SECTION E
STREAM CHANNEL CONDITION

INTRODUCTION

This report provides the results of an assessment of the stream channels of the Mendocino Redwood Company (MRC) ownership in the Gualala River watershed analysis unit (WAU). The assessment was done following a modified methodology from the Watershed Analysis Manual (Version 4.0, Washington Forest Practices Board). The stream channel analysis is based on field observations and stream channel slope class and channel confinement information developed from a digital terrain model in the company's Geographic Information System (GIS).

The goals of the assessment were to determine the existing channel conditions and identify the sensitivity of the channels to wood and sediment. Stream channels are defined by the transport of water and sediment. A primary structural control of a channel in a forested environment, besides large rock substrate, is from woody debris. Channel morphology and condition therefore reflect the input of sediment, wood and water relative to the ability of the channel to either transport or store these inputs (Sullivan et. al., 1986).

Stream channel conditions represent the strongest link between forest practices and fisheries resources. Changes in channel condition typically reflect changes to fish habitat. Because of this the fish habitat and stream channel assessments were done in the same reaches. The results for the fish habitat parameters are presented in Section F - Fish Habitat Assessment.

METHODS

The methods of the stream channel assessment are designed to identify channel segments that are likely to respond similarly to changes in sediment or wood and group them into distinct geomorphic units. These geomorphic units enable an interpretation of habitat-forming processes dependent on similar geomorphic and channel morphology conditions. The channels are also evaluated for current channel condition to provide baseline information for the evaluation of channel conditions over the long term.

Stream Segment Delineation

The stream channel network for the Gualala River WAU was partitioned into stream segments based on three classes of channel confinement and several classes of channel gradient. These classifications were based on channel classifications prepared from digital terrain data in Mendocino Redwood Company's Geographic Information System (GIS). The slope classes used for delineation are 0-3%, 3-7%, 7-12%, and 12-20%. Channel confinement was classified by confined, moderately confined, and unconfined. Confined channels have a valley to channel width ratio of <2, moderately confined channels have a valley to channel width ratio of <4, and unconfined channels have a valley to channel width ratio of >4.

Channel segments were delineated based on either a change in slope class or change in channel confinement. The channel segments were numbered with a two letter code, corresponding to the planning watershed the channel segment is located, followed by a unique number (*1 through n* for each planning watershed). For the Gualala River WAU data, channels for 6 planning watersheds are delineated. The delineated stream segments are shown on Map E-1.

Field Measurements and Observations

Selection of field sites for stream channel observations was based on gathering a sample of response (0-3% gradient) and transport (3-20% gradient) channels from each planning watershed of the WAU. No attention was focused on the source reaches (>20% gradient).

For each channel segment the bankfull width, bankfull maximum depth, bankfull average depth, floodprone depth, floodprone width, and channel bankfull width to depth ratio are measured at a cross section representative of the channel segment. A pebble count of 50 randomly selected pebbles is counted at the cross section to determine the D50 (median particle size) of the streambed. Streambed sediment characteristics are interpreted from observations of gravel bars, fine sediment abundance and particle size of the stream bed material. The segment is classified by morphology types based on Montgomery and Buffington (1993) and Rosgen (1994). The channel morphology is further interpreted by flood plain interaction for the segment (continuous, discontinuous, inactive, none) and channel roughness characteristics. Large woody debris (LWD) functioning in the channel is inventoried (presented in Section D, Riparian Function). The number and type of pools (LWD forced, bank forced, boulder forced, free formed) are observed. The field observations are summarized and defined in Table E-1.

Geomorphic Units

Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes.

Interpretations related to sediment supply, transport capacity and LWD response were the basis for development of sensitivity of geomorphic units to coarse sediment, fine sediment and LWD inputs. These interpretations were based primarily on existing conditions observed in the stream channels of the WAU. The channel sensitivity to changes to coarse sediment, fine sediment and LWD are based on how the current state of the channel is likely to respond to inputs of these variables.

RESULTS

Stream Channel Observations

Field channel surveys or observations were taken on 10 stream reaches in the Gualala River WAU during the summer of 2000. Table E-1 provides a summary of the data collected. Further detail specific to in-channel fish habitat relationships is found in Section F - Fish Habitat Assessment of this report. LWD measured and evaluated in stream channels is reported in the Riparian Function section.

Key to Table E-1.

Stream Channel Dimensions

Category	Description
ID #	The stream identification number (see Map E-1), two letter planning watershed code followed by unique number for the planning watershed. SA – Annapolis Falls SR – Flat Ridge ST – Tobacco Creek SH – Haupt Creek GD – Doty Creek GO – Robinson Creek
Geomorphic Unit	Number of the geomorphic unit the channel segment is in.
Channel confinement	Confined-channel width to valley width ratio < 2, moderately confined-channel width to valley width ratio 2-4, unconfined-channel width to valley width ratio >4, based on the DTM in GIS.
Survey Length	Length of stream surveyed.
GIS slope category	Slope class as designated by DTM in GIS.
Field Observed Slope	Mean slope of segment as observed in field.
Maximum Bankfull Depth	Maximum bankfull depth of representative cross section.
Mean Bankfull Depth	Average bankfull depth of representative cross section.
Bankfull width	Bankfull width of representative cross section.
Width/Depth Ratio	Ratio of bankfull channel width to average bankfull depth.
Floodprone depth	Maximum depth during flooding estimated by 2 times max. bankfull depth (Rosgen, 1996).
Floodprone width	Width of water at floodprone depth (Rosgen, 1996).
Entrenchment Ratio	Ratio of floodprone width to bankfull channel width.

Sediment/Bedform Characteristics

Category	Description
Montgomery/Buffington Class	The channel morphology type: PR = pool/riffle, FP/R = forced pool/riffle, SP = step pool, PB = plane bed, CAS = cascade (Montgomery and Buffington, 1993)
Rosgen Class	Rosgen channel morphology classification, (Rosgen, 1994).
Floodplain Continuity	Description of floodplain/channel interaction either: continuous, inactive, discontinuous or none.
Channel Roughness	B =boulders, C=cobbles, F=bedforms, V=live woody veg., W=large woody veg., R=bedrock, Bk=banks and roots.

Gravel Bar Abundance	Qualitative measure of amount of gravel bars in segment.
Gravel Bar Type	Gravel bar type either: A=alternating point bars, P=point, M=medial or F=forced.
Gravel Bar Proportion Class	Proportion of stream segment in gravel bars: 0-25%, 25-50%, 50-75%, 75-100%.
Fine Sediment Abundance	S=sparse, M=moderate, A=abundant
Fine Sediment Type	type of fine sediment accumulation: P=isolated pockets, M=moderate accumulations, B=high accumulations including in gravel bars.
D50	Median gravel size of the stream bed particle distribution at a representative riffle.

Pool Characteristics

Category	Description
Free	number of free formed pools in segment.
LWD Forced	number of LWD forced pools in segment.
Boulder Forced	number of boulder forced pools in segment.
Bank Forced	number of bank forced pools in segment.
Total # Pools	total number of pools in segment.
Pool Spacing	average space between pools by bankfull widths.
Mean Res. Pool Depth	average of all residual pool depths in segment.

Table E-1. Stream Segment Field Observations for Gualala WAU, 2000

		Stream Channel Dimensions											
Segment Name	ID #	Geomorphic Unit	Channel Confinement	Survey Length (ft)	GIS Slope Category (%)	Field Observed Slope (%)	Maximum Bankfull Depth (ft)	Mean Bankfull Depth (ft)	Bankfull Width (ft)	Width/Depth Ratio	Floodprone Depth	Floodprone Width	Entrenchment Ratio
Wheatfield Fork Gualala River	SA1	1	Moderately	2563	0-3%	0.1	7.8	4.7	140.0	30.0	15.6	165	1.2
Annapolis Falls	SA13	3	Confined	566	3-7%	1.4	2.3	1.4	26.5	19.0	4.6	41.5	1.6
Trib to Annapolis Falls	SA19	3	Confined	500	0-3%	3.1	1.9	1.1	13.5	12.3	3.8	63.0	4.7
Haupt Creek	SH1	2	Confined	1046	0-3%	0.9	2.9	1.8	55.0	30.0	5.8	65	1.2
Fuller Creek	SR1	2	Moderately	1071	0-3%	0.4	3.3	2.1	49.6	23.6	6.6	65	1.3
Fuller Creek	SR3	2	Moderately	1061	0-3%	0.8	3.2	2.1	35.0	16.7	6.4	35	1.0
Sullivan Creek	SR11	3	Confined	436	0-3%	2.3	2.6	2	10.3	5.1	5.2	17.3	1.7
Crocker Creek	ST10	3	Confined	406	3-7%	4.0	2.3	1.6	13.4	8.0	4.6	18	1.3
Crocker Creek	ST11	3	Moderately	264	3-7%	2.1	-	-	9.0	-	-	-	-
Tobacco Creek	ST19	3	Confined	510	3-7%	2.3	2.4	1.4	19.4	14.0	4.8	22	1.1

Table E-1 (continued) Stream Segment Field Observations for Gualala WAU, 2000

		Sediment/Bedform Characteristics										Pools						
Segment Name	ID #	Montgomery/ Buffington Class	Rosgen Class	Floodplain Continuity	Channel Roughness	Gravel Bar Abundance	Gravel Bar Types	Gravel Bar Proportion Class	Fine Sediment Abundance	Fine Sediment Type	D50 (mm)	Free	LWD Forced	Boulder Forced	Bank Forced	Total # Pools	Pool Spacing	Mean Res. Pool Depth (ft)
Wheatfield Fork	SA1	P/R	E4	None	E-B-LWD	Common	P-M	50-75%	A	M	24	0	3	0	5	8	2.3	4.8
Annapolis Falls	SA13	P/R, SP	BC4,G4,B4	None	C-B-V	Few	P-F	0-25%	M	P	81	1	4	0	2	7	3.1	1.1
Trib. to A. Falls	SA19	FP/R,SP,P/R	B4,G1,G5,C4	Discontinuous	LWD	Few	F	0-25%	A	M	NA	1	8	0	4	13	2.8	1.3
Haupt Creek	SH1	P/R	E4	Discontinuous	F	Common	P-M	50-75%	M	M	43	0	8	0	2	10	1.9	2
Fuller Creek	SR1	P/R	E4	Discontinuous	F-V-C	Common	P-M	-	S	P	45	0	3	1	4	8	2.7	2.7
Fuller Creek	SR3	P/R, PB	Bc4, E4, E4	None	F-LWD-BK	Common	P-F	25-50%	S	P	37	0	2	0	5	7	4.3	2.5
Sullivan Creek	SR11	SP,FP/R	G1,G4,B4	None	LWD-C	Common	F	0-25%	M	M	29	5	1	0	3	9	4.7	1.9
Crocker Creek	ST10	FP/R, CAS	G4, A4, B4	None	LWD	Few	F	0-25%	M	M	30	2	6	0	2	10	3.0	1.1
Crocker Creek	ST11	-	-	-	-	-	-	-	-	-	41	2	3	0	3	8	3.7	1.3
Tobacco Creek	ST19	SP, FP/R	F4, B4	None	C-LWD	Few	P-F	0-25%	M	M	22	0	6	2	2	10	2.6	1.4

Stream Geomorphic Units

Stream geomorphic units were developed for the stream network on the MRC property in the Gualala River watershed. These units are general representations of stream channels with similar sensitivities to coarse sediment, fine sediment and large woody debris inputs. Four stream geomorphic units were developed for interpretation of stream channel response to forest management interactions in the Gualala River WAU. The four stream geomorphic units are described below.

Geomorphic Unit I. Low Gradient, Confined Channel of the Wheatfield Fork, Gualala River.

Includes Segments: *Field observed* – SA1
Extrapolated - SA2, SA3, ST1, ST2, ST3, ST18

General Description: The channels within this unit meander through confined canyons. The channels are typically confined by hillslopes with a narrow floodplain occasionally present, typically on the inside of meander bends. Alternating gravel bars on meander bends often define the bankfull width. The bankfull was measured at a representative location as 140 feet. The sinuous path of the flow in these channels lowers the river gradient and creates alternating pool-riffle morphology. This makes the channel very stable, with limited bank erosion. However, inner gorge associated mass wasting is common particularly on the outside of meander of bends of these confined channels. The channels in this unit are low gradient (<1 percent), but sediment transport capacity is high due to the highly confined channel keeping water energy directed within the channel. High flow events within these channels will move all but the most stable large woody debris (LWD) accumulations or push accumulations to the channel margins. The channel bed is composed of primarily gravel-sized particles.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology. The Rosgen classification (Rosgen, 1994) for these channels are predominantly F4.

Fish Habitat Associations:
These channels are low gradient, depositional channels of a large watershed. These channels typically have sand to small gravel substrate that is not highly desirable for spawning habitat. The large size of these channels makes for a very wide bankfull channel with low shade, making for high summer water temperatures thus poor summer rearing habitat for salmonids. The lack of large woody combined with small substrate makes these channels also poor areas for over-wintering habitat, though salmonids likely can find refuge in the deep pools along these channels. These channels overall do not provide highly productive salmonid habitat.

Conditions and Response Potential:
Coarse Sediment: Moderate Response Potential
These channels are depositional areas for coarse sediment. Coarse gravel accumulations are common in point and medial gravel bars in this unit. The high confinement of these channels creates relatively high sediment transport capacity. However, if the supply of coarse sediment surpasses the transport capacity the impact can be filling of pools or increased scour of the bed.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, the Gualala watershed has a relatively high background sediment rate. This high rate of sediment input can result in pool filling or bed fining from high fine sediment accumulations. Fine sediment accumulations were observed in this unit on the top of gravel bars, accumulated in the bed of plane bed reaches, along pool margins, and in some pools.

Large Woody Debris: Low Response Potential
Large woody debris is sparse in this unit. The LWD that is present is providing stream habitat development and cover. The confined high energy flow and large channels of this unit require very large LWD pieces or debris jams to keep the LWD in place. Very large LWD is recruited into channels infrequently due to the long growing times of streamside trees. However, LWD in this unit is still important because the channels in this unit gain greater pool depths and cover, for fish habitat diversity, with increased LWD.

Geomorphic Unit II. Confined and Moderately Confined Low Gradient Channel Segments.

Includes Segments: *Field observed* – SR1, SR3, SH1
Extrapolated – SR2, SR4, SR5, SR6, SH2, SH3

***General Description*:**
The channels within this unit flow through confined to moderately confined canyons. Hillslopes or inner gorge topography typically controls the lateral movement of the channels. Some terraces are present and occasionally floodplains are present, though discontinuously. The bankfull channel is typically between 30 and 60 feet in width. The channels in this unit are low gradient (0-2 percent, but usually <1 percent). These channels exhibit moderate sediment transport capacity. When confined the channel keeps water energy directed within the channel but the meandering, low gradient pattern and profile facilitates sediment deposition. When terraces are present bank erosion is observed in this unit, particularly on the outside of meander mends and toes of large landslides.

Associated Channel Types:
This unit primarily exhibits pool/riffle morphology, with some plane bed morphology. The Rosgen classifications (Rosgen, 1994) for these channels are primarily F4, with some areas of E4 and Bc4.

Fish Habitat Associations:
Spawning habitat and gravel are in moderate amounts in this unit, but spawning gravel quality is good where present. These channels are confined within narrow canyons that produce good recruitment potential for LWD. The recruited LWD in turn facilitates pool development and offers shelter. Rearing habitat availability can be good where sufficient LWD creates good pool habitat and shelter, however summer rearing can be absent because some of the streams in this unit can go subsurface during the summer rearing period. Young fish would have to migrate to other areas to survive through the summer months. Overwintering habitat is provided by large cobble/boulder and bedrock substrates. LWD when present in this unit also provides overwintering habitat for juvenile salmonids.

Conditions and Response Potential:
Coarse Sediment: High Response Potential
These channels are depositional areas for coarse sediment. The moderate sediment transport capacity makes these channels vulnerable to changes in supply of coarse sediment. Fluctuations of coarse sediment can occur that will surpass the transport capacity of the stream. When this occurs pools can be filled, the influence of large woody debris and bedrock controlled sections are lessened and the channels can aggrade. Aggradation of the channel can create greater bank erosion, or produce limited lateral movement increasing localized bed scour thus causing the channels to entrench.

Fine Sediment: Moderate Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur in this unit. Sparse to abundant accumulations of fine sediment was observed in this unit. These accumulations were observed in the gravel bars, along channel margins, and in some pools.

Large Woody Debris: High Response Potential
The alluvial composition of the bed material in conjunction with a low gradient channel makes these channels highly responsive to LWD inputs. LWD is a dominant influence for pool development, sediment storage behind LWD accumulations and stabilization of bank and bedforms within the channels in this unit. LWD forced pool/riffle morphology is evident in some reaches within this unit.

Geomorphic Unit III. Moderate Gradient Confined Transport Segments.

Includes Segments: *Field observed* – SA13, SA19, SR11, ST10, ST11, ST19
Extrapolated – SA4, SA5, SA6, SA14, SA15, SA16 (partial), SA20, SA21, SA22, SR12, SH8, ST7, ST12, ST20, ST25, GD1

General Description:
Stream channel segments in this unit are confined within canyons, though areas of moderate confinement occur locally. Typically entrenchment ratios (bankfull to floodprone width) are between 1 and 5 bankfull widths. This is sufficient to allow some isolated terrace formation and channel meandering, though not common. The channel segments in this unit are near the transition between deposition and transport channels. Due to the moderate gradient (3-7 percent) of the channels, they are responsive to aggradation and degradation from changes in the stream sediment supply. The stream bed of these channels varies from gravel to boulder sized particles. The terraces in this unit appear to be created from large episodic sediment loads such as frequent mass wasting. The gradient of the stream is high enough that stream segments in this unit easily down-cut through the terrace deposits when flow is concentrated.

Associated Channel Types:
This unit primarily exhibits step pool and forced pool/riffle morphology, with areas of cascade morphology. The Rosgen classifications (Rosgen, 1994) for these channels vary from G1-4 with areas of B4 and A4 depending on the bank configuration, slope and channel substrate.

Fish Habitat Associations:
Spawning areas in this unit are infrequent, due to lack of accumulations of gravel sized particles. The steeper gradient segments of this unit typically form step-pool, cascade, and some pool-riffle habitat. The step-pools that are typically boulder formed, and offer substrate refugia, which provide both rearing and overwintering habitat.

Conditions and Response Potential:

Coarse Sediment: Moderate Response Potential
The channels in this unit have relatively high sediment transport capacity. In the lower gradient sections of these channels coarse sediment can create pool filling and aggradation, resulting in increased bank erosion and poor stream habitat. The step pool sections of these channels have relatively stable cobble and boulder component that can remain relatively static except in extreme flows. Increased coarse sediment supply can create pool filling, but is only moderately influential on the morphology because pool filling at these moderate gradients creates lower channel roughness which in turn promotes more step pool or cascade development, provided high inputs of coarse sediment subside.

Fine Sediment: Low Response Potential
The channels of this unit have high fine sediment transport capacity due to high flow capacity of the channel. However, when there is a high fine sediment supply in transport, accumulations of fine sediment do occur but typically have short residence times in this unit. Sparse to moderate accumulations of fine sediment was observed in this unit. These accumulations were observed in the bed and along channel margins.

Large Woody Debris: Moderate Response Potential

The high confinement or entrenchment of these channels provides little opportunity for the channel to meander or develop a floodplain. Water energy is concentrated within the confines of canyon walls or stream banks making the role of LWD less sensitive as channels with less confinement or entrenchment. LWD is less likely to enter the channel because it becomes suspended over the channels narrower bankfull width. The role of LWD is typically as sediment storage or forced step pool development in these channels. Bed morphology in channels with slope gradients of 4-10% is typically step pool (Montgomery and Buffington, 1993). The large bed forming material of step pool morphology is generally stable making the role of LWD in these channels less sensitive than other channel types.

Geomorphic Unit IV. High Gradient Transport Segments.

Includes Segments: SA7, SA8, SA9, SA10, SA11, SA12, SA17, SA18, SA23, SA24, SA25, SA26, SA27, SA28, SA29, SA30, SA31, SA32, SA33, SA34, SA35, SA36, SA37, SA38, SA39, SA40, SA41, SA42, SA43, SA44, SA45, SA46, SA47, SA48, SR7, SR8, SR9, SR10, SR13, SR14, SR15, SR16, SR17, SR18, SR19, SR20, SR21, SR22, SR23, SR24, SR25, SR26, SR27, SR28, SR29, SR30, SR31, ST4, ST5, ST6, ST8, ST9, ST13, ST14, ST15, ST16, ST17, ST18, ST21, ST22, ST23, ST24, SH4, SH5, SH6, SH7, SH9, SH10, GD1, GD2

General Description:
Channel segments in this unit are high gradient transport reaches from 7-20% with high sediment transport capacity. The channel segments in this unit typically flow through tightly confined, V-shaped canyons. These are typically zones of scour during high flows or debris flows. Stream substrate is typically from cobble to large boulders. Typically, there is no surface water flow in this unit in the summer drought season.

Associated Channel Types:
This unit varies its morphology from step pool to cascades with some occasional waterfalls. The cascades and waterfalls occur in the steepest segments of this unit and only during winter storm events. The Rosgen (Rosgen, 1996) classification for these channels varies between A2, A3, and AA2, AA3 depending on channel gradient and substrate composition.

Fish Habitat Associations:
The high gradient channels of this unit prevent coho salmon from accessing these areas. Potential for steelhead trout utilization is low due to the high gradient; 8% to 20% and small channel sizes. Rearing would be unlikely because stream flow typically goes subsurface in the summer months.

Conditions and Response Potential:

Coarse Sediment: Low Response Potential
Typically the channel morphology in this unit is cascade, with some step pool morphology at the lower gradients observed in these channels. These channels have bed material that is coarse and relatively immobile. Down cutting or bank erosion are not common in these high gradient, large substrate dominated channels even with increases in sediment supply. Debris flows can cover the substrate creating the cascade morphology but this is generally short-lived due to the high sediment transport capacity of the channels.

Fine Sediment: Low Response Potential
The high gradient of the channels in this unit creates a high fine sediment transport capability. Pools or storage areas for fine sediment in these channels are limited making the impacts from fine sediment minimal. Down cutting or bank erosion are not common in these high gradient, large substrate dominated channels even with increases in sediment supply.

Large Woody Debris: Moderate Response Potential
The role of LWD in these channels is to provide storage of sediment and also as a source for downstream LWD. LWD is needed in these channels however the need for LWD as a source for downstream LWD is episodic and therefore the least sensitive as other channel types. The storage of sediment by LWD in these channels is necessary, but can be accomplished by a range of size classes of LWD not necessarily very key LWD pieces.

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Gualala River Watershed Analysis Unit

Map E-1
Stream Channel Geomorphic Units and Segments

This map presents the stream channel network for the Gualala WAU partitioned into stream segments based on three classes of channel confinement and several classes of channel gradient. The slope classes used for delineation are 0-3%, 3-7%, 7-12%, and 12-20%. Channel segments were grouped into geomorphic units by similar attributes of channel condition, position in the drainage network, and gradient/confinement classes. The intent of the geomorphic units are to stratify channel segments of the Gualala WAU into units which respond similarly to the input factors of coarse and fine sediment, and LWD. These geomorphic units can then be interpreted to have similar habitat-forming processes.

Geomorphic Classes

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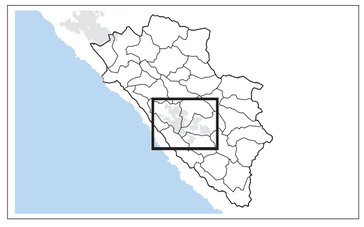
- Confined and Moderately Confined Low Gradient Channel Segments.
- Moderate Gradient Confined Transport Segments.
- High Gradient Transport Segments.

- MRC Ownership
- Planning Watershed Boundary
- Gualala River Watershed Boundary

Flow Class

- Class I
- Class II
- Class III

Sheet 1



N W E S

0 1/2 1 Mile

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Gualala River Watershed Analysis Unit

Map E-1
Stream Channel Geomorphic Units and Segments

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Flow Class

- Class I
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Sheet 2

0 1/2 1 Mile

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