Appendix A

Erosion Analysis, Artesa Fairfax THP and Conversion

Prepared for

Raney Planning and Management, Inc.
1501 Sports Drive
Sacramento, CA 95834

October 2007
Revised February 2011

By

____
Matt O'Connor, PhD, CEG #2449
William McDavitt, MS
O'Connor Environmental, Inc.
P.O. Box 794
Healdsburg, CA 95448

Table of Contents

Background 1
Overview of Approach 1
USLE and RUSLE Background and Applicability 2
RUSLE2 Methods 3
Annual Precipitation and Soils 3
Land Use 3
Slope Gradient and Slope Length 5
Estimation of Surface Erosion Rates and Sediment Yield 7
Erosion Mitigation 10
Previous Landslide Assessments 12
Methods for Sediment Source Assessment 16
Patchett Creek Sediment Yield Estimates 19
Patchett Creek Sediment Yield from Gualala Sediment TMDL 21
Summary of Project Effects on Sediment Yield 21
Monitoring 24
Channel Erosion and Sedimentation Basin Monitoring 24
Objective 24
Topographic Surveys of Selected Class III Channel Reaches 25
Annual Surveys of Class III Channels 25
Annual Surveys of Selected Sedimentation Basins 25
Post-construction Monitoring 26
ECP and SWPPP Review 26
Field Inspections 26
Response and Reporting 27
Adaptive Management 28
References Cited 29
Appendices 31
Appendix B-Soil Creep and Rockslide Creep Rate Estimates 33

Background

The draft hydrologic evaluation of the project site prepared by West Yost Associates (2004) for Raney Planning and Management identified two potentially significant issues pertaining to erosion and sedimentation as described in Table 13 of the evaluation. Issue No. B3 pertains to potential increases in erosion from vineyard operations and Issue No. D1 pertains to potential increases in downstream sediment loading resulting from vineyard operations. The potential significance of these impacts, despite proposed mitigations, follows from watershed impairment by sedimentation as cited in the Gualala TMDL (RWQCB 2001). The WYA evaluation estimated erosion only from proposed vineyard plots in the project area using only one method (Universal Soil Loss Equation-USLE), with a limited geographic and geomorphic scope. Consequently, the estimated increase in erosion rate could not be interpreted in the context of watershed erosion rates. In addition, the erosion rates predicted using USLE were implausible, particularly with respect to existing forest conditions. Consequently, WYA recommended that a "detailed sediment load/yield assessment for the project site" be developed. This analysis addresses that recommendation and provides a quantitative basis for interpretation of the likely significance of potential increases in erosion and downstream sediment loading resulting from vineyard operations.

Overview of Approach

This assessment is designed to evaluate potential increases in erosion and sediment yield associated with development of proposed vineyards on the project site. The potential significance of impacts is greatest in downstream areas of Patchett Creek that are thought to be accessible to anadromous salmonids, primarily steelhead. The WYA hydrologic evaluation considered potential impacts on runoff at two nodes in the watershed; Node 1 (Figure 4) is located at a natural barrier to migration and demarcates the upstream extent of anadromous fish use. Node 1 also receives runoff from the entire project area, along with portions of the watershed not within the project area. The confluence of Patchett Creek with the Wheatfield Fork Gualala River is located at Node 2 (Figure 4); the drainage area of Patchett Creek is about 1.76 mi^2. The reach of Patchett Creek between Node 1 and Node 2 encompasses the majority of steelhead habitat in the Patchett Creek watershed. Evaluation of potential erosion and sedimentation effects of the project on Patchett Creek and on the Wheatfield Fork Gualala River can be accomplished by developing a sediment source analysis (the erosion components of watershed sediment budget) for the Patchett Creek watershed.

The sediment source analysis was developed using techniques commonly employed in development of sediment budget for mountainous, forested areas. We used existing studies of the Gualala River watershed and field observations to develop a quantitative sediment source analysis specifically for Patchett Creek. Erosion rate estimates for the proposed project area, including proposed vineyard fields, were determined from application of a new USDA soil erosion model. This modeling effort utilized substantial geographic information developed for the analysis of project effects on peak runoff.

USLE and RUSLE Background and Applicability

"The USLE was first implemented by the USDA-Soil Conservation Service (now Natural Resources Conservation Service) in the early 1960's. AH282, published in 1965, documents the USLE at that time. The USLE has evolved through time and its application has greatly expanded from that in the early 1960's. AH537, published in 1978, documents the USLE as ARS recommended it be used in the late 1970's and early 1980's" (http://topsoil.nserl.purdue.edu/usle/index.html). The above-referenced versions of USLE may be appropriate to estimate potential future erosion on agricultural land, provided that the erosion process is soil surface erosion caused by rain drop impact and surface runoff.

USLE focused on erosion from croplands. It is a calibrated empirical model based on measurements of soil erosion from test plots in the field. USLE estimates detachment and mobilization of soil particles, but does not incorporate subsequent complexities of transport and deposition. Consequently, USLE tends to overestimate sediment delivery rates to streams. Moreover, in forested areas, where surface runoff is uncommon owing to vegetative canopy, organic litter covering the soil surface, and relatively high infiltration rates for forest soils, USLE is not an appropriate method. Erosion by rain drop impact and surface runoff in forested areas is not generally believed to be a significant sediment source (e.g. Selby 1982, p. 99-101), a conclusion that is reinforced by sediment source analyses for TMDL's in the northern Coast Range.

For example, the Gualala Sediment TMDL Technical Support Document (RWQCB 2001) does not identify surface erosion from forest areas as part of the background (natural) sediment production rate. Natural mass wasting (180 tons/mi^2/yr-Wheatfield Fork) and stream bank erosion (200 tons/mi^2/yr-Wheatfield Fork, based on a conservative hillslope creep rate of 1.6 mm/yr) were identified as the two erosion processes determining the natural watershed erosion rate. For comparison, the USLE for the project estimated mean annual erosion from forested areas under pre-project conditions to be about 0.17 t/ac/yr (about 110 tons/mi^2/yr-about 30% of TMDL background sediment production). This would suggest that surface erosion in forested areas is a significant process, contrary to scientific consensus among professionals that it is <u>not</u> a significant erosion process in most temperate forest environments. This calculation demonstrates the tendency for USLE to overestimate erosion rates.

Revisions of USLE (Revised Universal Soil Loss Equation-RUSLE1 and RUSLE2), have been developed to better represent potential complexity of erosion and sediment transport processes, including sediment deposition on vegetated hillslopes and the influence of slope shapes. RUSLE 2 (http://www.ars.usda.gov/Research/docs.htm?docid=6010) development began in 1993, and was released for public use in 2006.

RUSLE2 Methods

The RUSLE2 model was used to develop quantitative estimates of erosion rates by surface processes for the proposed vineyards, existing vineyards on adjacent properties, and existing grasslands. Erosion rates from existing forest in the project area are also estimated. These quantitative erosion rates were used in the sediment source analysis for the Patchett Creek watershed to evaluate potential changes in water quality resulting from the project.

Erosion rates for these processes are typically very low in forested areas owing to canopy cover and organic material accumulating on the forest floor that protects soil from rain drop impact (Selby 1982, p 99-101). Even where timber harvest removes forest canopy and ground disturbance by tractors disturbs the organic surface of the forest floor, studies at Redwood National Park found little evidence of accelerated erosion by surface processes in soils derived from sandstone parent material (Marron, Nolan et al. 1995). Nevertheless, this application of RUSLE2 included an estimate of erosion from existing forested areas of the project site for consistency.

Non-forested portions of the watershed with grassland cover at the former Sonoma County landfill site (adjacent to the refuse transfer station) were assumed to be non-contributing with respect to any potential grassland erosion owing to runoff control measures in place on that site. Some erosion probably occurs on the landfill site that contributes suspended sediment to the Patchett Creek watershed; the assumption of no off-site delivery is conservative because it tends to magnify the estimated contribution of the project watershed sediment load relative to existing conditions. Similarly, the negligible estimated surface erosion rates for forested areas are conservative in that they reduce the estimated background erosion rate, thereby increasing the relative magnitude of potential project effects.

Annual Precipitation and Soils

Mean annual rainfall of 58 inches was used for all model estimates. This value was based on interpretation of NOAA isopluvial maps (NOAA Atlas 2 Western Precipitation Frequency Maps, http://www.wrcc.dri.edu/pcpnfreq.html). Both soils in the area of interest were modeled: Goldridge Fine Sandy Loam (GdE) and Hugo Very Gravelly Loam (HkF). The RUSLE2 database contains various soil characteristics and erosion parameters pertaining to each these soils.

Land Use

The RUSLE2 database contains land use templates for Crop Management Zones (CMZ's) distributed across the United States. Sonoma County is located in CMZ 45. The model uses templates which can be modified to fit specific agricultural operations. A land use template is a compilation of management operations, vegetation and organic residue defined over specific periods in a calendar year.

For the grassland (pasture) condition, both existing and future, the management template used was "Pasture, permant; rotation grazing Z45". Custom templates (Table 1) were created for forest and vineyard land uses. Vineyards were represented with a combination of two templates: vine alleys and vine rows. Vineyard alleys were modeled to be 4.5 feet wide with barley planting on November 15th. Under this management scenario, the vineyard alley receives one mowing per year on June 15th. Vine rows were modeled to 1.5 feet wide, and annual groundcover growth was set to begin on November 15th as well. Biomass production by cover crops and grape vines that contribute organic matter and cover to the soil are inputs to the RUSLE2 templates; research in northern California regarding cover crops and vineyard soil management (McGourty, Tylicki et al. 2006; McGourty and Reganold 2004) provided much of the biomass data for these model inputs.

Management practices modeled with RUSLE2 templates are representative of expected practices in proposed and existing vineyards, particularly in the vineyard development period when erosion rates are expected to be highest. Initial cover crops of barley, however, are likely to be replaced by a different mixture of grasses. To help address such uncertainty (e.g. regarding detailed aspects of future vineyard cover crop management), the sensitivity of the RUSLE2 erosion rate estimates to actual versus modeled management practices and CMZ parameters is evaluated using the range of predicted erosion rates for the slope gradients and slope lengths modeled. This is described in more detail below.

Table 1a. RUSLE2 Land use template developed for existing forest

Date	RUSLE2 Operation	Vegetation	Yield (lb/ac)	Type of External Residue Added	Surface Residue Added (lb/ac)
15-Nov	Begin growth	Hardwood, established stands	100,000	NA	NA
15-Sep	Add mulch	(from hardwoods)	NA	Leaves	12,000

Table 1b. RUSLE2 Land use template developed for the proposed vineyard alleys; 1-mowing per year

15-Nov	Begin Cover Crop Growth	Barley, annual winter vineyard cover crop	3,000	NA	NA
1-Dec	Leaf Drop from Grape Vines	(From Grape Vine)	NA	Leaves	580
1-Jan	Prune Grape Vines	(From Grape Vine)	NA	Default	400
15-Jun	Shredder, flail or rotary mower	Barley, annual winter vineyard cover crop	NA	Cut Barley	4,300
15-Oct	Harvest	NA	NA	NA	NA

Table 1c. RUSLE2 Land Use template for proposed vine rows

15-Nov	Begin Barley Growth	Barley, annual winter vineyard cover crop	3,000	NA	NA
1-Dec	Leaf Drop from Grape Vines	(From Grape Vine)	NA	Leaves	580
15-Dec	Post Emergence Sprayer	(From Grape Vine)	NA	Barley Straw, spring	1,000
16-Dec	Begin Barley Growth	Barley, annual winter vineyard cover crop	3,000	NA	NA
1-Jan	Prune Grape Vines	(From Grape Vine)	NA	Default	400
1-Feb	Post Emergence Sprayer	(From Grape Vine)	NA	Leaves	1,000
2-Feb	Begin Weed Growth	Weeds (<9 mo old)	3,000	NA	NA
15-Jun	Mower, swather, windrower	Barley, annual winter vineyard cover crop	3,000	NA	2,300
15-Oct	Harvest	NA	NA	NA	NA

Slope Gradient and Slope Length

RUSLE2 allows model estimates to distinguish between vine rows oriented up and down hill (parallel to slope) or across hillsides (perpendicular to slope). Model scenarios were generated to estimate erosion rates for a variety of slope and length conditions representing expected vineyard layout and the erosion and runoff control measures. These typical slopes and slope lengths were derived from the Erosion Control Plan (ECP) prepared by Erickson Engineering for submittal to the County of Sonoma per its VESCO requirements.

For example, a combination of vine rows next to vineyard alleys (1.5 ft + 4.5 ft) were repeated ten times over the course of a 60 foot slope to represent the typical slope length and slope gradient between surface runoff interception berms for most proposed vineyard fields in the Erickson Engineering plan. For the 60 foot slope length, slopes of 4, 8 12 and 16% and flow parallel to vine row orientations (Table 2) were modeled to represent the typical range of mean slopes for vineyard fields drained by a combination of interception berms and drop inlets to buried drainage pipes. The ECP limits the slope length for runoff to 60 ft except where slopes are approximately 5% or less.

In addition, slopes of 4, 8, 12, 16, 25 and 35% with as slope length of 200 feet with flow parallel to row orientation were modeled. The latter two slopes (25% and 35%) with a slope length of 200 ft would not occur in the proposed vineyard, but provide an upper bound of estimated of erosion rates (Table 2). The model scenarios with these steeper slopes and relatively long slope lengths were used to estimate erosion rates from existing vineyard areas adjacent to the project site that drain to Patchett Creek.

For the existing conditions, the forest template was used with slope lengths of 200 and 500 feet for slope gradients of 5, 15, 25 and 35% (Table 2). The existing grassland (pasture) was modeled with slope lengths of 100 and 300 feet with the same slope classes as the forest cover type (Table 2).

Table 2. Annual erosion rates predicted by RUSLE2 (t/yr) for soils, vegetation, slope length and slope gradients in the project area.

Template Scenario		Mean slope					
Vine rows and alley management, soil type & planting orientation	Slope length (ft)	4%	8%	12%	16%	25%	35%
Goldridge Fine Sandy Loam (GdE) - rows perpendicular to flow	60	0.077	0.110	0.160	0.220	--	--
Goldridge Fine Sandy Loam (GdE) - rows perpendicular to flow	200	0.082	--	--	--	--	--
Goldridge Fine Sandy Loam (GdE) - rows parallel with flow	60	0.140	0.170	0.250	0.330	--	--
Goldridge Fine Sandy Loam (GdE) - rows parallel with flow	200	0.150	0.230	0.350	0.480	0.620	0.850
Hugo Very Gravelly Loam (HkF) - rows perpendicular to flow	60	0.110	0.170	0.250	0.330	--	--
Hugo Very Gravelly Loam (HkF) - rows perpendicular to flow	200	0.120	--	--	--	--	--
Hugo Very Gravelly Loam (HkF) - rows parallel with flow	60	0.110	0.170	0.250	0.330	--	--

		Mean slope			
Forested (woodland) cover	Slope length (ft)	5%	15%	25%	35%
Goldridge Fine Sandy Loam (GdE) – forested	200	0.0003	0.0007	0.0010	0.0013
Goldridge Fine Sandy Loam (GdE) – forested	500	0.0003	0.0007	0.0011	0.0014
Hugo Very Gravelly Loam (HkF) – forested	200	0.0004	0.0010	0.0016	0.0020
Hugo Very Gravelly Loam (HkF) – forested	500	0.0005	0.0011	0.0016	0.0021

		Mean slope			
Grassland (pasture) cover	Slope length (ft)	5%	15%	25%	35%
Goldridge Fine Sandy Loam (GdE), grassland	100	0.26	0.83	1.5	2.0
Goldridge Fine Sandy Loam (GdE), grassland	300	0.30	1.1	2.0	2.9

Estimation of Surface Erosion Rates and Sediment Yield

The geographic data used for the hydrologic change analysis was used for the RUSLE2 analysis as well, however, some additional data were needed. Soils distribution per the USDA Sonoma County Soil Survey (Miller 1972) were obtained from GIS data compiled by the State of California Gualala River NCWAP study. This information was "clipped" by the outline from the nodes and the soil attributes were simplified into either a Hugo very gravelly loam (HkF) or a Goldridge fine sandy loam (GdE).

An existing 1-meter grid resolution DEM obtained for the project was used to determine local slope within categories as shown in Table 3. The "reclassify", "raster to polygon" and geoprocessing tools were used to manipulate the data into the existing feature class. The soil and reclassified vector layer were merged into the previously created feature class for the hydrologic analysis. These slope data were used to determine the most representative slope gradient that would apply in different areas.

Table 3. Summary of reclassified DEM.

Proposed Vineyard Field Slope Ranges	Slope Category for RUSLE2	Existing Condition Slope Range	Slope Category for RUSLE2
< 6%	4%	< 10%	5%
6 to 10%	8%	10-20%	15%
10 to 14%	12%	20-30%	25%
>14%	16%	>30%	35%

Slope categories were distributed to landscape polygons representing combinations of soil type, vegetative cover (land use) and watershed to which drainage and eroded soil would be delivered. These land type and slope distributions were determined for both existing conditions (Table 4) and proposed project conditions (Table 5).

Note that for proposed project conditions shown in Table 5, a substantial portion of drainage area runoff (and eroded soil) is routed to receiving watersheds via proposed sedimentation basins, or to the reservoir. Sedimentation basins were designed by Erickson Engineering to capture sediment greater than about 0.1 mm diameter. Soil particle size distributions for the Hugo very gravelly loam (Miller, 1972, p. 132-3) and Goldridge fine sandy loam (Miller, 1972, p. 130-1 and p. 178) each have a median diameter of about 0.1 mm. Consequently, runoff routed through these sediment basins is expected to reduce sediment yield by about 50%. Perhaps more importantly, sedimentation basins should greatly reduce delivery of the sediment size fraction (sand and fine gravel) that tends to have the greatest potential for impairment of spawning habitat quality.

Estimated erosion rates (Table 2) were applied to acreages in Tables 4 and 5 to determine estimated annual sediment yield from the project area. The predicted sediment yield from the project area in Patchett Creek was subsequently incorporated in a broader sediment source assessment for the Patchett Creek watershed to evaluate the potential significance of erosion on the project site in relation to potential sedimentation or water quality effects on downstream fish habitat in lower Patchett Creek.

The estimated sediment yields are calculated as products of a slope-indexed erosion rate (Table 2) and acreage in the given soil type and vegetation (land use). For many of the soil/vegetation types, both a low-range and high-range estimate was developed. In the case of proposed project vineyard fields, the erosion rate used to estimate sediment yield the low range rates were derived by assuming vine rows perpendicular to slope and the high range rates were derived by assuming vine rows parallel to slope. In most vineyard fields, vine rows are expected to run up and down hill (parallel to slope), so the high range estimates are probably more typical. Vine rows oriented perpendicular to slope are planned only for gently sloping terrain, typically less than about 6%; these are also the locations where slope lengths could average as much as 200 ft. In situations where slopes are greater than about 6%, erosion control plan features limit slope lengths to about 60 ft. The difference in erosion rates between 60 ft and 200 ft slope lengths for average slopes of 4% is negligible; hence the proposed vineyard erosion estimates are based on the 60 ft slope length rates.

In existing forest and grassland areas, the low and high range erosion rates were determined in relation to the assumed slope length over which runoff could flow. In forest areas, slope lengths of 200 ft and 500 ft were evaluated (Table 2). In grassland (pasture) areas, slope lengths of 100 ft and 300 ft were evaluated (Table 2). Existing vineyard areas, which were characterized by review of aerial photos and road-side observations, were evaluated only for a 200 ft slope length. This should be regarded as a high range estimate.

Table 4. Existing distribution of acreage by slope class in project area as defined in hydrologic assessment (see Figures 6-10 in Hydrologic Assessment).

Vineyard, Goldridge soil				
Slope Class	**5%**	**15%**	**25%**	**35%**
Patchett Creek	4.0	18.5	9.1	2.7

Forest, Goldridge soil				
Slope Class	**5%**	**15%**	**25%**	**35%**
Unnamed tribs	3.6	8.1	5.9	11.4
Grasshopper	6.4	16.3	10.8	16.7
Patchett Creek	12.7	42.6	27.9	28.4

Forest, Hugo soil				
Slope Class	**5%**	**15%**	**25%**	**35%**
Patchet Creek	13.0	37.3	28.9	48.9

Grassland (pasture), Goldridge soil				
Slope Class	**5%**	**15%**	**25%**	**35%**
Unnamed tribs	0.3	0.4	0.1	0.0
Grasshopper	0.3	0.8	0.1	0.0
Patchett Creek	17.2	46.1	8.0	2.0

Table 5. Proposed project distribution of acreage by slope class in project area as defined in hydrologic assessment (see Figures 6-10 in Hydrologic Assessment).

Proposed vineyard, Goldridge soil, drainage to sediment basin

Slope Class	**4%**	**8%**	**12%**	**16%**
Unnamed tribs	0.2	0.5	0.9	4.4
Grasshopper	1.3	2.4	2.4	4.5
Patchett Creek	2.9	5.6	8.0	13.0

Proposed vineyard, Goldridge soil, normal drainage

Slope Class	**4%**	**8%**	**12%**	**16%**
Unnamed tribs	1.2	1.4	1.3	3.5
Grasshopper	0.6	1.0	1.3	7.1
Patchett Creek	0.6	1.9	3.1	7.5

Proposed vineyard, Hugo soil, drainage to sediment basin

Slope Class	**4%**	**8%**	**12%**	**16%**
Patchet Creek	4.3	6.3	6.8	24.4

Proposed vineyard, Hugo soil, normal drainage

Slope Class	**4%**	**8%**	**12%**	**16%**
Patchett Creek	1.4	2.4	2.7	12.9

Existing vineyard, Goldridge soil, drainage to sediment basin

Slope Class	**5%**	**15%**	**25%**	**35%**
Patchett Creek	0.2	1.2	1.0	0.2

Existing vineyard, Goldridge soil, natural drainage

Slope Class	**5%**	**15%**	**25%**	**35%**
Patchett Creek	3.8	17.3	8.1	2.5

Forest, Goldridge soil

Slope Class	**5%**	**15%**	**25%**	**35%**
Unnamed tribs	1.7	3.5	2.6	8.1
Grasshopper	3.3	7.9	6.5	11.7
Patchett Creek	10.6	38.4	18.4	21.5

Forest, Hugo soil

Slope Class	**5%**	**15%**	**25%**	**35%**
Patchett Creek	5.6	16.0	11.9	33.6

Grassland (pasture), Goldridge soil, natural drainage

Slope Class	**5%**	**15%**	**25%**	**35%**
Unnamed tribs	0.2	0.3	0.1	0.0
Grasshopper	0.3	0.8	0.1	0.0
Patchett Creek	10.9	22.7	3.8	1.4

Grassland (pasture), Goldridge soil, drainage to sediment basin

Slope Class	**5%**	**15%**	**25%**	**35%**
Patchett Creek	4.1	8.5	1.5	0.5

The estimated sediment yield from surface erosion for the project area draining to Patchett Creek is summarized in Table 7. Sedimentation basins as designed are predicted to reduce sediment yield by 50%, primarily by capturing sand and fine gravel > 0.1 mm diameter. Finer suspended sediment that passes through the sediment basins is relatively mobile in energetic stream systems such as Patchett Creek (NCASI 1999). Most of the sediment from the project site, following treatment in sedimentation basins, is expected to remain in the water column as it is transported through Patchett Creek with relatively little deposition. The sedimentation basins (and the reservoir collection system) reduce the predicted increase in sediment yield of about 5 to 7 t/yr to a net decrease of about 8 to 13 t/yr. This represents a decrease in Patchett Creek sediment at the project area boundary of about 10 to 13% (Table 7, last row) relative to existing conditions.

Table 7. Summary of surface erosion and sediment yield estimates for the project area derived from application of RUSLE2 erosion models.

		Existing Conditions	
Cover Type	**Drainage Type**	**Low Estimate (t/yr)**	**High Estimate (t/yr)**
Non-project Vineyard	Natural	17.4	17.4
Grassland	Natural	58.7	77.7
Forest	Natural	0.28	0.3
Total		**76.4**	**95.4**
		Project Conditions	
Project Vineyard	Natural	7.9	9.2
	Sed. Basin	16.3	18.9
Non-project Vineyard	Natural	16.0	16.0
	Sed. Basin	1.4	1.4
Grassland	Natural	30.2	39.9
	Sed. Basin	11.4	15.0
Forest	Natural	0.2	0.2
Total Sediment Yield		**83.4**	**100.6**
Total-Sed. Yield with Sed. Basin Mitigation		**68.8**	**82.9**
Change in Sediment Yield		7.0	5.2
Change in Yield, with Sed. Basin Mitigation		-7.6	-12.5
% Change in Sediment Yield		9.2%	5.4%
% Change in Yield, with Sed. Basin Mitigation		-10%	-13%

Erosion Mitigation

The project reservoir collection system will largely eliminate runoff to a 1,200 ft reach of Class III channel immediately south of the proposed reservoir site (see map, Appendix A). This channel has developed in an abandoned road or tractor trail. The channel erosion and bank creep processes in this section of channel are expected to be significantly reduced under project conditions. Based on an estimated 75% reduction in creep rate for this section of stream channel, mean annual sediment yield would be reduced 1.7 t/yr. Seepage erosion probably contributes to erosion processes in this channel; a seepage interception trench will be installed parallel to this section of channel (Erosion Control Plan Mitigation Site 3).

The reservoir collection system will also largely eliminate storm runoff delivered to two large gullies located between the proposed reservoir and reservoir sump (THP Sites C1 and C2 as shown on map, Appendix A; ECP Mitigation Sites 4 and 5). These large gullies were surveyed in the field in 2005 to estimate erosion rates; field data and estimated rate calculations are provided in Appendix A. Estimated current bank erosion rates in these gullies total 11 t/yr, and are used to represent the low-range erosion rate estimate. Long term gully evacuation rate estimates total 22 t/yr and are used to represent the high-range erosion rate estimate. To further mitigate erosion from these gullies, interception drains (per the ECP) will be installed along the vineyard perimeter above these gullies to curtail seepage erosion processes in the gullies. It is expected that the reduction in water surface runoff and subsurface seepage delivered to these gullies will substantially limit erosion processes. Assuming a reduction in erosion rates in these gullies of at least 75%, mean annual sediment yield would be reduced by 8.3 to 16.5 t/yr for the low range and high range estimates respectively.

Significant gully erosion existing on the project site under current conditions was observed in April 2007 at three additional locations (ECP Mitigation Sites 1, 6 and 7) affecting existing temporary or abandoned roads (see map, Appendix A). Erosion rates for these gullies were estimated based on field observations to total 14.1 to 17.7 t/yr for low range and high range estimates, respectively. Project mitigation for erosion at these sites will be implemented to correct inadequate drainage conditions that have caused gully erosion. Mitigation Site 7 was determined to be located on an adjacent parcel and not in the project area during Pre-Harvest Inspections in the Timber Harvest Plan review process; and consequently, that mitigation is not available for the project. Assuming a reduction in erosion rates in gullies at Sites 1 and 6 of at least 75%, mean annual sediment yield would be reduced by 6.0 to 8.7 t/yr for the low and high range estimates, respectively.

Total estimated active gully erosion on the project site (Table 10, fourth row) ranges from a low of 25 t/yr to a high of 40 t/yr. Estimated erosion rate in active gullies with proposed mitigation is 14.2 t/yr (low-range) to 25.2 t/yr (high-range). Reduced channel erosion adjacent to the reservoir (described above) is estimated to be 1.7 t/yr, resulting in reduced erosion of 15.9 t/yr to 26.9 t/yr for low and high range estimates, respectively. Rounded to the nearest ton, sediment savings from reduced gully erosion would total 16 to 27 t/yr for low and high range estimates of annual sediment yield (Table 10).

Watershed Sediment Source Assessment for Patchett Creek

Quantitative watershed-scale erosion assessments have been conducted at various scales using various methods in the Gualala River watershed in recent years. These include assessments by Mendocino Redwood Company (MRC 2003), the Regional Water Quality Control Board (RWQCB 2001), and the North Coast Watershed Assessment Program (Klamt et al, 2003). The assessments, particularly the MRC work, contain relevant data that can be utilized in development of a sediment source assessment for the watershed.

The MRC assessment includes quantitative estimates of sediment delivery to stream channels from MRC ownership in the Patchett Creek watershed (about 0.9 mi^2). MRC maps use the name Annapolis Falls Creek instead of Patchett Creek, which is unnamed on USGS maps. Specific sediment delivery data pertaining to debris slides (shallow landslides) and roads, separated into diffuse surface erosion processes and localized point sources, can be incorporated in our sediment source assessment.

Additional work was done in this sediment source assessment to estimate the likely range of bank erosion rates in the Patchett Creek watershed. Bank erosion is a primary mechanism for the transfer of sediment from hillslopes to channels, sometimes referred to as hillslope creep, that occurs at relatively small scales and at relatively slow rates. Bank erosion is believed to be an important geomorphic process that contributes significantly to background (i.e. natural) watershed erosion rates, and methods have been developed to estimate bank erosion rates (WFPB 1997). These methods have been previously applied to the Gualala watershed (RWQCB 2001, Klamt et al. 2003). This assessment applies the method described by the California Geological Survey (Klamt et al. 2003 Appendix C of Report Appendix 2; http://www.ncwap.ca.gov/gualala/synth_report.html) to estimate bank erosion rates for the Patchett Creek watershed.

Previous Landslide Assessments

The distribution of landslides is primarily controlled by the distribution and physical properties of the underlying geologic formations. The most comprehensive assessment of geology, landslides and slope stability in the Gualala River watershed was conducted by NCWAP (Klamt et al. 2003). The Gualala watershed is within the boundaries of the San Andreas Fault System and the Tombs Creek Fault Zone. As a result the underlying rocks tend to be intensely sheared and inherently unstable, mass wasting is common, and sediment supply rates to tributaries are relatively high.

NCWAP products include GIS thematic maps that portray geologic and geomorphic conditions in the area. The geologic map (Figure 1) and geologic hazards and geomorphic maps (Figure 2) display conditions in the Patchett Creek watershed.

Landslide potential is generally very low for flat marine terraces, lower stream valleys and flat topped ridges underlain by the Ohlson Ranch formation (Figure 2). Landsliding is not common on gentle to moderately steep slopes underlain by the relatively competent Coastal Belt Franciscan rocks, and flat topped ridges of Ohlson Ranch formation. Moderate landslide potential exists on moderate to moderately steep, relatively uniform slopes underlain by Coastal Belt Franciscan bedrock. These areas may include older dormant landslides in the Coastal Terrane west of the Tombs Creek fault zone. Landslides typically occur as small debris flows, debris slides and rockslides (Klamt et al. 2003).

Areas of very high landslide potential, including historically active landslides (<150 yrs old), inner gorges, and debris slide/flow source areas occur on steep to very steep slopes. Landslides typically occur as small rockslides, debris slides, and debris flows in Coastal Belt Franciscan rocks. Inner gorges along the stream channels generally have a high to very high landslide potential; lower Patchett Creek contains a section of inner gorge about 1,100 ft (0.2 mi) in length (Figure 2). From the NCWAP maps (Figure 2), the total area of debris slide slopes in Patchett Creek is about 95 ac (0.15 mi^2; about 8.5% of the watershed), the area of dormant landslides (rockslides) is about 64 ac (0.1 mi^2; about 5.7% of the watershed). One “small landslide” was mapped by NCWAP from the 1984 aerial photographs.

(MRC 2003) mapped two additional rockslides on the east side of Patchett Creek adjacent to the inner gorge zone, one covering about 9 ac (Figure 3, 19-14) and another about 2 ac (Figure 3, 19-4). These slides have likely delivered sediment directly to Patchett Creek.

The lower portions of Patchett Creek where elevated landslide hazard and historic landslides have been mapped coincides with the reach between WYA Nodes 1 and 2 (Figure 4), which is believed to contain steelhead habitat. Based on these data from NCWAP, it is apparent that this reach of Patchett Creek has historically been subject to relatively high natural erosion rates. Owing to the presence of accessible habitat, this reach of Patchett Creek is the location where potential erosion and sedimentation would be expected to have the most potentially significant impacts on fish habitat. Following is a quantitative assessment of sediment delivery rates to Patchett Creek at its confluence with the Wheatfield Fork (Node 2 in the WYA hydrologic evaluation).

Figure 1. Patchett Creek watershed geology map (left) and orthophoto (right), including partial road coverage, from NCWAP Gualala GIS.

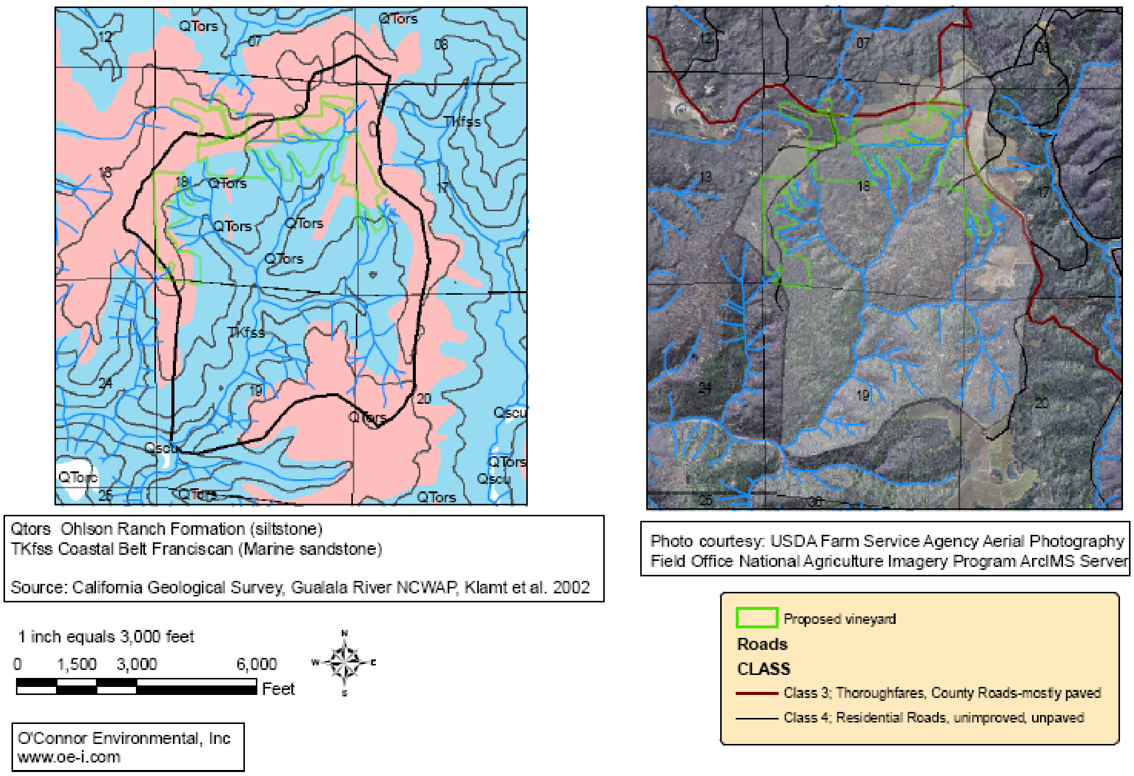


Figure 2. Patchett Creek watershed geologic hazards (top), and geomorphic map (bottom), from NCWAP Gualala GIS.

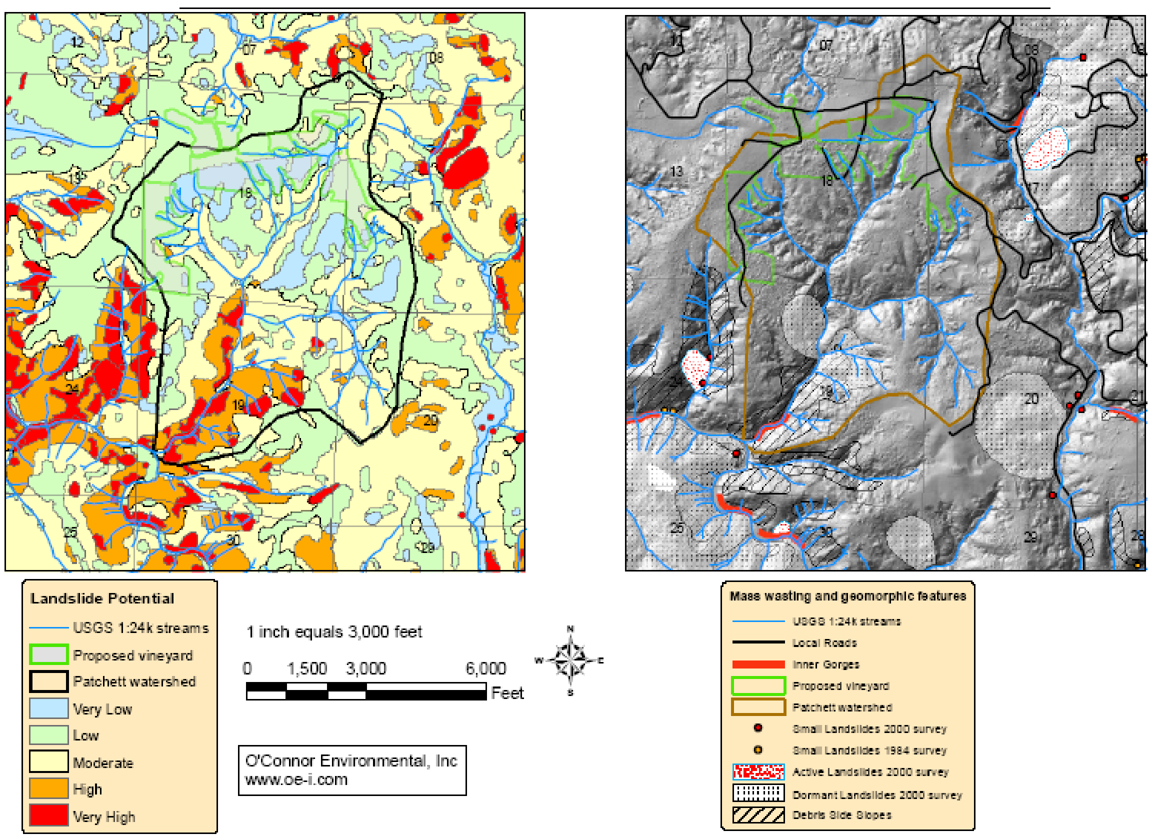
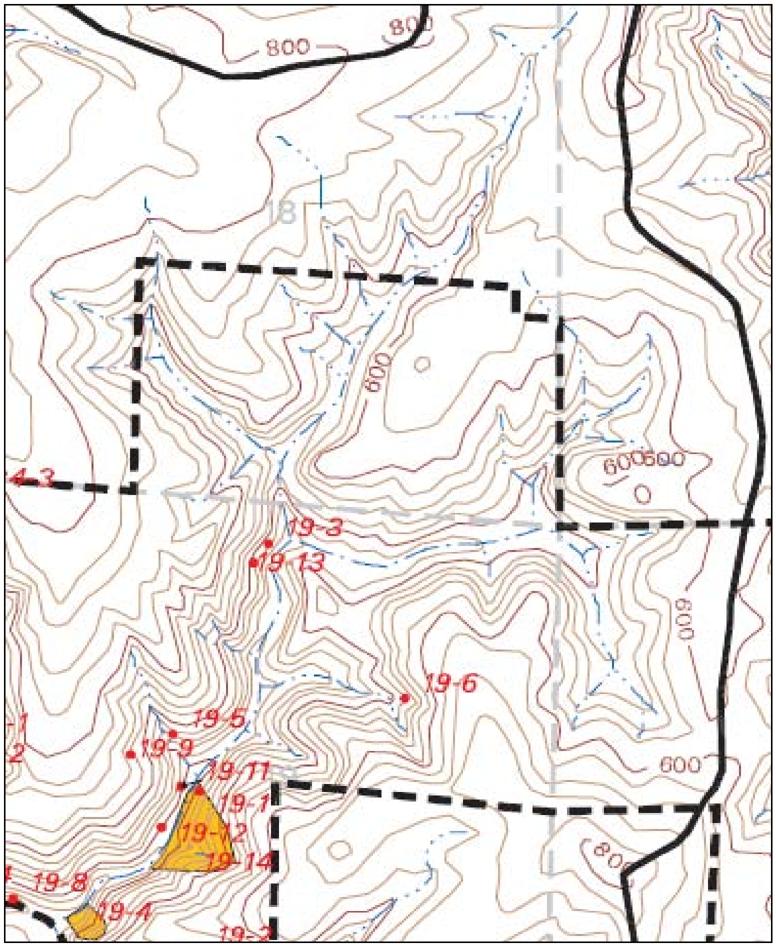


Figure 3. Landslide inventory map for Patchett Creek watershed (MRC 2003). Red dots represent discrete shallow landslides that delivered sediment to streams; gold polygons indicate probable rockslides.



Methods for Sediment Source Assessment

Sediment inputs to Patchett Creek can be estimated using existing data and previously developed techniques, including some from the above-referenced watershed scale assessments. Two different approaches were used to develop alternate estimates of mean annual sediment inputs to Patchett Creek. The first approach draws on available data and field observations in the project area to assess sediment sources based on specific conditions in Patchett Creek. The second approach simply applies sediment input rates developed for the Wheatfield Fork sub-watershed in the Gualala sediment TMDL (RWQCB 2001) to Patchett Creek on a unit-area basis.

The first approach includes sediment input estimates using the following:

- Bank erosion for ordinary slope conditions (Table 8-function of background creep rate, stream length, and estimated soil depth; determined from channel network shown in Figure 4 and computed per Appendix B).
- Creep rate inputs from rockslides to streams (Table 8-function of different creep rates for dormant and historically active rockslides, stream length in dormant rockslides or stream length adjacent to toe of historically active rockslides, and estimated bank height; computed per Appendix B).
- Shallow landslide sediment delivery (Table 9) estimated by (MRC 2003); based on terrain and landslide hazards in Patchett Creek, landslide inventory for MRC ownership (~0.9 mi^2) probably accounts for most mass wasting of this type in the watershed.
- Sediment delivery rate from forest road surface erosion and point source erosion estimated for MRC ownership in this portion of the Gualala, including but not limited to Patchett Creek (MRC 2003)
- Field estimates developed by OEI of the erosion rate of active gullies and other erosion features surveyed on the project site (see Erosion Mitigation above).

This method provides low-range and high-range estimates for erosion inputs from rockslides, roads and actively eroding gullies. For bank erosion under ordinary slope conditions, and for shallow landslide sediment delivery, only a single estimate was developed.

These estimates also provide a basis for estimating background erosion rates. Erosion from roads, active gullies and a portion of the shallow landslides is attributable to historic management. The remaining erosion sources—creep rate inputs from rockslides and bank erosion and the remaining portion of shallow landslides—represent natural background erosion.

Shallow landslide erosion was estimated on an annual basis using sediment delivery reported for Patchett Creek as summarized in Table 3 (MRC 2003). This estimate was based on landslide mapping and interpretation of aerial photographs spanning the time period 1980-2000. To obtain a mean annual rate, the total mass of delivered sediment was divided by 25 years (20 years between 1980 and 2000, plus 5 years to account for likely recognition of recent slides before they are obscured by vegetation potentially visible in 1980 photographs.

The portion of the shallow landslides attributable to management was estimated using the ratio of natural mass wasting to road related mass wasting (180 / 310 = 0.58) for the Wheatfield Fork Gualala as per the Gualala sediment TMDL (see below). Hence, the natural erosion rate for shallow landslides was estimated to be the average annual rate calculated as described above, multiplied by the factor 0.58. This is equivalent to assuming that management induced a 72% increase ({310 / 180} – 1) in sediment delivery from shallow landslides

Figure 4. Map of channel distribution based on West Yost Associates (draft) Figure 4, used for calculation of channel segment lengths and stream order; extent and location of channels modified by OEI based on field observations and topography.

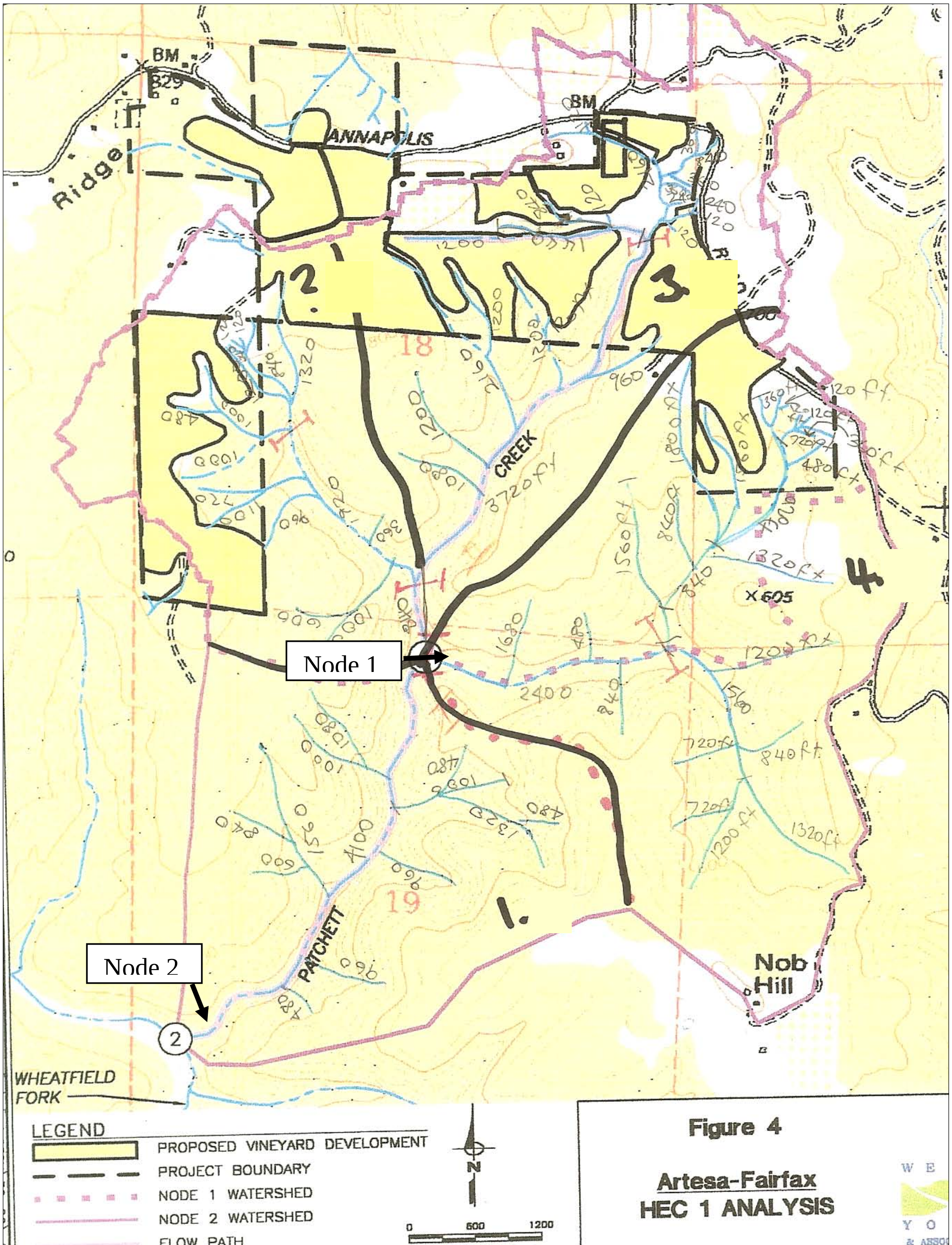


Table 8. CGS creep rates ranges for rockslides, earth flows and ordinary slopes applied for Gualala River sediment input rate estimates (from Klamt et al. 2002).

Erosion source/process	Low (mm/yr)	High (mm/yr)
Historically active earthflow	130	300
Dormant earthflow	10	20
Historically active rockslide	25	50
Dormant rockslide	5	10
Background creep (ordinary slope conditions)	1.6	n.a.

Table 9. MRC (2003) shallow landslide sediment delivery estimates for Patchett Creek watershed; tabular data are spatially referenced in Figure 3.

Slide no.	Date	Delivery volume (yd^3)	Mass (t)
19-9	1997	0	0
19-8	1995	326	440
19-6	1995	85	115
19-5	1995	59	80
19-3	1987	146	197
19-2	1987	73	98
19-13	1985	73	98
19-12	2000	31	42
19-11	1980	498	672
19-1	1987	121	184
Total		1,412	1,926

Additional data, estimates and assumptions used for the Patchett Creek sediment source assessment include a map of channel distribution developed by OEI based on WYA Figure 4, with added channel segments based on field experience regarding channel distribution in the area, and estimated bank heights for channels. A bank height of 1 m was assumed for all channels except on the mainstem of Patchett Creek between Node 1 and 2 (Figure 4), plus an additional 660 ft upstream of Node 1, where bank height was assumed to be 2 m. Stream channel length and calculations are compiled in Appendix B.

Patchett Creek Sediment Yield Estimates

The estimated sediment yield for Patchett Creek is summarized in Table 10, including estimated surface erosion from the project site using RUSLE2 for both existing and project conditions. Estimated sediment yield from the proposed project site decreases by about 24 to 39 t/yr for low and high range estimates, respectively. This represents a decrease of from 4.3% (24 t/yr / 557 t/yr) to 4.8% (39 t/yr / 828 t/yr) for low range and high range existing conditions sediment yield estimates, respectively.

Sediment yield under project conditions is reduced owing to design mitigations and other sediment mitigation to repair and prevent gully erosion on the project site. Sediment yield from vineyard fields has been largely controlled by erosion control practices, and further limited by construction of sedimentation basins at vineyard drainage outfalls. Sedimentation basins reduce estimated vineyard erosion by about two-thirds (Table 7), resulting in a net decrease in sediment yield ranging from 8 to 13 t/yr. Additional reductions in sediment yield by erosion mitigation designed to repair and control gully erosion at five sites in the project area is expected to reduce erosion rates by at least 16 t/yr (low range estimates) to 27 t/yr (high range estimates). These estimated sediment savings result in net decreases in sediment yield under project conditions of 24 to 39 t/yr.

Table 10. Sediment source summary for Patchett Creek under existing conditions.

Erosion Source or Process	Low Range Rate (t/yr)	High Range Rate (t/yr)	Source of Estimate
Bank erosion, ordinary slope conditions	133	133*	NCRWQCB 2001; Creep rate = 1.6 mm/yr * stream length * 2 banks * avg. bank height. Avg. bank height = 1m for all channels except 4rth order (mainstem Patchett Creek) = 2m (Appendix B)
Bank erosion in rockslides	66	131	CGS (see Table 8 and Appendix B)
Shallow landslides	77	77*	MRC 2003; estimated sediment delivery to Patchett Creek channels averaged over 25 yr (~ 1975-2000), see Table 9
Active gullies in project area	25	40	OEI field estimates for gully erosion processes
Roads; surface and point source	180	352	MRC 2003; low range is MRC road erosion rate applied to MRC ownership only; high range is MRC rate applied to entire Patchett Creek watershed
Existing vineyards & orchards	17	17*	RUSLE2 model predictions for project area
Existing pastures & abandoned orchards	59	78	RUSLE2 model predictions for project area
Total-Existing Conditions	557	828	Sum of each column
Estimated Natural	244	309	Sum of first two rows above and estimated “natural” component of shallow landslides (58%-see discussion in text)
Total-Project Conditions	533	789	Project conditions, including estimated decrease from project area of about 8 to 13 t/yr (see Table 7) and decreases from active gully erosion of 16 to 27 t/yr (see *Erosion Mitigation*, p. 11; Appendix A)

* no distinction between low and high range rate estimate

Patchett Creek Sediment Yield from Gualala Sediment TMDL

This approach uses watershed scale erosion rates for the Wheatfield Fork for specified erosion processes as per (RWQCB 2001, Table 6.1, p. 98), and applies them to the 1.76 mi^2 drainage area of Patchett Creek. In the following list, the first two items represent the natural erosion rate (380 t/mi^2/yr), while the remaining six comprise the human-caused erosion rate (810 t/mi^2/yr):

- Natural mass wasting (180 t/mi^2/yr)
- Stream bank erosion (200 t/mi^2/yr)
- Road related mass wasting (310 t/mi^2/yr)
- Road-stream crossing failures (40 t/mi^2/yr)
- Road related gullying (210 t/mi^2/yr)
- Road related surface erosion (120 t/mi^2/yr)
- Skid trail surface erosion (20 t/mi^2/yr)
- Other harvest related delivery (110 t/mi^2/yr)

Applying these rates to the Patchett Creek watershed (1.76 mi^2) yields mean annual natural sediment inputs and human-caused inputs of 669 t and 1,426 t, respectively. The total estimated erosion rate for Patchett Creek using this method is about 2,090 t/yr. This is roughly 3 to 4 times greater than the erosion rate estimated using data specific to Patchett Creek.

Summary of Project Effects on Sediment Yield

The estimated existing erosion rate for the Patchett Creek watershed against which potential vineyard erosion can be compared may range from as low as about 557 t/yr to as high as about 2,090 t/yr. The range of natural erosion rates is from about 244 t/yr to 669 t/yr. Sediment yield estimates for existing conditions specific to Patchett Creek developed for this project range from 557 to 828 t/yr. Sediment yield in Patchett Creek from the proposed project decreases by about 24 t/yr, (low range estimate) to 39 t/yr (high range estimate) with erosion and sedimentation mitigation. Patchett Creek sediment yield is predicted to decrease to 533 t/yr (low range estimate) or to 789 t/yr (high range estimate) equivalent to a decrease of about 4.3% and 4.8% respectively for low and high range estimates relative to existing conditions.

The proposed TMDL load allocation for sediment (RWQCB 2001, Table 6.2, p. 102) is 475 t/mi^2/yr. This is equivalent to 836 t/yr in Patchett Creek (475 t/mi^2/yr x 1.76 mi^2). Based on the erosion rate estimates in Table 10, the high range (worst case) estimate of 789 t/yr under project conditions is 47 t/yr (~6%) below the proposed sediment load allocation, and the low range estimate of 533 t/yr is about 303 t/yr (~36%) below the proposed sediment load allocation. The estimated decrease in the Patchett Creek sediment yield of 24 to 39 t/yr increases the margin of sediment yield below the TMDL proposed sediment load allocation.

These data indicate that current erosion rates in Patchett Creek are relatively low compared to other portions of the Gualala River watershed, and that water quality attributes related to erosion and sedimentation processes may not be significantly impaired in Patchett Creek. The relatively large differences between the Patchett Creek sediment yield estimate and TMDL estimates of sediment yield for the same area reflect common difficulties with erosion and sedimentation studies, including variations in methods, geographic scale and specificity of assessment, and wide naturally-occurring variation in erosion processes and rates. The data indicate that the magnitude of potential erosion from the project is not significant in relation to both existing and natural background rates.

Potential erosion associated with modest increases in peak flow (assessed in the Hydrologic Analysis) is not included in the foregoing sediment budget owing to substantial uncertainties regarding the likelihood and magnitude of this erosion process. Erosion rates in Class III channels are highly variable and not readily predictable (O'Connor et al., 2007). The extent and degree of channel sensitivity of headwater drainages that are expected to receive peak flow increases (assessed in the Hydrologic Analysis) does not represent a likely significant effect, defined as accelerated erosion processes inducing a significant increase in sediment delivery rates to Patchett Creek, particularly relating to degradation of habitat for coldwater fish. To assess potential significance of headwater channel erosion by peak flow increase, as estimate of the potential magnitude and significance of such erosion processes is required. As per the Hydrologic Analysis, an estimate of this erosion was developed as follows:

> If all moderately sensitive drainages were substantially eroded throughout their individual zones of sensitivity, the resulting erosion could approach sediment yield of on the order of 100 tons over several years of winter runoff. The order of magnitude estimate is obtained as follows: 20 drainages, each eroding over a length of 500 ft over an average width of 1 ft (~60% of mean active channel width) by a depth of 0.1 ft (25% of mean active channel depth); 20 x 500 ft x 1 ft x 0.1 ft x 0.05 ton/ft^3 = 100 t. If this were to occur over a 5 year interval, this quantity of sediment (~ 20 t/yr) could represent as much as a few percent of current erosion rates in the watershed. Erosion of this magnitude could conceivably have some sedimentation impacts in reaches of Patchett Creek accessible to coldwater fish.

There is no compelling evidence that hydrologic change will cause significant erosion in Class III channels draining the project area. Channel response to peak flows is controlled by the size of channels, channel substrate, and the proximity of bedrock and boulder controlled channels downstream. Potential erosion of channels draining the project area is limited to varying degrees by these factors. Furthermore, peak discharge for high-magnitude, low-frequency flows (> 5 yr recurrence interval events) under current conditions indicate that the largest increases in peak flows (2 yr recurrence interval events) predicted under project conditions would be well within the range of flows transmitted by the existing channels in most locations. Hence, several factors limit the potential for channel erosion related to peak flow change, reducing the likelihood that the magnitude of erosion would prove significant.

Given the threshold of significance as defined above and uncertainty regarding actual acceleration of channel erosion that might result from predicted peak flow increases, the recommended course of action is to implement a monitoring program capable of detecting channel response to peak flow prior to potentially significant effects becoming manifest. Should monitoring reveal substantial acceleration of erosion in channels draining the project area, appropriate documentation, reporting and implementation of erosion control measures would follow. A monitoring program pertaining to erosion and sedimentation at the project site would also reduce uncertainty regarding estimated erosion rates from vineyard areas and effectiveness of sedimentation basins. Such a monitoring program is described below.

The foregoing analysis evaluates project impacts for the constructed project with implementation of the long-term Erosion Control Plan (ECP). As described in the ECP, project construction activity is restricted to the dry season, and regulatory requirements of the County of Sonoma (VESCO) and the State of California will be in force to prevent erosion. Project construction is expected to be phased in a manner that will allow completion of permanent erosion control facilities and implementation of ECP provisions. In addition, a State-mandated Storm Water Pollution Prevention Plan (SWPPP) will be developed and submitted to the NCRWQCB. The SWPPP is intended to provide for installation of temporary drainage and erosion control facilities as appropriate for the site.

Nevertheless, construction activities create substantial site disturbance, and removal and replacement of vegetative cover creates potential for accelerated erosion. There is some potential for erosion to occur in unexpected locations or at unexpected rates, particularly in the first winter after construction. Given the threshold of significance discussed above pertaining to erosion impacts on water quality, a monitoring plan designed to supplement the ECP and SWPPP during the first winter after project construction. This monitoring program is described below.

Monitoring

Two separate monitoring plans are described in this section. The first pertains to potential acceleration of erosion rates in Class III channels draining the project area and sedimentation basin efficiency over a three-year period following construction. The second pertains to short-term erosion potential related to site disturbance in the construction area in the first year following construction.

Channel Erosion and Sedimentation Basin Monitoring

Erosion rates in existing Class III stream channels could be accelerated by increased runoff and peak flow expected to result from the project. This monitoring plan is motivated by findings of the Hydrologic Analysis (reviewed above) regarding the potential magnitude and potential significance of expected peak flow increases.

Given the relatively high variability of hydrologic and geomorphic processes, and the identified variability in existing channel conditions, channel response to predicted peak flow increases is somewhat uncertain. While the predictable potential effects of the project with mitigation are not significant, unpredictable events or unexpected responses could have substantial impacts. Consequently, a monitoring program is presented below at a conceptual level including substantial detail.

Objective

The objective of the monitoring plan is to observe and document erosion response, if any, of Class III channels draining the project area and to verify that the magnitude of response does not rise to a significant level. No net increase in sediment yield from the project area is an environmental objective of the project.

The foregoing analysis concluded that the project (with mitigation) is expected to reduce sediment yields by 24 to 39 t/yr. The specific objective of this monitoring plan is to determine whether potential increases in sediment yield associated with accelerated channel erosion are less than about 24 to 39 t/yr. In addition, the performance of sedimentation basins will be monitored to provide measurements of vineyard field erosion and sedimentation basin trapping efficiency. These measurements are warranted because they could lead to revisions of predicted vineyard field erosion, which could either increase or decrease the threshold of significance of channel erosion.

The monitoring plan has three components:

1. Detailed topographic surveys of selected channels,
2. Annual survey of erosion of "sensitive" channels, and
3. Survey of selected sedimentation basins.

Topographic Surveys of Selected Class III Channel Reaches

This element of the monitoring plan would include detailed topographic surveys using a total survey station to measure changes in channel elevation for sample sections of selected Class III stream channels. This study approach has been previously implemented by O'Connor Environmental for Class III streams in Humboldt County to fulfill monitoring requirements of the Pacific Lumber Company Habitat Conservation Plan. The strength of this approach is that it develops accurate, objective quantitative data documenting the dimensions and elevation of channels before the project and three years after project completion. This will provide statistical measures (using parametric techniques), of channel erosion rates that can be extrapolated to assess the magnitude of channel erosion in the project area. The study will be designed so that a range of hydrologic change is observed that will indicate whether peak flow change is correlated with channel erosion rate. Specifically, six channels (2, 20, 31, 40, 45B and 60A; see Hydrologic Analysis, Figure 6 for locations of these channels and Table 6 for the magnitude of expected peak flow change) would be monitored to determine erosion rates over a three year period.

Annual Surveys of Class III Channels

This annual survey would be conducted for the 18 channels considered to be moderately sensitive to peak flow (Hydrologic Analysis, Table 12). The survey technique to be employed would systematically observe and measure the surface area and depth of fresh channel and bank erosion features as a measure of annual erosion rates. This technique, while objective, requires field estimates that have only moderate levels of precision. The advantage of this approach is that it allows for broad coverage of the monitoring sites and is likely to detect significant changes in the rates of channel and bank erosion. Statistical tests for change would most likely utilize techniques for non-parametric data. These surveys would be conducted four times: once prior to project implementation to document baseline conditions, and then annually in late winter/early spring when annual erosion features are relatively easy to detect and measure. These annual surveys developed over a broad project area are also important in that they would likely detect unexpected rates of change in a time frame that would allow for timely response, if necessary.

Annual Surveys of Selected Sedimentation Basins

This annual survey would measure the volume of accumulated sediment and the grain size distribution of accumulated sediment in a sample of about 25% of the sedimentation basins in the project. By comparison to grain size distribution of the vineyard soils, the deposited sediment size distribution and volume can be used to estimate the erosion rate of the vineyard fields and the sedimentation basin trapping efficiency (Reid and Dunne, 1996, p. 49). The monitoring would be comprised of annual measurements of depth of accumulated sediment in selected basins and collection and laboratory analysis of samples of accumulated sediment. The selection of basins for monitoring would include a range of sediment basin sizes. Data analysis would include comparison of pre-project estimates of vineyard erosion rates and sediment trapping efficiency to measured rates and efficiency.

Post-construction Monitoring

As described previously, this monitoring plan is intended to supplement the project ECP and SWPPP for the first winter season after project construction. It may apply to specific sub-areas of the project, and could extend for more than one year, depending on the ultimate construction schedule. This monitoring plan should be implemented for areas where site preparation has occurred in the prior construction season, including soil preparation, grading and drainage installation. The first-year post-construction monitoring requirement is fulfilled if the monitoring period follows all grading and drainage work, regardless of whether vineyard planting and cover crops have been established. If site preparation work is conducted, but final grading and drainage installation is not complete, this monitoring plan will extend to the subsequent winter until final grading and drainage work is complete. This monitoring plan may be combined with provisions of the ECP or SWPPP as appropriate subject to governing regulations.

The post-construction monitoring plan has three components:

1. Review of ECP and SWPPP provisions and implementation.
2. Field inspections triggered by rainfall events.
3. Response and reporting.

ECP and SWPPP Review

These erosion and drainage control plans are prepared by professional engineers, and are reviewed and enforced under local and State regulatory authority. The monitoring plan will use these plans, consisting of maps with specific installations and Best Management Practices (BMP's), to define specific objectives of field inspections. The ECP and SWPPP will define anticipated erosion locations and processes. The monitoring plan will consist of a checklist and maps derived from the ECP and SWPPP that guide field inspection of project work areas, particularly the perimeters where eroded sediment and runoff would be delivered from source areas.

Field Inspections

On site inspections of portions of the project area subject to monitoring will occur in response to rainfall events as specified here. ECP and SWPPP requirements typically include complete installation of winter erosion control measures between October 1 and October 15. Rainfall reported for the Venado gage site located in the Coast Range in northwest Sonoma County will be used to determine the timing of field inspections. Real time data from this rain gage can be accessed via the internet from either of the following URL's:

- http://cdec.water.ca.gov/
- http://www.cnrfc.noaa.gov/precipMaps.php?group=rn&hour=24&synoptic=0

The first field inspection will occur within two days following the first rainfall exceeding 1 inch in a 24 hour period beginning October 1. The second field inspection will occur when one of the two following conditions are met: 1 inch of rainfall in a 24 hour period after cumulative seasonal rainfall of 6 inches has occurred, or 2 inches of rainfall in a 24 hour period. A third inspection would occur after 1 inch of rainfall in a 24 hour period following seasonal accumulation of 12 inches of rainfall. Thereafter, inspections would occur following 2 inches of rainfall in 24 hours or within four weeks of the previous inspection, whichever occurs first.

It is expected that any significant erosion problems will have developed and been addressed within the first few substantial rainstorms, and that there would be a diminishing likelihood of identification of new problems after the first few inspections. After a total of six inspections have been performed according to the protocol above, subsequent inspections are optional and may be performed at the discretion of the project proponent. Inspections are not required within 7 days of any prior inspection, regardless of rainfall.

Field inspectors will survey the portions of the site subject to monitoring and complete a visual inspection of the site guided by the checklist and maps developed during the ECP and SWPPP review. Supplemental documentation of conditions using photography is encouraged, but is not required. The checklist developed will be the primary reporting document and will include the following elements:

- Observation date, time, weather conditions, precipitation event or other circumstances requiring inspection, observers name and contact information, name and contact information for project personnel responsible for maintenance and repair of erosion control measures.
- A map developed for the monitoring program with cross-references between areas identified on ECP and SWPPP maps and checklist items.
- Field assessment of erosion control measures as adequate or requiring immediate additional controls or repairs.
- Measurements or quantitative estimates of volume of eroded and deposited material, referenced to a location, and assessment of whether sediment was delivered to a watercourse.

Response and Reporting

The field inspector will provide advance notice of inspections, to the extent possible, to responsible project personnel to facilitate immediate response should it be necessary. If the field inspection identified any locations requiring immediate attention to repair or expand erosion control measures, the inspector shall contact responsible project personnel as soon as possible. A copy of the inspection checklist will be provided to responsible project personnel via facsimile or e-mail for review within 24 hours of the inspection. Project personnel will provide a written summary of any erosion control measures implemented in response to the field inspection within 5 calendar days of receipt of the inspection report. A summary report for each winter monitoring season will be submitted not later than June 15 to the regulatory authorities responsible for review and implementation of the ECP (County of Sonoma) and SWPPP (NCRWQCB).

Adaptive Management

If monitoring data indicate that sediment yields from the project area are greater than predicted in the pre-project analyses, either from unexpected erosion of Class III channels or higher-than expected delivery rates of sediment eroded from vineyard fields, appropriate on- and off-site erosion mitigation will be developed with oversight by the lead CEQA agency or an alternative regulatory authority designated by lead CEQA agency.

On- and off-site erosion mitigation, if deemed necessary and appropriate, may include identification of additional and presently unidentified erosion sites on the project site or on other property in the Patchett Creek watershed. Potential erosion sites could include road-related erosion sites, gullies, eroding stream banks, eroding landslide deposits, or other erosion sites delivering or potentially delivering substantial quantities of sediment to the stream channel network. Off-site projects should be developed in cooperation with any property owner involved, and should include an appropriate level of contribution from each property owner. Disused or informally abandoned logging roads and skid trails are probably the most appropriate type of erosion site to target for off-site mitigation, however, other types of sites should be considered if identified. If suitable or practical sites cannot be located in the Patchett Creek watershed, then sites in the Wheatfield Fork Gualala River watershed should be considered.

References Cited

Klamt, R.C., C. LeDoux-Bloom, J. Clements, M. Fuller, D. Morse, and M. Scruggs (multidisciplinary team leads) 2003. Gualala River Watershed Assessment Report. North Coast Watershed Assessment Program, 367 pp plus Appendices. California Resources Agency and California Environmental Protection Agency, Sacramento, CA.

Marron, D. C., K. M. Nolan, et al. (1995). Surface erosion by overland flow in the Redwood Creek basin, northwestern California, effects of logging and rock type, USGS.

McGourty, G. and J. Reganold (2004). Managing Vineyard Soil Organic Matter with Cover Crops. Soil Environment and Vine Mineral Nutrition Symposium, June 29-30, San Diego, American Society for Enology and Viticulture.

McGourty, G., S. Tylicki, et al. (2006). “Performance of 18 cover crop species in new high elevation North Coast vineyard.” Practical Winery & Vineyard(September/October 2006).

Miller, V. C. (1972). Soil survey, Sonoma County, California. Washington DC, USDA Forest Service and Soil Conservation Service, In cooperation with Agricultural Experiment Station, University of California**:** 188, 123 p. illus.

MRC (2003). Watershed Analysis for Mendocino Redwood Company's Ownership in the Gualala River Watershed. Calpella, CA.

NCASI (1999). Scale considerations and the detectability of sedimentary cumulative watershed effects. Research Triangle Park, NC, National Council of the Paper Industry for Air and Stream Improvement**:** 327.

O'Connor, M., Perry, C. and McDavitt, W. (2007) Sediment yield from first-order streams in managed redwood forests: Effects of recent havests and legacy management practices. USDA Forest Service General Technical Report PSW-GTR-194, pp. 431-443.

RWQCB (2001). Gualala River Watershed Techincal Support Document for Sediment. Santa Rosa, CA, California Regional Water Quality Control Board, North Coast Region**:** 133.

Reid, L. and Dunne, T. (1996) Rapid Evaluation of Sediment Budgets. Catena Verlag GMBH. 164 p.

Selby, M. (1982). Hillslope Materials and Processes, Oxford University Press.

WFPB (1997). Standard Methodology for Conducting Watershed Analysis, Washington Forest Practices Board.

West Yost & Associates (2004). Fairfax Timberland Conversion and Vineyard Development Project-Hydrologic Evaluation (Draft). Prepared for Raney Planning and Management, December 17, 2004.

Appendices