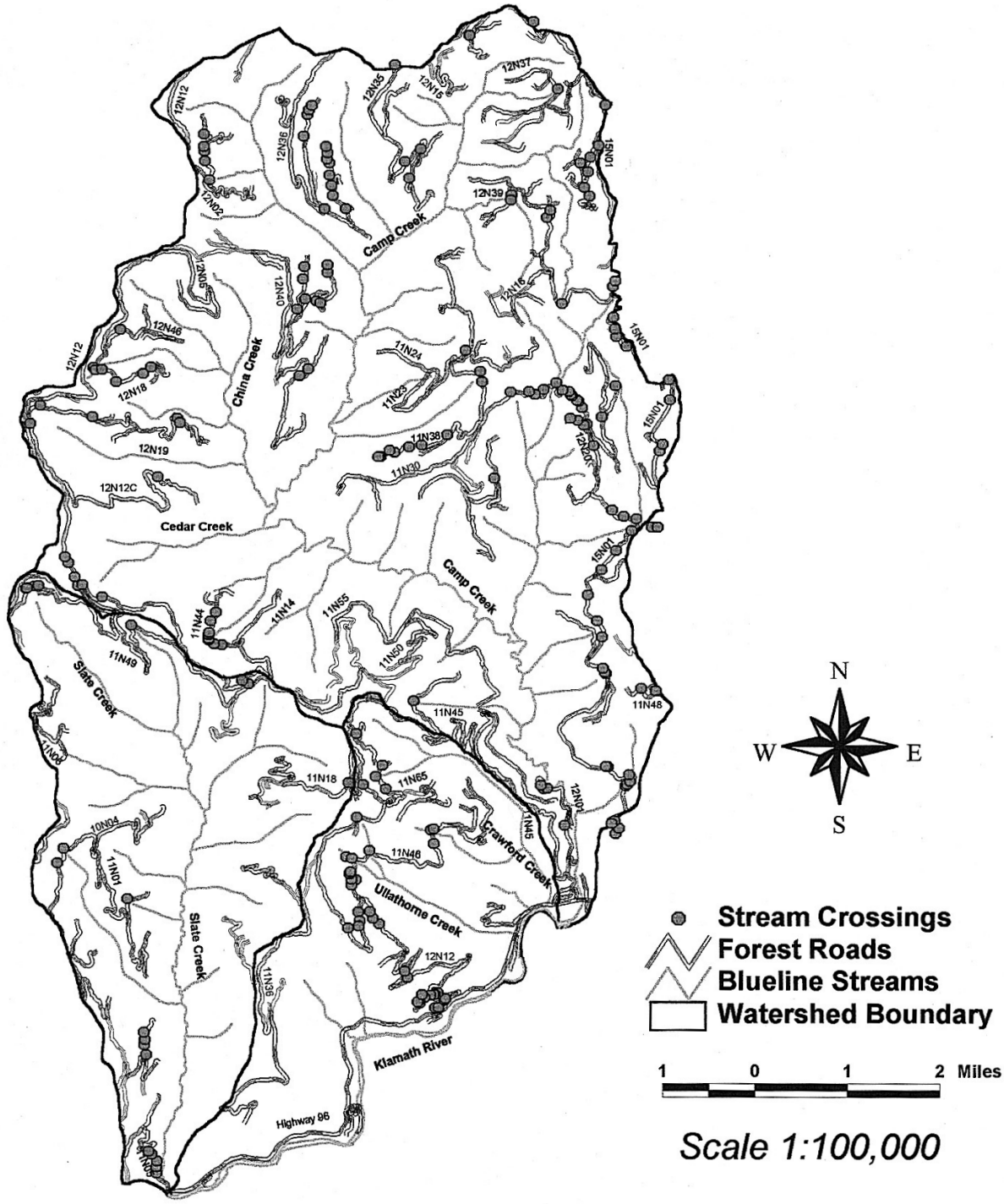


Figure 2. Location of Stream Crossings in the Camp-Slate Creek Watersheds.

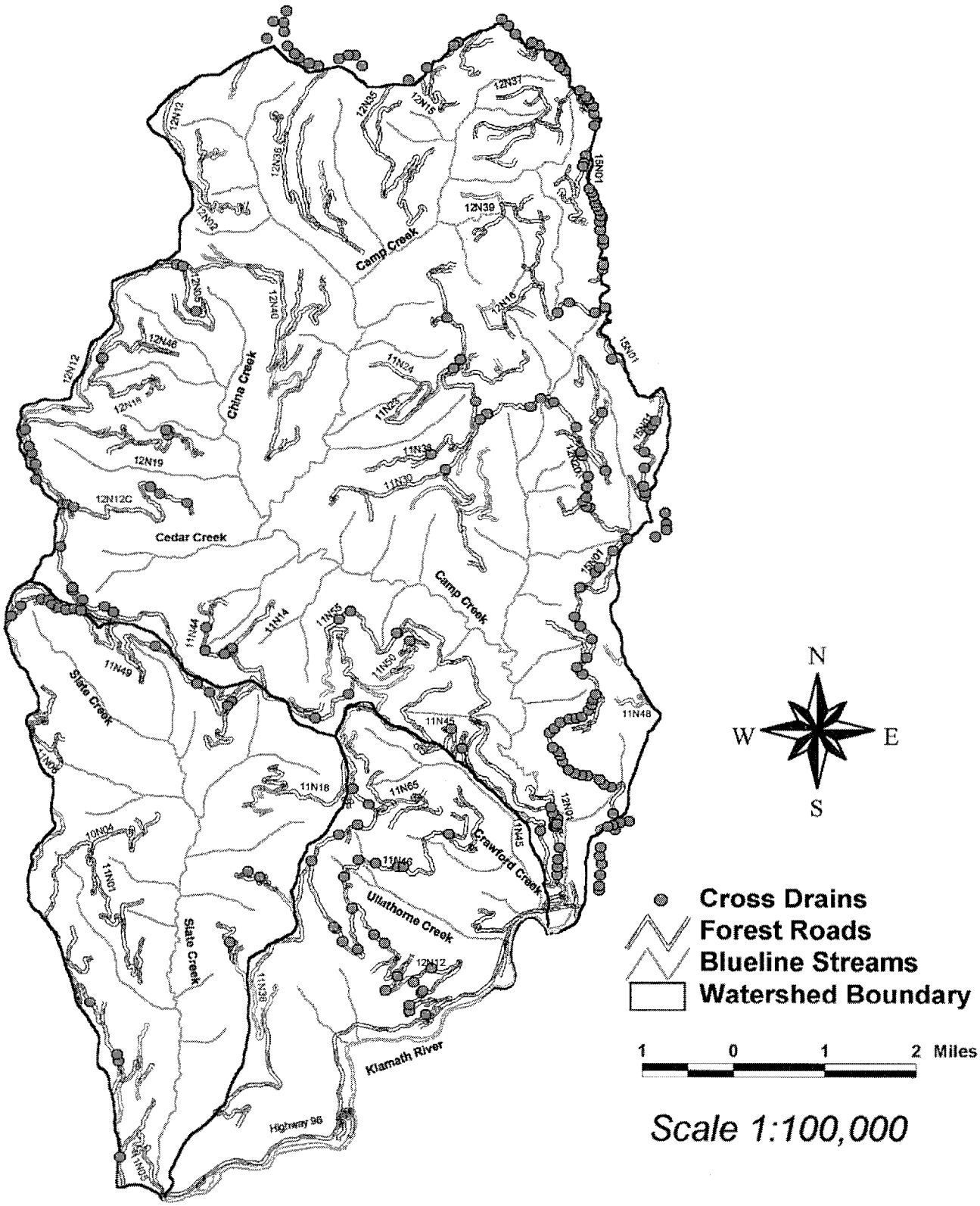


Figure 3. Location of Cross Drains in the Camp-Slate Creek Watersheds.

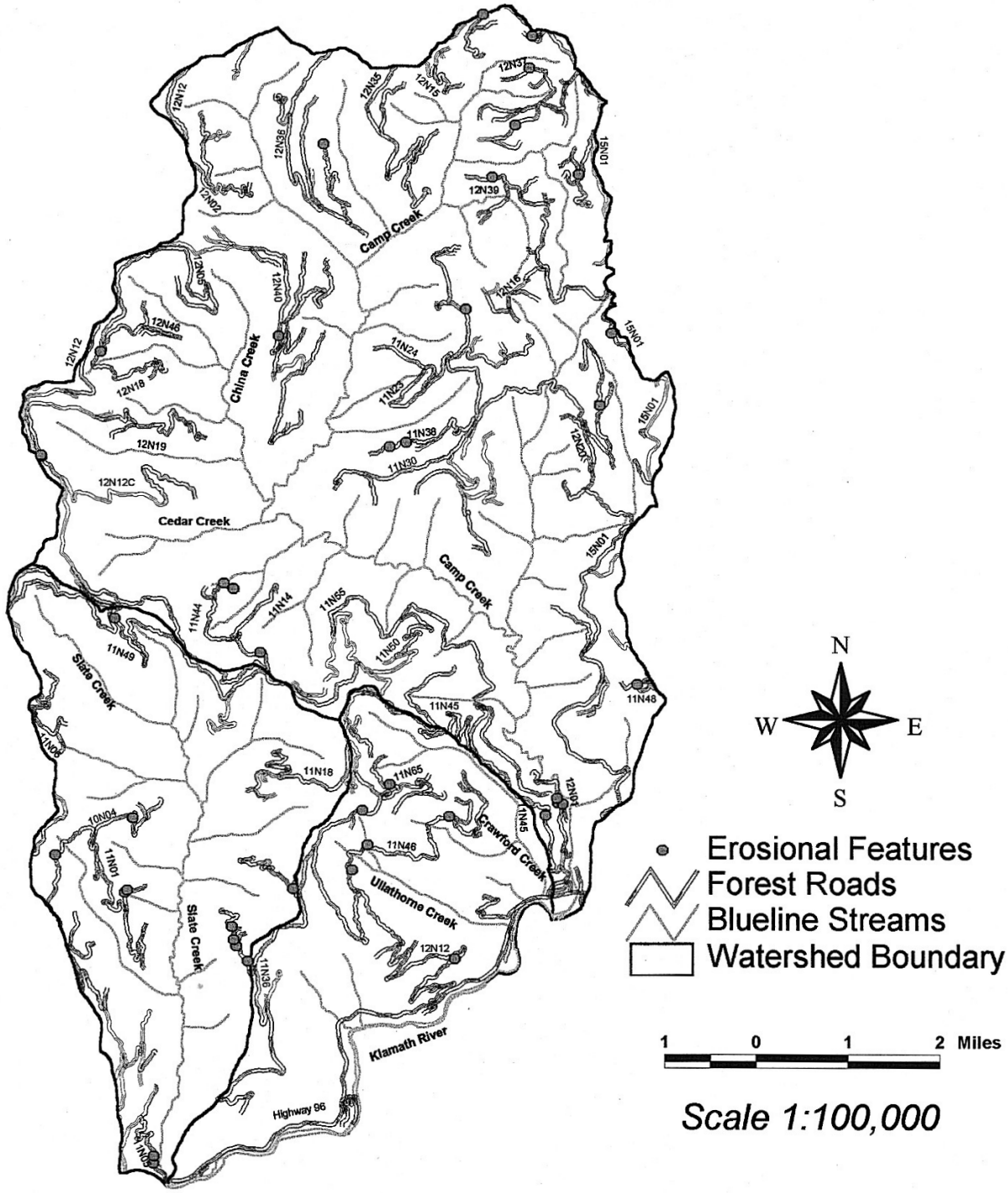


Figure 4. Location of Erosional Features in the Camp-Slate Creek Watersheds.

Appendix I

Field Data Forms

Stream Xing Data Sheet

Observers:

Date							
GPS Position							
UTC Time*							
No. of Points							

Road #							
Mile Post							
Xing Type							
CMP Slope							
Stream Type							
Inlet Type							
Diameter							
Ch Slope Ab							
In Fill Slope							
In Fill Length							
Flood Width							
Channel W 1							
Channel W 2							
Channel W 3							
Basin Width							
Overtop?							

Road Width							
Draw Width							
CMP Length							
Out F Slope							
Out F. Length							
Ch Slope B							
Rustline							

Outlet Type							
Trash Rack?							
Debris Upstr.							
L to 1st Xdrain							
L Inbd Ditch							
R to 1st Xdrain							
R Inbd Ditch							
Diverted?							
Diverts to							
Pot. Length							
Rec. Feature							

_____

Mile Post							
Inlet Plugged							
Inlet crushed							
Flow Under?							
Condition							
Priority							

Explain Priority (Why?)							
Comments							

X-Drains Data Sheet

Observer:

Date							
GPS Position							
UTC Time*							
No. of Points							

Road #							
Mile Post							
Diameter							
Contrib. Ditch Length							
Connected ?							
Wet Veg?							
Pot. Diversion Length							
CMP Cond. (good/main/failed)							
Ditch Cond. (good/main)							
Comments							
Why							

Erosional Features

Observer:

Date							
GPS Position							
UTC Time*							
No. of Points							

Road #							
Mile Post							
Feature							
Location							
Condition							
Volume of Feature (cy)							
Volume Excavated (cy)							
Volume Left (cy)							
Delivy Pot of Volume left (%)							
Spring (y/n)							
Wet Veg (y/n)							
Priority (H/M/L)							
Why							

_____

Appendix II

Environmental Risk Assessment Criteria

Environmental Risk Assessment Criteria for the Camp-Slate Creek Watersheds

Roads

[*RRS*] ROAD RISK SCORE

Each road containing at least one inventoried site (a stream crossing, cross drain, or erosional feature) within the Camp-Slate watershed was given an overall score, referred to as the Road Risk Score. This score is a measure of the risk the road poses to downstream resources. It is based on eleven road summary statistics from five different categories:

(1) downstream fisheries values,
(2) consequences of diversion,
(3) road drainage and surface erosion at stream crossings,
(4) drainage at cross drains, and
(5) density of high risk and maintenance sites.

The Road Risk Score is then computed using an equation with the form:

$$[RRS] = \Sigma(k_i * F_i)$$

where k_i is the weighting coefficient associated with the road summary statistic, F_i. The Road Risk Score has a maximum possible value of 66.

The Road Risk Score is used, along with professional judgment in the field, to rank roads for treatment.

Road Summary Statistics incorporated into the Road Risk Score:

Number of crossings on streams draining directly to an anadromous reach.
(Weighting Coefficient, $k_i = 3$)

0	none
1	1 crossings
2	2– 5 crossings
3	>5 crossings

Number of stream crossings with diversion potential. (Weighting Coefficient, $k_i = 3$)

0	none
1	1 – 2
2	3 – 8
3	> 8

Average diversion length for all crossings with diversion.
(Weighting Coefficient, $k_i = 2$)

0	none
1	1 ft - 250 ft
2	250 ft – 1000 ft
3	> 1000 ft

Percent of road length draining to stream crossings. (Weighting Coefficient, $k_i = 2$)

0	none
1	< 5%
2	5% - 20%
3	> 20%

Average ditch length to break-in-grade. (Weighting Coefficient, $k_i = 1$)

0	none
1	< 200 ft
2	< 1000 ft
3	>= 1000 ft

Number of cross-drains connected to streams. (Weighting Coefficient, $k_i = 2$)

0	none
1	1
2	2
3	>2

Average contributing ditch length to cross-drains. (Weighting Coefficient, $k_i = 1$)

0	< 100 ft
1	<250 ft
2	< 500 ft
3	>= 500 ft

Potential future sediment yield to streams at road-related erosion features.
(Weighting Coefficient, $k_i = 2$)

0	none
1	< 100 cy
2	< 500 cy
3	>= 500 cy

Number of stream crossings ranked high for treatment on the road.
(Weighting Coefficient, $k_i = 3$)

0	none
1	1
2	2 - 3
3	> 3

Number of stream crossings requiring maintenance (sites ranked high for treatment and also needing maintenance were included).
(Weighting Coefficient, $k_i = 1$)

0	none
1	1
2	2 - 3
3	> 3

Number of cross-drains requiring maintenance. (Weighting Coefficient, $k_i = 2$)

0	none
1	1
2	2 - 5
3	> 5

Environmental Risk Assessment Criteria for the Camp-Slate Creek Watersheds

Stream Crossings

[*ERS*] ENVIRONMENTAL RISK SCORE

Each stream crossing within the project area was given an overall score, referred to as the Environmental Risk Score. This score is the sum of four indexes: Culvert Hazard [*CH*], Fill Hazard [*FH*], Consequence [*C*], and Impact [*IP*].

$$[ERS] = [CH + FH + C + IP]$$

Each index measures a specific element of the overall risk posed to downstream resources by steam crossings. The Environmental Risk Score has a maximum possible value of 100.

The Environmental Risk score is used, along with professional judgment in the field, to identify stream crossing sites needing treatment and to rank them for treatment based on their overall risk to downstream resources.

[*CH*] - CULVERT HAZARD

Culvert Hazard is an index used to evaluate the likelihood of a culvert failing as a result of:

(1) its current condition,
(2) its capacity to transport watershed products (water, woody debris, and sediment), and
(3) the potential for overtopping of the inlet (HW/D=1).

Each stream-crossing site is given a Culvert Hazard score using the following equation:

$$[CH] = (2*T + 2*w + 1*s + 1*cp1 + 1*cp2 + 2*rl + 1*dus + 3*ip + 3*ic + 6*c)/1.63$$

where each variable is multiplied by a weighting coefficient ranging between one and six, and the entire term is divided by 1.63 to give the Culvert Hazard index a maximum possible score of 36 out of 100.

Variables incorporated into the Culvert Hazard index:

[*T*] an expression of hydraulic capacity.

[lower *T* values have greater hazard]
3 *T* = < 25 years
2 *T* = 25 - 100 years
1 *T* = > 100 years
0 no pipe or no definable drainage area

[*w*] an expression of woody debris capacity = culvert diameter / upstream channel width.

[lower values have greater hazard].
3 *w* = < 0.5
2 *w* = 0.5 - 1.0
1 *w* = > 1.0
0 no pipe or no definable channel

[*s*] a measure of the ability of a pipe to transport sediment = slope of pipe / slope of channel.

[lower values have greater hazard]
3 *s* = < 0.3
2 *s* = 0.3 - 0.6
1 *s* = > 0.6
0 no pipe

[*cp1*] collection potential – contributing ditch length to first cross drain structure; assumes cross drain is functioning.

3 *cp1* > 500 feet
2 *cp1* = 200 - 500 feet
1 *cp1* < 200 feet
0 no collection potential

[*cp2*] collection potential - contributing ditch length to road grade reversal or other feature that breaks collection potential; assumes that cross drains will plug during storm event (worst-case scenario).

3 *cp2* > 1,000 feet
2 *cp2* = 250 - 1,000 feet
1 *cp2* < 250 feet
0 no collection potential

[*rl*] rustline - an expression of active channel flow verses pipe capacity = height of rustline / culvert diameter.

[higher values have greater hazard]
3 *rl* = 0.5 - 1.0
2 *rl* = 0.25 - 0.5
1 *rl* < 0.25
0 no rustline in pipe

[*dus*] debris upslope - presence of woody debris upslope that could potentially plug a culvert.

1 pluggable woody debris upslope
0 no pluggable woody debris upslope

[*ip*] inlet plugged - percent of the culvert inlet plugged by sediment or woody debris (reduced capacity).

3 *ip* = > 75%
2 *ip* = 50%
1 *ip* = 25%
0 culvert not plugged

[*ic*] inlet crushed - percent of the culvert inlet crushed (reduced capacity).

3 *ic* = > 75%
2 *ic* = 50%
1 *ic* = 25%
0 culvert not crushed

[*c*] condition - current condition of the culvert

3 stream flow has overtopped culvert (HW/D=>1)
2 culvert needs maintenance
0 culvert in good condition

[*FH*] - FILL HAZARD

Fill Hazard is an index used to assess the potential for a stream-crossing fill prism to fail by mass movement. Each stream-crossing site is given a Fill Hazard rating using the following equation:

[*FH*] = [6**fuc* + 12**sr* + 6**rff*]/1.63

where each of the three variables is multiplied by a weighting coefficient of either six or twelve, and the entire term is divided by 1.63 to give the Culvert Hazard index a maximum possible score of 22 out of 100.

<u>Variables incorporated into the Fill Hazard index:</u>

[*fuc*] flow under CMP - presence of stream flow under a culvert and piping through the fill.

2 major stream flow under the culvert and through the fill
1 minor stream flow under the culvert and through the fill
0 no flow through the fill

[*sr*] saturated road fill - whether the road fill at the site is partially of fully saturated during the dry season.

1 saturated road fill
0 no water on road fill

[rff] road fill failing - whether the road fill has signs of mass movement

2 high volume slumps, slides or tension cracks on roadbed or fillslope
1 low volume rills, gullies, or tension cracks on roadbed or fillslope
0 no mass movement

[*C*] - CONSEQUENCE

Consequence is an index used to gage the physical effects of a future stream crossing failure. Each stream-crossing site is given a Consequence rating using the following equation:

[*C*] = [2**fv* + 4**div* + 3**dd* + 3**gm*]/1.63

where each variable is multiplied by a weighting coefficient between two and four, based on its perceived importance. The entire term is divided by 1.63 to give the Culvert Hazard index a maximum possible score of 22 out of 100.

Variables incorporated into the Consequence index:

[*fv*] fill volume – volume of sediment at risk of entering a stream if crossing fails (The potential volume delivered to a stream due to a diversion was assumed to be equal to the fill volume – likely to be an underestimate).

3 > 1,000 cubic yards (cy)
2 250 - 1,000 cy
1 < 250 cy
0 no fill volume

[*div*] diversion

3 has diverted in the past
2 potential to divert
0 no

[*dd*] diversion distance

3 > 1,000 feet
2 300 - 1,000 feet
1 < 150 feet
0 no potential diversion

[*gm*] geomorphic character of site drainage basin

3 abundant unstable geomorphic terrenes
2 abundant dormant slides, inner gorge, steep slopes
1 low relief, with limited dormant slides
0 stable geomorphic terrenes

[*IP*] - IMPACT

The Impact index measures the value of downstream resources that may be effected by failure of the stream crossing. Each stream-crossing site is given an Impact rating using the following equation:

$$[IP] = [2*ws + 4*fb + 2*fa + 2*bl]/1.63$$

where each variable is multiplied by a weighting coefficient of either two or four, based on its perceived importance. The entire term is divided by 1.63 to give the Culvert Hazard index a maximum possible score of 20 out of 100.

Variables incorporated into the Impact index:

[*ws*] water supply sources at risk – downstream potable surface water sources.

3 municipal source
2 > 5 domestic sources or campground
1 any potable source (< 5 domestic)
0 none

[*fb*] fish-bearing or perennial stream at site (&/or other "sensitive" aquatic species)

3 stream flows directly into anadromous fish habitat
2 residential fish at site
1 non fish-bearing perennial stream at site
0 no perennial stream at site

[*fa*] downstream facilities at risk

3 non-road facilities at direct risk* (e.g., buildings, campgrounds, trailheads)
2 more than one road crossings downstream
1 single road crossing downstream
0 none (or bridge only)

* "direct risk" means facility is:
(1) directly downslope,
(2) within the same or next higher order stream,
(3) less than one mile downstream, and
(4) located on floodplain (<= 100 year).

[*bl*] Proximity to blue line streams - streams shown on base layer (typically represents larger perennial streams).

3 site crosses blue line stream
2 < 200 feet from blue line stream
1 200 - 500 feet from blue line stream
0 > 500 feet from blue line stream

Appendix III

Results

Table III-1. **High Priority Stream Crossings.** Comments and recommendations for top priority stream crossing sites in the Camp-Slate Creek watersheds. Sorted by priority. Road numbers with a decimal place (e.g., 12N01.1) indicate a non-system road.

Road Number and Mile Post	Stream Type	Sediment 'Saved' (cy)	Existing Condition	Recommended Treatment
11N38-1.72	Spring	42	Culvert undersized. Stream overtopped culvert. Saturated roadbed. Actively diverting down road. Walk in access only.	Pull crossing. Decommission road.
11N44-1.20	Intermittent	233	Culvert undersized. Stream overtopped culvert. Inlet plugged. Fill failing. Actively diverting.	Re-size/replace culvert or clear inlet. Install diversion dip.
12N02-0.83	Ephemeral	113	Culvert undersized. Stream overtopped culvert. Active diversion causing gully.	Re-size/replace culvert. Install diversion dip.
12N36A-1.18	Spring	102	Culvert undersized. Stream overtopped culvert. Saturated roadbed. Fill failing. Actively diverting down road.	Re-size/replace culvert. Install diversion dip.
11N05-0.24	Intermittent	278	Stream overtopped culvert. Active slide upslope. Potential diversion. Fish bearing site.	Stabilize slide. Re-size/replace culvert. Stabilize slide. Install diversion dip.
11N05-0.30	Intermittent	234	Culvert undersized. Stream overtopped culvert. Debris flow up channel. Potential diversion. Fish bearing site.	Examine upstream slide for stabilization. Re-size/replace culvert. Install diversion dip.
11N46-0.10	Perennial	662	Culvert undersized. Stream overtopped culvert. Flow thru fill. Potential diversion. Pond below site.	Re-size/replace culvert. Install diversion dip.
11N44-1.04	Intermittent	807	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion.	Re-size/replace culvert. Clear inlet. Install diversion dip.
11N05-10.20	Ephemeral	201	Culvert undersized. Stream overtopped culvert. Potential diversion. Evidence of past failure by cutslope ravel. Spring near site.	Re-size/replace culvert. Install diversion dip.
12N18-0.90	Intermittent	349	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion. Water running down road.	Re-size/replace culvert or clear inlet. Install diversion dip.
12N19-0.83	Perennial	87	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion.	Re-size/replace culvert or clear inlet. Install diversion dip.
11N49-0.65	Intermittent	149	Culvert undersized. Stream overtopped culvert. Flow thru fill.	Re-size/replace culvert.
10N15A-0.22	Intermittent	85	Culvert undersized. Stream overtopped culvert. Inlet plugged. High consequence of failure. Walk in access only.	Re-size/replace, remove or clear culvert.

Table III-1. **High Priority Stream Crossings** (continued)

Road Number and Mile Post	Stream Type	Sediment 'Saved' (cy)	Existing Condition	Recommended Treatment
12N20-4.00	Perennial	854	Stream overtopped culvert. Evidence of high flows.	Re-size/replace culvert.
12N39B-0.15	Perennial	370	Culvert undersized. Stream overtopped culvert.	Re-size/replace culvert.
12N40B-1.8	Ephemeral	165	Culvert undersized. Inlet plugged. Flow thru fill. 1/3 of fill beginning to slump.	Re-size/replace culvert or clear inlet.
10N15A-0.10	unknown	325	Culvert undersized. Inlet plugged. Saturated roadfill. Walk in access only.	Re-size/replace, remove culvert or clear inlet.
15N01-2.38	Perennial	1,693	Culvert undersized. Inlet plugged. Potential diversion. Delivery to Delivery to fish bearing stream.	Re-size/replace culvert or clear inlet. Install diversion dip.
11N48-2.70	Perennial	196	Culvert undersized. Inlet plugged. Potential diversion. Long diversion length.	Re-size/replace culvert or clear inlet. Install diversion dip.
12N40H-0.04	Intermittent	528	Culvert undersized. Inlet plugged. Evidence of high flow.	Re-size/replace culvert or clear inlet. Install diversion dip.
11N38-1.35	Spring	192	Culvert undersized. Major flow thru fill. Saturated roadbed. Fill failing. Walk in access only.	Pull crossing. Decommission road.
12N12-0.70	Spring	206	Major flow thru fill. Culvert rusted thru. Potential diversion.	Re-size/replace culvert. Install diversion dip.
11N46-2.06	Spring	42	Culvert undersized. Major flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N20-1.28	Spring	107	Culvert undersized. Major flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N12-4.68	Perennial	544	Culvert undersized. Major flow thru fill. Culvert rusted thru.	Re-size/replace culvert.
12N12-0.72	Intermittent	431	Culvert undersized. Flow thru fill. Delivery to Delivery to fish bearing stream.	Re-size/replace culvert.
12N12-15.39	Intermittent	1,466	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N12-4.74	Perennial	3	Culvert undersized. Flow thru fill. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.

Table III-1. **High Priority Stream Crossings** (continued)

Road Number and Mile Post	Stream Type	Sediment 'Saved' (cy)	Existing Condition	Recommended Treatment
11N46-0.25	Perennial	348	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N38A/12N49-0.05	Spring	58	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N12-15.63	Ephemeral	18	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
11N46-0.21	Spring	190	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N12-3.25	Perennial	88	Culvert undersized. Flow thru fill.	Re-size/replace culvert.
11N46-1.82	Perennial	638	Culvert undersized. Flow thru fill.	Re-size/replace culvert.
12N40B-1.00	Intermittent	297	Culvert undersized. Flow thru fill.	Re-size/replace culvert.
12N12-5.50	Spring	158	Culvert undersized. Flow thru fill.	Re-size/replace culvert.
11N18-0.38	Spring	179	Culvert undersized. Saturated roadbed. Fill failing. Water ponding. Potential diversion.	Re-size/replace culvert. Install diversion dip.
11N38-0.80	Ephemeral	103	Culvert undersized. Saturated roadbed. Gullies on road. Potential diversion. Walk in access only.	Pull crossing. Decommission road.
11N38-1.45	Perennial	128	Culvert undersized. Saturated roadbed. Potential diversion to unstable slope. Walk in access only.	Pull crossing. Decommission road.
12N20-4.65	Ephemeral	86	Culvert undersized. Slump thru fill. Downspout unattached.	Re-size/replace culvert.
11N05-0.49	Intermittent	67	Culvert undersized. Fill failing. Gullies in stream channel. Potential diversion. Fish bearing site.	Re-size/replace culvert. Install diversion dip.
12N36-3.72	Spring	444	Fill failing. Potential diversion.	Re-size/replace culvert. Install diversion dip.
15N01-11.50	Ephemeral	4,225	Fill at risk from headcut erosion. Large gully at outlet flows 300 ft. to 12N38-0.15.	Re-size/replace culvert or armor fill slope.
11N05-0.38	Intermittent	240	Culvert undersized. Potential diversion. Delivery to Delivery to fish bearing stream.	Re-size/replace culvert. Install diversion dip.
12N01-1.00	Intermittent	248	Culvert undersized. Potential diversion. Delivery to fish bearing stream.	Re-size/replace culvert. Install diversion dip.
12N12-0.09	Perennial	131	Culvert undersized. Potential diversion. Delivery to fish bearing stream.	Re-size/replace culvert. Install diversion dip.

Table III-1. **High Priority Stream Crossings** (continued)

Road Number and Mile Post	Stream Type	Sediment 'Saved' (cy)	Existing Condition	Recommended Treatment
12N12-0.65	Perennial	71	Culvert undersized. Potential diversion. Delivery to fish bearing stream.	Re-size/replace culvert. Install diversion dip.
15N01-2.05	Perennial	9,216	Culvert undersized. Potential diversion. Delivery to fish bearing stream.	Re-size/replace culvert. Install diversion dip.
10N04-0.73	Intermittent	23	Culvert undersized. Potential diversion. Stream flows down skid trail above site.	Re-size/replace culvert. Install diversion dip/waterbar on skid trail.
12N38-0.50	Ephemeral	92	Culvert undersized. Potential diversion. Large gullies upstream start from x-drain 15N01-11.19	Re-size/replace culvert. Install diversion dip. Add additional drainage structures near cross drain above site.
12N12-5.32	Spring	92	Culvert undersized. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.
12N12-0.68	Perennial	234	Culvert undersized. Inlet plugged. High flow. Potential diversion.	Re-size/replace culvert. Install diversion dip.

Table III-2. **Stream Crossing Maintenance.** Stream crossing maintenance sites for Camp-Slate Creek watersheds sorted by road number. Road numbers with a decimal place (e.g., 12N01.1) indicate a non-system road.

Road Number	Maintenance Risk Score (max = 78)	Existing Condition
10N15A-0.10	16	Inlet 75% plugged. Walk in access only.
10N15A-0.22	23	Inlet 100% plugged. Walk in access only.
11N05-0.24	49	High plugging potential. Large gully at outlet. Fish bearing site.
11N05-0.30	47	Drop inlet needs cover. Fish bearing site.
11N05-10.18	22	Inlet 25% plugged.
11N05-10.20	11	Past failures by cutslope ravel.
11N05-11.30	31	Inlet 25% plugged. Crushed culvert.
11N38-0.80	31	Inlet 25% plugged. Gullies on road. Walk in access only.
11N38-1.25	28	Inlet 25% plugged.
11N38-1.35	22	Flow saturating fillslope. Walk in access only.
11N38-1.72	8	Crushed culvert. Walk in access only.
11N44-1.04	38	Inlet 100% plugged. Trash rack plugged.
11N44-1.20	44	Inlet 100% plugged. Gully on fillslope.
11N46-0.10	41	Inlet 25% plugged. Crushed culvert.
11N46-2.06	43	Outlet 50% buried.
11N48-2.70	30	Inlet 75% plugged.
11N49-0.65	38	Trash rack and ditch.
11N65A-0.31	26	Inlet 25% plugged.
11N65A-0.38	21	Inlet 25% plugged. Vegetation blocking inlet.
12N02-0.56	17	Inlet 75% plugged. Downspout separated from outlet.
12N02-0.83	38	Inlet plugged. Inlet basin filled.
12N02-0.92	22	Inlet 25% plugged. Outlet 50% plugged.
12N02-1.00	22	Inlet 25% plugged.
12N02-1.20	17	Inlet 75% plugged.
12N12-0.04	34	Outlet 100% buried. Fish bearing site.
12N12-0.18	37	Inlet 25% plugged and crushed. Outlet 25% buried.
12N12-0.65	40	Outlet 100% buried. Fish bearing site.
12N12-0.68	43	Inlet 25% plugged. Crushed culvert. Fish bearing site.
12N12-0.70	34	Culvert rusted thru at inlet and outlet. Fish bearing site.
12N12-1.02	18	Inlet 25% Plugged.
12N12-1.21	18	50% rusted. Drains spring.
12N12-16.00	30	Inlet 25% plugged. Large woody debris in inlet basin.
12N12-2.12	18	Inlet 25% Plugged.
12N12-2.99	24	Side of drop inlet 50% plugged. Ditch needs maintenance.
12N12-4.49	18	Outlet crushed. Pipe rusted. Drains spring.
12N12-4.68	14	Inlet rusted. Spring draining into ditch near crossing.
12N12-4.74	32	Crushed culvert.
12N12-5.32	25	50% of inlet rusted thru.
12N12-5.42	28	Crushed culvert.
12N12-5.50	11	Crushed culvert.
12N12-8.69	11	Inlet 25% plugged.

Table III-2. **Stream Crossing Maintenance** (continued)

12N18-0.90	44	Inlet 75% plugged. Water running down road.
12N18-0.92	36	Inlet 25% plugged.
12N18-1.66	24	Inlet 25% plugged. Vegetation blocking inlet.
12N18-1.78	24	Inlet 25% plugged. Vegetation blocking inlet.
12N19-0.18	33	Crushed culvert.
12N19-0.83	41	Inlet 100% plugged. Inboard ditch filled.
12N19-2.34	24	Inlet 25% plugged.
12N19-2.41	22	Inlet 25% plugged. Vegetation blocking inlet.
12N19-2.42	31	Inlet 25% plugged. Crushed culvert.
12N20-0.20	34	Inlet 25% plugged.
12N20-0.39	27	Outlet 80% plugged.
12N20-1.28	28	Inlet 25% plugged. Outlet buried.
12N20-2.12	13	Inlet 25% plugged.
12N20-4.00	23	Inlet 25% plugged.
12N20-4.65	8	Slump thru road. Downspout unattached.
12N20D-0.49	31	Crushed culvert.
12N35-2.00	17	Inlet 25% plugged. Crushed culvert.
12N35A-0.10	25	Inlet 50% plugged. Walk in access only.
12N36-2.30	31	Inlet 25% plugged.
12N36-3.09	22	Inlet 25% plugged.
12N36-3.20	28	Inlet 25% plugged. Crushed culvert.
12N36-3.65	28	Inlet 50% plugged. Outlet buried.
12N36A-1.05	25	Inlet 25% plugged.
12N38-0.50	34	Inlet 50% plugged. Crushed culvert.
12N38A/12N49-0.05	22	Inlet 25% plugged. Spring flow in ditch.
12N39-0.75	14	Inlet 50% plugged.
12N39-0.89	14	Inlet 50% plugged.
12N39B-0.10	23	Outlet plugged. Gully on road.
12N40-3.30	11	Inlet 25% plugged.
12N40-3.90	17	Inlet 100% plugged.
12N40-4.20	8	Inlet basin full. Water on road. Outlet 25% plugged.
12N40B-1.8	17	Plugged drop inlet culvert. 30% of road failing.
12N40G-0.81	8	Outlet 25% plugged.
12N40H-0.04	19	Inlet 100% plugged. Outlet 75% buried.
12N46-0.39	28	Inlet 75% plugged.
15N01-1.95	50	Inlet 25% plugged. Crushed culvert. Fish bearing site.
15N01-2.05	59	Inlet 50% plugged. Fish bearing site.
15N01-2.38	50	Inlet 75% plugged. Fish bearing site.
15N01-5.55	12	Inlet covered with debris.
15N01-6.33	27	Outlet buried.
15N01-6.41	29	Outlet buried.
15N01-7.55	35	Crushed culvert.
15N01-9.44	35	Inlet 50% plugged.
15N05-15.03	38	Inlet 50% plugged.

Table III-3. **Cross Drain High Priority.** Top priority cross drain sites in the Camp-Slate Creek watersheds sorted by road number. Road numbers with a decimal place (e.g., 12N01.1) indicate a non-system road.

Road Number and Mile Post	Culvert Diameter (inches)	Existing Conditions
11N05-10.50	18	Hydrologically connected.
11N44-1.27	18	Hydrologically connected.
11N46-0.30	18	Hydrologically connected. Ditch needs maintenance.
11N46-1.14	18	Fill saturated.
11N47.1-0.50	12	Inlet crushed. Outlet buried. Culvert rusted thru. Ditch needs maintenance.
11N49-0.23	12	Fill saturated. Ditch needs maintenance.
11N55-1.02	18	Hydrologically connected. Fill saturated. Ditch needs maintenance.
12N01-1.31	18	Hydrologically connected. Ditch needs maintenance.
12N01-1.41	18	Hydrologically connected.
12N12-1.19	18	Hydrologically connected. Inlet 25% Plugged. 50% rusted.
12N12-11.63	18	Culvert rusted thru. Ditch needs maintenance.
12N12-15.52	18	Hydrologically connected. Inlet 25% crushed.
12N12-15.76	18	Hydrologically connected.
12N12-17.89	18	Fill saturated. Inlet 25% plugged. Inlet 75% crushed. Outlet buried.
12N12-24.56	18	Hydrologically connected. Inlet 50% plugged. Highly rusted.
12N12-3.29	18	Hydrologically connected. Inlet 50% plugged. Outlet 75% Plugged
12N12-6.30	24	Hydrologically connected. Drains spring. Inlet rusted.
12N12C-2.27	24	Hydrologically connected.
12N20-0.65	18	Slump at site. Fill saturated.
12N20-2.11	18	Hydrologically connected.
12N20-3.80	18	Hydrologically connected. Inlet 50% plugged.
12N20-4.70	18	Fill saturated. Ditch needs maintenance.
12N38-0.19	24	Uproad stream in ditch/gullies connected to 15N01 - 11.50
12N46-0.11	24	Hydrologically connected. Drop inlet overgrown.
15N01-0.00	18	Hydrologically connected. Drains slump.
15N01-11.19	18	Gully at outlet runs 2000 ft. to 12N38. Ditch needs maintenance.
15N01-11.90	18	Hydrologically connected.

Table III-4. **Cross Drain Maintenance.** Cross drain sites in need of maintenance in the Camp-Slate Creek watersheds. Sorted by road number. Road numbers with a decimal place (e.g., 12N01.1) indicate a non-system road.

Road Number and Mile Post	Culvert Diameter (inches)	Existing Conditions
11N14-0.23	18	Inlet is 100% plugged. Ditch needs maintenance.
11N30-0.49	18	Inlet covered by debris. Ditch needs maintenance.
11N36A-0.85	18	36 inch downspout drains spring. Ditch needs maintenance. Road blocked 0.1 miles above.
11N36B-0.40	18	Ditch needs maintenance. Walk in access only.
11N44-0.71	18	Inlet 50% plugged.
11N45-0.83	18	Inlet partially plugged.
11N45-2.39	18	Ditch needs maintenance.
11N46-0.68	18	Inlet is 25% plugged. Ditch needs maintenance.
11N46-0.92	18	Ditch needs maintenance.
11N46-1.22	18	Inlet 50% plugged. Ditch needs maintenance.
11N46-2.37	18	Inlet is 25% plugged. Ditch needs maintenance.
11N55-1.10	18	Inlet 50% plugged.
12N01.080	24	Ditch needs maintenance. Diverts to another cross drain.
12N01.1-.10	18	Ditch needs maintenance.
12N01.1-.25	24	Abandoned road above 12N01. Culvert needs to be removed. Ditch needs maintenance.
12N01-0.50	18	Ditch needs maintenance.
12N01-0.60	24	36 inch drop inlet. Ditch needs maintenance.
12N01-0.65	24	Ditch needs maintenance.
12N01-1.10	24	36 inch drop inlet. Ditch needs maintenance.
12N01-1.14	18	36 inch drop inlet. Ditch needs maintenance.
12N01-1.20	18	Ditch needs maintenance.
12N05-0.33	18	Inlet is 100% plugged. Ditch needs maintenance.
12N05-0.42	18	Inlet is 100% plugged. Ditch needs maintenance.
12N12-1.02	18	Inlet 25% Plugged.
12N12-1.21	18	50% rusted. Drains spring.
12N12-11.13	18	36 inch drop inlet crushed and separated.
12N12-12.74	18	Inlet 100% plugged. Barely visible. Ditch needs maintenance.
12N12-12.85	24	36 inch drop inlet covered by brush and debris. Outlet not visible. Ditch needs maintenance.
12N12-13.23	24	36 inch drop inlet. Ditch needs maintenance.
12N12-15.16	18	Inlet 50% plugged.
12N12-16.80	18	Outlet is 90% plugged.
12N12-17.60	18	Outlet is 95% plugged.
12N12-2.12	18	Inlet 25% Plugged.
12N12-2.99	24	Side of drop inlet 50% plugged. Ditch needs maintenance.
12N12-24.86	18	Outlet 50% plugged. 36 inch drop inlet.
12N12-4.49	18	Outlet crushed. Pipe rusted. Drains spring.
12N12-5.70	18	Inlet and outlet 50% plugged. Does not drain inboard ditch.
12N12-6.16	18	Outlet is 75% plugged and crushed. Culvert rusted.
12N12-6.34	18	Inlet partially crushed. 36 inch drop inlet.

Table II I-4. **Cross Drain Maintenance** (continued)

12N12-7.24	18	Ditch needs maintenance.
12N12-8.72	18	36 inch drop inlet. Outlet not visible due to vegetation. Could be downspout or buried.
12N12C-0.12	18	Outlet is plugged. Ditch needs maintenance.
12N12C-0.42	18	Outlet is 50% crushed. Ditch needs maintenance.
12N12C-2.41	18	Ditch needs maintenance.
12N16-0.03	18	Outlet is 75% plugged. May need to remover some fill on fillslope.
12N16-0.06	24	Ditch needs maintenance. Ditch not catching flow.
12N19-2.24	18	Inlet plugged. Ditch needs maintenance.
12N19-2.28	18	Ditch needs maintenance.
12N20-0.92	18	Trash rack needs cleaning. Ditch needs maintenance.
12N20-2.40	18	Inlet plugged.
12N20-3.05	18	Inlet 50% plugged.
12N20-3.15	18	Outlet is 100% plugged.
12N20-3.25	18	Inlet 50% plugged.
12N20-5.18	18	Outlet is 90% plugged. 36 inch drop inlet. Cover rotted.
12N46-0.10	18	Inlet 100% plugged. Currently has flow from seep.
15N01-1.15	18	Inlet is 100% buried. Cutslope slump covering half of drop inlet. Ditch needs maintenance.
15N01-10.30	18	Outlet 100% plugged.
15N01-10.95	18	Drop inlet is 100% plugged.
15N01-11.10	18	Inlet is 75% plugged.
15N01-11.13	18	Inlet is 50% plugged with cutslope ravel.
15N01-12.20	18	Ditch needs maintenance. Ditch full of ravel.
15N01-12.62	18	Inlet 50% plugged. Drop inlet.
15N01-12.78	24	Ditch needs maintenance. Ditch full of ravel.
15N01-13.08	18	Outlet is 75% plugged.
15N01-16.00	18	Drop inlet cover needs replacing.
15N01-16.20	18	Drop inlet cover needs replacing.
15N01-4.73	18	Outlet is 75% plugged.
15N01-5.98	18	Inlet 50% plugged.
15N01-8.12	18	Inlet is 25% plugged.

Table III-5. **Erosional Features.** Road-related erosional features in the Camp-Slate Creek watersheds. Sorted by priority. Road numbers with a decimal place (e.g., 12N01.1) indicates a non-system road.

Road Number Milepost	Erosion Type	Location of Feature	Present Condition	Volume of Feature	Priority	Future Sediment Yield to Streams (cy)	Existing Conditions
11N05-0.24	debris slide	cutslope	active	3,150	High	800	Future failure of cutslope will cause diversion and have direct delivery into Slate creek.
11N44-0.27	debris slide	fillslope	active	2,250	High	345	Over steep fillslope ravel.
11N48-2.73	slump	cutslope	recovering	350	High	280	Large volume near stream.
11N38-1.35	debris slide	fillslope	active	378	High	198	Saturated road fill. Logs rotting in fill. Walk-in access only.
10N11-0.21	slump	fillslope	active	250	High	168	Tension crack in roadbed. Feature adjacent to stream crossing 10N11-0.20.
10N11-0.16	slump	fillslope	active	200	High	140	Tension cracks in roadbed. Stream directly below.
12N18-0.71	debris slide	cutslope	active	400	High	100	Sediment deposited into intermittent stream. Slide continues thru road.
12N36-3.72	debris slide	fillslope	active	60	High	20	Direct delivery but little volume remaining.
12N01-1.32	debris slide	cutslope	active	150	High	15	Debris slide originates from non-system road 12N01.1. Close proximity to Camp Creek.
11N05-0.31	debris slide	cutslope	active	50	High	8	May plug stream crossing 11N05-0.30 and cause long diversion.
12N01-1.21	gully	cutslope	active	168	High	0	Caused by cross drain on non-system road 12N01.1. Close proximity to Camp Creek.
11N65A-0.13	debris slide	fillslope	active	700	Medium	150	High in watershed. Delivery to ephemeral stream.
12N12-8.08	debris slide	cutslope	active	31	Medium	5	Rocky area with active rock slides.
12N20J-0.10	gully	roadbed	active	100	Medium	100	600 feet in length.
11N44-1.82.	slump	fillslope	active	500	Medium	100	Walk-in access only.
11N46-0.74	debris slide	fillslope	active	500	Medium	50	Close to spring. Sediment stored on hillslope.
15N01-9.31	gully	fillslope	active	50	Medium	50	Uproad inboard ditch drains onto fillslope. Old silt fences at site not working.
11N49-2.20	gully	roadbed	active	16	Medium	8	Gully runs along road for 400 ft.
12N12-1.68	debris slide	cutslope	active	31	Medium	0	Chronic cutslope failure.
11N36A-0.13	gully	roadbed	active	120	Medium	3	Bad gullies along first 0.3 miles of road. Recommend installation of waterbars.

Table III-5. **Erosional Features** (continued)

10N04-0.55	gully	roadbed	active	1	Medium	1	Delivers to channel.
11N36B-0.40	slump	fillslope	active	2,700	Low	265	No nearby perennial streams.
12N37E-0.65.	slump	fillslope	active	1,000	Low	50	6 inch tension cracks. Part of small landing far above creek.
15N01F-0.17	slump	fillslope	active	800	Low	35	Large bench below.
11N36B-0.35	slump	fillslope	Unknown	350	Low	18	
11N44-1.70	slump	fillslope	active	300	Low	15	Tension cracks on road and fill. Walk-in access only.
11N36B-0.30	slump	fillslope	Unknown	250	Low	13	
11N36B-0.20	slump	fillslope	active	160	Low	8	No nearby perennial streams.
11N45-0.83	debris slide	cutslope	active	60	Low	5	
11N46-0.05	debris slide	cutslope	active	50	Low	5	Sediment stored on road.
12N38B\ 12N38-0.05	gully	roadbed	active	6	Low	3	Settling basin catching half of sediment. On map as 12N38, signed on ground as 12N38B.
10N04-2.00	gully	roadbed	active	3	Low	0	Map shows stream below. Not sure its connected.
11N38-1.46	debris slide	fillslope	recovering	60	Low	0	May have been caused by old diversion or failed cutslope.
11N47.1-0.70	debris slide	roadbed	active	100	Low	0	Material deposited on road 12N12.
11N47.1-0.72	debris slide	roadbed	active	425	Low	0	Material deposited on road 12N12 and hillslope.
12N01.1-0.35	debris slide	cutslope	active	20	Low	0	
12N37-1.27	debris slide	fillslope	active	800	Low	0	Most material has failed. Remaining fillslope has been pulled. End of drivable road.
12N39-1.75	debris slide	fillslope	active	280	Low	0	
12N40-2.43	debris slide	cutslope	active	650	Low	0	No delivery to stream. Slide transects road.
11N46.1-0.05	gully	roadbed	active	240	Low	0	Sediment settles on flat area.
12N20-5.10	slump	roadbed	active	240	Low	0	Little potential of delivery.
12N23-0.01	slump	fillslope	active	1,500	Low	0	Large cracks but no vertical displacement. Feature continues down road.

Appendix IV

Road Log

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
10N04		**2.93**	**1**	**2**	**0.1%**	**Medium**	**159**
Mile Post			Existing Condition		Recommended Treatment		
0.55	Stream Xing	ephem	Gully flows into stream below crossing. Four large gullies close to crossing. Potential diversion.		Improve road drainage upslope of crossing. Install diversion dip.	**Medium**	131
0.55	Erosion					**Medium**	5
0.73	Stream Xing	intrmt	Culvert undersized. Potential diversion. Stream flows down skid trail above site.		Re-size/replace culvert. Install diversion dip/waterbar on skid trail.	**High**	23
2.00	Erosion					**Low**	0

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
10N11		**0.53**	**2**	**0**	**3.2%**	**Low**	**308**
Mile Post			Existing Condition		Recommended Treatment		
0.16	Erosion		Tension cracks - stream directly below.			**High**	140
0.20	Stream Xing	ephem				**Low**	
0.21	Erosion		Tension crack. Feature on opposite side of draw from stream crossing. Stream directly below.			**High**	168

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
10N15		**1.12**	**0**	**1**	**0.8%**	**Low**	**112**
Mile Post			Existing Condition		Recommended Treatment		
0.65	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	112

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
10N15A		**0.41**	**2**	**1**	**29.7%**	**High**	**565**
Mile Post			Existing Condition		Recommended Treatment		
0.10	Stream Xing	ephem	Culvert undersized. Inlet plugged. Saturated roadfill. Walk in access only.		Re-size/replace, remove culvert or clear inlet.	**High**	325
0.16	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	155
0.22	Stream Xing	intrmt	Culvert undersized. Stream overtopped culvert. Inlet plugged. High consequence of failure. Walk in access only.		Re-size/replace, remove or clear culvert.	**High**	85

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N05		**10.76**	**8**	**11**	**6.7%**	**High**	**2,830**
Mile Post			Existing Condition		Recommended Treatment		
0.24	Stream Xing	ephem	Stream overtopped culvert. Active slide upslope. Potential diversion. Flows directly to anadromous reach.		Stabilize slide. Re-size/replace culvert. Stabilize slide. Install diversion dip.	**High**	278
0.24	Erosion		Future failure of cutslope will cause diversion and have direct delivery to Slate Creek.			**High**	800
0.30	Stream Xing	intrmt	Culvert undersized. Stream overtopped culvert. Debris flow up channel. Potential diversion. Flows directly to anadromous reach.		Examine upstream slide for stabilization. Re-size/replace culvert. Install diversion dip.	**High**	234
0.31	Erosion		May plug CMP and cause long diversion.			**High**	20
0.38	Stream Xing	intrmt	Culvert undersized. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	240
0.49	Stream Xing	intrmt	Culvert undersized. Fill failing. Gullies in stream channel. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	67
0.51	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	154
1.65	X-Drain						
3.05	X-Drain						
3.12	X-Drain						
4.00	X-Drain						
9.95	X-Drain						
10.10	X-Drain						
10.18	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	163
10.20	Stream Xing	ephem	Culvert undersized. Stream overtopped culvert. Potential diversion. Evidence of past failure by cutslope ravel. Spring near site.		Re-size/replace culvert. Install diversion dip.	**High**	201
10.30	Stream Xing	ephem	Long contributing ditch. Potential diversion.		Disconnect ditch from stream. Install diversion dip.	**Medium**	144
10.35	Stream Xing	ephem	Long contributing ditch. Potential diversion.		Disconnect ditch from stream. Install diversion dip.	**Medium**	175
10.42	X-Drain						
10.50	X-Drain		Hydrologically connected		Disconnect from stream.	**High**	
10.55	X-Drain						
10.68	X-Drain						
10.76	X-Drain						
10.88	X-Drain						
10.95	X-Drain						
11.18	Stream Xing	ephem	Long contributing ditch. Potential diversion.		Disconnect ditch from stream. Install diversion dip.	**Medium**	104

Table IV-1. Camp-Slate Creek watersheds road log.

11.26	X-Drain					
11.30	Stream Xing	spr	Long contributing ditch. Potential diversion.	Disconnect ditch from stream. Install diversion dip.	**Medium**	249

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N14	**1.08**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.15	X-Drain					
0.23	X-Drain	Inlet buried.			**Maintenance**	

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Road High Immediacy	Total Sediment 'Saved' (cy)
11N18	**2.00**	**1**	**1**	**0.5%**	**Medium**	**179**
Mile Post		Existing Condition		Recommended Treatment		
0.38	Stream Xing	spr	Culvert undersized. Saturated roadbed. Fill failing. Water ponding. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	179

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N30	**2.12**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.49	X-Drain	Debris covering inlet.			**Maintenance**	

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N31A	**1.11**	**0**	**1**	**0.3%**	**Low**	**14**
Mile Post		Existing Condition		Recommended Treatment		
0.25	Stream Xing	per	2 seeps exist along road that are not properly drained. Surface erosion present. Culvert undersized. Potential diversion	Improve drainage. Re-size/replace culvert. Install diversion dip.	**Medium**	14

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N36A		**1.33**	**0**	**0**	**0.0%**	**Medium**	**3**
Mile Post			Existing Condition		Recommended Treatment		
0.13	Erosion					**Medium**	3
0.85	X-Drain					**Maintenance**	
1.25	X-Drain						

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N36B		**1.19**	**0**	**0**	**0.0%**	**Low**	**303**
Mile Post			Existing Condition		Recommended Treatment		
0.20	Erosion					**Low**	8
0.30	Erosion					**Low**	13
0.35	Erosion					**Low**	18
0.40	Erosion		No stream nearby.			**Low**	265
0.40	X-Drain		Walk-in only			**Maintenance**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N38		**1.66**	**5**	**6**	**12.7%**	**High**	**1,351**
Mile Post			Existing Condition		Recommended Treatment		
0.80	Stream Xing	ephem	Culvert undersized. Saturated roadbed. Gullies on road. Potential diversion. Walk in access only.		Pull crossing. Decommission road.	**High**	103
1.00	X-Drain						
1.25	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	106
1.35	Stream Xing	spr	Culvert undersized. Major flow thru fill. Saturated		Pull crossing. Decommission road.	**High**	192
1.35	Erosion		Fill and roadbed saturated. Logs rotting in fill. Walk-in			**High**	198
1.45	Stream Xing	per	Culvert undersized. Saturated roadbed. Potential diversion to unstable slope. Walk in access only.		Pull crossing. Decommission road.	**High**	128
1.46	Erosion					**Low**	
1.60	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	514
1.70	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	67
1.72	Stream Xing	spr	Culvert undersized. Stream overtopped culvert. Saturated roadbed. Actively diverting down road. Walk-in only.		Pull crossing. Decommission road.	**High**	42

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N44		**1.79**	**4**	**8**	**22.7%**	**High**	**3,683**
Mile Post			Existing Condition		Recommended Treatment		
0.27	Erosion		Oversteepened fill slope.			**High**	345
0.71	X-Drain		Inlet 50% plugged at perennial seep.			**Maintenance**	
0.81	Stream Xing	per	Undersized (high rustline) with diversion potential and long contributing ditch.		Re-size/replace culvert. Install diversion dip.	**Medium**	1,408
0.93	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	257
0.97	X-Drain						
1.02	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	110
1.04	Stream Xing	per	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion.		Re-size/replace culvert. Clear inlet. Install diversion dip.	**High**	807
1.07	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	154
1.09	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	46
1.20	Stream Xing	intrmt	Culvert undersized. Stream overtopped culvert. Inlet plugged. Fill failing. Actively diverting.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	233
1.27	X-Drain		Hydrologically connected. Stream crossing at MP-1.2 diverted to here.		Disconnect from stream	**High**	
1.33	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	208
1.70	Erosion					**Low**	15
1.82	Erosion					**Medium**	100

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N45		**5.29**	**0**	**0**	**0.0%**	**Low**	**3**
Mile Post			Existing Condition		Recommended Treatment		
0.83	Erosion					**Low**	3
0.83	X-Drain		Inlet maintenance			**Maintenance**	
2.39	X-Drain		Ditch Maintenance			**Maintenance**	
3.20	X-Drain						

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N45A		**1.17**	**0**	**0**	**0.0%**	**Low**	**47**
Mile Post			Existing Condition		Recommended Treatment		
0.50	Stream Xing	intrmt	2 channels at crossing, one eroding road. Culvert undersized.		Resize/replace culvert. Protect road prism from erosion	**Medium**	47

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N46		**3.45**	**7**	**7**	**10.0%**	**High**	**3,625**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Erosion					**Low**	3
0.10	Stream Xing	per	Culvert undersized. Stream overtopped culvert. Flow thru fill. Potential diversion. Pond below site.		Re-size/replace culvert. Install diversion dip.	**High**	662
0.15	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	196
0.21	Stream Xing	spr	Culvert undersized. Flow thru fill. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	190
0.25	Stream Xing	per	Culvert undersized. Flow thru fill. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	348
0.30	X-Drain		Hydrologically connected.		Disconnect from stream.	**High**	
0.42	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	369
0.43	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	1,128
0.68	X-Drain		Inlet 50% plugged			**Maintenance**	
0.71	Stream Xing	per				**Low**	
0.74	Erosion					**Medium**	50
0.92	X-Drain		Ditch Maintenance			**Maintenance**	
1.14	X-Drain		Drains spring along road. Fill saturated.			**High**	
1.22	X-Drain		Inlet partially buried.			**Maintenance**	
1.82	Stream Xing	per	Culvert undersized. Flow thru fill.		Re-size/replace culvert.	**High**	638
2.00	Stream Xing	per				**Low**	
2.06	Stream Xing	spr	Culvert undersized. Major flow thru fill. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	42
2.37	X-Drain		Inlet is 25% plugged.			**Maintenance**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N46.1		**0.15**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Erosion					**Low**	
0.10	Stream Xing	per				**Low**	

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N47.1			**1**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.50	X-Drain		Culvert rusted through. Inlet crushed and outlet buried.			**High**	
0.70	Erosion					**Low**	
0.72	Erosion					**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N48		**2.86**	**2**	**2**	**0.7%**	**High**	**587**
Mile Post			Existing Condition		Recommended Treatment		
2.49	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	111
2.70	Stream Xing	per	Culvert undersized. Inlet plugged. Potential diversion. Long diversion length.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	196
2.73	Erosion		Large volume remaining. Near Stream.			**High**	280

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N49		**2.79**	**2**	**0**	**0.3%**	**Medium**	**149**
Mile Post			Existing Condition		Recommended Treatment		
0.23	X-Drain		Seep saturating road fill. Fixed by cleaning ditch.			**High**	
0.65	Stream Xing	intrmt	Culvert undersized. Stream overtopped culvert. Flow thru fill.		Re-size/replace culvert.	**High**	149
2.20	Erosion					**Medium**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N50		**2.64**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
1.70	X-Drain						
2.41	X-Drain						
2.42	X-Drain						

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N55		**1.93**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
1.02	X-Drain		Hydrologically connected. High priority. Seep.		Disconnect from stream.	**High**	
1.10	X-Drain		Pipe 50% plugged			**Maintenance**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N59A		**0.35**	**0**	**0**	**0.8%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.10	Stream Xing	ephem				**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
11N65A		**0.67**	**0**	**1**	**1.7%**	**Medium**	**212**
Mile Post			Existing Condition		Recommended Treatment		
0.13	Erosion					**Medium**	150
0.23	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	62
0.31	Stream Xing	intrmt				**Low**	
0.38	Stream Xing	ephem				**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N01		**1.93**	**5**	**2**	**10.8%**	**High**	**291**
Mile Post			Existing Condition		Recommended Treatment		
0.50	X-Drain		Ditch Maintenance			**Maintenance**	
0.60	X-Drain					**Maintenance**	
0.65	X-Drain		Ditch Maintenance			**Maintenance**	
1.00	Stream Xing	per	Culvert undersized. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	248
1.10	X-Drain					**Maintenance**	
1.14	X-Drain		Ditch needs maintenance.			**Maintenance**	
1.20	X-Drain		Ditch Maintenance			**Maintenance**	
1.21	Erosion		Caused by cross-drain on above abandoned road. Close proximity to Camp Creek.			**High**	
1.31	X-Drain		Hydrologically Connected		Disconnect from stream.	**High**	

Table IV-1. Camp-Slate Creek watersheds road log.

1.32	Erosion		Caused by abandoned road upslope. Close proximity to Camp Creek.		**High**	15
1.41	X-Drain		Hydrologically connected.	Disconnect ditch from stream.	**High**	
1.74	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	29
1.76	Stream Xing	intrmt			**Low**	
1.82	Stream Xing	per			**Low**	
0.80	X-Drain		Diverts to another cross-drain.		**Maintenance**	

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N01.1		**0.20**	**0**	**0**	**0.0%**	**High**	**20**
Mile Post			Existing Condition		Recommended Treatment		
0.10	X-Drain		Ditch Maintenance			**Maintenance**	
0.25	X-Drain		Abandoned road.			**Maintenance**	
0.35	Erosion					**Medium**	20

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N02		**1.47**	**1**	**3**	**0.7%**	**Medium**	**274**
Mile Post			Existing Condition		Recommended Treatment		
0.56	Stream Xing	intrmt	Inlet 75% plugged and downspout separated from outlet.		Unplug and fix downspout.	**Medium**	26
0.83	Stream Xing	ephem	Culvert undersized. Stream overtopped culvert. Active diversion causing gully.		Re-size/replace culvert. Install diversion dip.	**High**	113
0.92	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	42
1.00	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	65
1.20	Stream Xing	ephem	Inlet plugged		Unplug inlet.	**Medium**	28

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N05		**2.29**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.33	X-Drain		Inlet 100% plugged			**Maintenance**	
0.42	X-Drain		Inlet 100% plugged			**Maintenance**	
1.02	X-Drain						

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N12		**23.82**	**27**	**22**	**41.4%**	**High**	**12,847**
Mile Post			Existing Condition		Recommended Treatment		
0.02	X-Drain						
0.04	Stream Xing	intrmt	Outlet buried. Culvert undersized. Potential diversion		Re-size/replace culvert. Install diversion dip.	**Medium**	154
0.09	Stream Xing	per	Culvert undersized. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	131
0.18	Stream Xing	per	Inlet plugged 25%. Potential diversion		Unplug inlet. Install diversion dip.	**Medium**	38
0.19	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	84
0.65	Stream Xing	per	Culvert undersized. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	71
0.68	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	234
0.69	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	123
0.70	Stream Xing	spr	Major flow thru fill. Culvert rusted thru. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	206
0.72	Stream Xing	intrmt	Culvert undersized. Flow thru fill. Flows directly to anadromous reach.		Re-size/replace culvert.	**High**	431
0.82	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	909
0.93	X-Drain						
0.99	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	573
1.02	X-Drain		Hydrologically connected. Inlet 25% plugged with sediment. Outlet partially plugged.			**Maintenance**	
1.05	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	691
1.19	X-Drain		Inlet 25% plugged and crushed.		Disconnect ditch from stream.	**High**	
1.21	X-Drain		Drains active spring 35 feet up the ditch.			**Maintenance**	
1.68	Erosion		Caused by lack of culvert above. Water on upper road is draining concentrating and draining on slope.			**High**	91
2.12	X-Drain		Hydrologically connected. Inlet 25% filled with sediment and debris.			**Maintenance**	
2.51	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	245
2.99	X-Drain		Hydrologically connected. Inlet 50% plugged with sediment.			**Maintenance**	
3.12	X-Drain						
3.25	Stream Xing	per	Culvert undersized. Flow thru fill.		Re-size/replace culvert.	**High**	88
3.29	X-Drain		Hydrologically connected. Inlet 50% plugged. Outlet 75% plugged.		Disconnect ditch from stream.	**High**	
4.36	X-Drain						
4.49	X-Drain		Hydrologically connected. Outlet crushed and highly rusted.			**Maintenance**	

Table IV-1. Camp-Slate Creek watersheds road log.

4.55	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	1,230
4.68	Stream Xing	per	Culvert undersized. Major flow thru fill. Culvert rusted	Re-size/replace culvert.	**High**	544
4.74	Stream Xing	per	Culvert undersized. Flow thru fill. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	3
5.23	X-Drain					
5.32	Stream Xing	spr	Culvert undersized. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	92
5.42	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	132
5.50	Stream Xing	spr	Culvert undersized. Flow thru fill.	Re-size/replace culvert.	**High**	158
5.70	X-Drain		Inlet 50% plugged.		**Maintenance**	
6.16	X-Drain		Outlet 75% crushed.		**Maintenance**	
6.24	Stream Xing	ephem			**Low**	
6.30	X-Drain		Hydrologically connected. Drains active spring in ditch 5 feet up road. Inlet rusted through.		**High**	
6.34	X-Drain		Inlet partially crushed.		**Maintenance**	
7.24	X-Drain		Ditch Maintenance.		**Maintenance**	
7.64	X-Drain					
7.89	Stream Xing	ephem			**Low**	
8.08	Erosion				**Medium**	5
8.08	X-Drain					
8.49	X-Drain					
8.69	Stream Xing	ephem			**Low**	
8.72	X-Drain		Outlet plugged or under debris.		**Maintenance**	
11.13	X-Drain		Drop inlet crushed and separated.		**Maintenance**	
11.63	X-Drain		Pipe rusted through.		**High**	
12.64	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	327
12.74	X-Drain		Inlet buried.		**Maintenance**	
12.85	X-Drain		Inlet hidden by brush and debris.		**Maintenance**	
13.23	X-Drain				**Maintenance**	
13.36	X-Drain					
15.16	X-Drain		Inlet 50% plugged by brush and sediment.		**Maintenance**	
15.29	X-Drain					
15.39	Stream Xing	intrmt	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	1,466
15.52	X-Drain		Hydrologically connected. Inlet 25% plugged.	Disconnect ditch from stream.	**High**	
15.63	Stream Xing	ephem	Culvert undersized. Flow thru fill. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	18
15.76	X-Drain		Hydrologically connected.	Disconnect ditch from stream.	**High**	
16.00	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	809
16.09	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	3,493
16.32	X-Drain					
16.80	X-Drain		Outlet 90% plugged.		**Maintenance**	
17.38	X-Drain					

Table IV-1. Camp-Slate Creek watersheds road log.

17.50	X-Drain					
17.60	X-Drain		Outlet 95% plugged.		**Maintenance**	
17.71	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	591
17.89	X-Drain		Ponding at inlet. 75% crushed and plugged. May have flow under. Outlet buried.		**High**	
24.56	X-Drain		Hydrologically connected. Inlet 50% plugged. Highly rusted.	Disconnect ditch from stream.	**High**	
24.86	X-Drain		Outlet blocked 50% by sediment.		**Maintenance**	

Road Number	**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N12C	**2.91**	**1**	**0**	**1.4%**	**Medium**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.12	X-Drain	Outlet plugged.			**Maintenance**	
0.42	X-Drain	Outlet 50% crushed.			**Maintenance**	
2.27	X-Drain	Hydrologically connected. Beginning of stream.		Disconnect ditch from stream.	**High**	
2.29	Stream Xing	spr			**Low**	
2.41	X-Drain	Ditch Maintenance.			**Maintenance**	
2.73	X-Drain					

Road Number	**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N12E	**0.87**	**0**	**0**	**0.9%**	**Low**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.44	Stream Xing	spr			**Low**	

Road Number	**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N16	**1.89**	**0**	**0**	**9.2%**	**Medium**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.03	X-Drain	Outlet 75% plugged.			**Maintenance**	
0.06	X-Drain	Ditch not catching flow.			**Maintenance**	
0.20	X-Drain					
0.71	X-Drain					
0.78	Stream Xing	ephem			**Low**	

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N18		**2.05**	**2**	**5**	**1.5%**	**High**	**1,777**
Mile Post			Existing Condition		Recommended Treatment		
0.71	Erosion		Slide continues through road. Looks connected to intermittent stream.			**High**	100
0.90	Stream Xing	intrmt	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion. Water running down road.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	349
0.92	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	614
1.02	Stream Xing	intrmt				**Low**	
1.24	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	160
1.66	Stream Xing	ephem	25% plugged by sediment. Potential diversion.		Unplug inlet. Install diversion dip.	**Medium**	286
1.78	Stream Xing	ephem	Inlet 25% plugged. Culvert undersized. Potential diversion		Re-size/replace culvert. Install diversion dip.	**Medium**	267

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N19		**2.72**	**1**	**5**	**5.7%**	**High**	**1,193**
Mile Post			Existing Condition		Recommended Treatment		
0.18	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	436
0.83	Stream Xing	per	Culvert undersized. Stream overtopped culvert. Inlet plugged. Potential diversion.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	87
2.24	X-Drain		Inlet plugged with woody debris.			**Maintenance**	
2.28	X-Drain		Ditch Maintenance			**Maintenance**	
2.34	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	427
2.41	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	117
2.42	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	125

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N20		**6.22**	**7**	**14**	**33.8%**	**High**	**10,654**
Mile Post			Existing Condition		Recommended Treatment		
0.01	X-Drain						
0.09	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	458
0.20	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	576
0.39	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	554
0.60	X-Drain						
0.65	X-Drain		Large slump.			**High**	
0.73	X-Drain						

Table IV-1. Camp-Slate Creek watersheds road log.

0.80	X-Drain					
0.92	X-Drain		Trash rack needs cleaning		**Maintenance**	
1.05	X-Drain					
1.28	Stream Xing	spr	Culvert undersized. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	107
1.30	X-Drain					
1.35	X-Drain					
1.54	Stream Xing	intrmt			**Low**	
1.67	X-Drain					
1.85	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	41
1.90	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	376
1.91	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	265
1.95	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	45
2.00	Stream Xing	spr	Potential diversion.	Install diversion dip.	**Medium**	114
2.02	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	146
2.11	X-Drain		Hydrologically connected	Disconnect ditch from stream.	**High**	
2.12	Stream Xing	ephem			**Low**	
2.30	Stream Xing	per	Long contributing ditch to large stream	Disconnect ditch from stream.	**Medium**	4,338
2.40	X-Drain		15 feet to Browns Creek. Partially plugged.		**Maintenance**	
2.49	Stream Xing	per	Potential diversion.	Install diversion dip.	**Medium**	791
2.59	X-Drain					
2.65	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	65
2.74	Stream Xing	spr	Potential diversion.	Install diversion dip.	**Medium**	1,634
2.95	Stream Xing	spr	Potential diversion.	Install diversion dip.	**Medium**	206
3.05	X-Drain		Inlet 50% plugged.		**Maintenance**	
3.15	X-Drain		Outlet buried.		**Maintenance**	
3.25	X-Drain		Inlet 50% plugged.		**Maintenance**	
3.80	X-Drain		Hydrologically connected. Inlet 50% plugged.	Disconnect ditch from stream.	**High**	
3.89	Stream Xing	ephem			**Low**	
4.00	Stream Xing	per	Culvert undersized. Culvert highly rusted. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**High**	854
4.60	X-Drain					
4.65	Stream Xing	ephem	Culvert undersized. Slump thru fill. Downspout unattached.	Re-size/replace culvert.	**High**	86
4.70	X-Drain		Fill saturated		**High**	
5.10	Erosion				**Low**	
5.18	X-Drain		Inlet 90% plugged		**Maintenance**	

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N20D		**0.90**	**0**	**2**	**7.1%**	**Medium**	**56**
Mile Post			Existing Condition		Recommended Treatment		
0.49	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	25
0.70	X-Drain						
0.90	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	31

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N20E		**0.33**		**2**	**60.3%**	**Medium**	**112**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Stream Xing	intrmt	Undersized culvert. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**Medium**	22
0.14	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	30
0.22	Stream Xing	per	Long contributing ditch.		Disconnect ditch from stream.	**Medium**	60

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N20G		**0.67**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.55	X-Drain						

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N20J		**1.28**	**0**	**0**	**0.0%**	**Low**	**100**
Mile Post			Existing Condition		Recommended Treatment		
0.10	Erosion					**Medium**	100

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N23		**0.61**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.01	Erosion					**Low**	

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N23A		**0.53**	**0**	**1**	**0.0%**	**Low**	**155**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Stream Xing	ephem	Gullies on roadbed. Potential Diversion		Improve road drainage. Install diversion dip.	**Medium**	155

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N35		**2.95**	**0**	**1**	**0.4%**	**Low**	**73**
Mile Post			Existing Condition		Recommended Treatment		
1.57	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	73
2.00	Stream Xing	ephem				**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N35A		**1.03**	**0**	**1**	**0.0%**	**Low**	**75**
Mile Post			Existing Condition		Recommended Treatment		
0.10	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	75

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N36		**3.81**	**2**	**8**	**0.1%**	**High**	**1,229**
Mile Post			Existing Condition		Recommended Treatment		
2.30	Stream Xing	ephem	Gully leading from roadbed down filslope at outlet. Potential Diversion.		Improve road drainage upslope of crossing. Install diversion dip.	**Medium**	142
2.87	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	74
3.09	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	123
3.20	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	57
3.36	Stream Xing	ephem				**Low**	
3.50	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	54
3.58	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	226
3.65	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	90
3.72	Stream Xing	spr	Fill failing. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	444
3.72	Erosion					**High**	20

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N36A		**1.32**	**1**	**4**	**3.1%**	**Medium**	**461**
Mile Post			Existing Condition		Recommended Treatment		
0.80	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	161
1.05	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	123
1.10	Stream Xing	ephem	Road surface rutted and wet. Potential diversion.		Improve drainage. Install diversion dip.	**Medium**	74
1.18	Stream Xing	spr	Culvert undersized. Stream overtopped culvert. Saturated roadbed. Fill failing. Actively diverting down road.		Re-size/replace culvert. Install diversion dip.	**High**	102

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N37		**1.74**	**0**	**0**	**0.3%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.89	Stream Xing	ephem				**Low**	
1.27	Erosion					**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N37E		**0.87**	**0**	**0**	**0.0%**	**Low**	**50**
Mile Post			Existing Condition		Recommended Treatment		
0.65	Erosion		6" tension cracks. Portion of landing far from stream.			**Low**	50

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N38		**1.03**	**2**	**2**	**22.4%**	**High**	**180**
Mile Post			Existing Condition		Recommended Treatment		
0.01	X-Drain						
0.19	X-Drain		Uproad stream in ditch. Gullies connected to stream at stream crossing.			**High**	
0.23	X-Drain						
0.30	Stream Xing	ephem	Long contributing ditch. Potential diversion.		Disconnect ditch from stream. Install diversion dip.	**Medium**	88

Table IV-1. Camp-Slate Creek watersheds road log.

0.50	Stream Xing	ephem	Culvert undersized. Potential diversion. Large gullies upstream start from x-drain 15N01-11.19	Re-size/replace culvert. Install diversion dip. Add additional drainage structures near cross drain above site.	**High**	92

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N38A/12N49		**0.65**	**1**	**1**	**24.1%**	**Medium**	**58**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Stream Xing	spr	Culvert undersized. Flow thru fill. Potential diversion.		Re-size/replace culvert. Install diversion dip.	**High**	58
0.15	Stream Xing	intrmt				**Low**	

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N38B\12N38		**0.14**	**0**	**1**	**5.5%**	**Medium**	**63**
Mile Post			Existing Condition		Recommended Treatment		
0.05	Erosion					**Low**	3
0.10	Stream Xing	per	Potential diversion.		Install diversion dip.	**Medium**	60

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N39		**2.08**	**0**	**0**	**0.0%**	**Medium**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.75	Stream Xing	ephem	Inlet plugged with fillslope material. No evidence of flow in swale.			**Low**	
0.89	Stream Xing	ephem				**Low**	
1.75	Erosion					**Low**	

Road Number		**Length (mi)**	**No. of High Immediacy Sites**	**Xings with Diversion Potential**	**Percent of Road Connected to Streams**	**Treatment Immediacy**	**Total Sediment 'Saved' (cy)**
12N39B		**0.60**	**1**	**1**	**15.4%**	**Medium**	**390**
Mile Post			Existing Condition		Recommended Treatment		
0.10	Stream Xing	ephem	Gully on road leading to Camp tributary. Potential diversion.		Improve road drainage upslope of crossing. Install diversion dip.	**Medium**	19
0.15	Stream Xing	per	Culvert undersized. Stream overtopped culvert.		Re-size/replace culvert.	**High**	370

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N40		**3.88**	**0**	**0**	**0.0%**	**Low**	**258**
Mile Post			Existing Condition		Recommended Treatment		
2.43	Erosion					**Low**	
3.30	Stream Xing	ephem				**Low**	
3.90	Stream Xing	ephem	Inlet plugged		Unplug inlet.	**Medium**	157
4.20	Stream Xing	spr	Inlet basin full. Water bypassing inlet causing large gully. Culvert undersized.		Clear out inlet basin. Re-size/replace culvert.	**Medium**	101

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N40B		**1.50**	**2**	**0**	**2.0%**	**Medium**	**462**
Mile Post			Existing Condition		Recommended Treatment		
0.35	Stream Xing	ephem				**Low**	
0.85	Stream Xing	intrmt				**Low**	
1.00	Stream Xing	intrmt	Culvert undersized. Culvert highly rusted.		Re-size/replace culvert.	**High**	297
1.70	Stream Xing	intrmt				**Low**	
1.80	Stream Xing	ephem	Culvert undersized. Inlet plugged. Flow thru fill. 1/3 of fill beginning to slump.		Re-size/replace culvert or clear inlet.	**High**	165

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N40G		**1.23**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post			Existing Condition		Recommended Treatment		
0.81	Stream Xing	ephem				**Low**	

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N40H		**1.50**	**1**	**0**	**1.6%**	**Medium**	**528**
Mile Post			Existing Condition		Recommended Treatment		
0.04	Stream Xing	intrmt	Culvert undersized. Inlet plugged. Evidence of high flow.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	528

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
12N46		**1.45**	**1**	**1**	**0.4%**	**Medium**	**104**
Mile Post			Existing Condition		Recommended Treatment		
0.10	X-Drain		Flow from seep. Inlet buried.			**Maintenance**	
0.11	X-Drain		Hydrologically connected. Draining seep. Inlet covered in willows.		Disconnect ditch form stream.	**High**	
0.39	Stream Xing	ephem	Inlet 75% plugged, small diversion potential		Unplug outlet. Install diversion dip.	**Medium**	104

Road Number		Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
15N01		**17.11**	**6**	**32**	**25.1%**	**High**	**64,747**
Mile Post			Existing Condition		Recommended Treatment		
0.00	X-Drain		Hydrologically connected. Drains slump.		Disconnect ditch from stream.	**High**	
0.06	X-Drain						
0.18	X-Drain						
0.29	X-Drain						
0.38	X-Drain						
0.48	X-Drain						
0.55	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	579
0.61	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	1,271
0.70	X-Drain						
0.98	X-Drain						
1.08	X-Drain						
1.15	X-Drain		Cutslope slump covers drop inlet.			**Maintenance**	
1.23	X-Drain						
1.29	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	345
1.31	Stream Xing	intrmt	Potential diversion.		Install diversion dip.	**Medium**	1,460
1.65	X-Drain						
1.89	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	395
1.90	Stream Xing	ephem	Potential diversion.		Install diversion dip.	**Medium**	383
1.95	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	513
2.05	Stream Xing	per	Culvert undersized. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert. Install diversion dip.	**High**	9,216
2.13	X-Drain						
2.24	X-Drain						
2.33	X-Drain						
2.38	Stream Xing	per	Culvert undersized. Inlet plugged. Potential diversion. Flows directly to anadromous reach.		Re-size/replace culvert or clear inlet. Install diversion dip.	**High**	1,693
2.41	Stream Xing	spr	Potential diversion.		Install diversion dip.	**Medium**	525
2.49	X-Drain						

Table IV-1. Camp-Slate Creek watersheds road log.

2.57	X-Drain					
2.63	X-Drain					
2.69	X-Drain					
2.80	X-Drain					
2.89	X-Drain					
2.95	X-Drain					
3.03	X-Drain					
3.20	X-Drain					
3.30	X-Drain					
3.38	X-Drain					
3.49	X-Drain					
3.55	X-Drain					
3.62	X-Drain					
3.71	X-Drain					
3.80	X-Drain					
3.85	X-Drain					
3.91	X-Drain					
4.03	Stream Xing	intrmt	Undersized culvert. Potential diversion.	Re-size/replace culvert. Install diversion dip.	**Medium**	235
4.09	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	276
4.12	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	979
4.25	X-Drain					
4.37	X-Drain					
4.53	X-Drain					
4.66	Stream Xing	per	Potential diversion.	Install diversion dip.	**Medium**	386
4.73	X-Drain		Inlet 75% plugged.		**Maintenance**	
4.85	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	933
4.95	X-Drain					
5.05	X-Drain					
5.18	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	357
5.42	X-Drain					
5.55	Stream Xing	ephem	Inlet covered with debris.		**Low**	
5.69	X-Drain					
5.73	X-Drain					
5.83	Stream Xing	ephem			**Low**	
5.98	X-Drain		Inlet 50% plugged.		**Maintenance**	
6.10	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	1,760
6.33	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	499
6.41	Stream Xing	intrmt	Potential diversion.	Install diversion dip.	**Medium**	9,232
6.51	X-Drain					
6.71	X-Drain					
6.75	X-Drain					
6.89	X-Drain					

Table IV-1. Camp-Slate Creek watersheds road log.

7.09	X-Drain					
7.19	X-Drain					
7.27	X-Drain					
7.50	X-Drain					
7.55	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	1,171
7.70	Stream Xing	per	Potential diversion.	Install diversion dip.	**Medium**	7,333
7.73	X-Drain					
8.05	X-Drain					
8.08	X-Drain					
8.12	X-Drain		25% plugged with ravel.		**Maintenance**	
8.24	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	121
8.48	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	2,379
9.14	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	1,617
9.20	X-Drain					
9.31	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	3,244
9.31	Erosion				**Medium**	
9.44	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	1,112
9.52	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	2,022
9.88	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	2,906
9.95	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	907
10.25	X-Drain					
10.30	X-Drain		Outlet buried.		**Maintenance**	
10.55	X-Drain					
10.59	X-Drain					
10.70	X-Drain					
10.80	X-Drain					
10.85	X-Drain					
10.91	X-Drain					
10.95	X-Drain		Drop inlet filled with wood and sediment.		**Maintenance**	
11.03	X-Drain					
11.10	X-Drain		Inlet 75% plugged.		**Maintenance**	
11.13	X-Drain		Inlet 50% plugged with cutslope .		**Maintenance**	
11.19	X-Drain		Gully forming at outlet runs 200 feet to 12N38 to previously failed culvert. Gully volume of 70 cy.	Disconnect ditch.	**High**	70
11.50	Stream Xing	ephem	Fill at risk from headcut erosion. Large gully at outlet flows 300 ft. to 12N38-0.15.	Re-size/replace culvert or armor fill slope.	**High**	4,225
11.90	X-Drain		Suspect large gully at outlet connected to Hines Creek.	Disconnect ditch from stream.	**High**	
11.95	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	883
12.03	X-Drain					
12.10	X-Drain					
12.20	X-Drain		Ravel falling into ditch.		**Maintenance**	

Table IV-1. Camp-Slate Creek watersheds road log.

12.23	X-Drain					
12.35	X-Drain					
12.62	X-Drain		Inlet 50% plugged		**Maintenance**	
12.70	X-Drain					
12.78	X-Drain		Ditch full of ravel.		**Maintenance**	
12.85	X-Drain					
13.00	X-Drain					
13.08	X-Drain		Inlet 75% plugged with ravel.		**Maintenance**	
13.18	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	2,971
13.30	X-Drain					
13.41	X-Drain					
13.52	X-Drain					
14.09	X-Drain					
14.13	X-Drain					
14.55	X-Drain					
14.79	X-Drain					
15.03	Stream Xing	ephem	Potential diversion.	Install diversion dip.	**Medium**	2,748
15.36	X-Drain					
15.50	X-Drain					
15.60	X-Drain					
15.70	X-Drain					
16.00	X-Drain		Inlet cover needs replacement.		**Maintenance**	
16.09	X-Drain					
16.20	X-Drain		Inlet cover needs replacement.		**Maintenance**	
16.24	X-Drain					
16.36	X-Drain					
16.58	X-Drain					
16.69	X-Drain					
16.80	X-Drain					

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
15N01.2	**??**	**0**	**0**	**0.0%**	**Low**	**0**
Mile Post		Existing Condition		Recommended Treatment		
0.01 X-Drain						

Table IV-1. Camp-Slate Creek watersheds road log.

Road Number	Length (mi)	No. of High Immediacy Sites	Xings with Diversion Potential	Percent of Road Connected to Streams	Treatment Immediacy	Total Sediment 'Saved' (cy)
15N01F	**0.34**	**0**	**0**	**0.0%**	**Low**	**35**
Mile Post		Existing Condition		Recommended Treatment		
0.17 Erosion					**Low**	35

NORTH COAST INTEGRATED REGIONAL WATER MANAGEMENT PLAN

North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

311 - Indian Creek Sewer Pipeline Crossing, Happy Camp Sanitary District

- Preliminary Summary, Indian Creek Sewer Pipeline Crossing, Happy Camp, Karuk Tribe in Cooperation with Happy Camp Sanitary District, November 29, 2010
- Mid-Klamath Sub-Basin Fisheries Resource Recovery Plan, Karuk Tribe of California. Department of Natural Resources, Klamath River Basin Fisheries Task Force, 2003

Preliminary Summary Sheet

Indian Creek Sewer Pipeline Crossing

Happy Camp, CA

Karuk Tribe in Cooperation with Happy Camp Sanitary District

(Revised November 29, 2010)

1. The proposed project is located in Happy Camp, CA. Happy Camp is located in Siskiyou County along State Highway 96, adjacent to the Klamath River.

2. The existing sewer creek crossing, consisting of two 6-inch diameter ductile iron pipes, is currently exposed in the bed of Indian Creek. The photo below, taken on 6-16-2010 from the Caltrans Highway 96 Bridge, shows the two pipes in the creek bed (left to right) under about 2 feet of water. The crossing serves the majority of Happy Camp, providing the only crossing of Indian Creek. An estimated 60,000 gallons per day (gpd) of the total estimated 90,000 gpd of sewage that flows to the wastewater treatment plant flows through this pipeline.

3. Originally buried approximately 3 feet below the creek bed, the pipelines were exposed in 2006, due to significant creek scour and erosion. Repairs were completed at that time, but high flows in the winter of 2009-2010 have again exposed the pipelines. Future scour or debris flows (rocks and loose trees) due to high water events could damage or undermine the pipes, potentially causing breakage. Pipeline breakage would result in a discharge of untreated sewage directly into Indian Creek, which flows into the Klamath River approximately 500 feet downstream.

4. The Happy Camp Sanitary District (HCSD) is the local agency responsible for operation and maintenance of the wastewater system. The California Department of Transportation (Caltrans) is the agency responsible for operation and maintenance of the Indian Creek Highway 96 Bridge.

5. The Indian Health Service (IHS) provides water and wastewater assistance to the Karuk Tribe. Karuk Tribal members are provided service through the HCSD's wastewater system. The most effective and efficient way of providing sewer service to Tribal members who have community sewer service in Happy Camp is to work in partnership with the Tribe and HCSD on wastewater improvement projects. The IHS is currently working on the development of a feasibility study for the wastewater system, which includes the bridge crossing. Additional detailed information from that study will be available in early 2011.

6. Based on preliminary coordination with Federal, State, Local, and Tribal representatives, alternatives were identified to address the existing conditions. These alternatives and some associated information are provided below.

   6.1. No action alternative – does not address existing potential for pipeline failure during high water events

   6.2. Action Alternatives

      6.2.1. Alternative 1 - Replace pipeline by directionally drilling under creek – high costs due to uncertainty of encountering bedrock or boulders, and due to potential deep depth of new pipeline to address creek bed scour potential during high water events. The Karuk Tribe has indicated an objection to placing any new sewer lines in or under the creek. The alternative was not considered for further evaluation for the purposes of the NCIRWMP grant request, since other potentially acceptable alternatives were available.

      6.2.2. Alternative 2 - Rehabilitate existing pipelines in place – would require significant permitting to place fill in the creek to cover the existing pipelines plus uncertainty regarding ability of the fix to work due to creek bed scour potential. The alternative was not considered for further evaluation for the purposes of the NCIRWMP grant request, since other potentially acceptable alternatives were available.

      6.2.3. Alternative 3 - Build a separate bridge to carry pipe across creek and build new lift station – very expensive to construct new bridge, plus uncertainty regarding required real estate easements, geotechnical conditions, and permitting.

      6.2.4. Alternative 4 - Attach pipeline to upstream side of bridge and build new sewer lift station – a cost effective solution that requires minimal real estate work (encroachment permits from Caltrans and Siskiyou County); the pipeline will need to be placed as high as possible

above the bottom of the bridge to avoid or minimize the potential for ice or debris flow damage during high water events.

6.2.5. Alternative 5 - Attach pipeline to downstream side of bridge and build new sewer lift station – more expensive than the alternative to attach the pipeline to the upstream side of the bridge, because the total pipeline length would be longer (two highway crossings would be required) than in Alternative 4, but provides additional protection against ice and debris flow from Indian Creek. There is uncertainty regarding effects of ice or debris flow backing up from the Klamath River about 500 feet downstream. Additional real estate easements and Caltrans and Siskiyou County encroachment permits would be required, as well as two new underground highway crossings. There is an existing telephone conduit crossing on the downstream side of the bridge that will need to be worked around.

7. All alternatives will be explored further in the feasibility study. For the purposes of the present NCIRWM grant request, Alternative 4 was selected as the proposed alternative. An Existing Conditions Schematic, a Proposed Alternative Schematic, and a cost estimate are provided. Available cost information for Alternatives 3 and 5 are also presented for comparison purposes.

8. Because annual operation and maintenance costs are approximately the same for Alternative 4 (attach pipeline to upstream side of bridge) and Alternative 5 (attach pipeline to downstream side of bridge), and each of these annual operation and maintenance (O&M) costs are significantly less than Alternative 3 (build a separate bridge to carry pipe across creek), because of the added cost associated with O&M of the new bridge, a direct comparison of capital costs without considering annual O&M costs would yield the same conclusion as comparing life cycle costs (present worth of capital costs and O&M costs). Capital costs for these alternatives are as follows:

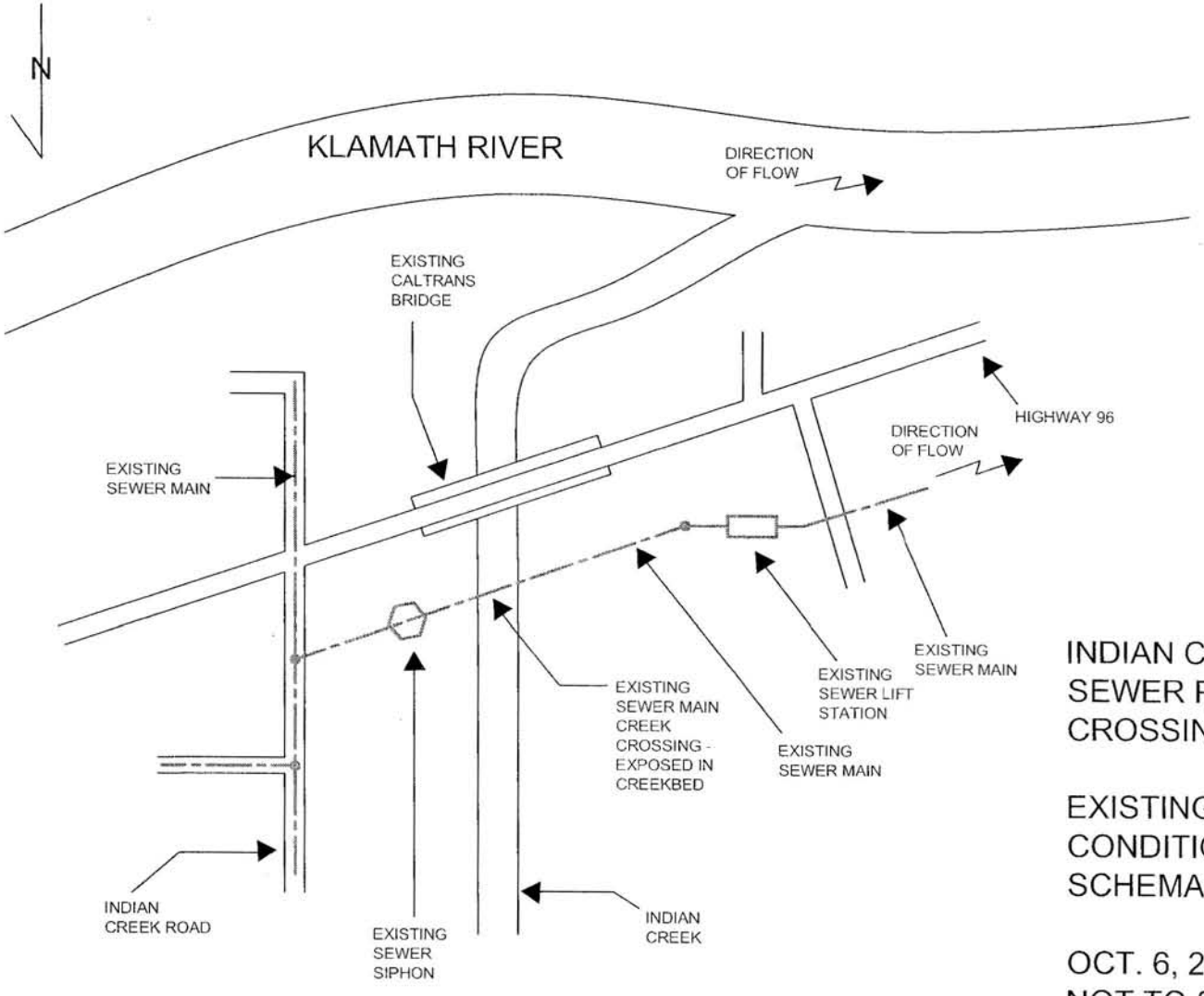
Alternative	Capital Cost
8.1. Alt. 4 - Attach Pipeline to Upstream Side of Bridge -	$807,000
8.2. Alt. 5 - Attach Pipeline to Downstream Side of Bridge -	$929,000
8.3. Alt. 3 - Build a Separate Bridge to Carry Pipe Across Creek –	$1,840,000

9. During initial scoping work for the feasibility study, additional deficiencies with the community wastewater system were identified. These deficiencies included a lack of a functional master sewage flow meter at the wastewater treatment plant and problems with the existing emergency generators for the existing sewer lift stations throughout the community. Work to address these deficiencies was beyond the work identified for the pipeline crossing. Since solutions to address these additional deficiencies were of a lower priority than alternatives to address the problems with the existing Indian Creek sewer pipeline crossing, the overall wastewater project for the Happy

Camp community wastewater system was split into two phases. Phase 1 work would address the sewer pipeline crossing and is included in the NCIRWMP grant request. Phase 2 work would address the additional deficiencies and any other problems or opportunities identified in the feasibility study; Phase 2 work is not included in the NCIRWMP grant request; future funding for Phase 2 will be sought separately. Phase 1 work and Phase 2 work are each stand-alone projects. Phase 1 and Phase 2 projects may also be completed concurrently.

Attachments:

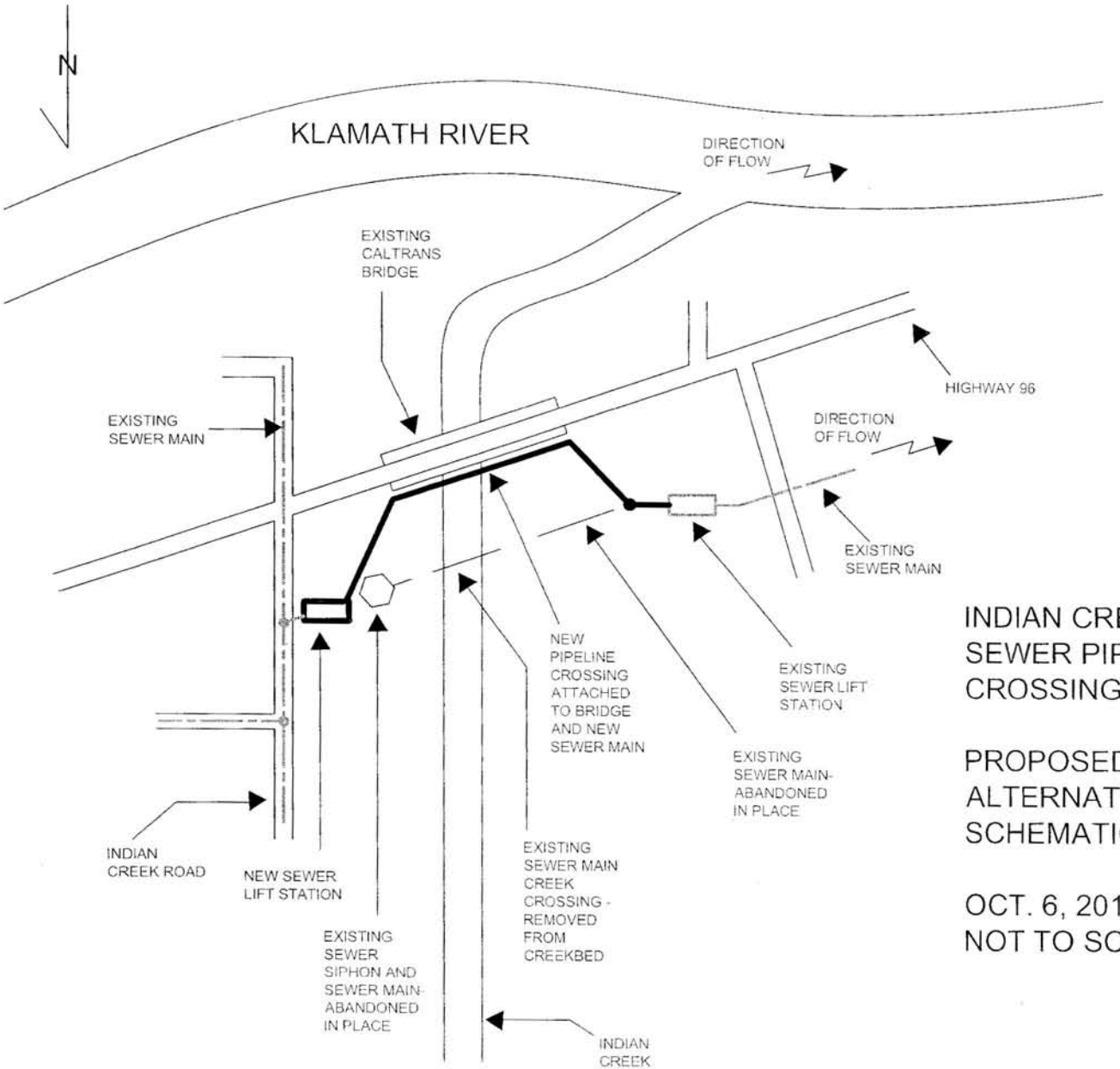
1. Existing Conditions Schematic
2. Proposed Alternative Schematic
3. Cost Est. Alt. 4 – Attach Pipeline to Upstream Side of Bridge and Build New Lift Station (Proposed Alternative)
4. Cost Est. Alt. 5 – Attach Pipeline to Downstream Side of Bridge and Build New Lift Station
5. Cost Est. Alt. 3 – Build Separate Bridge to Carry Pipe Across Creek and Build New Lift Station



INDIAN CREEK
SEWER PIPELINE
CROSSING -

EXISTING
CONDITIONS
SCHEMATIC -

OCT. 6, 2010
NOT TO SCALE



INDIAN CREEK SEWER PIPELINE CROSSING -

PROPOSED ALTERNATIVE SCHEMATIC -

OCT. 6, 2010
NOT TO SCALE

Cost Estimate - Attach Pipeline to Upstream Side of Bridge and Build New Sewer Lift Station

Revised October 6, 2010

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/Environmental Assessment/Permitting	1	LS	$30,000.00	$30,000.00
2	Aerial Survey and Mapping, Ground Survey, ROW Survey	1	LS	$10,000.00	$10,000.00
3	Preliminary Engineering Design Report	1	LS	$10,000.00	$10,000.00
4	Geotechnical Investigation	1	LS	$8,000.00	$8,000.00
5	A/E Design Development Services (approx. 6% of Line 29)	1	LS	$38,000.00	$38,000.00
6	A/E Engineering Construction Support (approx. 2% of Line 29)	1	LS	$13,000.00	$13,000.00
7	Sub-Total Section I:				$109,000.00
II. CONSTRUCTION					
	Wastewater Facilities				
8	Sewer Bridge Pipeline Crossing (6" carrier pipe with casing pipe; pipe capable of deflection without leakage; includes roller pipe supports, pipe expansion joints and other seismic features)	400	LF	$600.00	$240,000.00
9	Bridge Scaffolding (Fixed/Mobile as required)	1	LS	$30,000.00	$30,000.00
10	Temporary Sewer Bypass, Pump, & Appurtenances	1	LS	$5,000.00	$5,000.00
11	Traffic Control	1	LS	$5,000.00	$5,000.00
12	Lift Station Structure and Equipment	1	LS	$90,000.00	$90,000.00
13	Lift Station Electrical and Controls	1	LS	$50,000.00	$50,000.00
14	Lift Station Emergency Diesel Generator	1	LS	$20,000.00	$20,000.00
15	Sewer Main (6-inch, underground)	250	LF	$100.00	$25,000.00
19	Manholes	1	EA	$5,000.00	$5,000.00
20	Sewer Connections to Existing System	2	EA	$3,000.00	$6,000.00
21	Abandonment of Existing Siphon, Creek Sewer Crossing, and Sewer Main	1	LS	$30,000.00	$30,000.00
22	Fencing and Gates	1	LS	$10,000.00	$10,000.00
23	Erosion and Sediment Control	1	LS	$20,000.00	$20,000.00
24	Other Appurtenances	1	LS	$10,000.00	$10,000.00
27	Sub-Total Construction:				$546,000.00
28	Construction Contingencies (Rounded)	15%	of	$546,000.00	$81,900.00
29	Sub-Total Section II:				$627,900.00
III. ENGINEERING AND ADMINISTRATION					
30	Contract Administrative Fees (Lines 7 and 29)	3%	of	$736,900.00	$22,107.00
31	Indian Health Service (IHS) Construction Inspection (Line 29)	3%	of	$627,900.00	$18,837.00
32	IHS Project Technical Support (PTS) (Lines 7 and 29)	4%	of	$736,900.00	$29,476.00
33	Sub-Total Section III:				$70,420.00

V. SUMMARY

TOTAL PROJECT COSTS

Planning and Architect/Engineer Services Sub-Total:	$109,000.00
Construction Sub-Total:	$627,900.00
Engineering and Administration Sub-Total:	$70,420.00
Total Sections I, II, and III:	$807,320.00
Total Project Cost (Rounded to Nearest $1,000):	**$807,000.00**

PROJECT FUNDING

IRWMP Proposition 84 Implementation Grant (67%) * (Rounded):	$542,000.00
IHS Contribution (33%) * (Rounded):	$265,000.00
Total Project Funding:	**$807,000.00**

* Grant/Contribution subject to successful project proposals, available funding, data from completion of concurrent feasibility study, and other requirements.

Unit Cost/Indian Home Served:	175	Homes	Unit Cost =	$1,514.29
Unit Cost/Billing Unit Served:	532	Billing Units	Unit Cost =	$1,516.92

Cost Est. Alt. 5 - Attach Pipeline to Downstream Side of Bridge and Build New Sewer Lift Station

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/Environmental Assessment/Permitting	1	LS	$30,000.00	$30,000.00
2	Aerial Survey and Mapping, Ground Survey, ROW Survey	1	LS	$10,000.00	$10,000.00
3	Preliminary Engineering Design Report	1	LS	$10,000.00	$10,000.00
4	Geotechnical Investigation	1	LS	$8,000.00	$8,000.00
5	A/E Design Development Services (approx. 6% of Line 29)	1	LS	$43,000.00	$43,000.00
6	A/E Engineering Construction Support (approx. 2% of Line 29)	1	LS	$14,000.00	$14,000.00
7	Sub-Total Section I:				$115,000.00
II. CONSTRUCTION					
	Wastewater Facilities				
8	Sewer Bridge Pipeline Crossing (6" carrier pipe with casing pipe; pipe capable of deflection without leakage; includes roller pipe supports, pipe expansion joints and other seismic features)	400	LF	$600.00	$240,000.00
9	Bridge Scaffolding (Fixed/Mobile as required)	1	LS	$30,000.00	$30,000.00
10	Temporary Sewer Bypass, Pump, & Appurtenances	1	LS	$5,000.00	$5,000.00
11	Traffic Control	1	LS	$5,000.00	$5,000.00
12	Lift Station Structure and Equipment	1	LS	$90,000.00	$90,000.00
13	Lift Station Electrical and Controls	1	LS	$50,000.00	$50,000.00
14	Lift Station Emergency Diesel Generator	1	LS	$20,000.00	$20,000.00
15	Sewer Main (6-inch, underground)	250	LF	$100.00	$25,000.00
16	Sewer Utility Road Crossing	100	LF	$100.00	$10,000.00
17	Sewer State Highway Crossing	400	LF	$160.00	$64,000.00
18	AC Paving	150	LF	$30.00	$4,500.00
19	Manholes	2	EA	$5,000.00	$10,000.00
20	Sewer Connections to Existing System	2	EA	$3,000.00	$6,000.00
21	Abandonment of Existing Siphon, Sewer Crossing, and Main	1	LS	$30,000.00	$30,000.00
22	Fencing and Gates	1	LS	$10,000.00	$10,000.00
23	Erosion and Sediment Control	1	LS	$20,000.00	$20,000.00
24	Other Appurtenances	1	LS	$10,000.00	$10,000.00
27	Sub-Total Construction:				$629,500.00
28	Construction Contingencies (Rounded)	15%	of	$629,500.00	$94,425.00
29	Sub-Total Section II:				$723,925.00
III. ENGINEERING AND ADMINISTRATION					
30	Contract Administrative Fees (Lines 7 and 29)	3%	of	$838,925.00	$25,168.00
31	Indian Health Service (IHS) Construction Inspection (Line 29)	3%	of	$723,925.00	$21,718.00
32	IHS Project Technical Support (PTS) (Lines 7 and 29)	4%	of	$838,925.00	$33,557.00
33	Sub-Total Section III:				$80,443.00
IV. ROW AND EASEMENTS (Happy Camp Sanitary District)					
34	Purchase of ROW and Easements (if required)	1	LS	$10,000.00	$10,000.00
35	Sub-Total Section IV:				$10,000.00
V. SUMMARY					
	TOTAL PROJECT COSTS				
	Planning and Architect/Engineer Services Sub-Total:				$115,000.00
	Construction Sub-Total:				$723,925.00
	Engineering and Administration Sub-Total:				$80,443.00
	Purchase of ROW and Easements Sub-Total:				$10,000.00
	Total Sections I, II, III and IV:				$929,368.00
	Total Project Cost (Rounded to Nearest $1,000):				**$929,000.00**
	Unit Cost/Billing Unit Served:	532	Billing Units	Unit Cost =	$1,746.24

Cost Est. Alt. 3 - Build Separate Bridge to Carry Pipe Across Creek and Build New Lift Station

Revised November 29, 2010

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/ Environmental Assessment/Permitting	1	LS	$30,000.00	$30,000.00
2	Aerial Survey and Mapping, Ground Survey, ROW Survey	1	LS	$10,000.00	$10,000.00
3	Preliminary Engineering Design Report	1	LS	$25,000.00	$25,000.00
4	Geotechnical Investigation	1	LS	$30,000.00	$30,000.00
5	A/E Design Development Services (approx. 6% of Line 27)	1	LS	$87,000.00	$87,000.00
6	A/E Design Construction Support (approx. 2% of Line 27)	1	LS	$29,000.00	$29,000.00
7	Sub-Total Section I:				$211,000.00
II. CONSTRUCTION - TRIBAL PROCUREMENT					
	Wastewater Facilities				
8	Sewer Bridge Pipeline Crossing (6" carrier pipe with casing pipe; pipe capable of deflection without leakage; includes roller pipe supports, pipe expansion joints and other seismic features)	500	LF	$600.00	$300,000.00
9	Pipeline Bridge (500 foot span supported on abutments without Piers)	1	LS	$250,000.00	$250,000.00
10	Bridge Expansion Joints	1	LS	$50,000.00	$50,000.00
11	Bridge Abutments and Foundations	1	LS	$230,000.00	$230,000.00
12	Bridge Earthwork	1	LS	$50,000.00	$50,000.00
13	Bridge Formwork	1	LS	$20,000.00	$20,000.00
14	Bridge Scaffolding	1	LS	$30,000.00	$30,000.00
15	Temporary Sewer Bypass, Pump, & Appurtenances	1	LS	$5,000.00	$5,000.00
16	Traffic Control	1	LS	$5,000.00	$5,000.00
17	Lift Station Structure and Equipment	1	LS	$90,000.00	$90,000.00
18	Lift Station Electrical and Controls	1	LS	$50,000.00	$50,000.00
19	Lift Station Emergency Diesel Generator	1	LS	$20,000.00	$20,000.00
20	Sewer Main (6-inch, underground)	400	LF	$100.00	$40,000.00
21	AC Paving	400	LF	$30.00	$12,000.00
22	Manholes	2	EA	$5,000.00	$10,000.00
23	Sewer Connections to Existing System	2	EA	$3,000.00	$6,000.00
23	Abandonment of Existing Siphon, Creek Sewer Crossing, and Sewer Main	1	LS	$30,000.00	$30,000.00
24	Fencing and Gates	1	LS	$10,000.00	$10,000.00
23	Abutment Slope Protection	1	LS	$30,000.00	$30,000.00
24	Erosion and Sediment Control	1	LS	$20,000.00	$20,000.00
25	Other Appurtenances	1	LS	$10,000.00	$10,000.00
26	Sub-Total Construction:				$1,268,000.00
27	Construction Contingencies	15%	of	$1,268,000.00	$190,200.00
28	Sub-Total Section II:				$1,458,200.00
III. ENGINEERING AND ADMINISTRATION					
29	Tribal Administrative Fees (Lines 7 and 28)	3%	of	$1,669,200.00	$50,076.00
30	IHS Construction Inspection (Line 28)	3%	of	$1,458,200.00	$43,746.00
31	IHS Project Technical Support (PTS) (Lines 7 and 28)	4%	of	$1,669,200.00	$66,768.00
32	Sub-Total Section III:				$160,590.00
IV. ROW AND EASEMENTS (ineligible for IHS funding)					
33	Purchase of ROW and Easements (if required)	1	LS	$10,000.00	$10,000.00
34	Sub-Total Section IV:				$10,000.00
V. SUMMARY					
	TOTAL PROJECT COSTS				
	Planning Sub-Total:				$211,000.00
	Construction Sub-Total:				$1,458,200.00
	Engineering and Administration Sub-Total:				$160,590.00
	Purchase of ROW and Easements Sub-Total:				$10,000.00
	Total Sections I, II, III and IV:				$1,839,790.00
	Total Project Cost (Rounded to Nearest $1,000):				**$1,840,000.00**
	Unit Cost/Billing Unit Served:	532	Billing Units	Unit Cost =	$3,458.65

Working Draft:

MID-KLAMATH SUBBASIN FISHERIES RESOURCE RECOVERY PLAN

Prepared for: Karuk Tribe of California
Department of Natural Resources

Prepared by: Toz L. Soto
Michael Max Hentz

Funded by: Klamath River Basin Fisheries Task Force

Date: August 25, 2003

Section 1: Introduction

The Klamath River Fisheries Task Force determined the need for individual plans from the Klamath River subbasins that were identified in their 1991 Long Range Plan (Kier Associates, 1991). The Middle Klamath subbasin is defined as the portion of the Klamath River watershed encompassing all sub-watersheds (excluding the Salmon River, Scott River and Shasta River) between the Trinity River (River Mile 43.4) and Iron Gate Dam (River Mile 190.1).

The primary goal for this plan is to improve Middle Klamath River subbasin contribution to the Klamath River Basin's anadromous fish. This working draft identifies actions needed, whether it may be on-the-ground manipulation of impaired aquatic or terrestrial conditions, or more passive protection of unimpaired conditions.

Aquatic conditions and fisheries resources in the Klamath Basin have steadily declined for the past 150 years, and more rapidly during the past 50 years. The Klamath River fishery has a very complex and wide variety of problems, and public concerns about deteriorating salmon stocks have heightened in light of a recent large-scale fish kill that occurred in the Klamath River system. This plan only addresses problems within the scope of the Middle Klamath subbasin. Basin wide fisheries recovery will take a cooperative planned effort from all subbasins and Basin stakeholders.

Declines in Klamath River anadromous fish have impaired river ecosystem function, and have equally impacted tribal, sport and commercial fisheries. In addition, other land and water uses are restricted by management regulations that have been put into effect in response to these ecological system failures. Combined, these factors make planning recovery actions complex and challenging. The Middle Klamath River subbasin is especially challenging due to its large size and diversity in terms of landscape, land jurisdiction, socio-economic conditions, politics, and cultural representation.

The purpose of the Draft Mid-Klamath Subbasin Plan is to identify the set of core variables pertaining to ecological function in the subbasin, and to provide management priorities and objectives to guide land managers and stakeholders in their efforts to improve conditions within the subbasin. The 1991 Long Range Plan suggests that cooperation between stakeholders must take place in order to fully address the restoration needs in the Basin. The plan will be administered by the Karuk Tribe of California, in cooperation with federal and state managing agencies, private landowners, and local communities. Public input solicited through meetings, bulletins, and personal interface was incorporated into this plan through actions of the Karuk Tribe's subbasin coordinator.

The focus of this document is on the primary physical and biological processes in the subbasin that contribute to the Klamath River's unique ecological and evolutionary attributes (most importantly, its anadromous fish runs). Active restoration will focus on those processes most degraded by historic and current land uses. Passive restoration will focus on protection of currently functioning subbasin processes.

In this document, land use history is divided into three major eras: Native Inhabitation (prehistory-1850), Western-European Entrance and Settlement (1850-1950), and Resource Extraction and Contemporary Setting (1950-present day). Cumulative Watershed Impacts affecting specific regions in the Mid-Klamath subbasin are discussed. Upland management is considered, as it pertains to aquatic and ecological integrity. Discussion of upland management includes: grazing, mining, timber harvest, road building, and fire management. Opportunities for protection of wilderness and or unmanaged pristine areas are described. Regional wildlife is briefly described and species are listed. Biological and physical monitoring needs are described. Public comments from meetings held in Happy Camp, Orleans, and Scott Bar are included. Areas identified for future inclusion in upcoming Mid-Klamath land management proposals are summarized in "Planning Needs and Information Gaps".

Section 2: Mid-Klamath Subbasin Description

Mid-Klamath General Description

The Mid-Klamath subbasin, as defined by the Klamath Basin Fisheries Task Force, drains an area between Weitchpec (Klamath-Trinity River Confluence) and Bogus Creek (at Iron Gate Dam). This is an artificial construct, within an unbounded portion of the greater Klamath Watershed. "Unbounded" specifically refers to the influence of the Upper Klamath, Lower Klamath and the Trinity River drainages on Mid-Klamath ecosystem function. Within the subbasin, "unbounded" also refers to the direct effects of the Shasta, Scott, and Salmon River watersheds on the Mid-Klamath main stem.

Within this artificial construct, the watershed has been divided into eight distinct sub-watersheds for purposes of this plan. These sub-watershed regions are titled: Volcanic Outer Region, Checkerboard, Red Butte, Grider-Elk, Siskiyou, Western Marble Mountain, Orleans, and Red Cap. These regions were chosen based on the following factors:

- Influential Tributaries
- Biological and Physical Processes
- Cumulative Watershed Impacts (low or high)
- Key Issues and Priorities
- Land jurisdiction and management
- Land use history
- Geographic Area
- Restoration Action Opportunities

The lower Mid-Klamath includes the main stem and all watersheds from Weitchpec to Grider Creek, excluding the Salmon River. The upper Mid-Klamath includes all watersheds from Seiad Creek to the Iron Gate Reservoir, excluding the Scott and Shasta Rivers. This break loosely separates the Pacific Maritime influenced western subbasin, from the Interior and Continental climates of the eastern subbasin. It also captures the general shift from United States Forest Service (USFS)-based land ownership in the west to mixed federal and private ownership in the east.

Lower Mid-Klamath:

The lower Mid-Klamath subbasin is characterized by a coastal–influenced, pacific-maritime climate, grading to interior climates of the Klamath Range. The communities of Weitchpec, Orleans, Somes Bar and Happy Camp are included within this area, which comprises the Ancestral Karuk Territory. Karuk lands are now controlled by the USFS Klamath and Six Rivers National Forests. A Memorandum of Understanding between the Karuk Tribe and the USFS increases Tribal participation in management of these lands. Private ownership is restricted to small parcels, principally along river and creek corridors, often associated with homesteads, patented mining claims, or the communities of Weitchpec, Orleans, Somes Bar, and Happy Camp.

Currently, the highest integrity fisheries of the Mid-Klamath subbasin reside within the lower watersheds, particularly the "Key Watersheds" defined by the North West Forest Plan: Bluff, Red Cap, Camp, Dillon, Clear, Elk, Indian and Grider Creeks (excluding the Salmon River subbasin). The lower subbasin tributaries afford the largest quantities of cold, high quality water and accessible habitat.

These watersheds tend to be highly vegetated with rugged, steep slopes. Most stream channels are defined by very steep headwater channels. The southern and western Siskiyou Crest, western Salmon Mountains, and western and northern Marble Mountains form the principle divides of this region.

Highly productive mixed hardwood / conifer forests transition upslope to mixed conifer evergreen and true fir forests, with sub-alpine forests / meadows at the highest elevations. Extensive areas of fire-induced early seral and montane chaparral create a complex mosaic across much of the landscape. The Siskiyou Crest is characterized by large ultramaphic (e.g. Serpentine / Peridotite) exposures. Unique plant assemblages with reduced productivity and increased rarity correspond with this geology.

Large roadless areas remain in many of the most rugged areas that are peripheral to the Trinity Alps, Marble Mountains, Siskiyou and Red Butte Wilderness Areas. The rugged topography of the landscape in the subbasin is one factor that has contributed to these areas remaining roadless. Accessible National Forest lands within the subbasin, other than wilderness areas, have been utilized for timber production with accompanied road systems development. Wilderness designation was afforded in 1964 to parts of the Trinity Alps and Marble Mountains (previously primitive areas), and expanded in 1984 along with the additions of the Siskiyou and Red Buttes. These protected areas and peripheral roadless areas form the core reserve of functioning wildlands in the Mid-Klamath (see Roadless Areas: Mid-Klamath Subbasin, page 25).

Upper Mid-Klamath:

The upper Mid-Klamath subbasin is characterized by an interior montane climate, grading to the true continental climate of the Great Basin. The communities of Seiad, Hamburg, Horse Creek,

Hilt and Hornbrook, are included within this area. Karuk Ancestral Territory borders Shasta Tribal Lands, further shifting to the Klamath Tribal lands of the upper basin. Land ownership changes at Horse and Beaver Creeks from contiguous jurisdiction under the USFS to a mixed checkerboard of small private land ownership and large corporate commercial ownership.

The fisheries of the upper Mid-Klamath are impaired in terms of habitat quality, quantity, and availability (Kier 1991). This is partially due to the presence of Iron Gate Dam at the eastern edge of the subbasin, which restricts fish passage. In addition, there is concern about the fish hatchery at Iron Gate Dam and its potential impacts to the genetic and biological integrity of wild salmonids. High densities of naturally spawning chinook salmon in Bogus Creek could be attributed to the fish blockage at Iron Gate Dam and the close proximity of Iron Gate Hatchery. Spawners in Bogus Creek are included in the natural escapement numbers used for the Klamath River run size estimate. This may lead fisheries managers to overpredict wild salmon run size. However, this is an issue that should be investigated with further research.

The drainages of the upper Mid-Klamath transition from the rugged montane topography of the interior Klamath range to the volcanic derived features of the Cascades and Modoc Plateau. Constrained by the inner canyons and steep slopes of the Interior, the Klamath River opens into the tableland plateaus and subdued relief of the upper basins. Tributaries are often deeply cut and narrow, with moderate-low relief terrain above. Cottonwood Creek and Willow Creek consist of broad valley floors and that are now largely agricultural. The east-west (upstream-downstream) transect from Seiad to Bogus Creek results in a steep climatic gradient from interior and pacific maritime influences to a true continental climate. A resultant shift in vegetation pattern from Klamath Range to Great Basin Alliances occurs. Mixed conifer / hardwood associations of Seiad, Walker, O'Neil, Horse and Beaver Creeks gives way to the Chaparral Scrub, Sagebrush Steppe, and Juniper Woodland types of Humbug, Cottonwood, Willow, and Bogus Creeks. Upper slopes allow for the maintenance of mixed-conifer dominated canopies along the higher elevation slopes and ridges of the eastern periphery.

The climate, conditions, and vegetation types of the upper Mid-Klamath directly influence human settlement and land disposition patterns. The economy of the lower Mid-Klamath is primarily based on timberland resources, whereas grazing and water-intensive irrigated agriculture is central to the upper Mid-Klamath. The historic importance of railroad arteries with respect to the commerce of communities such as Hornbrook, has given way to the Highway 5 corridor.

Some of the primary ecological issues pertaining to the upper Mid-Klamath include:

- Dams, diversions, and groundwater utilization
- Mining influences along the main stem and tributaries
- Introduction of non-native plant and animal species.
- Small-scale agricultural and municipal development, such as water diversions for cattle and alfalfa fields from Cottonwood Creek, Bogus Creek, Willow Creek, Horse Creek, Humbug Creek, Doggett Creek, Barkhouse Creek, Beaver Creek, and Seiad Creek.
- Tribal cultural forest and range management.
- Loss of habitat supportive of migratory water fowl and the Pacific Flyway.

In addition, the following are issues that affect both the lower and upper Mid-Klamath:

- Hatchery influence on genetics of wild anadromous fish
- Extirpation of many fish and mammal species (e.g. beaver, grizzly, wolf, and upper basin salmonids)
- Decrease in quality and quantity of fisheries habitat

Mid-Klamath Land History Synopsis

The history of human presence within the Mid-Klamath subbasin is divided into three major eras:

- Native American Residence (pre-history-1850)
- Exploration, Western European Entrance, Settlement and Statehood: (1850-WWII);
- Resource Extraction / Contemporary Setting (WWII-Present).

Native American Residence (prehistory-1850):

The Karuk Tribe's ancestral territory makes up roughly half the land base in the Mid-Klamath subbasin, including the area downriver of Seiad Valley to Aikens Creek. The subbasin includes a small section of the Yurok and Hupa reservations between Aikens Creek and the Trinity River. The Shasta Tribal territory makes of the rest of the subbasin above Seiad Valley. The earliest origin dates of native presence in the Mid-Klamath region are not known, though some have estimated that indigenous habitation originated in the area as early as 10,000 years ago.

Settlement patterns were focused along the river corridor. Principle nutritional staples were anadromous fish, upland game, plants and plant products. In general, the tribes of the Mid-Klamath managed natural resources through the use of prescribed fire and by limiting take of plant and animal species. Spiritual practices and ceremonies, such as the annual world renewal ceremonies and first salmon ceremonies, were at the root of tribal land management.

European settlement in the mid nineteenth century had devastating impacts on the tribes of the Mid-Klamath. Efforts of Western settlers to gain control of tribal lands resulted in the extirpation of the majority of indigenous people in the area. Tribal people quickly went from being primary land managers to having little management power in the subbasin. In spite of this change, the Karuk Tribe continues to have increased involvement in land management efforts, continues to practice spiritual ceremonies, and still relies on anadromous fish for subsistence.

Exploration, Western European Entrance, Settlement and Statehood: (1850-World War II):

The earliest known interior Klamath exploration, conducted by Jedediah Smith, did not occur until 1827-1829. Smith explored the Trinity River and lower Klamath in this expedition. Ogden and Fremont explored the eastern Klamath region in 1829-1830 and 1845-1846, respectively. However, the true entrance, occupation, and settlement of the Klamath region did not begin until and the declaration of California statehood in the early 1850s. Within the condensed period of 1850-World War II, major changes affecting the Mid-Klamath occurred, including:

- Alteration of tribal presence and land management

- Initiation of modern resource extraction, such as gold mining and logging
- Extirpation of beaver, wolf, grizzly, and elk
- Draining of bottomlands
- Watershed diversions, and
- Building of the Copco dam across the Klamath

The Gold rush of the late nineteenth century, though productive, turned bust, and the highest population densities of the Mid-Klamath had come and gone. By the close of the period, the transition from early occupation to settlement to resource extraction had been completed.

Resource Extraction / Contemporary Setting (World War II-Present):

Following the events of World War II, attention was redirected back to the hard work of nation building. The emphasis was on resource extraction, including timber resources in the Mid-Klamath. Due to the productivity of Mid-Klamath forests, the region contributed significantly to the production of timber products for consumption. Fire suppression was put into effect to protect these resources from combustion. A large agency structure was developed and funded to oversee resource management in the region.

This period also saw the completion of major water projects, dams and aqueducts. The Iron Gate and Copco II dams were built on the Klamath River. The upper Klamath basin was promoted for its irrigated agriculture: incentives were given to veterans and complex diversions, ditches, and irrigation schemes were developed. This hydrological alteration cut off a large portion of salmon habitat in the upper basin, and is now believed to be a critical factor in the deterioration of anadromous fisheries in the watershed.

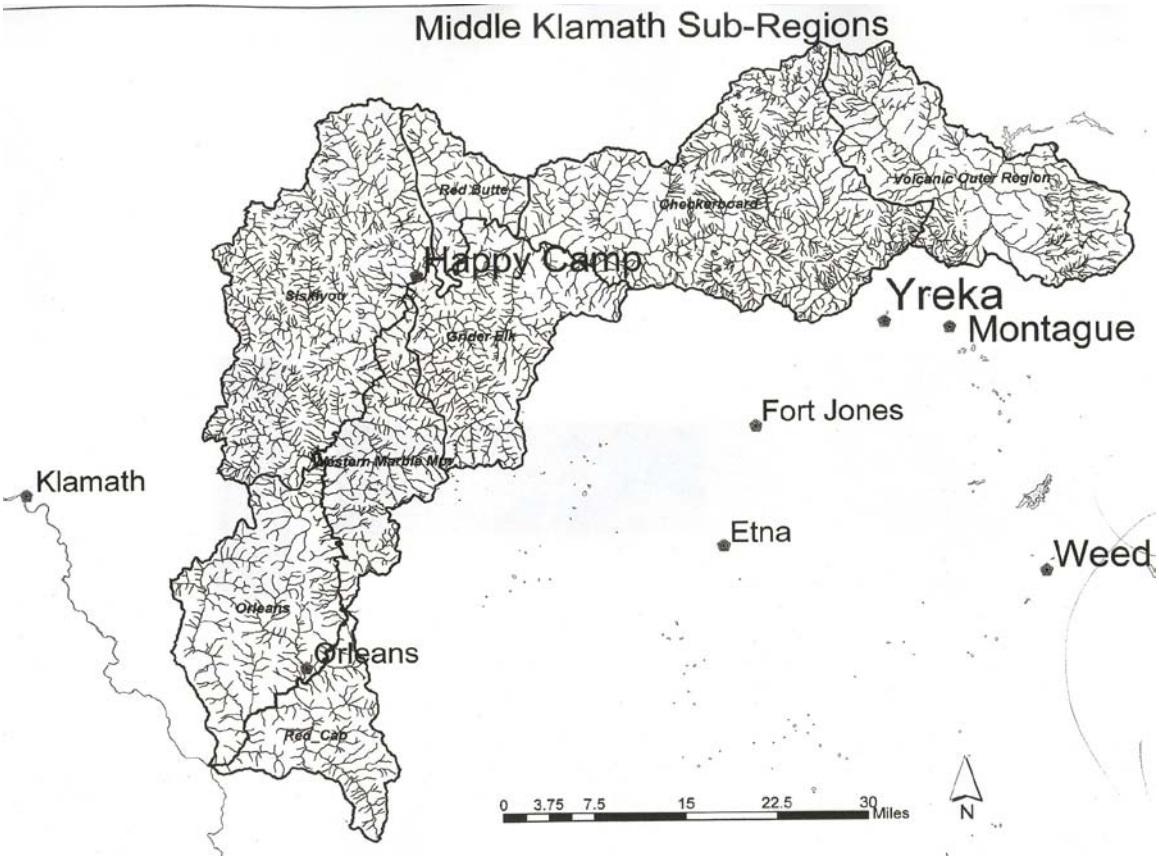
Sub-Watershed Region Descriptions

Eight sub-watersheds are identified within the Mid-Klamath Subbasin. These sub-watersheds were chosen based on landscape / watershed contiguity, biogeography, and the specific land management circumstances distinct to each. There is a direct relationship between the natural features of these areas, their derived uses, resultant alterations, and future restoration. The eight sub-watersheds are:

- Volcanic Outer Region
- Checkerboard
- Red Butte
- Grider Elk
- Siskiyou
- Western Marble Mountain.
- Orleans
- Red Cap

(see Figure 1.)

Figure 1: Middle Klamath River Sub-Watersheds



Each sub-watershed description includes:

Influential Tributaries:

Significant and influential direct tributaries to the Klamath River main stem are listed at the beginning of each sub-watershed description. These often have historic fisheries importance, either as direct suitable habitat or as sources of freshwater. The linkage of contiguous tributaries into these sub-watershed regions have seamless boundaries, and do not exclude any terrestrial surface of the Mid-Klamath. Seventy-nine named tributaries have been identified within the eight sub-watersheds. The Shasta, Scott, and Salmon are excluded.

Area Description:
A brief description of included lands and tributaries of each sub-watershed, focusing on boundary creeks as well as physical geography, is given.

Cumulative Watershed Impacts
Influential sources of anthropogenic disturbance are summarized. Topics include:

- Land ownership and use
- Aquatic influences (e.g. dams, diversions, use, alterations to water quality / quantity)
- Hydrology and fisheries affects of land management.
- Resource extraction (e.g. mining, timber harvest, grazing influences)
- Specific management influences (e.g. fire suppression and transportation systems)

Attempts are made to accentuate site specificity, and include sources of cumulative watershed impacts.

Key Issues:
Specific critical watershed influences from the Cumulative Watershed Impacts summary are described in more detail. This section is used to prioritize the most influential sources of Cumulative Watershed Impacts specific to each sub-watershed region.

Key Priorities:
Restoration priorities that are likely to return the greatest net advantage to watershed function, specifically focused on the health of the anadromous fisheries of the Mid-Klamath, are identified. Management opportunities directed toward restoration and landscape protection are given. Community outreach, education, and cooperation needs are summarized.

Restoration Action Opportunities:
Restoration opportunities are described, specific to the source of influence to be mediated or alleviated. Upland, in-Stream, road-System, mining, and grazing related restoration opportunities are emphasized.

Volcanic Outer Region

Maps of this region are located in Appendix A, pages 2-4.

Influential Tributaries:
Bogus Creek
Dry Creek
Little Bogus Creek
Willow Creek
Cottonwood Creek
Williams Creek

Area Description:
The Volcanic Outer Region consists of combined slopes and tributaries of the Main Stem Klamath River. It ranges from Cottonwood Creek to the Iron Gate Reservoir, including south side tributaries (Bogus, Willow). It drains the Oregon-California border, Siskiyou / Cascade National Monument, Willow Mountain., and an open volcanic plateau.

Cumulative Watershed Impacts:

- Fish hatchery: 1) Artificial propagation results in competition pressure from hatchery fish on wild salmon stocks, and can increase disease susceptibility in the wild fish. 2) Collection of carcasses and eggs at the hatchery decreases food and nutrient recycling, and may indirectly affect juvenile salmonids that depend on those nutrient sources.
- Major and minor impoundments (especially Iron Gate Dam), diversions, groundwater utilization: associated hydrological affects
- Gravel extraction
- Grazing (especially riparian grazing), agricultural conversion, exotic species introduction, dispersal, and colonization
- Transportation corridor (Highway 5, Railroad)

- Timber harvest on upper slopes, and road system management
- Land Management: Bureau of Land Management / United States Forest Service Checkerboard with extensive private commercial, industrial, residential, and agricultural lands

Key Issues:

- Water diversion, impoundment, ground water utilization
- Grazing (especially riparian grazing)
- Fish hatchery affects on salmonid ecology
- Timber harvest on forested slopes

Key Priorities:

- Riparian exclusion of cattle and revegetation
- Removal and restoration of (or fish passage at) main stem dams (Iron gate, Copco 1, Copco 2)
- Fish hatchery reevaluation

Restoration Action Opportunities:

- Grazing: Riparian fencing, cattle exclusion, revegetation, exotic species eradication.
- In-Stream: Removal of hydrologic impediments, and diversions. Fish screens
- Long term regeneration of Main Stem Klamath River channel, hydrology and habitat.
- Road System: Site specific road decommissioning, seasonal closures.
- Uplands: Wetland inundation, historic fire regime return.

Checkerboard

Maps of this region are located in Appendix A, pages 5-7.

Influential Tributaries:
Ash Creek
Dutch Creek
Empire Creek
Humbug Creek
Vesa Creek
Little Humbug Creek
Lumgrey Creek
Barkhouse Creek
Beaver Creek
McKinney Creek
Doggett Creek
Kohl Creek
Horse Creek
Seiad Creek

Area Description: The checkerboard sub-watershed region consists of combined slopes and tributaries to the Main Stem Klamath River. It ranges from Ash Creek to Seiad Creek (north

side), to the Humbug Creek to McKinney Creek (south side). It drains the Eastern Siskiyou crest, and Northern Scott Bar Mountains.

Cumulative Watershed Impacts:

- Historic mining (mineral) on tributaries and main stem, including limited gravel mining
- Timber harvest and fire management
- Road systems: road density and location, and road-related slope failures. Hwy. 96 channelization effects on Main Stem, with fish barriers
- Hydrological impacts of Iron Gate dam
- Upland water diversions: quantity / quality affects, fluvial geomorphology alterations.
- Non-native species introduction and dispersal.
- Land Management: USFS-Checkerboard management: corporate commercial timberlands, small private agriculture, grazing, residential.

Key Issues:

- Checkerboard land jurisdiction
- Road systems,
- Grazing, Timber harvest,
- Mining (historic and current)

Key Priorities:

- Education, communication, cooperation
- Cross-jurisdictional watershed management

Restoration Action Opportunities:

- Mining: Tailing reclamation, riparian restoration
- Road System: Decommissioning, seasonal closure, storm proofing, maintenance / upgrading, slope stabilization / landslide prevention
- Grazing: Riparian fencing, cattle exclusion, revegetation
- Uplands: Fuels reduction, return to historic fire regime; roadless area protection.
- In-Stream: Remove diversions, modernize ditches and irrigation, fish screens, fish access, habitat improvement structures.

Red Butte

Maps of this region are located in Appendix A, pages 8-10.

Influential Tributaries:

Portuguese Creek
Fort Goff Creek
Thompson Creek
Cade Creek

Area Description:

The Red Buttes sub-watershed region consists of combined northern slopes and tributaries to the Main Stem Klamath River: Portuguese Creek to Cade Creek. It drains Red Buttes Wilderness, bounded by Devils Peak Ridge to the east, and Thompson Ridge / Slater Butte to the west.

Cumulative Watershed Impacts:

- Low cumulative impacts are associated with Portuguese, Fort Goff and Upper Thompson Creeks. Due to the extensive roadless nature of the Red Butte sub-watershed region, many terrestrial processes have been retained.
- Fire suppression and management
- Timber harvest, especially salvage logging (lower Thompson and Cade Creeks)
- High road density (>4 roaded miles per square mile (USFS, 1998))
- Land Management: Klamath National Forest

Key Issues:

- Wilderness expansion opportunity (Red Buttes Roadless Area: Upper Thompson, Fort Goff and Portuguese Creek watersheds)
- Road system management: Lower Thompson and Cade Creeks
- Fire suppression and management

Key Priorities:

- Wilderness expansion.
- Road decommissioning
- Return to historic fire regime
- Fish access: Improve fish passage at Hwy 96 crossings

Restoration Action Opportunities:

- Road System: Decommissioning, seasonal closure, storm proofing, maintenance / upgrading, slope stabilization / landslide prevention.
- Roadless area protection
- Uplands: Return to historic fire regime, fuels reduction, wilderness expansion
- In-Stream: Replace culverts on Hwy. 96 with structures allowing for fish passage during all life stages, and flow regimes (Cade, Portuguese and Fort Goff)

Grider-Elk

Maps of this region are located in Appendix A, pages 11-13.

Influential Tributaries:
Tom Martin Creek
Mill Creek
Kuntz Creek
O'Neil Creek
Walker Creek
Grider Creek
West Grider Creek
Joe Miles Creek
China Creek
Elk Creek

Area Description: Grider-Elk Sub-Watershed region consists of the following combined slopes and tributaries to the Main Stem Klamath River: Tom-Martin Creek to Elk Creek, Northern slopes of the Marble Mountain Wilderness, Slinkard Ridge / Lake Mountain Divide (East), and Titus Ridge (West).

Cumulative Watershed Impacts:

- Grazing within Marble Mountain Wilderness in upper Grider and Elk Creeks (i.e Cliff Valley, Big Ridge) and lower Grider Creek valley (private)
- High road density (>4 roaded miles per square mile (USFS, 1998)), unstable steep geology, catastrophic road failures in 1997 flood event
- Timber extraction Extensive recent wildfire (especially 1987) and flood affects (especially 1997), (see de la Fuente and Elder, 1998)
- Fire suppression and fire management related alterations, including salvage timber harvest following the 1987 fire
- Limited agriculture (i.e. lower Grider and Elk Creeks)
- Limited small scale suction-dredge mining
- Land Management: Klamath National Forest, small mining claims, residential
- Highway 96 blocks fish passage at Tom Martin and O'Neil Creeks

Key Issues:

- Timber harvest
- Road building
- Fire suppression
- Cattle grazing within the Marble Mountain Wilderness.
- Historic and current mining (especially main stem Klamath River and lower Elk Creek)

Key Priorities:

- Reduction in road system related watershed impacts
- Return to a historic fire regime, and maintenance of fire induced vegetation patterns
- Opportunities for roadless area protection
- Reevaluation of cattle grazing within the Marble Mountain Wilderness

Restoration Action Opportunities:

- Road System: Decommissioning, seasonal closure, storm proofing, maintenance, upgrading slope stabilization / landslide prevention
- Grazing: Consideration of cattle exclusion. Potential compensation and land exchange for spring / summer foraging values within protected areas
- Revegetation, exotic species removal, and bank stabilization
- Uplands: Fuels reduction, return to historic fire regime, roadless area and unique bio-geographic asset protection (e.g. Foxtail Pine populations)
- In-Stream: Fish Accessibility (especially O'Neil Creek. and Tom Martin Creek.) maintain fish access at mouths of creeks

Siskiyou

Maps of this region are located in Appendix A, pages 14-16.

Influential Tributaries:

Indian Creek
Little Grider Creek
Oak Flat Creek
Wingate Creek
Clear Creek
Crawford Creek

Coon Creek
Swillup Creek
Elliot Creek
Aubrey Creek
Dillon Creek

Area Description:

The Siskiyou sub-watershed region consists of the following combined lands and tributaries along the Northwestern slopes of the Main Stem Klamath River: Indian Creek to Dillon Creek. It drains an area from the Thompson Creek Ridge (eastern), Southeastern Siskiyou Crest, to the Dillon Mountain-Rock Creek Butte Divide (western).

Cumulative Watershed Impacts:

- Urbanization: Happy Camp- 1,100 residents.
- Industrial sites (especially historic lumber mills in Happy Camp and Indian Creek)
- Mining (historic placer, hard rock, hydraulic)
- Luther Gulch Superfund site at Indian Creek and the Siskon Mine Superfund site (cyanide barrel and settling pond cap) at Dillon Creek
- High Road Density (>4 roaded miles per square mile (USFS, 1998)): Indian Creek
- Moderate Road Density (2-4 roaded miles per square mile (USFS, 1998)): Clear Creek, Dillon Creek, Swillup Creek, Wingate Creek, Little Grider Creeks
- Low Road Density (<2 roaded miles per square mile (USFS, 1998)): Aubrey Creek, Elliot Creek, Crawford Creek, Coon Creek
- Timber harvest and management, leading to increased vegetation homogeneity, even age relationships, and stand density, and significantly altering the historic fire regime
- Sport fishing
- Limited small-private agriculture (lower Indian Creek)
- Land Management: Klamath National Forest (majority of land area), small mining claims, residential

Key Issues:

- Road density and road disturbances
- Fire suppression and timber management effects on terrestrial and aquatic systems
- Superfund toxic mine sites (Dillon Creek and Indian Creek) and industrial sites
- Roadless area protection

Key Priorities:

- Road decommissioning
- Fire hazard/ fuels reduction, return to historic fire regime
- Education, communication, and cooperation
- Wilderness expansion

Restoration Action Opportunities:

- Road System: Road decommissioning, road storm proofing / upgrading, road maintenance
- Mining: Mine clean-up (of contamination and sediment sources), mine tailings reclamation
- In-stream: Woody structure implementation in Indian Creek, (strategically placed habitat structures). Restore summer Steelhead and Spring Chinook critical over-summering habitat

- Uplands: Fuels reduction, thinning, slash piling / burning, and prescribed fire

Western Marble Mountain

Maps of this region are located in Appendix A, pages 17-19.

Influential Tributaries:
Titus Creek
Independence Creek
Kings Creek
Ukonom Creek
Thomas Creek
Carter Creek
Burns Creek
Ti Creek
Sandy Bar Creek
Stanshaw Creek
Rodgers Creek

Area Description:
The Western Marble Mountain region consists of the combined slopes and tributaries along the Eastern side of the Main Stem Klamath River (below Happy Camp and above Somes Bar). It drains Titus Ridge, Sandy Ridge and Western Marble Mountain Crest / Wooly Creek Divide to Offield Mountain.

Cumulative Watershed Impacts:
- High road density (>4 roaded miles per square mile (USFS, 1998))
- Timber extraction and related disturbances
- Large fire disturbance events, especially 1987 (Titus, Independence, Kings, Ukonom Creeks)
- Salvage logging, high fuel loading
- High elevation grazing in wilderness
- Fish passage: Rodgers Creek, Sandy Bar Creek., Stanshaw Creek., Hwy. 96 culverts, as well as forest road stream crossings (i.e. Ti Creek, Sandy Bar Creek)
- Land Management: Klamath and Six Rivers National Forest, small mining claims, residential

Key Issues:
- Critical cold water contribution and excellent water quality
- Road-related deterioration of tributary water quality (especially sediment inputs)
- Fire management and suppression impacts
- No watershed analysis for Titus, Independence, and Kings Creeks
- Wilderness expansion opportunities along Marble Mountain Wilderness periphery

Key Priorities:
- Road decommissioning, storm proofing / upgrading
- Fuels reduction
- Stanshaw Creek diversion

- Grazing at upper elevation meadows and forests within the Marble Mountain Wilderness Area
- Fish passage at Rodgers Creek and Stanshaw Creek
- Protection of roadless areas (especially Ukonom, Kings and upper Independence Creeks)
- Forest thinning, prescribed fire, and return to historic fire regime

Restoration Action Opportunities:

- Road System: Decommissioning, seasonal closure, storm proofing / upgrading, road maintenance. Slope stabilization / landslide prevention
- Grazing: Cattle exclusion within wilderness. Potential compensation and land exchange for spring / summer foraging values within protected areas. Revegetation, exotic species removal and bank stabilization
- Uplands: Fuels reduction / treatment. Maintain vegetation age, composition, and species diversity. Hwy. 96 sediment dump /storage plan
- Roadless area protection
- In-Stream: Fish accessibility associated with tributary Main-stem habitat connectivity (especially off-channel refugia: Stanshaw, Independence, and Sandy Bar Creeks). Fish Screens at diversions (Stanshaw Creek). Road stream crossing fish passage

Orleans

Maps of this region are located in Appendix A, pages 20-23.

Influential Tributaries:
Dobbins Creek
Rock Creek
Halverson Creek
Reynolds Creek
Teneyck Creek
Natuket Creek
Mud Creek
Wilson Creek
Camp Creek
Crawford Creek
Ullathorne Creek
Slate Creek
Bluff Creek
Aikens Creek

Area Description:
The Orleans sub-watershed is bounded by: Dillon Mountain, Rock Creek Butte, Lonesome Ridge (Blue-Bluff Divide), Bee Mountain (east corner of Yurok Reservation), and Burrill Peak. Includes all west-side tributaries, south of Dillon Creek, to the confluence of the Klamath and Trinity Rivers at Weitchpec. Includes communities of Somes Bar, Orleans, and Weitchpec. Includes Karuk and Yurok ancestral territories.

Cumulative Watershed Impacts:

- Limited agriculture (Orleans, Klamath River flood terraces)

- High Road Density (>4 roaded miles per square mile (USFS, 1998)), unstable steep geology
- Timber extraction (Six Rivers / Klamath N.F.), primarily "matrix" and LSR lands
- Fire suppression and management
- Crawford Creek (Orleans community water supply)
- Land Management: Six Rivers National Forest management, small mining claims, residential

Key Issues:

- Road systems
- Fire and fuels management
- Fish passage
- Timber harvesting
- Tribal and National Forest cooperation
- Community involvement and education

Key Priorities:

- Reduction in road system-related watershed impacts
- Fuels reduction, especially around homes and private property in the towns of Orleans, Somes Bar, and Weitchpec, along routes through public lands leading to private inholdings, and managed lands such as roads and timber harvest areas.
- Fish passage at Crawford and Ullathorne Creeks
- Hwy 96 culverts
- Feasibility study of barrier removal in lower Rock Creek

Restoration Action Opportunities:

- Road System: Decommissioning, seasonal closure, storm proofing, maintenance / upgrading, slope stabilization / landslide prevention, road stream crossings
- Grazing: Presence of feral cattle in upper Bluff Creek (needing removal).
- Uplands: Fuels reduction, particularly associated with previously harvested lands and road corridors. Return to historic fire regimes
- In-Stream: Maintain fish accessibility (especially Camp Creek, Red Cap, and Rock Creek), barrier modification at Ullathorne and Crawford Creek (Hwy. 96). In-stream structure maintenance: Bluff, Camp, and Red Cap Creek. Rock Creek barrier, near mouth

Red Cap

Maps of this region are located in Appendix A, pages 24-27.

Influential Tributaries:

Ikes Creek
Pearch Creek
Cheenitch Creek
Boise Creek
Red Cap Creek
Hopkins Creek

Area Description:
The Red Cap sub-watershed region consists of the combined slopes and tributaries to the Klamath Main-stem, draining the Salmon Divide (Humboldt / Siskiyou County line), Somes Mountain, Orleans Mountain, Whitney's Peak, Salmon Mountain (Humboldt / Trinity County line), Devil's Backbone, Packsaddle Ridge, Mill Creek Ridge, to Klamath / Trinity divide. All lands along the Klamath River between the Salmon River and the Trinity / Klamath Confluence along the east side are included.

Cumulative Watershed Impacts:

- High road density (>4 roaded miles per square mile (USFS, 1998))
- Timber extraction, and related disturbances.
- Fire management (suppression and salvage harvest).
- Land Management: Six Rivers National Forest, small mining claims, residential
- Pearch Creek (Orleans Community Water Supply)

Key Issues:

- Timber harvest
- Road systems
- Fire management
- Roadless area protection
- Tribal and National Forest co-operation
- Community involvement and education

Key Priorities:

- Reduction in road system-related watershed impacts
- Return to historic fire regime on upper slopes and wilderness areas
- Fuels treatment along road corridors and previously managed lands
- Roadless area protection

Restoration Action Opportunities:

- Road System: Decommissioning, seasonal closure, storm proofing, maintenance / upgrading, slope stabilization / landslide prevention
- Uplands: Fuels reduction, thinning, slash piling, prescribed burning. Return to historic fire regime in roadless areas, and along wilderness periphery. Roadless area protection
- In-Stream: Fish accessibility (Red Cap Creek), maintain fish access at mouths of creeks. Upgrade existing in-stream structures (Red Cap Creek). Maintain main-stem tributary habitat continuity

Section 3: Mid-Klamath Status and Current Condition

Mid-Klamath River Anadromous Fish

Chinook	(*Oncorhynchus tshawytscha*)
Coho	(*Oncorhynchus kisutch*)
Steelhead	(*Oncorhynchus mykiss*)
Green Sturgeon	(*Acipenser medirostris*)
Pacific Lamprey	(*Lampetra tridentate*)

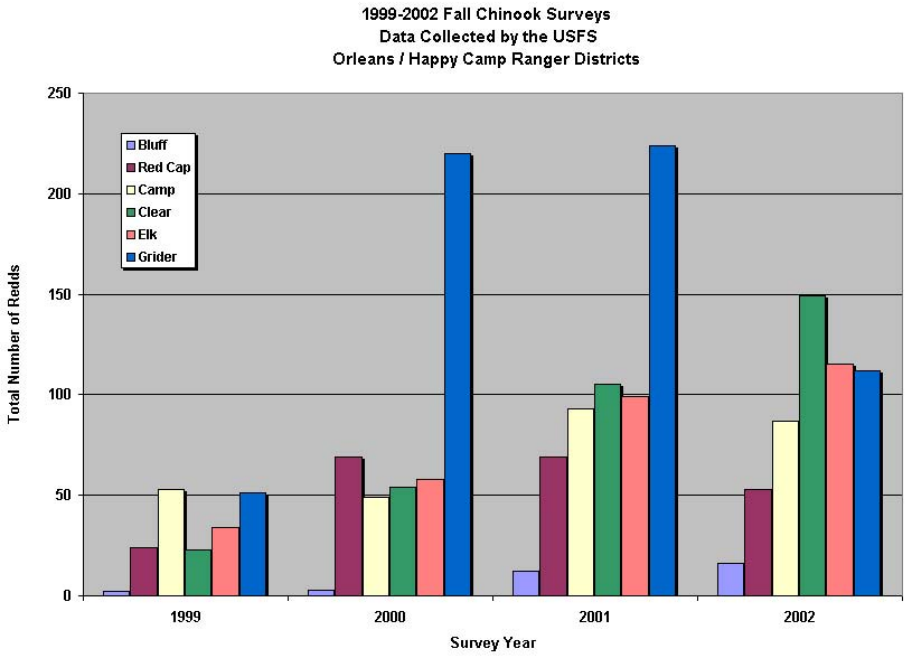
Chinook

Adult chinook salmon runs return to the Klamath River in the spring and in the fall months. Two distinct life-history types are displayed by Mid-Klamath chinook: spring returning (spring chinook) and fall returning (fall chinook) types. Fall chinook life-history type is described as having shorter freshwater residency and is sometimes referred as "ocean type" while spring chinook are described as having longer freshwater residencies and referred to as "stream type" (Spence et al. 1996).

Fall Chinook

Fall chinook spawn in the main stem Mid-Klamath River, predominately from Happy Camp to Iron Gate Dam. Many fall chinook are artificially spawned at Iron Gate Hatchery below the dam. Larger Mid-Klamath tributaries such as Bluff, Red Cap, Camp, Dillon, Clear, Indian, Thompson, Grider, Horse, Beaver, Cottonwood and Bogus Creeks host spawns most years (see Figure 2). Small tributaries such as Seiad, China, Little Grider, Independence, Swillup, Ti, Rock, Irving, Pearch, Boise, Slate and Hopkins Creeks host spawning, but are dependant on seasonal rains to provide flow for access.

Figure 2-Fall Chinook Redd Counts for Selected Mid-Klamath Tributaries



Spring Chinook

Spring chinook can be found in Mid-Klamath tributaries with cold deep pool holding habitat such as Dillon, Clear, Elk, Indian and Thompson Creeks, but usually numbers are less than ten fish per tributary (see map in Appendix A, page 1). Historically, many more spring-run salmon migrated through the Mid-Klamath to the Upper Klamath River Basin, but fish passage has since been blocked by dams. The spring run may once have been the dominant run of chinook in the Klamath River Basin (Myers et al., 1998). Warm Klamath River main stem water temperatures limit critical holding habitat for returning spring chinook.

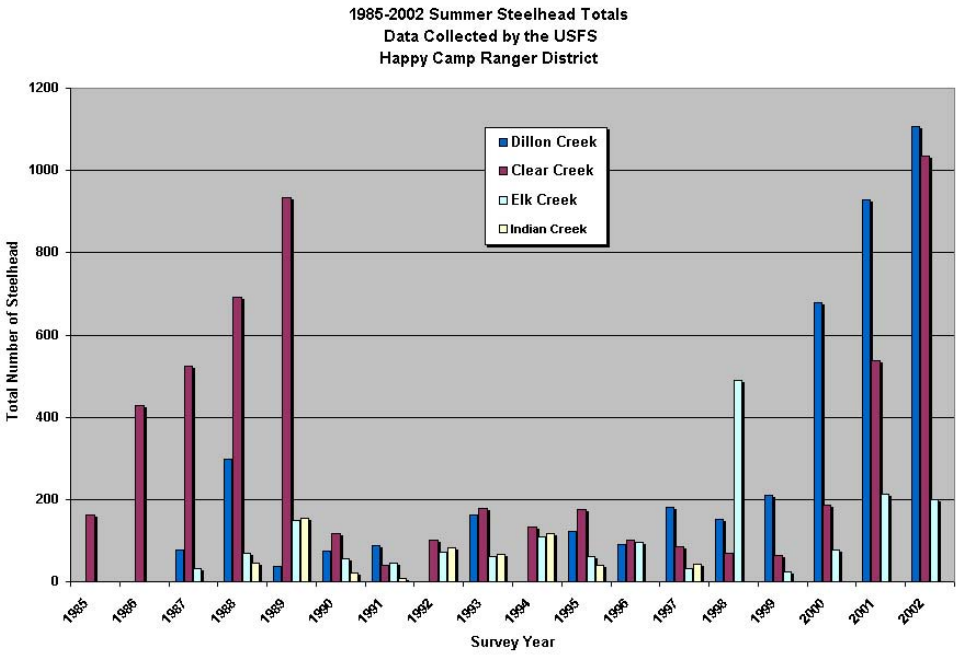
Coho

Adult coho salmon return to the Mid-Klamath River main stem and it tributaries during the fall and early winter (mid-October through mid-January). They then spawn from November through mid-January. Juvenile coho spend one to two growing seasons in freshwater before migrating to the ocean. They require summer and winter rearing areas that are protected from high winter flows and warm temperatures, which can be limited in the Mid-Klamath River main stem and its tributaries. Summer rearing occurs in many cold-water tributaries and other thermal refugia sites along the main stem Klamath River. Karuk tribal fisheries biologists have documented juvenile coho using off-channel thermal refugia ponds at the mouths of cold tributaries such as Beaver, Horse, Tom Martin, O'Neil, Independence, Sandy Bar, and Stanshaw Creeks. However, adult coho salmon have not been documented well in the subbasin. Known adult spawning coho populations are documented in Bluff, Red Cap, Camp, Boise, West Fork Clear, Elk, Indian, Seiad, Grider, Horse, Beaver, Barkhouse, Humbug, Cottonwood, Willow and Bogus. Other tributaries have juvenile coho present, but adult spawning in those tributaries are unknown.

Steelhead

Adult steelhead are present in the Mid-Klamath River twelve months of the year. Summer steelhead return to the Klamath River in the late spring and throughout the summer, and hold in larger tributaries and at coldwater tributary mouths. Tributaries such as Dillon, Clear, Elk and Indian support a large portion of the Klamath Basin summer steelhead run (see Figure 3). Other known summer steelhead streams are Red Cap, Bluff,Camp, Ukonom, Grider and Beaver. Fall and winter run steelhead hold in the main stem of the river and spawn in subbasin tributaries (usually from March through April) after seasonal rains increase flows. The "half-pounder", a small (1/2 pound to 2 pounds) sexually immature steelhead, is very prominent in the Klamath River and is popular with its anglers.

Figure 3-Summer Steelhead Population Census Numbers for Selected Mid-Klamath Tributaries



Sturgeon

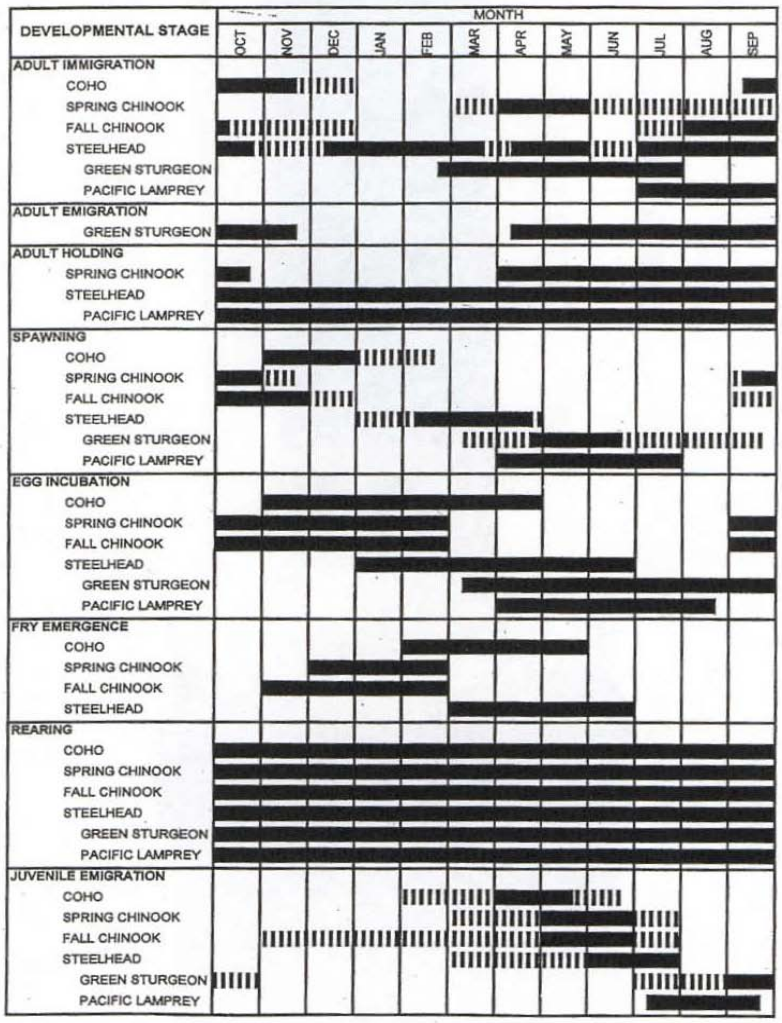
Both green and white sturgeon have been observed in the Mid-Klamath subbasin, but green sturgeon is the dominant species (CH2MHILL, 1985). The green sturgeon spawning migration begins in late February and continues through late July. Mature males typically spawn at age 15 to 35 years, and mature females at age 18 to 40 years old. Local residents have reported sturgeon above Ishi Pishi Falls, but most are seen below Ishi Pishi Falls. Sturgeon spawn during late spring and early summer, and migrate back to the ocean during the summer and fall. Little information exists on the life history of sturgeon in the Klamath River.

Pacific Lamprey

Pacific lampreys generally migrate to freshwater in the early spring to mid-summer. Karuk tribal fishermen catch lamprey in the main stem Mid-Klamath River during the spring and early summer. Spawning takes place generally from April to July, and then the fish die. Lamprey eggs hatch into "ammocoetes" within 2 to 3 weeks after they are fertilized (CH2MHILL, 1985). Ammocoetes live in the substrate of the main stem river and tributaries for up to 6 years until they immigrate to the ocean.

Figure 4- Life History Summary for Mid-Klamath Anadromous Fish

DEVELOPMENTAL STAGES THROUGH ONE WATER YEAR
FOR COHO, SPRING & FALL CHINOOK, STEELHEAD, GREEN STURGEON, AND PACIFIC LAMPREY
WITHIN THE KLAMATH BASIN



NOTES
1. The developmental stage timing represents basin-wide averages, local conditions may cause some variability.
2. Solid bars indicate periods of heaviest adult migration, spawning and juvenile emigration.
3. Acute shall be the maximum temperature observed in 96 hours or less. Chronic is the mean temperature of a seven day period.

Sources: CDFG, 1970(a) ; 1979 © ; 1979 (e) ; USFWS, 1984 (b)
Moffett and Smith, 1950 ; Scott and Crossman, 1979 ;
R. Adair, USFWS, personal communication, 1996

Geology of the Mid-Klamath

Mid-Klamath Subbasin Overview

The Mid-Klamath subbasin is bounded to the west by marine-sedimentary and metasedimentary rock. This geology is associated with the subduction of the Pacific Plate (dense / heavy ocean crust), under the North American Plate (less dense / lighter continental crust). Thus, the mountians in the Mid-Klamath are, in broad terms, located between unconsolidated coastal sedimentary and metasedimentary materials to the west and volcanic derived materials associated with the Cascade complex to the east. (For a list of rock types that occur in the Mid-Klamath subbasin, and their descriptions, see Appendix B)

Mid-Klamath Hydrology

The hydrologic traits of the Mid-Klamath subbasin are predominantly influenced by local climate and topography. The most easterly part of the subbasin, near Iron Gate Dam, receives about 15 inches of total rainfall, while the most westerly part of the subbasin, near the Trinity confluence, receives about 50 inches in a normal year. This difference in rainfall between eastern and western regions is primarily due to the rain shadow effect. The majority of precipitation occurs from November through March, with February being the wettest month. (USFS, 1998).

"Peak stream flows typically occur between November and March, although sustained high flows can last into June. The majority of peak flows and floods in this landscape are caused by rain-on-snow storms where warm winter rains melt accumulations of snow, adding snowmelt to rainfall runoff" (USFS, 1998). Rain-on-snow events are more common in the transitional snow zone. Summer thunderstorms are common causes for localized flooding and can make tributaries quite turbid after such events.

1997 Flood Effect

The flood event of 1997 caused substantial changes in stream channels throughout the Mid-Klamath subbasin. In the Klamath National Forest (KNF), mostly in the Mid-Klamath subbasin, the storm caused $27 million worth of damage to forest roads (de la Fuente and Elder, 1998). Flood effects were greatest in tributaries near the Happy Camp and Seiad Valley portion of the subbasin. De la Fuente and Elder found that flood effects were highest in a recently burned (1987) and highly roaded strip of land that encompasses Elk Creek, Grider Creek and Walker Creek. Other watershed such as Dillon Creek and Clear Creek, both recently burned in 1994, maintained high fish habitat and water quality values (Kier, 1999). Recent surveys in Grider Creek show high numbers of spawning chinook and steelhead, which may be an indication that the watershed is recovering (Grunbaum, J. 2001, personal communication). Surveys of summer steelhead show a steady population increase in the years following the 1997 flood event (complete data summaries are not yet available).

Vegetation Summary

The Mid-Klamath is characterized by vegetation heterogeneity and habitat diversity across latitudinal, longitudinal, and elevational scales. Changes associated with the transition from pacific-maritime to continental climate, as well as elevational change, disturbance, and the diverse geology of this area, all significantly influence the diversity of vegetation patterns. The spatial mosaic patterning of plant distribution is also influenced by fire history, geological parent material, geographic and site specific conditions.

In the western Mid-Klamath, vegetation structure can be characterized by conifer-dominated overstories with multi-tiered canopies that support diverse understories. In the east, it changes to chaparral scrub, sagebrush step, and juniper woodlands similar to those found in the Great Basin.

The connected role of vegetation, wildfire, and anadromous fish is just beginning to be understood. Woody debris on site as snags, as downed wood on slope, or as woody structure in riparian and in-stream locations is very important to both fish and wildlife species.

Vegetation in the Mid-Klamath has been altered by a variety of land management practices and structures, including dams and diversions, grazing, mining, road systems, timber harvest, and fire suppression. The overall effect of these influences has been to homogenize vegetation and decrease habitat diversity, as well as to increase susceptibility to invasive species.

See Appendix C for a list of plant associations that occur in the Mid-Klamath.

Fire Ecology and Management

Our knowledge of the historic role of fire within the Mid-Klamath region has improved as a result of recent scientific investigation. The critical role of historic fire regimes with respect to terrestrial system processes, structure and function, is now recognized. Two pre-western causes of fire are evident:

- Natural ignition associated with lightning events (atmospheric)
- Native American use of fire for cultural and management purposes (anthropogenic)

Natural fire events (lightning ignition), prior to western settlement and fire suppression, were dynamic and, to a certain degree, chaotic. It is evident from research that there is a wide array of influences determining fire behavior within the wild or natural state.
In general, lightning increases in frequency and intensity from west to east, further exacerbated at higher elevations. Therefore, potential fire starts are more likely along peaks, ridgelines and upper slope positions, and toward the eastern edges of the region.

Fire suppression in the Mid-Klamath was initiated in the early 1900s. This effort has expanded through time, with increasing applications of technology, funding, and training. Initially, fire suppression was developed as a protection against a disturbance event that was considered a threat to timberland resources. Today, however, it is widely recognized that natural wildfire is critical to functioning forest ecosystem types such as those that occur in the Klamath region.

Fire suppression, in concert with timber harvest (especially even-age prescriptions), have led to Mid-Klamath landscapes that are more susceptible to fires of greater intensity and stand replacing capability. Even age, closed canopy stands of high density, with elevated fuel accumulations, now comprise the majority of matrix lands and old plantations. These altered stands are at increased risk of burning at high intensity, if ignited (Key, 2000).

Salvage logging following fire tends to remove material critical to stream channel structure, such as large woody dead and downed debris from slopes and channels. This exacerbates soil erosion and transport within upland and stream systems. These factors directly affect anadromous fish, as downed woody debris is a critical structure to salmonid habitat. Downed woody debris is important for pool formation, sediment retention, overall channel stability, and provides cover complexity for species such as juvenile coho salmon. Lack of downed woody debris and

standing dead trees (future downed woody debris recruitment) decreases habitat complexity and channel stability (Spence et al., 1996).

Road System Interpretation

Road systems have been constructed within the Mid-Klamath subbasin principally for the purpose of resource extraction, utilization and management. The current, extensive USFS road system on the upland slopes of the Mid-Klamath was developed in support of resource-related entry following WWII, particularly during the period from 1960 to 1989. This era of rapid road construction facilitated the transition from a mineral based economy (gold), to one based on forest resources.

Long term road maintenance, though considered initially, was not implemented. In addition, there was limited knowledge of the hydrological affect of roads on slopes, or how to construct appropriate systems of channel / creek crossings. Culverts tended to be undersized for flood events, and were further stressed due to upslope management that exacerbated mass movement, landslope failures, and erosion. Creek channels were also utilized for tractor yarding / skidding and other activities. This historic treatment of slopes and drainages is now considered deleterious to aquatic and terrestrial habitat, as viewed within current land management and ecological frameworks.

Currently, roads are considered to be critical sources of watershed impairment. Scientific analysis has explicitly correlated increased sediment transport due to upland land management (timber harvest, road networks) with the decline of anadromous (especially salmonid) fish populations (Meehan, 1991). Road maintenance, decommissioning, upgrading, stormproofing, and protection of roadless areas are critical to the restoration of the Mid-Klamath subbasin, (especially its anadromous fisheries). These efforts will require significant funding, as well as the prioritization of road decommissioning and maintenance.

Section 4: Recovery Action Plan

There are two major types of restoration: 1) active restoration (e.g. on-the-ground projects), and 2) passive restoration, (involving implementation of policies meant to protect existing resources). Both types of restoration are represented throughout the Recovery Action Plan recommendations for the Mid-Klamath subbasin. The Mid-Klamath Sub-Watershed Regions Action Matrix included in this section corresponds with the following outlined restoration actions, identifying specific sub-watersheds for which each action would be appropriate. Data from ongoing monitoring efforts (described in Section 5) should be used to prioritize these recovery actions, as well as to provide feedback about the success of the efforts.

On-the-Ground Restoration Actions

Goal: *Mimic natural processes or allow natural process to function.*

A. Mid-Klamath Upslope Restoration Actions

1. Road decommissioning / slope stability
2. Storm proofing roads / hydrologic disconnection
3. Hazard fuels reduction
4. Toxic mine clean up
5. Develop a landslide sediment disposal plan for State Hwy 96 and County Roads to prevent waste from entering stream channels
6. Maintain vegetation age and species diversity

B. Mid-Klamath In-stream Restoration Actions

1. Improve fish passage at public and private road crossings
2. Screen diversions and modernize ditches / domestic water supplies
3. Improve in stream habitat at thermal refugia areas and near tributary mouths

C. Riparian and Stream Bank Restoration

1. Relocate/Eliminate roads segments from inner-gorge and riparian areas
2. Livestock exclusion from riparian areas
3. Mine tailing reclamation and revegetation
4. Riparian planting and stream shading

Management Actions

Goal: *Protect existing high quality watershed elements and critical fish habitat.*

A. Critical Habitat Protection

1. Limit land management activities in roadless area and designated wilderness areas
2. Implement sport fishery closures at thermal refugia sites during critical periods of poor main stem water quality
3. Limit other recreation based anthropogenic disturbances at thermal refugia sites during critical periods of poor main stem water quality

Public and Community Outreach Actions

Goal: *Include a variety of subbasin stakeholders with recovery actions to completely address problems across land jurisdictions, public, private and tribal.*

A. Education and Communication

1. Support Elementary school level watershed education programs
2. Conduct educational fisheries restoration focused workshops
3. Solicit public and community involvement with restoration projects
4. Support watershed restoration focused stakeholders
5. Solicit private landowner cooperation with restoration projects

B. Cooperation

1. Form restoration partnerships between private landowners
2. Form restoration partnerships between local, state and federal agencies
3. Form restoration partnerships between agencies and private landowners

Monitoring Actions

***Goal**: Use short and long term monitoring results to steer direction of recovery actions.*

A. Long Term Monitoring

1. Develop long term restoration project effectiveness monitoring plan
2. Monitor restoration project effectiveness
3. Stream Flow and Water Quality
4. Priority Fish Population and Run Size
5. Habitat Conditions

B. Short term Monitoring

1. Stream Flow and Water Quality
2. Fish disease and health monitoring
3. Harvest Monitoring
4. Priority Fish Population and Run Size

Middle Klamath Sub- watershed Region Actions Matrix

Actions	Sub-watershed Region	
	Volcanic Outer Region	Checkerboard
Upslope Restoration		
Road decommissioning	Low Need	High Need
Storm proofing roads/Upgrading	Low Need	High Need
Hazard fuels reduction	Moderate need	Moderate Need
Toxic mine clean up	Data gap	Data Gap
Maintain vegetation age and species diversity	Moderate need	High Need
Develop road failure waste storage plan	Low Need	Moderate Need
In-stream Restoration		
Fish Barrier Removal	High Need	Low Need
Screen Diversions	High Need	High Need
Modernize ditches/pipe water (Water Conservation)	High Need	High Need
Upgrade Existing In-stream Structures	Low Need	Moderate Need
Maintain Main stem/Tributary Habitat Connectivity	Moderate Need	Moderate Need
Riparian Restoration		
Relocate roads out of riparian areas	Moderate Need	High Need
Cattle exclusion fencing	High Need	High Need
Mine Tailing reclamation	Low Need	High Need
Riparian planting	High Need	Moderate Need
Education and Communication		
Watershed Education	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need
Community based restoration planning meetings	High Need	High Need
Foster restoration focused watershed groups	High Need	High Need
Cooperative Restoration Projects		
between landowners	High Need	High Need*
between tribal, county, state and federal agencies	High Need	High Need*
between private landowners and agencies	High Need	High Need*
Monitoring		
Develop effectiveness monitoring plan	High Need	High Need

*Cooperative projects are critical in this highly mixed public/private ownership region.

Middle Klamath Sub- watershed Region Actions Matrix

Actions	Sub-watershed Region		
	Red Butte	Grider Elk	Siskiyou
Upslope Restoration			
Road decommissioning	Moderate Need	High Need	High Need
Storm proofing roads/Upgrading	Moderate Need	High Need	High Need
Hazard fuels reduction	High Need	High Need	High Need
Toxic mine clean up	Low Need	Low Need	High Need
Maintain vegetation age and species diversity	Moderate Need	High Need	High Need
Develop roads failure waste storage plan	Moderate need	Moderate Need	Moderate Need
In-stream Restoration			
Fish Barrier Removal	High Need	Moderate Need	Low Need
Screen Diversions	None	Low Need	High Need
Modernize ditches/pipe water	None	Moderate Need	High Need
Upgrade Existing In-stream Structures	Low Need	Low Need	Moderate Need
Maintain Main stem/Tributary Habitat Connectivity	High Need	High Need	High Need
Riparian Restoration			
Relocate roads out of riparian areas	Low Need	Moderate Need	Moderate Need
Cattle exclusion/fencing*	None	Moderate Need	Low Need
Mine Tailing reclamation	Low Need	Low Need	Moderate Need
Riparian planting	Low Need	Moderate Need	Moderate Need
Education and Communication			
Local School Watershed Education	High Need	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need	High Need
Community based restoration planning meetings	High Need	High Need	High Need
Foster restoration focused watershed groups	High Need	High Need	High Need
Cooperative Restoration Projects			
between landowners	Moderate Need	Moderate Need	High Need
between tribal, county, state and federal agencies	High Need	High Need	High Need
between private landowners and agencies	High Need	High Need	High Need
Monitoring			
Develop effectiveness monitoring plan	High Need	High Need	High Need

*Cattle grazing in high elevation wilderness areas of Elk Creek and Grider Creek.

Middle Klamath Sub- watershed Region Actions Matrix

Actions	Sub-watershed Region		
	W. Marble Mountain	Orleans	Red Cap
Upslope Restoration			
Road decommissioning	High Need	High Need	Moderate Need
Storm proofing roads/Upgrading	High Need	High Need	High Need
Hazard fuels reduction	High Need	High Need	High Need
Toxic mine clean up	None	Low Need	Low Need
Maintain vegetation age and species diversity	Moderate need	High Need	High Need
Develop roads failure waste storage plan	Moderate need	Moderate Need	Moderate Need
In-stream Restoration			
Fish Barrier Removal	Moderate Need	Moderate Need	?
Screen Diversions	High Need	None	None
Modernize ditches/pipe water	High Need	None	None
Upgrade Existing In-stream Structures	None	Low Need	Low Need
Maintain Main stem/Tributary Habitat Connectivity	High Need	High Need	High Need
Riparian Restoration			
Relocate roads out of riparian areas	Low Need	Moderate Need	Low Need
Cattle exclusion/ fencing	None		None
Mine Tailing reclamation	Low Need	Low Need	Low Need
Riparian planting	Low Need	Low Need	Low Need
Education and Communication			
Local School Watershed Education	High Need	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need	High Need
Conduct community restoration focused workshops	High Need	High Need	High Need
Community based restoration planning meetings	High Need	High Need	High Need
Foster restoration focused watershed groups	High Need	High Need	High Need
Cooperative Restoration Projects			
between landowners	Moderate Need	High Need	Moderate Need
between tribal, county, state and federal agencies	High Need	High Need	High Need
between private landowners and agencies	High Need	High Need	High Need
Monitoring			
Develop effectiveness monitoring plan	High Need	High Need	High Need

*Local residents have reported feral cows in upper Bluff Creek.

Roads Restoration Actions

A main component of active restoration is and will continue to be fixing roads which block or degrade salmonid habitats. Roads are the primary source of sediments to Middle Klamath streams, as both chronic erosion and as starting points of mass failure during large storm events (de la Fuente and Elder, 1998). De la Fuente and Elder's assessment of the 1997 flood for the Klamath National Forest provides a detailed description of road failures in Middle Klamath watersheds and also provides good recommendations on how to minimize the risk of failures during large storm events like the 1997 Flood. A summary of recommended road treatments and categories of actions has been modified from *Road Sediment Source Inventory and Risk Assessment, Klamath National Forest* (USFS, 1999), and is included in this restoration actions section. Problem roads can be fixed either by upgrading /stormproofing or by decommissioning.

Many roads in the subbasin are not maintained, are poorly located or have faulty designs. For these roads, decommissioning is the only feasible solution. The cost-effective solution to problem roads that aren't used is decommissioning. Problem roads identified as needed because of private access needs, management needs or recreation needs will be upgraded / stormproofed and maintained to a level that minimizes impacts to salmonid habitats.

The Klamath and Six Rivers National Forests, in cooperation with the Karuk Tribe and the public, have developed travel management plans that assess road needs in the subbasin. The Klamath and Six Rivers National Forests and the Karuk Tribe have cooperatively completed Road Sediment Source (RSS) inventories in most Middle Klamath watersheds, which can be used for determining risk-analysis and transportation planning. The intent of transportation planning (described in USFS, 1999) is to find a balance between the benefits of access and roads-associated effects on aquatic resources, such as clean water and fish. The newly developed long-term road policy is based on four primary objectives:

1. more carefully considered decisions to build new roads,
2. eliminate old, unneeded roads,
3. upgrade and maintain roads important to public access, and
4. develop new and dependable funding for forest road management.

Road System Management

The management of existing road networks presents a significant challenge to land managers. The following list summarizes some of the major tasks and options with respect to the management of existing road networks in the Mid-Klamath:

Road Management Actions

- **Road Upgrades and Stormproofing:** Redesign problem roads to better withstand large storms and require less maintenance.
- **Seasonal Road Closures:** Close unsurfaced secondary roads during the wet season.
- **Permanent Road Closures:** Close roads until decommissioning actions are implemented

- **Decommissioning:** Hydrologically disconnecting roads from stream channels, including stream crossing removal and recontouring.

Road System Upgrades and Stormproofing

- **Upgrade Culvert**
  - Replace undersized culverts to a larger size fitted for large 100 year type storms.
  - Miter existing culvert inlets to increase flow capacity.
- **Pull (clear) Ditches**
  - Clean debris from ditches to allow better water transport.
- **Unplug Culverts**
  - Clear all culverts of rock and earthen materials, as well as woody and organic material.
- **Road Surfaces**
  - Surface roads with crushed rock to minimize surface erosion.
  - Grade roads and place rolling - dips, water bars and other structures in order to get water off road surface.
  - Out slope in board ditched roads and pave primary roads.
- **Road-Crossings**
  - Re-contour creek crossings and reduce fill volumes.
  - Replace road stream crossings fill with rock fills.

Decommissioning

- Hydrologically disconnecting roads from stream channels
- Road recontouring
- Stream crossing and in-steam road removal

Mid-Klamath Roadless Area Protection

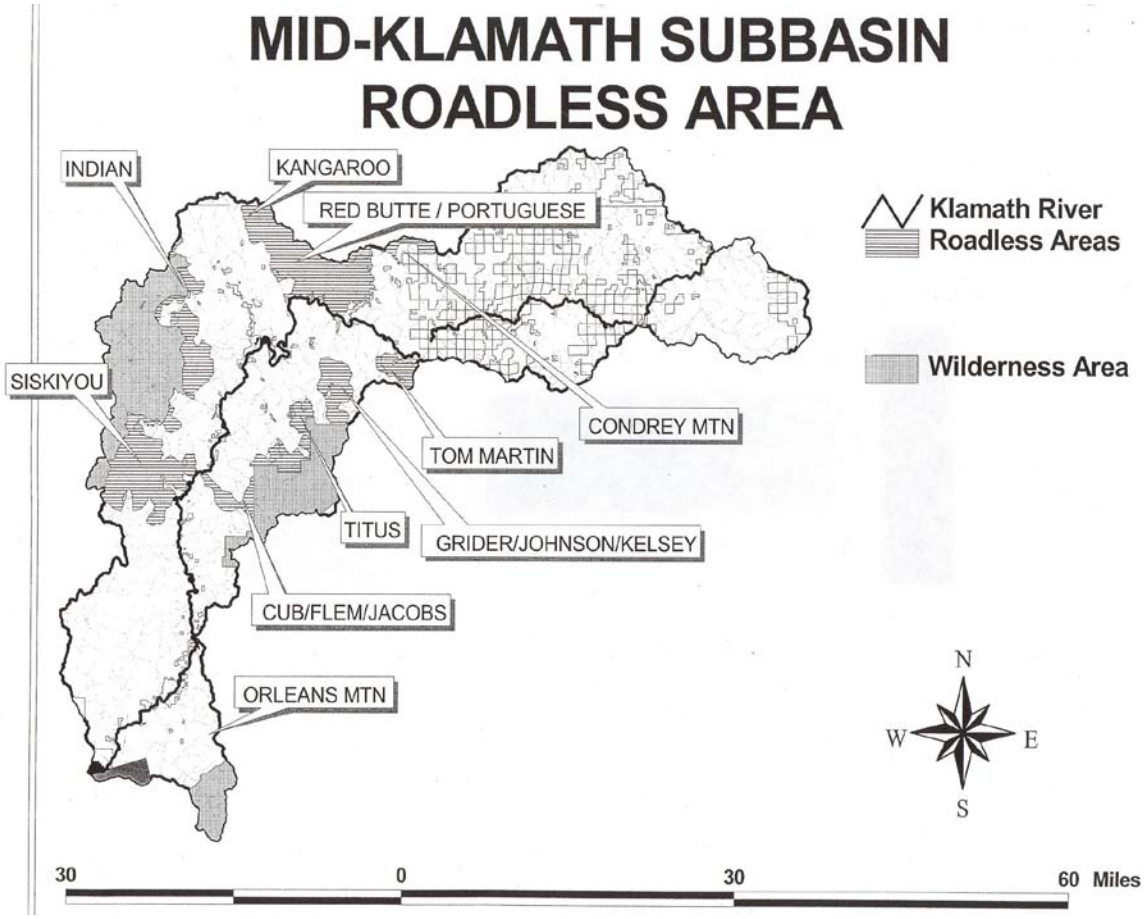
Ecologically significant roadless areas remain within the Mid-Klamath subbasin. The importance of these areas requires special management considerations with appropriate protective designations. Mid-Klamath roadless areas include wilderness designated lands and other areas rugged enough to prevent road building. In general, these areas have not been managed for timber, mining or other land disturbing actions. The remoteness of these lands has also prevented effective fire suppression; thus, most roadless areas are functioning under a historic fire regime. Roadless area protection is probably the most cost-effective recovery action that is needed in the Mid-Klamath.

Within the Mid-Klamath subbasin, four wilderness periphery expansions (Siskiyou, Red Butte, Marble Mountain and Trinity Alps), and four adjacent roadless areas (Tom Martin Peak, Lake Mountain, Condrey Mountain, and Titus) are recommended for protection (See Figure 5). These recommendations for Wilderness Expansion and addition are based on the 1978 *RARE II*, and more recent *Roadless Area Conservation Plan 2000*. However, larger areas with greater connectivity have also been identified to be considered for protection.

Area Code:	Area Name:	Gross Acres:	Comment:
5-701:	Siskiyou	(128,400)	1984 Wilderness Designation, significant Wilderness expansion opportunities around periphery.
5-272:	Cub	(200)	West Marble Mountain Wilderness Periphery
5-273:	Flem	(200)	Upper: Ukonom, Kings, Independence Creeks.
5-274:	Jacobs	(200)	Under-evaluation of potential wilderness area expansion and connectivity.
5-283:	Titus	(6,200)	Klamath River Corridor, across from Clear Creek.
5-067:	Grider	(11,000)	North Marble Mountain Wilderness Periphery
5-068:	Johnson	(9,300)	Upper: Elk Creek, Grider, Kelsey Creeks.
5-070:	Kelsey	(4,400)	Priority linkage and expansion opportunity
5-069:	Tom Martin	(9,400)	Scott River / Klamath River corridor confluence
5-074:	Portuguese	(39,100)	Southwest Marble Mountain Wilderness Periphery Salmon River / Klamath River corridor confluence Connection of Salmon River tributaries to Marble Crest (partly included in 1984 wilderness expansion)
5-079:	Orleans Mtn.	(100,700)	Northern and Northwestern Trinity Alps Periphery Upper tributaries to main stem and South Fork Salmon River. Large contiguous roadless opportunity, partially included 1984 expansion of Trinity Alps Wilderness.
5-702:	Indian Creek	(6,200)	Red Buttes Wilderness Periphery
5-703:	Kangaroo	(40,500)	Upper Indian, Thompson, Fort Goff, Seiad, Applegate partially included in 1984 Red Buttes Wilderness
5-704:	Condrey Mtn.	(3,100)	Seiad, Horse, Beaver Creeks, Cook and Green Area East

Acreage's attributed to Roadless Areas from RARE II summary, extended in our consideration
Synthesized from 1978 RARE II, California, USFS, Klamath National Forest

Figure 5- Mid-Klamath Roadless Area Map



Community Planning and Cooperative Restoration

In a mixed ownership landscape like much of the Middle Klamath, community and landowner cooperation is necessary. Large landscape-type restoration projects (e.g. hazard fuels reduction) that address both public and private lands are the most effective. Several cooperative community efforts and organizations focusing on work in the Mid-Klamath are currently in effect.

Subbasin Planning

The Karuk Tribe's Department of Natural Resources (KTDNR) has initiated community planning through its Mid-Klamath Subbasin Planning efforts, funded by the Klamath River Basin Fisheries Task Force. The Karuk Tribe's planning efforts began in 1997, when the Tribe was funded to begin Mid-Klamath subbasin planning. This draft subbasin plan is a product of that community planning effort.

Community planning begins with outreach to community about fisheries restoration issues, through education (school watershed education programs and community workshops) and communication (public meetings, requests for public comment, news letters, news bulletins).

The KTDNR's subbasin planning project, in the summer of 2000, involved coordinating informative meetings in the towns of Orleans, Happy Camp and Scott Bar. Three meetings in distinct locations were held due to the considerable distance between the communities. Information about current fisheries related restoration projects and the currents status of the subbasin's anadromous fish were presented, and comments about the same subjects were taken (see Appendix D). The subbasin planning project aims to assist restoration-focused watershed groups and other community planning groups with active cooperation and participation in recovery actions needed for fisheries restoration.

*Example***:** The formation of the Orleans/Somes Bar Fire Safe Council (OSFSC) was partly a product of outreach efforts implemented by the KTDNR's subbasin planning project. The OSFSC has developed a community fire planning strategy (see Appendix E) and implemented hazard fuels reductions projects in the subbasin.

*Example***:** The KTDNR's subbasin planning project in part is reponsible for the formation of the Middle Klamath Watershed Council (MKWC). This watershed group has implemented volunteer-based and funded restoration projects, and also publishes a restoration focused newsletter.

Orleans/Somes Bar Fire Safe Council

Since May of 2001, the Orleans/Somes Bar Fire Safe Council (FSC) has been planning and implementing fuels reduction projects on private lands. Through the creation of shaded fuelbreaks along roads and property boundaries and wildfire safety zones around structures, the FSC has reduced the risk of fires originating on private land spreading to surrounding National Forests. These fuels treatments also protect private resources from fires on public lands, and allow the Forest Service to use prescribed fire as a management tool without threatening private lands.

The FSC has organized 16 community volunteer workdays at the homes of elderly and disabled residents, held over 20 monthly meetings and workshops to collect community and agency input, conducted a Critical Info and Fire Protection Survey to gather information for the local volunteer fire department and prioritize fuels projects, and treated hazardous fuels on nearly 200 acres of private land.

The communities of the Mid Klamath are well aware that one of the major problems facing the subbasin today is fuels buildup due in part to fire suppression. The recent formation of Fire Safe Councils in the towns of Klamath River, Seiad, and Happy Camp show the willingness of communities to work together to protect private resources.

The long-term goal of this work is to re-establish historic fire regimes within the range of natural variability in the subbasin while reducing the risk of uncharacteristically intense fires and protecting public and private resources. Multiple watershed functions depend on fire. Less large wood recruitment to streams, decreased summer flows from increased plant uptake and more frequent high intensity fires, and sedimentation are a few ways suppression has impacted the fisheries of the Mid Klamath.

By first treating around communities and protecting private and key public resources, such as major roads and watersheds that supply city water, public land managers can more quickly implement prescribed fire and wildland fire use at the landscape level.

Community members who have project ideas or are interested in getting involved with the FSC can contact Will Harling or Ben Riggan at the FSC office in Somes Bar ((530) 469-3216).

Mid-Klamath Watershed Council

Since April 2001, the Mid Klamath Watershed Council (MKWC) has been coordinating volunteer workshops and workdays in the subbasin, highlighting the need to protect our declining fisheries resource. Participants include local fisherman, fisheries biologists, farmers, botanists, Forest Service employees, Karuk Tribe DNR members, raft guides, loggers, forestry technicians, school teachers, and business owners. The MKWC has modeled its program after the Salmon River Restoration Council, to bring this type of community-based watershed planning to the Mid Klamath subbasin. Community members who would like to get involved with MKWC can contact Blythe Reis (mail@sandybar.com).

Cooperative Restoration

Cooperative restoration planning is a mechanism of implementing large landscape restoration treatments, but is also important for securing the necessary funding to complete large restoration projects. Cooperative partnerships between tribal, county, state and federal agencies are capable of generating multiple funding sources for large expensive projects (e.g. road decommissioning). The Karuk Tribe has entered into a "Watershed Restoration Partnership" and other restoration partnerships with the Six Rivers National Forest and the Klamath National Forest. Currently, road decommissioning and fuels reduction projects are being implemented through this partnership (See Appendix F)

An effective restoration partnership is need in the "Checkerboard" sub-watershed region of the Middle Klamath. This highly mixed ownership region is severely degraded by roads, principally in Beaver Creek and Horse Creek. Most roads in these watersheds dissect large blocks of private and public lands. Treatments need to addresses all segments of road within a given watershed to ensure projects are effective at the watershed level.

Section 5: Middle Klamath Monitoring Status Report

There are several watershed elements that are currently being monitored in the Mid-Klamath. They include 1) fish populations, 2) stream flow, 3) water quality, 4) physical habitat, and 5) restoration sites. Monitoring is being carried out by multiple agencies, tribes and community groups. These groups include: Karuk Tribe, Yurok Tribe, United States Forest Service (USFS), United States Fish and Wildlife Service (USF&W), California Department of Fish and Game (DFG), the North Coast Water Quality Control Board (NCWQCB), United States Geological Survey (USGS), and the Mid-Klamath Watershed Council (MKWC). Coordination between these groups is essential to identify data gaps and to minimize redundancy in data collection.

The following outline describes current monitoring efforts in the Mid-Klamath, and identifies who is administering them.

Fish Population Monitoring

Chinook Spawning

- Spawning escapement surveys for Chinook are conducted on the main stem Klamath River from Happy Camp to Iron Gate Dam (Karuk Tribe, Yurok Tribe, USFS, DFG, and USF&W).
- The Karuk Tribe, Yurok Tribe, USFS and DFG survey major tributaries below Iron Gate annually.

Summer Steelhead Holding Counts (USFS and Karuk Tribe)

- Surveyed Summer Steelhead Streams (see Appendix G):
    - Bluff Creek
    - Red Cap Creek
    - Camp Creek
    - Dillon Creek
    - Clear Creek
    - Elk Creek
    - Indian Creek
    - Thompson Creek

Steelhead Spawning

Steelhead spawning surveys were conducted by the USFS from the mid-1980's through the mid-1990's on major tributaries. An effort is currently underway by the Karuk Tribe's fisheries program to continue this monitoring on select tributaries.

Outmigrant Trapping:

Outmigrant rotary screw traps are operated on the main stem Klamath River and tributaries:

- Klamath River below Bogus Creek (USFS)
- Klamath River above Scott River (USF&W, Karuk Tribe)
- Klamath River at Big Bar below Orleans (USF&W, Karuk Tribe)
- Red Cap Creek (USFS, Orleans Ranger District)

Main stem thermal refugia surveys (USF&W, Yurok Tribe, Karuk Tribe):

As part of the Klamath River flow study, all, major and minor tributary confluences with the main stem Klamath River are monitored to assess fish use of thermal refugia. These areas are monitored to assess fish health during periods of poor water quality.

Stream flow Monitoring

USGS Stream Flow Gauges:

Stream flow gauges are present below Iron Gate Dam, below Seiad Valley, in Indian Creek and below Orleans.

Tributary Summer Discharge Monitoring (USFS, Karuk):

Summer low-flow discharge rates are measured annually on all major and most minor tributaries to the main stem Mid-Klamath River.

Water Quality Monitoring

Water Temperature Data Loggers (USFS, Karuk Tribe, Yurok Tribe, NCWQCB):
Continuous water temperature data has been recorded on most tributaries in recent years (data is available in the current version of KRIS). A complete compilation of current recording sites has not been produced.

Continuous Water Quality Data Loggers (Hydrolabs and Datasons) (USF&W, Karuk, NCWQCB):
Continuous water quality stations are present in the main stem Klamath River below Iron Gate Dam, Seiad Valley and most recently Orleans. Hydrolab water quality monitoring parameters include: pH, specific conductivity, dissolved Oxygen, turbidity, and water temperature.

Physical Habitat Monitoring

Habitat Typing (USFS):
Habitat typing has been completed for most of the major and minor tributaries of the Mid-Klamath. Highly altered stream channels (1997 flood effects) in Grider Creek, Elk Creek and Indian Creek were recently re-surveyed.

Klamath "Flow Study" (USF&W, Yurok Tribe, Karuk Tribe):
Assessment of in-stream flow needs for all salmonids species in the main stem Klamath River is presently underway.

Fish Barrier Assessment (USFS, Karuk Tribe):
Suspected migration barriers exist at road stream crossings on some subbasin tributaries. State Hwy 96 dissects much of the subbasin and suspected barriers are present at crossings of O'neil Creek, Portuguese Creek, Fort Goff Creek, Cade Creek, Sandy Bar Creek, Stanshaw Creek and Crawford Creek (below Orleans). The Forest Service and the Counties are in the process of assessing suspected barriers on their respective roads.

Restoration Site Monitoring

Periodic Project Site Visits:
Road decommissioning and other on the ground projects will be visited periodically and current follow up site descriptions will be completed.

Photo Monitoring:
Descriptive pre-project photos should be taken and followed up by post-project photos. Permanent photo points should be established so that site conditions through time can be tracked (e.g. revegetation, slope stability, etc.).

Section 6: Planning Needs and Information Gaps

Section 7: Sources Cited

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Spence, Brian C., G.A. Lomnicky, R.M. Houghs and R.P. Novitsiki. 1996. *An Ecosystems Approach to Salmonid Conservation.* TR-4501-96-6057. Man. Tech. Environmental Research Services Corp., Corvallis, OR.

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U.S. Forest Service. 1999. *Road Sediment Source Inventory and Risk Assessment*, Klamath National Forest. Yreka, California.

NORTH COAST INTEGRATED REGIONAL WATER MANAGEMENT PLAN

North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

306 - Water Treatment System Upgrade, Happy Camp Community Services District

- Preliminary Water Treatment System Upgrade, Happy Camp, Karuk Tribe in Cooperation with Happy Camp Community Services District, November 30, 2010
- Happy Camp Community Services District, Water Treatment Evaluation Study, HydroScience Engineers, Inc., 2010

Preliminary Summary Sheet

Water Treatment System Upgrade

Happy Camp, CA

Karuk Tribe in Cooperation with Happy Camp Community Services District

(Revised November 30, 2010)

1. The proposed project is located in Happy Camp, CA. Happy Camp is located in Siskiyou County along State Highway 96, adjacent to the Klamath River.

2. The existing treatment plant includes a surface intake and an under-creekbed intake in Elk Creek. Water flows from the intakes by gravity to a wetwell (a small underground storage reservoir). Water is pumped from the wetwell through pressure filters and up to a 1,000,000 gallon water storage tank. The two existing filters are plumbed in parallel, so one or both filters may be used at a time. In the raw water piping upstream of the filters, coagulant is injected to increase filter effectiveness. In the filtered water piping downstream of the filters, a solution of sodium hypochlorite (liquid chlorine) is injected to provide disinfection. Contact time for chlorine disinfection is provided within the water storage tank and within the transmission line between the water treatment plant and the tank. From the tank, the treated water flows by gravity into the distribution system and ultimately to the Happy Camp community water system users.

3. The California Department of Public Health (CDPH) has indicated that the existing treatment system is missing a flocculation step and does not meet State requirements to qualify as direct filtration, and therefore does not meet the requirements of the Federal Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR). The LT1ESWTR will soon be adopted by the State of California.

4. Flocculation is the process where a coagulant is added to raw (unfiltered) water and the mixture is allowed time for small particles in the water to bind (floc) together. This process creates larger particles than found in the raw water, making it easier for the pressure filters to remove the particles. Particle removal and associated reduction in turbidity is a goal of water filtration plants. Particle removal and subsequent disinfection purify water for drinking and other consumptive uses. Without an approved filtration system, the customers of the Happy Camp Community Services District are considered to be more vulnerable to water borne pathogens, such as Giardia and Cryptosporidium.

5. Another problem identified with the existing water treatment system is that electrical equipment for the wetwell pumps, which push water through the treatment plant, is considered to be at risk of damage during floods less frequent than the 100-year and therefore is considered to be within the 100-year floodplain. Flooding could subject this equipment to damage.

6. The Happy Camp Community Services District (HCCSD) is the local agency responsible for operation and maintenance of the water system. The California Department of Public Health (CDPH) is the State agency responsible for drinking water regulatory compliance for the water system.

7. The Indian Health Service (IHS) provides water and wastewater assistance to the Karuk Tribe. Karuk Tribal members are provided service through the HCCSD's water system. The most effective and efficient way of providing water service to Tribal members who have community water service in Happy Camp is to work in partnership with the Tribe and HCCSD on water improvement projects. The IHS is currently working on the development of an evaluation study for the water treatment system. Additional detailed information from that study will be available in early 2011.

8. Federal and State drinking water requirements currently differ. The State has not yet adopted the Federal Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) or the Federal Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Since the State has lead responsibility for this water system, the focus of the study and associated alternatives will be compliance with State requirements. Additional information will be provided in the study to provide potential items for future compliance with Federal requirements that are beyond current State requirements.

9. Based on preliminary coordination with Federal, State, Local, and Tribal representatives, alternatives were identified to address the existing conditions. These alternatives and some associated information are provided below.

   9.1. No Action Alternative – this alternative does not address the existing problem regarding a lack of a flocculation step identified by the CDPH and the problem associated with potential flood damage to wetwell electrical equipment.

   9.2. Action Alternatives

      9.2.1. Alternative 1 – Install New Roughing Filter - Construct a new roughing filter upstream of the existing two pressure filters. Provide additional upgrades including: provide inspection of the existing pressure filters; upgrade the existing wetwell pumps and electrical equipment to handle the additional hydraulic and electrical load; relocate the wetwell electrical equipment to place this equipment a safe distance outside the 100-year floodplain; provide improvements to the existing backwash disposal pond to handle additional filter backwashing cycles; and provide Supervisory Control and Data Acquisition (SCADA) improvements for the existing water storage tank for better control of water storage tank levels and wetwell pump operation – this alternative provides a least cost method of addressing the flocculation and wetwell electrical equipment issues relative to other alternatives.

9.2.2. Alternative 2 – Upgrade the existing filters to improve filtration – Provide baffling and reconfiguration of existing filters and provide additional upgrades noted under Alternative 1, except possibly an upgrade of the existing wetwell pumps and electrical equipment to handle an additional hydraulic and electrical load – the alternative may require higher turbidity removal standards per State requirements that may be difficult to obtain under all conditions, the alternative may not meet State requirements for direct filtration, and the work could require each filter to be out of service for an extended period of time affecting the ability of the plant to meet water demands. There is uncertainty of whether or not this alternative can meet State requirements regarding the flocculation issue. The alternative was not considered for further evaluation for the purposes of the NCIRWMP grant request, since other potentially acceptable alternatives were available.

9.2.3. Alternative 3 – Flocculation and Clarification Package Plant – Install a separate flocculation and clarification package plant upstream of the existing pressure filters, provide the additional upgrades noted under Alternative 1, reconfigure the wetwell pumps to only pump from the wetwell to and through the flocculation/clarification package plant, and install a new pump booster station to pump water from the package plant through the filters and to the water storage tank – this alternative addresses the flocculation and wetwell electrical equipment issues, but based on initial estimates, at a significantly higher cost than Alternative 1.

9.2.4. Alternative 4 – Pipeline Flocculation - Add additional length of pipeline between the wetwell and the pressure filter to provide additional time for the coagulant to cause flocculation, and provide additional upgrades noted under Alternative 1 – It appears that there is a lack of sufficient area to provide the length of pipeline required to provide 10-15 minutes of flocculation time. The alternative was not considered for further evaluation for the purposes of the NCIRWMP grant request, since other potentially acceptable alternatives were available.

9.2.5. Alternative 5 – New Package Plant – this alternative replaces the existing treatment plant with an entirely new treatment plant and provides the additional upgrades noted under Alternative 1, except for providing inspection of the existing filters, since these filters would be demolished. This alternative addresses the flocculation and wetwell electrical equipment issues, but based on initial estimates, at a significantly higher cost than Alternative 1.

10. All alternatives will be explored further in the evaluation study. For the purposes of the present NCIRWM grant request, the least cost action alternative that addressed the flocculation and wetwell electrical equipment issues, Alternative 1, Install New Roughing Filter, was selected as the proposed alternative. An Existing Conditions Schematic, a Proposed Alternative Schematic, and a cost estimate for the proposed alternative are provided. Available cost information for the Flocculation and Clarification Package Plant alternative (renamed Alt. 2. in the title of the attached Table) and for

the New Package Plant alternative (renamed Alt. 3 in the title of the attached Table) are also presented for comparison purposes.

11. Because annual operation and maintenance costs are lowest for Alternative 1 - Install New Roughing Filter, a direct comparison of capital costs without considering annual operation and maintenance (O&M) costs would yield the same conclusion as comparing life cycle costs (present worth of capital costs and O&M costs). Capital costs for these alternatives are as follows:

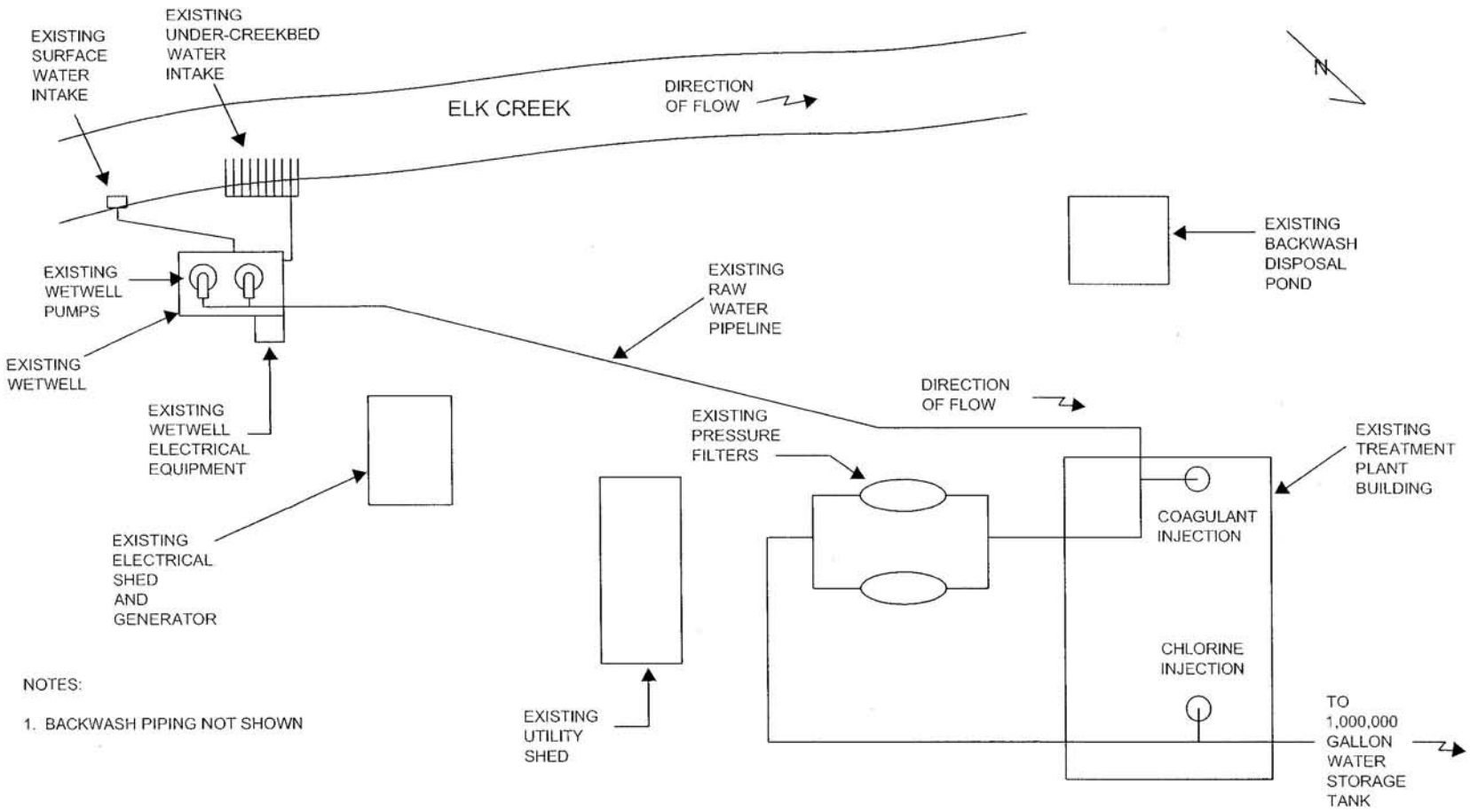
	Alternative	Capital Cost
11.1.	Install New Roughing Filter -	$447,000
11.2.	Flocculation and Clarification Package Plant –	$510,000
11.3.	New Package Plant –	$644,000

12. Additionally, in Alternative 1 – Install New Roughing Filter, the new roughing filter is sized to handle 1,440 gallons per minute (gpm) of flow, which is equal to the capacity of the existing pressure filters. The other two alternatives are only sized at 250 gpm. Increasing the capacity of these two alternatives to be comparable with Alternative 1 would further increase the costs of these two alternatives.

13. During the course of the evaluation study, additional deficiencies with the community water system were identified. These additional deficiencies included (1) upgrades to the backwash systems and controls for the existing pressure filters and possible repair or replacement of the older of the two existing filters and repair of the newer filter, and (2) installation of additional water quality monitoring and reporting equipment to meet potential future State drinking water requirements. Work to address these deficiencies was beyond the work identified for the filter upgrade project. Since solutions to address these additional deficiencies were of a lower priority than alternatives to address the problems with the existing water treatment plant, the overall water project for the Happy Camp community water system was split into three phases. Phase 1 work would address the treatment plant upgrade to comply with the soon to be adopted State drinking water requirements and relocation of the electrical equipment a safe distance outside the 100-year floodplain, and is included in the NCIRWMP grant request. Funding for Phase 2, which includes upgrades to the existing pressure filters and possible repair or replacement of the older of the two existing filters and repair of the newer filter, and funding for Phase 3, which includes additional upgrades to water quality monitoring equipment, are <u>not</u> being requested under the current Phase 1 project; future funding for Phase 2 and Phase 3 will be sought separately. Phase 1 is a stand-alone project. Phase 2 is dependent on work completed in Phase 1; once Phase 1 is completed, Phase 2 is a stand-alone project. Phase 1 and Phase 2 projects may also be completed concurrently. Phase 3 is dependent on work completed in Phase 1 and Phase 2; once these two phases are completed, Phase 3 is a stand-alone project.

Attachments:

1. Existing Conditions Schematic
2. Proposed Alternative Schematic
3. Table 2A. Alt 1. Phase 1. Roughing Filter and related Improvements
   Preliminary Cost Estimate (Proposed Alternative)
4. Table 3. Alt 2. Package Flocculation/Clarification Improvements
   Preliminary Cost Estimate
5. Table 4. Alt 3. Package Plant and Related Improvements
   Preliminary Cost Estimate



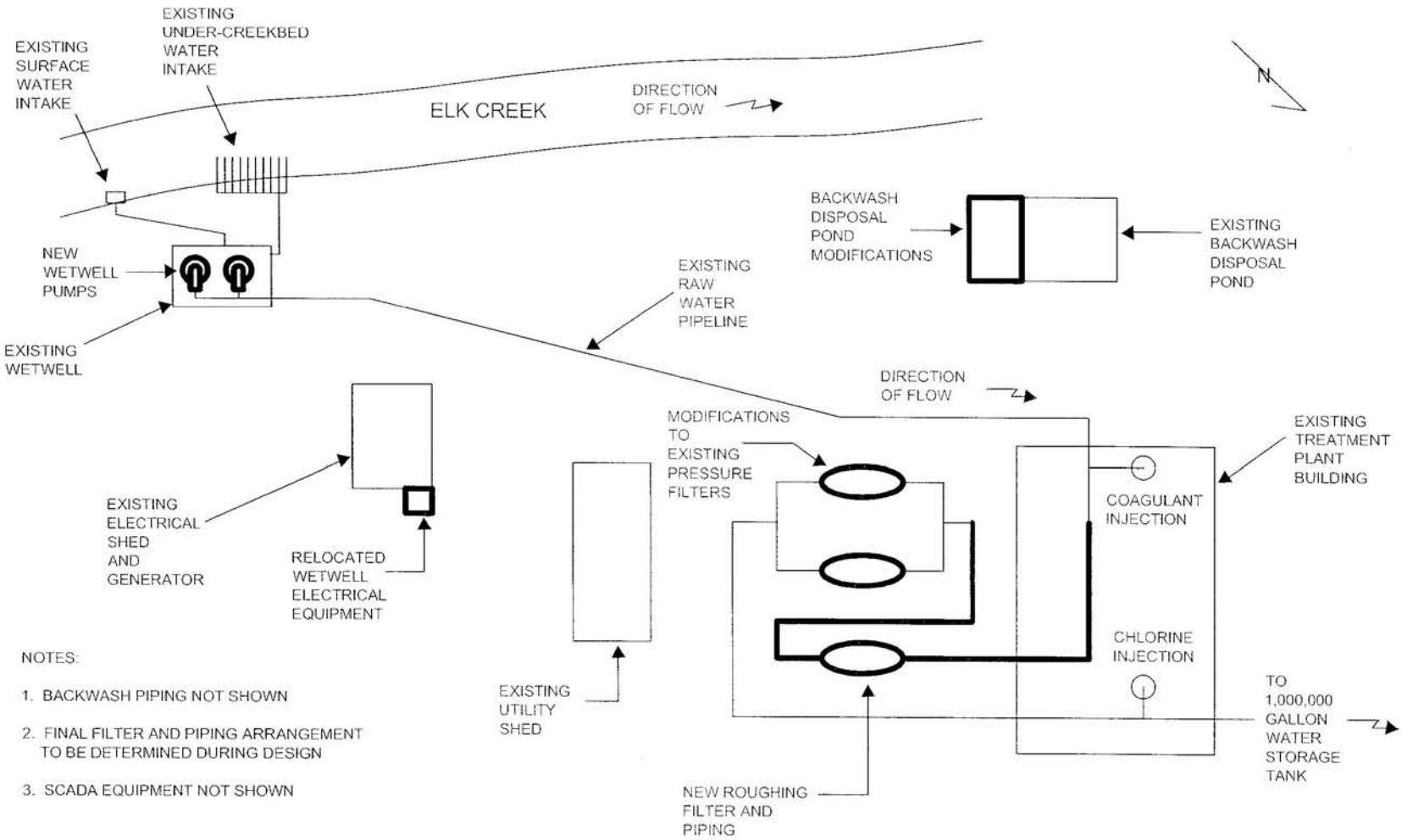
NOTES:

1. BACKWASH PIPING NOT SHOWN

WATER TREATMENT PLANT UPGRADE-

EXISTING CONDITIONS SCHEMATIC -

OCT. 6, 2010
NOT TO SCALE



NOTES:

1. BACKWASH PIPING NOT SHOWN
2. FINAL FILTER AND PIPING ARRANGEMENT TO BE DETERMINED DURING DESIGN
3. SCADA EQUIPMENT NOT SHOWN

WATER TREATMENT PLANT UPGRADE-

PROPOSED ALTERNATIVE SCHEMATIC -

OCT. 6, 2010
NOT TO SCALE

Table 2A. Alt 1. Phase 1. Roughing Filter and related Improvements PRELIMINARY COST ESTIMATE

Revised November 24, 2010

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/Environmental Assessment/Permitting	1	LS	$15,000.00	$15,000.00
2	Ground Design Survey	1	LS	$15,000.00	$15,000.00
3	Preliminary Engineering Design Report	1	LS	$12,000.00	$12,000.00
4	Geotechnical Services	1	LS	$5,000.00	$5,000.00
5	A/E Design Development Services (approx. 6% of Line 9)	1	LS	$20,000.00	$20,000.00
6	A/E Engineering Construction Support (approx. 2% of Line 19)	1	LS	$7,000.00	$7,000.00
7	Sub-Total Section I:				$74,000.00
II. CONSTRUCTION					
	Water Facilities				
8	New 1440 gpm Roughing Filter	1	LS	$205,000.00	$205,000.00
9	Existing Pressure Filter Inspection	2	LS	$5,000.00	$10,000.00
10	Existing Wetwell Pump Station Mechanical Modifications, two 500 gpm pumps	1	LS	$20,000.00	$20,000.00
11	Existing Wetwell Pump Station Electrical Modifications and Relocation	1	LS	$15,000.00	$15,000.00
12	Site Piping and Tie-Ins	200	LF	$50.00	$10,000.00
13	SCADA Upgrade	1	LS	$7,500.00	$7,500.00
14	Backwash Pond Modifications and Rehabilitation	1	LS	$15,000.00	$15,000.00
15	Erosion and Sediment Control	1	LS	$3,000.00	$3,000.00
16	Other Appurtenances	1	LS	$5,000.00	$5,000.00
17	Sub-Total Construction:				$290,500.00
18	Construction Contingencies (Rounded)	15%	of	$290,500.00	$43,575.00
19	Sub-Total Section II:				$334,075.00
III. ENGINEERING AND ADMINISTRATION					
20	Contract Administrative Fees (Lines 7 and 19)	3%	of	$408,075.00	$12,242.00
21	Indian Health Service (IHS) Construction Inspection (Line 19)	3%	of	$334,075.00	$10,022.00
22	IHS Project Technical Support (PTS) (Lines 7 and 19)	4%	of	$408,075.00	$16,323.00
23	Sub-Total Section III:				$38,587.00

V. SUMMARY

TOTAL PROJECT COSTS	
Planning and Architect/Engineer Services Sub-Total:	$74,000.00
Construction Sub-Total:	$334,075.00
Engineering and Administration Sub-Total:	$38,587.00
Total Sections I, II, and III:	$446,662.00
Total Project Cost (Rounded to Nearest $1,000):	**$447,000.00**
PROJECT FUNDING	
IRWMP Proposition 84 Implementation Grant (57%) * (Rounded):	$253,000.00
IHS Contribution (43%) * (Rounded):	$194,000.00
Total Project Funding:	**$447,000.00**

* Grant/Contribution subject to successful project proposals, available funding, data from completion of concurrent feasibility study, and other requirements.

Unit Cost/Indian Home Served:	200	Homes	Unit Cost =	$970.00
Unit Cost/Billing Unit Served:	460	Billing Units	Unit Cost =	$971.74

Table 3. Alt 2. PackageFlocculation/Clarification Improvements PRELIMINARY COST ESTIMATE

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/Environmental Assessment/Permitting	1	LS	$15,000.00	$15,000.00
2	Ground Design Survey	1	LS	$15,000.00	$15,000.00
3	Preliminary Engineering Design Report	1	LS	$12,000.00	$12,000.00
4	Geotechnical Investigation	1	LS	$5,000.00	$5,000.00
5	A/E Design Development Services (approx. 6% of Line 20)	1	LS	$23,000.00	$23,000.00
6	A/E Engineering Construction Support (approx. 2% of Line 20)	1	LS	$8,000.00	$8,000.00
7	Sub-Total Section I:				$78,000.00
II. CONSTRUCTION					
	Water Facilities				
8	Package flocculation/clarification; 250 gpm	1	LS	$212,000.00	$212,000.00
9	Existing Wet Well Pump Station mechanical modifications	1	LS	$15,000.00	$15,000.00
10	Existing Wet Well Pump Station electrical modifiacitons and relocation	1	LS	$15,000.00	$15,000.00
11	Site Piping and tie-ins	200	LF	$50.00	$10,000.00
12	New Pump Station structural and mechanical	1	LS	$35,000.00	$35,000.00
13	New Pump Station electrical	1	LS	$20,000.00	$20,000.00
14	SCADA upgrade	1	LS	$7,500.00	$7,500.00
15	Backwash Pond Modifications and Rehabilitation	1	LS	$15,000.00	$15,000.00
16	Erosion and Sediment Control	1	LS	$3,000.00	$3,000.00
17	Other Appurtenances	1	LS	$5,000.00	$5,000.00
18	Sub-Total Construction:				$337,500.00
19	Construction Contingencies (Rounded)	15%	of	$337,500.00	$50,625.00
20	Sub-Total Section II:				$388,125.00
III. ENGINEERING AND ADMINISTRATION					
21	Contract Administrative Fees (Lines 7 and 20)	3%	of	$466,125.00	$13,984.00
22	Indian Health Service (IHS) Construction Inspection (Line 20)	3%	of	$388,125.00	$11,644.00
23	IHS Project Technical Support (PTS) (Lines 7 and 20)	4%	of	$466,125.00	$18,645.00
24	Sub-Total Section III:				$44,273.00
V. SUMMARY					
	TOTAL PROJECT COSTS				
	Planning and Architect/Engineer Services Sub-Total:				$78,000.00
	Construction Sub-Total:				$388,125.00
	Engineering and Administration Sub-Total:				$44,273.00
	Total Sections I, II, and III:				$510,398.00
	Total Project Cost (Rounded to Nearest $1,000):				**$510,000.00**
	Unit Cost/Billing Unit Served:	460	Billing Units	Unit Cost =	$1,108.70

Table 4. Alt 3. Package Plant and related Improvements PRELIMINARY COST ESTIMATE

ITEM	DESCRIPTION	QTY	UNIT	UNIT PRICE	TOTAL PRICE
I. PLANNING & ARCHITECT/ENGINEER (A/E) SERVICES					
1	Archaeology/Environmental Assessment/Permitting	1	LS	$15,000.00	$15,000.00
2	Ground Design Survey	1	LS	$15,000.00	$15,000.00
3	Preliminary Engineering Design Report	1	LS	$12,000.00	$12,000.00
4	Geotechnical Investigation	1	LS	$5,000.00	$5,000.00
5	A/E Design Development Services (approx. 6% of Line 20)	1	LS	$30,000.00	$30,000.00
6	A/E Engineering Construction Support (approx. 2% of Line 20)	1	LS	$10,000.00	$10,000.00
7	Sub-Total Section I:				$87,000.00
II. CONSTRUCTION					
	Water Facilities				
8	Clarifier with filters/ Direct Filtration Plant	1	LS	$315,000.00	$315,000.00
9	Existing Wet Well Pump Station mechanical modifications	1	LS	$15,000.00	$15,000.00
10	Existing Wet Well Pump Station electrical modifiacitons and relocation	1	LS	$15,000.00	$15,000.00
11	Site Piping and tie-ins	200	LF	$50.00	$10,000.00
12	New Pump Station structural and mechanical	1	LS	$35,000.00	$35,000.00
13	New Pump Station electrical	1	LS	$20,000.00	$20,000.00
14	SCADA upgrade	1	LS	$7,500.00	$7,500.00
15	Backwash Pond Modifications and Rehabilitation	1	LS	$15,000.00	$15,000.00
16	Erosion and Sediment Control	1	LS	$3,000.00	$3,000.00
17	Other Appurtenances	1	LS	$5,000.00	$5,000.00
18	Sub-Total Construction:				$440,500.00
19	Construction Contingencies (Rounded)	15%	of	$440,500.00	$66,075.00
20	Sub-Total Section II:				$506,575.00
III. ENGINEERING AND ADMINISTRATION					
21	Contract Administrative Fees (Lines 7 and 20)	3%	of	$506,575.00	$15,197.00
22	Indian Health Service (IHS) Construction Inspection (Line 20)	3%	of	$506,575.00	$15,197.00
23	IHS Project Technical Support (PTS) (Lines 7 and 20)	4%	of	$506,575.00	$20,263.00
24	Sub-Total Section III:				$50,657.00
V. SUMMARY					
	TOTAL PROJECT COSTS				
	Planning and Architect/Engineer Services Sub-Total:				$87,000.00
	Construction Sub-Total:				$506,575.00
	Engineering and Administration Sub-Total:				$50,657.00
	Total Sections I, II, III and IV:				$644,232.00
	Total Project Cost (Rounded to Nearest $1,000):				**$644,000.00**
	Unit Cost/Billing Unit Served:	460	Billing Units	Unit Cost =	$1,400.00

NORTH COAST INTEGRATED REGIONAL WATER MANAGEMENT PLAN

North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

408 - Del Norte Agricultural Enhancement Program, Del Norte Resource Conservation District

- USDA Manure Transfer, High Pressure Underground PVC Mainline, Plans and Specifications. NRCS. 2008
- USDA High Pressure Underground PVC Mainline, Wheel Line Sprinkler System, Irrigation Water Management & Structure for Water Control, Plans and Specifications. NRCS. 2008
- USDA Riparian Forest Buffer, Conservation Practice Job Sheet, NRCS 1997

Riparian Forest Buffer

Conservation Practice Job Sheet ***391***

Natural Resources Conservation Service (NRCS) ***April 1997***

Landowner_____

Definition

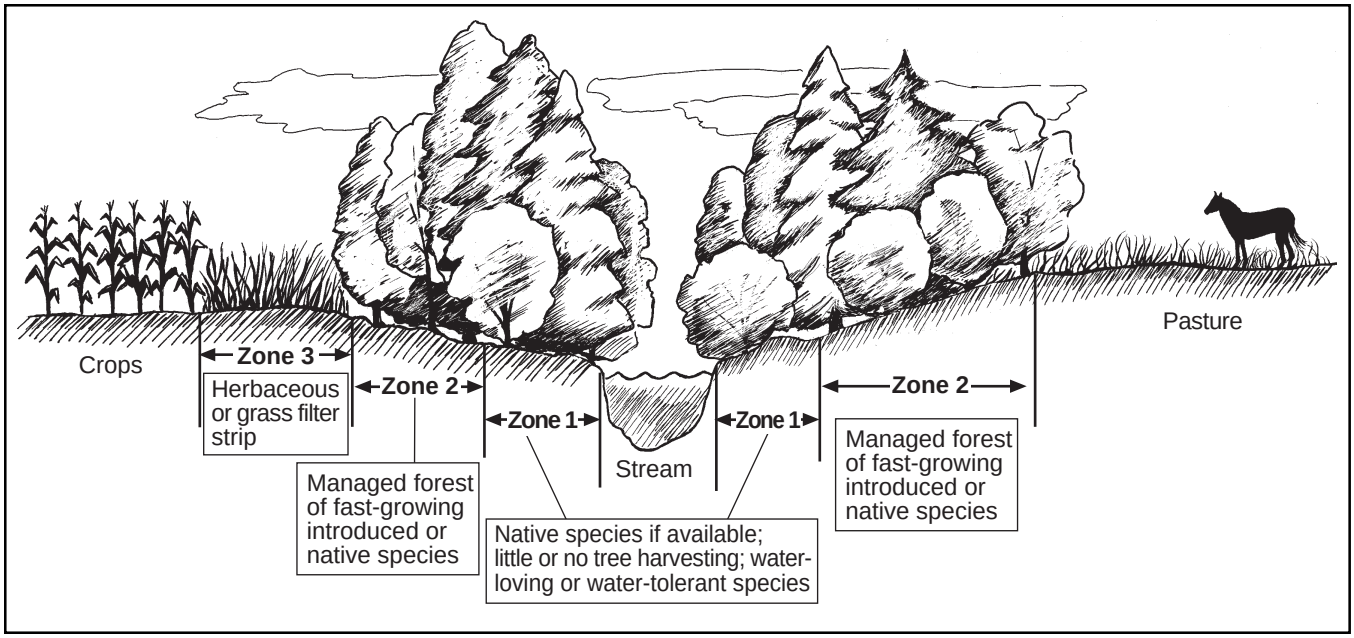
A riparian forest buffer is an area of trees and shrubs located adjacent to streams, lakes, ponds, and wetlands.

Purpose

Riparian forest buffers of sufficient width intercept sediment, nutrients, pesticides, and other materials in surface runoff and reduce nutrients and other pollutants in shallow subsurface water flow. Woody vegetation in buffers provides food and cover for wildlife, helps lower water temperatures by shading waterbody, and slows out-of-bank flood flows. In addition, the vegetation closest to the stream or waterbody provides litter fall and large woody debris important to aquatic organisms. Also, the woody roots increase the resistance of streambanks and shorelines to erosion caused by high water flows or waves. Some species established or managed in a riparian forest buffer can be managed to provide timber, wood fiber, and horticultural products.

Where used

Buffers are located by permanent or intermittent streams, lakes, ponds, wetlands, and seeps. Many of these areas have year-round or seasonal beneficial



A riparian forest buffer includes zone 1, the area closest to the waterbody or course, and zone 2, the area adjacent to and up gradient of zone 1. Trees and shrubs in zone 1 provide important wildlife habitat, litter fall for aquatic organisms, and shading to lower water temperature. This zone helps stabilize streambanks and shorelines. Trees and shrubs in zone 2 (along with zone 1) intercept sediment, nutrients, pesticides, and other pollutants in surface and subsurface water flows. Zone 2 can be managed to provide timber, wood fiber, and horticultural products. A third zone, zone 3, is established if periodic and excessive water flows, erosion, and sediment from upslope fields or tracts are anticipated. Zone 3 is generally of herbaceous plants or grass and a diversion or terrace, if needed. This zone provides a “first defense” to assure proper functioning of zones 1 and 2.

moisture, which allows woody species to establish quickly. A new riparian forest buffer can rapidly benefit a variety of settings, such as cropland, rangeland, forest land, and urban areas.

Conservation management system

Riparian forest buffers are normally established concurrently with other practices as part of a conservation management system. For example, adjoining streambanks or shorelines must be stabilized before or in conjunction with the establishment of the buffer (streambank and shoreline protection). To maintain proper functioning of a planting, excessive water flows and erosion must be controlled upslope of the riparian forest buffer (filter strip, diversion, critical area planting). New plantings must be protected from grazing during establishment.

Wildlife

Connecting a buffer with existing perennial vegetation, such as woodlots and woody draws (tree/shrub establishment) or hedgerows (windbreak/shelterbelt establishment), benefits wildlife and aesthetics. Select species and a planting pattern that benefits the wildlife species of interest.

Operation and maintenance

Trees in the buffer as well as adjacent forested areas are periodically maintained and harvested (forest stand improvement and forest harvest trails and landings). As the buffer matures, periodic harvesting of some of the trees becomes an important activity for maintaining plant health and buffer function.

Specifications

Site-specific requirements are listed on the specifications sheet. Additional provisions are entered on the job sketch sheet. Specifications are prepared in accordance with the NRCS Field Office Technical Guide. See practice standard Riparian Forest Buffer code 391.

Riparian Forest Buffer – Specifications Sheet

Landowner _____ Field number_____

Purpose (check all that apply)	
☐ Intercept sediment, nutrients, pesticides, other contaminants	☐ Wildlife habitat
☐ Lower water temperature	☐ Other (specify):

Location and Layout		
Water body/course type and name, other:		
Minimum buffer zone widths (ft.) - specify left and right of stream (facing upstream) for a two-side buffer; use left only for water bodies, such as lakes and ponds; include herbaceous species in zone 3 notes or refer to other job sheets:		
Zone 1	**Zone 2**	**Zone 3**
Left: Right:	Left: Right:	Left: Right:
Notes:	Notes:	Notes (refer to filter strip job sheets):
Buffer zone length (ft):	Buffer zone area (ac):	
Additional location and layout requirements:		

Woody Plant Materials Information				
Species/cultivars: Spacing[2]:	Plants/acre:	Kind of stock[1]:	Planting dates:	Average
Zone #1				
1				
2				
3				
4				
Zone *#2*				
1				
2				
3				
4				

[1]BAreroot, COntainer, CUtting; include size, caliper, height, and age as applicable. [2]Average spacing between plants to achieve plants/acre.

Temporary Storage Instructions
Planting stock that is dormant may be stored temporarily in a cooler or protected area. For stock that is expected to begin growth before planting, dig a V-shaped trench (heeling-in bed) sufficiently deep and bury seedlings so that all roots are covered by soil. Pack the soil firmly and water thoroughly.
Site Preparation
Remove debris and control competing vegetation to allow enough spots or sites for planting and planting equipment. Additional requirements:
Planting Method(s)
For container and bareroot stock, plant stock to a depth even with the root collar in holes deep and wide enough to fully extend the roots. Pack the soil firmly around each plant. Cuttings are inserted in moist soil with at least 2 to 3 buds showing above ground. Additional requirements:

Buffer Maintenance
The buffer must be inspected periodically and protected from damage so proper function is maintained. Replace dead or dying tree and shrub stock and continue control of competing vegetation to allow proper establishment. Periodic harvesting of trees and shrubs in zones 1 and 2 may be necessary to maintain the health and vigor of mature stands. Additional requirements:

Riparian Forest Buffer – Job Sketch

If needed, an aerial view or a side view of the vegetation types, widths of zones 1, 2, and 3 (as applicable to this site), a direction arrow, and the type of water body or water course are shown below. Other relevant information, such as shoreline or bank shape, upslope field conditions including crop types, and complementary practices, and additional buffer specifications may also be included.

Scale 1"=_____ ft. (NA indicates sketch not to scale: grid size=1/2" by 1/2")

Additional Specifications and Notes:

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication program information (Braille, large print, audiotape, etc.) should contact the USDA Office of Communications (202) 720-2791.

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, D.C., 20250, or call 1-800-245-6340 (voice) or (202) 720-1127 (TDD). USDA is an equal opportunity employer.

NORTH COAST INTEGRATED REGIONAL WATER MANAGEMENT PLAN

North Coast Integrated Regional Water Management Plan
Proposition 84 Round 1 Implementation Grant

Priority Project Technical Documents: Plans and Specifications

352 - Gualala River Sediment Reduction Program, Gualala River Watershed Council

- Robinson Creek Sediment Reduction 2010
- Gualala River Watershed Council Quality Assurance Project Plan for Monitoring Sediment Reduction (GRWC 2008)

GUALALA RIVER WATERSHED COUNCIL

Robinson Creek

Sediment Reduction 2010

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Prepared by the Gualala River Watershed Council
2010

Robinson Creek Sediment Reduction Project

Gualala River Watershed Overview

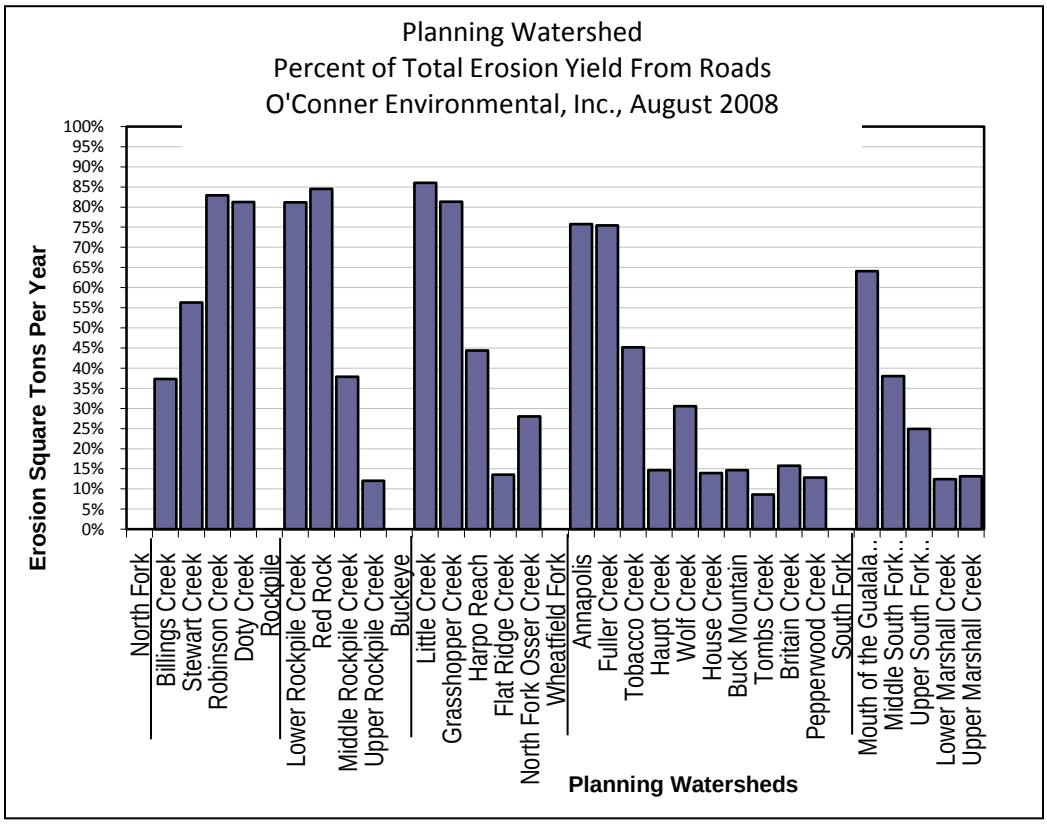
Located in both Mendocino and Sonoma Counties, the watershed drains 685 miles of blue line streams in the northern California Coastal Ranges. The Gualala River enters the Pacific Ocean at the town of Gualala, 114 miles north of San Francisco and 17 miles south of Point Arena. At 212,563 acres (342 mi^2) it is the largest watershed in the Mendocino Coast Hydrological Unit.

The watershed has a rural population of 3,419 centered near four unincorporated communities; Gualala, Sea Ranch, Annapolis and Stewarts Point. The economic viability of the area has long depended on timber and agriculture as a main source of employment with 80% of all the watershed lands zoned for timber production.

Extensive logging and road building practices in this fragile and highly erosive landscape have contributed to erosion and mass wasting, producing a legacy of increased sediment loads severely impacting aquatic habitat in the Gualala and its tributaries. Data collected in stream channels throughout the watershed show channel grading and simplification due to amplified sediment inputs.

Large scale block clear-cutting projects in the 1950s and early 1960s eliminated over-story shade canopy from primary anadromous spawning grounds. The removal of coniferous species in the riparian corridors has resulted in a lack of mature riparian for woody debris recruitment and thus a lack of deep pools with shelter needed for salmon and steelhead summer rearing habitat.

In 1993, the USEPA listed the Gualala River on its federal Clean Water Act §303(d) list of impaired water bodies due to declines in anadromous salmonids from excessive sedimentation. The listing was updated in 2003 and water temperatures in the basin are now considered impaired as well. *A Technical Support Document (TSD) for the Total Maximum Daily Load for the Gualala* was completed by the



North Coast Regional Water Quality Control Board (NCRWQCB) in 2003.

The Gualala River lies within the Central California Coast Coho salmon Evolutionary Significant Unit (ESU), which is listed as endangered under the Endangered Species Act (NMFS 2005).

Bruer (1953) stated that the Gualala River was a prime steelhead and Coho salmon stream and should be used to provide recreation for hundreds of anglers. Coho were known to spawn and rear in 14 tributaries, but began to decline by the late 1960s. By 1964 California Department of Fish and Game stream surveys were recommending stocking Coho salmon to re-establish viable self supporting runs in streams with pre-existing populations.

In the 1954-1955 fishing season the Gualala received more angler use than any other stream north of the Bay Area except for the Russian River. Historically, steelhead were found to be the most abundant species in a fish community composed of coho, Gualala roach, stickleback, sculpins and lampreys. Starting in 1940s and continuing through today, although a catch and release regulation is now in effect, salmonids have been actively fished on the Gualala River.

A long history of movement along the San Andreas Fault has been a dominant force in shaping the drainages in the Planning Watersheds. The long linear reaches with little sinuosity of the Little North Fork illustrate the influence the San Andreas rift zone has in controlling the stream channels in the lower North Fork area.

The Gualala Watershed has one of the longest histories of timber harvesting on the North Coast. Impacts from this legacy include the destruction or down-grading of riparian habitat from timber harvesting along the riparian corridors up to the streambed. This practice has resulted in a decrease of available LWD for recruitment to streams by bank erosion, wind throw, land sliding, and other causes of tree mortality.

Historic streamside and in-stream road and landing networks spanned most of the natural fluvial drainage system of the area. These roads dominated stream channel structure and the deeply incised channel topography concentrated flows during storm events causing a high level of road debris slide failures.

Sedimentation from these practices is believed to be a major contributing factor in the decline of the historic runs of salmon and steelhead trout. The project watersheds contained in this proposal are the last remaining areas of the watershed to have documented populations of CCC coho and are designated as Core Areas in the NOAA CCC Coho Salmon ESU Draft Recovery Plan, 2010. They are of the highest priority to the GRWC and have had extensive focus for the past 16 years. This focus has included in-stream assessment and monitoring and both upslope and in-stream restoration through the GRWC integrated Monitoring, Restoration and Education & Outreach Programs.

These efforts are starting to be reflected by confirmed habitat improvements that are quantified by the GRWC Collaborative Monitoring Program. This project will continue this integrated watershed-wide effort which is critically important to the survival of the CCC coho salmon and steelhead populations in the Gualala.

The projects included in this proposal will continue this integrated approach and reduce anthropogenic sediment loads, remediate the legacy effects of increased in-stream sediment, continue the outreach to landowners within the watershed and monitor project viability.

Robinson Creek Planning Watershed Road Assessment Report Technical Merit

Erosion control and erosion prevention work is the first and perhaps the most important step to protecting and restoring watersheds and their anadromous fish populations. This is especially true for Gualala river tributaries where sediment is a limiting factor to fisheries production. Unlike many watershed improvement activities, erosion prevention and "storm-proofing" has an immediate benefit to the streams and the aquatic habitat of the basin. Roads are a major source of erosion and sedimentation on most managed forest and ranch lands (Weaver and Hagans, 1997).

This project is proposed to complete the implementation of sediment source reduction on all roads in the Robinson Creek Planning Watershed. This implementation plan and the assessment of roads in the neighboring Stewart Creek Planning Watershed are the two highest priority upslope sediment reduction projects proposed for the Gualala River Watershed.

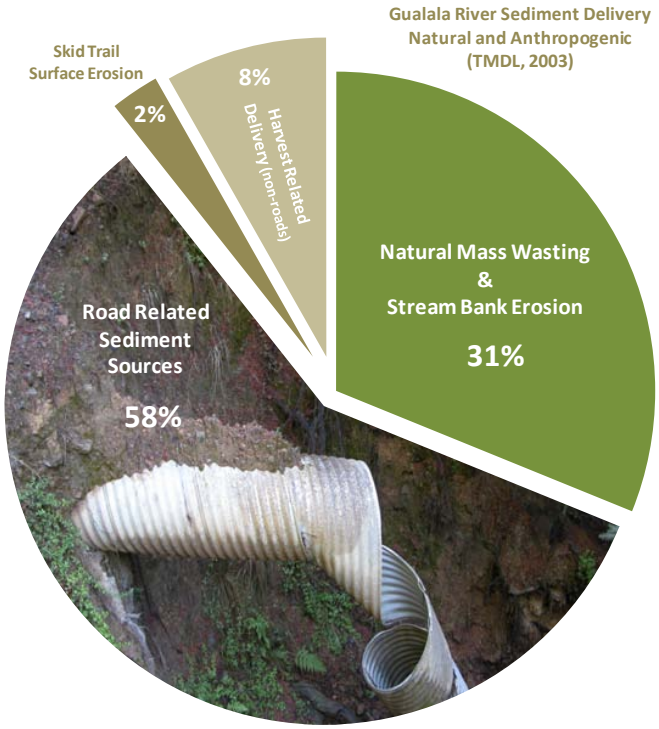
The Robinson Creek CalWater (PW) is located in the North Fork basin. The 47.9 mi^2 North Fork drains 127 miles of blue line streams, flowing into the upper Gualala River estuary. The North Fork comprises 16% of the total Gualala drainage and is the most important basin in the watershed; providing the remaining habitat for coho salmon and supplying greater freshwater baseflows to the estuary than the other major tributaries during the late season periods when the estuary is prone to high salinity conditions (ECORP Consulting, Inc. *et al*., 2005).

Two CalWater Planning Watersheds, Doty Creek and Robinson Creek, in the North Fork Basin contain the tributaries where the only remaining populations of Coho salmon are still found in the Gualala. Road sediment source implementation is complete in the Doty Creek PW. The GRWC, California Department of Fish & Game, Sotoyome Resource Conservation District and the landowner, Gualala Redwoods, Inc., completed a sediment reduction project in the Doty Creek planning watershed in 2005; upgrading all road systems (45 miles of road and 118 sediment sources) within the PW boundaries.

Robinson Creek (PW) borders Doty Creek (PW) on the eastern side and is a 13.7 mi^2 (8792 acres) sub-watershed that drains 45.9 miles of blue line stream of which 12.2 miles is salmonid habitat.

Along with the main North Fork, the Robinson Creek (PW) contains three main tributaries; Dry Creek, Robinson Creek and McGann Gulch, and 3 smaller tributaries; of which one is named Hoodoo Gulch.

The Gualala River TMDL TSD (NCRWQCB, 2003) estimated that fifty-eight percent (58%) of the total delivered sediment is road related within the watershed. Eighty-three percent (83%) of the total estimated erosion in the Robinson Creek PW is from road sources (O'Connor Environmental, Inc., 2008).



Road density in the Robinson Creek PW is fairly high with 6.85 miles of road per $mile^2$ of watershed. In-stream sediment levels, indicative of disturbance, occur along 9.2 (20%) of 45.9 miles of the blue lines streams in the Robinson Creek subbasin. The majority of these deposits are found in the lower reaches of the tributaries and the North Fork mainstem where this work is proposed and where the majority of the 12.2 miles of salmonid habitat exist (NCWAP, 2003).

Three large tributaries within the Robinson Creek PW, Dry, Robinson and McGann, all have fully suitable temperatures for summer rearing of coho salmon and small populations of coho are still found in these tributaries.

However pool frequency and depth are a limiting factor in all tributaries along with the North Fork mainstem within the Planning Watershed (NCWAP, 2003).

The North Fork SPW is a focused coho watershed, and meets the goals and objectives of the GRWC Sediment Reduction Program through which over 236 miles of road have already been upgraded, abandoned or decommissioned preventing *56,000 dump truck* loads of sediment from entering the watercourses. This has been accomplished through the participation of landowners throughout the watershed, in the Gualala River Watershed Council.

Robinson Creek Sediment Reduction Project Description

This project will treat 90 sediment sources on 12 miles of high priority roads that will prevent 30,000 yds^3 from entering the watercourses in the North Fork basin and eventually the estuary. The project will complete all of the sediment source implementation within the Robinson Creek PW.

Approximately 1.6 miles of road will be abandoned, .08 miles of road will be decommissioned and 10.32 miles of road will be storm proofed. All road segments will be outsloped, rolling dips installed, and berms and side-cast fill removed. On the abandoned and decommissioned segments; 20 culverts will be pulled and existing stream crossings will be excavated to grade, cobble will be placed in the channel to reduce erosion where necessary. Nine rocked fords will be installed with large rip-rap buttressing the base of the armor, and smaller rock on the road surface to reduce erosion. Storm proofed road segments will have 9 culverts upgraded to replace undersized culverts; fill will be removed and culverts will be installed as near to the natural gradient of the original stream channel as possible. At crossings, rock will be placed around the culvert outlet for energy dissipation and fill stabilization and critical dips will be installed to eliminate diversion potential. Specific site information and maps are attached in the addendum.

All work will be done in accordance with protocols developed by William Weaver, PhD. and Danny Hagans of Pacific Watersheds and Associates as outlined in the Hand Book for Forest and Ranch Roads. In addition, Pacific Watershed & Associates, specifically Danny Hagans will be hired as a consultant and will oversee and approve all road related treatments for this sediment source implementation project.

This project was developed from a comprehensive inventory of the road systems, selected hillslope areas, and the stream channels. All roads, including both maintained and abandoned routes, were inspected by trained personnel and all existing and potential erosion sites were identified and described. Sites, as defined in this assessment, include locations where there is direct evidence that future erosion or mass wasting could be expected to deliver sediment to a stream channel. Sites of past erosion were not inventoried unless there was a potential for additional future sediment delivery. All road segments have been assessed and detailed site specific plans and maps are included in the Addendum.

Typically, recommended treatments in a watershed range from reconstructing and upgrading existing roads that are favorably located, to closing (decommissioning or abandoning) roads which are no longer needed or are located in hillslope areas where higher rates of erosion and sediment yield are occurring or can be expected in the future.

Inventoried road-related erosion sites fell into one of three treatment categories: 1) upgrades roads - defined as maintained open roads that are to be retained for access and management; and 2) decommissioned sites - defined as sites exhibiting the potential for future sediment delivery that have been recommended for temporary closure; and 3) Abandoned sites - defined as sites exhibiting the potential for future sediment delivery that have been recommended for permanent closure.

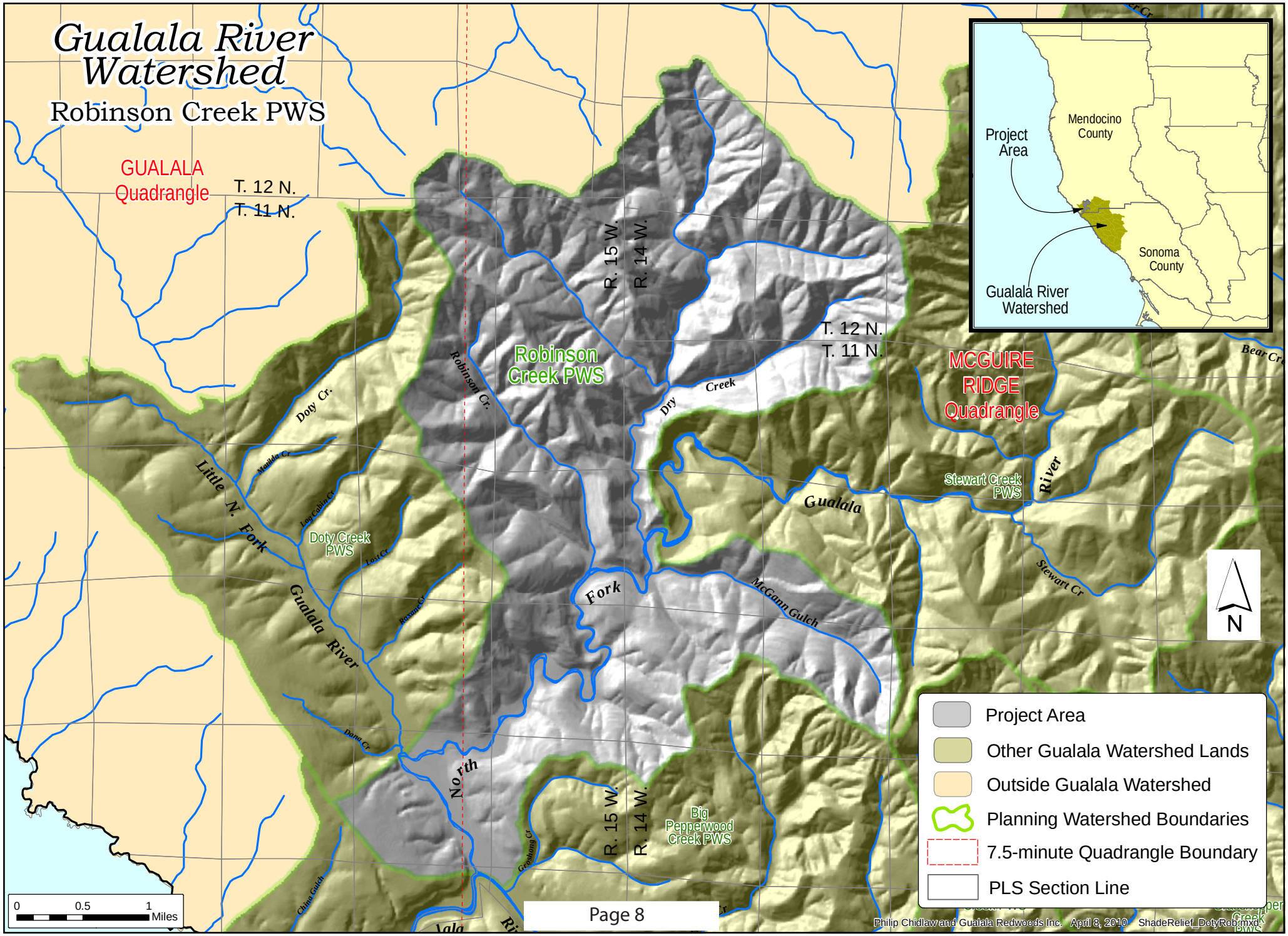
Prescribed treatments are divided into two components: a) site specific erosion prevention work identified during the watershed inventory; and b) control of persistent sources of road surface, ditch and cutbank erosion and associated sediment delivery to streams. The site-specific work is further divided into road upgrading activities and road closure (decommissioning) activities.

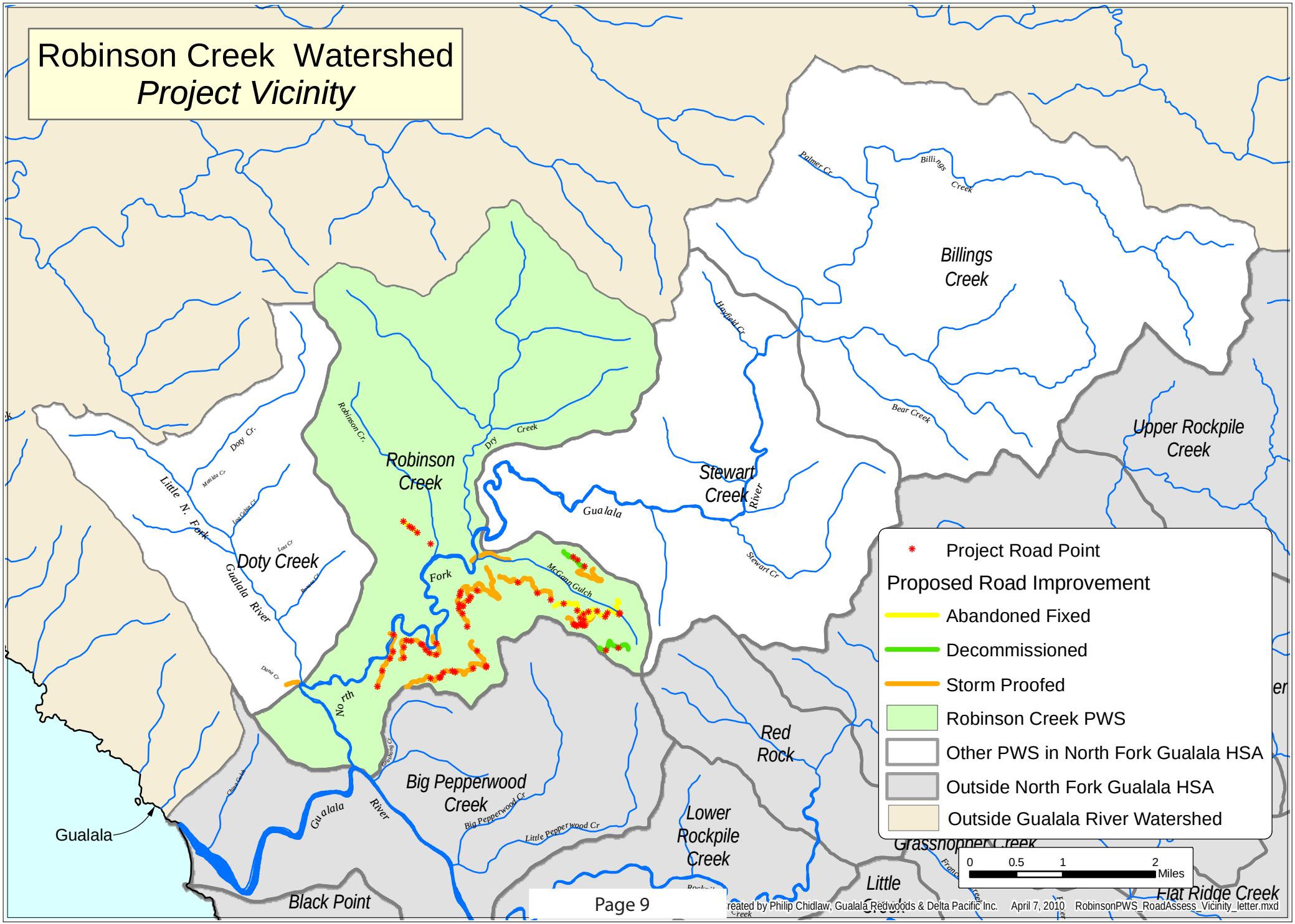
The most common problems which lead to erosion at stream crossings include: 1) crossings with

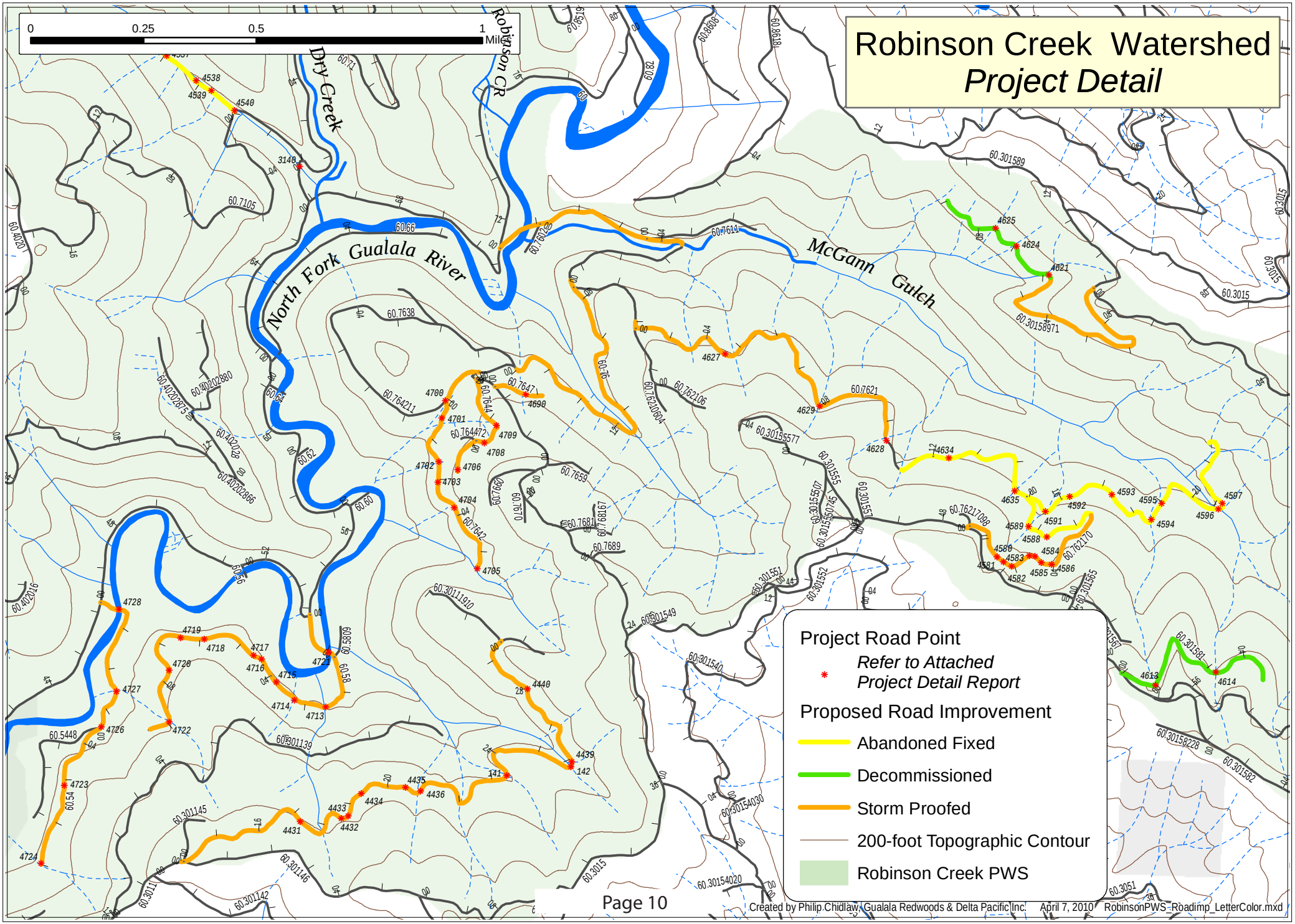
undersized culverts, 2) crossings with culverts that are likely to plug, 3) decomposing Humboldt stream crossings, 4) stream crossing with a diversion potential and 5) crossings with gully erosion at the culvert outlet. The sediment delivery from stream crossing sites is always classified as 100% because any sediment eroded at the crossing site is then delivered to the channel. Even sediment that is delivered to small ephemeral streams will eventually be delivered to downstream fish-bearing streams.

To manage and assess projects in the watershed the Gualala River Watershed Council has developed Geographic Information System coverage of the watershed, linked to an extensive data base that includes road networks, restoration, and monitoring. The watershed road network inventories road systems by unique road number (routes), distance (mile posting) and specific site numbers. The road inventory contains site specific information including, road number, site identifying number, mileage, site problem, site solution, hours of equipment, cost, sediment yield, sediment saved and photos. The following pages are maps and site specific data base details. Use the road number and site number on the maps to track site specific work.

Gualala River Watershed


Gualala River Watershed
Robinson Creek PWS
GUALALA Quadrangle
T. 12 N.
T. 11 N.
R. 15 W.
R. 14 W.
Robinson Creek PWS
Robinson Cr.
Dry Creek
T. 12 N.
T. 11 N.
MCGUIRE RIDGE Quadrangle
Bear Cr.
Doty Cr.
Little N. Fork
Mailda Cr.
Log Cabin Cr.
Doty Creek PWS
Lost Cr.
Rowna Cr.
Gualala River
Stewart Creek PWS
River
Gualala
Stewart Cr
Fork
McGann Gulch
N
Dana Cr.
North
R. 15 W.
R. 14 W.
Big Pepperwood Creek PWS
Greenhorn Cr.
China Gulch
0 0.5 1 Miles
Project Area
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
PLS Section Line
Mendocino County
Project Area
Sonoma County
Gualala River Watershed
Philip Chidlaw and Gualala Redwoods Inc. April 8, 2010 ShadeRelief_DotyRob.mxd


Robinson Creek Watershed
Project Vicinity
Billings Creek
Upper Rockpile Creek
Stewart Creek
Robinson Creek
Doty Creek
Big Pepperwood Creek
Red Rock
Lower Rockpile Creek
Black Point
Flat Ridge Creek
Gualala
Gualala River
North Fork
Little N. Fork
Dry Creek
Robinson Cr.
Doty Cr.
Palmer Cr.
Billings Creek
Bear Creek
Stewart Cr
McGann Gulch
Big Pepperwood Cr
Little Pepperwood Cr
Project Road Point
Proposed Road Improvement
Abandoned Fixed
Decommissioned
Storm Proofed
Robinson Creek PWS
Other PWS in North Fork Gualala HSA
Outside North Fork Gualala HSA
Outside Gualala River Watershed
0 0.5 1 2 Miles
Created by Philip Chidlaw, Gualala Redwoods & Delta Pacific Inc. April 7, 2010 RobinsonPWS_RoadAssess_Vicinity_letter.mxd



Created by Philip Chidlaw, Gualala Redwoods & Delta Pacific Inc. April 7, 2010 RobinsonPWS_Roadimp_LetterColor.mxd

Robinson Stewart 84 Sediment Reduction Project

Hydrologic Unit All **Repair type** All
Planning Watershed All **Priority** All
Road # All **From** All **To** All **Road Class** All

Road # / Road Class	GIS# / ID#	Mile / End	Plan / Crew	Final / Done	THP# / Rd Pt	THP Name / ECP Number	Problem / Solution	Repair Type / Priority/Shedule	Cr. Class / Old Dia	New Dia	DRCs / Ln	Left D / Right D	Exca. / Cat	Truck / Labor	Gra. / Com.	Rock / Yds	Cost / $/FSD	Total Yds / FSD Yds
60	5293	0.000	Alden		RobStu84	Robinson Stewart 84	No Problem	Storm Proofing	N/A		0	0	0	111	10	932	$36,379	0
Storm Proofed	5293	0.000	Unk			ECP Not	Other	No Action	-	-	0	0	0	0	30	0	$0	0
This is the move in move out costs and the use of a water truck, grader and compactor at various sites. Water truck (87 hours x $113.84/Hr), transport truck (24 hours x $113.84/Hr), pilot car (11hours x $70/Hr), compactor (19 hours x $70/Hr) and grader (10 hours x $113.84/Hr). This also includes 932 Cubic Yards of road base to be used as needed ($22/Yard).																		
60.3011	4441	1.400	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	47	0	0	0	$14,673	758
Storm Proofed	4441	2.950	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	53	0	0	0	$19	758
60.3011	4431	1.740	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	III		0	0	4	0	0	10	$1,519	50
Storm Proofed	4431	0.000	Unk		17	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	2	0	20	$30	50
High on class III. Rock Ford or 24" culvert.																		
60.3011	4432	1.860	Alden		RobStu84	Robinson Stewart 84	Culv.	Assessment	II		0	0	8	0	0	10	$3,347	75
Storm Proofed	4432	0.000	Unk		18	ECP Not	Culv. Replace	Medium	12"	24"	40	0	8	2	0	0	$45	75
Head of Class II. Water emerges just above the road.																		
60.3011	4433	1.880	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	III		0	0	2	0	0	0	$595	50
Storm Proofed	4433	0.000	Unk		19	ECP Not	Dip Critical	Medium	-	-	0	0	2	0	0	0	$12	50
Small Class III crossing. No sign of scour. Rock if available.																		
60.3011	4434	1.950	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	N/A		0	0	4	0	0	0	$1,190	10
Storm Proofed	4434	0.000	Unk		20	ECP Not	Dip Critical	Low	-	-	0	0	4	0	0	0	$119	10
Very small draw. Armor if rock is available.																		
60.3011	4435	2.060	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	N/A		0	0	2	0	0	0	$595	10
Storm Proofed	4435	0.000	Unk		21	ECP Not	Dip Critical	Low	-	-	0	0	2	0	0	0	$60	10
Very small draw. Armor if rock is available.																		
60.3011	4436	2.080	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	III		0	0	4	0	0	10	$1,519	40
Storm Proofed	4436	0.000	Unk		22	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	2	0	20	$38	40
Small Class III. Signs of scour.																		
60.3011	141	2.320	Alden		RobStu84	Robinson Stewart 84	Culv.	Assessment	II		0	0	40	40	0	30	$18,973	4,000
Storm Proofed	4437	0.000	Unk		141	ECP Not	Culv. Install	High	30"	36"	60	0	40	2	0	4,000	$5	4,000
Old failing landing. 30" x 20' culvert is set high. Water emrges 100' below landing and goes under 50' up from landing. Excavate top to bottom and replace culvert. End haul right 300' to ridge top.																		
60.3011	142	2.580	Alden		RobStu84	Robinson Stewart 84	Culv.	Assessment	II		0	0	50	40	0	20	$22,138	4,000
Storm Proofed	4438	0.000	Unk		142	ECP Not	Culv. Replace	High	30"	42"	60	0	50	2	0	4,000	$6	4,000
Old landing. 30" x 40' CMP with down spout. Small class II enters from right bank. Stored sediment runs from 75' downstream to 200' upstream. The upper end of the stored sediment is vegetated and stable. Excavate 75' downstream and 50' upstream. Rock armor head of cut to stabalized.																		
60.3011	4439	2.590	Alden		RobStu84	Robinson Stewart 84	Culv.	Assessment	II		0	0	8	0	0	10	$3,974	50
Storm Proofed	4439	0.000	Unk		142.5	ECP Not	Culv. Install	Medium	-	30"	60	0	8	1	0	50	$79	50
This is a small class II that enters the landing and will need a separate pipe. It may be possible to bring it in above the larger pipe. In that case increasing site 142's culvert to 48" should carry all the water.																		

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60.3011	4440	2.800	Alden		RobStu84	Robinson Stewart 84	Dip Critical	Assessment	N/A		0	0	2	0	0	0	$595	5
Storm Proofed	4440	0.000	Unk		25	ECP Not	Dip Critical	Low	-	-	0	0	2	0	0	0	$119	5
	Small draw. Not a Class III. Critical dip.																	
60.301581	4612	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	14	0	0	0	$4,544	235
Decommissioned	4612	0.480	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	16	0	0	0	$19	235
	This road hasn't been used in 30 years. No waterbars, but no serious erosion on the road surface.																	
60.301581	4613	0.090	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	16	0	0	0	$4,978	160
Decommissioned	4613	0.000	Unk		1	ECP Not	Excavate Soil	Medium	-	Pull	0	0	16	4	0	400	$39	128
	Dry Class III. Pull back spoil locally.																	
60.301581	4614	0.330	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	12	0	0	0	$3,679	60
Decommissioned	4614	0.000	Unk		1	ECP Not	Excavate Soil	Medium	-	Pull	0	0	12	2	0	100	$102	36
	Dry Class III. Pull back spoil locally.																	
60.30158971	4622	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	17	0	0	0	$5,490	284
Storm Proofed	4622	0.580	Unk			ECP Not	Tip and Dip	Low	-	-	0	0	20	0	0	0	$19	284
	The road is drained and stabalized. It is drivable. No work needed.																	
60.30158971	4623	0.580	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	10	0	0	0	$3,029	156
Decommissioned	4623	0.900	Unk			ECP Not	Tip and Dip	Low	-	-	0	0	11	0	0	0	$19	156
	The road surface is drained vegetated. The crossings are pretty good. Improvements can be made at the next entry.																	
60.30158971	4621	0.590	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Storm Proofing	II		0	0	3	0	0	0	$1,056	40
Decommissioned	4621	0.000	Unk		6	ECP Not	Excavate Soil	Medium	Pull	Pull	0	0	3	3	0	100	$26	40
	Crossing was removed but not down to grade. Not much happening. Could wait unitl next logging. Pull crossing down to grade spoil locally.																	
60.30158971	4624	0.700	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Storm Proofing	III		0	0	2	0	0	0	$704	100
Decommissioned	4624	0.000	Unk		7	ECP Not	Excavate Soil	Medium	Pull	Pull	0	0	2	2	0	60	$7	100
	Some cutting. There is a 2' x 2' gully but it is stable. Crossing was removed but not down to grade. Not much happening. Could wait unitl next logging. Pull crossing down to grade spoil locally.																	
60.30158971	4625	0.770	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Storm Proofing	III		0	0	4	0	0	0	$1,299	100
Decommissioned	4625	0.000	Unk		8	ECP Not	Excavate Soil	Medium	Pull	Pull	0	0	4	2	0	0	$13	100
	60' of road fill failure on the right bank. Half the road is gone. It is fixable. It is stable now.																	
60.54	4729	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	21	0	0	0	$6,626	342
Storm Proofed	4729	0.700	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	24	0	0	0	$19	342
	Tip and dip																	
60.54	4728	0.050	Alden		RobStu84	Robinson Stewart 84	No Problem	Storm Proofing	I		0	0	6	6	0	0	$2,631	0
Storm Proofed	4728	0.000	Unk			ECP Not	Remove Crossing	See Comments	-	-	0	0	6	3	0	0	$0	0
	Temporary crosssing																	
	An excavator will place a 6' boiler half round over wetted channel. Fill material will be placed over the boiler. Equipment will not operate in the wetted channel during installation. Remove after work completion. Try to plan operations for late in the season.																	
60.54	4727	0.250	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	40	0	0	20	$14,972	400
Storm Proofed	4727	0.000	Unk		25	ECP Not	Culv. Install	High	-	48"	60	0	40	4	0	500	$37	400
	Failing Class II																	
	Install new culvert.																	

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60.54	4726	0.340	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	25	0	0	20	$9,846	300
Storm Proofed	4726	0.000	Unk		24	ECP Not	Culv. Install	Medium	-	36"	60	0	25	4	0	400	$33	300
	Failing Class II crossing																	
	Install new culvert.																	
60.54	4723	0.520	Alden		RobStu84	Robinson Stewart 84	Other	Storm Proofing	Spr.		0	0	6	4	0	10	$2,460	50
Storm Proofed	4723	0.000	Unk		20	ECP Not	Armored Ford	Medium	-	RkFd	0	0	6	0	0	50	$98	25
	A spring above a landing is draining across the left side of the landing.																	
	Keep the water to the left of the landing. Rock armor down the landing fill.																	
60.54	4724	0.700	Alden		RobStu84	Robinson Stewart 84	Other	Storm Proofing	N/A		0	0	2	0	0	10	$815	10
Storm Proofed	4724	0.000	Unk		21	ECP Not	Dip Critical	Medium	-	-	0	0	2	0	0	50	$82	10
	Landing in dry draw																	
	Build a cirtical dip to the left of the landing. No sign of erosion.																	
60.58	4731	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	28	0	0	0	$8,898	460
Storm Proofed	4731	0.940	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	32	0	0	0	$19	460
	Tip and dip																	
60.58	4721	0.100	Alden		RobStu84	Robinson Stewart 84	No Problem	Storm Proofing	I		0	0	6	6	0	0	$2,631	0
Storm Proofed	4721	0.000	Unk			ECP Not	Remove Crossing	See Comments	-	-	0	0	6	3	0	0	$0	0
	Temporary crosssing																	
	An excavator will place a 6' boiler half round over wetted channel. Fill material will be placed over the boiler. Equipment will not operate in the wetted channel during installation. Remove after work completion. Try to plan operations for late in the season.																	
60.58	4713	0.260	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	II		0	0	24	0	0	0	$9,881	50
Storm Proofed	4713	0.000	Unk		1	ECP Not	Culv. Install	High	-	48"	60	0	24	6	0	100	$198	50
	Blown out class II crossing.																	
60.58	4714	0.340	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	4	2	0	10	$1,747	100
Storm Proofed	4714	0.000	Unk		2	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	2	0	0	$17	100
	No obvious draw upstream. Cutting in down side. Moist road surface. Rock ford																	
60.58	4715	0.380	Alden		RobStu84	Robinson Stewart 84	Cut Bank Failure	Assessment	N/A		0	0	4	0	0	0	$1,190	0
Storm Proofed	4715	0.000	Unk		3	ECP Not	Excavate Soil	Low	-	-	0	0	4	0	0	0	$0	0
	Shallow slide 60' ramp over.																	
60.58	4716	0.450	Alden		RobStu84	Robinson Stewart 84	Other	Assessment	III		0	0	2	0	0	10	$869	50
Storm Proofed	4716	0.000	Unk		4	ECP Not	Armored Ford	Medium	-	RkFd	0	0	2	1	0	0	$17	50
	Small Class III crosses left side of landing. Keep it in place dip our and rock armor outlet. This landing is an endhaul spoil site.																	
60.58	4717	0.460	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Assessment	N/A		0	0	30	0	0	0	$8,925	0
Storm Proofed	4717	0.000	Unk		15	ECP Not	Keyway Con.	Medium	-	-	0	0	30	0	0	500	$0	0
	100' from landing there is a fill failure that is 100' long. The road is gone. Dig our and rebuild taking care to properly compact the soil. There is a perched old growth stump that will complicate the work.																	
60.58	4718	0.560	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Assessment	N/A		0	0	40	60	0	0	$19,003	0
Storm Proofed	4718	0.000	Unk		16	ECP Not	Full Bench	Medium	-	-	0	0	40	5	0	600	$0	0
	Bank failure frist 50 feet then 150 of road fill failure.																	
	Full bench through failed section. Endhaul left 1,000 feet to raise road on point at 0.7 mile.																	

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60.58	4719	0.650	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Assessment	N/A		0	0	10	10	0	0	$4,113	200
Storm Proofed	4719	0.000	Unk		16	ECP Not	Excavate Soil	Medium	-	-	0	0	10	0	0	200	$0	0
	Failing fill and wet spot																	
	Pull back and end haul 500' left and build up road around the point.																	
60.58	4720	0.770	Alden		RobStu84	Robinson Stewart 84	Other	Assessment	III		0	0	2	4	0	10	$1,325	40
Storm Proofed	4720	0.000	Unk			ECP Not	Armored Ford	Medium	-	RkFd	0	0	2	1	0	0	$33	40
	Small Class III crosses left side of landing. Keep it in place dip out and rock armor outlet.																	
60.58	4722	0.900	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	35	0	0	0	$10,630	400
Storm Proofed	4722	0.000	Unk		19	ECP Not	Remove Crossing	High	-	Pull	0	0	35	4	0	600	$27	400
	Failing Class II crossing.																	
	Remove and spread locally. It is 50' wide, 100' long and 12' deep at the face. If endhauling is needed take it right 2,500 feet to road around the point.																	
60.71	3140	0.090	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Storm Proofing	I		0	0	4	0	0	0	$1,353	0
Upgraded	5244	0.000	Unk			ECP Not	Temp. Crossing	See Comments	-	-	0	0	4	3	0	0	$0	0
	An excavator will place a 6' boiler half round over wetted channel. Fill material will be placed over the boiler. Equipment will not operate in the wetted channel during installation. Remove after work completion. Try to plan operations for late in the season.																	
60.7105	4540	0.200	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Storm Proofing	II		0	0	2	0	0	0	$704	50
Upgraded	4540	0.000	Unk		1	ECP Not	Excavate Soil	Medium	Pull	Pull	0	0	2	2	0	0	$14	50
	Pull back and stablalize fill at crossing and 25' upstream.																	
60.710518	4535	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	2	0	0	0	$595	98
Abandoned Fixed	4535	0.200	Unk			ECP Not	Waterbar	Medium	-	-	0	0	2	0	0	0	$6	98
	Waterbars every 50'																	
60.710518	4539	0.100	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	N/A		0	0	1	0	0	0	$298	60
Abandoned Fixed	4539	0.000	Unk		4	ECP Not	Excavate Soil	Medium	-	-	0	0	1	0	0	0	$5	60
	Perched fill with stress cracks																	
	Pull back 30 feet of fill down to the redwood trees.																	
60.710518	4538	0.130	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	N/A		0	0	1	0	0	0	$298	60
Abandoned Fixed	4538	0.000	Unk		3	ECP Not	Excavate Soil	Medium	-	-	0	0	1	0	0	0	$5	60
	Perched fill with stress cracks																	
	Pull back 60 feet of fill																	
60.710518	4537	0.200	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	N/A		0	0	4	0	0	0	$1,190	80
Abandoned Fixed	4537	0.000	Unk		2	ECP Not	Excavate Soil	Medium	-	-	0	0	4	0	0	80	$37	32
	Perched fill with stress cracks																	
	Pull back 40' of fill. From old slide just before the Redwood in the middle of the road.																	
60.76	5248	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	14	0	0	0	$4,260	220
Storm Proofed	5248	0.450	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	15	0	0	0	$19	220
60.76	5248	0.750	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	23	0	0	0	$7,100	367
Storm Proofed	5353	1.500	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	26	0	0	0	$19	367
60.7621	4632	0.200	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	24	0	0	0	$7,726	406
Storm Proofed	4632	1.030	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	28	0	0	0	$19	406

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60.7621	4627	0.480	Alden		RobStu84	Robinson Stewart 84	Cut Bank Failure	Maintenance	N/A		0	0	2	0	0	0	$595	0
Storm Proofed	4627	0.000	Unk		1	ECP Not	Excavate Soil	Medium	-	-	0	0	2	0	0	0	$0	0
	Small fill failure and large bank failure (100') ramp over.																	
60.7621	4629	0.800	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	30	0	0	0	$10,045	50
Storm Proofed	4629	0.000	Unk		3	ECP Not	Culv. Install	Medium	-	24"	60	0	30	3	0	0	$201	50
	Small class II. Bank failure and slide from 200' left bank. Ramp over and inistall 24" pipe																	
60.7621	4628	1.040	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	16	0	0	0	$4,978	50
Storm Proofed	4628	0.000	Unk		4	ECP Not	Remove Crossing	Medium	-	Pull	0	0	16	4	0	0	$100	50
	Small class II. Pull. There is no road beyond																	
60.7621	4590	1.120	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	35	0	0	0	$10,886	562
Abandoned Fixed	4590	2.270	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	39	0	0	0	$19	562
	Use a combination of outsloping, dipping and waterbars to put the road to bed.																	
60.7621	4634	1.240	Alden		RobStu84	Robinson Stewart 84	Cut Bank Failure	Storm Proofing	N/A		0	0	2	0	0	0	$595	0
Storm Proofed	4634	0.000	Unk		7	ECP Not	Excavate Soil	Medium	-	-	0	0	2	0	0	0	$0	0
	Bank failure, ramp over.																	
60.7621	4635	1.460	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	30	0	0	0	$6,950	200
Storm Proofed	4635	0.000	Unk		10	ECP Not	Remove Crossing	Medium	-	Pull	0	0	30	4	0	0	$35	200
	Fill slowly failing																	
60.7621	4591	1.550	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	40	60	0	0	$18,948	600
Decommissioned	4591	0.000	Unk		43	ECP Not	Excavate Soil	High	-	Pull	0	0	40	4	0	0	$32	600
	This is just below the convergance of two class IIs. There seems to be a skid trail diversion that comes in on the right bank causing a fill failure. The source should be explored to see if it can be fixed. This is the site of an old dope garden.																	
60.7621	4592	1.630	Alden		RobStu84	Robinson Stewart 84	Cut Bank Failure	Storm Proofing	N/A		0	0	0	0	0	0	$0	0
Decommissioned	4592	0.000	Unk		44	ECP Not	Other	Low	-	-	0	0	0	0	0	0	$0	0
	ramp over the cut bank failure to continue decoming the road																	
60.7621	4593	1.740	Alden		RobStu84	Robinson Stewart 84	Gully	Storm Proofing	N/A		0	0	3	0	0	0	$893	20
Decommissioned	4593	0.000	Unk		45	ECP Not	Dip Rolling	Low	-	-	0	0	3	0	0	0	$0	0
	Gully caused by 200' berm. T&D.																	
60.7621	4594	1.840	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	35	0	0	0	$10,848	200
Decommissioned	4594	0.000	Unk		48	ECP Not	Remove Crossing	Medium	-	Pull	0	0	35	8	0	0	$54	200
	There is a large debris jam upstream try to leave wood in the channel. Dig out.																	
60.7621	4595	1.900	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	N/A		0	0	2	0	0	0	$595	0
Decommissioned	4595	0.000	Unk		49	ECP Not	Dip Rolling	Medium	-	-	0	0	2	0	0	0	$0	0
	Berm diversion caused small fill failure. Tip and dip.																	
60.7621	4596	2.080	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	40	60	0	0	$18,948	600
Decommissioned	4596	0.000	Unk		50	ECP Not	Remove Crossing	High	-	Pull	0	0	40	4	0	0	$32	600
	This is a low gradient class II. It was an old landing 200'x100'. There is lots of debris in fill. Dig out.																	
60.7621	4597	2.090	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	4	0	0	0	$1,299	60
Decommissioned	4597	0.000	Unk		51	ECP Not	Remove Crossing	Medium	-	Pull	0	0	4	2	0	0	$22	60
	A class III comes in on the right bank. It enters the landing and fans out.																	

Road # / Road Class	GIS# / ID#	Mile / End	Plan / Crew	Final / Done	THP# / Rd Pt	THP Name / ECP Number	Problem / Solution	Repair Type / Priority/Shedule	Cr. Class / Old Dia	New Dia	DRCs / Ln	Left D / Right D	Exca. / Cat	Truck / Labor	Gra. / Com.	Rock / Yds	Cost / $/FSD	Total Yds / FSD Yds
60.76217	4579	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	7	0	0	0	$2,083	122
Abandoned Fixed	4579	0.250	Unk			ECP Not	Waterbar	Medium	-	-	0	0	7	0	0	0	$17	122
60.76217	4589	0.070	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	40	60	0	0	$18,948	400
Decommissioned	4589	0.000	Unk		42	ECP Not	Remove Crossing	High	-	Pull	0	0	40	4	0	0	$47	400
	Failed class II crossing. 100' of road gone. Pull back and stabalize as much as possible.																	
60.76217	4588	0.130	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	II		0	0	40	60	0	0	$18,894	400
Decommissioned	4588	0.000	Unk		41	ECP Not	Remove Crossing	High	-	Pull	0	0	40	3	0	0	$47	400
	Failed class II crossing. 100' of road gone. Pull back and stabalize as much as possible.																	
60.76217	4578	0.250	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	12	0	0	0	$3,881	200
Storm Proofed	4578	0.660	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	14	0	0	0	$19	200
	Tip and dip out to the switch back landing.																	
60.76217	4587	0.380	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	12	5	0	0	$4,248	60
Storm Proofed	4587	0.000	Unk		39	ECP Not	Armored Ford	Medium	-	RkFd	0	0	12	2	0	0	$118	36
	A class III crosses the road. It has diverted 200' down the road and caused a fill failure. Correct drainage and rebuild the road.																	
60.76217	4586	0.400	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	8	0	0	0	$2,543	100
Storm Proofed	4586	0.000	Unk		38	ECP Not	Armored Ford	Medium	-	RkFd	0	0	8	3	0	0	$64	40
	A class III crosses the road. It has diverted 50' down the road and caused a fill failure																	
60.76217	4585	0.430	Alden		RobStu84	Robinson Stewart 84	Spring	Storm Proofing	III		0	0	0	0	0	0	$109	20
Storm Proofed	4585	0.000	Unk		37	ECP Not	Armored Ford	Medium	-	RkFd	0	0	0	2	0	0	$54	2
	Spring and small gully.																	
60.76217	4584	0.450	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	Spr.		0	0	4	0	0	0	$1,190	20
Storm Proofed	4584	0.000	Unk		36	ECP Not	Dip Critical	Medium	-	-	0	0	4	0	0	0	$0	0
	Spring crosses the road and caused a fill failure.																	
60.76217	4583	0.470	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	N/A		0	0	5	0	0	0	$1,488	20
Storm Proofed	4583	0.000	Unk		35	ECP Not	Dip Rolling	Medium	-	-	0	0	5	0	0	0	$248	6
	Berm has channeled water down road to weak fill. Get water off the road.																	
60.76217	4582	0.500	Alden		RobStu84	Robinson Stewart 84	Fill - Road	Storm Proofing	III		0	0	6	0	0	0	$1,894	50
Storm Proofed	4582	0.000	Unk		34	ECP Not	Armored Ford	Medium	-	RkFd	0	0	6	2	0	0	$38	50
	Wet class III and fill failure. Rocked ford or 24" culvert.																	
60.76217	4581	0.530	Alden		RobStu84	Robinson Stewart 84	Spring	Storm Proofing	Spr.		0	0	2	0	0	0	$730	0
Storm Proofed	4581	0.000	Unk		33	ECP Not	Dip Rolling	Medium	-	-	0	0	3	0	0	0	$0	0
	Spring runs down the road 50'. No gully. Install dip.																	
60.76217	4580	0.550	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	4	0	0	0	$1,299	20
Storm Proofed	4580	0.000	Unk		32	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	2	0	0	$130	10
	Small Class III. Some surface flow across the road. Small gully. Rock armor the bank.																	
60.7642	4699	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	16	0	0	0	$5,112	264
Storm Proofed	4699	0.540	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	18	0	0	0	$19	264
60.7642	4700	0.110	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	2	4	0	10	$1,379	40
Storm Proofed	4700	0.000	Unk		94	ECP Not	Armored Ford	Medium	-	RkFd	0	0	2	2	0	0	$34	40
	Small class III that has formed a small pond. Do not lower the road. Rock armor the fill slope.																	

Road # / Road Class	GIS# / ID#	Mile / End	Plan / Crew	Final / Done	THP# / Rd Pt	THP Name / ECP Number	Problem / Solution	Repair Type / Priority/Shedule	Cr. Class / Old Dia	New Dia	DRCs / Ln	Left D / Right D	Exca. / Cat	Truck / Labor	Gra. / Com.	Rock / Yds	Cost / $/FSD	Total Yds / FSD Yds
60.7642	4701	0.150	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	3	0	0	0	$947	40
Storm Proofed	4701	0.000	Unk		95	ECP Not	Armored Ford	Medium	-	RkFd	0	0	3	1	0	50	$24	40
	This is a class III that is cutting. Install an armored ford or a 24" culvert.																	
60.7642	4702	0.260	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	4	0	0	0	$1,299	50
Storm Proofed	4702	0.000	Unk		96	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	2	0	70	$26	50
	This is a class III that is cutting. Install an armored ford or a 24" culvert.																	
60.7642	4703	0.310	Alden		RobStu84	Robinson Stewart 84	Spring	Assessment	Spr.		0	0	2	0	0	0	$1,067	0
Storm Proofed	4703	0.000	Unk		97	ECP Not	Culv. Install	Low	-	18"	40	0	2	0	0	50	$0	0
	This is a spring. And 18" culvert will drain it. It is not causing a problem. It would be ok to leave it and use a temporary drain as needed when logging.																	
60.7642	4704	0.370	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	4	0	0	0	$1,244	60
Storm Proofed	4704	0.000	Unk		98	ECP Not	Armored Ford	Medium	-	RkFd	0	0	4	1	0	80	$21	60
	This is a class III that is cutting. Install an armored ford or a 24" culvert.																	
60.7642	4705	0.540	Alden		RobStu84	Robinson Stewart 84	Humboldt	Assessment	II		0	0	120	400	0	40	$83,205	5,000
Storm Proofed	4705	0.000	Unk		100	ECP Not	Remove Crossing	High	-	Pull	0	0	120	20	0	5,000	$17	5,000
	This is an old landing in a class II. It is a wedge 100' long, 60' wide and 15' deep. It needs to be removed and hauled back to flat ground near the intersection.																	
60.7644	4710	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	8	0	0	0	$1,859	137
Storm Proofed	4710	0.280	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	9	0	0	0	$14	137
60.7644	4709	0.120	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	3	0	0	0	$775	60
Storm Proofed	4709	0.000	Unk		105	ECP Not	Armored Ford	Medium	-	RkFd	0	0	3	2	0	100	$13	60
	This is a class III that is cutting. Install an armored ford or a 24" culvert.																	
60.7644	4708	0.150	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	3	0	0	0	$775	50
Storm Proofed	4708	0.000	Unk		103	ECP Not	Armored Ford	Medium	-	RkFd	0	0	3	2	0	100	$16	50
	This is a class III that is cutting. Install an armored ford or a 24" culvert.																	
60.7644	4706	0.260	Alden		RobStu84	Robinson Stewart 84	Temp. Crossing	Assessment	III		0	0	1	0	0	0	$406	30
Storm Proofed	4706	0.000	Unk		101	ECP Not	Remove Crossing	Low	-	Pull	0	0	1	2	0	20	$14	30
	This is a small class III. Removing the fill would be ok.																	
60.7647	4691	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	3	0	0	0	$787	114
Storm Proofed	4691	0.110	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	4	0	0	60	$7	114
60.7647	4690	0.070	Alden		RobStu84	Robinson Stewart 84	Humboldt	Storm Proofing	III		0	0	5	0	0	0	$1,225	60
Storm Proofed	4690	0.000	Unk			ECP Not	Excavate Soil	Medium	-	Pull	0	0	5	2	0	60	$20	60
	This is a class III crossing with no culvert that was partially dug out. There is a hole developing in the lower end. Spoil soil locally																	
80.62	5564	0.100	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	41	45	0	0	$19,442	518
Storm Proofed	5564	1.160	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	51	13	0	0	$38	518
	To be assessed and disconnected																	
80.6225	5565	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	67	73	0	0	$31,364	836
Storm Proofed	5565	1.710	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	83	21	0	0	$38	836
	To be assessed and disconnected																	
80.622562	5566	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	5	6	0	0	$2,568	68
Storm Proofed	5566	0.140	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	7	2	0	0	$38	68
	To be assessed and disconnected																	

Road # / Road Class	GIS# / ID#	Mile / End	Plan / Crew	Final / Done	THP# / Rd Pt	THP Name / ECP Number	Problem / Solution	Repair Type / Priority/Shedule	Cr. Class / Old Dia	DRCs / New Dia	Ln	Left D / Right D	Exca. / Cat	Truck / Labor	Gra. / Com.	Rock / Yds	Cost / $/FSD	Total Yds / FSD Yds
80.622564	5567	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	10	11	0	0	$4,585	122
Storm Proofed	5567	0.250	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	12	3	0	0	$38	122
	To be assessed and disconnected																	
80.7003	5568	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	25	27	0	0	$11,555	308
Storm Proofed	5568	0.630	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	30	8	0	0	$38	308
	To be assessed and disconnected																	
80.70033	5569	0.000	Alden		RobStu84	Robinson Stewart 84	Surface Drainage	Assessment	N/A		0	0	48	53	0	0	$22,744	606
Storm Proofed	5569	1.240	Unk			ECP Not	Tip and Dip	Medium	-	-	0	0	60	15	0	0	$38	606
	To be assessed and disconnected																	
Planning Watershed	Robinson Creek					**Grand Total All Sites**	90	**Culvert Costs**	$13,876			0	1,357	1,145	10	1,162	$595,589	26,043
												0	1,443	204	30	17,420	$23	25,548
						Grand Total All Sites	90	**Culvert Costs**	$13,876			0	1,357	1,145	10	1,162	$595,589	26,043
												0	1,443	204	30	17,420	$23	25,548

Road #	GIS#	Mile	Plan	Final	THP#	THP Name	Problem	Repair Type	Cr. Class	DRCs	Left D	Exca.	Truck	Gra.	Rock	Cost	Total Yds
Road Class	ID#	End	Crew	Done	Rd Pt	ECP Number	Solution	Priority/Shedule	Old Dia	New Dia Ln	Right D	Cat	Labor	Com.	Yds	$/FSD	FSD Yds

Road Work

- Road # – This is unique road ID number for each road segment on the property.
- Road Class – This is the type of road.
    a. Upgraded – Outsloped and dipped
    b. Storm proofed – Outsloped, dipped and culverts repaired.
    c. Decommissioned – Outsloped, dipped, culverts pulled, and the road will be reused.
    d. Abandoned – Outsloped, dipped, culverts removed and the road will not be reused.
- GIS# - Each existing site in the field (like a culvert) has a unique GIS number, usually the first visit ID#. It appears on the road maps. A new visit to an existing site will reference the GIS#. You can look up the history of visits to a particular site by calling up all the records with the same GIS#.
- ID# - Each "new" road site visit has a unique ID number. It is generated when the record is entered into the database.
- Mile – Each numbered road has mileage ticks from 0 to the end of the road. "Mile" is the distance out the road to the site.
- End – If the site is along a length of road, like tipping and dipping, there is a start point (Mile) and "end" mileage.
- Insp. – The name of the inspector that identified the site and made the prescription is listed here. The inspectors are trained to identify potential sediment sources and make prescriptions in accordance with the Handbook for Forest and Ranch Roads, Weaver and Hagans, 1992. Estimates of sediment production and delivery are made by the inspector.
- Crew – These are the initials of contractor that did the work.
- Planned – Date of site identification.
- Done – Date site work was completed.
- THP# - THP Number
- Rd Pt - This is the working number (THP road point) created by the inspector in the field. It is often found on field flagging.
- THP Name – The THP or program the work is associated with.
- ECP Name – The Erosion Control Plan the site is associated with.
- Problem – The type of problem.
- Solution – The type of solution.
- Repair type – Why was the work done.
- Priority – This reflects the urgency of the problem. A high priority site is one that is likely to deliver a significant amount of sediment during the next 5 year storm event. Medium and low priority sites need upgrading, but are unlikely to deliver significant amounts of sediment in the next several years. High priority sites will be scheduled for completion prior to a low or medium priority site.
- Stream Class – As per the Forest Practice Rules
- Old Dia – The diameter of the old culvert.
- New Dia Ln – The diameter and length of the new culvert if any.
- DRCs – Number of ditch relief culverts needed for the site.
- Rock – Yards of rock needed at the site – rip rap, rock surface, etc.
- Right and Left Ditch – Feet of road to the right and left of the site that is connected and needs treatment.
- Equipment Hours
    a. Exca. – Excavator
    b. Cat – Caterpillar tractor
    c. Labor – Hand labor
    d. Truck – Dump truck or water truck
    e. Gra. – Grader
    f. Com. - Compactor and pilot car if needed.
- Yds - This is the total yardage of soil that must be moved at the site.
- Cost – All the equipment costs plus the culvert costs. This does not include administration or logistic costs.
- $/FSD – This is the total cost divided by the yards of soil prevented form delivery (FSD) to the watercourses.
- Total Yds – This is the estimate of yardage that will be mobilized in a failure if the work is not done.
- FSD (Future Sediment Delivery) – This is the amount of soil that will be prevented from being delivered into the watercourses if the project is completed. It is the relative potential for sediment delivery (RPSD). This yardage only appears if the inspector has been trained to estimate this. This also includes road surface erosion that disconnecting the roads from the watercourses will prevent from being delivered. On upgraded roads it is typically 0.2 cubic feet per square foot of road per decade for the portion (typically 50%) that has been disconnected. The road and cut bank width is assumed to be 25 feet.

Robinson Creek Planning Watershed Sediment Reduction Project

Road Upgrading **Photo #** 4135
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4431 **Road** 60.3011 **Mi.** 1.74
Armored Ford **Old** - **New** RkF
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4135 IMG_2027.jpg

Road Upgrading **Photo #** 4134
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4431 **Road** 60.3011 **Mi.** 1.74
Armored Ford **Old** - **New** RkF
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4134 IMG_2025.jpg

Road Upgrading **Photo #** 4136
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4431 **Road** 60.3011 **Mi.** 1.74
Armored Ford **Old** - **New** RkF
Creek **Cr Dist** 0
Ref Up **LWD Site** **Tag#** 0
Monitoring 0

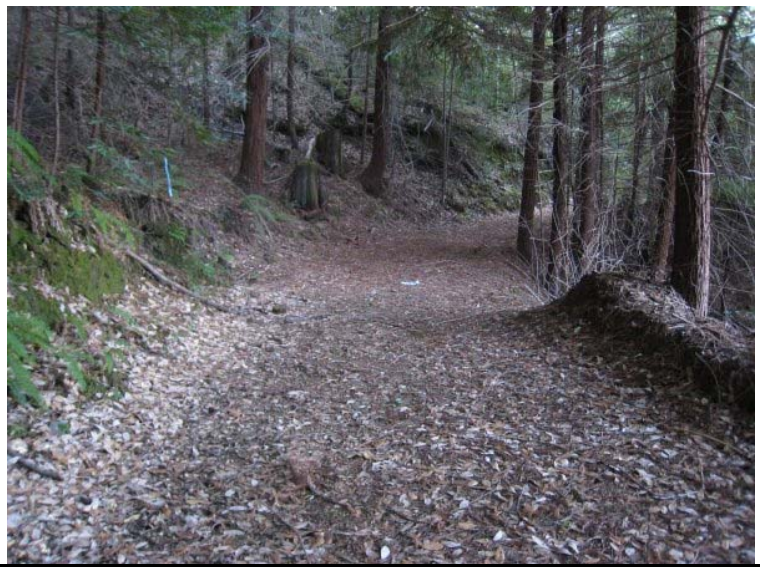
People in Photo:

F:\GRI Photos\Small\Bigger\4136 IMG_2029.jpg

Road Upgrading **Photo #** 4138
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4432 **Road** 60.3011 **Mi.** 1.86
Culv. Replace **Old** 12" **New** 24"
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4138 IMG_2032.jpg



Road Upgrading **Photo #** 4139
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4432 **Road** 60.3011 **Mi.** 1.86
Culv. Replace **Old** 12" **New** 24"
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4139 IMG_2035.jpg

Road Upgrading **Photo #** 4137
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4432 **Road** 60.3011 **Mi.** 1.86
Culv. Replace **Old** 12" **New** 24"
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4137 IMG_2031.jpg

Road Upgrading **Photo #** 4140
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4432 **Road** 60.3011 **Mi.** 1.86
Culv. Replace **Old** 12" **New** 24"
Creek **Cr Dist** 0
Ref Up **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4140 IMG_2038.jpg

Road Upgrading **Photo #** 4143
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4433 **Road** 60.3011 **Mi.** 1.88
Dip Critical **Old** - **New** -
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4143 IMG_2045.jpg

Road Upgrading **Photo #** 4142
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4433 **Road** 60.3011 **Mi.** 1.88
Dip Critical **Old** - **New** -
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4142 IMG_2043.jpg

Road Upgrading **Photo #** 4144
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4433 **Road** 60.3011 **Mi.** 1.88
Dip Critical **Old** - **New** -
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4144 IMG_2047.jpg

Road Upgrading **Photo #** 4141
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 4433 **Road** 60.3011 **Mi.** 1.88
Dip Critical **Old** - **New** -
Creek **Cr Dist** 0
Ref Up **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4141 IMG_2039.jpg

Road Upgrading **Photo #** 4145
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 141 **Road** 60.3011 **Mi.** 2.32
Culv. Install **Old** 30" **New** 36"
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4145 IMG_2053.jpg

Road Upgrading **Photo #** 4146
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 141 **Road** 60.3011 **Mi.** 2.32
Culv. Install **Old** 30" **New** 36"
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4146 IMG_2055.jpg

Road Upgrading **Photo #** 4148
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 142 **Road** 60.3011 **Mi.** 2.58
Culv. Replace **Old** 30" **New** 42"
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4148 IMG_2059.jpg

Road Upgrading **Photo #** 4147
PW Robinson Cr 12/11/07
Project Robinson Roads **PID** 0
Map Pt 142 **Road** 60.3011 **Mi.** 2.58
Culv. Replace **Old** 30" **New** 42"
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4147 IMG_2057.jpg

Road Upgrading **Photo #** 4279
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4542 **Road** 60.7105 **Mi.** 0.69
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4279 IMG_2499.jpg

Road Upgrading **Photo #** 4280
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4542 **Road** 60.7105 **Mi.** 0.69
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4280 IMG_2501.jpg

Road Upgrading **Photo #** 4278
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4542 **Road** 60.7105 **Mi.** 0.69
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4278 IMG_2497.jpg

Road Upgrading **Photo #** 4276
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4543 **Road** 60.7105 **Mi.** 0.96
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

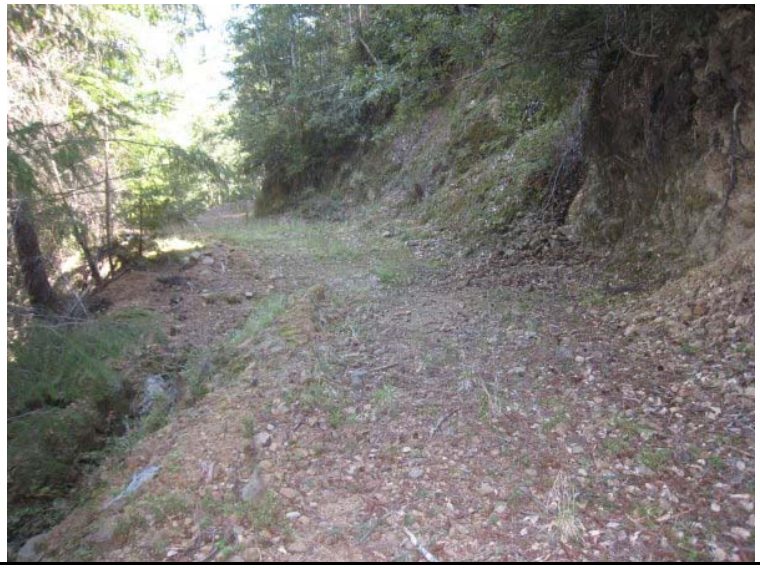
People in Photo:

F:\GRI Photos\Small\Bigger\4276 IMG_2493.jpg

Road Upgrading **Photo #** 4277
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4543 **Road** 60.7105 **Mi.** 0.96
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4277 IMG_2495.jpg



Road Upgrading **Photo #** 4275
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4543 **Road** 60.7105 **Mi.** 0.96
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4275 IMG_2490.jpg

Road Upgrading **Photo #** 4273
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4544 **Road** 60.7105 **Mi.** 0.98
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4273 IMG_2486.jpg

Road Upgrading **Photo #** 4274
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4544 **Road** 60.7105 **Mi.** 0.98
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4274 IMG_2489.jpg

Road Upgrading **Photo #** 4272
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4544 **Road** 60.7105 **Mi.** 0.98
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4272 IMG_2484.jpg

Road Upgrading **Photo #** 4270
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4545 **Road** 60.7105 **Mi.** 1.38
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4270 IMG_2481.jpg

Road Upgrading **Photo #** 4269
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4545 **Road** 60.7105 **Mi.** 1.38
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref left **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4269 IMG_2479.jpg

Road Upgrading **Photo #** 4271
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4545 **Road** 60.7105 **Mi.** 1.38
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4271 IMG_2482.jpg

Road Upgrading **Photo #** 4267
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4546 **Road** 60.7105 **Mi.** 1.46
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref down **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4267 IMG_2475.jpg

Road Upgrading **Photo #** 4268
PW Robinson Cr 04/16/08
Project Robinson Roads **PID** 0
Map Pt 4546 **Road** 60.7105 **Mi.** 1.46
No Action **Old** Pull **New** Pull
Creek **Cr Dist** 0
Ref Right **LWD Site** **Tag#** 0
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\4268 IMG_2477.jpg

GRWC Large Wood In the Stream Program Technical Merit

NOAA CCC Coho Salmon ESU Draft Recovery Plan: GuR-A-6.1.2.1, Priority 1, page 255

"Place instream structures to improve pool depth and habitat complexity"

This project directly addresses this task by placing LWD structures consisting of 100 MBF (~200 logs/rootwads) in reaches within the Core Areas of Robinson and Doty Creeks CalWater Planning Watersheds, favorably impacting habitat on 12 miles of stream.

This proposal will increase the level of large wood pieces in wood deficient reaches; *advancing primary pool formation towards the target level of >40%, increase overall habitat complexity and specifically decrease channel aggradations in defined areas of the proposed reaches and increase functionality of existing project wood.*

This proposal will also implement this task within NOAA's Recovery Plan required timeframe of 2009-2014.

The focus is on CalWater watersheds that serve as critical habitat for coho salmon in the Gualala River Watershed and the CCC coho salmon ESU. This restoration project will benefit juvenile summer and winter rearing habitat as well as adult migration and spawning habitat aiding in the recovery of a viable CCC coho population in the Gualala.

The Gualala River Synthesis Report, by the North Coast Watershed Assessment Program (NCWAP, 2003), determined pool depth and shelter to be the two highest limiting factors to salmonids in the target CalWater watersheds. Furthermore, it determined that the "enhancement of in-stream structure" by LWD placement is the most important in-stream restoration project for these sub-basins.

"Enhancement of in-stream structure is priority 1 for restoration in the North Fork basin" NCWAP (2003)

The current lack of large wood in-stream structures, in part due to stream clearing projects in 1970s and 1980s, and lack of potential recruitment due to the historic destruction or down-grading of riparian habitat is also well documented (NCWAP, 2003).

The draft Central California Coast Coho Recovery Plan (NOAA, 2010) has determined that continuing large wood placement to be the first priority for Recovery Action in the project areas. Doty Creek, Robinson Creek along with Stuart Creek and Big Pepperwood Creek (which includes the estuary) CalWater Planning Watersheds are listed as the core implementation sites for Phase I of Coho Recovery Action in the Gualala. Also stated in the report was a recommendation for agencies to continue to support the collaborative efforts of the GRWC.

"Support the ongoing efforts of the Gualala Redwoods…to increase LWD abundance, and to upgrade or decommission roads."

Coho Recovery Plan NOAA (2010)

The positive role that large wood plays creating suitable salmonid habitat in riverine ecology is well

documented (Martin and Benda 2001). In forested streams large wood is associated with the majority of pools and the amount of large wood in the channel has a direct affect on pool volume, pool depth and the percentage of pool area. (Elliot 1986; Murphy et al 1986; Carison et al 1990; Beechie and Wyman 1992). Woody debris benefits all life stages of salmonids (Bisson et al. 1987, Sullivan et al. 1987).

This project is not a "stand-alone" project but part of a long-term comprehensive restoration plan focused on first remediating anthropogenic sediment sources and second, creating specific in-stream benefits that include: pool scour, velocity shelter from winter peak flows, development of complex flow patterns that sort stream bed sediment, and the development of complex channel morphology that provides diverse flow and cover conditions for fish.

The first phase, remediating anthropogenic sediment loads, is complete for the Doty Creek Planning watershed, the highest priority watershed in the North Fork SPW, and anthropogenic sediment sources will be remediated through this proposal in the Robinson Creek watershed.

Implementation of the second phase of restoration began in 2001 with the placement of 64 pieces of large wood in the Little North Fork. With funding assistance from the CDF&G, by 2005 a total of 330 logs with a volume level of 40,564 ft^3 were placed in 5 tributaries within the two Planning Watersheds. This proposal will fund the placement of 200 additional logs over the next 2 years and implement three primary objectives. First, increase the level of large wood pieces in wood deficient reaches; advancing primary pool formation towards the target level of >40%. Second, increase overall habitat complexity and specifically decrease channel aggradations in defined areas of the proposed reaches. Third, increase functionality of existing project wood.

LWD Objective 1: Increase Primary Pool Frequency

Literature suggests a number of different targets for large wood loading levels to achieve optimum habitat response. All are based on stream size and/or drainage area and include numeric targets for large wood piece and volume levels or quantity of key large wood pieces. Research derived from large wood inventory data collected through the GRWC Cooperative Monitoring Program demonstrates the need for increased LWD levels in all reaches in the watersheds.

Through the GRWC Cooperative Monitoring Program, habitat and biological response to large wood placement has been monitored over the past 12 years (4 years pre-project, 8 years post project) allowing for the development of a data set that tracts habitat specific results due to large wood loading levels. Although volume levels in some reaches appear to be reaching published

Little North Fork #203 - Increase in pools

Year	Pools *per 1000'*	Maximum Depth	Average Depth
1998	8	1.98	1.60
1999	9	1.99	1.52
2000	7	1.89	1.72
2001	7	2.12	1.76
2002	12	3.24	1.76
2003	13	3.15	1.89
2004	13	3.07	2.05
2005	11	3.03	2.03
2006	15	2.93	1.60
2007	15	4.36	1.78
2008	14	4.37	1.88
2009	14	4.26	1.83
2010	14	3.87	1.78

Pre-project wood placement

Post-project wood placement

placement.

	Percent Pools per 1000 ft.			Pool Area
Year	≥ 1ft. Depth	≥ 2 ft. Depth	≥ 3 ft. Depth	Sq. ft. *per 1000'*
1998	35%	0%	0%	264
1999	38%	0%	0%	275
2000	23%	0%	0%	150
2001	23%	7%	0%	161
2002	42%	14%	4%	304
2003	39%	16%	3%	363
2004	47%	25%	4%	374
2005	42%	20%	6%	386
2006	57%	14%	0%	436
2007	56%	18%	3%	452
2008	61%	24%	3%	482
2009	49%	18%	2%	432
2010	53%	20%	4%	423

Pre-project wood placement

Post-project wood placement

Thalweg data from annual surveys show a substantial increase in primary pool area - post large wood placement.

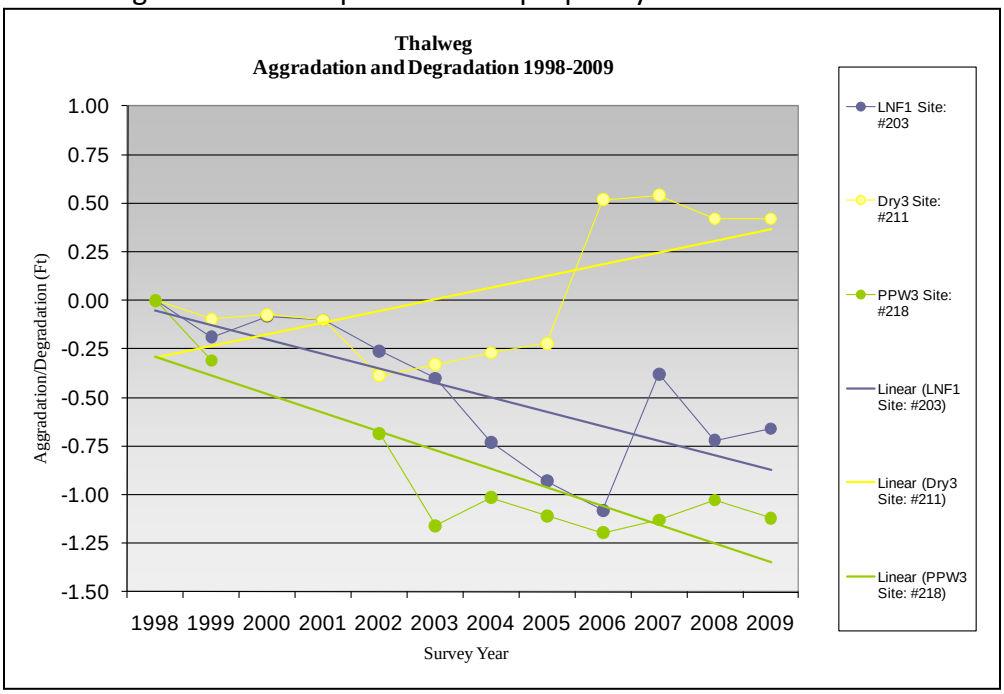
target levels (>6,000 ft^3) piece level is still substandard (>150 per 1,000 ft). Data suggests that targets for volume and piece levels cannot be independently applied.

Primary pool development has increased in reaches where project wood has been placed in the past, but is still well below target levels of >40%. GRWC large wood project specific thalweg data suggest that although the square area of pools created by project large wood continues to increase, high levels of wood pieces are the most common structure associated with increased primary pool formation.

LWD Objective 2: Increase Habitat Complexity and Decrease Channel Aggradations

Increases in habitat complexity from past wood projects are evident in thalweg profiles. Not only is wood placement increasing shelter and pool formation it is enhancing complexity by increasing channel meander and creating more variation in channel contour.

Profiles show thalweg degradation in all reaches where project wood has been placed. Two specific areas within the project reaches are impacted by gravel aggradations causing dry streambeds during low flow periods. These sites will be targeted for wood placement to purposely cause channel degradation.



LWD Objective 3: Increase Functionality of Existing Wood

The Gualala River Wood In the Stream Program was developed to be adaptive in nature. New wood will be added to existing structures and a few existing pieces will be repositioned to increase function.

Based on the past 12 years of data collected in the watersheds, the GRWC considers LWD as the most effective in-stream

restoration program for most non-bedrock controlled reaches. This is supported historically by the inter-agency report; North Coast watershed Assessment Program (2003), and has now been reaffirmed by NOAA in their draft CC Coho Recovery Plan (2010).

Large Wood in the Stream Project Description

The Wood In the Stream Project began in 2000 under funding by the SB271 program. The placement of large woody debris has been a phased approach starting with the first placement of logs in 2001. To date 530 logs, 76 logging truck loads have been placed (63,010 ft^3 or 378,064 board feet) in 9 tributaries (8 miles of blue line stream) within the watershed.

An interesting aspect of this program makes it possible to explore alternatives to the concept of costly engineered structures. The methodology developed for large wood placement attempts to mimic nature and allow project wood to adjust naturally to a stream's hydraulics.

Logs and rootwads are donated by landowners and hauled to staging areas and from where they are placed in the stream by using rubber tired skidders or excavators. Wood pieces are placed in the stream "naturally keyed" using stream side vegetation or placed purposely to float downstream and lodge naturally in high winter flows.

To mimic natural processes, the large wood reaches are scheduled for log placement on an annual basis based on the past year's monitoring data.

Reach and drop site selection are based on natural wood inventory levels, stream order, size of sub-watershed drainage, channel form, shelter ratings, Rosgen channel type, and accessibility. All placement sites are in tributaries where GRWC has established, or plans to establish, in-stream monitoring reaches through GRWC Cooperative Monitoring Program.

Baseline inventories using a number of different metrics that assess and monitor; pool quantity and quality, aggradations or degradation of the streambed, substrate composition; and riparian condition are conducted to assess the impacts from wood placement.

An Access Database and GIS coverage were developed at project inception to document the monitoring of the effectiveness of the program.

A number of monitoring metrics have been developed specifically for the Wood Program. These include:

Individual logs are tracked by identifying numbers and by distance placed (or moved to) in each tributary

Log description type; size and placement; right/left bank/in-channel; angle to bank; keyed/mobile; and stream channel location.

Photo documentation points are established and photographs taken before and after placement.

In-stream measurements are taken to document pool formation and pool depth for each log.

The addition of unanchored large woody debris (LWD) will be used to enhance selected reaches on property owned by Gualala Redwoods, Inc. LWD will be placed in 1st, 2nd and 3rd order streams as the structural agent to form pools to create summer and winter rearing habitat for Coho salmon and steelhead trout.

The placement of the unanchored logs in the streambed will be consistent with the procedures recommended in the CDFG California Salmonid Stream Habitat Restoration Manual, Section VII.

Logs selected for placement will have at least 500 board feet and a minimum diameter of twelve

inches. The desirability of logs with rootwads attached and lengths greater than 1.5 times the mean bankfull width is understood.

Pre-placement:

The project coordinator will identify the specific drop sites for log placement in the project reaches. Sites will be reviewed, pre-project surveyed if required, and loading levels and log placement planned by the project coordinator with assistance from the field technicians.

Logs selected for placement will be similar to a Northern California Scaling Bureau XP grade or a Maser and Trappe (1984) decay class III or better. Redwood logs are preferable, but Douglas fir is acceptable. Most logs will have at least 80 cubic feet (roughly 500 board feet); logs with root wads attached are the most desirable. Rootwads will count toward billable board feet; a conversion of six board feet per cubic foot will be used. Approximately 135 MBF of logs/rootwads will be selected.

- Logs and rootwads for the project are acquired in three different ways:
- During timber harvesting the licensed timber operators set aside non-merchantable logs during their operations. The Project Coordinator inspects the logs on the landing and approves them for placement. Logs are then hauled to staging areas for placement where they are measured, tagged with an identification number and painted with a bright color to identify them as project pieces.
- Acceptable size rootwads and logs discovered during road improvement projects are hauled to staging areas for placement where they are measured, tagged with an identification number and painted with a bright color to identify them as project logs.
- Logs and rootwads from residential lot clearing projects are donated and hauled to staging areas for placement where they are measured, tagged with an identification number and painted with a bright color to identify them as project logs.
- All data including the staging area site is recorded and entered into an access database. Based on log/rootwad size and project reach bankfull width and channel classification, logs are assigned placement sites.

Placement:

The project coordinator will supervise the placement of the logs by the operator. An excavator and/or a rubber tired skidder will be used for stream placement allowing the achievement of a fairly high level of accuracy in log placement. Several placement techniques are used based on channel type, channel width, type and abundance of riparian vegetation (used for wedging) and existing channel LWD load. Additionally, some of the logs placed during previous Wood In Stream phases have been so effective at scouring and creating pools, they are now above the creek bed. These logs will resume pool production with minor readjustment. This will be done in areas where equipment is scheduled to place new logs.

- Digger logs are placed pointing upstream, where appropriate, to maximize scour and pool formation. One end will be placed on the bank and the other end will be in the channel. Logs will be stabilized by wedging into riparian structure or by sizing the log according to channel size.
- Logs with root wads intact have the root wad extending down into the pool.
- Logs will be positioned to point upstream and downstream; placement will be dependent on channel form and Rosgen type at placement site.
- Mini log jams are created by placing several logs across each other to mimic the naturally occurring debris or log jams created when trees falls into the stream. The purpose of this is to provide cover for juvenile rearing and adult spawning and as a collection site for additional LWD to increase diversity. Their use will be restricted to areas where there is no danger of causing bank failure or channel migration. A log with a root wad or branches will be added to increase pool cover or to create scour.
- Logs are buried in the larger channels to increase their chance of surviving winter floods and to act as "shark's teeth" to catch other LWD moving down the channel.
- Several smaller logs are cabled together to mimic a very large log for placement in larger streams.
- Logs are simply set in the channel to float down stream and add to the existing complexity.
- If sites are located where high lead logging operations cross a stream logs are lowered into the stream channel.

Project Effectiveness Monitoring:

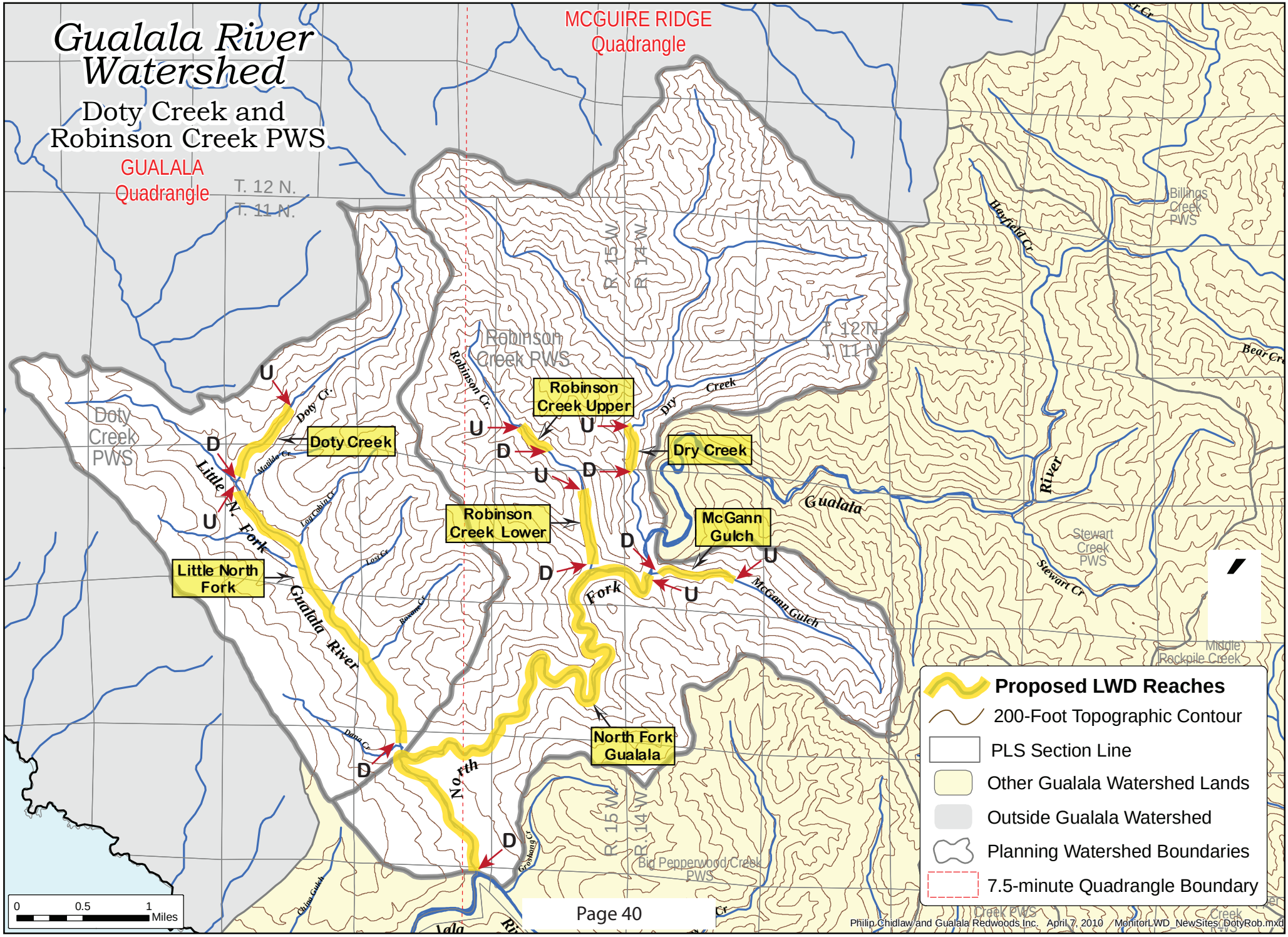
For long-term monitoring, an inventory methodology was developed to collect reliable data from the placement sites and to enable tracking of each piece of LWD placed. Annual data sets collected for each LWD piece contain the following information:

- LWD piece number and site number
- Distance in tributary – distance of LWD piece is measured to the nearest foot by hip chain along the thalweg of the stream in an upstream direction from the mouth of the tributary.
- Species - Redwood, Douglas fir, etc is recorded.
- Type - describes the different ways in which LWD might have entered the stream. In this case it will be "Project". Other examples of "Type" used at monitoring stations throughout the watershed where wood inventories are conducted are "undercut bank" and "wind throw". The category "Project" along with the piece number will distinguish the LWD from naturally occurring LWD in future inventories during instream monitoring and within the monitoring database.
- Quality defines the potential mobility of the LWD. Usually project wood is either "Keyed" or

"Mobile." "Keyed" is defined as: a log that is buried, wedged, or braced making it unlikely to become mobile during high flows.

- Placement – left/right bank, bank to bank, or within bankfull width is recorded.
- LWD measurement – total length, length within bankfull, large end diameter, small end diameter, and bankfull diameters are all recorded for each log. Root wads A, B, C axis are measured and recorded. Wood volumes are then calculated for both total wood and wood within bankfull.
- LWD angle – angle of LWD from downstream bank.
- Maximum depth (MLWD) – the maximum stream depth at each LWD piece is recorded to measure scour efficiency.
- Residual pool depth is measured at each LWD piece.

Gualala River Watershed
EUREKA HILL Quadrangle
ZENI RIDGE Quadrangle
ORNBAUN VALLEY Quadrangle
Oregon
Idaho
Utah
Nevada
California
Gualala River Watershed
North Fork
MCGUIRE RIDGE Quadrangle
GUALALA Quadrangle
GUBE MOUNTAIN Quadrangle
Rockpile Creek
Mendocino County
Sonoma County
Gualala
Buckeye Creek
The Sea Ranch
Annapolis
ANNAPOLIS Quadrangle
STEWARTS POINT Quadrangle
TOMBS CREEK Quadrangle
WARM SPRINGS DAM Quadrangle
Wheatfield Fork
Kashia
Stewarts Point
Coastal Gualala
Pacific Ocean
South Fork Gualala
CAZADERO Quadrangle
PLANTATION Quadrangle
FORT ROSS Quadrangle
Fort Ross
ARCHED ROCK Quadrangle
DUNCANS MILLS Quadrangle
Project Area
Gualala Watershed Boundary
Gualala Watershed Hydrologic Subarea
Outside Gualala River Watershed
0 1.25 2.5 3.75 5 Miles
April 7, 2010 Watershed_StateInset_DotyRob.mxd


Gualala River Watershed
Doty Creek and Robinson Creek PWS
GUALALA Quadrangle
MCGUIRE RIDGE Quadrangle
T. 12 N.
T. 11 N.
R. 15 W.
R. 14 W.
Doty Creek PWS
Robinson Creek PWS
Billings Creek PWS
Stewart Creek PWS
Big Pepperwood Creek PWS
Doty Cr.
Middle Cr.
Little N. Fork
Four Cabin Cr.
Lost Cr.
Rexford Cr.
Dana Cr.
Gualala River
North Fork
Robinson Cr.
Dry Creek
Hayfield Cr.
Bear Cr.
Stewart Cr.
McGann Gulch
Middle Rockpile Creek
Chino Gulch
Greyhound Cr.
Doty Creek
Little North Fork
Robinson Creek Upper
Robinson Creek Lower
Dry Creek
McGann Gulch
North Fork Gualala
U
D
Proposed LWD Reaches
200-Foot Topographic Contour
PLS Section Line
Other Gualala Watershed Lands
Outside Gualala Watershed
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
0 0.5 1 Miles
Philip Chidlaw and Gualala Redwoods Inc. April 7, 2010 MonitorLWD_NewSites_DotyRob.mxd

Gualala River
Large Wood in the Stream Projects

The moss covered logs to the left were some of the first logs placed in 2001. Additional logs have been added through the years to enhance habitat.

Gualala River Large Wood in the Stream Projects

Large Woody Debris **Photo #** 1293
PW Big Pepperwood 10/18/02
Project **PID** 0
Map Pt 0 **Road** 60.3051 **Mi.** 0.04
Old **New**
Creek Big Pepperwood **Cr Dist** 928
Ref down **LWD Site** 5 **Tag#** 2512
Monitoring 0

People in Photo:

F:\GRI Photos\Small\BigNum\1293 35 2521 B DCP_186

Large Woody Debris **Photo #** 3561
PW Big Pepperwood 08/02/06
Project **PID** 0
Map Pt 0 **Road** 60.3051 **Mi.** 0.04
Old **New**
Creek Big Pepperwood **Cr Dist** 928
Ref down **LWD Site** 5 **Tag#** 630
Monitoring 0
This is a new log jam

People in Photo:
Amber Earheart Sarah Earheart

F:\GRI Photos\Small\Bigger\3561 DCP_3419.jpg

Large Woody Debris **Photo #** 1281
PW Big Pepperwood 10/18/02
Project **PID** 0
Map Pt 0 **Road** 60.3051 **Mi.** 0.04
Old **New**
Creek Big Pepperwood **Cr Dist** 1,015
Ref Up **LWD Site** 5 **Tag#** 634
Monitoring 0
This is the channel before LWD placement

People in Photo:

F:\GRI Photos\Small\BigNum\1281 35 634 B DCP_1864.

Large Woody Debris **Photo #** 1413
PW Big Pepperwood 01/15/03
Project **PID** 0
Map Pt 0 **Road** 60.3051 **Mi.** 0.04
Old **New**
Creek Big Pepperwood **Cr Dist** 1,015
Ref Up **LWD Site** 5 **Tag#** 634
Monitoring 0

This is the log digging a pool and catching debis during high water.

People in Photo:

F:\GRI Photos\Small\BigNum\1413 35 634 DCP_2259.J

Large Woody Debris **Photo #** 1802
PW Big Pepperwood 10/22/03
Project **PID** 0
Map Pt 0 **Road** 60.3051 **Mi.** 0.04
Old **New**
Creek Big Pepperwood **Cr Dist** 1,015
Ref Up **LWD Site** 5 **Tag#** 634
Monitoring 0

People in Photo:

F:\GRI Photos\Small\BigNum\1802 DCP_2818.jpg

Large Woody Debris **Photo #** 1728
PW Doty Creek 10/15/03
Project **PID** 0
Map Pt 0 **Road** 60.402 **Mi.** 0.1
Old **New**
Creek LNF Gualala **Cr Dist** 4,482
Ref 0 **LWD Site** 6 **Tag#** 2988
Monitoring 0

People in Photo:
Rick Loghry

F:\GRI Photos\Small\BigNum\1728 DCP_1479.jpg

Large Woody Debris **Photo #** 1849
PW Doty Creek 10/30/03
Project **PID** 0
Map Pt 0 **Road** 60.402 **Mi.** 0.1
Old **New**
Creek LNF Gualala **Cr Dist** 4,482
Ref Left **LWD Site** 6 **Tag#** 2988
Monitoring 0
this is the site before rootwad placement

People in Photo:

F:\GRI Photos\Small\BigNum\1849 DCP_1600.jpg

Large Woody Debris **Photo #** 1887
PW Doty Creek 12/10/03
Project **PID** 0
Map Pt 0 **Road** 60.402 **Mi.** 0.1
Old **New**
Creek LNF Gualala **Cr Dist** 4,482
Ref Left **LWD Site** 6 **Tag#** 2988
Monitoring 0

People in Photo:

F:\GRI Photos\Small\BigNum\1887 DCP_1717.jpg

Large Woody Debris **Photo #** 2004
PW Doty Creek 02/17/04
Project **PID** 0
Map Pt 0 **Road** 60.402 **Mi.** 0.1
Old **New**
Creek LNF Gualala **Cr Dist** 4,482
Ref Left **LWD Site** 6 **Tag#** 2988
Monitoring 0
North Fork Gage 17'

People in Photo:

F:\GRI Photos\Small\BigNum\2004 DCP_3011.jpg

Large Woody Debris **Photo #** 5412
PW Doty Creek 04/04/09
Project **PID** 0
Map Pt 0 **Road** 60.402 **Mi.** 0.1
Old **New**
Creek LNF Gualala **Cr Dist** 4,482
Ref left **LWD Site** 6 **Tag#** 2988
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\5412 2988left_ IMGP1560.j

Large Woody Debris **Photo #** 826
PW Doty Creek 12/18/01
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2765
Monitoring 0

This is LWD 2778 and it has caused a 3' pool to develop.

People in Photo:
Kerry Williams

F:\GRI Photos\Small\826 lwd 2338 kerry DCP_1164.jpg

Large Woody Debris **Photo #** 852
PW Doty Creek 03/27/02
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2765
Monitoring 0

This is LWD piece 2778 and the pool it has created.

People in Photo:
Kathleen Morgan

F:\GRI Photos\Small\852 digger lwd DCP_0014.jpg

Large Woody Debris **Photo #** 1109
PW Doty Creek 08/13/02
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2778
Monitoring 0
This is an RCD field trip to the Gualala.

People in Photo:
Roger Dingman
Jill Butler
Don Morse
Kathleen Morgan
Timmothy Osmer

F:\GRI Photos\Small\BigNum\1109 LWD 2338 DCP_039

Large Woody Debris **Photo #** 1355
PW Doty Creek 12/18/02
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2765
Monitoring 0

People in Photo:

F:\GRI Photos\Small\BigNum\1355 DCP_1009.jpg

Large Woody Debris **Photo #** 1459
PW Doty Creek 05/03/03
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2778
Monitoring 0
Doug Albin visits the log.

People in Photo:

F:\GRI Photos\Small\BigNum\1459 DCP_1136.jpg

Large Woody Debris **Photo #** 1421
PW Doty Creek 05/03/03
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2778
Monitoring 0

The LWD field trip standing on Henry's favorite log.

People in Photo:

Kathleen Morgan	Matt O'Conner
Jill Butler	Brenda Roesser

F:\GRI Photos\Small\BigNum\1421 DCP_2406.jpg

Large Woody Debris **Photo #** 1497
PW Doty Creek 06/11/03
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2778
Monitoring 0

The Novacks visti the log.

People in Photo:

Tod Novak	Jane Novak
Emily Novak	Wayne Novak

F:\GRI Photos\Small\BigNum\1497 DCP_2597.jpg

Large Woody Debris **Photo #** 1936
PW Doty Creek 12/24/03
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref Down **LWD Site** 8 **Tag#** 2778
Monitoring 0

10 am RYTD=16.09 - 58Hr=2.24 - 34Hr=2.24 - 10Hr=1.32 GWF 16.49' 9,334 CFS NFG 15.82'

People in Photo:

F:\GRI Photos\Small\BigNum\1936 DCP_1869.jpg

Large Woody Debris **Photo #** 2011
PW Doty Creek 02/17/04
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref down **LWD Site** 8 **Tag#** 2765
Monitoring 0
North Fork Gage 17'

People in Photo:
Kathleen Morgan

F:\GRI Photos\Small\BigNum\2011 DCP_3043.jpg

Large Woody Debris **Photo #** 3473
PW Doty Creek 01/02/06
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref down **LWD Site** 8 **Tag#** 2765
Monitoring 0

People in Photo:
Henry Alden

F:\GRI Photos\Small\LWD\3473 IMG_0256.jpg

Large Woody Debris **Photo #** 5409
PW Doty Creek 04/04/09
Project **PID** 0
Map Pt 0 **Road** 80.4 **Mi.** 1.2
Old **New**
Creek LNF Gualala **Cr Dist** 14,105
Ref down **LWD Site** 8 **Tag#** 2778
Monitoring 0

People in Photo:

F:\GRI Photos\Small\Bigger\5409 2788Dn_IMGP1613.jp

Large Woody Debris **Photo #** 532
PW Doty Creek 04/18/01
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,591
Ref up **LWD Site** 10 **Tag#** 2846
Monitoring 0

Digger logs place in the Little North Fork of the Gualala to create pools.

People in Photo:
Nola Craig

F:\GRI Photos\Small\532LWD10 pp2up r Dcp_0184.jpg

Large Woody Debris **Photo #** 1939
PW Doty Creek 12/24/03
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,591
Ref up **LWD Site** 10 **Tag#** 2846
Monitoring 0

10 am RYTD=16.09 - 58Hr=2.24 - 34Hr=2.24 - 10Hr=1.32 GWF 16.49' 9,334 CFS NFG 15.82'

People in Photo:

F:\GRI Photos\Small\BigNum\1939 DCP_1881.jpg

Large Woody Debris **Photo #** 2355
PW Doty Creek 09/24/04
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,591
Ref Up **LWD Site** 10 **Tag#** 2935
Monitoring 0

Winter storms have created pools around these logs.

People in Photo:

F:\GRI Photos\Small\BigNum\2355 DCP_3458.jpg

Large Woody Debris **Photo #** 534
PW Doty Creek 04/18/01
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,631
Ref PP3 up **LWD Site** 10 **Tag#** 2903
Monitoring 0

Logs placed in the the Little North Fork of the Gualala to create pools and catch other logs floatiing downstream,

People in Photo:

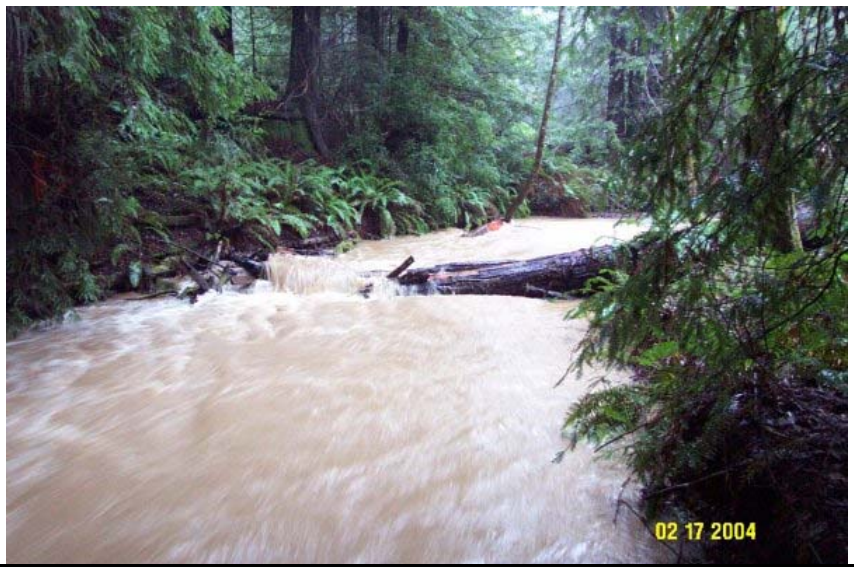
F:\GRI Photos\Small\534LWD10 pp3up Dcp_0186.jpg

Large Woody Debris **Photo #** 878
PW Doty Creek 04/25/02
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,631
Ref PP3 Up **LWD Site** 10 **Tag#** 2903
Monitoring 0

Floater logs placed upstream and other debris were caught by log 2803 and are creating cover for fish.

People in Photo:
Nola Craig

F:\GRI Photos\Small\878 LWD 10 DCP_1279.JPG



Large Woody Debris **Photo #** 2021
PW Doty Creek 02/17/04
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,631
Ref PP3 Up **LWD Site** 10 **Tag#** 2903
Monitoring 0

North Fork Gage 17'

People in Photo:

F:\GRI Photos\Small\BigNum\2021 DCP_3071.jpg

Large Woody Debris **Photo #** 5411
PW Doty Creek 04/04/09
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,631
Ref Up **LWD Site** 10 **Tag#** 2903
Monitoring 0

People in Photo:

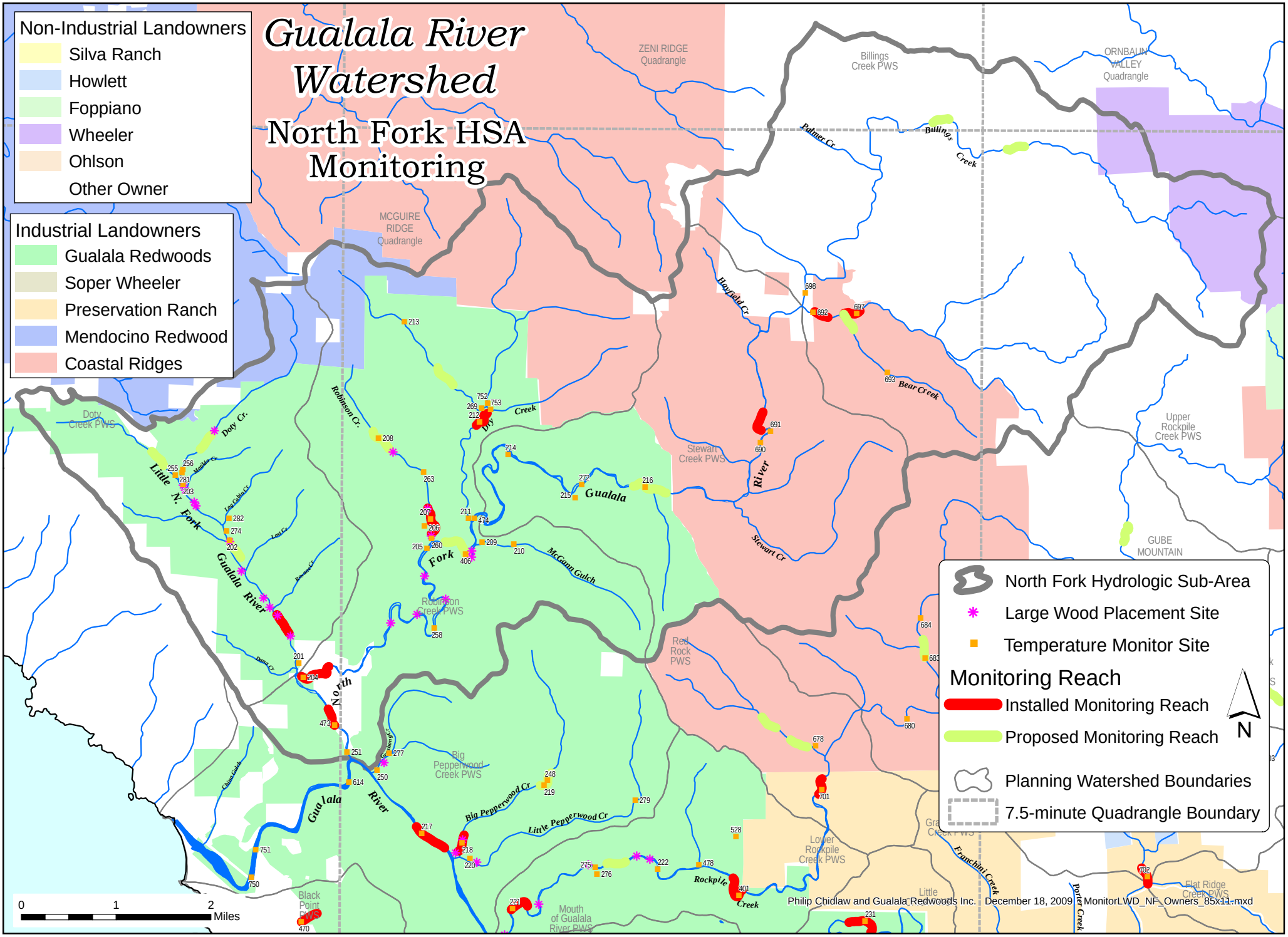
F:\GRI Photos\Small\Bigger\5411 2903Up_IMGP1599.jp

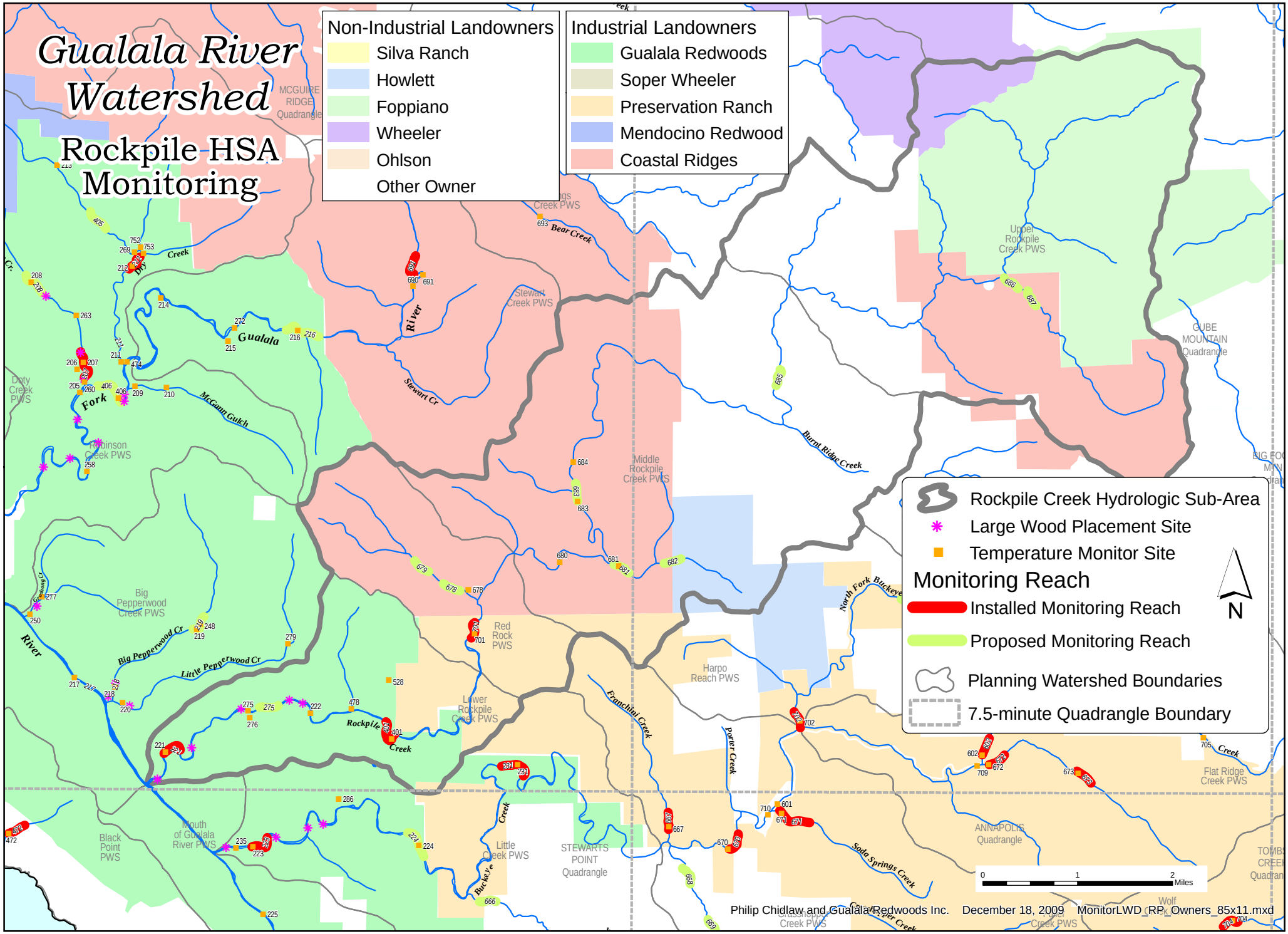
Large Woody Debris **Photo #** 5410
PW Doty Creek 04/04/09
Project **PID** 0
Map Pt 0 **Road** 80.4046 **Mi.** 0.02
Old **New**
Creek LNF Gualala **Cr Dist** 15,631
Ref Up **LWD Site** 10 **Tag#** 2903
Monitoring 0

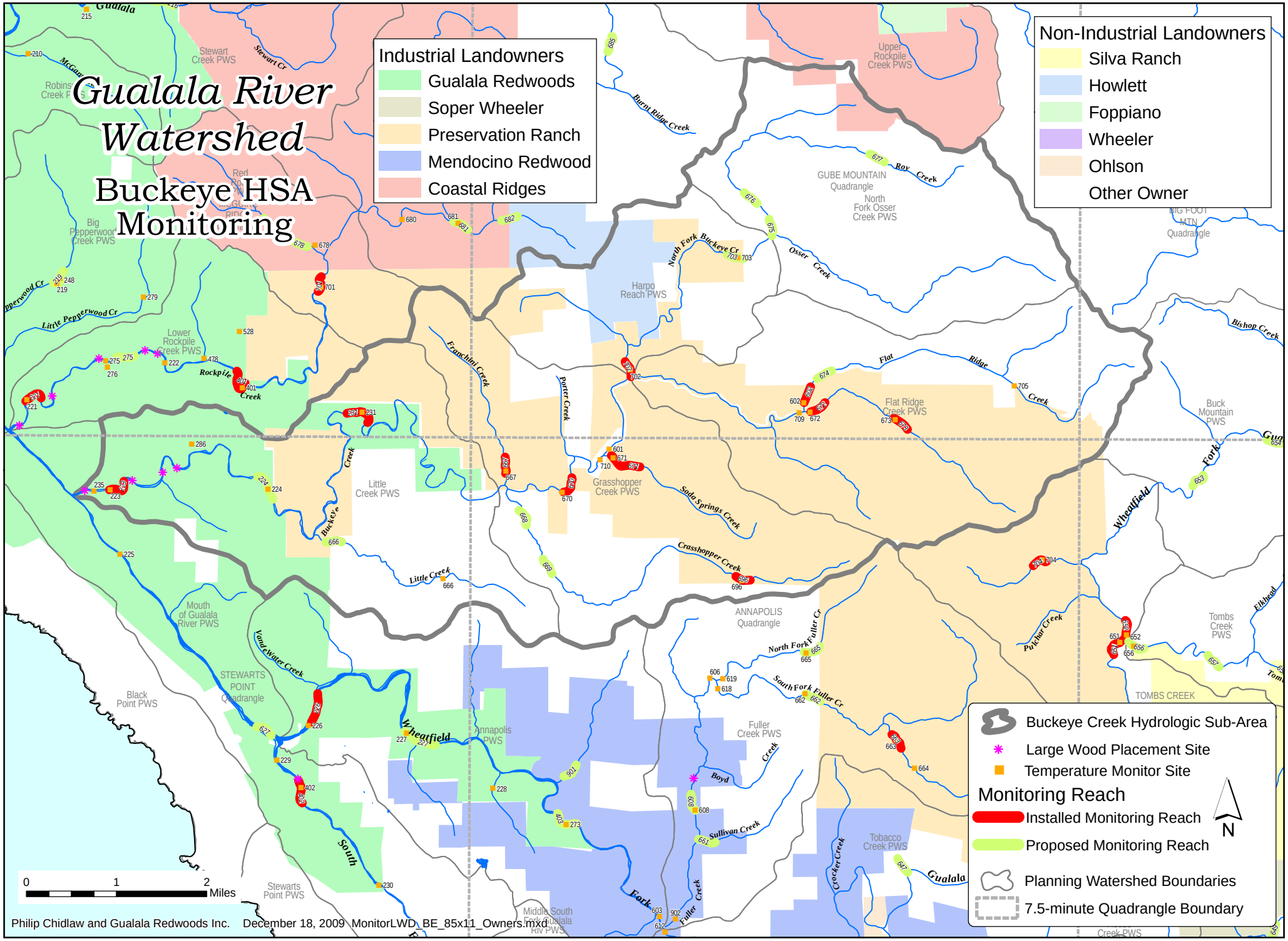
People in Photo:

F:\GRI Photos\Small\Bigger\5410 2903Up_IMGP1594.jp

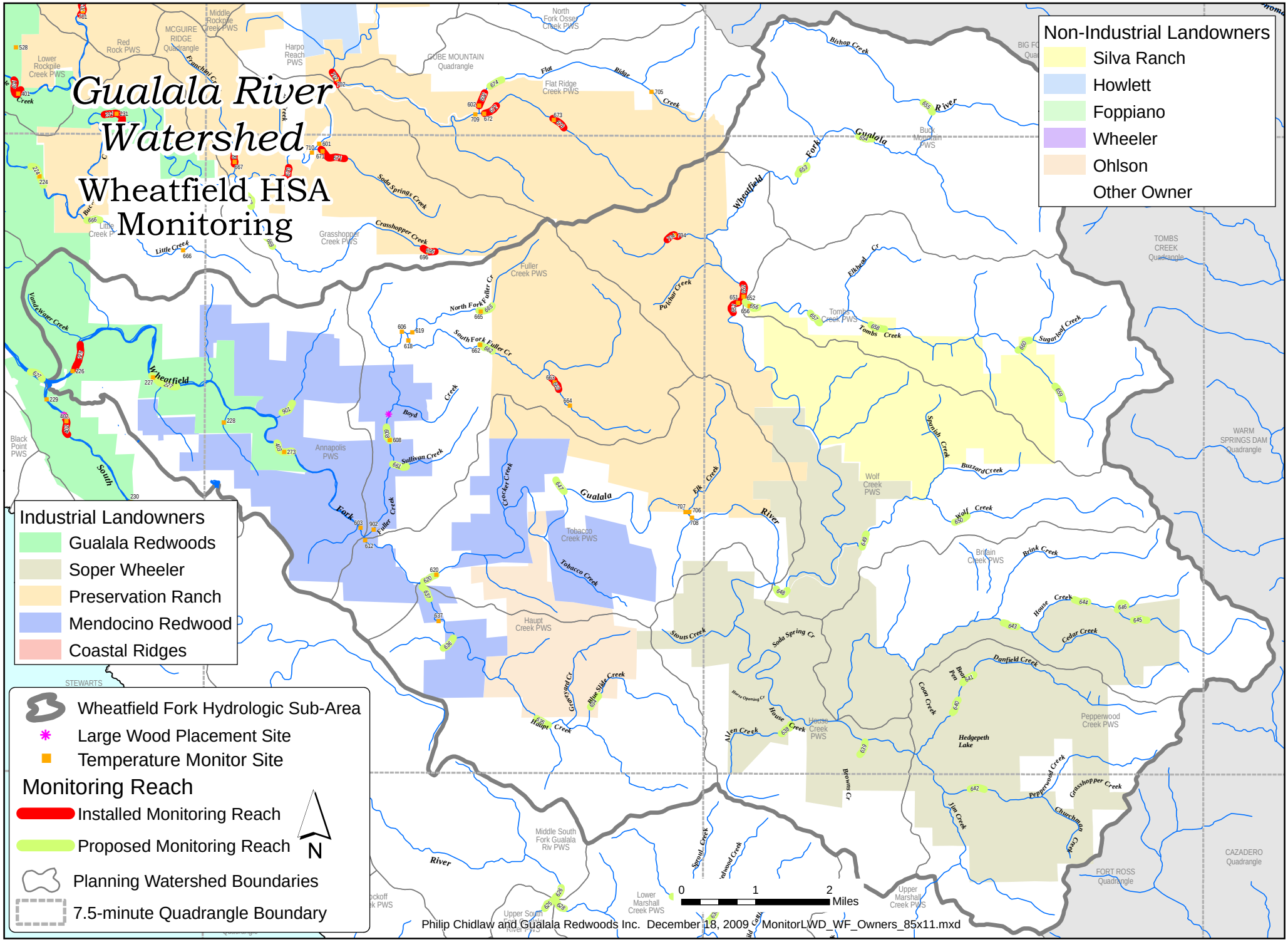
Monitoring Addendum

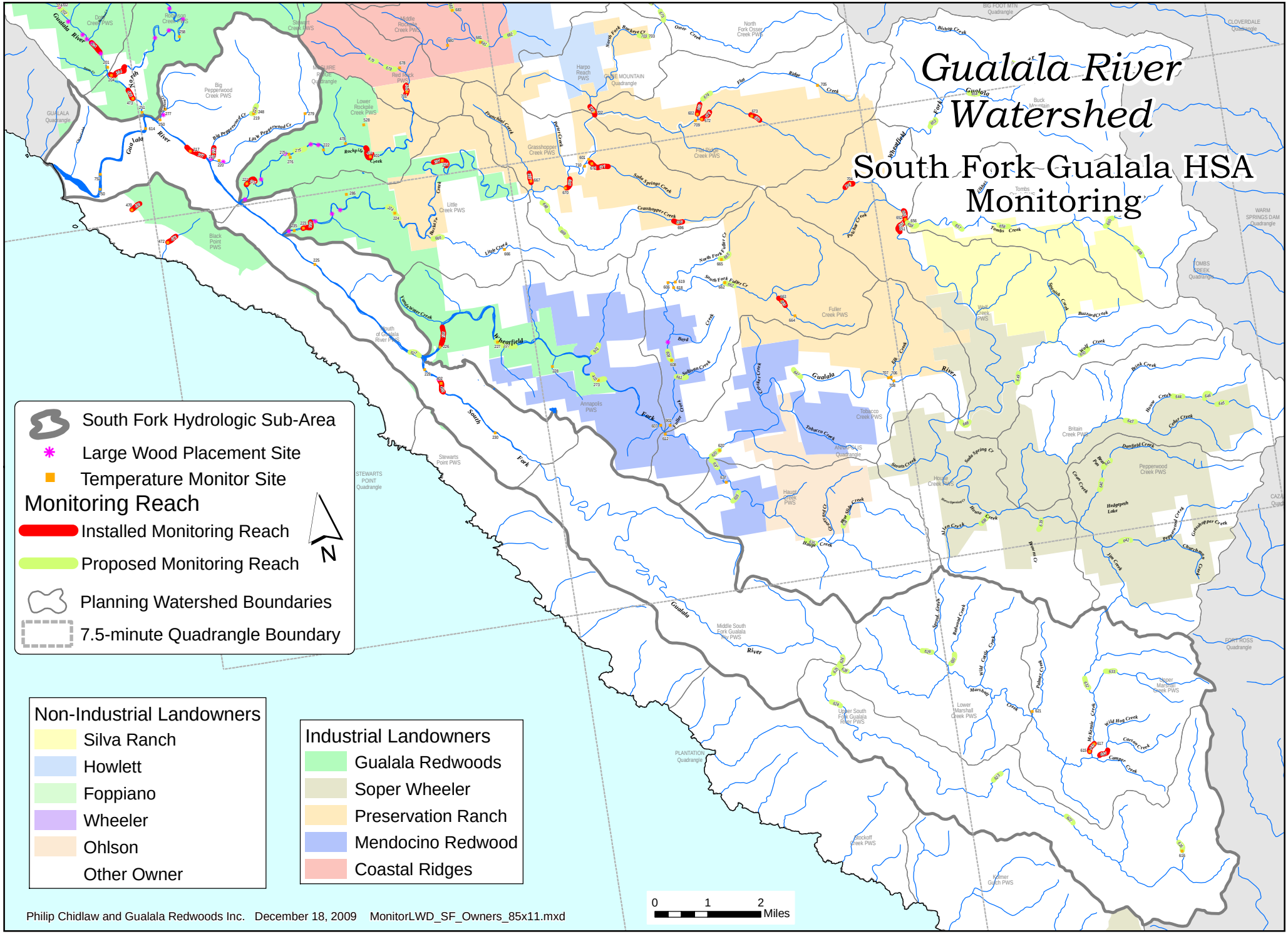

Gualala River Watershed
North Fork HSA Monitoring
Non-Industrial Landowners
Silva Ranch
Howlett
Foppiano
Wheeler
Ohlson
Other Owner
Industrial Landowners
Gualala Redwoods
Soper Wheeler
Preservation Ranch
Mendocino Redwood
Coastal Ridges
North Fork Hydrologic Sub-Area
Large Wood Placement Site
Temperature Monitor Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
0 1 2 Miles
Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_NF_Owners_85x11.mxd
ZENI RIDGE Quadrangle
MCGUIRE RIDGE Quadrangle
ORNBALIN VALLEY Quadrangle
GUBE MOUNTAIN
Billings Creek PWS
Upper Rockpile Creek PWS
Stewart Creek PWS
Red Rock PWS
Lower Rockpile Creek PWS
Big Pepperwood Creek PWS
Robinson Creek PWS
Doty Creek PWS
Black Point PWS
Mouth of Gualala River PWS
Little N. Fork Gualala River
North Fork Gualala River
Gualala River
Doty Cr.
Doty Creek
Robinson Cr.
McGann Gulch
Big Pepperwood Cr
Little Pepperwood Cr
Rockpile Creek
Stewart Cr
Stewart River
Hayfield Cr
Bear Creek
Palmer Cr
Billings Creek
Franchini Creek
Porter Creek


Gualala River Watershed
Rockpile HSA Monitoring
Non-Industrial Landowners
Silva Ranch
Howlett
Foppiano
Wheeler
Ohlson
Other Owner
Industrial Landowners
Gualala Redwoods
Soper Wheeler
Preservation Ranch
Mendocino Redwood
Coastal Ridges
Rockpile Creek Hydrologic Sub-Area
Large Wood Placement Site
Temperature Monitor Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
0
1
2
Miles
Gualala
River
Fork
Dry
Creek
Bear Creek
Stewart Cr
McGann Gulch
Big Pepperwood Cr
Little Pepperwood Cr
Rockpile
Creek
Franchini Creek
Porter Creek
Burnt Ridge Creek
North Fork Buckeye
Buckeye
Soda Springs Creek
Flat Ridge Creek PWS
Upper Rockpile Creek PWS
Middle Rockpile Creek PWS
Lower Rockpile Creek PWS
Stewart Creek PWS
Red Rock PWS
Harpo Reach PWS
Little Creek PWS
Big Pepperwood Creek PWS
Black Point PWS
Mouth of Gualala River PWS
Doty Creek PWS
Robinson Creek PWS
MCGUIRE RIDGE Quadrangle
GUBE MOUNTAIN Quadrangle
ANNAPOLIS Quadrangle
STEWARTS POINT Quadrangle
Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_RP_Owners_85x11.mxd



Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_BE_85x11_Owners.mxd


Gualala River Watershed
Wheatfield HSA Monitoring
Non-Industrial Landowners
Silva Ranch
Howlett
Foppiano
Wheeler
Ohlson
Other Owner
Industrial Landowners
Gualala Redwoods
Soper Wheeler
Preservation Ranch
Mendocino Redwood
Coastal Ridges
Wheatfield Fork Hydrologic Sub-Area
Large Wood Placement Site
Temperature Monitor Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
0
1
2
Miles
Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_WF_Owners_85x11.mxd


Gualala River Watershed
South Fork Gualala HSA Monitoring
South Fork Hydrologic Sub-Area
Large Wood Placement Site
Temperature Monitor Site
Monitoring Reach
Installed Monitoring Reach
Proposed Monitoring Reach
Planning Watershed Boundaries
7.5-minute Quadrangle Boundary
N
Non-Industrial Landowners
Silva Ranch
Howlett
Foppiano
Wheeler
Ohlson
Other Owner
Industrial Landowners
Gualala Redwoods
Soper Wheeler
Preservation Ranch
Mendocino Redwood
Coastal Ridges
0 1 2 Miles
Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_SF_Owners_85x11.mxd

Gualala River Watershed

Coastal Gualala HSA Monitoring

- Coastal Gualala Hydrologic Sub-Area
- Large Wood Placement Site
- Temperature Monitor Site

Monitoring Reach

- Installed Monitoring Reach
- Proposed Monitoring Reach
- Planning Watershed Boundaries
- 7.5-minute Quadrangle Boundary

N

Industrial Landowners

- Gualala Redwoods
- Soper Wheeler
- Preservation Ranch
- Mendocino Redwood
- Coastal Ridges

Non-Industrial Landowners

- Silva Ranch
- Howlett
- Foppiano
- Wheeler
- Ohlson
- Other Owner

0 1 2 Miles

Philip Chidlaw and Gualala Redwoods Inc. December 18, 2009 MonitorLWD_CG_Owners85x11.mxd

Stream Monitoring Report

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates			
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant	Russian R Index
Hydrologic Unit						**NF Gualala**																	
Stream			**Abieta Springs**																				
752		0.09		Avg	17.9	16.6																	
				Max	17.9	16.6																	
Abieta Springs				Avg	17.9	16.6																	
				Max	17.9	16.6																	
Stream			**Bear Creek**																				
693		0.57		Avg	17.1	15.1																	
				Max	17.1	15.1																	
Bear Creek				Avg	17.1	15.1																	
				Max	17.1	15.1																	
Stream			**Billings Cr**																				
698	Bil	0.00		Avg	25.6	21.2																	
				Max	26.0	21.6																	
Billings Cr				Avg	25.6	21.2																	
				Max	26.0	21.6																	
Stream			**Doty Creek**																				
256	Dot2	0.02		Avg	14.1	12.9			15.7%														
				Max	14.1	12.9			21.6%														
281	Dot1	0.02		Avg	14.6	13.6																	
				Max	14.8	13.7																	
Doty Creek				Avg	14.5	13.3			15.7%														
				Max	14.8	13.7			21.6%														
Stream			**Dry Creek**																				
211	Dry3	0.19		Avg	16.2	14.6	5,862	85	14.2%	42	0.76%	22	0.04	88%	81%	210	89	6	174	32	0.79	4.4	16	40
				Max	17.7	15.9	7,230	110	24.3%	62	0.86%	29	0.54	93%	87%	210	89	23	407	32	0.79	4.4	16	40
212	Dry2	1.29		Avg	19.2	17.0	2,331	33		36	1.86%	14	-0.4	82%	70%	81	60	0	500	41	0.92	4.5	22	19
				Max	20.9	17.9	2,477	37		36	1.89%	14	-0.4	87%	85%	81	60	0	500	41	0.92	4.5	22	19
753		1.61		Avg	16.5	15.7																	
				Max	16.5	15.7																	

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
Dry Creek				Avg	17.3	15.5	5,358	78	14.2%	42	0.92%	21	0.002	86%	78%	146	75	5	215	37	0.86	4.5	19	30
				Max	20.9	17.9	7,230	110	24.3%	62	1.89%	29	0.54	93%	87%	210	89	23	500	41	0.92	4.5	22	40
Stream			Little North Fork Gualala																					
201	LNF5	0.02		Avg	16.2	15.0			18.0%															
				Max	16.9	15.7			36.1%															
404	LNF3	0.45		Avg			5,227	76		34	0.68%	45	-0.6	97%	96%	163	75	5	329					
				Max			5,250	83		34	0.79%	57	-0.6	97%	96%	163	75	16	589					
202	LNF2	1.47		Avg	16.4	14.6			16.7%									11	357					
				Max	16.4	14.6			32.3%									32	391					
274	LNF8	1.68		Avg	16.2	14.3																		
				Max	16.4	14.6																		
203	LNF1	2.27		Avg	15.2	13.8	4,846	119	17.6%	42	1.47%	28	-0.5	87%	89%	344	92	0	313	30	0.85	4.5	19	35
				Max	15.8	14.5	5,923	146	28.0%	65	1.54%	34	-0.08	89%	91%	391	100	0	803	31	0.85	4.6	19	41
408	LNF7	2.37		Avg	14.9	13.7																		
				Max	14.9	13.7																		
255	LNF6	2.86		Avg	15.9	14.3			20.1%															
				Max	15.9	14.3			32.6%															
Little North Fork Gualala				Avg	15.7	14.3	4,900	113	17.8%	41	1.35%	30	-0.5	90%	91%	284	86	3	323	30	0.85	4.5	19	35
				Max	16.9	15.7	5,923	146	36.1%	65	1.54%	57	-0.08	97%	96%	391	100	32	803	31	0.85	4.6	19	41
Stream			Lost Creek																					
215	LCr	0.04		Avg	16.4	15.4																		
				Max	17.0	15.9																		
Lost Creek				Avg	16.4	15.4																		
				Max	17.0	15.9																		
Stream			McGann Gulch																					
209	MGG2	0.08		Avg	16.2	15.3			22.0%									0	104					
				Max	16.7	15.9			48.3%									0	104					
210	MGG1	0.42		Avg	15.7	14.6																		
				Max	20.4	16.4																		
McGann Gulch				Avg	15.9	14.8			22.0%									0	104					
				Max	20.4	16.4			48.3%									0	104					
Stream			North Fork Gualala																					

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates		
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness Simpson	Hilsenhoff Russian R Index	% Dominant
251	NFG	0.06	Avg 19.1	16.8																
			Max 19.3	17.5																
473	NFG4	0.44	Avg 18.6	16.2	2,518	64		26	0.26%	28		93%	84%	148	72	0	291			
			Max 19.3	16.6	2,518	64		26	0.26%	28		93%	84%	148	72	0	291			
204	NFG3	1.25	Avg 19.2	17.1	2,848	65		22	0.36%	27	-0.7	72%	58%	140	73	0	432			
			Max 20.6	18.7	3,161	97		28	0.38%	31	-0.4	80%	69%	140	73	0	1,484			
258	NFG	3.83	Avg 24.5	19.3																
			Max 24.5	19.3																
205	NFG	4.94	Avg 20.5	17.7																
			Max 21.4	18.1																
406	NFG2	5.38	Avg 21.4	18.6												0	303			
			Max 21.4	18.6												0	303			
474	NFG	6.08	Avg 21.5	18.7																
			Max 22.4	19.3																
214	NFG	7.99	Avg 24.0	21.1												0	1,081			
			Max 24.3	21.4												0	1,081			
272	NFG	9.09	Avg 23.8	20.5																
			Max 24.5	21.4																
216	NFG1	9.85	Avg 26.4	21.7												0	236			
			Max 26.9	22.0												0	236			
690	NFG	11.86	Avg																	
			Max																	
691	NFG5	12.22	Avg 23.8	20.2	227	4		20	0.32%	43		50%	43%							
			Max 24.4	21.0	227	4		20	0.32%	43		50%	43%							
North Fork Gualala			Avg 21.6	18.7	2,356	54		22	0.33%	30	-0.7	72%	61%	144	72	0	449			
			Max 26.9	22.0	3,161	97		28	0.38%	43	-0.4	93%	84%	148	73	0	1,484			
Stream		Peaches Creek																		
269	Pea3	0.30	Avg 16.7	15.6																
			Max 17.5	16.0																
213	Pea2	1.52	Avg 17.4	16.2																
			Max 17.8	16.4																

Station	Miles	Year	Temperature			LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
				Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant Russian R	Index	
Peaches Creek			Avg	17.0	15.9																		
			Max	17.8	16.4																		
Stream		Robinson Cr East																					
697	Rbn1	0.00	Avg	23.0	18.7	656	9		30	0.60%	29	-0.4											
			Max	23.0	18.7	690	11		33	0.61%	35	-0.4											
692	Rbn2	0.00	Avg	20.8	18.1	153	8		44	1.64%	65		73%	77%									
			Max	21.0	18.2	153	8		44	1.64%	65		73%	77%									
Robinson Cr East			Avg	21.5	18.3	488	9		34	0.95%	41	-0.4	73%	77%									
			Max	23.0	18.7	690	11		44	1.64%	65	-0.4	73%	77%									
Stream		Robinson Cr West																					
260	Rob	0.01	Avg	14.6	13.8																		
			Max	14.6	13.8																		
207	Rob2	0.11	Avg	17.7	15.1	1,643	49	17.1%	36	1.39%	13		66%	74%	246	95	2	172					
			Max	20.2	16.2	1,643	49	24.8%	36	1.39%	13		66%	74%	246	95	12	422					
409	Rob	0.57	Avg	16.0	14.6																		
			Max	16.0	14.6																		
263	Rob	0.78	Avg	17.7	15.5												0	209					
			Max	17.7	15.5												0	317					
208	Rob1	1.29	Avg	16.5	14.9												0	76					
			Max	16.7	15.0												0	76					
Robinson Cr West			Avg	17.0	15.0	1,643	49	17.1%	36	1.39%	13		66%	74%	246	95	1	169					
			Max	20.2	16.2	1,643	49	24.8%	36	1.39%	13		66%	74%	246	95	12	422					
Stream		Sosueme Cr																					
206	Sosu	0.04	Avg	17.6	14.1																		
			Max	20.4	14.4																		
Sosueme Cr			Avg	17.6	14.1																		
			Max	20.4	14.4																		
Hydrologic Unit NF Gualala			Avg	18.1	16.1	4,233	81	17.6%	37	1.02%	27	-0.3	81%	76%	210	81	3	297	33	0.85	4.5	19	33
Hydrologic Unit					**Rockpile**																		
Stream		Dynamite Cr.																					

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates		
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant Russian R Index
478 Dyn1	0.00	Avg	14.3	13.3																
		Max	14.8	13.4																
Dynamite Cr.		Avg	14.3	13.3																
		Max	14.8	13.4																
Stream		Emily Creek																		
276 Emy	0.07	Avg	14.8	13.8																
		Max	15.2	14.1																
Emily Creek		Avg	14.8	13.8																
		Max	15.2	14.1																
Stream		Horsethief Canyon																		
681 Hor1	0.00	Avg	16.9	16.4																
		Max	17.5	17.0																
Horsethief Canyon		Avg	16.9	16.4																
		Max	17.5	17.0																
Stream		Red Rock Creek																		
678	0.19	Avg	15.6	15.1																
		Max	15.6	15.1																
Red Rock Creek		Avg	15.6	15.1																
		Max	15.6	15.1																
Stream		Rockpile Creek																		
221 Roc3	0.50	Avg	22.1	18.7	2,062	26		25	0.28%	13	-0.3	90%	37%	272	90	0	290			
		Max	23.2	19.8	2,514	31		31	0.31%	17	-0.2	90%	37%	272	90	0	1,552			
275 Roc2	1.93	Avg	20.8	19.0												0	508			
		Max	23.9	20.2												0	508			
222 Roc	2.65	Avg	22.6	19.6																
		Max	23.5	19.8																
401 Roc1	3.56	Avg	21.4	19.3	5,416	56		24	0.16%	29		99%	58%	478	86			26	2.9	29
		Max	23.7	20.8	5,416	56		24	0.16%	29		99%	58%	478	86			26	2.9	29
701 Roc4	6.06	Avg	21.3	19.0	2,961	36		34	0.24%	52		83%	60%	265	67			26	3.0	39
		Max	21.3	19.5	2,961	36		34	0.24%	52		83%	60%	265	67			26	3.0	39
680 Roc	7.77	Avg	24.2	20.4																
		Max	24.8	21.2																

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate	Streambed				Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R	% Dominant Index
683	Roc5	8.71	Avg	23.6	19.8																	
			Max	24.0	20.6																	
Rockpile Creek			Avg	22.1	19.1	2,913	34	27	0.25%	24	-0.3	91%	52%	338	81	0	312	26		3.0		34
			Max	24.8	21.2	5,416	56	34	0.31%	52	-0.2	99%	60%	478	90	0	1,552	26		3.0		39
Hydrologic Unit Rockpile			Avg	20.6	18.1	2,913	34	27	0.25%	24	-0.3	91%	52%	338	81	0	312	26		3.0		34
Hydrologic Unit				**Buckeye**																		
Stream		**Buckeye Creek**																				
709	Buc	0.00	Avg	23.6	20.3																	
			Max	23.6	20.3																	
235	Buc	0.23	Avg	21.1	18.3																	
			Max	21.1	18.3																	
223	Buc3	0.34	Avg	21.3	18.2	2,580	62	28	0.26%	52	-0.7	80%	55%	143	99	0	185	32	0.88	4.0	19	26
			Max	22.7	19.7	2,965	69	33	0.32%	58	-0.7	81%	56%	143	99	0	459	32	0.88	4.0	19	26
224	Buc2	3.01	Avg	22.4	19.3											0	287					
			Max	23.9	19.9											0	287					
231	Buc1	6.25	Avg	23.3	20.3	273	11	25	0.36%	27												
			Max	24.4	21.1	273	11	25	0.36%	27												
670	Buc4	11.17	Avg	22.6	19.6	944	8	15	0.58%	26		100%	89%	323	64			27		4.6		38
			Max	26.3	22.2	944	8	15	0.58%	26		100%	89%	323	64			27		4.6		38
601	Buc7	12.31	Avg	25.3	20.8																	
			Max	26.0	21.0																	
672	Buc8	15.53	Avg	21.2	17.9	232	6	71	1.49%	69		33%	36%	76	84			35		4.1		22
			Max	24.4	19.4	232	6	71	1.49%	69		33%	36%	76	84			35		4.1		22
673	Buc9	16.48	Avg	26.7	22.8	325	20	60	1.64%	58		28%	29%	106	82			38		3.6		18
			Max	26.7	22.8	325	20	60	1.64%	58		28%	29%	106	82			38		3.6		18
Buckeye Creek			Avg	22.8	19.5	1,156	28	38	0.77%	47	-0.7	64%	53%	162	82	0	196	33	0.88	4.1	19	26
			Max	26.7	22.8	2,965	69	71	1.64%	69	-0.7	100%	89%	323	99	0	459	38	0.88	4.6	19	38
Stream		**Flat Ridge Creek**																				
602	FLR2	0.04	Avg	25.7	21.2	1,181	17	47	1.14%	89		12%	11%	155	88			38		3.2		25
			Max	26.3	22.6	1,181	17	47	1.14%	89		12%	11%	155	88			38		3.2		25

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates		
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness Simpson	Hilsenhoff Russian R Index	% Dominant
674 FLT	0.38	Avg	19.5	16.7																
		Max	19.5	16.7																
Flat Ridge Creek		Avg	24.5	20.3	1,181	17		47	1.14%	89		12%	11%	155	88			38	3.2	25
		Max	26.3	22.6	1,181	17		47	1.14%	89		12%	11%	155	88			38	3.2	25
Stream		Franchini Creek																		
667 FRN1	0.00	Avg	16.1	14.9	4,627	150		32	3.47%	31		75%	97%	228	59			29	4.2	31
		Max	18.7	16.4	4,627	150		32	3.47%	31		75%	97%	228	59			29	4.2	31
Franchini Creek		Avg	16.1	14.9	4,627	150		32	3.47%	31		75%	97%	228	59			29	4.2	31
		Max	18.7	16.4	4,627	150		32	3.47%	31		75%	97%	228	59			29	4.2	31
Stream		Grasshopper Creek																		
696 GRS1	2.65	Avg	15.1	14.5	8,002	191		28	2.22%	24		82%	88%	406	65			30	3.8	31
		Max	15.1	14.5	8,002	191		28	2.22%	24		82%	88%	406	65			30	3.8	31
Grasshopper Creek		Avg	15.1	14.5	8,002	191		28	2.22%	24		82%	88%	406	65			30	3.8	31
		Max	15.1	14.5	8,002	191		28	2.22%	24		82%	88%	406	65			30	3.8	31
Stream		Little Creek																		
666 LiCr	0.09	Avg	13.7	12.9																
		Max	13.7	12.9																
Little Creek		Avg	13.7	12.9																
		Max	13.7	12.9																
Stream		Meg Creek																		
286 Meg	0.01	Avg	15.0	13.8																
		Max	15.1	14.3																
Meg Creek		Avg	15.0	13.8																
		Max	15.1	14.3																
Stream		North Fork Buckeye Creek																		
702 NFB2	0.02	Avg	20.2	17.9	771	12		40	0.62%	62		96%	82%	318	59			31	3.9	27
		Max	21.0	18.6	771	12		40	0.62%	62		96%	82%	318	59			31	3.9	27
North Fork Buckeye Creek		Avg	20.2	17.9	771	12		40	0.62%	62		96%	82%	318	59			31	3.9	27
		Max	21.0	18.6	771	12		40	0.62%	62		96%	82%	318	59			31	3.9	27
Stream		Soda Springs Creek																		
671 SSP1	0.08	Avg	19.7	17.9	1,303	56		66	2.22%	68		100%	94%	251	74			34	3.6	21
		Max	19.7	17.9	1,303	56		66	2.22%	68		100%	94%	251	74			34	3.6	21
Soda Springs Creek		Avg	19.7	17.9	1,303	56		66	2.22%	68		100%	94%	251	74			34	3.6	21
		Max	19.7	17.9	1,303	56		66	2.22%	68		100%	94%	251	74			34	3.6	21

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate	Streambed				Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant	Russian R Index	
Hydrologic Unit Buckeye		Avg	21.5	18.6	2,075	54		40	1.30%	51	-0.7	68%	64%	223	75	0	196	33	0.88	3.9	19	27
Hydrologic Unit				**Wheatfield**																		
Stream		**Elk Creek**																				
706	Elk	0.00	Avg	20.1	17.3																	
			Max	21.0	18.4																	
Elk Creek			Avg	20.1	17.3																	
			Max	21.0	18.4																	
Stream		**Fuller Creek**																				
902	Ful	0.06	Avg	24.0	18.9																	
			Max	24.0	18.9																	
608	Ful1	0.38	Avg	20.7	17.3																	
			Max	21.0	17.8																	
609	Ful3	2.31	Avg	19.4	17.5																	
			Max	19.4	17.5																	
606	Ful	3.03	Avg	22.1	18.3																	
			Max	23.6	19.8																	
Fuller Creek			Avg	21.6	18.0																	
			Max	24.0	19.8																	
Stream		**Haupt Cr**																				
637		0.38	Avg																			
			Max																			
Haupt Cr			Avg																			
			Max																			
Stream		**Jennifer Creek**																				
228	Jen	0.19	Avg	14.7	13.6																	
			Max	16.3	14.2																	
Jennifer Creek			Avg	14.7	13.6																	
			Max	16.3	14.2																	
Stream		**North Fork Fuller Creek**																				
619	NFU	0.02	Avg	21.7	17.9																	
			Max	23.2	19.6																	

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates		
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness Simpson	Hilsenhoff Russian R Index	% Dominant
665	NFu2	1.14		Avg	18.1	16.3																
			Max		18.1	16.3																
North Fork Fuller Creek				Avg	21.3	17.7																
			Max		23.2	19.6																
Stream			Palchett Creek																			
901	97-3	0.08		Avg	15.7	14.5																
			Max		15.7	14.5																
Palchett Creek				Avg	15.7	14.5																
			Max		15.7	14.5																
Stream			Redwood Creek																			
704	Rdw1	0.38		Avg	20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52			30	4.2	25
			Max		20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52			30	4.2	25
Redwood Creek				Avg	20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52			30	4.2	25
			Max		20.6	19.7	5,409	146		26	6.90%	20		79%	97%	125	52			30	4.2	25
Stream			South Fork Fuller Creek																			
618	SFU	0.02		Avg	21.4	18.4																
			Max		23.2	20.1																
662	SFu2	1.52		Avg	21.8	18.4																
			Max		21.8	18.4																
663	SFu1	2.65		Avg	15.2	14.2	4,280	59		61	2.05%	24				129	44			32	3.2	26
			Max		15.2	14.2	4,280	59		61	2.05%	24				129	44			32	3.2	26
South Fork Fuller Creek				Avg	20.8	17.9	4,280	59		61	2.05%	24				129	44			32	3.2	26
			Max		23.2	20.1	4,280	59		61	2.05%	24				129	44			32	3.2	26
Stream			Tombs Creek																			
656		0.09		Avg	26.0	20.4																
			Max		26.0	20.4																
Tombs Creek				Avg	26.0	20.4																
			Max		26.0	20.4																
Stream			Wheatfield Fork Gualala River																			
707	WFG	0.00		Avg	26.6	22.7																
			Max		28.7	23.4																
708	WFG	0.00		Avg	26.2	22.3																
			Max		29.5	24.3																

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant	Russian R Index	
226	Wfg3	0.42	Avg	23.5	20.6	1,592	23	21	0.08%	25	0.05	84%	27%	158	101	0	340	32	0.85	4.3	15	32
			Max	25.5	21.9	1,828	29	27	0.08%	29	0.05	86%	40%	158	101	0	981	32	0.85	4.3	15	32
29	62	0.69	Avg						0.15%	22												
			Max						0.15%	22												
32	WFGr	0.69	Avg						0.15%	21												
			Max						0.15%	21												
30	70	0.99	Avg						0.14%	19												
			Max						0.14%	19												
227	Wfg2	2.69	Avg	24.7	21.5											0	286					
			Max	25.3	22.2											0	286					
403	WFG1	5.28	Avg	26.4	22.9																	
			Max	26.4	22.9																	
273	WFG	5.45	Avg	26.4	22.0																	
			Max	26.4	22.0																	
603	WFG	7.29	Avg	24.0	21.6																	
			Max	24.0	21.6																	
612	WFG	7.58	Avg	25.6	22.4																	
			Max	25.6	22.4																	
620	WFG4	8.90	Avg	26.4	22.6																	
			Max	27.8	23.1																	
651	WFG6	22.73	Avg	24.4	21.7	10	1	49	0.63%	38		66%	18%	82	40			24		4.0		20
			Max	27.0	23.5	10	1	49	0.63%	38		66%	18%	82	40			24		4.0		20
652	WFG7	23.11	Avg	26.5	23.3	107	1	22	0.55%	26		87%	63%	188	44			29		3.7		24
			Max	27.9	25.8	107	1	22	0.55%	26		87%	63%	188	44			29		3.7		24
Wheatfield Fork Gualala Rive			Avg	25.4	22.0	979	14	27	0.25%	25	0.05	80%	34%	143	62	0	329	28	0.85	4.0	15	25
			Max	29.5	25.8	1,828	29	49	0.63%	38	0.05	87%	63%	188	101	0	981	32	0.85	4.3	15	32
Hydrologic Unit Wheatfield			Avg	22.5	19.3	2,083	39	32	1.19%	24	0.05	80%	46%	136	56	0	329	29	0.85	3.9	15	25

Hydrologic Unit SF Gualala

Stream Big Pepperwood

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant	Russian R Index	
218	Ppw3	0.15	Avg	16.1	14.6	7,544	152	34	1.46%	15	-1.0	92%	87%	455	72	0	64	32	0.79	4.7	15	39
			Max	17.3	15.6	10,382	200	45	1.56%	17	-0.3	96%	88%	563	87	0	153	32	0.79	4.7	15	39
219	Ppw2	1.29	Avg	16.6	14.6																	
			Max	17.8	15.0																	
248	PPW	1.33	Avg	17.2	14.6																	
			Max	17.2	14.6																	
Big Pepperwood			Avg	16.3	14.6	7,544	152	34	1.46%	15	-1.0	92%	87%	455	72	0	64	32	0.79	4.7	15	39
			Max	17.8	15.6	10,382	200	45	1.56%	17	-0.3	96%	88%	563	87	0	153	32	0.79	4.7	15	39
Stream		Camper Creek																				
699	Cmp	0.00	Avg	17.9	16.4																	
			Max	17.9	16.5																	
Camper Creek			Avg	17.9	16.4																	
			Max	17.9	16.5																	
Stream		Carson Cr																				
605	Car	0.00	Avg	17.4	16.2																	
			Max	18.1	16.8																	
631	Car1	0.00	Avg			2,724	39	39	1.45%	42		88%	98%	143	106							
			Max			2,724	39	39	1.45%	42		88%	98%	143	106							
Carson Cr			Avg	17.4	16.2	2,724	39	39	1.45%	42		88%	98%	143	106							
			Max	18.1	16.8	2,724	39	39	1.45%	42		88%	98%	143	106							
Stream		Groshong Gulch																				
250	Gros	0.05	Avg	15.1	13.2																	
			Max	16.2	13.3																	
277	GrG	0.27	Avg	15.8	14.0																	
			Max	17.8	14.5																	
Groshong Gulch			Avg	15.5	13.6																	
			Max	17.8	14.5																	
Stream		Gualala River																				
614	Gua8	0.00	Avg	22.3	18.2																	
			Max	22.9	18.4																	
750		1.19	Avg	22.5	19.2																	
			Max	22.5	19.2																	

Station		Miles	Year		Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate		Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
					Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff	% Dominant	Simpson	Russian R Index
751		1.52		Avg																				
			Max																					
Gualala River				Avg	22.3	18.6																		
			Max		22.9	19.2																		
Stream			Little Pepperwood																					
220	Lpw	0.11		Avg	16.2	14.8												0	65					
			Max		19.4	16.0												0	121					
Little Pepperwood				Avg	16.2	14.8												0	65					
			Max		19.4	16.0												0	121					
Stream			Marshall Creek																					
607	Mar	0.00		Avg	22.5	19.7																		
			Max		22.5	19.7																		
Marshall Creek				Avg	22.5	19.7																		
			Max		22.5	19.7																		
Stream			McKenzie Creek																					
615	McK1	0.00		Avg	19.1	16.9	997	8		38	1.24%	27		95%	95%	262	133							
			Max		20.6	17.8	997	8		38	1.24%	27		95%	95%	262	133							
617	McK1	0.00		Avg	20.1	18.0																		
			Max		20.7	18.7																		
McKenzie Creek				Avg	19.7	17.5	997	8		38	1.24%	27		95%	95%	262	133							
			Max		20.7	18.7	997	8		38	1.24%	27		95%	95%	262	133							
Stream			Palmer Creek																					
621	Plm	0.00		Avg	21.3	18.2																		
			Max		23.6	19.3																		
Palmer Creek				Avg	21.3	18.2																		
			Max		23.6	19.3																		
Stream			South Fork Gualala River																					
217	Gua1	0.98		Avg	23.8	19.9	1,149	24		19	0.09%	23	-0.03	95%	17%	239	90	0	72	28	0.87	4.4	16	28
			Max		25.3	22.4	1,639	34		25	0.13%	27	0.19	96%	17%	239	90	0	166	28	0.87	4.4	16	28
225	SFG	4.36		Avg	23.4	20.7																		
			Max		24.8	20.8																		
16	280	5.13		Avg							0.10%	22												
			Max								0.10%	22												

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	% Dominant	Russian R Index	
19 SFGr	5.13	Avg							0.13%	28												
		Max							0.13%	28												
17 295	5.25	Avg							0.18%	25												
		Max							0.18%	25												
18 310	5.67	Avg							0.23%	32												
		Max							0.23%	32												
20 370	6.77	Avg							0.31%	20												
		Max							0.31%	20												
229 SFG	7.39	Avg	23.7	19.8																		
		Max	25.6	20.5																		
402 SFG	7.77	Avg	22.2	19.3	1,432	32		19	0.37%	30	-0.1	76%	26%	197	108	0	539					
		Max	22.4	19.7	1,473	33		19	0.41%	31	-0.1	76%	26%	197	108	0	1,327					
230 SFG	9.32	Avg	22.5	19.3																		
		Max	24.4	22.3																		
616 SFG4	33.52	Avg	19.3	16.9																		
		Max	19.8	17.4																		
South Fork Gualala River		Avg	22.5	19.2	1,196	26		19	0.16%	25	-0.04	88%	20%	218	99	0	287	28	0.87	4.4	16	28
		Max	25.6	22.4	1,639	34		25	0.41%	32	0.19	96%	26%	239	108	0	1,327	28	0.87	4.4	16	28
Stream		**Wild Hog Creek**																				
604 Whg	0.00	Avg	16.4	15.9																		
		Max	17.9	17.2																		
Wild Hog Creek		Avg	16.4	15.9																		
		Max	17.9	17.2																		
Hydrologic Unit SF Gualala		Avg	19.2	16.8	3,897	78		27	0.71%	22	-0.5	90%	64%	292	97	0	190	30	0.83	4.6	16	33
Hydrologic Unit			**Coastal Gualala**																			
Stream		**Russian Gulch**																				
471 RuG1	0.61	Avg	19.5	15.3	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
		Max	21.6	15.8	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
Russian Gulch		Avg	19.5	15.3	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
		Max	21.6	15.8	8,615	169			0.85%	38		77%	40%	153	44			27	0.81	4.9	11	38
Stream		**Salal Creek**																				

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt		Substrate	Streambed				Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Simpson	Hilsenhoff	Russian R Index	% Dominant
470	Sal1	0.76	Avg	14.5	13.4	2,048	127	9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
			Max	15.3	13.5	2,048	127	9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
Salal Creek			Avg	14.5	13.4	2,048	127	9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
			Max	15.3	13.5	2,048	127	9	4.69%	11		87%	89%	158	92			33	0.86	2.9	20	29
Stream		School House Creek																				
472	ScH	0.27	Avg			829	66	0	5.86%	54		97%	97%	474	93							
			Max			829	66	0	5.86%	54		97%	97%	474	93							
School House Creek			Avg			829	66	0	5.86%	54		97%	97%	474	93							
			Max			829	66	0	5.86%	54		97%	97%	474	93							
Hydrologic Unit Coastal Gual			Avg	17.0	14.4	3,830	121	5	3.80%	34		87%	75%	261	76			30	0.83	3.9	16	33
Hydrologic Unit			Russian Estuary																			
Stream		Jenner Gulch																				
407	Jen1	0.61	Avg	16.2	14.1	2,124	71	20	3.26%	40		87%	88%					40	0.90	4.2	22	26
			Max	18.0	14.4	2,124	71	20	3.26%	40		87%	88%					40	0.90	4.2	22	26
Jenner Gulch			Avg	16.2	14.1	2,124	71	20	3.26%	40		87%	88%					40	0.90	4.2	22	26
			Max	18.0	14.4	2,124	71	20	3.26%	40		87%	88%					40	0.90	4.2	22	26
Hydrologic Unit Russian Estu			Avg	16.2	14.1	2,124	71	20	3.26%	40		87%	88%					40	0.90	4.2	22	26

Station	Miles	Year	Temperature		LWD Bank Full > 6 " > 4 ' or > 10 CuFt			Substrate	Streambed			Riparian Zone				Fish per Mile		Macroinvertebrates				
			Seasonal Maximum	MWAT	CuFt/ 1000'	Pieces/ 1000'	< 0.85 mm	D50	Slope	VI	A/D	Canopy % WLPZ	Canopy % Cr.	Basal Area	Tree Ht.	Coho	SH (1+)	Richness	Hilsenhoff Simpson	Hilsenhoff Russian R	% Dominant Index	% Dominant
		Avg	19.8	17.3	3,595	72	17.6%	33	1.05%	28	-0.4	81%	67%	233	78	1	262	31	0.85	4.0	18	29
		Min	13.7	12.9	10	1	4.5%	0	0.03%	10	-1.3	12%	11%	76	40	0	0	24	0.79	2.9	11	18
		Max	29.5	25.8	10,382	200	48.3%	71	6.90%	89	0.54	100%	98%	563	133	32	1,552	41	0.92	4.9	22	41
Old Growth Watersheds (HRSP)			18.5	16.6			21.6%	62										26.2	0.89			
Poor-Normal-Good										>20								26-35	.8-.89	4.6-3.1	12-17	39-15
NCWQCB Target			18.3	16.8			<14%															

Temperature

- Seasonal Maximum – The highest water temperature recorded during the summer.
- Maximum weekly average temperature (MWAT) - The highest average temperature for any seven day rolling average

Large Woody Debris (LWD)

- LWD must be at least 6 inches on the small end and longer than 4 feet.
- Cubic Feet per 1,000 feet – The cubic volume of LWD located between the bankfull lines.
- Pieces per 1,000' – The number of LWD pieces per 1000'

Stream Substrate

- <0.85mm – The percent fines less than 0.85 millimeters in a McNeal sample.
- D50- The pebble size of the median pebble of a 100 pebble sample. Three sample sites on each reach are averaged.

Fish Surveys

- Presence/absence snorkel surveys were conducted. Rough estimates were made of fish numbers per mile.
- Coho – Coho salmon any age.
- SH (1+) – Steelhead one year old or older.

Streambed (Thalweg) Survey

- Slope – the slope of the channel
- VI – The variation index is the [(SD of residual depth/bank full depth) *100]. This is a way of quantifying roughness and hence suitability for fish. Greater than 20 is a good indication of recovery.
- A/D – The change in elevation of the channel (aggradation or degradation) relative to the first year of measurement.

Riparian Condition

- Canopy Cover percent as measured with a spherical densiometer. Every 200', canopy percent is measured in the center of the channel. And at bank full and 50' into the riparian zone from bankfull on both sides of the channel. Four measurements are averaged at each point.
- WLPZ (Watercourse and Lake Protection Zone) – The average of all the measurements taken on either side of the channel 50' into the riparial zone.
- Cr. – The average of all the measurements taken in the center of the channel.
- Riparian inventory plots were locate both sides of the channel every 200'
- Basal Area – Is the average basal area in square feet of all the riparian plots
- Tree Ht. – Is the average height of the 100 tallest trees per acre.

Macroinvertebrates

- Richness – Total number of Genuses represented.
- Simpson Diversity Index – Measures the evenness of species diversity
- Hilsenhoff – This is a locally modified Hilsenhoff index. It indicates levels of organic pollution
- Russian River Index – A localized index that combines several standard metrics
- Percent Dominant Taxon – this is a species distribution index

GUALALA RIVER WATERSHED COUNCIL

Quality Assurance Project Plan
For
Monitoring Sediment Reduction

Revised Version for Proposition 50

QUALITY ASSURANCE PROJECT PLAN FOR MONITORING SEDIMENT REDUCTION IN THE GUALALA RIVER WATERSHED

Prepared for:
California State Water Resources Control Board
and
California North Coast Regional Water Quality Control Board

By
Kerry Williams, Sotoyome Resource Conservation District
Kathleen Morgan, Gualala River Watershed Council
December 2002

A. PROJECT MANAGEMENT

1. Title Page and Approvals

QUALITY ASSURANCE PLAN FOR MONITORING SEDIMENT REDUCTION IN THE GUALALA RIVER WATERSHED

This Document was compiled by:
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Approvals:

North Coast Regional Water Quality Control Board

By: Peter Otis Date: December 4, 2002
Environmental Planner
Quality Assurance Manager

AA. Revisions Page and Approvals

I. Table 7.1: Total Suspended Solids has been revised 4/1/08 to the following:

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Total Suspended Solids (TSS)	Residue, Non-Filterable (EPA Method 160.2)	mg/l	4	NA	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	80%

II. Section 5, page 21, paragraph 5 has been revised 4/1/08 to the following:

If data do not meet the project's specifications (see Table 7.2 –error tolerance), the following actions will be taken. First, the technical advisors will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. If the problem cannot be corrected by re-training, revision of techniques, or replacement of supplies/equipment, then the technical advisors and the TAC will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, the parameter should be eliminated from the monitoring program.

Approval:

_____ 4/1/08
Kathleen Morgan Date
GRWC CQAO
GRWC Contract Manager

_____ _____ _____ _____
SWRCB QAO Date SWRCB Contract Manager Date

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3. Distribution List

Primary distribution list for the Gualala River Watershed Monitoring Program Quality Assurance Plan:

NAME	AGENCY/ORGANIZATION
Lauren Clyde	North Coast Regional Water Quality Control Board
Bill Cox & Doug Albin	California Department of Fish & Game
Matt O'Connor	O'Connor Environmental, Inc.
Steering Committee	Gualala River Watershed Council
Technical Advisory Committee	Gualala River Watershed Council
Field Team Leaders	Gualala River Watershed Council

Once approved, this Quality Assurance Project Plan (QAPP) will be available to any interested party by requesting a copy from the Sotoyome Resource Conservation District (SRCD) (see address on title page).

4. Project/Task Organization

The members of the Gualala River Watershed Council (GRWC) in partnership with the SRCD are implementing the Gualala River Watershed Monitoring Program. The GRWC is an association of stakeholders in the Gualala River watershed. These stakeholders include any persons and/or entities that live within, own property within, use water from, operate commercial businesses within or are affected by land uses within the Gualala River Watershed. There is also consistent participation by representatives of local, state and federal agencies.

Formation of the GRWC in 1997 was facilitated by the North Coast Regional Water Quality Control Board (NCRWQCB), the California Department of Forestry (CDF), the Redwood Coast Land Conservancy (RCLC) and with ongoing support from the SRCD.

The development of a Gualala River Watershed Monitoring Program with a QAPP is part of the ongoing development of a watershed enhancement plan for the Gualala River watershed. This program is currently being funded by grants from the State Water Resource Control Board (State WRCB) 319(h) program and the California Department of Fish and Game (CDFG) SB271 program.

The GRWC monitoring program is managed by the SRCD with program over site and coordination by the GRWC Steering Committee, and Matt O'Connor, O'Connor Environmental, Inc.

The following personnel and subcontractors will perform sample collection and analysis:

- Trained GRWC citizen volunteers
- Trained GRWC supervising staff

- O'Connor Environmental, Inc.
- Forest Science Project
- Macroinvertebrate Lab

The Sediment Reduction in the Gualala River Watershed Monitoring 319(h) Project is a multi-organization project. Consultants and volunteer citizen monitors and staff from Gualala Redwoods, Inc. (GRI) will work together to monitor and assess natural streams in the Gualala River watershed at monitoring sites selected as outlined in the scope of work for the project. The results of this monitoring shall be reviewed during periodic technical advisory committee (TAC) meetings. In addition, any problems, concerns, and/or proposed amendments to this QAPP will also be reviewed and discussed by the TAC.

The following is a list of key personnel and their project responsibilities.

TASK	**KEY PERSONNEL**
Contract Manager	Lauren Clyde, North Coast RWQCB
Project Director	Kerry Williams, Sotoyome RCD
Coordinator for Field Teams & TAC	Kathleen Morgan, GRWC
Equipment Supply, Calibration	Nola Craig, DFG Staff, SRCD Staff, GRI Staff, Kathleen Morgan, Matt O'Connor, GRWC volunteers
Field Data Collection	Nola Craig, DFG Staff, SRCD Staff, GRI Staff, Kathleen Morgan, Matt O'Connor, GRWC volunteers
Data Management	Matt O'Connor, Kathleen Morgan, Kerry Williams, SRCD Staff, GRI staff
Quality Assurance/Quality Control	Matt O'Connor, GRWC Team Leaders
Technical Advisors	Matt O'Connor, agency members of TAC

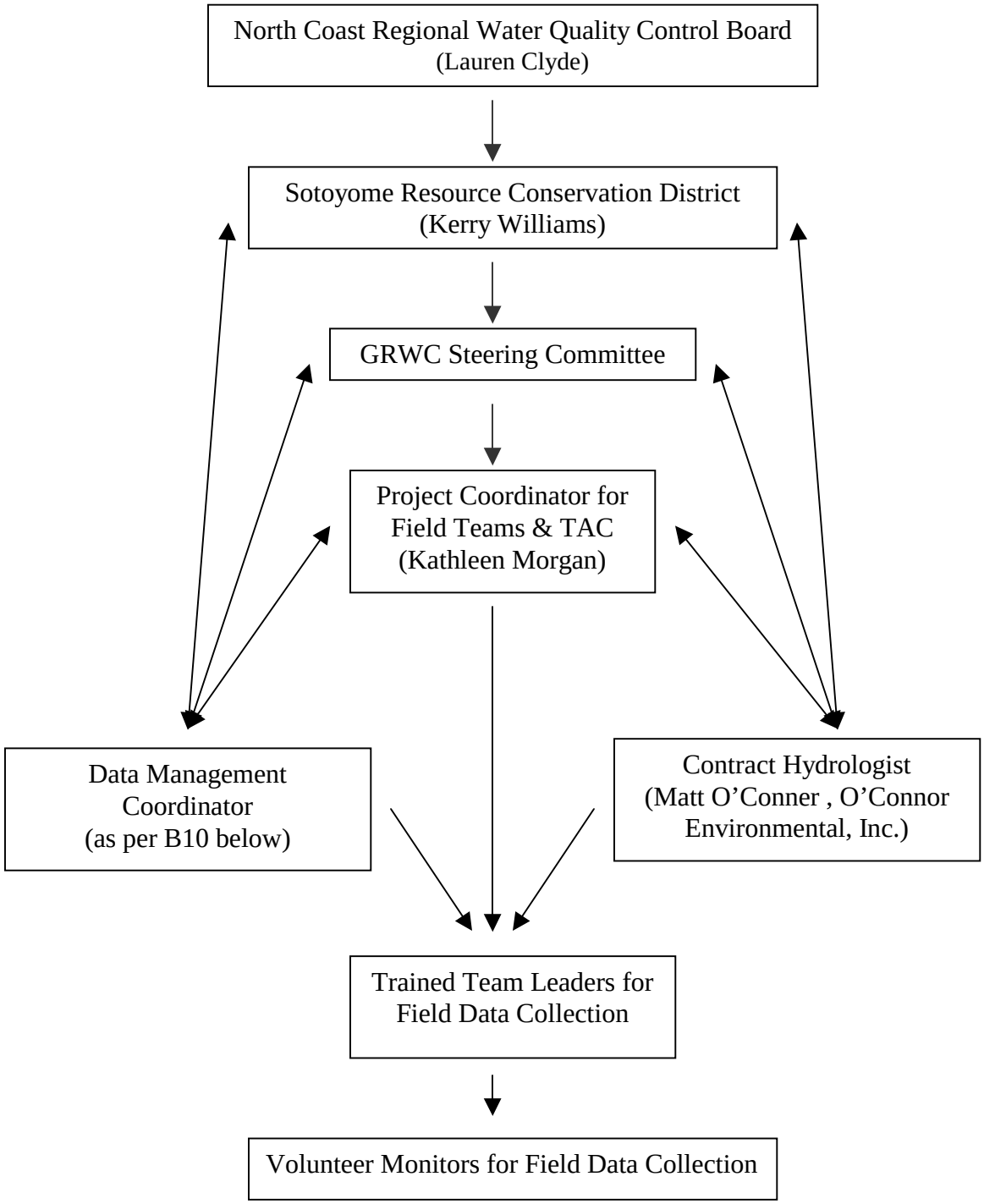
The organizational structure of the GRWC monitoring program is illustrated in Figure A-1.

5. Problem Definition/Background

Land use practices, combined with erosive landscape characteristics have accelerated the rate of erosion and mass wasting, and contributed to sedimentation in the Gualala River and its tributaries. Sedimentation is a result of a variety of natural and anthropogenic factors, including mass wasting, roads, and surface erosion. Sedimentation is believed to be a major contributing factor to the decline of historic runs of salmon and steelhead..

There is insufficient information to adequately assess the status of aquatic resources in the Gualala River watershed. The GRWC was formed in order to address watershed conditions and activities, including water quality concerns within the watershed. There are also small citizen monitoring groups forming to conduct monitoring in the various areas of the watershed and some private landowners have been conducting monitoring for several years. If quality assurance is adequate, valuable information will be provided for watershed management. One of the primary tasks of the GRWC is to design and implement a monitoring program for the watershed. A TAC has been formed to advise on this task.

Figure A-1 Organizational structure of the GRWC monitoring program.



6. Project/Task Description

This project will supplement existing agency information by monitoring streams in the Gualala River watershed. The focus of the project is on physical aquatic habitat and physical and biological water quality measures that will assist in identifying the status of these aquatic resources. Analysis, for the most part, will be conducted in the field with test kits and field instruments.

The objective of this project is to improve water quality through collaboration between public agencies, community groups, and private landowners. The project involves a three-year incremental process to implement non-point source controls, emphasizing on road improvements and to develop a mechanism for further assessments and implementation for reducing sedimentation in the watershed. The assessment and implementation will be aimed at improving water quality by reducing up-slope erosion impacts to the aquatic resources, improving the riparian zone, and enhancing anadromous salmonid habitat in the tributaries and main stem of the Gualala River watershed.

A map of the Gualala River watershed is attached as Appendix A.

The GRWC monitoring groups will be monitoring water quality in Gualala River watershed. Physical and biological parameters are measured; however, not all groups are measuring all parameters. Table 6.1 identifies the type and frequency of the monitoring parameters.

This QAPP addresses data quality objectives for the following parameters:

- Temperature
- Longitudinal Profiles & Benchmarks
- Cross-section Measurements
- Pebble Counts
- Large Woody Debris
- Canopy and Riparian Measurements
- Benthic Macroinvertebrate
- Streamflow, Turbidity and Total Suspended Solids

Table 6.1 Type and Frequency of Monitoring in the Sediment Reduction in the Gualala River Watershed Monitoring Program

Parameter	Maximum Frequency	Time of Year
Temperature	A	Summer
Longitudinal Profiles & Benchmarks	B	Summer
Cross-sections	B	Summer
Pebble Counts	B	Summer
Large Wood Debris	B	Summer
Canopy & Riparian Measurements	B	6/1-8/31
Benthic Macroinvertebrates	B	Fall
Stream Flow, Turbidity & Total Suspended Solids (Optional monitoring element)	C	Winter/Spring

Frequency: A: Annual B: Annual or less frequently depending on objectives C: Seasonal, frequency depending on objectives and flow conditions

7. Quality Objectives and Criteria

Table 7.1 Data Quality Objectives for Conventional Water Quality Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Temperature	Thermometer (-5 to 50)	^{o}C	-5	0.5 ^{o}C	± 10%	± 10%	80%
Turbidity	Tubes (5 -)	JTUs	< 5	5 JTUs	± 5 JTUs	NA	80%
Total Suspended Solids (TSS)	Refer to page ia for revisions						

NA: not applicable

Table 7.2 Data Quality Objectives for Physical Aquatic Habitat Parameters

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Large woody debris survey	1 year maximum and after major events.	Stream reaches of 1000 ft or 20 bankfull widths, whichever is more.	All LWD > 6 in. diameter and > 4 ft length within the bankfull channel; locate position of LWD in the long-profile.	Length +/- 1 ft per 5 ft, Diameter +/- 2 in. per 6 in., Root wad dimensions +/- 1 ft per 2 ft of size. Distance from start point (long profile survey) +/- 3 ft to center point of log.	Notes on how to locate beginning and ending points of reach, associated long-profile data, associated cross-section data.	Measurement techniques, how to handle odd LWD shapes, how to estimate jam volumes when all pieces are not visible.
Longitudinal channel profile	1 year maximum and after major events.	Stream reaches of 1000 ft or 20 bankfull widths, which ever is more. Thalweg elevation minimum of 10 ft intervals.	The most important features to measure are: riffle crests, breaks in slope and deep points of pools. Measure elevation (± 0.02 ft) whenever the channel bed changes slope and at least every 15 ft where the slope is relatively uniform (e.g. a long run, riffle or pool).	Elevation +/- 0.02 ft; distance (± 3 ft) from start point and left right offset (± 4ft). Elevation closure within 0.01 ft for each benchmark, each turning point, and each 500 linear feet of distance.	Notes on how to locate beginning and end points of reach, associated cross-section data, pebble count data, photo-documentation of stream channel and benchmarks.	Surveying techniques, site selection.
Cross-sections	1 year maximum and after major events.	3 per 1000 ft reach are conventional; sites initially selected are likely spawning sites defined as riffles located at pool tails.	Elevation observations at inflections points with at least one intervening point between breaks in slope. The most important features to measure are: breaks in slope, bankfull, wetted width and thalweg. Average spacing between observations equivalent to < 5% of bankfull width.	Elevation closure within 0.01 ft for each benchmark, each turning point, and each 500 linear feet of distance.	Notes on how to locate beginning and ending points of cross-section, associated long-profile data, pebble count data, and photo-documentation of stream channel.	Surveying techniques, site selection.

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Pebble count (Wolman 1954) (as specified for GRWC) Refer to Appendix F	1 year maximum and after major events.	4 per 1000 ft reach are conventional; sites initially selected are likely spawning sites defined as riffles located at pool tails.	100 measurements in a random walk on the riffle surface from upstream to downstream, collecting a pebble diameter at 3 ft intervals (about one stride by the observer). Lateral extent of observation area defined by active bed deposits lacking significant vegetation or leaf litter.	Individual pebbles to +/- 1mm	Location within long profile and associated cross-section stations and reach end point.	Measurement techniques and data recording.
Riparian Canopy Closure	1 year at time of installation of the temperature data logger.	Thermal reaches of a 1000 to 2000 feet above data logger installation site.	Using a spherical densiometer adapted to the Strickler method (1959). From center of channel take measurements at 100 ft. intervals along the thermal reach.	+/- 2 intersections in the field of view	Notes on how to locate beginning and ending points of a thermal reach and center of channel, associated Forest Science protocols.	Measurement technique and data recording.
Riparian Canopy Density	1 year maximum and after major events.	In stream channel and riparian forest stand plots located at 200 ft intervals along monitoring reach.	Using a spherical densiometer, measure the percentage of overhead canopy density at 5 locations along a transect perpendicular to the stream channel: center of channel, at the left and right edge of the bankfull channel, and at 50ft beyond the bankfull channel edge in the riparian zone.	+/- 2 squares in the field of view i.e. +/- < 10%	Notes on how to locate beginning and ending points of reach, associated long-profile data, reference to associated riparian stand inventory plots.	Measurement technique, sampling rules regarding non-standard situations (e.g. what is done if the 50 ft distance ends on a road, or a very steep slope that cannot be negotiated?).

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Riparian forest stand inventory	1 year maximum and after major events.	Sample of trees and downed logs within a 100 ft long, 21.8 ft wide (20th acre) rectangular plot and understory in a 100th acre sub-plot in riparian forest stands located at 200 ft intervals along monitoring reach.	Measure height and live crown % and distance of the first 3 conifer trees > 5.6 in DBH from the origin of the plot centerline. Estimate DBH and measure distance of all remaining tree species >5.6 in DBH. The diameter of all down logs that intersect the 100 ft centerline of the plot is also measured. A 100th acre lesser vegetation sub-plot is established 15 ft from bankfull. The plot is established and monumented with rebar at the edge of the bankfull channel and the 100 ft end point.	Length/Height +/- 1 ft. Diameter +/- 1 in. Distance from plot start point +/- 1 ft	Notes on how to locate beginning and ending points of plot, adjust 100 ft measurement for slope, associated long-profile data, reference to associated riparian canopy data.	Measurement techniques and sampling rules for non-standard situations (e.g. what is done if the 100 ft distance ends on a road? or a very steep slope that cannot be negotiated?).
Turbidity	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	NTU's, see Table 7.1	See Table 1, +/- 10%	Manufacturer's instruction manuals.	Training of monitoring team leaders; QA/QC on data and instrument logs
Stream Discharge	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	cubic feet per second (cfs)	+/- 10%	US Geologicial Survey WRI Report 00-4036, ver. 1.1 (CD-ROM interactive training manual)	Training of monitoring team leaders; QA/QC on data and instrument logs

Table 7.2 continued…

Parameter	Time scale	Spatial scale	Endpoints/units	Tolerated error	Supporting documentation	Prep by professionals
Total Suspended Solids	Instantaneous during periods of storm runoff	Designated cross-section locations within larger monitoring sites	Sample collected using a depth-integrated sampler; sample represents verticle spatial average concentration of solids in the water column; optimal sample is in or near channel thalweg as flow conditions permit; number of samples likely to be limited by funds available for lab processing; intended for correlation with turbidity data and stream discharge collected at the same site and time	See Table 1, +/- 10%	Manufacturer's instruction manual for use of depth integrated sampler (equivalent to USGS DH-48 sampler)	Training of monitoring team leaders; QA/QC on data and instrument logs

Benchmarks for each parameter are addressed separately

Table 7.3 Data Quality Objectives for Biological Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity*	Precision	Accuracy	Completeness
Benthic Macro-invertebrates	Calif. Stream Bioassessment Protocol (CDFG)	N/A	Family level	N/A	$\leq$ 5% difference	$\leq$ 5% difference	80%

8. Special Training/Certification

The Gualala River Watershed Coordinator, members of the GRWC, employees of SRCD, employees of Gualala Redwoods, Inc. and volunteers from the community will collect data at selected sites in the watershed and will receive training in techniques used to evaluate general watershed condition. All protocols and example data collection sheets are attached in the Appendices and source documentation is identified in the protocols themselves.

The data will be made available to the public to use for educational and informational purposes. It is hoped that information gained from the ongoing volunteer monitoring program will lead to land management decisions that consider the health of the watershed.

All citizen-monitoring leaders must participate in three hands-on training sessions related to water quality and channel monitoring conducted by either GRWC or a comparable entity and approved by the SRCD and RWCQB. Training sessions will be held in the Gualala River watershed. Certificates of completion will be provided once all training as been completed. The following topics will be covered under this training:

- General hydrology
- Ecology
- Health and Safety
- Quality Assurance and Quality Control (QA/QC) Measures
- Sampling Procedures
- Field Analytical Techniques
- Data recording

The trainer will ensure that volunteer citizen monitoring leaders are reading instruments and recording results correctly. Individual trainees are evaluated by their performance of analytical and sampling techniques, by comparing their results to known values, and to results obtained by trainers and other trainees. Sampling and safety techniques will also be evaluated. The trainer will discuss corrective action measures with the volunteers, and the date by which the action will be taken. The citizen-monitoring leader is responsible for reporting back if any corrective action is taken. Certificates of completion will be provided once all training has been completed.

To be certified for macroinvertebrate bioassessment citizen monitoring leaders must also participate in a three-day training course provided by the CDFG, the Sustainable Lands Stewardship Institute, the American Fisheries Society, or the State WRCB.

9. Documents and Records

All field results will be recorded at the time of completion in the field, using the data sheets (data sheets are included with each individual protocol in the appendices B through H) and field logbooks. Each monitoring group will also keep and record information in the instrument maintenance logs.

Data sheets will be reviewed for outliers and omissions before leaving the sample site at the completion of each data collection. Data sheets will be signed after review by a team-monitoring leader. Data sheets will be turned in to data headquarters within one week of actual data collection. Data headquarters will be either the SRCD office or.(we need to choose another alternate location in Gualala area)The monitoring coordinator's house. Copies of all data sheets will be made immediately upon receipt at data headquarters. Original copies will be stored in an "original binder" and copies will be put into a "working binder." Copies of all information in the field logbooks will be made and inserted into the working copy binder. Entry of all data will be made into a computer database within three months of data collection. computer backup copies will be made on a quarterly basis and will be made and held at data headquarters. All data entry and other tasks involving data sheets will utilize the working binder. The original binder shall be used as a reference only. Field sheets are archived for three years from the time they were collected.

Instrument maintenance logs will also be kept by each citizen-monitoring group for each instrument in use. These include HOBO temperature units. The instrument logs detail the dates of equipment inspection and calibrations, as well as the dates reagents are replaced. The logs will be returned to the team-monitoring leader following each monitoring event, in case a review is necessary. Instrument logs will be turned in with data sheets and photocopies will be placed in the working binder.

A field site log pertaining to the location, including maps, specific directions to locating sample sites in the field, photographs, and site characteristics (including site selection criteria particular to each site) will be maintained at headquarters and updated annually. Within one week after each site visit, copies of the field log will be made and inserted in the working binder. Once field logs are full, the original will be kept at data headquarters along with other original documentation.

The Monitoring Program Coordinator and scientific members of the Technical Advisory Committee will complete an annual audit of data sheets and instrument logs.

B. DATA GENERATION AND AQUISITION

1. Sampling Process Design

Up to 30 sampling sites will be selected as part of this program with the GRWC and TAC participation. The following criteria will be evaluated when choosing sampling locations:

- sample can be taken in main river current or where homogeneous mixing of water occurs (pertains to temperature and turbidity measurements);
- sample is representative of the part of the river of interest which may include sampling related to implementation projects;
- location complements or supplements historical data;
- location represents a stream reach that possesses typical representative value for fish and wildlife or recreational use.

Additional criteria that will help determine the location of sampling sites includes:

- access (convenience in terms of time and effort);
- safety (access and specific site conditions anticipated during periods of field data collection);
- permission to cross private property (access agreement).

The monitoring program, as outlined in task 4 of the 319h contract, requires reference sites to assess the effectiveness of implementation projects. These locations will be chosen upstream and downstream of any potential impact, and upstream and downstream of any secondary discharge or disturbance.

Prior to final site selection, permission to access the stream is obtained from all property owners. If access to the site is a problem, the citizen-monitoring leader will select an alternate site. Safety issues will be included in the Gualala River Watershed Monitoring Manual.

The group leader will review sample sites. Relevant site characteristics will be observed and recorded on the field data forms and logs.

Data pertaining to date and time of sampling and weather conditions will be transcribed to the field data log (described in A9 above). A catalog of site photographs will be maintained as part of the field data log. See tables 6.1, 7.1, 7.2, 7.3.

2. Sampling Methods

Field Observations

Sampling Site Observations

Site condition observations will include pertinent detail about the location of the site, access, special considerations, photos obtained, and sampling point location(s), as well as climatic and hydrologic variables. These observations will be documented in a waterproof field data log as well as on data collection sheets (referred to in A9) to maintain standardization of information, and ensure all variables are recorded. All forms for data collection will be included in the appendices for each individual protocol. The field data pertaining to site conditions will be transcribed to the field data log (see A9).

Automated Sample Collection

Data loggers are effective in collecting physical-chemical measurements on short time intervals over many days without constant staff oversight. Data are stored on internal memory chips and downloaded to a computer in the field or office for further data analysis. The only protocol utilizing automated sample collection in this QAPP is temperature.

Temperature

Temperature loggers manufactured by Onset® Corp., will be programmed to sample at least every 96-minutes. With 8K of internal memory, a full summer of data can be collected. Additionally, the 96-minute sampling interval is the minimum specified in the cooperative effort developed by the Forest Science Project (FSP 1998) to detect daily maxima (Appendix B).

Basic considerations for site selection are presented in the modified protocol. The primary use of the data at this point is for characterizing a stream reach, so placement is in a well-mixed, flowing section of the stream that is representative of a reach.

A thermal reach is a reach with similar (relatively homogenous) riparian and channel conditions for a sufficient distance to allow the stream to reach equilibrium with those conditions. The length of reach required to reach equilibrium will depend on stream size (especially water depth) and morphology (TFW, 1993). A deep, slow moving stream responds more slowly to heat inputs and requires a longer thermal reach, while a shallow, faster moving stream will generally respond faster to changing riparian conditions, indicating a shorter thermal reach. Generally, it takes about 1000 feet of similar riparian and channel conditions to establish equilibrium with those conditions in fish-bearing streams.

Data sheets for calibration, deployment, and site conditions accompany the data for each deployment and are provided in Appendix B. Raw field data is delivered to the Forest Science Project (FSP) for processing and analysis according to FSP protocols. The processed temperature data is then returned to the GRWC in both raw and analyzed form.

Channel Measurements

Stream channels form and are maintained by the interaction of streamflow and sediment regimes in a process that yields consistent average channel shape and size (Dunne and Leopold 1978). A reach is a section of a stream at least 20 times longer than its average channel width (Flosi and Reynolds, 1994) that maintains relatively homogenous channel morphology, flow, and physical, chemical, and biological characteristics.

The width and depth of a channel reflects the discharge and sediment load the channel receives, and must convey, from its drainage area. Channels are formed during peak flow events, and channel dimensions typically reflect hydraulic conditions during bankfull (channel-forming) flows.

Channel form and composition is monitored at low water. The monitoring is done within a section of a stream called a study reach. All locations for study reaches will be selected, reconnoitered with respect to reach criteria described above, and flagged by GRWC Technical Committee Members (TAC) and/or Technical Advisors before the sites are assigned to be surveyed. During reach reconnaissance, locations where cross-sections and bed composition protocols will be implemented are flagged. The study reach will be re-visited on a seasonal schedule consistent with the monitoring objectives. The study reach procedure for channel form monitoring is outlined below and specific information regarding basic surveying techniques is available in Appendix C.

- The study reach is first laid out on the ground
- Bankfull indicators are identified and bankfull width is determined
- Three benchmarks are established
- Three cross-sections are then located and staked
- A longitudinal survey is performed
- Cross-sections are surveyed
- Bed composition protocols are performed
- Large woody debris is surveyed
- Riparian measurements and Canopy Density are recorded
- Water quality tests are run

The following descriptions are summaries of the measurements with reference to specific literature. Specific methods and the actual references for these metrics are presented in the appendices.

Longitudinal (Thalweg) Profiles & Benchmarks

The amount of variability in thalweg along a longitudinal axis in the stream is a good measure of complexity of the wetted stream channel. Pools, logs, boulders, riffles, etc. add complexity to the channel that affect sediment transport, channel form, and fish habitat. Changes in the thalweg profile reflect overall changes in the channel complexity, which are a result of channel-forming forces in the stream. Reduction of complexity occurs with excessive sediment introduction. Increased complexity indicates a recovery from such a condition. Thalweg profiles provide information on existing conditions, but are useful in trend analysis over the long term.

Strictly implemented, a thalweg profile or survey, as mentioned above, measures the streambed elevation along the thalweg of the stream, taking particular care to measure all breaks-in-slope, riffle crests, maximum pool depths, and pool tail-outs. Concurrently, while the tapes, levels, etc., are set up for measuring thalweg profiles, the locations of transects for cross-sections are also usually documented and measured (Madej, and Ozaki, 1996; Ramos, 1996). Since it is impossible to uniformly arrange the longitudinal tape exactly over the thalweg, measurements should be perpendicularly referenced to the centerline tape, and read to within one foot. Ramos suggests that as thalweg measurements intersect the point of a designated cross-section, the thalweg should be measured at the intersection first, and then the cross-section is surveyed before

proceeding upstream. In addition to the thalweg elevations, other variables, such as water surface, bar height, substrate size, high water marks, and comments on local channel features such as pools, riffles, runs, and the presence or absence of large woody debris can be recorded. Subsequent analysis of the profile allows the detection of changes in the vertical dimensions of channel features. Depending on the data obtained from the thalweg survey, standard parametric and non-parametric statistical methods can be applied to more fully interpret survey results.

Depending on the study's intent, the reach length surveyed in a thalweg profile may vary from 20 to 50 channel widths. Rather than channel widths, surveys can also be modeled around a specific number of meander segments, generally three to four, within a reach (Madej, and Ozaki, 1996; Trush, 1997; Rosgen, 1996). The important consideration in selecting a specific length for a reach to conduct thalweg profiles is the ability of the study design to answer any questions or hypotheses proposed, whether it is to detect changes over time in channel aggradation or degradation, or to inventory available pool and riffle habitat for salmonids and other insteam biota.

Specific methods and the actual references for Longitudinal Profile surveys are presented in Appendix E.

Cross-sections

Channel cross-section measurements provide valuable information on the shape and dimension of a stream channel and its relationship to the flood plain. Coupled with other measurements, cross-sections measured repeatedly over a period of years provide valuable information on the transport and storage of sediment in the stream channel and inter-annual variation of stream channel geometry. Common parameters can include width/depth ratio, bankfull depth, entrenchment, and flood-prone area. For utility and ease of reference, other parameters, such as scour chain and bank-pin placement (for monitoring bed scour and fill and bank erosion and accretion, respectively), pebble counts, riparian canopy measurements, etc., can also be combined and conducted at cross-section locations.

Monitoring the long-term changes in cross-sectional data can provide insights into channel bed and bank stability, and relationships between sediment transport and discharge (Beschta and Platts 1986). , For example, stream aggradation may be manifested by changes in channel geometry such as decreasing thalweg depth, increasing channel width, and increasing mean bed elevations. Channel incision (i.e. downcutting) may be indicative of a return to more "natural" conditions from previous management and/or impacts of major storms and floods (McDonald, et al., 1991).

A typical study design can have as few as three, or as many as 15-20 cross-sections located in a study reach. A reach has been variously defined as 20-50 bankfull flow widths (Kondolf and Micheli), one thousand meters (Knopp, 1993), or a predetermined length based on the geomorphic characteristics of the watercourse under study. For example, Madej and Ozaki, defined a study area as 26 kilometers long in Redwood Creek from its confluence with the

Pacific Ocean to a slope-determined end point. Within the study area the 26 km stream segment was divided into three interconnected reaches, an upper, middle, and lower reach. A total of 58 cross-sections were nested within the three reaches. The end points of each reach were determined by major breaks in stream gradient.

A cross-sectional profile is developed by measuring points along a tape measure stretched across the stream and recording the distance, and surveying streambed elevations at each specific point along the tape. Streambed characteristics, such as changes in bottom elevations, the position of the field estimated bankfull height, wetted width, breaks in slope, and the deepest points in the particular channel feature being measured are recorded. The end points of the cross-section should extend at least above the estimated bankfull stage and preferably beyond the current floodplain.

Specific methods and the actual references for Longitudinal Profile surveys are presented in Appendix E.

Pebble Counts

One of the most widely used methods of sampling grain size from a streambed is the pebble count technique (Wolman, 1954). It can be used as a simple and rapid stream assessment method that may help in determining if land use activities or natural land disturbances are introducing fine sediment into streams (Potyondy and Hardy, 1994). Pebble counts are routinely used by geomorphologists, hydrologists and others to characterize bed material particle size distributions of wadable, gravel bedded streams. The procedures have been adapted in fisheries studies as a preferred alternative to visually characterizing surface particle sizes commonly used during instream flow studies (Kondolf and Li, 1992). The methodology is best applied in gravel and cobble streams with a single channel and are not applicable to lower gradient, sand-bed dominated channels. A recent, comprehensive review of [Bunte, 2001 #641] measurement of streambed sediment in wadable, gravel bedded streams describes the advantages and constraints of a wide variety of sampling designs.

Pebble counts are conducted by randomly collecting, counting and measuring the intermediate diameter (b-axis) of 100, and up to 200 (Kappesser, 1993) particles from the surface of a given streambed. Bunte and Abt (2001) suggest that accurate characterization of the size distribution of sediment for a given reach requires a sample of 400 measurements. Riffles deemed suitable for spawning salmonids are the preferred location for sampling efforts (Schuett-Hames, et al., 1999). Pebbles are collected along transects at measured points following a predetermined grid pattern, or by walking the streambed and picking up individual pebbles at the toe of a boot along a toe-to-heel, zigzag pattern. Whether the structured grid pattern or the toe-to-heel method is used, all transects should traverse the stream channel from the estimated bankfull to bankfull stage.

After at least 100 pebbles are sampled cumulative size distribution curves can be developed for the D50, median particle size, the diameter at which 50% of the particles are finer, and the D16

and D84, the diameters at which 16% and 84% of the particles are finer. Other analyses that may be applied are the geometric mean diameter: $dg = [(D84)(D16)]^{0.5}$ and the geometric sorting coefficient: $sg = (D84/D16)^{0.5}$ (Kondolf and Li, 1992). As mentioned, it has been shown that shifts toward the lower end of the pebble count cumulative frequency curves may be indicative of significant increases in streambed fines from accelerated natural and or land-use disturbances. Conversely, a progressive coarsening of streambed surface particles may indicate improving conditions from past upstream and/or upslope disturbances.

Specific methods and the actual references for pebble count procedures are presented in Appendix F.

Large Woody Debris

Large Woody Debris (LWD) is known to be an important structural element of stream channels. It improves juvenile Coho salmon and steelhead trout summer rearing habitat by increasing the numbers and depths of pools. Large amounts of LWD also increase winter cover that is critical for salmonid protection from predation and the reduction of water velocity.

Beechie and Sibley (1997) concluded that when the number of LWD pieces (>8 inches in diameter) reached about 122 pieces /1,000 Ft., pool formation is less sensitive to further increases in LWD loading. Similarly, Martin (1999) found that the effectiveness of LWD for forming pools in alluvial channels was diminished when the LWD load exceeded a threshold of approximately 137 pieces. LWD loading (m^3 of LWD per 100 m of channel length) in surveyed stream reaches in northern California have been compiled and may provide another useful basis for assessment of LWD abundance [O'Connor Environmental, 2000 #687].www.fire.ca.gov/bof/pdfs/garcia_LWD_final.pdf

To monitor large woody debris we use an inventory method developed in partnership by GRI and the GRWC after reviewing other accepted techniques. It is designed to allow sorting and recompiling of data to answer different questions over time. A measurement is made of every piece that breaks the plane of the bankfull line and is at least 6” in diameter on the small end and 4’ long.

Specific methods and references for monitoring LWD are presented in Appendix G.

Riparian Measurements and Canopy

Riparian, or streamside forest, provides habitat for many types of wildlife, shades the creek keeping water temperatures cool for salmon and trout, and protects creek banks. When a tree is undercut and falls into the creek it becomes the large wood, and essential element for fish habitat. There are several features of riparian forest that indicate its value as habitat and as part of the stream system. The density and diversity of plant species, the width of the riparian corridor beyond the edge of the creek scour channel, the size of the trees in the corridor and the occurrence of dead trees, vines, downed wood and other features, all describe the habitat value of the forest for birds, mammals, reptiles, amphibians and salmonids.

The density of the streamside tree canopy creating shade over the creek, and the availability of large trees along the banks to become wood in the stream are features of the riparian forest, which relate to salmon and trout habitat in the creek channel. The extent of creeks in the watershed with dense riparian corridor indicates where water temperatures are likely to be low. By assessing the riparian area the current conditions of the riparian areas will be documented and these current conditions can be compared throughout the watershed. The objective of the riparian assessment is to understand and identify areas in need of restoration and enhancement. In addition, monitoring over time will provide the opportunity to investigate the relationship between riparian stand conditions and LWD recruitment to stream channels and effect on aquatic habitat.

The riparian surveys use the Forest Projection System (FPS) developed by Dr. Jim Arney of Forest Biometrics. Riparian forest stands will be inventoried by identifying a sample of trees by species within 20th acre plots at 200 ft intervals along the established monitoring reaches. The 20th acre fixed plots are run up-hill from bank-full to 100 feet and are 21.8' wide. Measurements of live trees, snags, down-logs and understory vegetation are documented.

Canopy density is measured using a spherical densiometer to record the riparian vegetation shading the creek. The measurements are taken in conjunction with the riparian surveys. Measurements are taken at five points at the established riparian plot sites: center of channel, bank-full (right & left), and 50 ft. inland from the bankfull point. Four readings per location are made first facing upstream, left bank, downstream, and right bank then the results are averaged to provide an estimate of canopy cover for that point.

Specific methods and the actual references for canopy and riparian monitoring procedures are presented in Appendix H.

Biological Sample Collection

Freshwater benthic macro invertebrates include worms, snails, clams, crustaceans, aquatic beetles, the nymph form of mayflies, stoneflies, dragonflies and damselflies and larval form of caddisflies and true flies. They are a minimum of 0.5 mm in length and live primarily on instream boulder, cobble or gravel substrate. They are most easily categorized into feeding guilds, species that obtain a common food source in a similar manner. The most common feeding guilds are shredders, filter-collectors, collect-gatherers, scrapers-grazers, and predators.

The physical structure of rivers and streams are measured by stream order, which is related to watershed size. Stream order influences the assemblage of benthic macro invertebrates. The Gualala River mainstem is a fourth order stream, all other tributaries within the basin are of smaller order. The predominant feeding guilds in fourth order streams are scrapers, which consume the algal growth associated with a more open canopy cover and collectors utilizing the high amount of fine particulate organic matter, which has drifted downstream. Shredders, which

process leaf litter and other forest debris, and collectors, which further process shredder excrement, usually dominate first and second order streams.

Macroinvertebrate samples will be obtained using the methodology outlined in the *California Stream Bioassessment Procedure* (CDFG 1999). Sampling sites will be selected according to guidance provided in those protocols as well as knowledge of the watershed and land uses upstream of the site.

Other interesting, descriptive, or unusual biota will be noted in the field log at the time of sampling to provide additional qualitative information on the relative health of the water body.

Stream Discharge, Turbidity, and Total Suspended Solids

The measurements and data analysis presented below describe a limited monitoring program utilizing field observations and measurements collected by monitoring personnel that could be used to quantitatively characterize the magnitude of the measured parameters. Although the protocol provides for the collection of quantitative data, the interpretation of the data is limited by high sample variance and small sample size. A statistically robust data set that could potentially be used to assess trends or cause-effect relationships between water quality and land management would require at minimum a continuous data record that could be produced only by automated samplers, supplemented by a field monitoring program comparable to that presented here. It would be possible for committed field personnel to produce a valuable data set using this monitoring protocol, however, the investment of time and effort would be high.

Simultaneous measurements of stream discharge (instantaneous rate of flow in units of cubic feet per second), water turbidity, and total suspended solids in the water column form a discrete component of the monitoring program that can be conducted during periods of storm runoff from October through the end of the rainy season. Monitoring sites will require installation of a monumented cross-section, a staff plate allowing observation of water surface elevation surveyed in the cross-section, and must be relatively accessible and safe for sampling during periods of runoff.

The field protocol includes observations of time and stream stage, collection of a depth integrated water sample for subsequent lab analysis of suspended solids, collection of a surface grab sample for field measurement of turbidity, and measurement of stream discharge (requires at least 0.5 hours of wading and measurement of stream velocity with a current meter). Supplemental data on flow velocity at the water surface will be collected using a float test. The relationship between stream discharge and surface velocity will be used to improve the accuracy of estimated stream discharge during periods when in-stream measurements are not possible or unsafe. Following the discharge measurement, a second set of stage and water samples are collected. Observations of stage, turbidity, and suspended solids immediately before and following discharge measurements are intended to account for variability of conditions in the short-term, including potentially rapid changes in stream stage and discharge.

The surface grab sample for field measured turbidity should be taken as near the channel thalweg as possible, and must be collected from a location where flow is well-mixed. The same criteria apply to the depth integrated sample. Samples for turbidity will be processed immediately in the field. Samples for suspended solids will be labeled and refrigerated and will be transported to a contract laboratory as soon as possible, normally within 72 hours. Chain of custody forms will be maintained for these samples.

Stream discharge measurements typically require measurement of stream velocity at a minimum of 10 points, and preferable 20, in the cross-section. These measurements necessarily include periods of storm runoff. Safety considerations are paramount, and it is anticipated that there will be periods of flow when field personnel will determine that in-stream measurements are not sufficiently safe. In recognition of this reality of field work in streams, supplemental observations of surface velocity are included in the monitoring protocol.

Specific methods and the actual references for canopy and riparian monitoring procedures are presented in Appendix I.

Photo Documentation

Photos of the downstream end of the reach are taken to document location of benchmarks used to relocate and resurvey the reach. In addition, instream photo monitoring using photos taken both upstream and downstream from station zero, at each cross-section station, and at end of the reach is conducted to record general channel conditions and assist in interpretation of channel change over time. No formal analysis of photos is conducted. Specific methods are included in the monitoring procedure where photo documentation is part of the methodology (i.e. longitudinal profiles, cross-sections).

3. Sample Handling and Custody

Field teams will collect data with a team leader supervising. All data sheets and instrument logs will be turned into the team leader who will check the data for quality and completeness. As noted above, chain of custody will be documented for water samples collected for laboratory processing, withshipment to laboratory based on the protocols for the individual metrics. Chain of custody (COC) forms will be maintained for all samples.

4. Analytical Methods

The parameters being measured as part of this QAPP are physical in nature and do not involve analytical methods, with the exception of turbidity and total suspended solids. Turbidity measurements will be collected using a field instrument approved for this purpose by the California Regional Water Quality Control Board, North Coast region (RWQCB). Total suspended solids would be determined using EPA Method 160.2. Additional information regarding these methods is provided in Appendix I.

5. Quality Control Requirements

Each of the parameters being used in this QAPP has an associated Quality Control, which is addressed in the Appendices.

Field data sheets will be checked and signed in the field by the monitoring leader. For laboratory samples the monitoring team leader will discard any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information (recorded in the instrument logs) is missing or inadequate. Following each event, the team leader will collect the field notebooks and data sheets. All notebooks and data sheets will then be copied and stored in a site-specific binder. The binder and the original data will be stored in a specied location.

Independent laboratories will report their results to the monitoring leader. The leader will verify sample identification information, review the chain-of-custody forms, and identify the data appropriately in the database.

Data sheets and data files will be reviewed quarterly by the technical advisors to determine if the data meet the Quality Assurance Project Plan objectives. They will identify outliers, spurious results or omissions to the citizen-monitoring leader. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the citizen-monitoring leader. Problems with data quality and corrective action will be reported in final reports.

If data do not meet the project's specifications (see Table 7.2 –error tolerance), the following actions will be taken. First, the technical advisors will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. If the problem cannot be corrected by re-training, revision of techniques, or replacement of supplies/equipment, then the technical advisors and the TAC will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, the parameter should be eliminated from the monitoring program.

6. Instrument/Equipment Testing, Inspection and Acceptance Maintenance

All sampling equipment will be inspected for broken or missing parts, and will be tested to ensure proper operation. Inspection of equipment will occur as a pre-sampling check prior to use or as indicated by an exceeded QC limit. Maintenance will be performed in accordance with manufacturers recommendations or more frequently if problems are identified by QC checks.

Testing, inspection, and calibration for each specific piece of equipment are addressed in the Appendices. The following is a list of equipment that will be needed for the parameters being measured in this QAPP:

- ✓ Onset Hobo Temperature Data Loggers
- ✓ Non-Mercury Thermometers (NIST certified)
- ✓ Engineers Level, tripod, Stadia rod, 8” carpenter level
- ✓ Compass
- ✓ Clinometer
- ✓ Densiometer
- ✓ Calculator
- ✓ Camera
- ✓ 200’ Fiberglass 2-sided tape, 150” Fiberglass tape, Spenser tape, 25’steel tapes, clear metric rulers
- ✓ (optional) Turbidometer, field unit (issued by RWQCB to GRWC)

Additional equipment that will be used but will not require any testing, QA/QC related inspection or maintenance will include:

- ✓ Fence Posts
- ✓ D-shaped kick net (0.5 mesh)
- ✓ Lag Bolts & Driver
- ✓ 3’ Rebar
- ✓ Flagging
- ✓ Rudd Paint
- ✓ Aluminum & Code Tags
- ✓ Sledge Hammer
- ✓ Fence Post Pounder
- ✓ Clippers & Machete

7. Instrument/Equipment Calibration and Frequency

The equipment calibration and frequency is addressed for each protocol where equipment needs to be calibrated. This includes the calibration of the data loggers discussed in the temperature protocol (Appendix B) and the calibration of the turbidometer used in the optional water quality protocol (Appendix I).

8. Inspection/Acceptance of Supplies and Consumables

The inspection of supplies and consumables for the macroinvertebrate sampling are outlined in California Stream Bioassessment Procedure. Inspection of equipment will occur as a pre-sampling check prior to use or as indicated by an exceeded QC limit. Maintenance will be performed in accordance with manufacturers recommendations or more frequently if problems are identified by QC checks.

9. Non-direct Measurements

N/A to project

10. Data Management

Refer to A9 above for discussion regarding handling of data sheets and instrument logs. The designated data management coordinator will review the field sheets and enter the data deemed acceptable by the citizen monitoring leader(s) and the technical advisors. Data will be entered into a spreadsheet or a database using a format that is approved by the RWQCB. The data coordinator will review electronic data, compare to the original data sheets and correct entry errors. After performing data checks, and ensuring that data quality objectives have been met, data analysis will be performed. Summary statistics will be generated annually.

Raw Data

Raw data will be provided to the State WRCB and RWQCB in electronic form at least once every year so that it can be included in the 305(b) report and referenced for other watershed improvement projects and/or studies. Appropriate quality assurance information can be provided upon request. This should occur when the data files are updated and backed up (see A9 above). Refer to B2, B3 and B5 for additional discussion regarding data quality control processes.

Analysis

Temperature

Raw temperature data will be processed according to the methods outlined in the FSP protocols. A core set of metrics will be calculated from the data on a seasonal basis. These will include:

- daily minimum
- daily maximum
- daily average
- seven-day moving average of the daily mean
- seven-day moving average of the daily maximum

Yearly summary statistics calculated from the daily and weekly data will be produced for each site for each year. Yearly site-specific statistics of the seasonal maximum for the Maximum Weekly Average Temperature (MWAT) and the seasonal Maximum (Max) will be produced in chart form for each Super Planning Watershed (NCWAP Synthesis Report, 2002).

Longitudinal (Thalweg) Profiles & Benchmarks

Subsequent analysis of the channel profile may reveal subtle changes in channel morphology resulting from small scale shifts in bed sediment associated with low-magnitude annual floods and will document major changes in the stream bed that may result from high-magnitude floods that occur relatively infrequently. A core set of metrics will be calculated from the thalweg elevation data on an annual basis. These will include:

- channel slope

- a plot of the thalweg profile and associated summary data used to evaluate:
    - local changes in bed conditions, including location and depth of pools
    - changes in channel elevation relative to base year elevation
- Variation Index (Madej, 1999), a metric developed in northern California to evaluate channel response to and recovery from bed aggradation.

Summary statistics for slope, the thalweg profile and channel elevation are calculated by using an Excel database developed for Gualala Redwoods, Inc. The Variation Index is a means to quantifying variability in a longitudinal channel profile and is calculated by using the Longpro database developed by the USGS and Redwood National Park.

Cross-sections

Analysis of the cross-sectional profile may reveal changes in streambed elevation, bank stability, bankfull width/depth ratio, and channel scour and/or fill (aggradation/degradation). A core set of metrics will be calculated on an annual basis. These will include:

- bankfull width/depth ratio
- a cross-sectional profile plot to evaluate changes in streambed elevation and bank stability.
- changes in channel elevation relative to base year elevation
- channel scour and/or fill (Madej, 1999)

Summary statistics for bank-full width/depth ratio are calculated by using the CDF&G protocol. The cross-sectional profile plot and the channel elevation change are calculated by using an Excel database developed by Gualala Redwoods, Inc. Channel scour and/or fill is calculated by using the Winscour database developed by the USGS and Redwood National Park

Pebble Counts

It has been shown that shifts toward the lower end of the pebble count cumulative frequency curves may be indicative of significant increases in streambed fines from accelerated natural and or land-use disturbances. Conversely, a progressive coarsening of streambed surface particles may indicate improving conditions from past upstream and/or upslope disturbances. A core set of metrics will be calculated on an annual basis. These will include:

- d50, median particle size, the diameter at which 50% of the particles are finer
- d16, the diameter at which 16% of the particles are finer
- d84, the diameter at which 84% of the particles are finer

Summary statistics for the particle size diameters will be provided for individual sites and averaged by study reach. Other analyses that may be applied on a site-specific basis are the geometric mean diameter, $dg = [(D84)(D16)]^{0.5}$, and the geometric sorting coefficient, $sg = (D84/D16)^{0.5}$ (Kondolf and Li, 1992).

Large Woody Debris

Beechie and Sibley (1997) concluded that when the number of LWD pieces (>8 inches in diameter) reached about 122 pieces /1,000 Ft., pool formation is less sensitive to further increases in LWD loading. Similarly, Martin (1999) found that the effectiveness of LWD for forming pools in alluvial channels was diminished when the LWD load exceeded a threshold of approximately 137 pieces.

Calculating the size, position and number of LWD pieces within a survey reach will allow monitoring of natural LWD recruitment and assist in planning and monitoring future LWD restoration plans. A core set of metrics will be calculated from the data on an annual basis. These will include:

- cubic feet of LWD per 1,000 feet (also determined in units of m^3/100 m)
- number of LWD pieces per 1,000 feet

Yearly summary statistics are reported by monitoring study reach. A comparison of LWD load in each sample reach to the frequency distribution for regional values may be provided.

Riparian Measurements and Canopy

Subsequent analysis of riparian data allows the calculation of the riparian habitat within the study reaches. A core set of metrics will be calculated from the riparian surveys and canopy data on an annual basis. These will include:

- canopy density at center of channel, bank-full and 50' into the riparian zone
- riparian composition
- basal area
- tree height

Summary statistics for canopy density, riparian composition and basal area are averages for the study reach sites. Tree height is calculated by averaging the height of the 100 tallest trees per acre.

Turbidity

If and when turbidity data are collected, simultaneous measurement of stream discharge must occur. The turbidity data would be summarized in tabular format, including collection time and date, location of sample site, and stream discharge. In addition, for each sample station, a scatter plot showing turbidity as a function of stream discharge will be presented, and a linear regression analysis will be performed using stream discharge as the independent variable and turbidity as the dependent variable. If a relatively large data set is collected, it is expected that turbidity will be correlated with discharge.

Stream Discharge

In addition to the data report above, stream discharge observations will also be computed in terms of discharge per unit watershed area for comparison to continuous gauge data collected at

the North Fork, Wheatfield, and South Fork gauges. If a relatively large data set is collected, it is expected that discharge will be correlated with one of the continuous gauges, and that a predictive relationship using linear regression can be developed whereby the continuous gauge data can be used to estimate discharge in smaller tributary watersheds based on drainage area.

Total Suspended Solids

These data are collected to determine the extent to which turbidity is correlated with suspended sediment transport. To the extent that these parameters are correlated at a monitoring site, turbidity data can be interpreted as an estimator for sediment load. Where available, total suspended solids will be reported in the summary table along with turbidity and discharge data. In addition, for each sample station, a scatter plot showing total suspended solids as a function of turbidity will be presented, and a linear regression analysis will be performed using turbidity as the independent variable and total suspended solids as the dependent variable. If a relatively large data set is collected, it is expected that total suspended solids will be correlated with turbidity. For individual sampling stations, a predictive relationship will be developed using linear regression which relates total suspended solids to turbidity. It is anticipated that the number and frequency of collection of samples for analysis of total suspended solids will decrease over time, once the predictive relationship is established.

Biological Sample Collection

Benthic macro invertebrate biotic condition is commonly measured by species richness, species composition, and tolerance/intolerance metrics. Species richness and composition tend to decrease in response to habitat disturbance. Harrington (2000) developed the Russian River Index of Biological Integrity, which includes six metrics:

- taxa richness
- percent dominant taxa
- EPT taxa
- modified EPT taxa
- Shannon diversity
- tolerance value

These six metrics will be integrated into a single score, which is compared to determine biotic condition categories: excellent (30-24), good (23-18), fair (17-12), and poor (11-6).

C. ASSESSMENT AND OVERSIGHT ELEMENTS

1. Assessment and Response Actions

Review of all field and data activities is the responsibility of the monitoring leader, with the assistance of the TAC. The monitoring leader, or a technical advisor will accompany volunteers on the 1st and 2nd sampling trips. If possible, volunteers in need of performance improvement will be retrained. All volunteers must attend a refresher course offered annually by the GRWC,

SRCD or other recognized agency or entity. If errors in sampling technique are consistently identified, retraining may be scheduled more frequently.

Within the first three months of the monitoring project, State WRCB staff, or its designee, will evaluate field and laboratory performance and provide a report to the citizen-monitoring group. All field and laboratory activities, and records may be reviewed by state and EPA quality assurance officers as requested. If corrective action is required, State WRCB and the Regional WQCB staff will work with the SRCD and monitoring group to implement improvements.

2. Reports

The technical advisors will review draft reports to ensure the accuracy of data analysis and data interpretation. Raw data will be made available to data users per their request. The individual citizen monitoring organizations will report their data to their constituents after quality assurance has been reviewed and approved by their technical advisors. Every effort will be made to submit data and/or a report to the State and/or Regional Board staff in a fashion timely for their data uses, e.g. 305(b) report or special watershed reports.

D. DATA VALIDATION AND USABILITY ELEMENTS

1. Data Review, Validation and Verification

Data sheets will be reviewed quarterly by the technical advisors to determine if the data meet the Quality Assurance Project Plan objectives. They will identify outliers, spurious results or omissions to the monitoring team leaders. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the citizen-monitoring leader. Problems with the data quality and corrective action will be reported in final reports.

2. Validation and Verification Methods

As part of the standard field protocols, any sample readings out of the expected range will be reported to the monitoring team leader. A second sample will be taken as soon as possible to verify the condition. It is the responsibility of the team monitoring leader to re-train volunteers until performance is acceptable.

3. Reconciliation with User Requirements

All references are contained in the appendices.

Appendix

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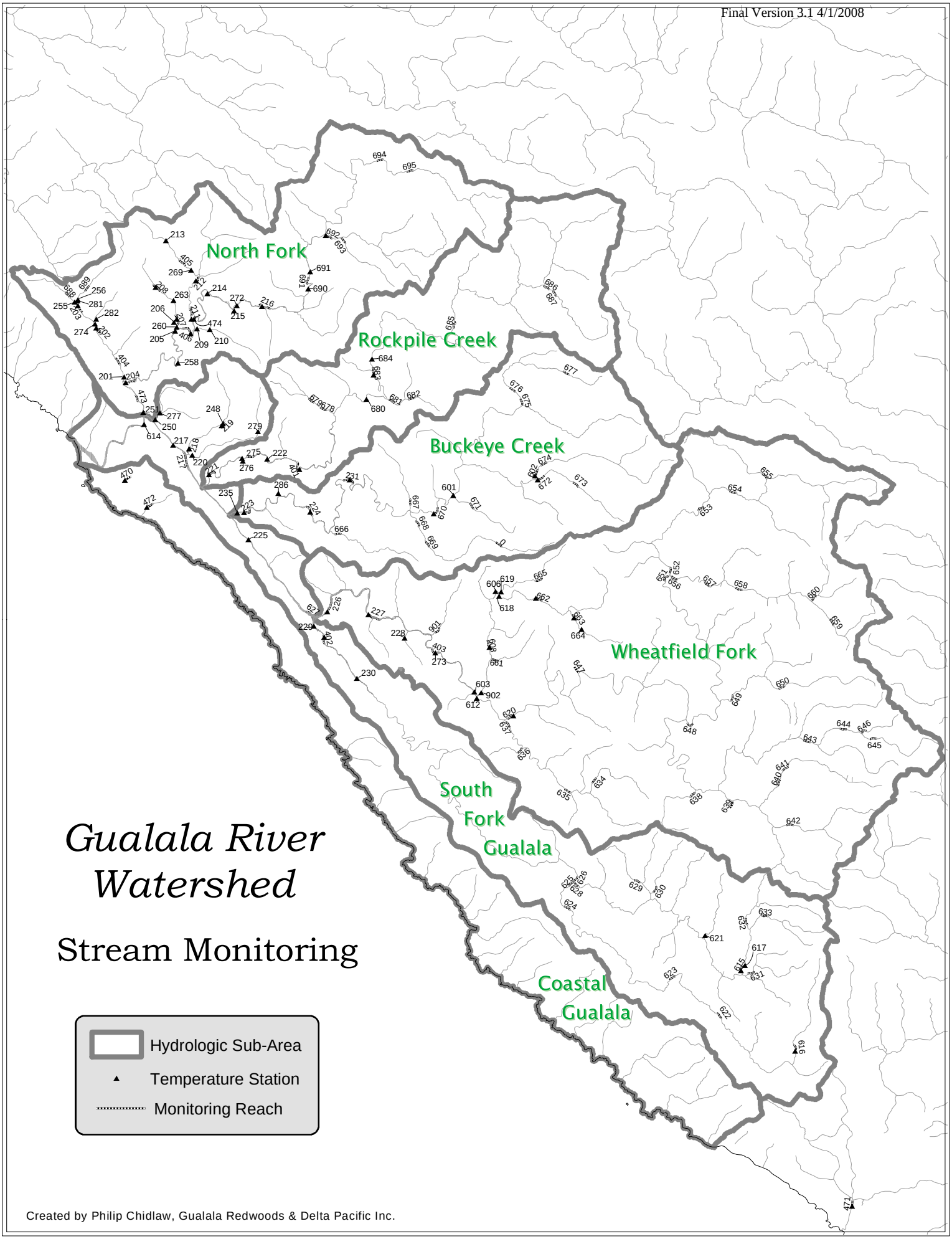

Created by Philip Chidlaw, Gualala Redwoods & Delta Pacific Inc.

Appendix B
Water Temperature Monitoring

Introduction

Background
This protocol has been adapted in large part from the Forest Science Project's Protocol (FSP 1998). Stream temperature is one of the most important environmental factors affecting aquatic ecosystems. The vast majority of aquatic organisms are poikilothermic--their body temperatures and hence their metabolic demands are determined by temperature. Temperature has a significant effect on cold-water fish, both from a physiological and behavioral standpoint. Below is a brief list of the physiological and behavioral processes affected by temperature (Spence et al., 1996):

- Metabolism
- Food requirements, appetite, and digestion rates
- Growth rates
- Developmental rates of embryos and alevins
- Timing of life-history events, including adult migrations, fry emergence, and smoltification
- Competitor and predator-prey interactions
- Disease-host and parasite-host relationships

This protocol sets forth a sampling approach that will provide consistent data that can be used to address stream temperature issues at broad regional scales, i.e., watershed, basins, and regions.

Scope and Application
The field methods described in this protocol are for obtaining representative stream temperatures from perennial streams for regional monitoring. The field methods are specifically applicable for the deployment of continuous monitoring temperature sensors (e.g., Hobo Temps, Temp Mentors, Stowaways, etc.) for the purpose of identifying diurnal changes in temperature, seasonal changes in thermal regime as well as seasonal changes. Possible interferences in the accurate and precise measurement of stream temperature include: 1) exposure of the sensor to ambient air, 2) improper calibration procedures, including date and time settings, 3) improper placement of the sensor in the stream, 4) low battery, 5) inherent malfunctions in the sensor or data logger, and 6) vandalism.

Summary of Method
All continuous stream temperature monitoring sensors should be calibrated against a National Institute of Standards and Technology (NIST) traceable thermometer. Sensors not meeting precision and accuracy data quality objectives should not be used. Sensors should be placed in a well-mixed zone, e.g., at the end of a riffle or cascade. Monitoring location should represent average conditions — not pockets of cold water refugia or isolated hot spots. Location of sampling points should either avoid or account for confounding factors that influence stream temperatures such as:

- confluence of tributaries
- groundwater inflows
- channel morphology (particularly conditions that create isolated pools or segments)
- springs, wetlands, water withdrawals, effluent discharges, and other hydrologic factors
- beaver ponds and other impoundments

The sensor should be placed toward the thread or thalweg of the channel. Keep in mind that flow will decrease throughout the summer resulting in an exposed sensor. The thermistor portion of the device should not be in contact with the bottom substrate or other substrate that may serve as a heat sink (e.g., bridge abutment or boulder). Secure the sensor unit to the bottom of the channel with aircraft cable, surgical tubing, rebar, or diver's weights. The sensor should be set to record temperatures at sampling intervals that should not exceed 1.6 hours (96 minutes).

Equipment and Supplies

Calibration and Standardization
Prior to deployment of sensors, calibration of each sensor must be performed. The following is a list of equipment and supplies for calibration:

- NIST traceable thermometer - resolution of 0.2ºC or better, an accuracy of ±0.2ºC or better.
- controlled-temperature water bath, or water-filled thermos
- ice chest
- laboratory notebook
- ice

Field Measurements
There are several useful materials and pieces of equipment that should be taken to the field to install or service temperature sensors. These include:

- securing material such as zip ties, bailing wire, aircraft cable, surgical rubber tubing, locks, rebar, cinder blocks, large rocks with drilled holes, diver's weights
- GPS w/extra batteries
- surveyors marking tape or flagging
- sledge hammer (e.g., two-pound)
- wire cutters and/or pocket knife

- thermistor equipment items (silicone rings, submersible cases, silicone grease, silica packets)
- portable computer or interface for data downloading and launching
- backup batteries and thermistors
- timepiece/watch
- Rite-in-the-Rain field book w/ extra field sheets
- NIST-traceable auditing thermometer
- waders
- camera and film
- brush removal equipment (e.g., safety axe)
- maps and aerial photos
- first aid kit
- spray paint, rags and clean up cloths
- metal stakes or spikes, rebar

Pre- and Post-Deployment Calibration and Standardization

A. A NIST-traceable thermometer must be used to test the accuracy and precision of the temperature sensors. The NIST-traceable thermometer should be calibrated annually, with at least two calibration points between 10ºC (50ºF) and 25ºC (77ºF). Calibrations should be performed using a thermally stable mass of water, such as a controlled-temperature water bath, or water-filled thermos or ice chest. The stable temperature of the insulated water mass allows direct comparison of the unit's readout with that of the NIST-traceable thermometer. Accuracy of the NIST-traceable thermometer must be within ±0.5ºC.

B. Prior to use, all continuous monitoring devices should be calibrated at room temperature (~25ºC, 77ºF) and in an ice water bath to insure that they are operating within the accuracy over the manufacture's specified temperature range. Calibrate all continuous monitoring devices with a NIST-traceable laboratory thermometer at two temperatures, room temperature (i.e., ~77ºF, 25ºC) and near the freezing point of water as follows:

   When calibrating and prior to deployment, set all units to the same current date and synchronize all devices using an accurate watch/clock that will be used to time the recording intervals of the reference thermometer. Call for the correct time.

   Set the record interval of each thermograph to a short period, six to 30 seconds.
   Record the date, sensor serial number, data logger serial number, and analyst's name in a laboratory notebook. Table 1 is an example of a format that can be used for data collection. The same sensor and same data logger should be deployed in the field as they were paired together during calibration.

   Place the reference thermometer and the continuous monitoring devices in a five-gallon pail filled with about three gallons of water that has reached room temperature overnight or in a controlled-temperature water bath that has reached room temperature (~77ºF, 25ºC). Make

sure the casings of all continuous monitoring devices are completely submerged. Stir the water, just prior to, and during the calibration period to prevent any thermal stratification.

After allowing 10 to 20 minutes for the continuous monitoring devices to stabilize, begin recording data for a 10-minute interval. Record the time, the reference thermometer temperature, and the continuous monitoring device temperatures measured at the predetermined sampling frequency (e.g., 6 second, 10 second) used during the 10-minute interval. After all readings are completed, calculate the difference between the reference thermometer and each of the continuous monitoring devices for each reading and calculate the mean difference. Record the data using a format similar to that shown in Table 1.

Table 1. Example of Calibration Data Collection Table

4/12/98	**Sensor Serial Number = 10043 Data logger S.N. = 2S256S**	**Analyst: Joe Celsius**	**Reference Thermometer No. 412**
Time (sec)	**NIST Thermometer Reading (ºC)**	**Device Reading (ºC)**	**Difference (ºC)**
0	25.0	24.8	-0.2
10	25.1	25.0	-0.1
20	25.0	24.9	-0.1
30	25.2	25.0	-0.2
40	25.0	24.6	-0.4
Etc.			
		Mean = 24.9 S.D. = 0.16	Mean Diff. = -0.16

C. Any continuous monitoring devices not operating within their specified accuracy range should be thoroughly scrutinized. If a particular device returns readings that are outside of the manufacturer's accuracy limits, but is still precise, then a correction factor (addition and/or multiplication) can be applied to the data. Precision should be within 0.2 standard deviations (S.D.) of the mean. Acceptable precision should be observed over the range of temperatures that will be experienced in the field. The correction factor, when applied over the calibration range, should give temperature values that are within the accuracy limits of the device. If units are inaccurate and imprecise they should not be used.

D. Using the same water bath, add enough ice to nearly fill the bucket and bring the temperature down to nearly freezing. Stir the ice bath to achieve and maintain a constant water temperature. Place the reference thermometer and the continuous monitoring devices in the water bath or five gallon pail. Again, make sure that the casings are completely submerged.

E. Repeat steps 2B-D with ice water bath.

F. Also confirm that thermograph batteries have sufficient charges for the entire monitoring period (will the length of the upcoming field season fit into the life expectancy of the unit's lithium batteries?).

G. Calibration (post-deployment calibration) should also be repeated when sensors are retrieved at the end of the sampling season. Repeat steps 2A-F.

Quality Assurance and Quality Control

Laboratory
Precision and accuracy should be 0.2 SD and ±0.5ºC, respectively for each continuous monitoring device.

Monitoring equipment with detachable sensors must be marked in order to match the sensor with the data logger. This allows instrument and sensor to be calibrated and tested prior to deployment, and also makes malfunctions easier to diagnose and correct. A logbook must be kept that documents each unit's serial number, calibration date, test results, and the reference thermometer used (Table 1).

Field
In addition to laboratory quality control checks, temperature monitoring equipment should be audited during the field season if possible. A field audit is a comparison between the field sensor and a hand-held NIST-traceable reference thermometer. The purpose of a field audit is to ensure the accuracy of the data and provide an occasion for corrective action, if needed. A minimum of two field temperature audits should be taken during the sampling period — one after deployment when the instrument has reached thermal equilibrium with the environment, and ideally one prior to recovery of the device from the field. Reference thermometers used for field audits must meet the same specifications as those used for laboratory calibrations: accuracy of ±0.5ºC, resolution of 0.1ºC. Exercise caution with mercury thermometers in the field.

A field audit is performed as follows:

Place the reference thermometer in close proximity to the continuous monitoring device.

Record the reference thermometer temperature and the sensor temperature in a field notebook. A stable reading is usually obtained within 10 thermal response units or time constants. For example, a reference thermometer with a ten-second time constant should give a stable reading in 100 seconds.

Post-processing audit accuracy must be within ±0.5ºC .

> Response time (time constant) is the time required by a sensor to reach 63.2% of a step change in temperature under a specific set of conditions. Response time values should be provided by the manufacturer. Five time constants are required for the sensor to stabilize at 100% of the step change value. Ten time constants are recommended to ensure that the reference thermometer has reached equilibrium with the stream temperature.

Data loggers typically set date and time based on the set-up computer's clock. It is important that field personnel synchronize their watches to the computer clock's time. Prior to the field audit, the computer clock should be set to the correct date and time by calling for the correct Pacific time.

Procedures

Water temperatures vary through time and space. The temporal and spatial aspects of deploying stream temperature monitoring devices is discussed in the following sections.

Temporal Considerations of Sensor Deployment

Sampling Window
Launch sensors to capture the hottest period of the field season, which will vary with watershed location. Coastal streams in Humboldt and Del Norte Counties require deployment at least during July, August, and September; whereas Mendocino County and more inland streams may require longer recording periods (June-October) (FFFC, 1996). For consistency it is recommended that the sampling window be from June 1 to October 1. This sampling window will ensure that the highest temperatures during the summer will be captured in the data set.

Sampling Frequency
The time interval between successive temperature readings can be adjusted from every few seconds, to every few hours, to every few days, for most continuous monitoring devices. Table 2 shows some of the typical sampling frequencies and the number of days the device can be left in the field prior to data downloading. In most monitoring activities, the primary objective is to determine the highest temperatures attained during the year. Thus, one of the deciding factors in setting the sampling frequency on a device will be to ensure that the daily maximum temperature is not missed.

The more frequent the monitoring, the more precisely the duration of daily maximum temperature can be characterized. The disadvantage of frequent data collection is reduced number of days of data storage and increased number of data points to be analyzed. Some agencies and other groups have found that an 80-minute sampling interval still captures the daily maximum stream temperatures for sites (OCSRI, 1996). If a less frequent sampling interval is desired, then a pilot study must be performed with monitoring at 30-minute intervals over a one to two week period during the hottest time of the year to determine how rapidly stream temperatures change. Pilot study information can provide information on the time interval most appropriate for capturing the daily maximum.

Table 2. Typical Sampling Frequencies and Storage Capacity of a Hobo® Data Logger Used for Stream Temperature Monitoring

2K Memory / 1,800 Meas.	8K Memory / 7,944 Meas.	32K Memory / 32,520 Meas.	Sample Frequency
37.5 days	165 days	677 days	30 min
45 days	198 days	813 days	36 min
60 days	264 days	1084 days	48 min
75 days	331 days	1355 days	1 Hr
90 days	397 days	1626 days	1.2 Hr
120 days	529 days	2165 days	1.6 Hr
150 days	662 days	2710 days	2 Hr
180 days	799 days	3270 days	2.4 Hr
240 days	1050 days	4300 days	3.2 Hr
360 days	1590 days	6540 days	4.8 Hr

Note: BoxCar and LogBook software's launch menu allows the user to choose from 42 intervals ranging from 0.5 seconds to 4.8 hours. The table shows the most likely settings that may be used for stream temperature monitoring. Mention of trade names does not denote endorsement by the Fish, Farm, and Forests Community Forum, the Forest Science Project, or any of their cooperators.

Selection of appropriate sites for monitoring is dependent upon the purpose and monitoring questions being asked. There are two scales of consideration for the appropriate monitoring site: selection of a sample point or location in the stream which provides representative data and the broader strategy of selecting sites that can provide useful information to answer the questions being asked.

Data Downloading

It is preferable to have the data cover the entire monitoring without interruptions. However, if data must be downloaded during the monitoring period due to insufficient data logger memory, record the date and time the sensor was removed from the stream and the date and time when it was returned to the stream. Some models may allow for downloading of data without interruption or removal of the sensor from the stream. Be sure to return the sensor to the same approximate location and depth after downloading. During a field visit for data downloading or auditing, record in the field notebook whether the sensor was exposed to the air due to low flow, discontinued flow, or vandalism. This information will be valuable for verification and validation of the data in the office.

Mid-Season Field Audit/Calibration Check

If data downloading is performed in mid-season, an opportunity for a mid-season field audit and calibration check presents itself. See Field Section for mid-season field audit and calibration procedures.

Spatial Considerations of Sensor Deployment

Stream Sample Point Location
The simplest and most specific scale is a sampling point on a stream. Here, the focus is on sample collection methods that will reduce variability and maximize representativeness.

Monitoring must record daily maxima at locations which represent average conditions - - not pockets of cold water refugia or isolated hot spots. Measurements should be made using a sampling protocol appropriate to indicate impact to beneficial uses (OCSRI, 1996). Thus, location of sampling locations should be done in a manner that is representative of the waterbody or stream segment of interest. In order to collect representative temperature data, sampling site selection must minimize the influence of confounding factors, unless the factor is a variable of interest. Some confounding factors include:

- confluence of tributaries
- groundwater inflows
- channel morphology (particularly conditions that create isolated pools or segments)
- springs, wetlands, water withdrawals, effluent discharges, and other hydrologic factors
- beaver ponds and other impoundments

Site Installation
Unless study design dictates differently, all sensors should be placed in the thalweg of riffles to insure a complete mixing of the water and to maintain sufficient water depth for the duration of the sampling window. Alternatively, if riffles are too shallow place the sensor in a pool or glide that exhibits well-mixed conditions. Do not place the sensor in a deep pool that may stratify during the summer, unless this is the objective of your study. This measure insures that sensors are not selectively placed in cooler areas such as stratified pools, springs, or seeps or in warm, stagnant locations (hot spots) that would misrepresent a stream reach's temperature signature. A hand-held thermometer can be used to document sufficient mixing by making frequent measurements horizontally and vertically across the stream cross-section. If stream temperatures are relatively homogenous (±1-2 C) throughout the cross-section during summer low-flow conditions, then sufficient mixing exists.

Monitoring devices should be installed such that the temperature sensor is completely submerged, but not in contact with the bottom. Place the sensor near the bottom of the stream by attaching it to a rock, large piece of woody debris, or a stake. Use zip ties, surgical tubing, or aircraft cable to attach the sensor to the bottom substrate. Rebar or diver's weights can be used if no suitable fastening substrate is available. For non-wadeable streams, the sensor should be placed one meter below the surface, but not in contact with a large thermal mass, such as a bridge abutment or boulder (ODF, 1994). If the monitoring site is not in a heavily visited area, mark the location of the sensor by attaching flagging marked with the gauge number or site ID number to nearby vegetation.

Precautions against vandalism, theft, and accidental disturbance should be considered when installing equipment. In areas frequented by the public, it is advisable to secure or camouflage equipment. Visible tethers are not recommended because they attract attention. When equipment

cannot be protected from disturbance, an alternative monitoring site should be considered. For external data loggers that are not waterproof, place them above the mean high water line to prevent loss during a freshet. Some data loggers must be housed in a waterproof metal or plastic box that should be locked and chained to a tree. Data logger boxes and cables should be covered with rocks, moss, and wood to hide equipment.

Install the sensor in a shaded location; shade can be provided by canopy cover or some other feature such as large woody debris. If no shaded locations are available, then it may be necessary to construct a shade cover for the sensor (e.g., using a section of large diameter plastic pipe.) The intention for this measure is to avoid direct solar warming of the sensor. The intent is not to suggest that sensors should be placed only in shaded thermal reaches.

Sensors should be located at the downstream end of a thermal reach, so as to characterize the entire thermal reach, as opposed to local conditions. Protocols for characterizing thermal refugia can be found in FFFC (1996).

The number of thermograph units deployed will vary with 1) drainage area of the watershed, 2) numbers and sizes of inflow tributaries or other transitions in riparian condition, 3) changes in elevation, and 4) proximity to coastal fog zone. In all circumstances, a continuous monitoring device should be located as far downstream as surface water flows during the summer. In watersheds with multiple sensors locate them in a lower/upper or lower/middle/upper distribution.

Mark all monitoring site locations on a USGS 1:24,000 topographic map, aerial photo, or GIS map. Clearly show the location of the site with respect to other tributaries entering the stream, e.g., above or below the confluence. Record measured distance to a uniquely distinguishable map feature (i.e., road crossing, specific tributary, etc.) Draw a diagram of the monitoring area. Include details such as: harvest unit boundaries, sensor location and thermal reach length, tributaries with summer flow, description of riparian stand characteristics for each bank, areas where portions of the stream flow become subsurface, beaver pond complexes, roads near the stream, other disturbances to the channel or riparian vegetation (heavy grazing, gold dredging, gravel mining, water withdrawals).

Record the serial number of each sensor/data logger combination at each monitoring site. Make an effort to deploy the same sensor/data logger combination at the same site each year.

Once a sensor/data logger combination has been deployed at a site, do not move the equipment to another location. Adjustments in sensor location may be necessary if the initial location ran dry, and the sensor must be moved to the active, flowing channel. This will necessitate a unique site_id for spatial statistical analysis. Make notes of such relocations in the field notebook.

If sensors are used to collect long-term baseline or trend data in specific watersheds, establish fixed-location monitoring stations so that data sets will be comparable.

Site-Specific Data Collection
Other site-specific data should be collected at the time of sensor deployment or retrieval. These additional attributes will greatly assist in post-stratification and interpretation of status and trends in stream temperatures.

Length of Thermal Reach or Stream Segment
The thermal reach extends 300-600 meters above the site, depending on stream size (TFW, 1993). With a hip chain or measuring tape, measure the length of thermal reach or stream segment (in feet). If the stream has more than one channel, measure along the channel that carries most of the summer flow.

Canopy Closure
Use a spherical densiometer at evenly spaced intervals to determine average canopy closure for the thermal reach above the monitoring site. Take canopy closure measurements at 50-meter intervals along the thermal reach. If the percent canopy cover varies by more than 20% between measurements, then take additional measurements at 25-meter intervals to more accurately determine the average percent canopy closure for the reach. In order to save time, it may be advantageous to determine canopy closure at 25-meter intervals from the start, thus avoiding the need to back-track in cases where the variability exceeds 20%. In addition to calculating the average canopy closure, keep a record in a field notebook of the percent canopy closure at each sampling interval and note the locations on a map or sketch of the reach to document how the shade level varies through the reach. At each 25- or 50-meter interval, stand in the center of the channel and measure canopy closure four times: facing upstream, downstream, right bank, and left bank. Average these four values to obtain canopy closure for the location.

Elevation
Determine the elevation at the midpoint of the thermal reach from a USGS topographic map, or altimeter and record on data sheet to nearest feet.

Average Bankfull Width and Depth
Bankfull width and depth refer to the width and average depth at bankfull flow. These dimensions are related to discharge at the channel-forming flow, and can be used to characterize the relative size of the stream channel. This characterization will be useful for later post-stratification and assessment of stream temperature data. In addition, the ratio of bankfull width to depth (width:depth ratio) of a stream channel provides information on channel morphology. Width:depth ratio is related to bankfull discharge, sediment load, and resistance to bank erosion (Richards, 1982). For example, channels with large amounts of bedload and sandy, cohesionless banks are typically wide and shallow, while channels with suspended sediment loads and silty erosion-resistant banks are usually deep and narrow. Changes in width:depth ratio indicate morphologic adjustments in response to alteration of one of the controlling factors (Schumm, 1977).

Refer to Channel Form Monitoring Appendix E for step-by-step procedures for estimating bankfull width and depth.

Average Wetted Width
Measure the wetted channel width at the location where the sensor is placed. This measurement should be collected at the time of deployment and at the time of retrieval. Change in wetted width over the field season will provide information on the change in flow during the monitoring period. Follow the method outlined in Flosi (1998).

Habitat Type
Record the habitat type in which the sensor was placed. Use the following codes for the habitat types:

Riffle	Shallow reaches with swiftly flowing, turbulent water
run	Relatively uniform flowing reaches with little surface agitation
spool	Shallow pools less than 2 feet in depth with good flow (no thermal strata)
mpool	Mid-sized pools 2 to 4 feet in depth with good flow (no thermal strata)
dpool	Deep pools greater than 4 feet in depth or pools suspected of maintaining thermal strata (possible thermal strata)

Stream Class
Record the stream classification as defined by the California Forest Practice Rules.

1 - *Class I Watercourse:* Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning.

2 - *Class II Watercourse:* a) Fish always or seasonally present offsite within 1000 feet downstream and/or 2) Aquatic habitat for nonfish aquatic species. 3) Excludes Class III waters that are tributary to Class I waters.

3 - *Class III Watercourse:* No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I and II waters under normal high water flow conditions after completion of timber operations.

4 - *Class IV Watercourse:* Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use.

For Class I watercourses make a concerted effort to collect fish presence/absence and/or abundance data in the same thermal reaches or stream segments where stream temperature data is being gathered. Conduct fish surveys during the period when stream temperatures are highest (July-August).

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Data Field Form

To assist in the collection and organization the site-specific information a field data form has been adapted from the Forest Science Project form. The form can be found below. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

GRWC Stream Temperature Field Data Form

Station ID:	**File Name:**
Stream Name:	
X Coordinate:	**Y Coordinate:**
Projection (UTM Zone 10 NAD 27 preferred):	
Basin Name:	**USGS Quadrangle:**
Describe Placement:	
Surveyor:	**Organization:**
Device ID (serial #):	**Device Type:**
Calibration Date:	
Installation:	***Removal:***
Date Launched:	**Date Retrieved:**
Time:	**Time:**
Air Temperature ©:	**Air Temperature ©:**
Water Temperature ©:	**Water Temperature ©:**
Depth at Instument:	**Depth at Instrument:**
Depth of Instrument:	**Depth of Instrument:**
Maximum Depth:	**Maximum Depth:**
Wetted Width:	**Wetted Width:**
Wetted Length:	**Wetted Length:**

Habitat Type (circle one):	
Riffle	shallow reaches with swiftly flowing, turbulent water
Run	relatively uniform flowing reaches with little surface agitation
Spool	shallow pool less than 2 feet in depth with good water flow
Mpool	mid-sized pool 2 to 4 feet in depth with good water flow
Dpool	deep pools greater than 4 feet in depth or pools suspect of maintaining thermal strata
Mpool	mid-sized pool 2 to 4 feet in depth with good water flow

Thermal Reach Information:	Diagram or Photo
Bankfull Width:	
Bankfull Depth:	
Reach Length:	
Mean Canopy Closure:	
Average Channel Gradient:	
Average Channel Aspect:	
Channel Type (Flossi et al., 1998):	
Stream Class (I,II, etc.):	
Elevation:	
Drainage area:	
Comments:	

Appendix C
SURVEYING BASICS

Introduction

Topographic surveying is an essential tool in watershed monitoring. A basic field survey establishes the horizontal and/or vertical location of a series of points in relation to a starting point (called a benchmark). Repeated surveys of the stream channel, in each study reach, are used to document changes over time in the shape of the streambed. Changes in the sediment supply affect the shape of the streambed. The shape of the streambed, in turn, affects the amount of bedload material that the stream can carry.

Sediment levels are an important factor in determining the quality of salmon habitat. Salmon spawn on gravel beds in the stream. High levels of sediment prevent the circulation of oxygen and inhibit the ability of salmon eggs to develop into fry.

Figure 1. Automatic Level

Protocol Summary

The objectives of the survey include measuring the bankfull width of the stream, the slope of the streambed and the size of bed material. By making annual survey measurements, over a number of years, it is possible to assess changes in the amount of material stored in the bed of the stream, this information will indicate trend in the amount of bedload that is being delivered to the study reach.

The cross-section survey, in conjunction with identifying bankfull indicators, allows the direct measurement of the bankfull width. The longitudinal survey measures the channel slope. The longitudinal survey also shows the shape of the streambed along the direction of flow.

A survey of the stream channel is accomplished by using a surveying tool called an *automatic level* (see Figure 1). The automatic level is carefully set up to establish a horizontal reference plane. The horizontal reference plane allows the relative elevation of different features on the streambed to be measured. Distances from the horizontal reference plane are measured down to the surface of the ground using the *survey rod*. The Survey Protocol (*page 2*) describes, in detail, the steps to be followed in setting up the tripod and the automatic level. It describes how to use the automatic level (Figure 1) and the survey rod to measure elevation.

Surveying requires at least two people. The *Instrument Person* operates the automatic level and records the measurements in the level logbook. The *Rod Person*, selects sites and holds

the survey rod at the site while the Instrument Person is reading it. The protocol explains how to calibrate the instrument using a point of known elevation called a *benchmark*.
The general procedure for surveying is to first set up the instrument. Once the instrument is level, the rod is placed on a point with a known elevation called a benchmark. The instrument person looks through the telescope on the level and reads the number on the rod. The reading (backsight) is added to the elevation of the benchmark to give the elevation of the instrument crosshairs. The rod is then placed on a point whose elevation is to be determined. The reading (foresight) is subtracted from the elevation of the instrument to get the elevation of the new point.
Distances between points are measured with a tape measure or are measured optically with the level and the rod. Careful notes, including sketch maps, are taken to help interpret the survey information.

Surveying Protocols

Directions for Instrument Person

- Step 1: Setting Up the Tripod.
  1. Extend the legs of the tripod until the top of the tripod is level with your chin.
  2. Push one of the legs firmly into the ground. Spread the tripod legs 3' to 4' apart. Push the other two legs into the ground.
  3. Level the top of the tripod by raising or lowering the legs.
     Note: Leveling the instrument will be easier if the tripod head is on a nearly horizontal plane.
  4. After the head is level check that the leg adjusting screws are tight and the legs are firmly set in the ground.

- Step 2: Setting Up the Level.
  1. Place the instrument on the tripod.
  2. Screw the level snugly (finger-tight) to the head of the tripod.
     Note: Do not over-tighten the screw.
  3. Move the level screws in pairs to bring the bubble into the target circle on the level vial.
  4. Rotate the scope 90^0 degrees and re-level.
  5. Repeat until the bubble stays in the target circle throughout a 360^0-degree rotation. This procedure brings the instrument into the range where the self-leveling pendulum prism can operate.
  6. Turn the telescope to bring the rod into the field of vision.

- Step 3: Reading the Rod

The numbers on the face of the rod show the distance measured from the ground in feet. The scale can be read to the one hundredths of a foot. Whole numbers of feet are marked off on the scale on the left of the rod by the longer line with an angled end. For example, see the number 3.00 in Figure 2. The number of feet is read at the top of this line and is indicated by the large red numbers. Tenths-of-feet are also marked by a line with an angled end. For example, see the number 2.90 in Figure 2. The black numbers indicates the number of tenths-of-feet.

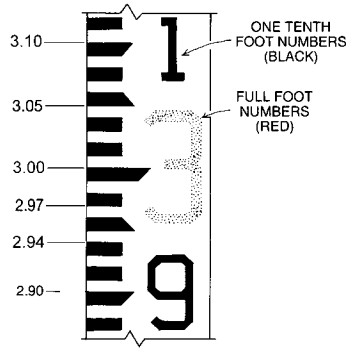

Figure 2. Face of the survey rod

Each black line and each white space on the scale is exactly one hundredths of a foot. The top of each black line, between the angled tenth-of-a-foot lines, mark off 2/100th's of a foot. Even number hundredths of a foot can be read at the top of the lines. Odd number hundredths of a foot are read at the bottom.

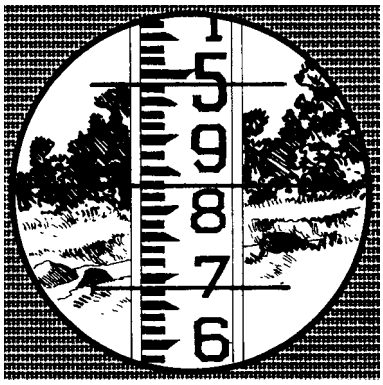

Figure 3. Reading the rod. The elevation is read at the middle line. The upper and lower lines are called stadia.

Point the telescope towards the rod. The center crosshairs should cross the face of the rod (Figure 3). Turn the focus knob until the rod can be clearly seen. Adjust the eyepiece to darken or lighten the cross hairs. I f the rod is leaning to the side, ask the rod person to move the top of the rod until it is vertical. The rod person should try to keep the rod vertical along your line-of-sight. The center crosshair gives the elevation. Do not use the upper or lower lines for elevation. The upper and lower lines are called stadia. Using the stadia lines to measure distance will be described later.

Directions for the Rod Person

The rod person decides where to set the rod, which is the most vital part of the survey.

The level is attached to the back of the rod. Use the bubble on the level to adjust and maintain the rod so that it is vertical. Stand behind the rod so that the rod can be held vertical and the level can be read. Holding the rod vertical is essential. If the rod leans forward or backwards the reading will be larger than the true value, see Figure 4.

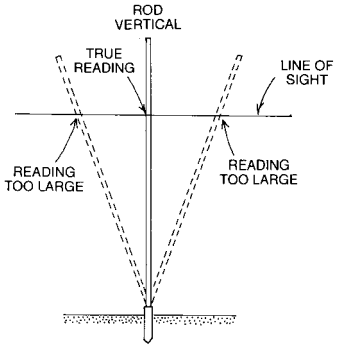

Figure 4. Keep the rod vertical.

When changing the length of the rod it is essential that each section be fully extended and properly secured. When a section of the rod is fully extended a locking button should pop into place.

Measuring Distance

Measuring with Tape

- Tapes marked in feet that can be read to the hundredth of a foot can be used to measure distance. Always make sure that the tape for the horizontal distance is the same standard as your stadia rod.
- When measuring horizontal distance stretch the tape tight before making the reading.
- Do not use a tape to measure the horizontal distance if the tape cannot be stretched out on a horizontal line between the points.

Measuring distance with surveying level

Use the level and the survey rod to estimate distances where stretching a tape would be difficult. To do this read the *stadia,* the short crosshairs above and below the central crosshair on the survey rod.

- Set up the level at one end of the distance to be measured. Place the Survey Rod at the other point.
- Read the rod at the upper and the lower stadia line.
- Subtract the lower stadia reading from the upper stadia reading
- Multiply the difference by 100 to get the distance from the instrument to the rod.

Differential Level Survey

A differential level survey is used to measure the relative elevation of points that are quite far apart. For example, a differential level survey can be used to determine the true elevation of your benchmark if a point of known true elevation is several hundred feet from your site. It consists of making a series of instrument setups along a route that ends back where it began. The route of the survey is called a *traverse*. From each instrument setup, the rod is taken to a point of known elevation to establish the *instrument height*. The instrument height is used to calculate the elevation of new points after the rod is read on the new point. Temporary reference points, called *turning points*, are

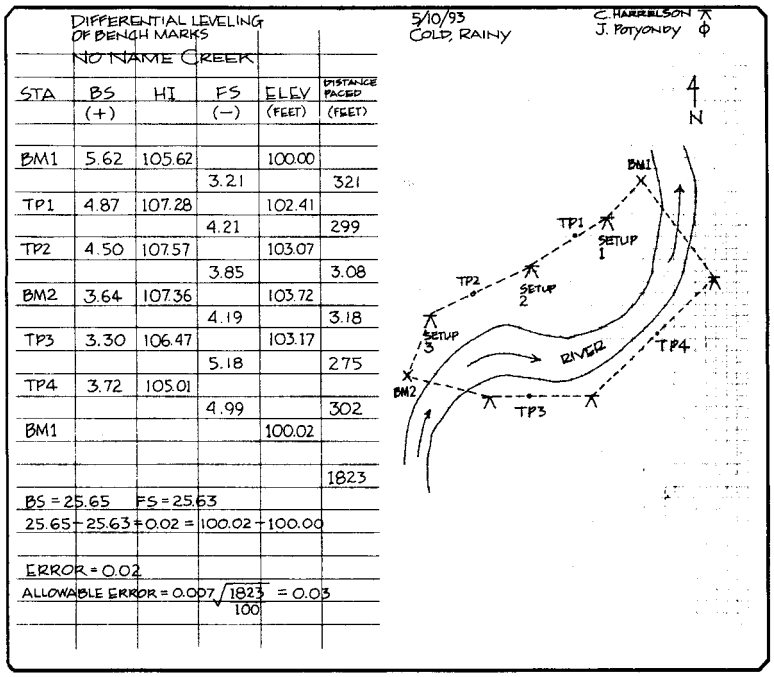

Figure 5. Field notes from a differential survey. The purpose of the survey is to find the elevation of BM-2 relative to BM-1. The traverse starts at BM-1. Returning to BM-1 closes the survey.

established before the instrument is moved to a new location. The details of the process are described below.

- The first reading (a reading is also called a *shot*) is to the benchmark. In Figure 5, the benchmark is BM-1. The elevation of the benchmark is known or assumed, see Figure 6. If the elevation of the benchmark is assumed it is strongly recommended that you survey from your benchmark to a benchmark with known elevation.
- Place the rod on the benchmark.
- Get the rod vertical.
- Read the scale where the crosshair crosses the rod face.
- Record the reading in the field book as a *backsight*. In the notes, *backsight* is abbreviated as BS.

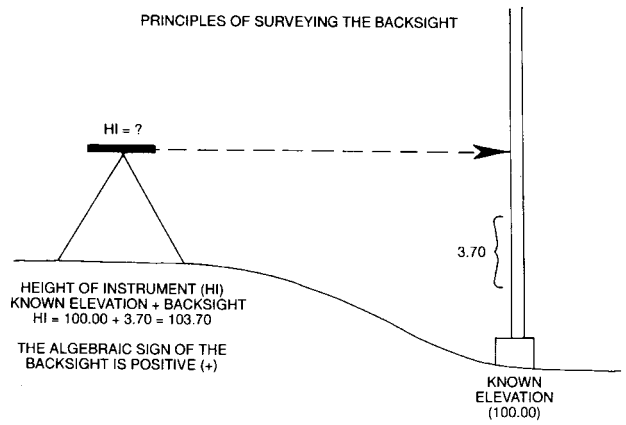

Figure 6. Shooting the backsight to find the instrument height.

- The shot to the benchmark is called a backsight. The backsight reading is added to the elevation of the benchmark to calculate the *instrument height*, see Figure 6. The instrument height is the elevation of the instrument crosshair.
- The notes shown in Figure 5 give an example of a differential survey. The elevation of BM-1 is given as 100.00 feet. The backsight to BM-1 is 5.62 feet. Thus, the height of the instrument, for the first setup, is 105.62 feet.
- Use a tape, the stadia method, or pacing to measure the distance from the instrument to the benchmark. Record the distance in the field book. The total distance covered by the survey is used to calculate the allowable error of the survey. This will be explained below.
- In Figure 5, the distance was determined by pacing. The distance between BM-1 and TP-1 is shown as 321 feet.
- The rod person should drive a stake in the ground as a temporary reference known as a turning point, TP. The TP should be in the direction of the survey and about the same distance from the instrument as the benchmark. The stake should be solidly in the ground so that it does not shift.
- The rod is then placed on the TP and the instrument person reads the elevation and records it as a foresight, see Figure 7.
- For example, in Figure 5, the foresight, FS, of TP-1 is 3.21.
- The foresight of TP-1 is subtracted from the instrument height to determine the elevation of TP-1.

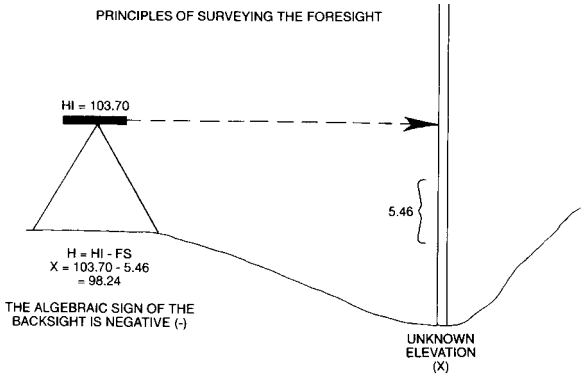

Figure 7. Shooting a foresight. The instrument height is already known.

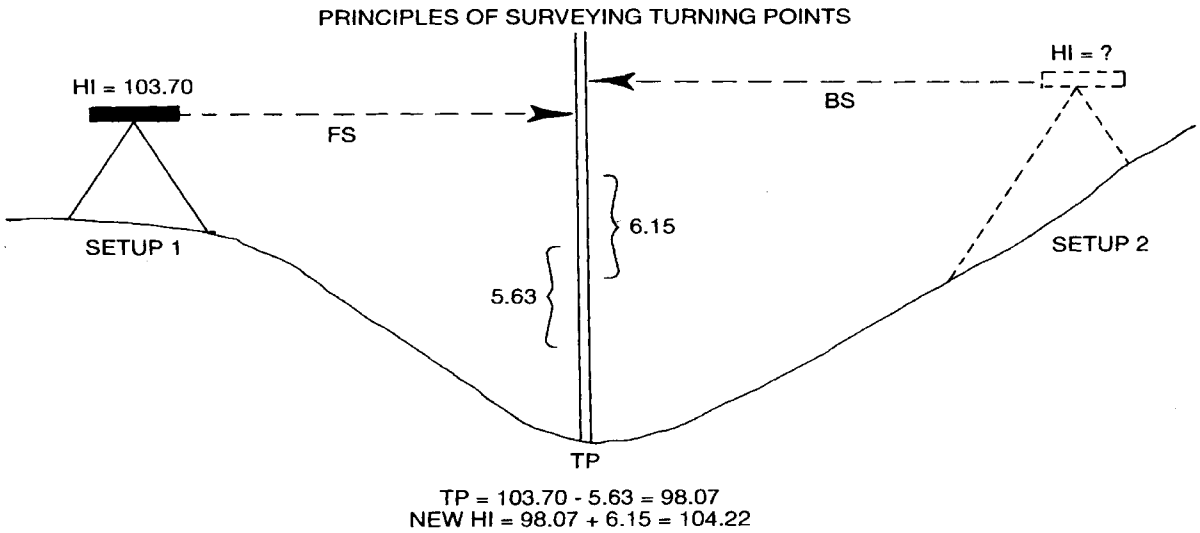

Figure 8. Using *turning points* to move the instrument.

- For example, in Figure 5, the foresight of TP-1 (3.21) is subtracted from the instrument height (105.62) to calculate the elevation of TP-1 (102.41).
- The instrument is then moved to the other side of TP-1.
- The rod is then placed on TP-1 and the rod is read as a backsight, after the instrument has been setup and leveled. The backsight is added to the elevation of TP-1 to calculate the instrument height. For example, the backsight to TP-1 from setup 2 is 4.87 feet. The backsight (4.87) is added to the elevation of TP-1 (102.41) to calculate the instrument height (107.28) at setup 2.
- The process outlined in steps 1-8 is repeated until the traverse is closed by shooting the original benchmark as a foresight. See the map in Figure 5.
- After you have closed the survey, the elevation of the benchmark at the end of the survey is compared to its original value. This process is known as closing the survey. The difference between the calculated elevation of the benchmark and its original value is the error.

  The acceptable amount of error depends on the total distance of the differential level survey. One equation to estimate the acceptable error is:

$$Acceptable\ \ Error \leq 0.007\sqrt{(total\ \text{distance})/100}$$

Where the *total distance* is the sum of the distances between the instrument stations in the differential level survey loop. For example, in Figure 7, the total distance of the differential level survey is 1,823 feet and the acceptable error is 0.03 feet.

A differential level survey can be performed as part of a longitudinal survey or cross-section survey. These types of surveys are described in other protocols. The purpose of the longitudinal and cross-section surveys is to gather elevation and distance data for selected points along the stream channel.

References

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Appendix D
Field Equipment

Introduction

There are a variety of different types of equipment and instrumentation available to help take field measurements. Below is a description of the equipment we will be using for in-stream monitoring program. Please carefully read the instructions describing the use of each. For quality and measurement control each surveying team will have to fill out the attached instrument form.

Tapes

We have two types of tapes: lineal tapes that measure distance, and Spenser diameter tapes for measuring tree diameter.

Lineal Tapes

We have several lengths of tapes. The longest tapes are 200 ft. tapes, fiberglass and marked in tenths of feet. These tapes are used for the longitudinal profiles and cross-sections. The tapes that are marked in inches (usually reel tapes) are used for the riparian plots.

Spenser diameter tapes

Spenser tapes are two sided tapes. One side is calibrated so that when the tape is wrapped around the circumference of a tree, the tape is actually showing the diameter of the tree [so it is adjusted by a factor of π because C (circumference) $= \pi$ (diameter)]. This side of the tape is printed in red ink. The other side is a lineal tape. A common error is to read the lineal side of the tape instead of the diameter side. Be sure to check your reading of the tape to make sure the number you have called out for diameter actually makes sense.

Diameter is almost always measured at breast height (DBH). DBH is the point on the tree trunk that is 4.5 feet from the ground. An easy way to measure DBH in the field is to pre-measure where 4.5 ft. is located on your body, then you will be able to easily estimate this height.

Pacing

In many field situations, pacing (or counting your steps) is the preferred method of measuring distance, where very precise distance measurements are not necessary. With practice, pacing can be quite accurate. However, it is usually not so accurate in the mountains of the Pacific Northwest, where slopes are steep, slipping is common, and large logs often interfere with straight-line travel. Nevertheless, pacing is a standard method used for rough separations of distance.

Start with a lineal tape and lay out a straight-line course of at least 300 feet. A pace is defined as two steps, so if you start walking with your right foot, the spot where your left foot lands is equivalent to one pace. Pace to the end of the calibrated line and total the number of paces you took. Repeat the process several times. The average number of paces, divided into the length of the line, is your pace length. Some people find that pace length in meters is preferable, others like the English units of feet (which are a little more precise as the unit is smaller). Pick your favorite, but know the conversion factor between them (feet X 3.3 = meters, meters/3.3 = feet).

Once you know your pace, you can follow simple compass courses on flat ground with relative ease.

Clinometers

A clinometer is a handy device for determining slope (in percent) and for measuring tree height. The standard Suunto brand will be employed. It has a dial containing two scales: percent on the left, and degrees on the right. As one sights the clinometer with one eye and leaves the other eye open, objects are lined up with the horizontal line in the dial, and a degree or percent then can be read off the dial. In case there is confusion about the dial, turn the clinometer up vertically and the scales are defined on the left and right side of the dial. We employ the percent scale to denote slope steepness, and the angle scale for an estimate of tree height.

Slope Determinations

In order to determine slope steepness, sight the clinometer directly upslope or downslope on an object that is at eye height in either direction. The reading on the clinometer is the percent slope (left scale) or slope angle (right scale). In the upslope direction, the reading will be (+), while in a downslope direction it will read (-). Often, an upslope and downslope measurement will be averaged to determine average slope steepness, but the direction of the reading (+ or -) is not included.

Tree Height Determinations

The determination of tree height uses the angle scale on the clinometer.

You must be a known distance of 66 ft away from the tree. Sight the clinometer at the base of the tree and then the top of the tree. On flat ground, you are generally sighting from zero to the top of the tree, but "zero" is really eye height, so your eye level must be added to the height.

If you have to take readings on slopes. Try to move laterally (across slope) for tree height measurements - your horizontal distance will be more accurately measured.

On a slope you will generally be either below or above the base of the tree. Generally the position above the tree is more accurate than being below the tree. If above the tree base but below the top, you must add both sightings together. If below the tree base, you must take a sighting to the top of the tree, and subtract from it the sighting to the bottom of the

tree: (for example, 100 to top, 30 to bottom = 70 ft. reading). If above both the tree base and the top of the tree, usually you'll have to move your position.

Spherical Densiometers

The spherical densiometer can be used as a hand held instrument to estimate relative vegetative canopy closure or canopy density caused by vegetation. Vegetation canopy closure is the area of the sky over the selected stream channel that is bracketed by vegetation (regardless of density). Canopy density is the amount of the sky blocked within the closure by vegetation. Canopy closure can be constant throughout the season if fast growing vegetation is not dominant, but density can change drastically if canopy vegetation is deciduous.

Canopy density is measured in conjunction with the riparian plot surveys and canopy closure is measured when installing temperature data loggers.

Operation of the Spherical Densiometer to Estimate Canopy Density

The spherical densiometer should be held 12-18 inches in front of your body and at elbow height, so that the operator's head is not visible in the mirror (and will not be counted as canopy cover!). Make sure the level bubble is level. In each square of the grid, assume that there are four dots, representing the center of quarter-square subdivisions of each of the grids. In the following instructions, it is assumed that you are under a forest canopy where openings are less common than canopy. Systematically count the number of dots NOT occupied by canopy (where you can see sky at that dot). Multiply the total count by 1.04 to obtain the percent of overhead area not occupied by canopy, as there are only 96 dots to count. The difference between this and 100 is the canopy cover in percent. Make four readings per location – start by facing upstream then turn in a clockwise fashion taking a reading every 90 degrees – and average them to provide an estimate of canopy cover from that point.

Obviously, this instrument is not useful for measuring understory tree, shrub, or herb cover.

Operation of the Spherical Densiometer to Estimate Canopy Closure

These instructions are for using a convex spherical densiometer that has adapted to the modifications developed by Strickler (1959). Strickler uses only 17 of the line intersects as observation points by taping a right angle on the mirror surface (Figure D-1).

Stand in the middle of the stream channel facing upstream. The densiometer is held in the hand, in front of the body at waist level, with the arm from the hand to the elbow parallel to the water surface. The convex densiometer is held away from the observer's body with the apex of the V pointed towards the observer. The observer's eye reflection should be seen along the margin of the original grid (Figure D-1). Level the densiometer using the bubble indicator and maintain the level and standard eye positions while recording. The grid between the V formed by the tape encloses 17 observation points. Each point has a value of 1.5 percent when four different readings are made. The number of points <u>surrounded by vegetation</u> are counted when measuring canopy closure.

Measurements are taken in four quadrants while standing on the same point (facing upstream, right bank, downstream, left bank).

The points counted for each reading are totaled and multiplied by 1.5 to obtain the percentage of canopy closure.

If all possible observation points are counted, the total value will be 102 percent (68 x 1.5 = 102). Although this error is small and not considered important for comparisons of relative values, the following correction factor can be applied to determine the correct percentile:

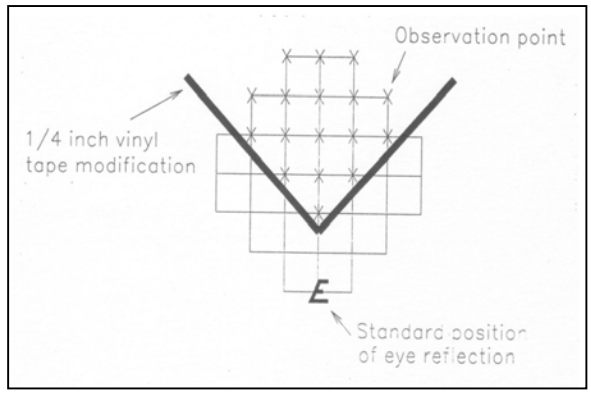


Figure D-1: Modified grid of spherical densiometer.

Calculated Value	Subtract from Calculated Value
Less than 30	0
30 to 60	-1
Over 60	-2

Example: (8+11+7+12)(1.5) = 57% subtract 1% = 56% closure

The Compass

Compasses come in many types. The examples below use the Silva Ranger Type 15 compass. This may or may not be the type of compass you have in the field. The Silva Ranger has some adjustments not seen in other compasses. While the principles of compass use are standard, their application to a particular compass type may be unique. This compass is graduated in 2 degree (^{o}) increments of azimuth from 0° to 360°. North is 0°, east is 90°, south is 180°, west is 270° and north again is 360° (0°). The compass has three basic parts. The Magnetic Needle is attracted by the magnetic North Pole of the earth. The red end points north and the white end south. The Graduated Dial turns and can be set to any desired bearing. The bearing is set to read in degrees. The Base Plate with Sighting Mirror is the housing of the compass and serves to point out the line of travel.

Beware of iron or steel objects if they are close to the compass. They will throw off the readings of the compass.

Map and Field Bearings

If you are working from a bearing on a map, it is referenced to true north and is called a true bearing. This is not the same as working from uncorrected bearings in the field, such as the location of a mountaintop in the distance that you take a compass bearing on. Sections A, B, C, D, and E below are based on working from “map to terrain” and deal with true bearings. Sections F and G are uncorrected bearings and are based on working from terrain to map.

Section A. How to use the compass to point out desired directions

First, the dial must be set to the desired degree reading. If this is known, simply turn the dial so that the correct reading appears at the index pointer. Second, without changing the dial setting, the entire compass must be positioned so that the orienting arrow lines up with the magnetic needle and the red end of the needle lies within the two orienting points. When these two conditions are fulfilled, the desired direction is indicated by the sighting line. Always keep the compass level so that the needle can move freely.

Section B. Using the compass without the sight.

When the dial is set as described in Section A, you can use the compass either with or without the aid of the sight. In situations where fast action is important, open the cover wide and make sure the orienting arrow and magnetic needle are lined up. The sighting line extends straight from the index pointer across the sight. Fix your sight on a distant object and head for it.

Section C. Using the compass with the sight.

For situations where accuracy counts, use the sight. The dial is set as in Section A. Hold the compass at eye level and adjust the cover to slightly less than a 90° opening, so the mirror reflects a top view of the compass dial. While looking in the mirror, move your sighting eye sideways until you see the sighting line intersect one of the two luminous points. Without changing the relationship between compass and eye, pivot yourself and compass together until you see in the mirror that the orienting arrow is lined up with the magnetic needle and the red end of the needle is between the orienting points. Your direction or objective will now lie straight beyond the sight on the upper edge of the cover.

Section D. How to obtain your bearing from a map.

In Section A, one of the two basic conditions for using the compass is to set the dial at the desired degree setting. If this degree, or bearing, is not known, it can be easily determined from a map. First, lay the compass on the map so either the inch scale or millimeter scale is exactly on (or parallel with) the line on the map you wish to travel, AND the hinged cover points in the direction you wish to travel. Then, while holding the compass in position on the map, turn the dial so the meridian lines of the compass are exactly parallel with any meridian (north-south) line on the map, AND the letter “N” on the top of the dial is toward North on the map (not turned down toward South). You may now remove the compass from the map. In these two steps your compass was set for the degree reading to your destinations and this reading may now be used as the index pointer. In fact, while performing these two steps you automatically fulfilled the first basic condition mentioned in Section A, and you may directly proceed to use the compass as per Section B or C.

Section E. How to Take a Bearing.

A "bearing" means the direction or the degree reading from one object to another. One of those objects is usually YOU. To "take" a bearing means to determine the direction from one object to another.

A. From a map, bearings are taken as described in Section D. The "bearing" is the degree reading indicated at the index pointer.

B. Out in the terrain, bearings can be taken by reversing the steps described in Sections B and C. For example, if you are using the compass without the sight, open the cover wide and hold it level and waist high in front of you. The sight and sighting line should be pointing directly ahead of you. The sighting line acts as a pointer. Pivot yourself and your compass around together until the sighting line points straight to the object on which you are taking the bearing. Without changing the position of the compass, carefully turn the dial until the orienting arrow and the magnetic needle are lined up and with the red end of the needle lying between the two orienting points. The "bearing" to your objects is now the degree reading indicated at the index pointer.

C. In a similar manner, bearings can be taken by using the sight. In this case, hold the compass at eye level and adjust the cover so the top of the dial is seen in the mirror. Face toward your object and sight across the compass sight. Look in the mirror and adjust the position of the compass so that the sighting line intersects one of the luminous points. While you simultaneously see your object across the sight, and the sighting line across one of the luminous points, turn the dial so that the orienting arrow is line up with the needle, red end being between the orienting points. The "bearing" to your object is now the degree reading indicated at the index pointer.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual*, Third Edition.

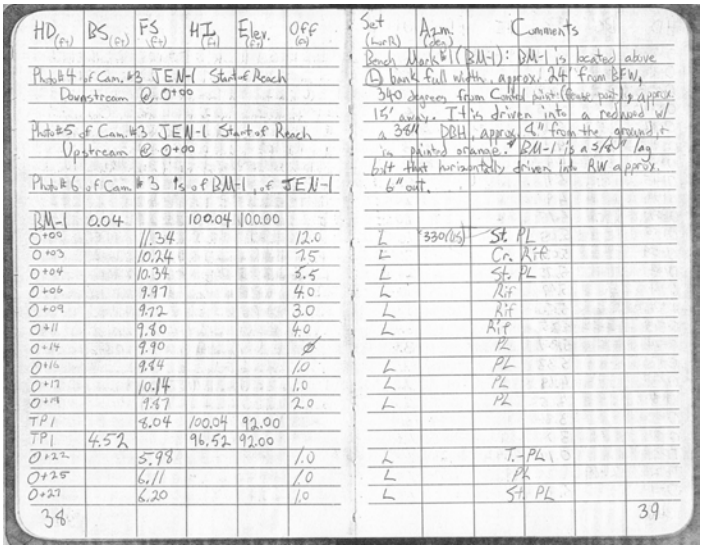
Appendix E
CHANNEL FORM MONITORING

Getting started

Before the fieldwork starts surveyors need to organize their notebooks, forms and equipment. Verify with the GRWC that all the property owners along the study reach have given permission for the monitoring. In addition, make sure that proper notice is given to the property owners before starting the fieldwork.

Directions for Organizing the Level Notebook

Set up the level notebook for the site. Use a *Rite-in-the-Rain* (or equivalent brand) All-Weather Level Notebook. These books are about 5”x 7” and each page has six columns. Laid flat, they photocopy onto 8-1/2” x 11” sheet for standard filling.



HD (Ft)	BS (Ft)	FS (Ft)	HI (Ft)	Elev. (Ft)	Off (Ft)	Set (Left/R)	Azm. (deg)	Comments
Photo #4 of Cam. #3 JEN-1 Start of Reach Downstream @ 0+00								
Photo #5 of Cam. #3 JEN-1 Start of Reach Upstream @ 0+00								
Photo #6 of Cam. #3 ↑s of BM-1, of JEN-1								
BM-1	0.04		100.04	100.00				
0+00		11.34			12.0	L	330(1/5)	St. PL
0+03		10.24			25	L		Cr. Rif
0+04		10.34			8.5	L		St. PL
0+06		9.97			4.0	L		Rif
0+09		9.72			3.0	L		Rif
0+11		9.80			4.0	L		Rif
0+14		9.90			Ø			PL
0+16		9.84			1.0	L		PL
0+17		10.14			1.0	L		PL
0+19		9.87			2.0	L		PL
TP1		8.04	100.04	92.00				
TP1	4.52		96.52	92.00				
0+22		5.98			1.0	L		T. PL
0+25		6.11			1.0	L		PL
0+27		6.20			1.0	L		St. PL

Bench Mark #1 (BM-1): BM-1 is located above (1) bank full width, approx. 2ft from BFW, 340 degrees from Control point (base point) approx. 15' away. It is driven into a redwood w/ a 36" DBH, approx. 4" from the ground it is painted orange. BM-1 is a 3/4" lag bolt that horizontally driven into RW approx. 6" out.

Figure 9: Sample page from Level Notebook

- Step 1: Number all the pages in your notebook.
  Note: Leave the first page blank for the Table of Contents, which will be filled in after the survey is finished.
- Step 2: Introductory page. Go to the second page and prepare an introductory page with the site name and number, project description, date and weather, names and tasks of crew.
  Note: This information will be repeated in a new introductory page each day before you start surveying.
- Step 3: Label the notebook columns, see Figure 2.
  - The first column is labeled **HD** for *Horizontal Distance*.
    The HD is the distance along the thalweg where the elevation readings are taken.
  - The second column is labeled **BS** for *Backsight*.
    The BS is the actual vertical distance from the point of known elevation to a horizontal line projected by the instrument. There is only one BS for each setup of the instrument and it will always be your first reading after setup.
  - The third column is labeled **FS** for *Foresight.*
    The FS is a rod reading taken on any point to determine its elevation.

- The fourth column is labeled **HI** for *Height of the Instrument.*
  The HI is computed by adding the backsight reading to the benchmark elevation or the elevation on which the backsight was taken. HI=Elev +BS
- The fifth column is labeled **Elev**ation.
  The point at which elevations are known or determined are either benchmarks or turning points. To determine the elevation of all other points use Elev=HI-FS.
- The sixth & seventh column is labeled **Offset** for the *horizontal distance offset*.
  The offset is the distance from the HD tape to the actual rod placement site in the thalweg. It is rounded to the nearest foot. Which side of the tape the offset is on is also noted by listing left or right bank.
- The eighth column is labeled **AZM** for the *azimuth* of the *horizontal distance* tape.
  The azimuth of the horizontal distance tape is taken looking upstream and always when there is a change in the direction of the tape.
- The last four columns are labeled **Comment**.
  This is where the surveyors record the type of habitat being surveyed (i.e. pool, riffle, run). In addition, surveyors should record other factors such as fish or amphibian presence, types of vegetation or unusual features.

Be neat and orderly so that the data you record can be easily read. Note all pertinent details in your descriptions. Over the years, the field book will be used to re-locate the benchmark and various survey stakes or markers. The field book will also be the source of data used to analyze the changes in stream shape with time.

Figure 10: Surveying Equipment

Directions for Organizing the Supplemental Forms

Set up a binder or covered clipboard that contains the following documents and supplemental data forms copied onto *Rite-in-the-Rain* paper:

- ❑ A topographical map
- ❑ Copies of old field notes and data forms
- ❑ Copies of all the landowner access agreements
- ❑ Equipment Form
- ❑ Pebble Count Forms (2 sheets)
- ❑ Large Woody Debris Forms (5)
- ❑ Canopy Forms (1)
- ❑ Riparian Plot Forms (12 sheets)

Directions for Organizing the Equipment

Make sure all your equipment has been properly calibrated and is in good working order, see Figure 10. Fill out the Equipment List Form (page 12) making sure you include all the serial numbers. Check your equipment against the following list:

- ❑ Engineer's Level
- ❑ Tripod
- ❑ Stadia Rod
- ❑ Bullet Level
- ❑ Compass
- ❑ Calculator
- ❑ 11 Fence Posts
- ❑ 10 Lag Bolts & Driver

- ❑ 200’ Fiberglass Tape
- ❑ 150’ Fiberglass Tape
- ❑ Spencer Tape
- ❑ 25’ Steel Tape
- ❑ Clear Metric Ruler
- ❑ Clinometer
- ❑ Densiometer
- ❑ 24 pieces of 3’ Rebar
- ❑ Flagging
- ❑ Rudd paint
- ❑ Aluminum & Code Tags
- ❑ Sledge Hammer
- ❑ Fence Post Pounder
- ❑ Clippers & Machete

Identifying Bankfull

A stream is said to be at bankfull when the water is at the top of the bank and just about to overflow, see Figure 4. The flow at bankfull (bankfull discharge) is the flow that, over time, shapes the channel. The bankfull width is measured by locating indicators of the bankfull level on opposite banks of the channel and measuring the horizontal distance between the points.

Bankfull Indicators (Leopold, 1994).

1. The point bar is the sloping surface that extends into the channel from the bank on the inside bend of a curve in the channel. The top of the point bar is usually at the level of the floodplain. Floodplains generally result from the extension of point bars as the river moves laterally by erosion and deposition through time. The top of a point bar is the lowest possible level of bankfull.
2. The bankfull level is usually marked by a change in vegetation. For example, the change from bare gravel bar to forbs, herbs and grass. Willows can occur well below bankfull. Usually large mature alders do not occur below bankfull. The type of lichens or moss may change at the bankfull level.
3. A topographic break usually occurs at bankfull. The ground may change from a slope bar to a near vertical bank. The change in topography may be subtle.
4. The bankfull level is often marked by a change in size of material on the bed. The change can be from fine to coarse or from coarse to fine.
5. Deposits of flood debris are unreliable and should be used only as a confirmation of other indicators. Debris deposits often indicate the level of the last large flood and may not indicate the bankfull level. Debris in willow branches may have been deposited when the branches were bent over by the force of the floodwater.

Directions for Locating Bankfull Indicators

Use the following procedure to flag bankfull indicators on both sides of the stream. The most consistent indicators on both sides of the channel will indicate the bankfull level. Designate one color of flagging for bankfull indicators. An easy method to flag the bankfull indicators is to put a nail through a piece of flagging and push the nail into the ground

- Step 1: Flag the top of any point bars in the marked reach.
- Step 2: Look for the lower limit of perennial vegetation or a change in vegetation type or density. Flag several of these points on both banks.

  Note: Remember that after extended periods of drought, perennial plants may invade the channel.
- Step 3: Flag the lower limit of moss or lichens on the banks or rocks.

- Step 4: Flag the lowest mature alders on both sides of the channel.
- Step 5: Look for and flag changes in the slope of the bank.

  Note: A change from a near vertical to a horizontal surface is the best indicator of the floodplain and bankfull level. Many streambanks have multiple changes in slope so be careful. A slope break may also indicate a terrace. A terrace is an old floodplain that has been abandoned by a downcutting stream. A terrace usually has perennial vegetation and definite soil structure.

- Step 6: Flag changes in bank materials.

  Note: Typically, a change from coarse to fine material on the surface of the bank indicates the bankfull level. However, the change can also be from fine to coarse. Changes in bank slope are often associated with a change in the size of the bank material.

- Step 7: Look for undercut banks covered by dense root mat from perennial vegetation. Feel up beneath the root mat and estimate the upper extent of the undercut. A spike or pin-flag may be inserted horizontally through the root mass and located by touch at the upper extent of the undercut. This will probably be slightly lower than bankfull.

  Note: Undercut banks are often the best indicators in steep or confined streams that lack a floodplain.

- Step 8: Note any inundation water lines. These may be marked by sediment or lichen. Stain lines are often left by frequent low flows so bankfull is at or above the *highest* stain line.
- Step 9: Wade to the center of channel to view bankfull on both banks. Note features such as bars, boulders, root wads that may effect the water surface elevation or direct the current.
- Step 10: Discuss the significance of individual indicators. Assess the indicators and determine bankfull.
- Step 11: Remove flagging that does not designate bankfull.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the flagging used to mark the bed-material regions. Pick up any trash you may have dropped.

Establish the Benchmarks

When the study reach is established a primary benchmark is selected and its location documented. The survey level is set up where the benchmark and the stream channel are visible. The elevation of the benchmark is shot and recorded. In subsequent years, the benchmark is used as the vertical (elevation) reference for the survey.
A benchmark is a permanent mark near the area to be surveyed that can be located every year. The benchmark serves as the vertical or elevation reference point for the study reach. The elevation may be assumed (100 ft. is normally used) or tied into a project datum or mean sea level.

- For long-term permanent sites three benchmarks are established near the beginning of the study reach. Each cross-section associated with a longitudinal profile must have a benchmark installed on the left and right bank.
- The benchmarks are located outside of the channel, above bankfull and if possible above the floodplain but within line of sight of the reach start point.
- One of the benchmarks should be located on the opposite bank from the other two. This will allow recovery in case of a bank failure.
- The two recommended methods for establishing benchmarks are:
  1. Lag bolt monument – screw a 6-inch lag bolt into the base of a large, healthy tree so the stadia rod can be set on its head and be visible and leveled (no over-hanging branches, etc.). Select a healthy tree (typically a conifer) 14'' in diameter or larger, with roots that are protected from stream erosion, and not subject to windthrow.
  2. Fence post monument – drive an 8' fence post vertically to within 2' of the ground surface. Fence posts need to be installed above bank-full.

Before starting to survey always review the material in the Surveying Basics, Appendix C.

Directions for Installing Benchmarks

- Step 1: Install the access marker for the study reach.
  Install a fence post marker at the nearest road access point. Tag with station ID (stream name & site #).
- Step 2: Install the benchmarks.
  Install 3 benchmarks using lag bolts screwed into the base of trees or fence posts. Number the benchmarks and tag (use aluminum tags) with station ID (stream name and site #), and benchmark #.

  Note: All benchmarks need to be installed outside of bankfull, in stable ground. At least one benchmark should be installed on the opposite bank. All benchmarks need to have a clear line of sight to the reach start point. Benchmark #1 should be the primary benchmark with the most secure location and the best line of sight to the study reach start point.
- Step 3: Document the primary benchmark position.
  Stand at the access marker and with your compass find the azimuth and estimate the distance from the access marker to the primary benchmark (benchmark #1). Record the azimuth in your level notebook.
- Step 4: Document the secondary benchmarks positions.

Stand at the primary benchmark (benchmark #1), find the azimuth and estimate the distance to both secondary benchmarks (benchmarks #2 and #3), record in your level notebook under site description.

- Step 5: Photo Documentation.
  From the access marker take a photo of the primary benchmark (benchmark #1).
  From the primary benchmark take photos of the secondary benchmarks (benchmarks #2 & #3). Log the photo numbers with a description of the photos (i.e. Photo #1 = BM1 taken from access marker) in your level notebook.
- Step 6: Mapping.
  In your level notebook describe in detail the location of your benchmarks, access marker and study reach start. Draw a site map of the area.

Reviewing the Study Reach

After finding bank-full at the start of the study reach, installing or finding the existing access markers and benchmarks, your next step is to walk the study reach from beginning to end. As you walk up the reach, observe the following:

- Location of benchmarks
- Bankfull and the active channel
- Location of all cross-sections
- Location of logjams
- Location of the reach end points
- Roads and topographic features

Documents from past surveys will help you identify the beginning and end of the reach and cross-section benchmarks. If the study reach has not been previously surveyed then you need to look for flagging that delineates the reach segments. Also note access points to the nearest road. As you work your way up the study reach you may find it helpful to find new access points along the way.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Longitudinal (Thalweg) Profiles

Repeated longitudinal profile surveys of the stream channel are done to document changes in channel form and hydraulic variables. After the benchmark elevation is calculated, the rod person moves to the downstream end of the study reach and the thalweg is profiled. Riffles, runs and pools are defined and the elevations measured.

The survey is conducted in conjunction with the benchmarks, the cross-sections, the pebble counts and the Large Woody Debris surveys. All five surveys are linked by either elevation or horizontal distance.

Before starting to survey always review the material in the Surveying Basics, Appendix C.

Directions for Laying out the Horizontal Distance

- Step 1: Monument the start of the study reach.
  Install fence posts outside of bankfull on the left and right banks in a line, which is perpendicular to the flow. Starting at left bank lay a tape between the fence posts.
- Step 2: Find the starting point for the horizontal distance (HD).
  Find the center of the channel in the lay line between the two fence posts marking the start of the study reach. *This is your starting point for the HD*. Stake by using a temporary piece of rebar.
  > *Note: This is your starting point for the longitudinal profile. You will attach the zero (0+00) end of your thalweg tape to this stake.*
- Step 3: Document the HD starting point.
  Record the distance from the left bank fence post to the HD starting point.
  Then stand at the primary benchmark. Take a bearing to the HD starting point, record.
  Measure and record the distance from the primary benchmark to the HD starting point.
  > *Note: Record all distances and azimuths in your level notebook under the description of the site. The measurements will assist future surveyors to find the exact starting point of your survey.*
- Step 4: Laying the horizontal distance tape.
  Attach the zero ft end of a 200' fiberglass tape to the HD starting point stake. Walk up-stream near the thalweg and lay the tape in as straight a line as possible. Stake any curves in the tape. Stake the 200 ft end.
  > *Note: The tape may be layed up to 20' from the thalweg. Any curve in the tape needs to be staked to an angle.*
- Step 5: Flagging for riparian plots.
  Flag left and right bankfull at the HD starting point for the riparian plot surveys. You will continue to flag bankfull every 200' when you start a new segment.
  > *Note: <u>Always</u> record on flagging: stream name, site #, distance, date, purpose, crew.*
- Step 6: Photo documentation.
  Stand in middle of channel at the HD starting point. Take photos of the stream channel; first looking downstream then upstream. Record photo numbers in your level notebook.
  > *Note: Photo documentation is repeated at all cross-sections and the end point (1000')*

Directions for Performing the Longitudinal Profile Survey

- Step 1: Setup the engineer's level.
  Setup the level at a location where both the benchmark and the downstream end of the study reach are visible. The line-of-sight of the level must be higher than the benchmark.
  Note: To set up the level follow the instructions in Surveying Basics in Appendix C. Choose the location to minimize the number of times the level will have to be moved. Moving the level adds time and potential error to the survey.
- Step 2: Surveying the benchmarks.
  1. Turn the telescope to view the primary benchmark. The rod person places the rod on top of the benchmark. The rod is held vertically by using a level.
     Note: Stand so that you can control the rod and see the level.
  2. The instrument person reads the elevation on the rod and records it as a backsight. After recording the backsight elevation, re-check the rod reading.
     Note: The elevation of the primary benchmark will be set at 100'. See Figure 6 in the Surveying Basics section.
  3. Calculate the instrument height by adding the elevation of the benchmark to the backsight (HI=Elev + BS).
  4. Turn the telescope to the secondary benchmarks and repeat the process.
     Note: Elevations of the secondary benchmarks are not recorded in the BS column but in the site description area.
- Step 3: Surveying the thalweg.
  1. The rod person stands at the HD starting point looking up-stream. Take the azimuth and distance (in this case the distance would be 0+00) of the first straight section of the HD tape. The instrument person records the azimuth in the AZM column at the distance the azimuth is taken.
     Note: The distance and the azimuth of the HD tape are always recorded at each angle change throughout the longitudinal profile.
  2. The rod person moves to the thalweg at the HD starting point, tells the instrument person the horizontal distance (in this case it would be 0+00) and then levels the rod.
  3. The instrument person always waits until the rod person says "level" then reads the elevation and records it as a foresight.
  4. The rod person then tells the instrument person the offset of the stadia rod from the tape.
     Note: The offset is rounded to the nearest foot and needs to be recorded as to which side of the HD tape; left or right bank.
  5. Calculate the elevation of the thalweg at the start point by subtracting the foresight from the instrument height (Elev=HI-FS).
  6. The rod person moves upstream to the next survey point in the thalweg.
     - First take the azimuth if the HD tape has changed angles.
     - Second take the horizontal distance
     - Third place and level the rod in the thalweg
     - Fourth take the elevation
     - Fifth take the offset

     Note: The most important thalweg features to measure are; riffle crests, breaks in slope, and the deep points of pools.
     Always measure the beginning, middle and end of any feature.

Measure the elevation whenever the channel bed changes slope. Where the slope is relatively uniform (e.g. a long run, riffle or pool) measurements can be farther apart but not more than 15'.

- Step 4: Follow the above procedure until the instrument person can no longer see the stadia rod. The line of sight may be blocked by vegetation or the stream may curve.
  Note: Vegetation can be moved by using bungee cords to tie it back.

Directions for Moving the Instrument (Turning Points)

- Step 1: Finding a stable foresight elevation.
  Pick a point for a foresight that is stable.
  Note: A boulder, a nail hammered into a piece of large wood or a stake are all good choices.
- Step 2: Recording a Turning Point (TP) foresight.
  In the HD column write TP1 instead of the horizontal distance. Record the elevation in the foresight (FS) column.
  Note: For accuracy, repeat the turning point foresight by removing the rod and then replace it in the same spot, verify elevation.
- Step 3: Moving the engineer's level.
  Setup the level at a location where both the TP and the thalweg of the study reach are visible. The line-of-sight of the level must be higher than the TP.
  Note: To set up the level follow the instructions in Surveying Basics in Appendix C. Choose the location to minimize the number of times the level will have to be moved. Moving the level adds time and potential error to the survey.
- Step 4: Recording a Turning Point (TP) backsight
  Place the rod in the exact spot the TP1 foresight was taken. In the HD column write TP1 instead of the horizontal distance. Record the elevation in the backsight (BS) column.
  Note: For accuracy, repeat the turning point backsight by removing the rod and then replace it in the same spot, verify elevation.
- Step 5: Continue surveying the thalweg along the horizontal distance tape.
  Note: Follow the above steps every time the engineer's level is moved.

Directions for Closing the Survey

- Step 1: Ending the thalweg survey.
  Always end the survey at the designated ending point. Continue surveying up to the end of the designated reach if your last tape lay was short of the ending point.
- Step 2: Differential Survey.
  After you have reached the end of the horizontal distance for the longitudinal survey, you must run a differential survey back to the benchmark. The elevation of the benchmark at the end of the survey is compared to its original value. This process is known as closing the survey. Closing the survey is accomplished by executing a number of turning points from the end of the longitudinal survey back to the primary benchmark. The difference between the calculated elevation of the benchmark and its original value is the error.
  Note: To close the survey you want to use the shortest way back to the beginning (primary benchmark). It is sometimes easiest to use a road or trail that parallels the stream.

For more information consult the Differential Level Survey section in Surveying Basics, Appendix C.

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Cross-section Survey

Permanent cross-sections are essential for monitoring the stream channel. Additionally, the cross-sections sites provide established locations for pebble counts and photo surveys.
Each of our study reaches has three monumented cross-sections and they are surveyed in conjunction with the longitudinal survey. The cross-sections are placed at pool tail crests to document salmonid spawning habitat. Stakes are placed on opposite streambanks to mark each end of the cross-section. The line connecting the stakes should be at right angles to the stream flow. Distance along the cross-section is referenced to the stake on the left bank (facing downstream).

The rod is read on top of the left bank stake. The rod is then placed on the ground next to the stake and read. The rod person then places the rod on a series of points across the channel. The distance is recorded and the rod is read at every *break in slope*. A break in slope is the point where the angle of the ground surface changes (for example, at the top of a bank there is a distinct change in the slope of the ground surface).

The rod and distance should also be read at every significant channel feature such as the top of bank, bankfull indicators, bottom of the bank, edge of water and the thalweg (deepest point in channel).

Before starting to survey always review the material in Surveying Basics, Appendix C.

Directions for Performing a Cross-section Survey

- Step 1: Monument the cross-section.
  Install fence posts outside of bankfull on the left and right banks in a line that is perpendicular to the flow.
- Step 2: Delineate the cross-section data.
  In your level notebook draw a line below your last entry for the thalweg survey. Note that this is the start of a cross-section and the cross-section number.
- Step 3: Measuring the cross-section.
  Starting at left bank lay a tape between the fence posts. Stretch the tape from the left bank stake to the right bank stake. Read and record the horizontal distance between the stakes.
  Note: Leave the tape stretched to guide the rod person as she/he moves from point to point along the cross-section.
- Step 4: Surveying the cross-section.
  1. Start the survey at the left bank stake. Place the rod on top of the left bank stake and record the elevation as a foresight. The HD will be zero and under comments you will note that this elevation is at the top of the left bank stake.

2. Place the rod vertically on the ground next to the stake. Read the rod and record the value as a foresight. The cross-section distance of this elevation is also zero. Note in the comment section that this elevation is the base of the left bank stake.
   Note: All elevations for the cross-section will be foresights unless you need to move the instrument.
3. Then proceed to the next break in slope or the next channel feature, such as the bankfull stage or wetted width.
   Note: The elevations of all breaks in slope, bankfull stage, wetted width and the thalweg need to documented by identifying those elevations in the comment section.
   The maximum spacing between elevations cannot be greater than 5% of bankfull width.

- Step 5: Ending the cross-section survey.
  Continue shooting the elevation and recording the distance at each point along the cross-section. Finish the cross-section by taking the elevation at the base of the right bank stake and then on top of the right bank stake.
  Note: If the tape is too high for the rod person to read the instrument person can read the distance from the instrument to the rod using the stadia lines (see the Basic Surveying protocol). If the distance between the rod and the instrument is measured, make sure that it is recorded as such. It will be necessary to convert the distance from, "the distance from the instrument" to, "the distance from the left bank stake".
  Occasionally you will have to move the instrument to complete the cross-section survey. This may happen if an obstacle such as a large tree limb is blocking your line of sight. Do your turning points before and after you move the instrument. Follow the instructions in Surveying Basics, Appendix C.
- Step 6: Photo documentation.
  Stand in middle of channel at cross-section. Take photos of the stream channel; first looking downstream then upstream. Record photo numbers in your level notebook.
  Note: Photo documentation is repeated at all cross-sections and the start point (0+00') and end point (10+00')

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., ***A View of the River***, 1994, Harvard University Press, Cambridge, MA.

GRWC Monitoring Equipment List

Station: _____ Date: _____

Crew: _____

Equipment	Serial Number
Surveying Book	
200' Fiberglass Tape	
150' Fiberglass Tape	
Carpenters 25' Steel Tape	
Spencer Tape	
Metric Ruler	
Engineers Level	
Tripod for Engineer Level	
Bullet Level	
Stadia Rod	
Stadia Rod Level	
Compass	
Densiometer	
Clinometer	
Camera	
Fence Post Hammer	
Maul	
Electric Drill	
Ratchet	
Machete and/or Clippers	
Other:	

Appendix F
Pebble Counts

Introduction

The composition of the streambed (substrate) is an important factor in how streams behave. Observations tell us that steep mountain streams with beds of boulders and cobbles act differently from low gradient streams with beds of sand or silt. This difference can be documented with a quantitative description of bed material.

The most efficient basic technique is the Wolman Pebble Count (1954). Pebble counts can be made using grids, transects, or random step-toe procedure. We use a step-toe procedure here. Pebble counts are conducted at the three cross-sections in the study reach.

Starting at bankfull, the riffle is traversed and every three feet the surveyor randomly selects a pebble. The pebble is measured at the intermediate axis. It is important for the surveyor to avert their eyes and pick up the first particle touched by their index finger at the toe of your wader. This continues in a zigzag pattern transecting the stream until 100 pebbles are measured.

Pebble counts are easier if you have two surveyors. One to act as the observer who will wade the stream and measure the pebbles and the other as data recorder who remains on the bank.

Directions for Performing a Pebble Count

- Step 1: Start the transect.
  1. Select the closest riffle downstream from the cross-section.
  2. Record the Horizontal Distances (HD) of the downstream and upstream ends of the riffle.
  3. Select a random starting point (perhaps by tossing a pebble) at one of the bankfull elevations.
  4. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader.
- Step 2: Measure the intermediate axis (Figure F-1).
  Measure (with the metric ruler) the intermediate axis (neither the longest nor the shortest of the three mutually perpendicular sides of each particle picked up)
  Note: To measure embedded particles or those too large to be moved in place, measure the smaller of the two exposed axis.
- Step 3: Call out the measurement.

To make sure the recorder has heard the correct measurement have the note taker repeat back the information for confirmation.

- Step 4: Take one step across the channel in the direction of the opposite bank and repeat the process.
- Step 5: Traverse across the stream perpendicular to flow. Continue your traverse of the cross-section until you reach an indicator of bank-full stage on the opposite bank so that all areas between bank-full elevations are representatively sampled. Move up and down the stream in a zigzag fashion.
- Step 5: Continue to pick up particles until you have 100 measurements.

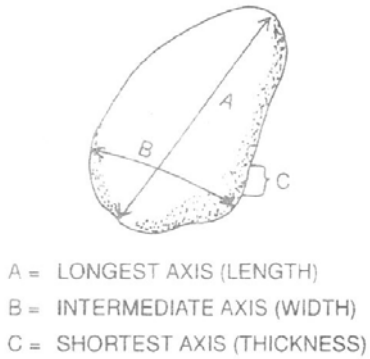


Figure F-1: Pebble Axis

Equipment and Forms List for 1,000 ft. Reach

- ❑ Clear plastic metric ruler (meters)
- ❑ 2 sheets of Pebble Count Forms (4 forms)
- ❑ Clipboard
- ❑ Pencils

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., *A View of the River*, 1994, Harvard University Press, Cambridge, MA.

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found below. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

Station: _____ Date: _____ Crew: _____

Distance: _____ Cross-section number: _____

Pebble Count

1	26	51	76
2	27	52	77
3	28	53	78
4	29	54	79
5	30	55	80
6	31	56	81
7	32	57	82
8	33	58	83
9	34	59	84
10	35	60	85
11	36	61	86
12	37	62	87
13	38	63	88
14	39	64	89
15	40	65	90
16	41	66	91
17	42	67	92
18	43	68	93
19	44	69	94
20	45	70	95
21	46	71	96
22	47	72	97
23	48	73	98
24	49	74	99
25	50	75	100

Station: _____ Date: _____ Crew: _____

Distance: _____ Cross-section number: _____

Pebble Count

1	26	51	76
2	27	52	77
3	28	53	78
4	29	54	79
5	30	55	80
6	31	56	81
7	32	57	82
8	33	58	83
9	34	59	84
10	35	60	85
11	36	61	86
12	37	62	87
13	38	63	88
14	39	64	89
15	40	65	90
16	41	66	91
17	42	67	92
18	43	68	93
19	44	69	94
20	45	70	95
21	46	71	96
22	47	72	97
23	48	73	98
24	49	74	99
25	50	75	100

Appendix G
Large Woody Debris Survey

Introduction

Large Woody Debris (LWD) is known to be an important structural element of stream channels. It improves juvenile Coho salmon and steelhead trout summer rearing habitat by increasing the numbers and depths of pools. Large amounts of LWD also increase winter cover that is critical for salmonid protection from predation and high water velocity.

All wood pieces greater that 6" in diameter and 4' long that are within the stream channel or the pith breaks the bankfull plane are included in the survey. The thalweg tape layed for the longitudinal survey is used to record the horizontal distance of the pieces. As the team walks up the channel each piece is numbered and tagged for tracking purposes and the horizontal distances are recorded. The type of piece is determined as log or root wad and species is recorded. Total length and the length within bank-full are measured. Using a Spenser tape the team measures a number of different diameters including diameter at bankfull LWD must always be measured with a Spenser tape.

The LWD survey will always be conducted in 200' segments after each tape lay of the longitudinal survey has been completed. It is important to work as a team. One surveyor is the recorder and their duties consist of reading the horizontal distance, recording the measurement information and helping to take the physical measurements. The other surveyor is the LWD tagger and the primary measurement taker.

In small streams bankfull and the LWD is fairly evident from mid-channel so you can inventory both banks as you walk up the steam segment. In larger streams it may be necessary to survey the left and right banks separately.

Directions for Performing the LWD Survey

- Step 1: LWD form.
  Fill out the LWD form with all location, date and crew information.
- Step 2: Horizontal distance.
  Start at the beginning of your tape, which will be the downstream position of your segment.
  Note: If it is the start of the study reach then your starting point is 0+00'.
- Step 3: LWD size assessment.
  1. Determine if the piece is 6 inches in diameter for a length of 4 feet. If not, the piece is too small to include in the survey and is not considered to be LWD.

2. Next determine if the piece is in the bankfull channel. LWD that is partially within bankfull is included if the pith breaks the bankfull plane of the bankfull line.

- Step 4: LWD Horizontal Distance.
  If the piece is considered to be LWD then first determine and record the horizontal distance. The horizontal distance is always taken at the LWD downstream point of contact.
- Step 5: LWD Number.
  Tag and number the piece. Record the number on the form. Plastic tags with pre-determined numbers will be provided. In addition, with the landowner's permission, spray paint the number so it is visible from the survey channel.

  Note: Staple guns will be used to secure the tags. Try to attach tags in cavities or areas that are protected. Painting large numbers on the LWD will assist future survey crews.
- Step 6: LWD Species and Location.
  Determine the LWD Species and record the wood Location. If the pith of the LWD breaks the bankfull plane then the wood is not considered to be in bankfull but on the left or right bank.

  Note: Left and right bank are always determined by looking downstream.
- Step 7: LWD Quality.
  First decide if the piece is part or a logjam or possibly perched above the stream. If not, then decide if the piece is keyed in or mobile. Always envision the piece reacting to bankfull stage to make this determination.
- Step 8: LWD Source.
  To determine the source of the LWD first look to see if the wood is part of a restoration project. Wood that has been manually placed in the streams is usually marked. If you can't see markings you can sometimes see cables or bolts. If the wood does not appear to be part of a restoration project then try to determine how the piece entered the stream. Most pieces will be simply "unknown" which means the origin cannot be determined.
- Step 9: LWD Total Measurements.
  a. Length: If the LWD is a log measure the total length. If the LWD is a log with a root wad attached, measure only to 1 ft. above assumed ground level of the tree if it was upright.

     Note: The rootwad will be measured separately. Measurements for length are taken to the original LWD size parameter of 6" in diameter. Always stop your length measurement when the diameter of the LWD goes below 6".

  b. Diameters: First measure the large end of the log this is the D1. If the log has a root wad attached then measure the diameter at 1 ft. above assumed ground level. Second measure the small end this is the D2.

     Note: For diameter measurements make sure you use the appropriate side of the Spenser tape (the numbers are red). Remember, the small end diameter will never be less than 6".
- Step 10: LWD Bankfull measurements.

  Note: You will always measure the portion of the log that is within bankfull as if it is a separate log.

a. Length: If the LWD is a log measure the length of the log within bankfull. This means measure from the instream end of the log to where it breaks the bankfull line or plane. If the LWD is a log with a root wad attached, remember to measure only to 1 ft. above assumed ground level of the tree if it was upright. If the whole log is within bankfull then the Bankfull length is equal to the Total length.

   Note: The rootwad will be measured separately. Measurements for length are taken to the original LWD size parameter of 6" in diameter. Always stop your length measurement when the diameter of the LWD goes below 6".

b. Diameters: First measure the large end of the log this is the D1. Depending how the log is situated this measurement could be either the instream end of the log or the diameter of the log where it breaks the bankfull line or plane. If the whole log is within bankfull then the Bankfull diameters are equal to the Total diameters. If not, then measure the length of the log within bank-full and record as bankfull length. Second measure the small end this is the D2.

   Note: *For diameter measurements make sure you use the appropriate side of the Spenser tape (the numbers are red). Remember, the small end diameter will never be less than 6" and if the log has a root wad attached then measure the diameter at 1 ft. above assumed ground level.*

- Step 11: LWD Rootwad Measurements.
  Root wads are measured by first measuring the height of the wad. This is the distance from the roots to 1 ft. above ground level point. Next measure the width and then the depth.

Equipment & Forms List for 1,000 ft. Reach

- ❑ Installed Horizontal Distance Tape (200 ft.)
- ❑ Spenser Tape
- ❑ Large Wood Forms (5)
- ❑ Clipboard
- ❑ Pencils
- ❑ Paint
- ❑ Plastic Numbered Tags
- ❑ Aluminum Tags and Nails
- ❑ Hammer and Staple Gun

Clean-Up

Remove all the temporary stakes from the channel bed. Remove all the excess flagging. Wind up all of the tapes. Pick up any trash you may have dropped.

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found attached. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245.

Jackson, Dennis, Marcus, Laurel (1999) *Creating a Watershed Atlas and Monitoring Program, Watershed Stewardship Workbook.*

Leopold, Luna B., *A View of the River*, 1994, Harvard University Press, Cambridge, MA.

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual*, Third Edition.

Large Woody Debris Inventory Form

Modified on 03/10/03

Station ID: _____

Date: _____

Crew: _____

Reach Length: _____

Species	Code	**Location**	Code	**Quality**	Code	**Source**	Code
Redwood	1	In Bankfull	2	Keyed	1.0	Unknown	1.0
Douglas Fir	2	Left bank*	3	Digger wedged	1.2	Green Unknown	1.4
Pine	3	Right bank*	4	Digger cabled	1.3	Windthrow	5.0
White Wood	4	Bank to bank	5	Buried	1.4	Green Windthrow	5.4
Tanoak	5			Mobile	2.0	Undercut Bank	6.0
Alder	6			Log Jam	5.0	Green UC Bank	6.4
Maple	7			Perched	6.0	Landslide	7.0
Willow	8					Green Landslide	7.4
Other HW	9					Project	9.0

Note: *To qualify as LWD a piece of wood must be at least 6" in diameter for 4' in length.*

Distance	LWD#	Sp.	Loca-	Quality	Source	Log Total			Log Bankfull			Root Wad Size (Feet)		
From 0' (Feet)			tion			Length	D1 *Large End*	D2 *Small End*	Length	D1 *Large End*	D2 *Small End*	A Axis Height	B Axis Width	C Axis Width

* Left bank and right bank determined by looking down stream.

Appendix H
Riparian Surveys

Introduction

Riparian surveys use a fixed 20th acre plot every 200' starting at the zero point along the steam monitoring reaches. The plots run perpendicular to the stream channel, are 21.8' wide and extend from a permanent point at bankfull to a permanent point 100' inland (adjusted for slope). All trees larger than 5.6" in diameter at breast height (DBH) are recorded as to size, species and placement within the plot. A sampling method for tree height allows for a statistical projection of tree height per acre. A smaller 100th acre lesser vegetation plot is established 15' inland from the bankfull point. The lesser vegetation survey records the number and the species of trees and brush less than 5.6" DBH plus the vegetation type and percent of ground cover.

Canopy density is measured by using a spherical densiometer. Measurements are taken in conjunction with the riparian surveys every 200 ft. starting at the zero point of the survey reach. The density is measured at center of channel, left and right bank and 50 ft. inland from bankfull.

The Riparian surveys need to be conducted by a survey team (2 or more) and are completed after the longitudinal profile and LWD surveys are finished. The start or zero points of the riparian plots are always the left and right bankfull sites that were flagged during the longitudinal survey.

Riparian surveys are not conducted where the slope is greater than 75%.

Before starting the riparian survey review the material in Field Equipment, Appendix D.

Directions for Performing the Riparian Survey

- Step 1: Riparian survey form.
  Fill out the top box of the riparian survey form. Include station (reach name & number), date, the form number in relationship to the total number of riparian forms for the study reach and crew names. For plot location always use the HD of the plot along the study reach. Make sure you designate left or right bank (i.e. 0+00RB).
  Note: Left and right bank are designated when looking downstream.
- Step 2: Laying out the riparian plot.
  1. Always start with the left bank plot. Place rebar at the bankfull point, paint for easier identification.
  2. Using your compass, stand perpendicular to the stream then sight on a feature approximately 100 ft. inland and record the azimuth on your plot form. Keep the bearing on your compass because this will be the lay line for your tape.

Note: The reciprocal bearing is the tape lay line for the right bank plot.

3. Attach the riparian plot lineal tape to the rebar. This will be your start point (zero).
   Note: This tape will be in feet and inches.
4. One team member stays at bankfull, the second team member starts to lay the tape 100 ft. inland using a compass and following the plot bearing.
5. As the second team member lays the tape they flag both the 15 ft. point and the 50 ft. point. This will be the center of the 100th acre lesser vegetation plot (15 ft.) and where canopy density (50 ft.) is measured.

- Step 3: Determining slope.
  The horizontal distance of the plot is always adjusted to compensate for slope. A clinometer and the slope adjustment table are used to develop a specific horizontal distance for each riparian plot.
  1. Using a clinometer, the team member at bankfull sights on the team member at 100 ft.
     Note: To determine slope the person using the clinometer always sights on an object at eye level.
  2. Record the slope percent and using the slope adjustment chart (Table 2) determine and then record the true horizontal distance.
  3. The team member now adjusts the tape to the true horizontal distance and places and paints a piece of rebar. Flag above the rebar for easy identification.
- Step 4: Measuring tree diameters.
  Record the location and measure the diameter of all trees that are larger than 5.6" diameter at breast height (DBH) within 10', 10.7" of either side of the tape. In addition, record the distance and measure the diameter of any downed log at the point the tape transects the log.
  1. First determine if the tree is within the plot. If it is larger than 5.6" DBH and located within 10' 10.7" of either side of the tape then fill in the location number.
     Note: The location number is the distance the tree is from bankfull on the horizontal distance tape.
  2. Using the code tables attached to your Riparian Form fill in the codes for Tree Species (Table 2) and Group (Table 4).
  3. Using a Spenser tape measure the diameter and record.
  4. If a log transects the tape, is larger than 4 inches in diameter for 6 ft in length then record Location, Species and Group and measure the diameter at the point the log transects the horizontal distance tape.
     Note: Downed logs are only measured if they transect the horizontal distance tape.
  5. Continue until all trees are measured and recorded.
- Step 5: Measuring tree height.
  Measure the diameter, height and crown ratio of the first 3 conifers from bankfull in the riparian plot.
  1. After recording the Location, Species and Group of the first conifer from bankfull attach a Spenser tape to the tree. Walk 66 feet to an area where you can see the base and the top of the tree.
     Note: Although it is not always possible, the reading will be more accurate if you try to stay at the same elevation as the tree you're measuring.

2. Using a clinometer first site on the base of the tree, record. Make sure you record whether the number is negative or positive. Next site on the top of the tree, record reading in the Top column. Using the formula, add negative numbers and subtract positive numbers, record tree height in the Total column.
3. Next estimate the percent of live crown.
4. Measure the diameter, height and crown ratio of the next two conifers, for a total of 3 conifers.

- Step 6: 100th Acre Lesser Vegetation Plot.
  Lesser vegetation plots are fixed radius plots measured 11.78' from a point 15' inland from the bankfull rebar. Trees less than 5.6" DBH are recorded along with the percent of lesser vegetation ground cover.
  1. Stand at the 15' point along the horizontal distance tape. This will be the center of the fixed radius plot. Extend a tape out 11.78".
  2. Rotate the tape 360 degrees and record all trees less than 5.6" DBH as to Species, Group and Diameter that are within the circle.
     Note: Lesser vegetation trees may be grouped into size categories by species.
  3. Next within the same plot area, record the lesser vegetation using the codes listed in Table 3. Estimate the percent of area covered for each lesser vegetation species within the plot area and record in the % Cover column.
     Note: The total of the % Cover column for the lesser vegetation may be larger than 100% because of vegetation layers.
- Step 7: Canopy density.
  In the study reach canopy density is always surveyed in conjunction with the riparian plots. Density is measured using a spherical densiometer at the center of channel, left and right bank at bankfull and left and right at the 50' point in the riparian plots.
  1. Fill out canopy form with station (reach name & number), date and crew initials.
  2. Next fill out the plot location. This will be the horizontal distance of the riparian plot along the study reach.
  3. Measure the bankfull width by stretching a tape from the left bankfull rebar to the right bankfull rebar, record.
  4. Stand in the center of channel between the bankfull rebar facing upstream. Hold the densiometer 12-18 inches in front of your body and at elbow height, so that your head is not visible in the mirror. Make sure the level bubble is level.
  5. In each square of the grid, assume that there are four dots, representing the center of quarter-square subdivisions of each of the grids. Systematically count the number of dots NOT occupied by canopy.
  6. Multiply the total count by 1.04 to obtain the percent of overhead area not occupied by canopy,
  7. The difference between this and 100 is the canopy cover in percent. Record this number in Column 1. Make four readings per location – start by facing upstream then turn in a clockwise fashion taking a reading every 90 degrees – and average them to provide an estimate of canopy cover from that point.
  8. Repeat the above instructions at all canopy measurement sites.

Clean-Up

Wind up all of the tapes. Pick up any trash you may have dropped.

Equipment List for 1,000 ft. Reach

- ❑ Compass
- ❑ Clinometer
- ❑ Spherical Densiometer
- ❑ Calculator
- ❑ 200 ft. tape (tenths) for Bankfull Width
- ❑ 150 ft. tape (inches) for Riparian Plots
- ❑ Spenser tape
- ❑ 24 pieces of rebar
- ❑ Hammer
- ❑ Paint
- ❑ Flagging

Forms List for 1,000 ft. Reach

- ❑ 12 sheets of Riparian Survey Forms (24 forms)
- ❑ 1 Set of Riparian Tables (Tables 1-4)
- ❑ 1 Canopy Density Form
- ❑ Clipboard
- ❑ Pencils
- ❑ Permanent Marker (black)
- ❑ Study Reach Level Notebook

References

Dr. James D. Arney, Forest Biometrics, Forest Projection and Planning System (FPS)

State of California Resources Agency, Department of Fish and Game (1998), *California Salmonid Stream Habitat Restoration Manual,* Third Edition.

Riparian Survey Form

Station ID: _____ **Date:** _____ **Page:** _____ **Of:** ____

Plot **Fixed** **Minimum** **Vegetation**

Location: _____ **Plot:** 20th acre **DBH:** 5.6" **Plot:** 100th Acre

Slope: _____ **Azimuth:** _____ **Offset from HD tape:** 10', 10.7"

20th Acre Plot								100th Acre Plot			
				Tree Height & % Crown							%
Location	Species	Group	DBH	Base	Top	Total	Crown	Species	Group	DBH	Cover

Riparian Survey Form

Station ID: _____ **Date:** _____ **Page:** _____ **Of:** ____

Plot **Fixed** **Minimum** **Vegetation**

Location: _____ **Plot:** 20th acre **DBH:** 5.6" **Plot:** 100th Acre

Slope: _____ **Azimuth:** _____ **Offset from HD tape:** 10', 10.7"

20th Acre Plot								100th Acre Plot			
				Tree Height & % Crown							%
Location	Species	Group	DBH	Base	Top	Total	Crown	Species	Group	DBH	Cover

Riparian Survey Tables

Table 1
Slope Adjustment Table

% Of Slope	Horizontal Distance (feet)
0	100'
5	100.12'
10	100.15'
15	101.12'
20	101.98'
25	103.08'
30	104.4'
35	105.95'
40	107.7'
45	109.66'
50	111.8'
55	114.13'
60	116.62'
65	119.27'
70	122.07'
75	125'

Table 2
Tree Species

Survey Code	Species
BM	Big-leaf Maple
BP	Bishop Pine
BO	California Black Oak
LO	Canyon Live Oak
DF	Douglas Fir
GC	Golden Chinquapin
GF	Grand Fir
PM	Madrone
CX	Misc. Conifers
HX	Misc. Hardwoods
BL	Pepperwood (Bay)
PP	Ponderosa Pine
RA	Red Alder
RW	Redwood
SP	Sugar Pine
TO	Tanoak
MY	Wax Myrtle
WH	Western Hemlock
WI	Willows

Table 3
Lesser Vegetation

Survey Code	Species
AZ	Azalea
BE	Berry, Sp.
BB	Blue Blossom
CE	Ceanothus, Sp.
CO	Coffee Berry
CB	Coyote Brush
OG	Dwarf Oregon Grape
EH	Evergreen Huckleberry
EQ	Equisetum Sp.
FN	Ferns Sp.
FW	Fireweed
FO	Forbes
GR	Grass
LU	Lupine
AR	Manzanita
PG	Pampas Grass
PO	Poison Oak
RH	Red Huckleberry
RD	Rhodendron
RO	Roses
SA	Salal
SB	Scotch Broom
TH	Thistle, Sp.

Table 4
Group

Survey Code	Description
..	Green Trees
.D	Snag
DD	Down Log
LV	Lesser Vegetation
.P	Planted Tree
.C	Fresh Stump

Canopy Density Form

Station ID: _____ Date: _____ Crew: _____

			1	2	3	4	Avg.
Plot							
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					
Plot			1	2	3	4	Avg.
Location:	_____	Channel center					
		Bank full left					
BF Width:	_____	50' left					
		Bank full right					
		50' right					

Appendix I
Stream Discharge, Turbidity, and Total Suspended Solids

Monitoring Objectives

1. Collect streamflow and water quality data during the rainy season at selected monitoring stations to establish baseline water quality conditions.
2. Monitor water quality and streamflow over several winters and attempt to establish trends in water quality conditions.
3. Develop a data set for water quality and streamflow in a Gualala River sub-watershed for future comparisons to other locations.

Monitoring Overview

Please refer to Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245 for the specific procedures for measuring and monitoring stream discharge.

Establish Monitoring Stations

1. Install staff plate
2. Survey cross-section and staff plate elevation
3. Establish the "course" for observations of surface float velocity

Data Collection

1. Upon arrival at monitoring station, record the following
    a. Sample location (monitoring station name)
    b. Date and time
    c. Description of weather conditions and flow conditions
    d. Gage height of water surface
    e. Repeat gage height observation
2. Water quality sample collection
    a. Turbidity sample (grab sample from surface as near center of channel as possible for immediate processing using field turbidity meter)
    b. Suspended sediment sample (depth integrated using DH- 48 for laboratory analysis for Total Suspended Solids; remove a sample aliquot for turbidity measurement using field meter)
    c. Note approximate location of sample location in relation to staff plate and centerline of channel (e.g. "5 ft downstream of staff plate from surface 4 ft from left edge channel")

3. Discharge measurement using the current meter **AND/OR** float velocity observations (minimum of 6)
4. Repeat 2 above
5. Repeat 1-4 above at each sampling station
6. Perform turbidity measurements on samples immediately following completion of sampling circuit (process all samples at the same time, noting the time of sample processing)
7. Complete sample storage and chain of custody forms; shipment to laboratory to be arranged.
8. Photocopy data sheets and instrument logs; notify data coordinator regarding data collected.

Monitoring Procedures

- Step 1: Site Information.
  1. Fill in the appropriate station at which observations and samples are collected.
  2. Record initials of the individuals collecting observations and samples.
  3. Date and time of arrival at site.
- Step 2: Current weather.
  Circle one of the five choices that best describes the weather conditions at time of arrival at the site. If conditions change significantly, this can be noted in #7.
- Step 3: Flow conditions.
  This provides two descriptions of stream flow conditions described below.
  1. Circle one of the three choices that best describe the appearance of the water in the stream.
  2. Circle one of the four choices that best describe stream flow conditions regarding whether the stream is at or near a steady and low base flow, whether the stream is rising, falling or at or near a steady peak discharge.
  3. Water temperature measured in the field; circle F if Fahrenheit or C if Centigrade degrees (see Appendix B)
- Step 4: Previous weather.
  This provides two types of descriptions of recent weather affecting streamflow; it is possible that choices from 6a and 6b may apply. Note that this will be used as a supplemental description of rainfall records from rain gages in the watershed.
  1. Circle one of the two choices pertaining to preceding dry weather.
  2. Circle all of the four choices that apply pertaining to preceding rainy weather.
- Step 5: Comments.
  Note any additional information, problems or issues that may affect the data reported. If stream flow is very high and wading the stream is not safe, note that here.
- Step 6: Water surface elevation.
  Data collected pertain to the elevation of the stream observed at the staff plate (stream gage). Observations are made twice as described below.
  1. Time and elevation (staff plate reading) <u>before</u> discharge measurement (or float velocity).
  2. Time and elevation <u>after</u> discharge measurement (or float velocity).
- Step 7: Crest gage reading.

These measurements pertain to previous high water elevation recorded at the crest gage by water dissolving toothpaste smeared on a cedar grapestake fitted inside the PVC tube near the staff plate.

1. Measure and record the distance from the top of the grapestake to the end of the toothpaste remaining on the grapestake,
2. The adjustment factor needed to convert 9a to the equivalent water surface elevation on the staff plate; a value will be established for each station based on cross-section survey data.
3. Adjusted peak water surface elevation at the gage (staff plate).

- Step 8: Water quality samples.
  Three samples are collected: two grab samples and one depth-integrated sample using a DH-48 suspended load sampler (refer to DH-48 manufacturer's instructions or USGS Field Methods for additional details of sampling procedure). Grab samples are collected from the surface in a bottle as near to the thalweg (location of highest stream velocity) and are analyzed for turbidity at the end of the day. The DH-48 sample is sent to a contract laboratory for analysis of Total Suspended Solids (TSS); a small portion of this sample is used for turbidity analysis.
  1. Grab sample #1 is collected prior to discharge measurement.
  2. DH-48 depth integrated sample is collected in the thalweg (if possible) after the discharge measurement is completed.
  3. Grab sample #2 is collected immediately after the DH-48 sample.
  4. Date & time turbidity analysis is conducted, results of analysis, and the initials of the individual conducting the analysis.
  5. Remarks regarding any special circumstances or conditions affecting the timing, location or quality of water samples.
  6. Chain of custody information: Storage conditions for sample #2 for subsequent delivery to laboratory for analysis. Include location (address/residence), date & time, and storage conditions (ice chest, refrigerator, etc.)
- Step 9: Discharge measurement field observations.
  Refer to USGS instructional materials for detailed instructions at background on the technique. <u>Not to be performed by a novice.</u>
  1. Position on discharge measurement cross section measured with zero located on the left bank (facing downstream). This position defines the center of each discharge sub-cell for which a velocity measurement is obtained. LEW is the horizontal position of the left edge of water; REW is the horizontal position of the right edge of water facing downstream.
  2. Water depth at the velocity measurement position corresponding to location (a) above.
  3. Velocity measurement depth-point where velocity meter is positioned on the top set rod. The top set rod is designed to allow rapid positioning of velocity meter at above the bed equivalent to 0.4 times the water depth; this is equivalent to the position 0.6 times the depth below the water surface.
  4. Record the number of revolutions of the current meter as expressed by the number of audible "clicks" in the time interval selected (minimum 20 seconds or as specified by USGS guidance). For relatively low velocity flows, the sensor wire should be positioned to graze the single-revolution cam on the current meter axle. For high

velocity flows, the wire should be positioned to graze the five-revolution cam on the current meter axle. The selected cam for the discharge measurement is set at the beginning of the measurement and should not be changed after measurements begin.

5. Length of velocity measurement interval in seconds. This can vary for different locations in the cross-section, but should not be less than 20 seconds.
6. Mean water velocity computed from current meter rating table. This column is left blank in the field. Qualified personnel perform computations in the office.
7. Discharge of flow cell. This column is left blank in the field. Qualified personnel perform computations in the office. Discharge of the cell is calculated as the product of the width of the cell (horizontal distance between adjacent flow cells entered in column a), flow depth at the center of the cell (entered in column b), and the mean velocity of the cell (column g).
8. Total measured discharge. This column is left blank in the field. Qualified personnel perform computations in the office. Calculated as the sum of discharge cells (column g).
9. Name of operator of current meter.
10. Name of individual who computes discharge and date computed.

- Step 10: Float Velocity Data.
  These stream velocity data supplement current meter measurements and need not be collected in all cases. These data are most useful during periods of high stream discharge and should be collected after discharge measurements are completed at the same location. In some cases, stream discharge may be too high to safely measure by wading with the current meter, and the discharge is estimated from the velocity of surface floats. Over the course of the first sampling season, we would like to obtain paired data from current meter measurements and float velocity measurements to develop an adjustment factor between mean velocity (11f) and mean surface velocity. In the absence of site-specific data, the relationship is mean velocity = 0.85 x surface velocity. Refer to the appendix in the QAPP for technique of float measurements. Dried orange peels are an ideal float.
  1. Record the length of stream channel over which velocity is measured with floats.
  2. Location of float test in cross-section (left, center or right of channel surface); two float observation are required for each third of the channel width.
  3. Time in seconds for each float to travel the test length of stream surface.
  4. Raw float velocity (course distance divided by time of travel (12a divided by 12c). Computed in the office or in the field-may be left blank in the field.
  5. Adjusted float velocity (raw velocity x 0.85 <u>or</u> a site specific adjustment factor determined by qualified personnel)-may be left blank in the field.
  6. Measure mean channel width.

Equipment & Forms List

- ❑ Current meter
- ❑ Wading rod
- ❑ DH 48 suspended sediment sampler
- ❑ Sample bottles for DH 48
- ❑ Flexible nylon measuring tape (165 ft)
- ❑ Stop watch
- ❑ Steel tape measure (pocket size)
- ❑ Toothpaste (for crest gages)
- ❑ Thermometer
- ❑ Floats (dry orange peels)

Clean-Up

- Disassemble, dry and lubricate current meter
- Dry and secure turbidometer

Data Field Form

To assist in the collection and organization of site-specific information, a field data form can be found attached. Please photocopy the form onto Write-in-the-Rain paper for data collection activities. Please use a No. 2 pencil.

References

Harrelson, Cheryl C., C. L. Rawlins, John P. Potyondy, (1994) *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*, USFS General Technical Report RM-245

Edwards, Thomas K. and Glysson, G. Douglas (no date), Field Methods for Measurement of Fluvial Sediment. U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter C2

Instructions for Sampling with a US DH-48 Depth-Integrating Suspended Sediment Sampler (manufacturer's product)

Gualala River Watershed Council-Hydrologic and Water Quality Monitoring Form-Fuller Creek (3/2002)

1. Station: North Fork South Fork Mainstem Sullivan **2. Observers:**

3. Date:_____ **Time:** _____ am pm **4. Current Weather:** Clear Cloudy Showers Rain Heavy Rn.

5. Flow Conditions: **5a.** Clear / Turbid / Muddy

5b. Base Flow / Rising Flow / Peak Flow / Falling Flow **5c.** Water Temp. _____ F / C

6. Previous Weather: **6a**. Dry: 1-3 days / 3+days **6b.** Rain: Overnight / Yesterday / Past 2 days / 3+days

7. Comments on 1-6:_____

_____

_____

8. Water Surface Elevation: **8a.** Time_____ Elev. _____ ft **8b.** Time_____ Elev. _____ ft

9. Crest Gage Reading: **9a.** High Water Mark (Distance From Top of Wood Insert) _____ ft

9b. Adjustment to Gage Datum _____ft **9c.** Crest Peak (Gage Equivalent) _____ft

10. Water Quality Samples: ***Sample Labels Include Station, Date, and Sample #***

10a. Sample #1-Surface grab Location Time_____

10b. Sample #2-Depth integrated (DH-48) Location Interval Time Time_____

10c. Sample #3-Surface grab Location Time_____

10d. Turbidity Analytic Results Sample Turbidity Sample Processing by:_____

Sample #	Date Processed	Time Processed	NTU's
1			
2			
3			

10e. Comments on samples: _____

_____

_____

10f. Chain of Custody:

Sample for Laboratory Analysis (Sample #2) Stored At_____

Date _____Time _____ Storage Conditions <

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11. Discharge Measurement: ***Conduct "spin test" on current meter. Note wire on Cam 1x or 5x. Items f, g and h are <u>not</u> completed in the field.***

11a. Station (ft)	*11b. Depth (ft)*	*11c. Sample Depth (0.4 D) (ft)*	*11d. # of Revolutions*	*11e. Sample Duration (sec)*	*11f. Velocity (ft/s)*	*11g. Discharge (cfs)*
LEW						
REW						

				11h. Total Discharge=	

11i. Current meter operator:_____

11j. Discharge computations by: _____Date_____

12. Float Velocity *(if performed)* 12a. **Float Course Distance (feet)**

12b. Observation # & Location	1-	2-	3-	4-	5-	6-
12c. Time for Float (seconds)						
12d. Raw Velocity (ft/s)						
12e. Adjusted Velocity (ft/s)						

12f. Mean Width of Water Surface (feet)

Discharge Measurement Notes & Comments: