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 two sampling events in February 2014 under the SWRCB 319(h) funded Estero Americano Watershed Sediment Reduction Project, Phase II. The data period included two winter storm sampling events (February 8 and February 28).

The first significant rainfall event of the 2014 water year (which began October 1, 2013) occurred on February 8, 2014. Up until this rainfall event, the annual rainfall totals are well below normal, triggering an emergency declaration of drought at both a state and federal level . The greater than 8” cumulative rainfall during the 2/8 storm event resulted in connected flow conditions throughout Americano Creek and the Estero Americano for the first time since June 2013. The sampling was conducted during the first wave of multi-wave storm cycle, so samples were near, but not entirely reflective of peak flows. Storm sampling conducted on 2/28/14, did capture the peak flow conditions.

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.

Figure 1: Hydrograph of Salmon Creek from 2/7/14 to 2/10/14, includes 2/8/14 storm sample

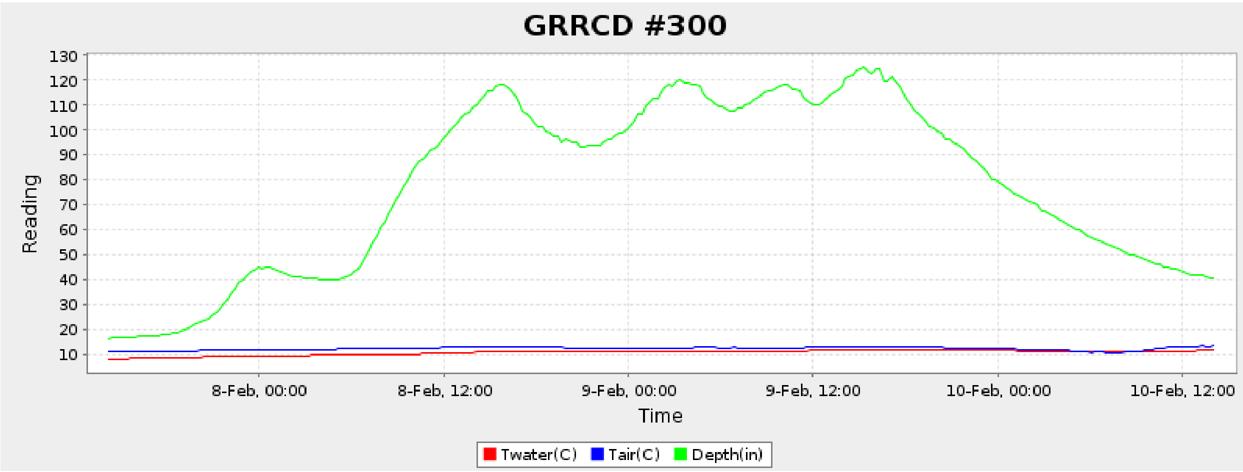


Figure 2: Hydrograph of Salmon Creek from 2/27/14 to 3/2/14, includes 2/28/14 storm sample

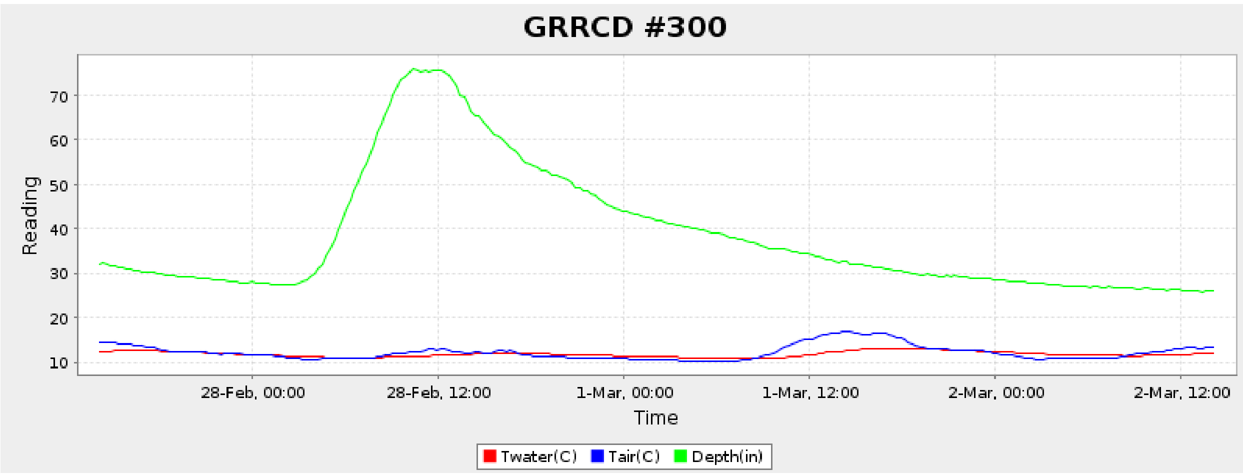
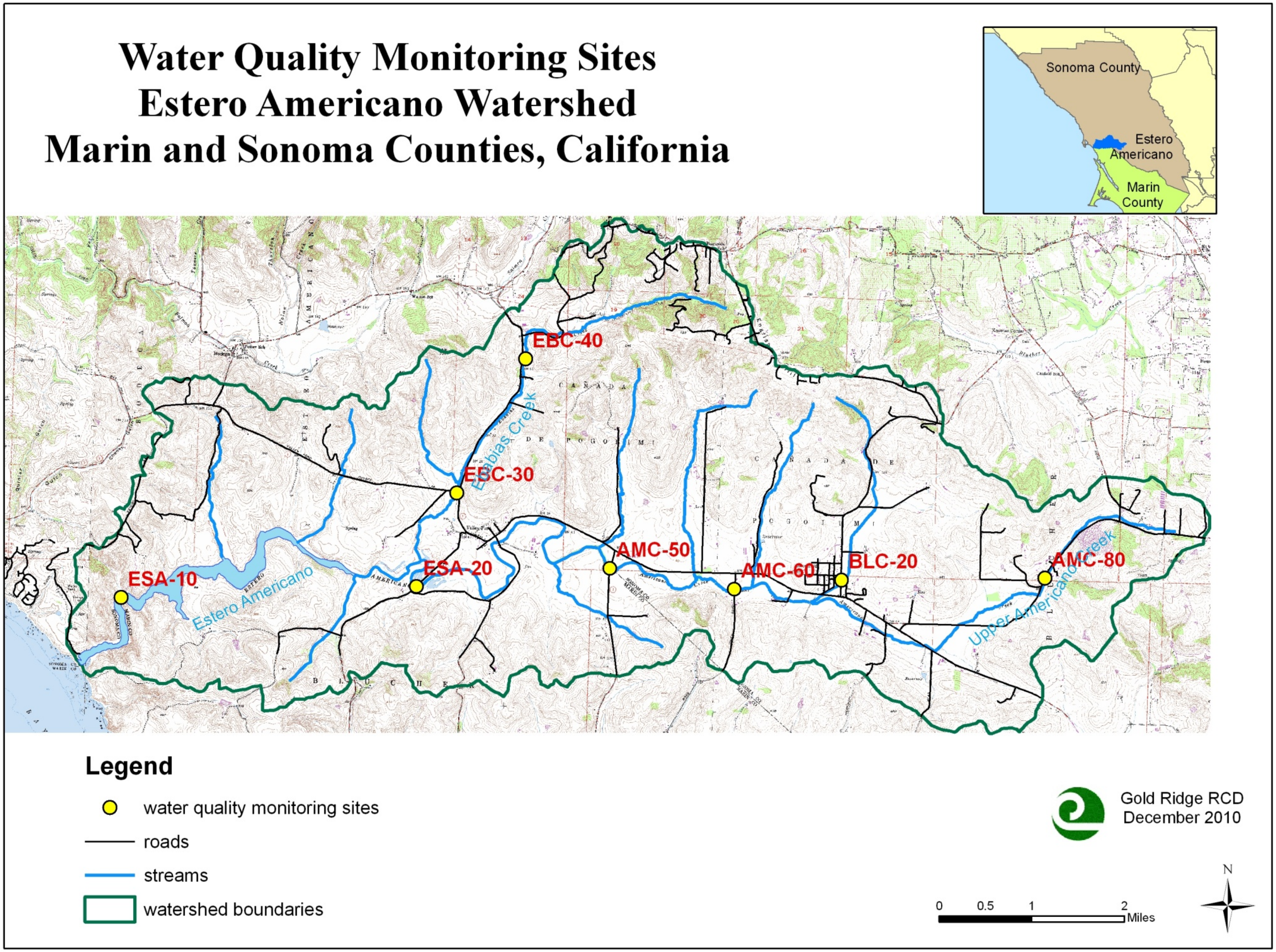


Figure 3: Map of sampling locations throughout the Estero Americano Watershed.



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)

Results and Discussion

Because both of the sampling events summarized in this report were storm events, the Estero Americano station (ESA-20) was not sampled. This is due to large volume of water at the sampling location and the fact that once it has overflowed its banks, there is no representative location to safely sample from. Additionally, the tidal influence and resulting high salinity at this location makes the results more difficult to compare to than the freshwater Americano Creek stations.

In addition to the two February 2014 sampling events that occurred during this reporting period, storm events from previous years have been depicted on graphs for comparative purposes.

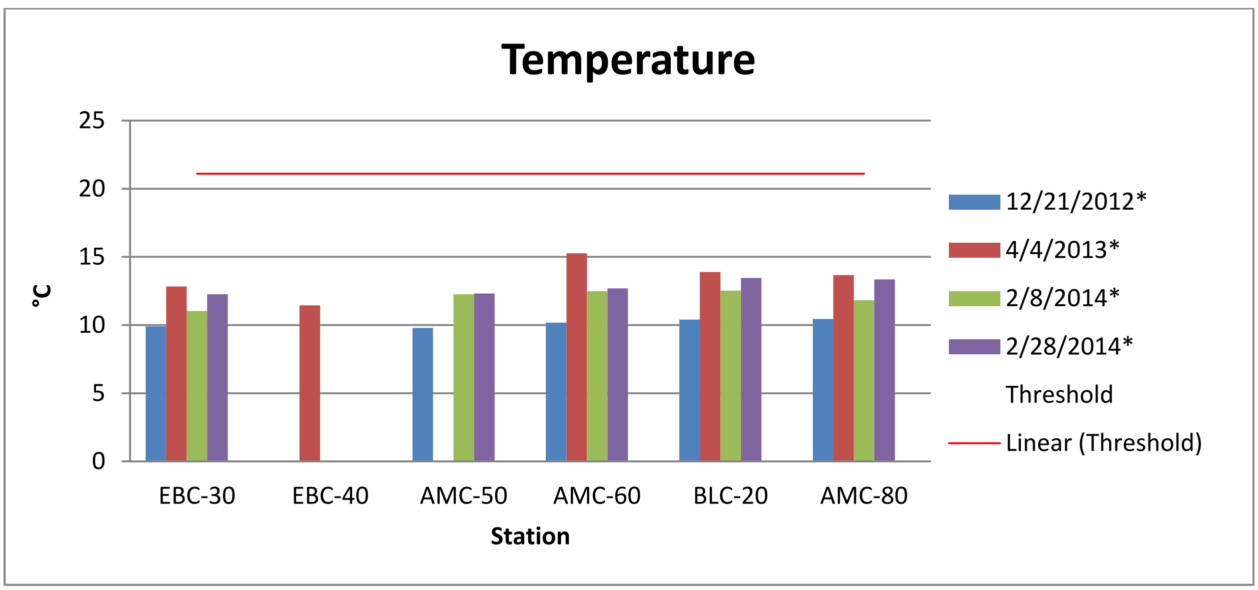
Temperature

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 11.03 to 13.35 °C for the freshwater stations. 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, particularly prior to the storm events.

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

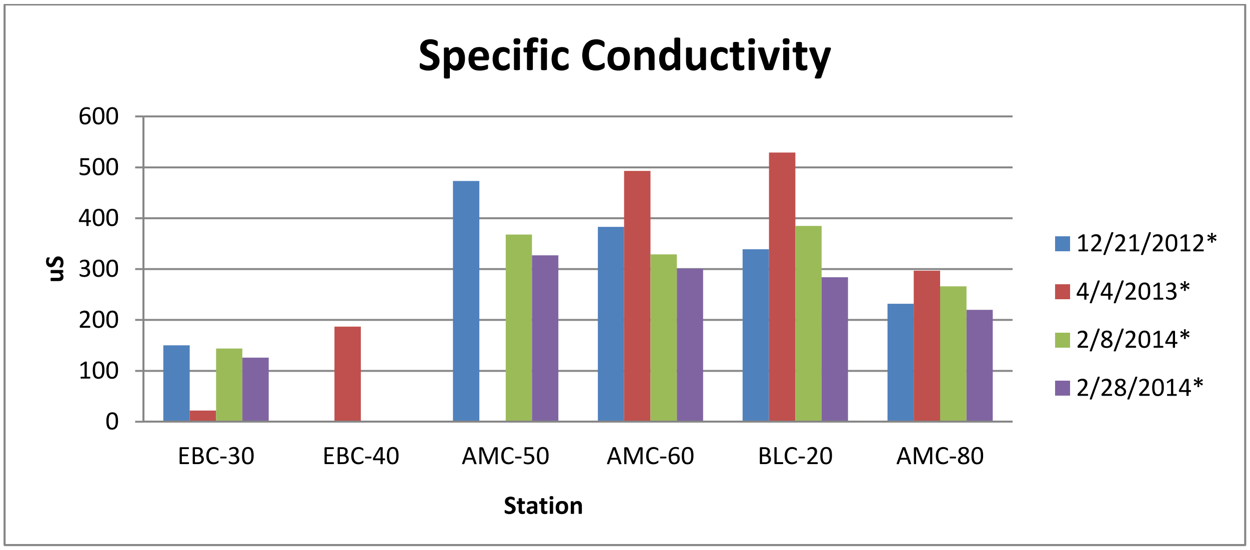


Conductivity

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 144 to 385 µS for the freshwater stations. Low conductivity results are generally expected during high flow storm events conditions. The February 2014 storm samples exhibited lower conductivity results than storm samples depicted from the previous years. Ebabias Creek continues to exhibit the lowest conductivity conditions of all sampled stations throughout the watershed.

Figure 5: Specific Conductivity Measurements



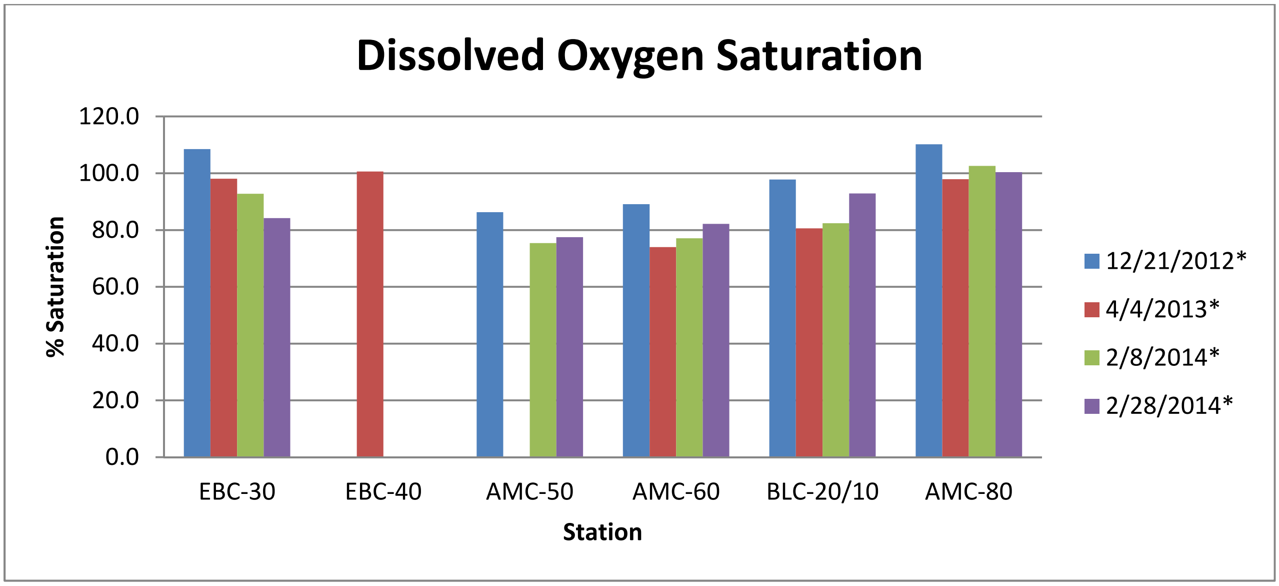
Dissolved oxygen

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 74.0 to 110.2% saturation in Americano Creek at its freshwater tributaries. The 74.0% result at AMC-60 is slightly low for a high flow measurement, but the landscape is very low slope at this site and there are very few riffles throughout the reach.

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.

Figure 6: Dissolved Oxygen Measurements

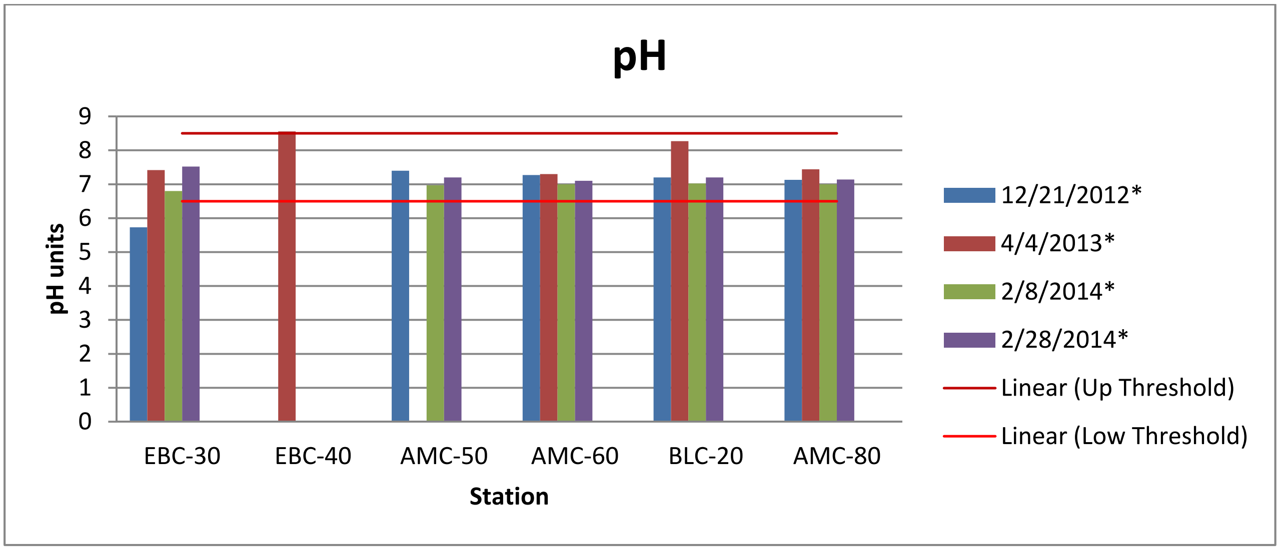


pH

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 6.8 to 7.52 pH units. All stations met the pH water quality objective. The most acidic pH measurement was taken at EBC-30 during the storm sampling event on February 8, 2014, but this may have been due to the fact that the flows were so high coming through the culvert at this sampling station that we were having difficulty keeping the sonde sensors submerged. For subsequent storm events, we have taken the sonde measurements out of the bucket immediately after sampling rather than from the creek channel.

Figure 7: pH Measurements



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.

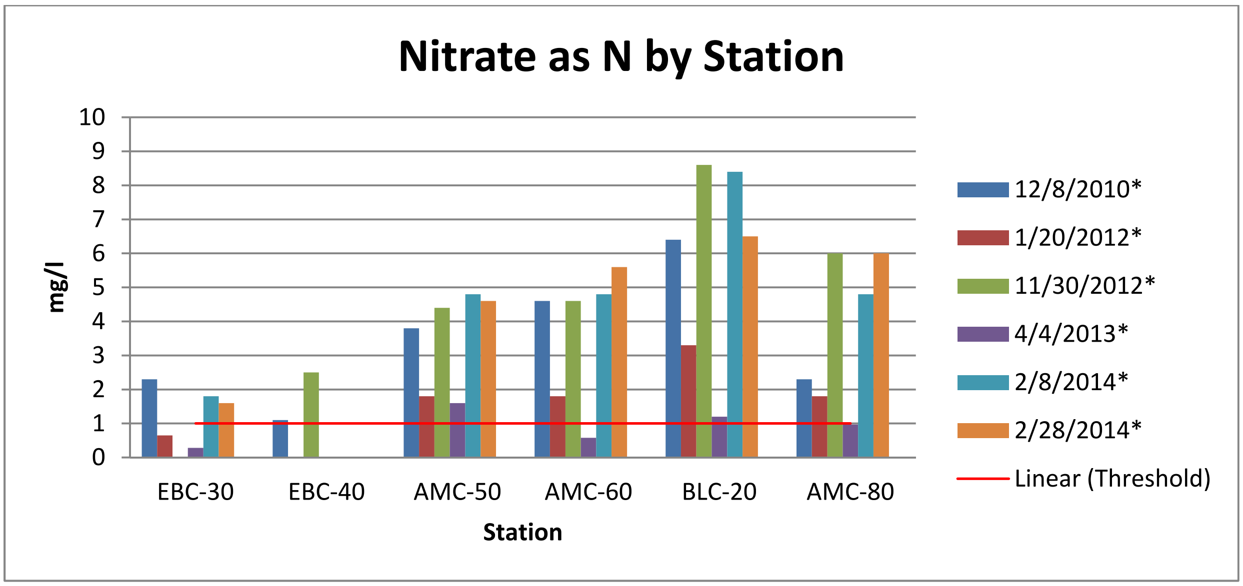
While nutrient levels generally have the greatest impact to water quality both directly (through toxicity) and indirectly (through depressed dissolved oxygen levels due to the biological oxygen demand of decaying plants and algae) during the low flow summer months, the highest concentrations are observed 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.

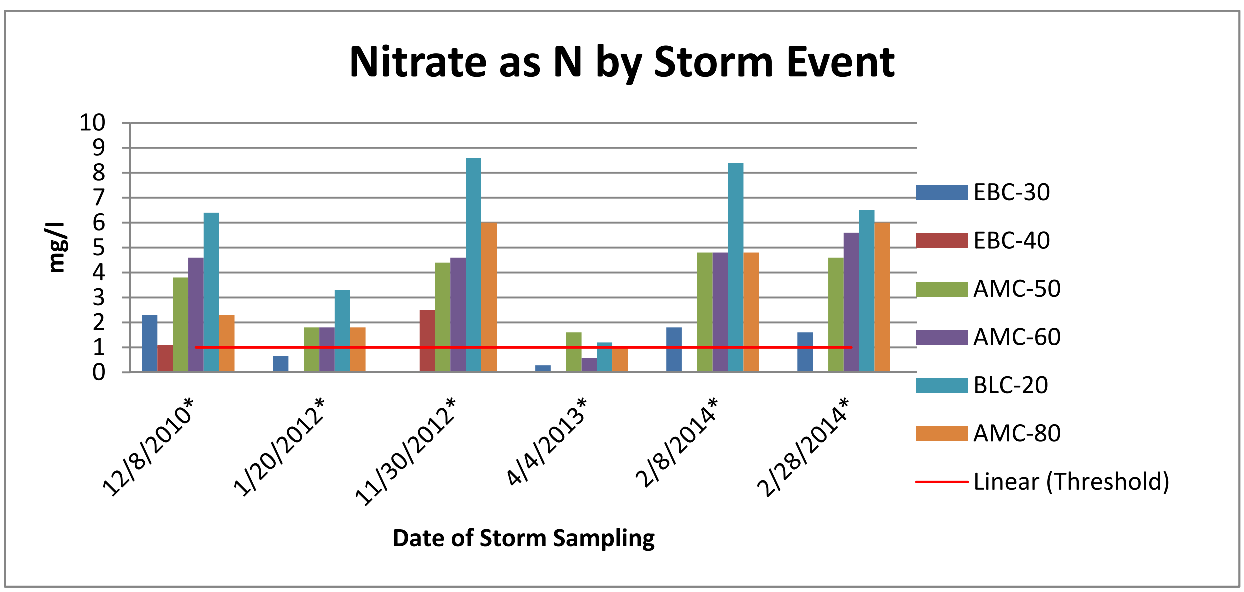
Again, as mentioned in previous reports, based on the large amount of algae and aquatic macrophytes observed throughout the Americano Creek system, particularly during the summer and fall months, it would be a good future monitoring priority to collect continuous dissolved oxygen data to see if the aquatic 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. During the sampling period, nitrate results at freshwater stations ranged from 1.8 to 8.4 mg/l for freshwater stations, with all stations exceeding the 1.0 mg/l Water Quality Objective.

Figures 8, 9: Nitrate Measurements





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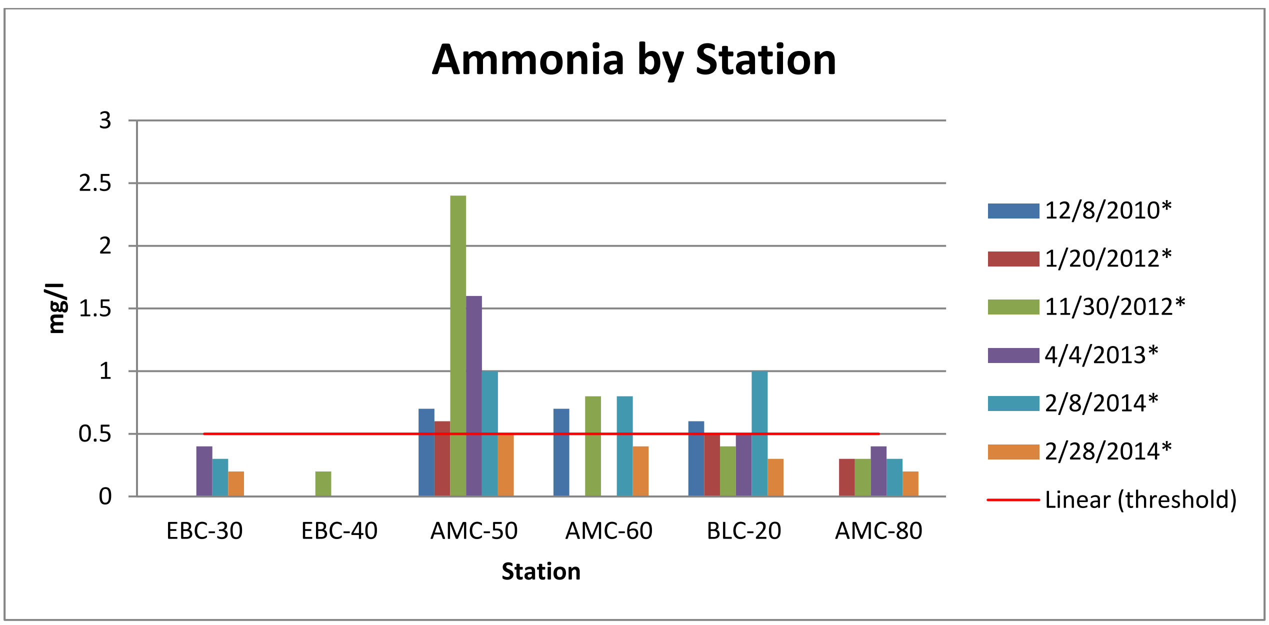
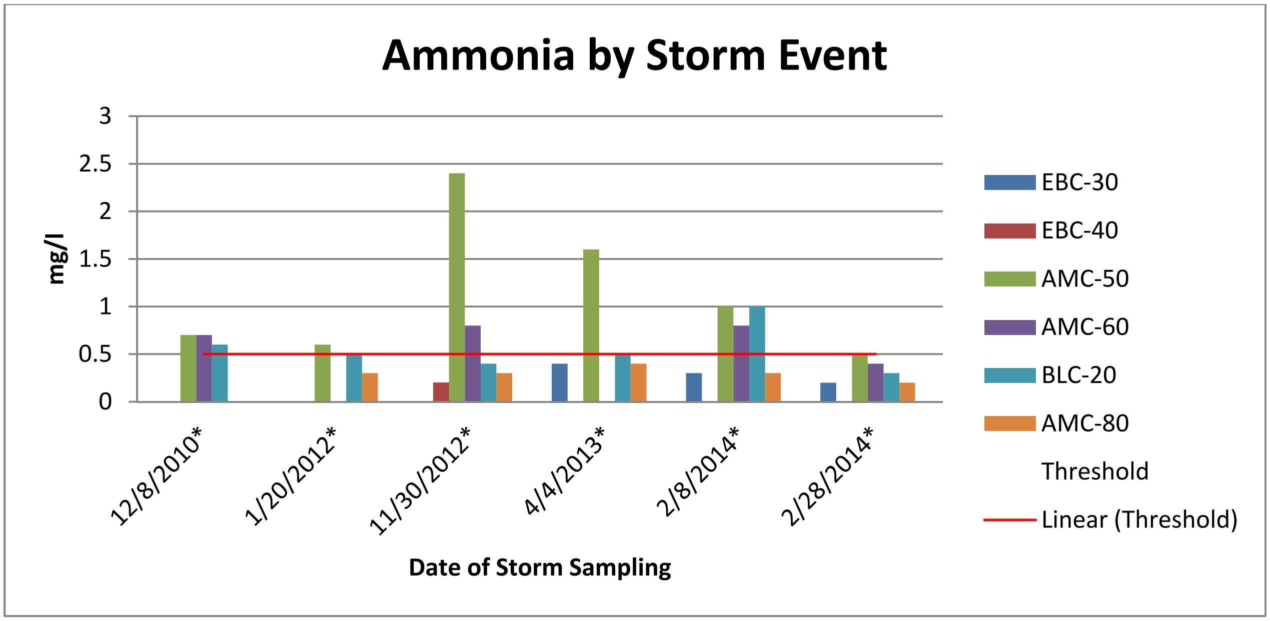
Ammonia

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.

During this sampling period, ammonia concentrations ranged from 0.2 to 1.0 mg/l. As seen in past years, ammonia concentrations generally only exceeded the water quality objective during the first significant storm of the season 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 from surface runoff should continue to be employed throughout the watershed.

Figures 10, 11: 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 in conditions that allow algal and aquatic plant growth, it is considered excessive since it can result in algal blooms and eutrophication. Eutrophication or hypertrophication, the ecosystem response to the addition of excess nutrients to an aquatic system, is of concern due to the potential for associated depletion of oxygen in the water, which can cause a reduction in sensitive aquatic species.

During this sampling period, orthophophate results ranged from 0.54 to 6.9 mg/l, with all stations exceeding the 0.1 mg/l Water Quality Objective. Despite the WQO exceedence throughout the watershed, the concentration measured during the 2/28/14 storm event, ranging from 0.67 to 3.6 mg/l, were significantly lower than those measured during the 2/8/14 storm event.

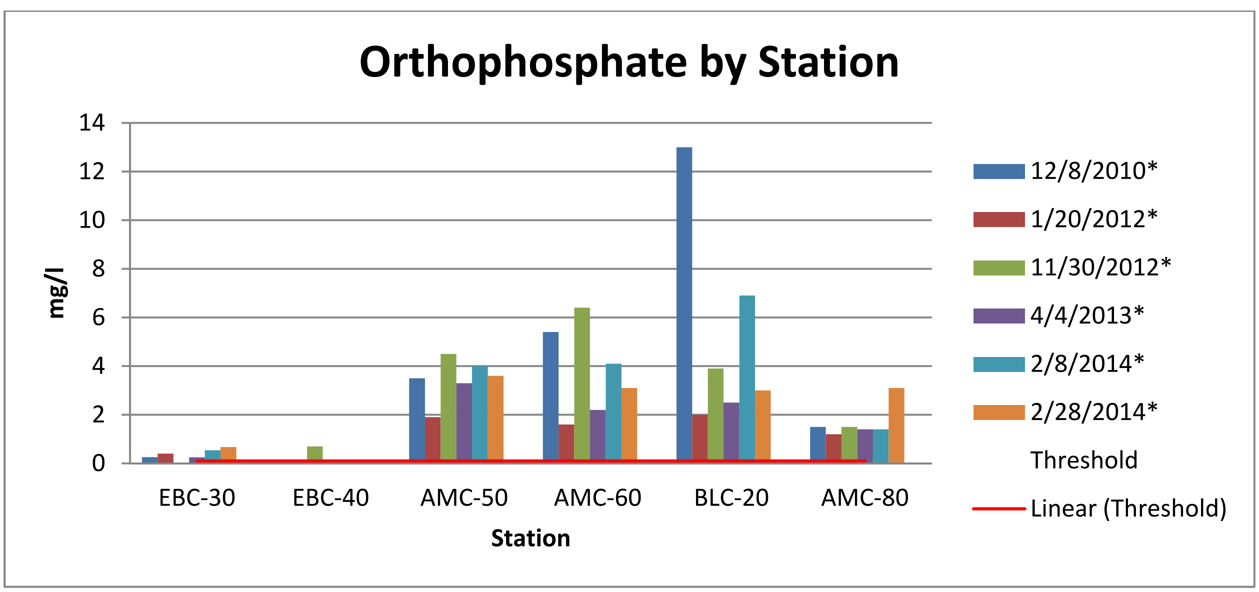
Considering the amount of algal and aquatic plant growth observed throughout Americano Creek and its tributaries under low flow conditions, it is likely that persistently high orthophosphate concentrations are causing a habitat and water quality impact.

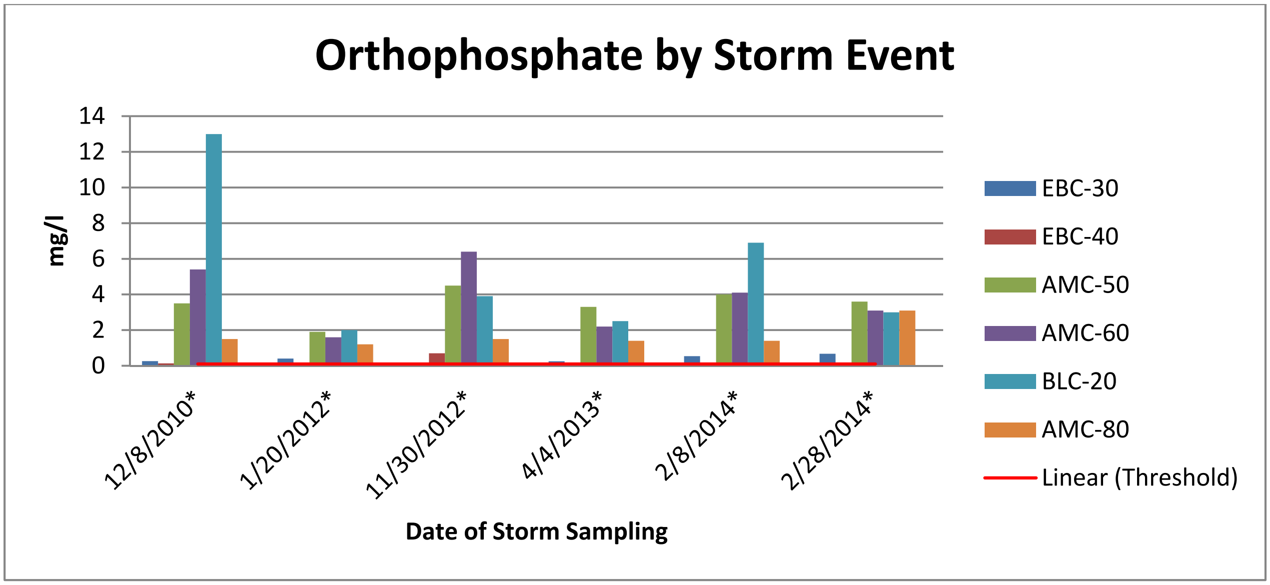
It is likely that there may be several pathways of phosphate entering Americano Creek and its tributaries, but based on past soil sampling conducted at selected locations in the Estero Americano watershed (see Table below), the Phosphorus concentrations stored in the soil are rated "VH" which stands 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 12, 13: Orthophosphate Measurements





Orthophosphate by Storm Event
14
12
10
8
6
4
2
0
mg/l
12/8/2010*
1/20/2012*
11/30/2012*
4/4/2013*
2/8/2014*
2/28/2014*
Date of Storm Sampling
EBC-30
EBC-40
AMC-50
AMC-60
BLC-20
AMC-80
Linear (Threshold)

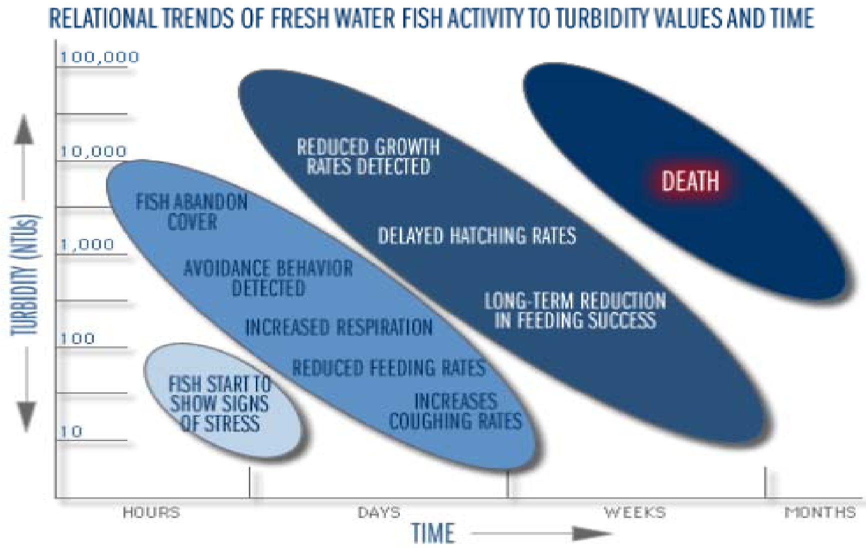
Turbidity and Total Suspended Solids

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.

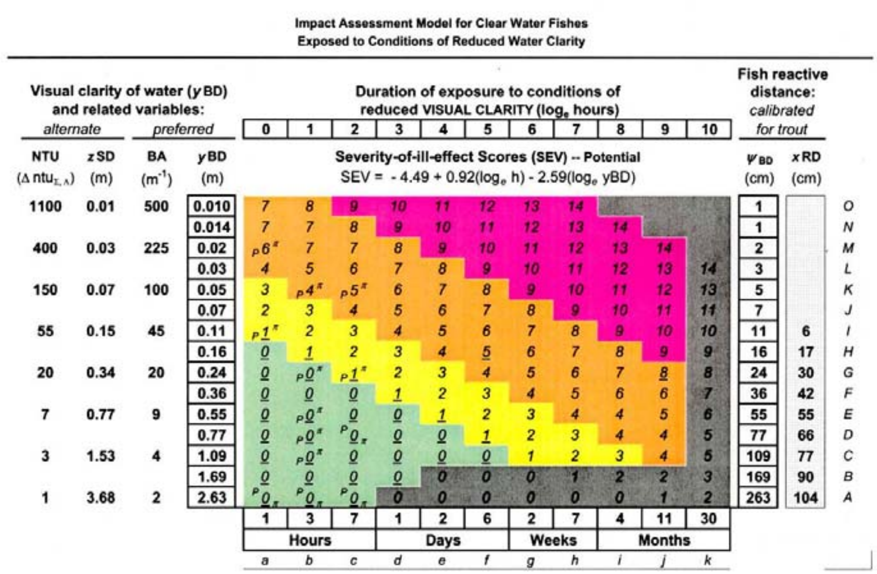
Excess turbidity reduces light, thereby reducing benthic organisms and ultimately fish populations. High turbidity level can increase water temperatures due to suspended particles absorbing heat. High turbidity levels also affect aquatic organisms by causing reduced feeding rates, reduced growth rates, 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, cold 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 14, 15: 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).



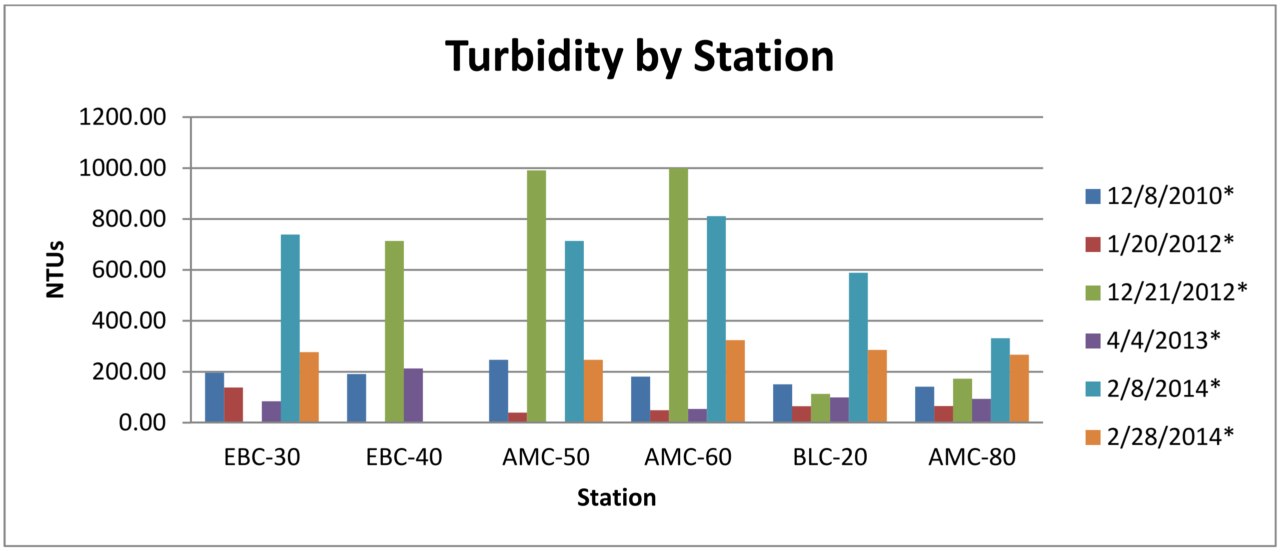
Impact Assessment Model for Clear Water Fishes
Exposed to Conditions of Reduced Water Clarity

Visual clarity of water (yBD) and related variables: alternate		preferred		Duration of exposure to conditions of reduced VISUAL CLARITY ($\log_e$ hours)											Fish reactive distance: calibrated for trout		
				0	1	2	3	4	5	6	7	8	9	10			
NTU ($\Delta ntu_{\Sigma,\Lambda}$)	zSD (m)	BA (m^{-1})	yBD (m)	Severity-of-ill-effect Scores (SEV) -- Potential: SEV = $-4.49 + 0.92(\log_e h) - 2.59(\log_e yBD)$											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 2/8/14 storm event ranged from 332 to 811 NTUs and from 247 to 324 NTUs during the 2/28/14. Both turbidity and TSS levels were high during the 2/8/14 storm, and it has been the trend that during the first high volume rainfall of the each season that the turbidity levels are high, while subsequent storms result in lower turbidity levels. Since addressing erosion rates from the surrounding landscape can affect both turbidity and nutrient concentration in creeks during storm events, BMPs that target reducing nutrient sources and soil erosion in surface runoff should continue to be employed throughout the watershed.

Figures 16, 17: Turbidity Measurements



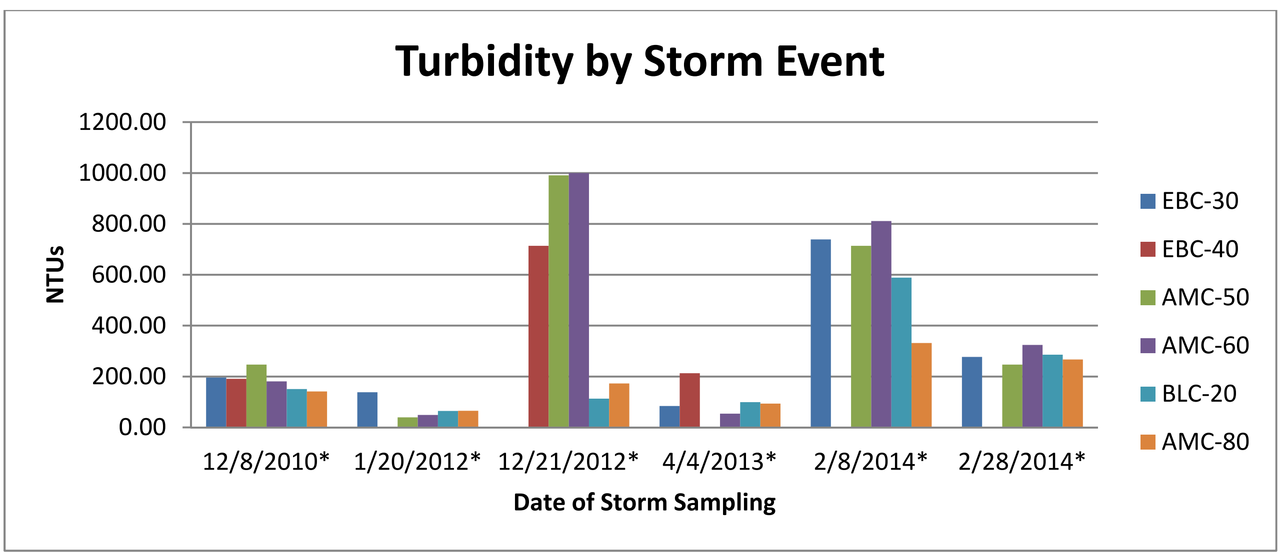
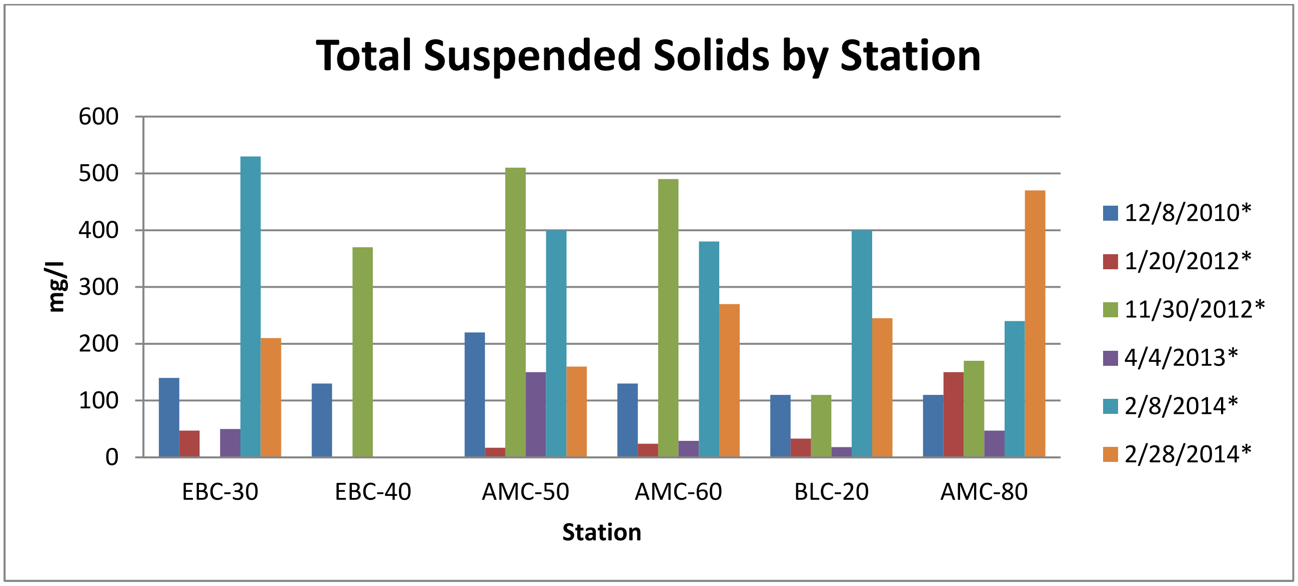
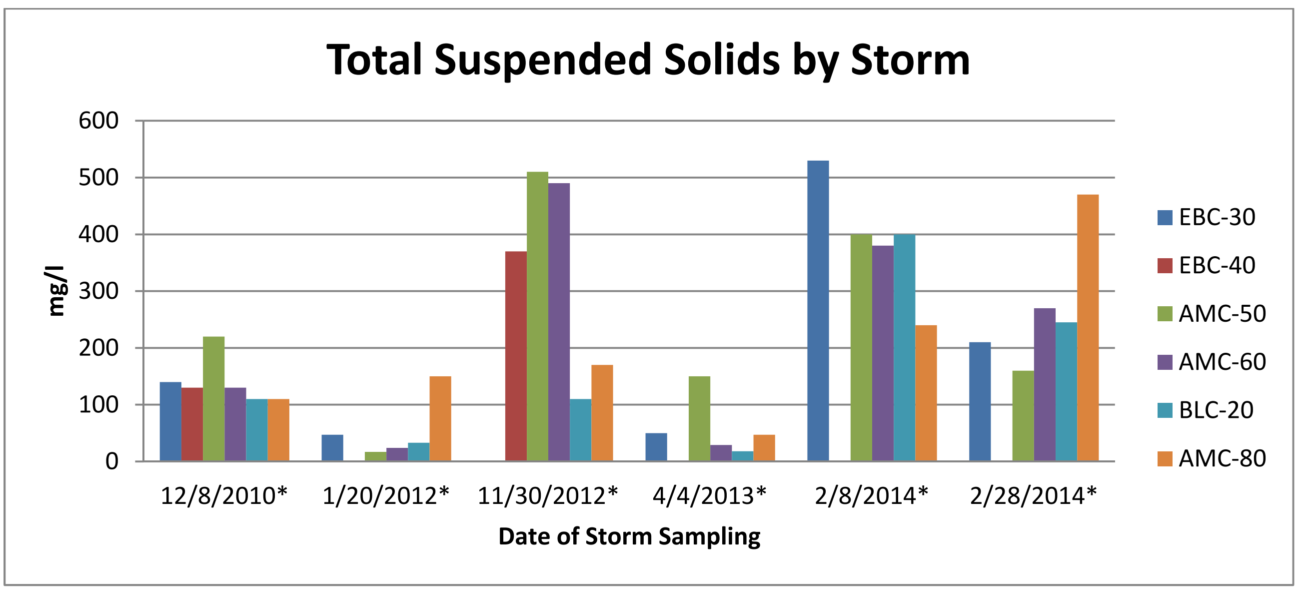


Figure 18, 19: Total Suspended Solids Measurements





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.

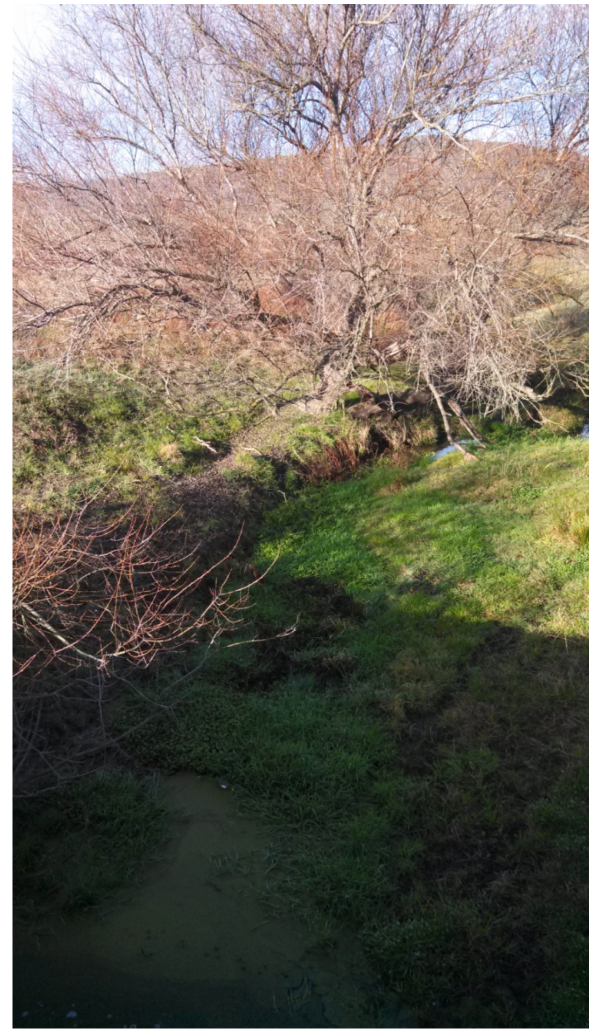
Gold Ridge RCD. (2010). *Salmon Creek Integrated Coastal Watershed Management Plan.* Occidental, California: Gold Ridge Resource Conservation District.

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.

EAWS field check post 02-03-14 rainfall event to evaluate flow conditions for sampling

Flow over downstream concrete apron of bridge @ AMC80

AMC80: Continuous flow upstream of and through culvert, unsure of whether connected flow continues downstream through pasture lands. Some flow response visible in the disturbance of the duck weed. Strong odor of manure.



Flow downstream of bridge, channel enters grassland

Flow conditions from spillway on upstream side of Roblar Road at AMC-80. Continuous flow conditions from right and left channels, which converge under the bridge

BLC-20: Continuous flow under Bloomfield Road bridge into large pool at downstream side. Downstream of bridge, there appears to be little to no outflow from ponded pool.

Flow from Bloomfield Creek does not meet Americano Creek; flow observed at Valley Ford Road crossing is isolated pools. County? Maintenance crew clearing channel at bridge (no photo taken). Still strong manure odor.

No storm sampling will be conducted until continuous flow conditions throughout the Americano Creek watershed are continuous. Rainfall is forecasted for 2/8-2/9/14. If >0.5" falls within a 24 hour period, flow conditions will be reassessed.

Continuous flow conditions upstream of Bloomfield Road bridge

Isolated pool downstream Bloomfield Rd bridge