Estero Americano Watershed Sediment Reduction Project, Phase II, Sonoma and Marin Counties, CA

Draft Quarterly Monitoring Report
Item B.4.2

This quarterly report summarizes data collected from December 2011 through February 2012 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included two winter base flow monthly ambient sampling events (December 14 and February 23) and a storm sampling event (January 20).

There was only one significant rainfall event during the sampling period, January 20-24. Thus far in the 2012 Water Year (since October 1, 2011), rainfall is well below normal. The greater than 6.2″ cumulative rainfall during that event was the first since late November that resulted in storm response in the Estero watershed. The sampling was conducted during the first wave of multi-wave storm cycle, so samples were not reflective of peak flows.

Since there are no public streamflow gauges deployed in the Estero Americano Watershed, the Salmon Creek streamflow gauge is used as a proxy for evaluating streamflow response to rainfall. Below is the hydrograph associated with this sampling period.

All of the sampling sites had continuous surface flow throughout the sampling period.

January 15, 2012 stream flow conditions at EBC-30

Figure 1: Hydrograph of Salmon Creek from December 2011 to March 2012

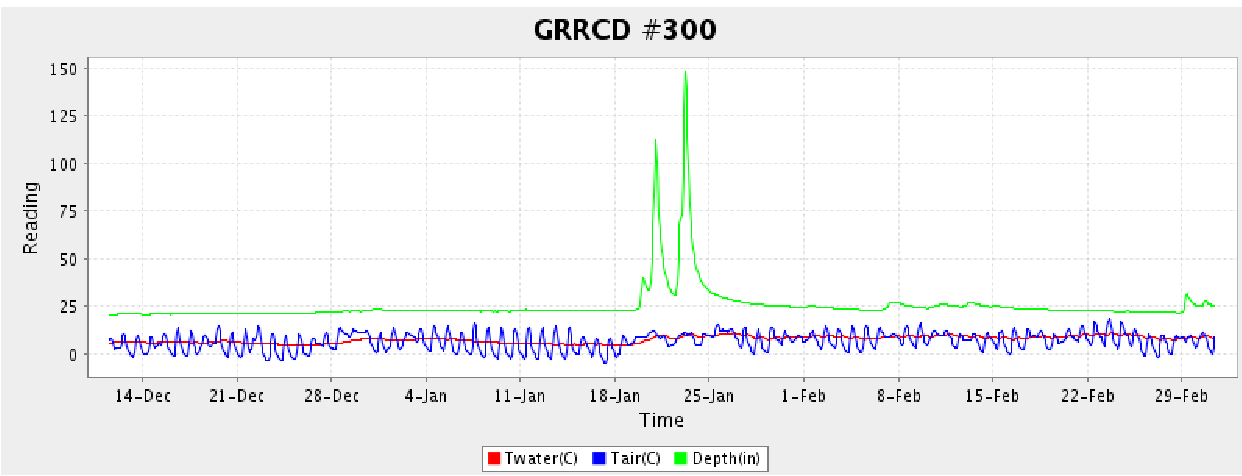


Figure 2: Hydrograph of Salmon Creek from 1/16/12 to 1/23/12, includes 1/20/12 storm sample

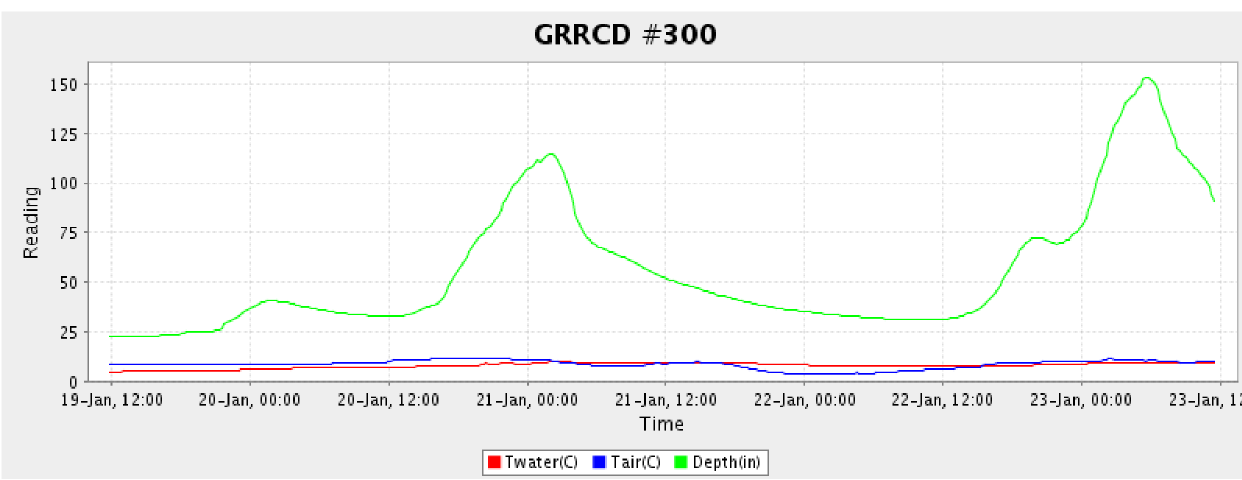
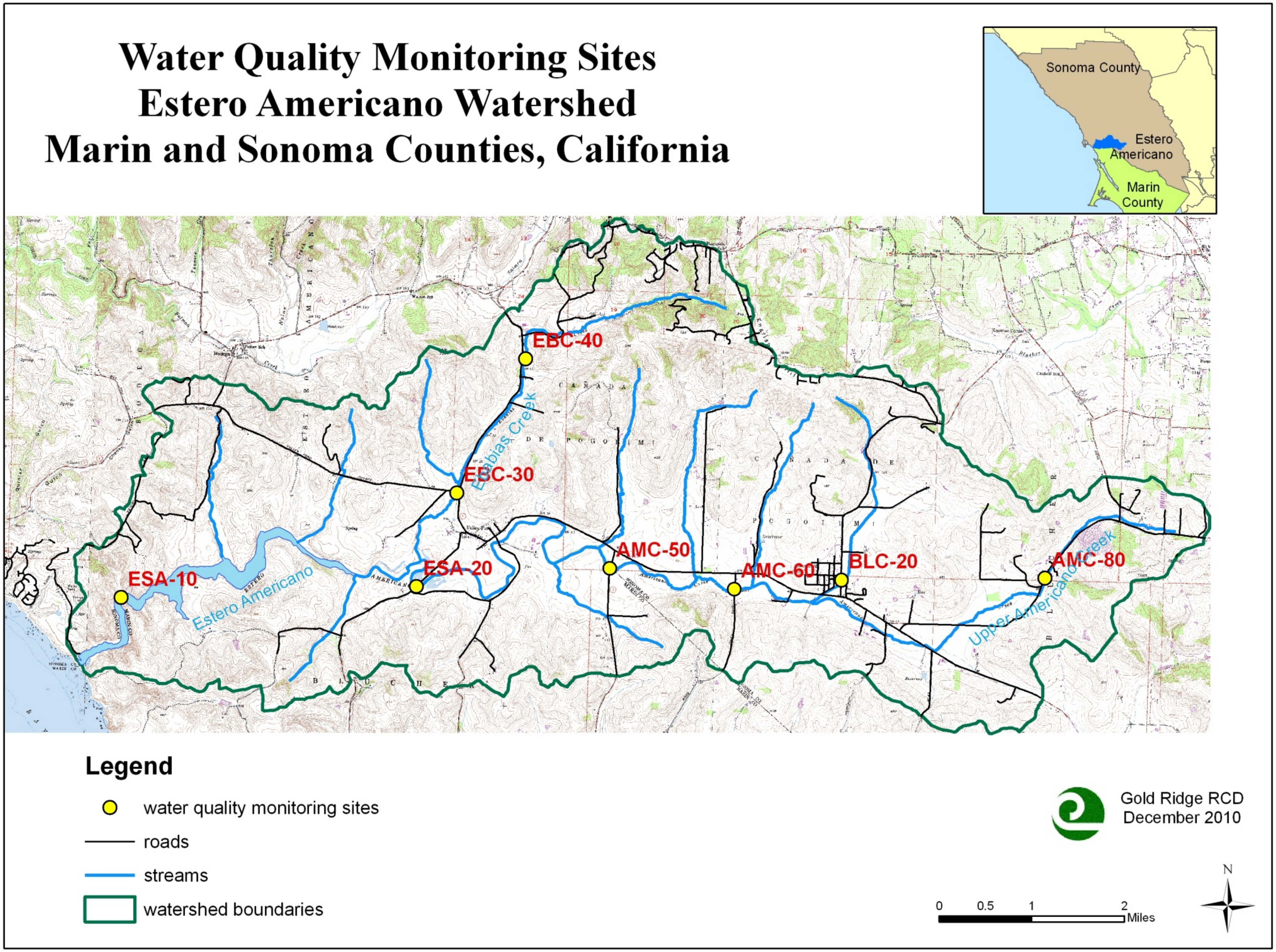


Figure 3: Map of sampling locations throughout the Estero Americano Watershed.



Water Quality Objectives/Targets

As with previous GRRCD evaluations of water quality in the Estero Americano Watershed, the Water Quality Objectives or comparative thresholds are listed in the table below. The North Coast Regional Water Quality Control Board (NCRWQCB) has not set numeric standard water quality objectives for the Estero Americano Watershed, which falls into the "Bodega Bay" water body description (NCRWQCB, 1994). Statewide criteria set by the US Environmental Protection Agency (EPA), Region 9(US Environmental Protection Agency, 2000) and/or the objectives for the nearby Russian River water body by the North Coast Regional Water Quality Control Board (NCRWQCB, 1994) have been used as targets and are outlined in Table 2 below.

Table 2: Water Quality Objectives.

Parameter (reporting units)	**Water Quality Objectives**	**Source of Objective**
Dissolved Oxygen (mg/l or ppm)	Not lower than 7	North Coast Region Basin Plan Objective for Cold Water Fish
pH (pH units)	Not less than 6.5 or more than 8.5	General Basin Plan objective
Water Temperature (°C)	Not to exceed 21.1	USEPA (1999) 20-22 range, supported by Sullivan (2000)
Conductivity (uS)	None established	N/A
Nitrate as N (mg/l)	Not to exceed 1.0	
Ammonia-Nitrogen (mg N/l)	Not to exceed 0.5	USEPA (2009)
Orthophosphate (mg/l)	Not to exceed 0.10 (for streams and flowing waters not discharging into lakes or reservoirs)	USEPA(2000)
Turbidity	1. Not to exceed 55 NTUs during low flow; 2. not to exceed 150 NTUs during storm events	GRRCD selected thresholds, 1. Supported by Sigler (1984); 2. supported by Newcombe (2003)

A meeting to discuss the water quality results collected during this project was convened on January 12, 2012 and included representatives from local agricultural organizations (United Western Dairymen, Sonoma County Farm Bureau), the Gold Ridge and Marin County RCDs, UC Cooperative Extension and lower agricultural producers. The goals was to share the results, discuss potential sources of the high nutrient concentrations measured during 2010-11 storm sampling and discuss whether the Water Quality Objectives being used are appropriate for the Estero Americano watershed. Since most of Americano Creek and its tributaries (with the exception of Ebabias Creek) is not known to support the sensitive aquatic organisms for which many of the currently used WQOs were established, the objectives may be unrealistic for this watershed. It was discussed that due to the physical similarities (size, topography, land use, tidal influence, etc.) water quality data from neighboring Estero San Antonio might be more appropriate comparator than the Russian River objectives currently being used. A number of reports documenting water quality conditions in Estero San Antonio were provided by attendees and these are under review by GRRCD staff.

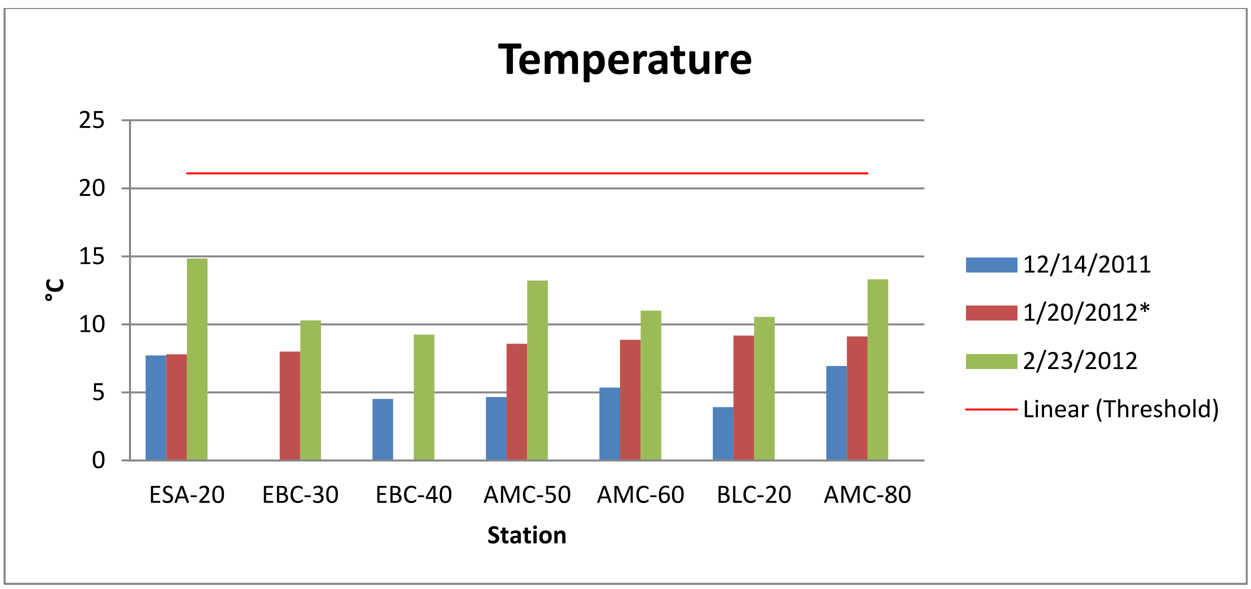
Results and Discussion

Temperature

Water temperature is important to fish and other aquatic species, as well as the function of the aquatic ecosystem. It influences the rate of metabolism for many organisms, including photosynthesis by algae and other aquatic plants, as well as the amount of dissolved oxygen that the water can hold.

Over the data period, temperature measurements varied from 3.92 to 13.32 °C for the freshwater stations and 7.72 to 14.84 for the Estero (ESA-20) station. As expected during winter conditions, all stations met temperature objectives during the all sampling events during the data period. Despite having warmer than usual winter daytime maximum temperatures, the frequency of frost events kept stream temperatures low throughout the data period. AMC-80, the upstream-most sampling station, continued to exhibit the highest temperatures of all of the freshwater stations. It is of concern that this site is exceeding temperature objectives, but it appears that these temperatures are not persisting downstream. Since the collected measurements were grab samples, this information is not conclusive of the maximum temperature conditions, a future monitoring recommendation would be to install continuous temperature loggers to capture diurnal and seasonal variations, particularly during the summer months when temperatures are of concern.

Figure 4: Temperature Measurements

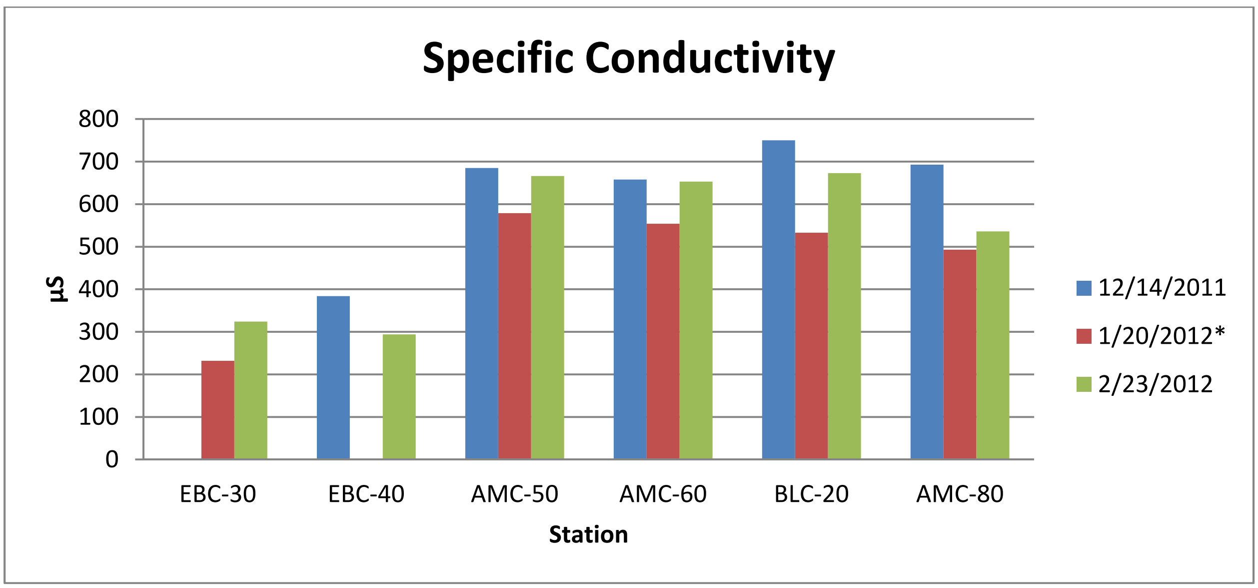


Conductivity

Conductivity is a measure of water's capacity for conducting electricity and is a measure of the ionic (dissolved) constituents present in the sample. While there is no specific water quality objective for conductivity, conductivity can be used as an indicator of pollutant levels.

Over the data period, specific conductivity measurements in Americano Creek ranged from 232 to 750 µS and from 32,327 to 43,487 µS in the Estero Americano (the ESA-20 conductivity results are not included in the graph below since high conductivity conditions are assumed to be a function of the tidal nature of this site, rather than an indicator of pollutant levels, and would have skewed the graph). As expected, the highest conductivity results were observed in the earliest sampling (12/14/11) and lowest results were observed during the storm sampling event (1/20/12). Ebabias Creek continues to exhibit the lowest conductivity conditions of all sampled stations throughout the watershed.

Figure 5: Specific Conductivity Measurements



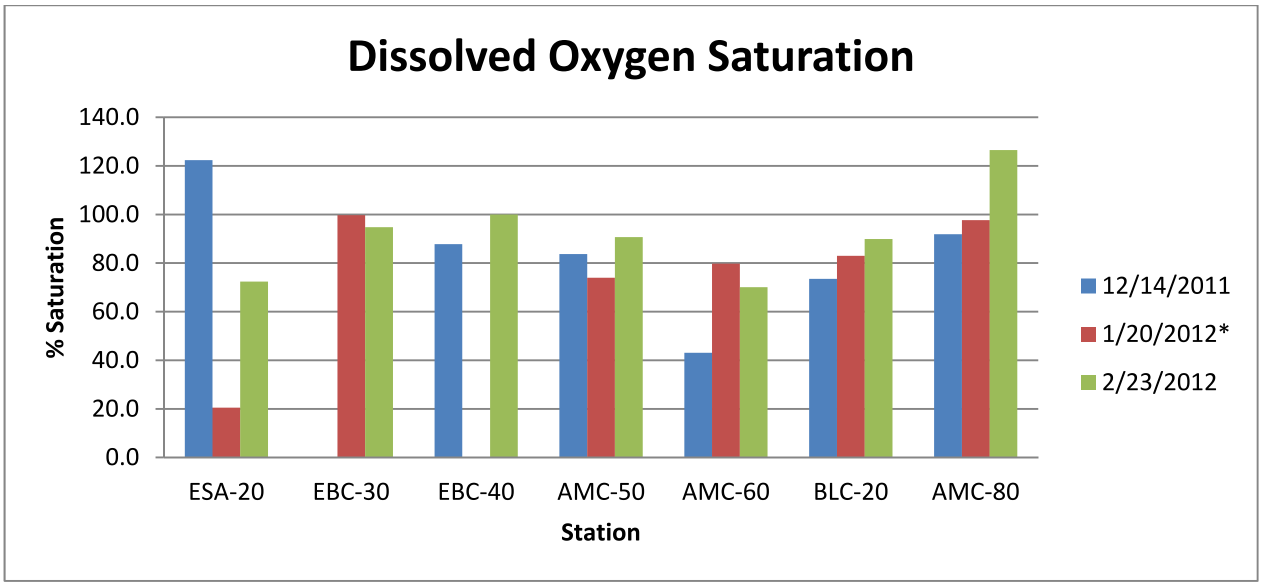
Dissolved oxygen

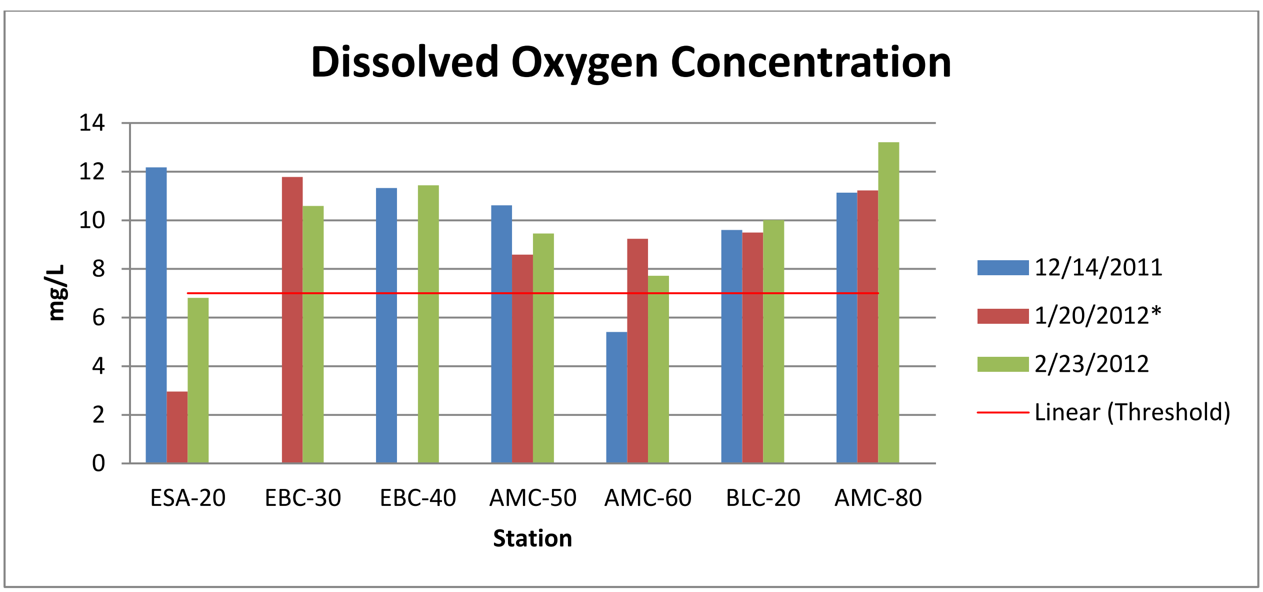
Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water and available to aquatic organisms. Dissolved oxygen is added to water through diffusion from air, turbulence, and photosynthesis of aquatic plants, and removed through respiration of aquatic organisms, decomposition of organic material, and other chemical reactions that use oxygen.

Throughout the data period dissolved oxygen levels ranged from 43.1 to 126.5% saturation and 5.41 to 13.21 mg/l in Americano Creek at its freshwater tributaries and from 20.5 to 122.4% saturation and 2.96 to 12.18 mg/l in the Estero. The 5.41 mg/l result at AMC-60 is unusually low for a December measurement, but the condition did not persist during the following two sampling events. The super-saturated DO conditions at AMC-80 on 2/23/12 were accompanied by relatively high temperature (the warmest freshwater station) and the presence of algae and aquatic plants. This may have been an isolated event, since the lack of high flows has resulted in both low winter baseflow levels and a lack of scour.

Since the collected measurements were grab samples, this information is not conclusive of the minimum dissolved oxygen conditions, a future monitoring recommendation would be to install continuous DO loggers to capture diurnal and seasonal variations.

Figures 6, 7: Dissolved Oxygen Measurements



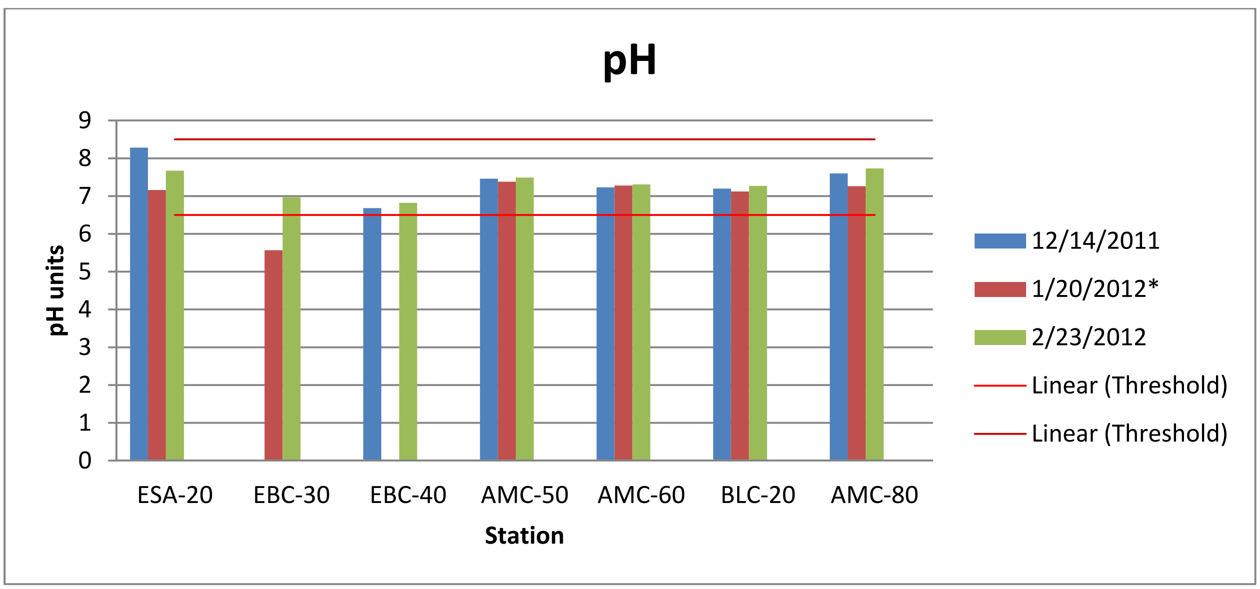


pH

pH refers to the concentration of hydrogen ions in water and determines the acidity or alkalinity of water. Natural pH levels are affected by geology, vegetation, and soil types in the streambed and surrounding the stream, and the availability of carbon dioxide. Changes in pH can have critical effects on water chemistry and the biological systems dependent on the aquatic environment. For example, the solubility and toxicity of metal compounds and nutrients changes greatly with pH.

pH measurements ranged from 5.57 to 7.73 pH units. There was one acidic exceedance of the pH water quality objective (results of <6.5) at EBC-30 during the storm sampling event on January 20, 2012. This is not the first occurrence of an acidic exceedance of WQO at this site. While this acidic condition did not persist throughout the watershed, it is of concern since Ebabias Creek supports several sensitive aquatic organisms including California freshwater shrimp and steelhead trout. The acidic condition did not persist on Ebabias Creek in February, but pH conditions at this site should continue to be monitored.

Figure 8: pH Measurement



Nutrients

Nitrate-nitrogen, phosphate and phosphorous are not directly toxic to aquatic organisms but, where sunlight is available, these chemical nutrients act as biostimulatory substances that stimulate primary production (i.e. plant and algae growth). Excessive inputs of these nutrients, known as eutrophication, can result in abundant plant growth and resulting decay which depletes dissolved oxygen and can degrade habitat quality. While this effect is not generally of concern during winter and spring flow conditions, the input and deposition of high nutrient sediments can exacerbate these conditions later in the year.

As per the Monitoring Plan for this project, nutrients are measured several times a year to characterize seasonal conditions when they may have water quality impacts. The conditions monitored during the course of this quarterly report include the first storm sampling event of water year 2012 on January 20, 2012. Data from the previous winter storm samplings on December 8, 2010 and January 26, 2011 are included on the nutrient graphs for reference and trend comparison.

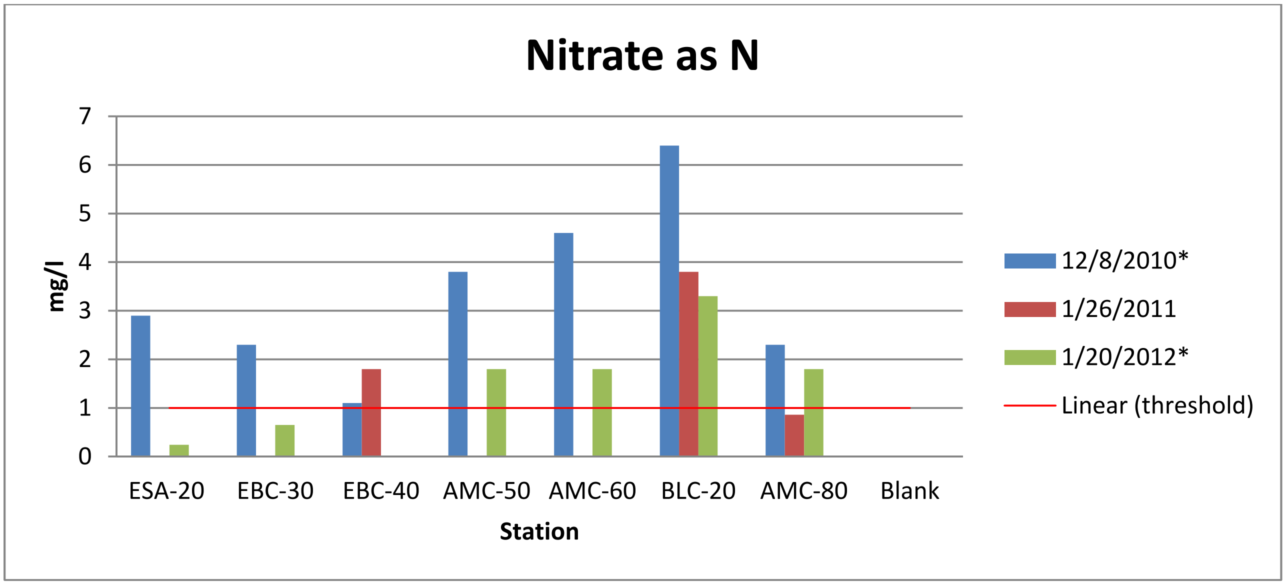
While nutrient levels generally have the greatest impact to water quality both directly (through toxicity) and indirectly (through depressed dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae) during the low flow summer months, the highest concentrations are observed during storm runoff. Since this has been a relatively dry winter so far and winter baseflow conditions have been low, high concentration nutrient runoff can have a significant water quality impact.

Again, as mentioned in previous reports, based on the large amount of algae and aquatic macrophytes observed throughout the Americano Creek system, particularly during the summer and fall months, it would be a good future monitoring priority to collect continuous dissolved oxygen data to see if the aquatic vegetation is causing the assumed diurnal and seasonal dissolved oxygen concentration fluctuations and associated impacts.

Nitrate

Nitrate (NO_3) is an inorganic form of nitrogen that is soluble and therefore subject to leaching and biological uptake. For the 1/20/12 storm sampling event, Nitrate results at freshwater stations ranged from 0.65 to 3.3 mg/l for freshwater stations, with all stations except Ebabias Creek (EBC-30) exceeding the 1.0 mg/l Water Quality Objective. The results were uniformly lower than during 12/8/2010 storm sampling event, but that storm was significantly larger and resulted in higher peakflow and erosion rates.

Figure 9: Nitrate Measurements

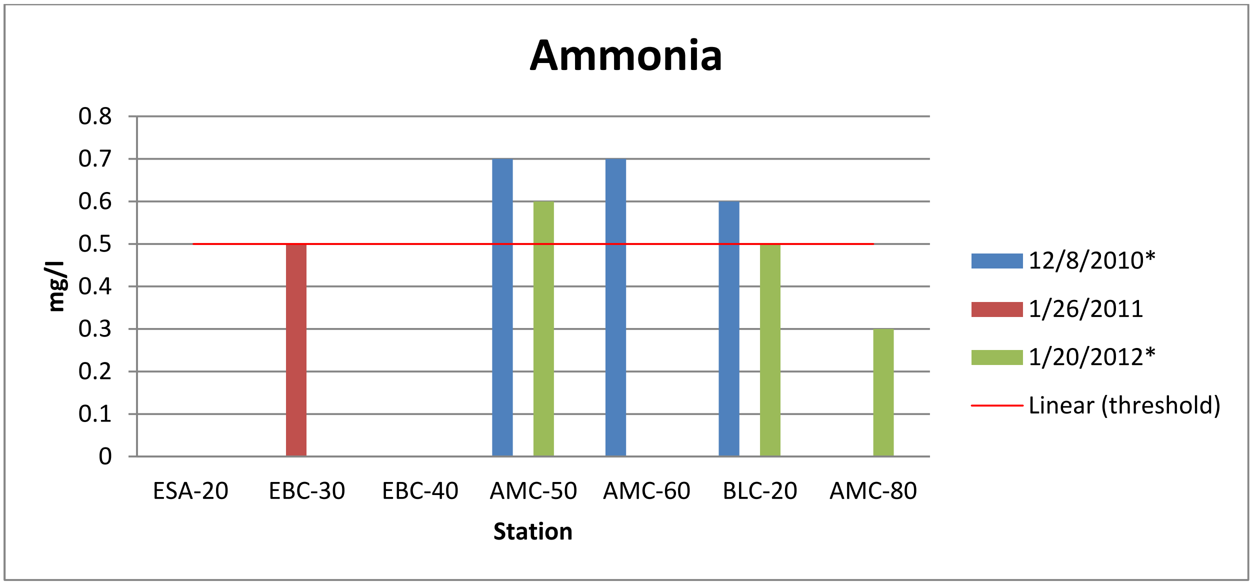


Ammonia

Total ammonia is composed of two forms; ionized ammonia (NH_4^+), and un-ionized ammonia (NH_3).Un-ionized ammonia, which primarily results from decomposition of manure and other organic debris by microbes, can be toxic to aquatic organisms in small concentrations. The percent of total ammonia in the harmful un-ionized form increase with higher temperatures and pH values.

Ammonia concentrations ranged from <0.2 (ND) to 0.6 mg/L during the 1/20/12 sampling event. Ammonia concentrations only exceeded the water quality objective at the AMC-50 station, and only slightly. Due to the low water temperatures and generally neutral pH values during the sampling period, toxicity due to unionized ammonia concentration is not likely a threat to aquatic organisms. Ammonia concentration becomes more potentially toxic as water volumes decrease and water temperatures increase under summer conditions. BMPs that target reducing nutrient sources for surface runoff should continue to be employed throughout the watershed.

Figure 10: Ammonia Measurements



Orthophosphate

Phosphorus is a natural element found in rocks, soils and organic material and is a nutrient required by all organisms for basic biological function. Phosphorus clings to soil particles and is readily used by plants, so in natural conditions, phosphate concentrations are very low. Phosphorus is considered the growth-limiting nutrient in freshwater systems, meaning that when it is present and available in freshwater systems, it is readily absorbed and utilized by algae and aquatic plants for their growth. Orthophosphate is a dissolved and readily bioavailable form of Phosphorus. When Orthophosphate is present in measurable concentrations under conditions that allow algal and aquatic plant growth, it is considered excessive since it can result in algal blooms and eutrophication.

For the 1/20/12 storm sampling event, Orthophophate results ranged from 0.4 to 2.0 mg/l for freshwater stations, with all stations exceeding the 0.1 mg/l Water Quality Objective. Despite this WQO exceedence throughout the watershed, the concentration measured during the 1/20/12 storm event were significantly lower than those measured during the 12/8/10 storm event. Again, the January 2012 storm was smaller and resulted in lower stream flow levels.

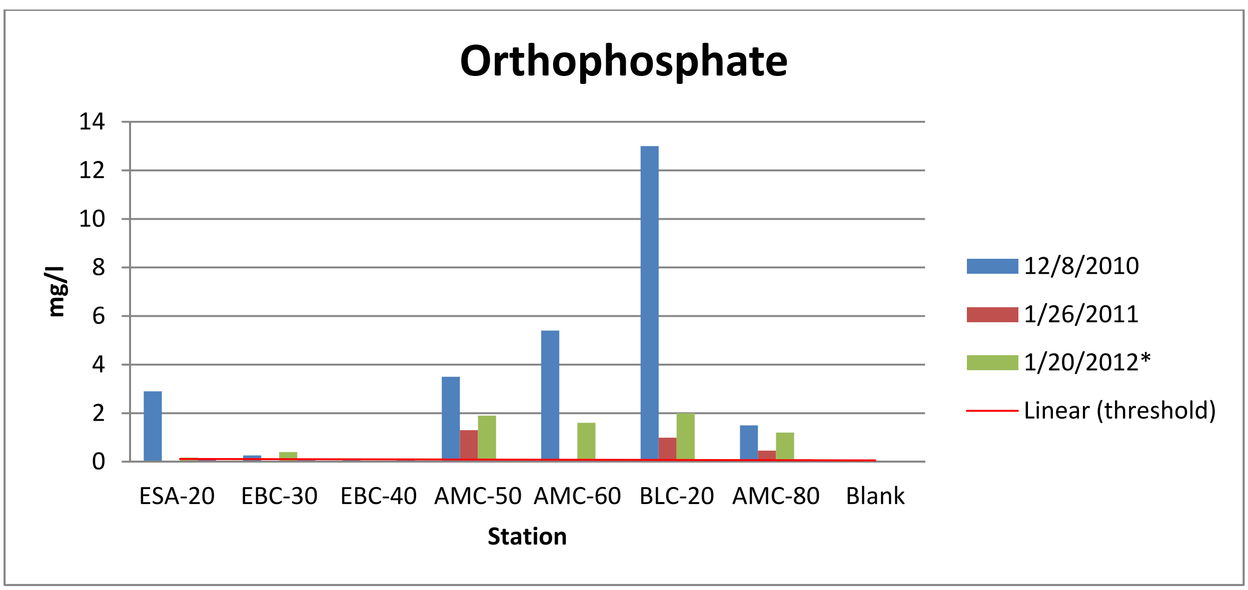
Considering the amount of algal and aquatic plant growth observed throughout Americano Creek and its tributaries under low flow conditions, it is likely that persistently high orthophosphate concentrations are causing a habitat and water quality impact.

It is likely that there may be several pathways of Phosphate entering Americano Creek and its tributaries, but based on past soil sampling conducted at selected locations in the Estero Americano watershed (see Table below), the Phosphorus concentrations stored in the soil are rated "VH" which stands for "very high". Since Phosphorus readily binds to soil particles that settle out in the stream channel, BMPs that target reducing nutrient sources and soil erosion for surface runoff should continue to be employed throughout the watershed.

Table 3. Soil Analysis Report taken from agricultural lands in Estero Americano Watershed

Sample ID	Organic Matter		Phosphorus	Potassium	Magnesium	Calcium	Sulfur
	% Rating	*ENR (lbs/A)	P ppm	K ppm	Mg ppm	Ca ppm	SO_4-S ppm
Field A	5.5VH	140	48VH	156M	359M	1746M	11M
Field B	4.4H	118	95VH	250M	441VH	1341L	8L
* Estimated Nitrogen Release (ENR) in lbs per acre is derived from % organic matter and represents the "potential" amount of organic nitrogen that will be mineralized by soil microbes during the growing season.							

Figure 11: Orthophosphate Measurements



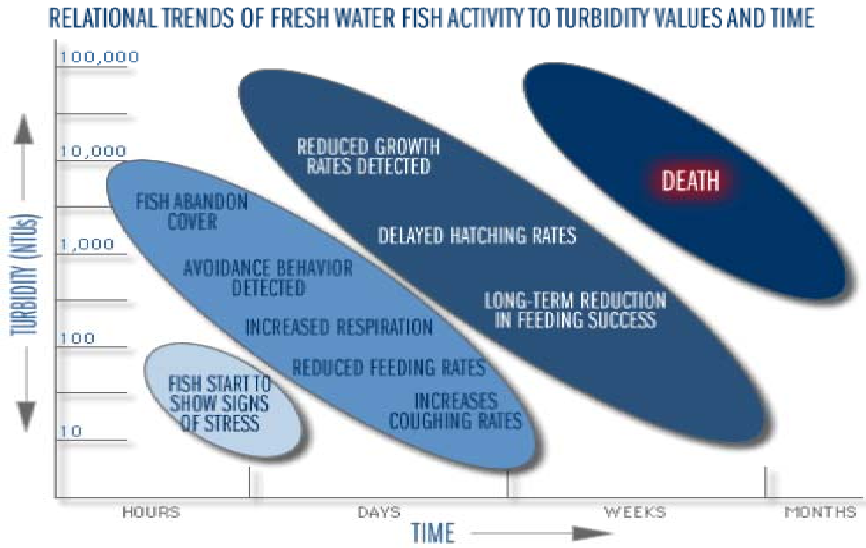
Turbidity and Total Suspended Solids

Turbidity, which can make water appear cloudy or muddy, is caused by the presence of suspended and dissolved matter, such as clay, silt, finely divided organic matter, plankton and other microscopic organisms. Sources of turbidity include soil erosion, streambank erosion, animal waste, road and urban runoff, and excessive algal growth.

Excess turbidity reduces light, thereby reducing benthic organisms and ultimately fish populations. High turbidity level can increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates, damage to gills, and fatality.

Water quality objectives for turbidity and Total Suspended Solids (TSS) are not definitively established for the Estero Americano Watershed. While the North Coast Regional Water Quality Control Board mandates that turbidity levels not be increased more than 20% above naturally occurring background levels (NCRWQCB, 2007), when a background level has not been established (as is the case with the Estero), this objective is difficult to use. Since at least part of the watershed sustains anadromous fish, clear water fishery objectives have been employed as water quality targets. Newcombe (Newcombe, 2003) described the detrimental impacts to clear water fishes at several turbidity levels. Newcombe states that turbidity levels of 55 NTUs caused significant impairment to fish after one day and severe impairment after four months, while turbidity levels of 150 NTUs caused significant impairment after three hours and severe impairment after two weeks. For summer baseflow conditions, when turbidity is generally expected to be low, a threshold of 25 NTUs has been used.

Figures 12, 13: Representations of impairment relationships between turbidity and fresh water fish



"Figure 10: Idealized model of fish response to increased suspended sediments. Schematic source of above figure is unknown; it is a generic, un-calibrated impact assessment model based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16: 693-727. Reprinted, with permission, from: http://wow.nrri.umn.edu/wow/under/parameters/turbidity.html" (Berry, 2003).

Impact Assessment Model for Clear Water Fishes Exposed to Conditions of Reduced Water Clarity

Visual clarity of water (yBD) and related variables: alternate		preferred		Duration of exposure to conditions of reduced VISUAL CLARITY (log$_e$ hours) / Severity-of-ill-effect Scores (SEV) -- Potential: SEV = - 4.49 + 0.92(log$_e$ h) - 2.59(log$_e$ yBD)											Fish reactive distance: calibrated for trout		
NTU ($\Delta ntu_{\Sigma,\Lambda}$)	zSD (m)	BA (m^{-1})	yBD (m)	0	1	2	3	4	5	6	7	8	9	10	ψ_{BD} (cm)	xRD (cm)	
1100	0.01	500	0.010	7	8	9	10	11	12	13	14				1		O
			0.014	7	7	8	9	10	11	12	13	14			1		N
400	0.03	225	0.02	p6*	7	7	8	9	10	11	12	13	14		2		M
			0.03	4	5	6	7	8	9	10	11	12	13	14	3		L
150	0.07	100	0.05	3	p4*	p5*	6	7	8	9	10	11	12	13	5		K
			0.07	2	3	4	5	6	7	8	9	10	11	11	7		J
55	0.15	45	0.11	p1*	2	3	4	5	6	7	8	9	10	10	11	6	I
			0.16	0	1	2	3	4	5	6	7	8	9	9	16	17	H
20	0.34	20	0.24	0	p0*	p1*	2	3	4	5	6	7	8	8	24	30	G
			0.36	0	0	0	1	2	3	4	5	6	6	7	36	42	F
7	0.77	9	0.55	0	p0*	0	0	1	2	3	4	4	5	6	55	55	E
			0.77	0	p0*	p0*	0	0	1	2	3	4	4	5	77	66	D
3	1.53	4	1.09	0	p0*	0	0	0	0	1	2	3	4	5	109	77	C
			1.69	0	0	0	0	0	0	0	1	2	2	3	169	90	B
1	3.68	2	2.63	p0*	p0*	p0*	0	0	0	0	0	0	1	2	263	104	A
				1	3	7	1	2	6	2	7	4	11	30			
				Hours			Days			Weeks		Months					
				a	b	c	d	e	f	g	h	i	j	k			

"Figure 11: Matrix of impairment levels by turbidity level and duration. Yellow indicates slight impairment with changes in feeding and other behaviors, orange indicates significant impairment with altered fish growth and habitat quality, and red indicates severe impairment with physiological condition changes and habitat alienation (Newcombe 2001, 2003)" (Gold Ridge RCD, 2010).

The turbidity levels during the 1/20/12 storm event ranged from 39.8 to 138.0 NTUs. Both turbidity and TSS levels were relatively low, compared with the higher volume and intensity 12/8/10 storm event. The highest turbidity result was measured at EBC-30, while the highest TSS results was measured at AMC-80. The AMC-80 result might have been due to suspended algae observed at that station. Turbidity and TSS data will be more meaningful when compared to additional storm sampling results this year.

Figures 14: Turbidity Measurements

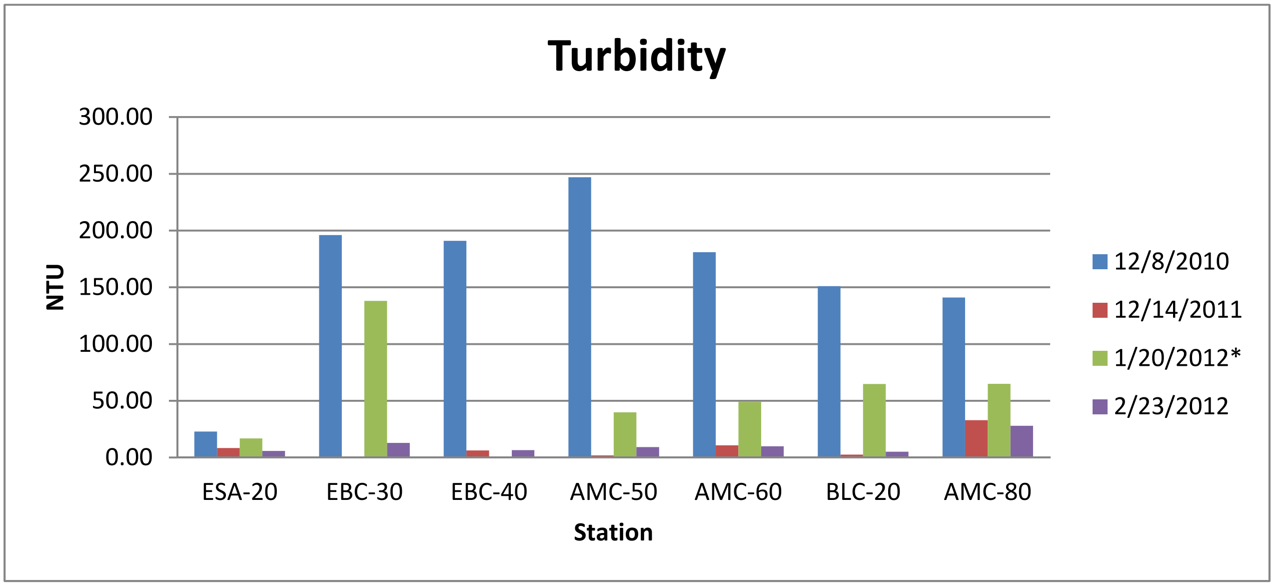
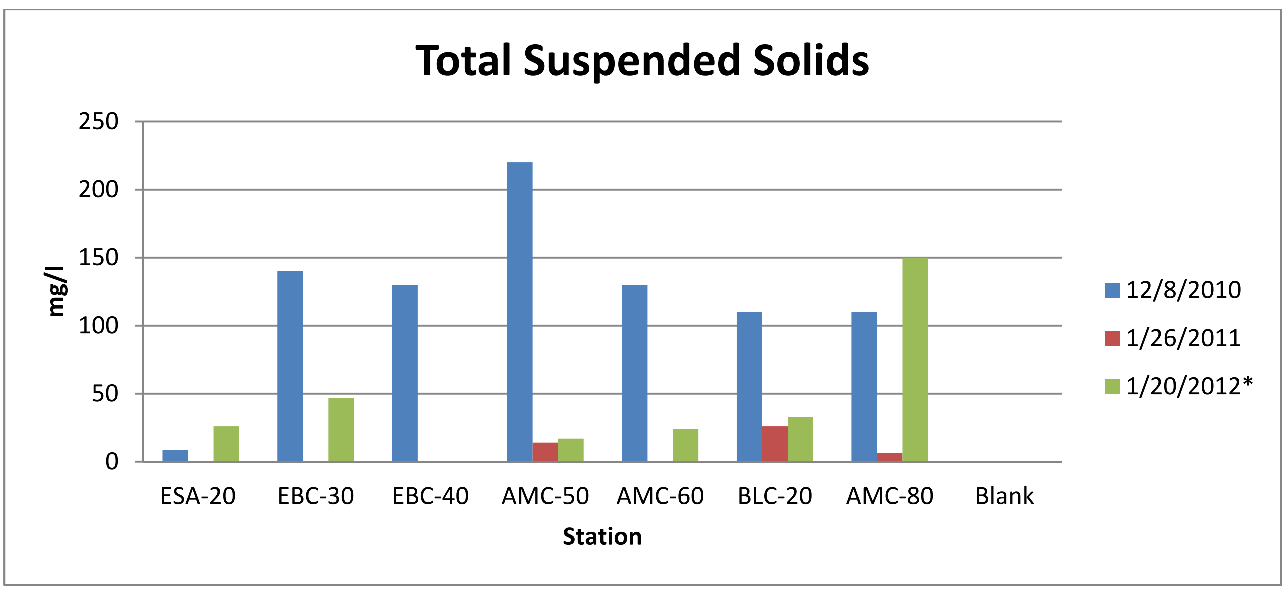


Figure 15: Total Suspended Solids Measurements



List of Works Cited

Berry, W. N. (2003). *The Biological Effects of Suspended and Bedded Sediment (SABS) in Aquatic Systems: A Reivew.* Narraganset, RI: US Environmental Protection Agency.

Gold Ridge RCD. (2010). *Salmon Creek Integrated Coastal Watershed Management Plan.* Occidental, California: Gold Ridge Resource Conservation District.

Newcombe, C. (2003). *Impact assessment model for clear water fishes exposed to excessively cloudy water.* Journal of the American Water Resources Association (JAWRA) 39(3):529-544.