CHANNEL AND RIPARIAN ASSESSMENT
For Specific Reaches of Etna Creek

Assessment Process

The goal of this assessment is to use our understanding of riparian habitat function and to use local scientific information to design a biologically effective watercourse and lake protection zone. The stream channel and riparian habitat assessment is intended to describe and assess site specific stream channel and riparian conditions. From this data collection and assessment the site specific prescriptions necessary to maintain a healthy stream channel and riparian habitats can be designed. As appropriate and prudent, specific effectiveness monitoring may be selected to provide scientific validation of the assessment. The assessment, prescriptions and any effectiveness monitoring are to be used as an adaptive management tool. Adaptive management is designed to provide feedback on whether channel and riparian conditions were maintained or enhanced as predicted.

Overview of Riparian Habitat Concepts

Riparian habitats can provide numerous functions that help maintain productive aquatic habitats. Research has found that the riparian vegetation provides five key functions: stream channel shade, nutrients, filtration of sediment, recruitment of large woody debris for fish habitat and stream bank stability (Spence et al, 1996; FEMAT 1993; McDade et al, 1990). Many effects of riparian vegetation on streams decrease with increasing distance from the streambank (Beschta et al. 1987). These distances can be influenced by the degree of channel constraint, floodplain width, tree species and overall vegetation site quality.

Generalized curves have been developed that describe the distances at which each key function influences stream channel habitats (Spence et al, 1996; FEMAT 1993). If specific stream channel information is available, results may indicate that these generalized curves need modification. Results from the Alsea Watershed Studies in Oregon found that effective riparian shade buffers from partially harvested riparian habitats occurs between 25 feet to 100 feet wide (Brown 1971) but that riparian shade could potentially influence streams equal to one site-potential tree height (Beschta et al. 1987). The effectiveness of riparian habitats to deliver leaf and other particulate organic matter begins to decline at distances greater than approximately one-half a tree height away from the channel (FEMAT 1993). Filtration of sediment from overland flow occurs by physical barriers that trap sediment like vegetation and down woody debris which occurs at distances equal to one site-potential tree height (FEMAT 1993). The majority of large woody debris that helps form fish habitat is recruited at relatively close distances to the stream channel (Murphy and Koski (1989)), however, large woody debris can potentially enter the stream channel from up to one site potential tree height (FEMAT 1993). And finally, stream bank stability is maintained through tree and vegetation root strength at distances less than one-half a tree crown diameter (Burroughs and Thomas 1977). When managing riparian habitats all five of these key factors should be assessed and considered in development of the forest management prescriptions.

In addition to understanding the natural processes at work within riparian habitats it is important to assess other more stochastic natural processes. Riparian habitats are typically changed by disturbances such as fire and windthrow. Riparian habitats are also changed through channel disturbances such as lateral channel erosion, peak flow flooding and deposition of debris during peak flows. These disturbances help create a relatively highly diverse plant and tree community (Gregory et al. 1991). Accordingly, condition of site specific riparian habitats and frequency of local stochastic events may be reviewed in this channel assessment.

(1) Riparian Shade

Effective riparian shade that maintains stream water temperatures can be achieved between 25 feet to 100 feet from the stream channel (Brown 1971) and was verified in a cause-and-effect study in Oregon (Brown 1972). However, riparian shade could potentially influence streams equal to one site-potential tree height (Beschta et al. 1987). Also, local site specific riparian conditions including topography, channel orientation, channel width, forest composition and forest density all influence shading of stream channels (Beschta et al. 1987). Stream temperatures may also be influenced by elevation, the presence or absence of ground water springs and local air temperatures (Quigley et al, 2001; Sullivan et al, 1990).

This assessment of riparian shade and the potential of proposed forest management prescriptions to modify riparian shade and stream water temperatures will include: (a) aerial photo review of watershed level stream shade, (b) review of previous forest management plans that modified riparian shade, (c) review of stream water temperatures, and (d) assessment of proposed forest management prescriptions.

(a) Watershed Level Stream Shade

Using aerial photos a watershed level stream channel assessment was completed for Etna Creek following standard *Watershed Analysis methodology* (DNR 1995). Stream reach levels of shade (canopy closure) were identified and determined using *Watershed Analysis methodology Table D-9* for riparian function. Etna Creek was assessed from the east property line in section 1 (T41N R10W) to the headwaters. The stream had a total of 29 distinct individual riparian reaches over a total of 22,753 feet or 4.3 miles (Table 1). A total of 49% of the reaches had canopy closure over 70% and 84% of the reaches had canopy closure over 40%. Review of 1964 and 1971 photos indicated that stream reaches that currently have 20-40% canopy closure were severely scoured by the 1964 flood and vegetation along the stream is still recovering. A relatively short reach (750 feet) that contains 0-20% canopy closure is located immediately adjacent to the County road which encroaches into the stream channel.

Table 1 Results of *Watershed Analysis* methodology of Etna Creek

Aerial Photo Percent Estimated Shade	Number of Stream Reaches	Length of Stream Reaches	Percent of Length
> 90%	4	3,750	16%
70 - 90 %	9	7,482	33%
40 - 70 %	9	7,905	35%
20 – 40 %	6	2,866[1]	13%
0 – 20 %	1	750[2]	3%
TOTAL	29	22,753	100%

[1] All 20-40% canopy closure reaches are along lower Etna Creek scoured by the 1964 flood

[2] All 0-20% canopy closure reaches are where the County road encroaches into the stream channel

(b) Forest Management Modification of Riparian Shade

As part of the Cumulative Impacts Assessment (Section IV) previous timber harvest plans that have operated within the watershed assessment area are listed. Some of these timber harvest plans have operated in riparian habitats which modified riparian shade. A portion of these are also tributary to stream temperature sensor locations collected since 1997. Table 2 lists the timber harvest plans, units and riparian shade quantities that have been modified that are also upstream of stream temperature sensors. Note Class III streams are not included in this assessment due to the lack of stream water flow during peak of summer water temperatures.

Table 2 Riparian Management along Tributary streams.

Year of Operation	Tributary Hobo Location	Harvest Plan Unit #	Length Class I (feet)	Canopy Closure Class I (%)	Length Class II (feet)	Canopy Closure Class II (%)
1997[ab]	Lower Etna Creek	1	0	0	600	
	Lower Etna Creek	2 - 6	5900	50	4200	50[b]
	Upper/Lower Etna Creek	7	0	0	300	50[b]
2002[cd]	Lower Etna Creek	1	0	0	1500	50
	Lower Etna Creek	2	0	0	600	50
	Lower Etna Creek	3	0	0	1600	50
	Upper/Lower Etna Creek	5,6	1400	75	3300	50
	Upper/Lower Etna Creek	7	2000	75	0	
	Upper/Lower Etna Creek	8,8a	500	75	1300	50
	Upper/Lower Etna Creek	10	700	75	0	
	Upper/Lower Etna Creek	13,14	0	0	2500	50
	Upper/Lower Etna Creek	16	0	0	2300	50
	Upper/Lower Etna Creek	17,20	0	0	2200	50
	Lower Etna Creek Total		10500		20400	
	Upper Etna Creek Total		4600		11900	

[a] Class I WLPZ width was 100 feet and 50% overstory canopy closure.
[b] Class II WLPZ width was 50 feet and 50% of overstory and understory canopy covering the ground.
[c] Class I WLPZ width was 75 feet (85% canopy closure) and next 75 feet (65% canopy closure).
[d] Class II WLPZ width was 25 feet (70% canopy closure) and next 25-75 feet (50% canopy closure.

In summary, a total of 10,500 feet of Class I riparian habitat and 20,400 feet of Class II riparian habitat has been modified since 1997 tributary to the Lower Etna Creek stream temperature sensor. And a total of 4,600 feet of Class I riparian habitat and 11,900 feet of Class II riparian habitat has been modified since 1997 tributary to the Upper Etna Creek stream temperature sensor.

(c) Review of Stream Water Temperatures

Measurement of stream water temperatures is commonly completed using continuous running temperature monitoring sensors (Quigley et al., 2001; Sullivan et al., 1990). Stream temperatures were collected using HOBO H8 temperatures sensors. These sensors were set to collect streams temperatures every 90 minutes which is suitable to detect stream temperature peaks (Lewis et al., 2000). These sensors are accurate to $\pm$ 0.5C and have been calibrated to a NIST traceable thermometer (ASTM# 6016). Site selection, field protocols, calibration and maintenance of sensors followed recommended protocols and standards described in Lewis et al., 2000.

Since 1997 stream water temperatures have been collected at two individual locations in the watershed. The results from each location has the sampling year, sampling period, the dates of the peak temperatures described by the 7-day Maximum Weekly Average Temperature (MWAT) and the MWAT calculated in Celsius and Fahrenheit.
The stream water temperature locations have been: Lower Etna Creek (TEC02) (Table3) and Upper Etna Creek (TEC04)(Table 4).

Table 3 Lower Etna Creek (TEC02)

Calendar Year	Sampling Period	7-day MWAT Period	MWAT[1] C° and F°
1996	No Data		
1997	Dewatered		
1998	5/14 to 11/26	8/9 to 8/15	15.4 (60.0)
1999	5/21 to 11/18	7/30 to 8/5	13.5 (56.6)
2000	5/25 to 10/31	8/2 to 8/8	16.1 (61.3)
2001	7/17 to 10/9	8/3 to 8/9	15.6 (60.4)
2002	6/19 to 10/9	7/12 to 7/18	16.0 (61.1)
2003	Hobo Stolen		
2004	6/2 to 9/22	7/23 to 7/29	16.1 (61.3)

1 MWAT is the Maximum Weekly Average Temperature

Figure 1 Lower Etna Creek (TEC02)

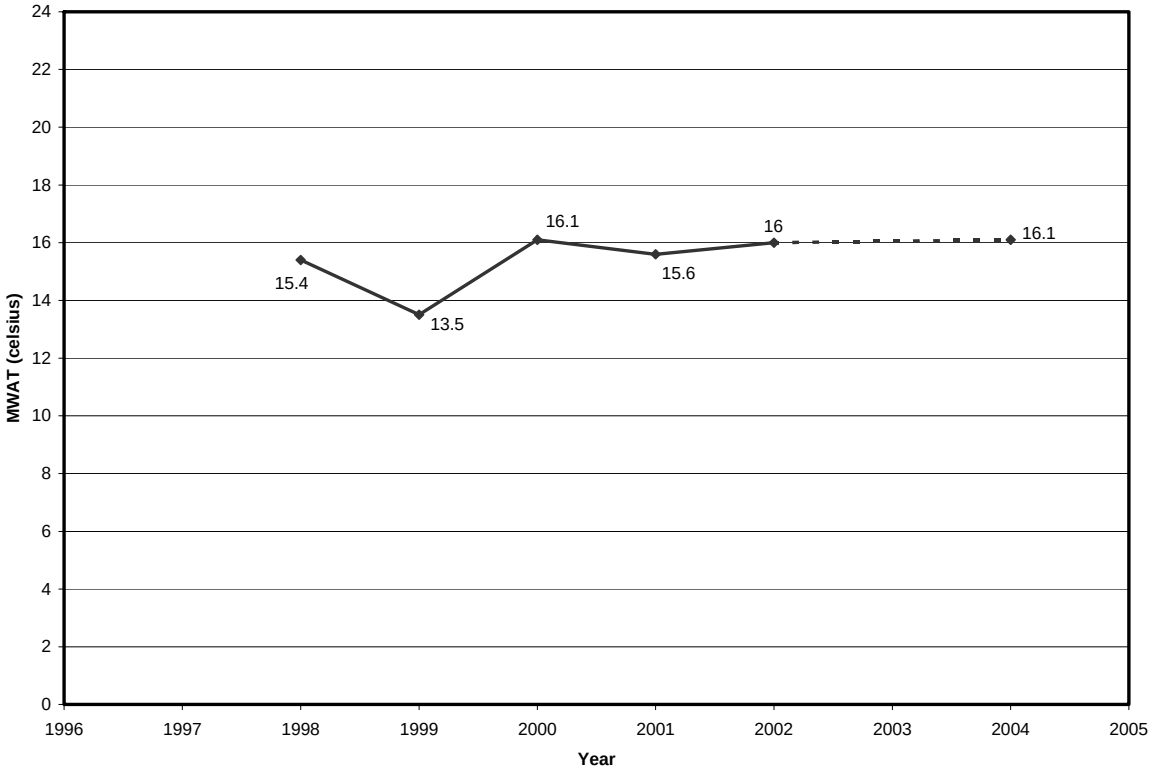
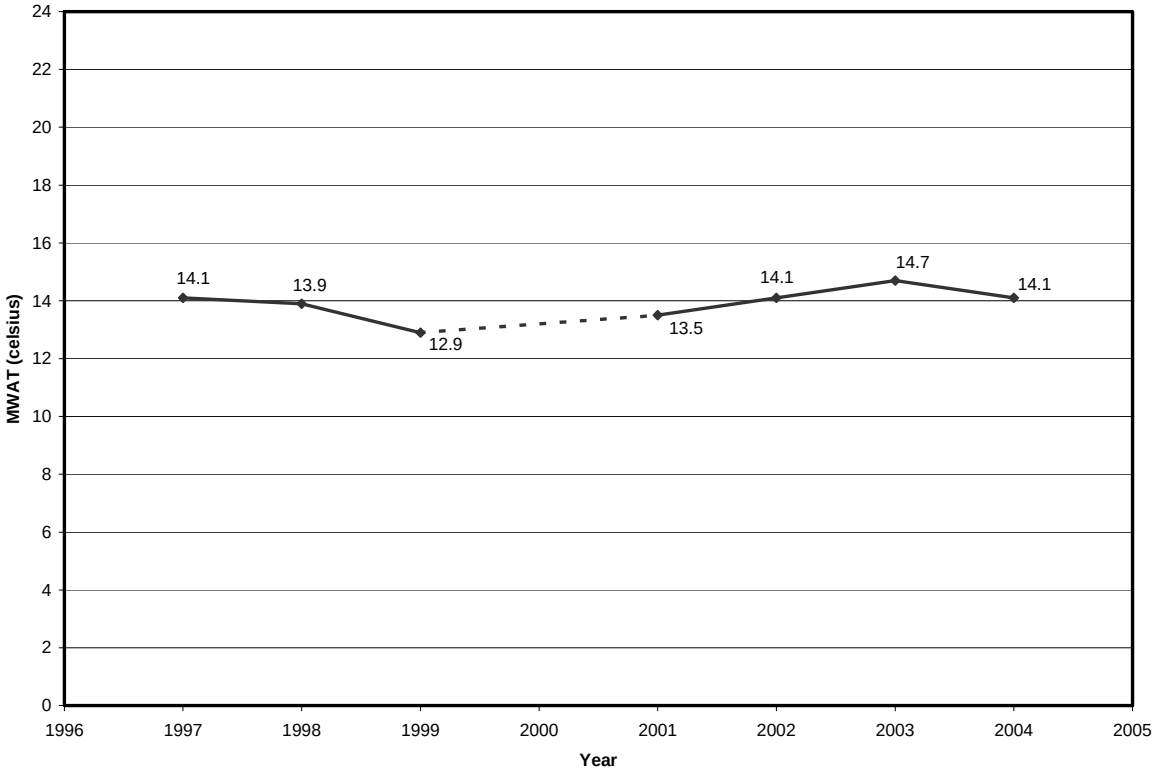


Table 4 Upper Etna Creek (TEC04)

Calendar Year	Sampling Period	7-day MWAT Period	MWAT[1] C^o and F^o
1996	No Data		
1997	7/18 to 11/1	8/4 to 8/10	14.1 (57.7)
1998	5/14 to 7/28	7/22 to 7/28	13.9 (57.3)
1999	5/21 to 11/18	8/23 to 8/29	12.9 (55.5)
2000	Hobo Malfunction		
2001	7/17 to 10/9	8/3 to 8/9	13.5 (56.6)
2002	6/19 to 10/9	7/11 to 7/17	14.1 (57.7)
2003	5/16 to 10/1	7/22 to 7/29	14.7 (58.7)
2004	6/2 to 9/22	7/23 to 7/29	14.1 (57.7)

2 MWAT is the Maximum Weekly Average Temperature

Figure 2 Upper Etna Creek (TEC04)



(d) Assessment of proposed forest management prescription

Results of temperature monitoring indicate that previous timber harvest within riparian habitats does not appear to have increased stream water temperatures. The Upper Etna Creek stream temperatures (MWAT) have remained unchanged from the harvest of 4,600 feet of Class I riparian habitat modified from 1997 to 2004 (Figure 1). The Lower reach of Etna Creek MWAT stream temperatures have had little if any change from the harvest of 10,500 feet of Class I riparian habitat and 20,400 feet of Class II riparian habitat modified since 1997 (Figure 2). In conclusion, stream water temperatures do not appear to have been either increased or decreased due to previous riparian habitat management (Table 2) that included retention of 50% canopy closure in WLPZ's.

These results and conclusions are similar to other studies. In the Alsea watershed studies in Oregon, it was shown that shade nearest the stream channel (25 feet) most effectively shaded the stream to achieve moderate stream water temperatures (Brown 1970; Brown et al. 1971). Brown et al (1971) also concluded that managed vegetation buffers between 25-100 feet along streams can be as effective as undisturbed forest in maintaining stream water temperatures. On going research being conducted in California has presented preliminary results showing that clearcut harvesting of riparian habitats between 75 feet and 150 feet from the stream channel have maintained stream water temperatures (James, 2004).

The watershed level assessment of riparian conditions along Etna Creek found a high percentage (49%) of reaches with greater than 70% canopy closure and 84% of reaches with greater than 40%. Stream reaches that currently have 20-40% canopy closure were severely scoured by the 1964 flood and vegetation along the stream is still recovering. A relatively short reach (750 feet) that contains 0-20% canopy closure is located immediately adjacent to the County road which encroaches into the stream channel.

Assessment of the Proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Water Class **Slope %**	**Class I** **WLPZ width (feet)**	**Protection Measures**	**Canopy Closure**
All Slope Classes	0 to 50 feet	Q	100% retention of existing canopy closure No harvest Alternative
All Slope Classes	50 to 150 feet	Q	50% Canopy closure

Based on the site specific observed stream temperatures and habitat assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.9(a) and 936.9(i) for the beneficial function of riparian zones?

☒ Yes ☐ No Explain and justify proposal or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

(1) The proposal provides no harvest of riparian shade in the closest 50 feet most important to maintaining stream temperatures.
(2) Beyond 50 feet, the proposal will provide riparian shade which could potentially provide additional maintenance of stream temperatures.
(3)The proposed WLPZ and SOZ are designed from the results of water temperature monitoring which indicate the proposed WLPZ and SOZ will **meet** existing riparian habitat standards by maintaining existing water temperatures.

(2) Nutrients: Leaf and Other Particulate Organic Matter Input

Nutrients from organic matter enter the stream channel primarily as leaf fall. Nutrients can also be recruited into the stream channel during high stream flow events that flow over alluvial flood plains. The delivery of leaf and other particulate organic matter is also influence by the presence of hardwood versus conifer trees. Riparian vegetation also regulates the exchange of nutrients and material from upland forests to streams (Gregory et al. 1991). Due to contribution of organic matter the riparian habitats are also an important component of the aquatic ecosystem food base (Bilby and Likens 1980). In general, the effectiveness of riparian habitats to deliver leaf and other particulate organic matter begins to decline at distances greater than approximately one-half a tree height away from the channel (Spence 1996; FEMAT 1993). Based on the local site tree height delivery of nutrients and other organic matter is expected to occur up to 60 feet from the stream channel (one-half tree height).

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Based on the site specific observed habitat conditions and assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.9(a) and 936.9(i) for the beneficial function of riparian zones?

☒ Yes ☐ No Explain and justify or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

The proposed WLPZ and SOZ were designed based on the scientific understanding of nutrient delivery into stream channels. The proposed measures retain 100% of all vegetation and conifer and hardwoods trees for nutrient delivery within 50 feet of the stream channel. An additional 50% canopy closure beyond 50 feet would also potentially deliver nutrients to the stream channel. Based on the scientific information presented in this assessment the WLPZ and SOZ design **exceeds** the protection measures required in CCR 936.9.

(3) Filtration of Sediment: Maintaining Water Quality

In general, filtration of sediment from overland flow occurs by physical barriers that trap sediment such as ground vegetation and down woody debris and occurs at distances equal to one site-potential tree height (FEMAT 1993). Local riparian effectiveness of filtration varies as a function of geomorphic characteristics such as slope and soil type and by vegetative structure and cover. Vegetation retained during the 1997 timber harvest plan included 50% canopy closure (100 feet) along Class I streams and 50% vegetation cover (50 feet) along Class II streams. And vegetation retained during the 2001 timber harvest plan included 85% canopy closure (75 feet) and 65% canopy closure (for an additional 75 feet) along Class I streams and 70% canopy closure (25 feet) and 50% canopy closure (for an additional 25-75 feet) for Class II streams. In addition these previous riparian habitats were protected through the use of Equipment Exclusion Zones which left understory vegetation, down logs, rocks and forest floor litter intact as physical barriers to filter any potential sediment from overland flow.

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Do the measures proposed by this alternative WLPZ and SOZ based on the site specific observed habitat conditions and assessment ensure the proposed WLPZ and SOZ prescriptions meet or exceed riparian sediment filtration function?

☒ Yes ☐ No Explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

(1)The proposed WLPZ and SOZ were designed based on the scientific understanding of filtration of sediment by riparian habitats.
(2)The proposed measures retain 100% of all vegetation and conifer and hardwoods trees, down logs, rocks and forest floor litter for filtration within 50 feet of the stream channel.
(3)An additional 50% canopy closure for the remaining zone width and the use of an Equipment Limitation Zone (restricted to existing tractor roads in Unit #8) would maintain understory vegetation, down logs, rocks and forest floor litter to also potentially filter sediments before being delivered to the stream channel.
(4) Based on this scientific information presented in this assessment the WLPZ and SOZ design **meets** the protection measures described in CCR 936.9.

(4a) Fish Habitat: Results and Evaluation of Stream Habitat Surveys

Etna Creek

A field examination and survey was conducted of each Class I watercourse reach that occurred within or adjacent to harvest units in order to identify at a minimum the quantities of pool, flatwater, and riffle percentages within the selected reach (14 CCR 916.4, 936.4, 956.4). One reach of Etna Creek was surveyed. The survey was conducted on 9/10/01 through 9/13/01 and was completed from point 1 to point 170 for the first reach located on the attached Habitat Survey Map. Manhours required was 90.0 hours. The survey was conducted according to the following protocols:

Habitat Survey Method:	Modified California Salmonid Stream Habitat Restoration, 3rd Edition
Habitat Survey Level:	Level IV
Stream Channel Types:	Bisson et al.(1982), Decker, Overton et al. (1985) and Sullivan(1988)
Channel Assessment Process:	Selected portions of Standard Methodology for Conducting Watershed Analysis (Version 3.0 November 1995), Washington Department of Natural Resources
Results:	(Summary of Field Habitat Survey to Level II standard)

Preliminary Assessment Results:

A preliminary channel assessment was conducted prior to completion of field stream surveys to assess information on past and present stream channel conditions.

Stream Order (Strahler, 1957 based on 1:24,000 scale) ☐ 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5

Total Stream Length: 47,800 Feet 9.05 miles

Total Stream Surveyed: 7,467 Feet 1.41 miles

Percent of Total Stream Length Surveyed: 15.6 %

Stream Survey Results:

Observation of encroachments within the stream flood-plain:

☒ Forest Roads ☐ Urban Roads ☒ Timber Harvest ☐ Mining

☐ Agriculture ☐ Water Diversion ☐ Structures or Dams ☐ Urbanization

Observation of potential barriers to anadromous fish distribution:

Location	Habitat Type	Habitat Length (feet)	Habitat Depth (feet)	Elev. Gain (feet)
HU#170	Bedrock Wall	23	10	Estimate Over 14’

*This potential barrier was reviewed by Dennis Maria (DFG) and was determined to be a barrier to anadromous distribution.

Based on stream cross sections of flood plain width (FPW) and bank full channel width (BFCW) the channel bed morphology is (*Watershed Analysis standard methodology*):

☐ Unconfined FPW > 4 BFCW ☐ Moderately Confined 2 BFCW < FPW < 4BFCW ☒ Confined FPW < 2 BFCW

Considering the channel gradient and confinement the channel response reach is (*Watershed Analysis standard methodology*): Gradient = 5.5%

☐ Response Reach (0 – 4%) ☒ Transport Reach (4 - 20%) ☐ Source Reach (> 20%)

Considering the survey results of channel gradient the specific channel response type is (*Watershed Analysis standard methodology*):

☐ Pool-Riffle < 1%	☐ Pool-Riffle Plane-Bed 1 - 2%	☐ Plane–Bed Forced Pool-Riffle 2 – 4 %	☒ Step-Pool 4 - 8%	☐ Cascade 8 – 20%	☐ Colluvial > 20%

Natural Channel Processes:

Considering the channel bed morphology *(Confined)* and specific channel response type *(Step-Pool)*, what were the *expected versus observed natural channel processes* for this reach (*Watershed Analysis Table E-2 Channel Response Matrix*):

Sediment	Expected	Observed
Fine Sediment Deposition	☐	☐
Course Sediment Deposition	☐	☐
None	☒	☒
Large Woody Debris		
Large Woody Debris Loss	☒	☐
Large Woody Debris Gain	☐	☒
Catastrophic Events		
Debris Flow Scour	☒	☒*
Debris Flow Deposition	☒	☒*
Dam Break Flood	☒	☐
None	☐	☐

* Debris Flow Deposition and Scour was evidenced from the 1964 flood along the mainstem.

Percent Pool Habitats:

Considering the channel response type, gradient and confinement what are the expected quantity of pools for this reach *(Watershed Analysis Table F-6, Table F-2):*

Expected Percent Pool Habitats Channel*: >5% gradient, <45 ft wide*	☐ Good > 30%	☒ Fair 20-30%	☐ Poor <20%
Observed Percent Pool Habitats Channel: *>5% gradient, <45 ft wide*	☒ Good > 30%	☐ Fair 20-30%	☐ Poor <20%

Habitat Type	Total Length	Percent
Riffles	1810	24
Runs	2493	33
Pools	3155	42
Other	9	0
Total	7,467	100%

LWD Pieces per Channel Width:

Considering the channel response type, gradient and confinement what are the <u>expected quantity of LWD</u> for is reach *(Watershed Analysis Table F-6, Table F-2):*

Expected LWD Pieces per Channel Width ☐ Good > 2 ☒ Fair 1 – 2 ☐ Poor < 1

Observed LWD Pieces per Channel Width: ☒ Good > 2 ☐ Fair 1 – 2 ☐ Poor < 1

Mean Bank Full Channel Width	Total Stream Survey Length	Total Number Channel Widths	Total Number LWD Pieces[1]	LWD Pieces Per Channel Width
51	7,467	149	389	2.61

[1]In water or bank full width.

<u>Assessment of Stream Conditions and Restoration Opportunities</u>:

Do the observed habitats meet or exceed the expected habitat quality:

Natural Channel Processes:

☒ Yes ☐ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

Percent Pool Habitats:

☒ Yes ☐ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

LWD Pieces per Channel Width:

☒ Yes ☐ No If No, explain other observations of channel condition that may be effecting watershed or channel forming processes.

Does the proposed Timber harvest Plan have any mitigation measures that will contribute towards the restoration of stream conditions that are below what would be expected:

☐ Yes ☒ No (If yes, describe location in THP)

(1)Stream conditions meet or exceeded expected values. A summary list of beneficial measures incorporated in to the proposed THP may be found under Item #26 and Item #38.
(2) Proposed Class I WLPZ is designed to improve riparian shade and potential LWD recruitment.

Considering the results of the preliminary channel assessment, stream survey results, stream survey assessment and existing Timber Harvest Plan mitigation measures, *are there additional restoration opportunities within this stream reach*:

☐ Yes ☒ No (Explain if needed)

4(b) Large Woody Debris: Delivery to Stream Channels

Large woody debris found in stream channels control stream flows and formation of fish habitat (McDade et al., 1990). A variety of mechanisms can deliver large woody debris to the stream channel including; windthrow, stream bank erosion, landslides, floods and wildfires. The majority of large woody debris that helps form fish habitat is recruited at relatively close distances to the stream channel (Murphy and Koski (1989)), however, large woody debris can potentially enter the stream channel from up to one site potential tree height (FEMAT 1993). The probability that a falling tree will enter the stream is a function of slope distance from the channel in relation to tree height (McDade et al., 1990). To design riparian habitat management plans it is helpful to understand the recruitment mechanisms and understand the recruitment distances of large woody debris.

As part of the detailed stream channel level IV survey conducted (Section 4a), the size, type, source and recruitment distance of large woody debris was measured following the protocols described by McDade et al., 1990. One reach of stream was surveyed in the Etna Creek watershed. A total of 7,467 feet of stream channel was surveyed along Etna Creek and a total of 389 pieces of large woody debris were found in the stream channel. Using *Watershed Analysis* (Section 4a) protocols it was determined that for a confined channel bed morphology and step-pool response type the quantity of large woody debris found (2.61 pieces/channel width) exceeded the quantity of large woody debris for this type of stream channel. It was also determined that the quantity of pool habitats (>30%), within this channel morphology and response type, exceeded the expected value.

Results of field surveys show that large woody debris has been delivered Etna Creek stream channel from a variety of sources (Table 2). From the total 389 pieces the source and mechanism of each piece of large woody debris was identified for 135 pieces or 36 percent. Mechanisms that occur at relatively close distances to the stream channel including bank erosion and windthrow (vegetative disturbance), accounted for 27.4 percent of identifiable wood. Trees in various levels of decay accounted for 15.6 percent of the identifiable large woody debris. ***The source distance assessment found that 100 percent of all identifiable large woody debris was recruited within 100 feet of the stream channel*** (Figure 5). In addition, ***79.3 percent was recruited from within 50 feet and 61.5 percent from within 30 feet of the stream channel***. These results are similar to findings found in coastal Oregon and Washington (McDade et al., 1990), central Washington state (Benda and Sias 1998) and in coastal redwood forests in California (Benda 2004).

Assessment of the Proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Water Class Slope %	Class I WLPZ width (feet)	Protection Measures	Canopy Closure
All Slope Classes	0 to 50 feet	Q	100% retention of existing canopy closure No harvest Alternative
All Slope Classes	50 to 150 feet	Q	50% canopy closure

Based on the site specific observed habitat conditions and assessment does the proposed WLPZ and SOZ prescriptions meet or exceed the protection measures described under 936.4(b) for vegetation structure and 936.6(a) and 936.9(i) for the beneficial function of riparian zones?

☒ **Yes** ☐ **No** Explain and justify proposal or explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat processes.

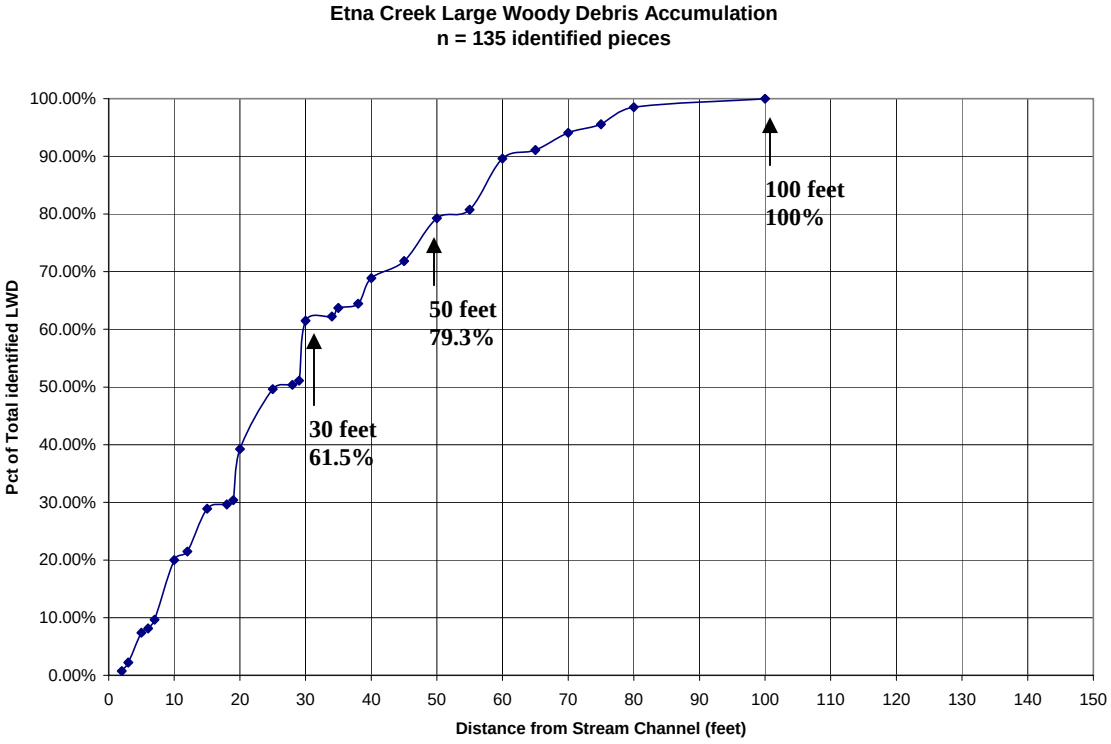
(1) The proposed WLPZ was designed to increase potential recruitment from within 50 feet of the stream channel where 79 percent of all large woody debris is currently recruited.

(2) The proposed WLPZ and SOZ also maintain existing recruitment potential for distances greater than 50 feet (currently beyond known measured recruitment distances of 100 feet for the 150 foot Etna Creek zone)

Table 2 Etna Creek Large Woody Debris Source

LWD Source	Total LWD (pieces)	Identified LWD (pieces)	Identified LWD (%)
Bank Erosion	16	16	11.9
Decay	21	21	15.6
Jam Wood	175		
Manmade	2	2	1.5
Vegetative Disturbance	96	96	71.1
Unidentified	59		
TOTAL	369	135	100

Figure 5



(5) Channel Stabilization: Root Strength

Root systems along active stream channels stabilize banks, allow development and maintenance of undercut banks, and protect banks during large storm flows (Sedell and Beschta 1991). Root strength provided by conifer and hardwood trees and shrubs contribute to slope stability. Researches have found that root strength of vegetation can influence stream channel stability within one half a tree crown diameter. The contribution of root strength to maintaining streambank integrity also declines rapidly at distances greater than one-half a crown diameter (Burroughs and Thomas 1977; FEMAT 1993). This maximum distance that root strength can stabilize stream channels for local conifer and hardwood trees species is assumed to be 30 feet.

Assessment of the proposed Watercourse and Lake Protection Zone and Special Operating Zone Alternative Prescriptions:

Do the measures proposed by this alternative WLPZ and SOZ based on the site specific observed habitat conditions and assessment ensure the proposed WLPZ and SOZ prescriptions meet or exceed channel stabilization function.

☒ Yes ☐ No Explain other observations of riparian habitat conditions that may be affecting watershed, channel or riparian habitat forming processes.

The proposed WLPZ and SOZ were designed based on the scientific understanding of riparian habitats stabilized channels. The proposed measure retains 100% of all vegetation and conifer and hardwoods trees that would be expected to provide rooting strength to the stream channel. Based on the scientific information presented this WLPZ and SOZ design exceeds the protection measures described in CCR 936.9.

Summary of Channel and Riparian Assessment

Key Functions of Riparian Habitat	Meets Protection Standard Described in 936.9	Exceeds Protection Standard Described in 936.9
Riparian Shade	**X**	
Nutrients		**X**
Filtration of Sediment: Maintaining Water Quality	**X**	
Large Woody Debris: Fish Habitat		**X**
Large Woody Debris: Delivery to Stream		**X**
Channel Stabilization: Root Strength		**X**

Terminology:

California Salmonid Stream Habitat (Level IV)

BFCW - bank full channel width

BRS - bedrock sheet

FPW - flood plain width

HU - habitat unit

LWD - large woody debris

PLP - plunge pool

References Cited:

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