

Francis Creek Annual Suspended Sediment Yield

Turbidity Threshold Sampling Summary Report

Hydrologic Year 2015

Site FRC – 1099 Van Ness Avenue Ferndale, California

A collaborative project between

National Marine Fisheries Service

Humboldt County

Coastal Conservancy

Humboldt County Resource Conservation District

North Coast Regional Water Quality Control Board

For the

Salt River Ecosystem Restoration Project

**By Clark Fenton
8-27-15**

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1. Introduction

The Salt River Ecosystem Restoration Project is a joint effort by various agencies, including The County of Humboldt, The California State Water Control Board, Ducks Unlimited, The State of California Coastal Conservancy, The California Department of Fish and Wildlife, The California Department of Conservation and the California Department of Water Resources. It is currently the largest restoration project in California.

The goals are to improve riparian and fish habitat, reduce flooding, enhance sediment routing and lessen sewer plant impacts on Francis Creek and the Salt River. Suspended sediment yields from the Francis Creek watershed will continue to be quantified to provide planning data for future dredging downstream. The EIR and current progress may be viewed on the HCRCD's web site <http://www.humboldtred.org>, Salt River Restoration Project tab or at the Salt River Watershed Council website <http://saltriverwatershed.org/>.

Thanks to Valentina Cabrera-Stagno, Duane James, Lucrina Jones, Greg Nagle and Peter Husby of the United States Environmental Protection Agency – Region 9 Laboratory for running the Francis Creek suspended sediment concentration samples for Hydrologic Year 2015. Funding for running the ssc samples locally was not obtained for this year. Summer Daughterty of the Humboldt County Resource Conservation District stepped up and persuaded the EPA to run our samples again this year.

The large HY 15 storm event on February 6th 2015 transported 19,500 cubic yards of suspended sediment and brought the annual suspended sediment load total way up. Since starting operation in 2007 the Francis Creek TTS station has measured over **198,000 cubic yards** of suspended sediment passing the station.

The Humboldt County Materials Testing Lab and Clark Fenton continue to maintain a Turbidity Threshold Sampling (TTS) Station on Francis Creek in Ferndale California. Hydrologic Year 2015 was the ninth year and eighth full year of TTS monitoring on Francis Creek. Sarah Wilson continues to analyze and report the annual suspended sediment yields.

On 5-28-15 the Ferndale Enterprise reported the following about the latest Salt River progress.

“watershed council coordinator Doreen Hansen said work this spring has included keeping vegetation down in the portion of the channel scheduled for second phase work this summer. “ Calfire has been doing lots of burns and weeding because everything is growing superfast” said Hansen, adding that the goal is to eliminate any possible bird-nesting habitat that could hinder the second phase work. “Design plans are at 100 percent and they will go out to bid in 2 weeks” said Hansen, adding that this week a bid walk will take place. ”Hopefully, the bids will come in reasonably and we go to construction this year.” Plans call for another 2,000 feet of channel clearing leading up to the city’s wastewater treatment plant. “We’re hoping to add on to some plot channels and alleviate some of the flooding at “Lake Vevoda” said Hansen, referring to the massive ponding that has increased over the years next to the treatment plant on land once owned by John Vevoda.”

Work has begun as of 8-18-15 on replacing the culvert at Port Kenyon and Francis Creek.



Photo #1.

2014 Aerial view of mouth of the Eel River and Salt River looking west.

The excavated channel is on the right side of photo.

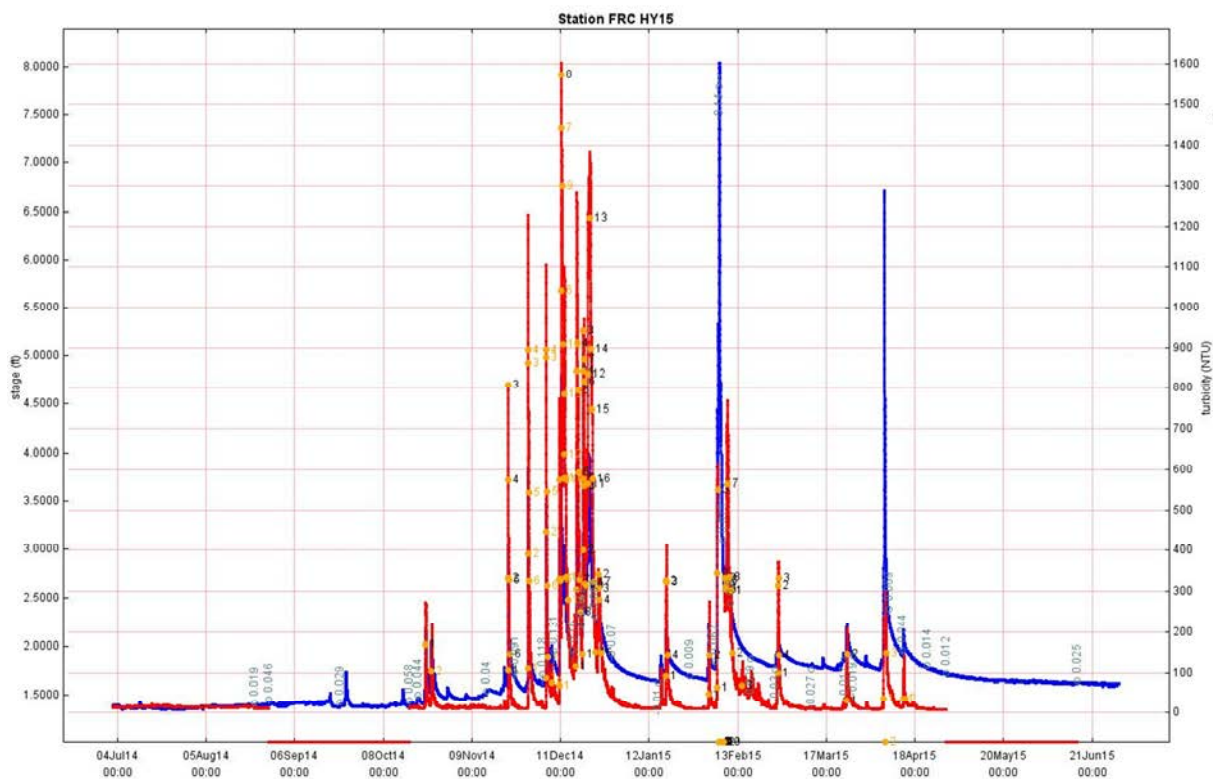
The annual suspended sediment yield from the Francis Creek watershed above Site FRC for **Hydrologic Year 2015 from July 2nd, 2014 to June 30th, 2015 was 84.4 million pounds**. At the 8.04 foot peak stage of the biggest storm of HY 15 on 2-6-15, **almost 600,000 pounds / 260 cubic yards** of suspended sediment was flowing past the Francis Creek TTS Station **every 10 minutes**. A bulk specific gravity of 85 lbs. per cubic foot was used to calculate cubic yards of fresh flood deposit sediment. (USDA, 93) The purpose of this TTS monitoring station is to provide guidance on how much suspended sediment can be expected to enter the Salt River dredge or detention areas over time from the Francis Creek watershed.

The Ferndale Enterprise reported on 7-2-15 that rainfall for Ferndale for “The weather year to date from 7-1-14 to 6-28-15 was 97% of average at **38.77 inches**. Rainfall **last year** from 7-1-13 to 6-29-14 was **19.50 inches**. The Weather Year average from 1971, July 1st to 6-28-15 is **40.11 inches** rainfall.”

The results from the last 8 water years are summarized below. The HY 2011, 2012, 2013, 2014 and 2015 totals include suspended sediment from the Francis Creek Ranch Slide in March 2011.

Hydrologic Year	Total Suspended Sediment Lbs.	Total Suspended Sediment Kg	Total Suspended Sediment Cubic Yards	Highest Single Storm Sediment Kg	Highest Single Storm Flow CFS	Annual Suspended Sediment Yield Tons/ Sq. Mile
2008	41,739,922	18,932,910	18,187	4,511,312	274	6,521
2009	12,578,664	5,705,593	5,480	1,351,049	135	1,965
2010	38,979,924	17,685,991	16,985	4,270,058	215	6,091
2011	70,342,760	31,915,953	30,650	17,045,608	268	10,991
2012	65,859,288	29,881,710	28,696	12,563,530	230	10,291
2013	139,352,629	63,209,938	60,720	28,228,313	462	21,774
2014	2,419,062	1,097,578	1,054	355,314	46	378
2015	84,450,445	38,316,899	36,798	20,380,963	488	13,195
Totals	455,722,694	206,746,572	198,570			Avg = 8900

Table # 1 – Francis Creek Annual suspended sediment summaries



Plot # 1 Stage / turbidity plot of the HY 2015 water year at Site FRC on Francis Creek.

Maximum storm stage 2-6-15 in blue was 8.04 feet @ 488 cfs.

The Salt River is a tributary of the Eel River that heads in the Wildcat Mountains above Ferndale, flows across the Eel River Delta, and enters the Eel River within one mile of the Pacific Ocean. The watershed is part of the Franciscan Complex and mainly underlain by Quaternary mudstones, siltstones and sandstones of the Wildcat formation (McLaughlin, R.J. and others. 2000). Habitats and land uses that characterize the Salt / Eel River delta include the fourth largest estuary in California, salt-, brackish-, and freshwater marshes, riverine wetlands, riparian wetlands, agricultural lands dominated by dairy farms and irrigated pastures, and small communities. (USDA, 1993)

Sedimentation in the Salt River Channel has resulted in problems associated with flooding and drainage, including:

- Decreased agricultural production and land values;
- Degradation of the estuary and its habitats as excess nutrients are transported from flooded dairy lands downstream, Loss of a once navigable waterway; and
- Increased health hazards posed by water quality degradation. (USDA, 1993)

Humboldt County Public Works was awarded a grant from the Department of Fish & Wildlife's Fisheries Restoration Grant Program, supplemented with funds from the state Department of Water Resources, to replace the culverts on Francis Creek at Port Kenyon Road with a 42-foot-wide CON/SPAN modular bridge structure. The project will remove a fish migration barrier and open access to over three miles of spawning habitat in Francis Creek and remove a hydraulic constriction to allow more effective sediment transport and channel flushing. (Hank Seeman, personal communication 2013)

The Port Kenyon Culvert replacement project bids were opened on June 23rd, 2015.

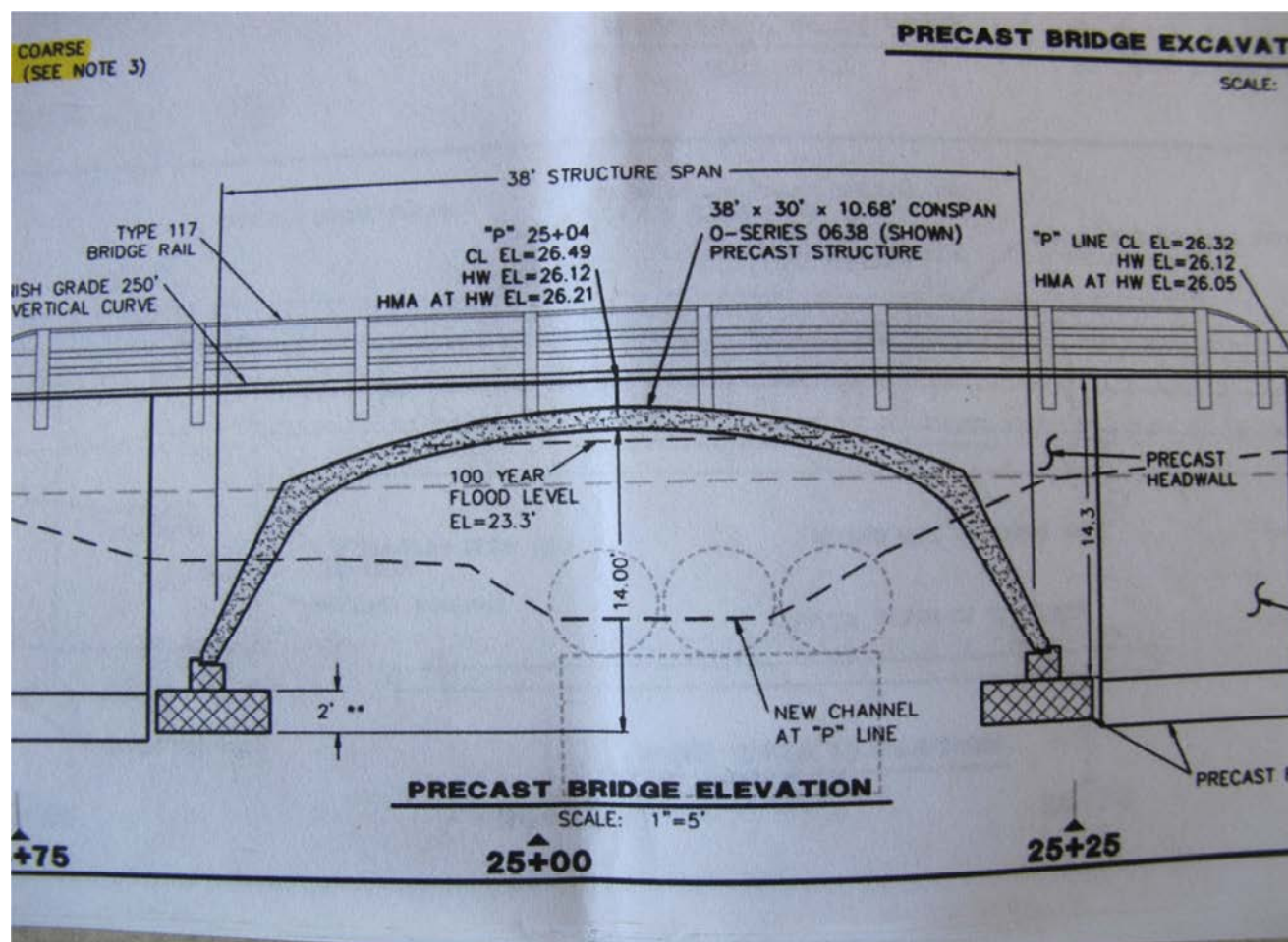


Figure # 1 – Port Kenyon Culvert plan

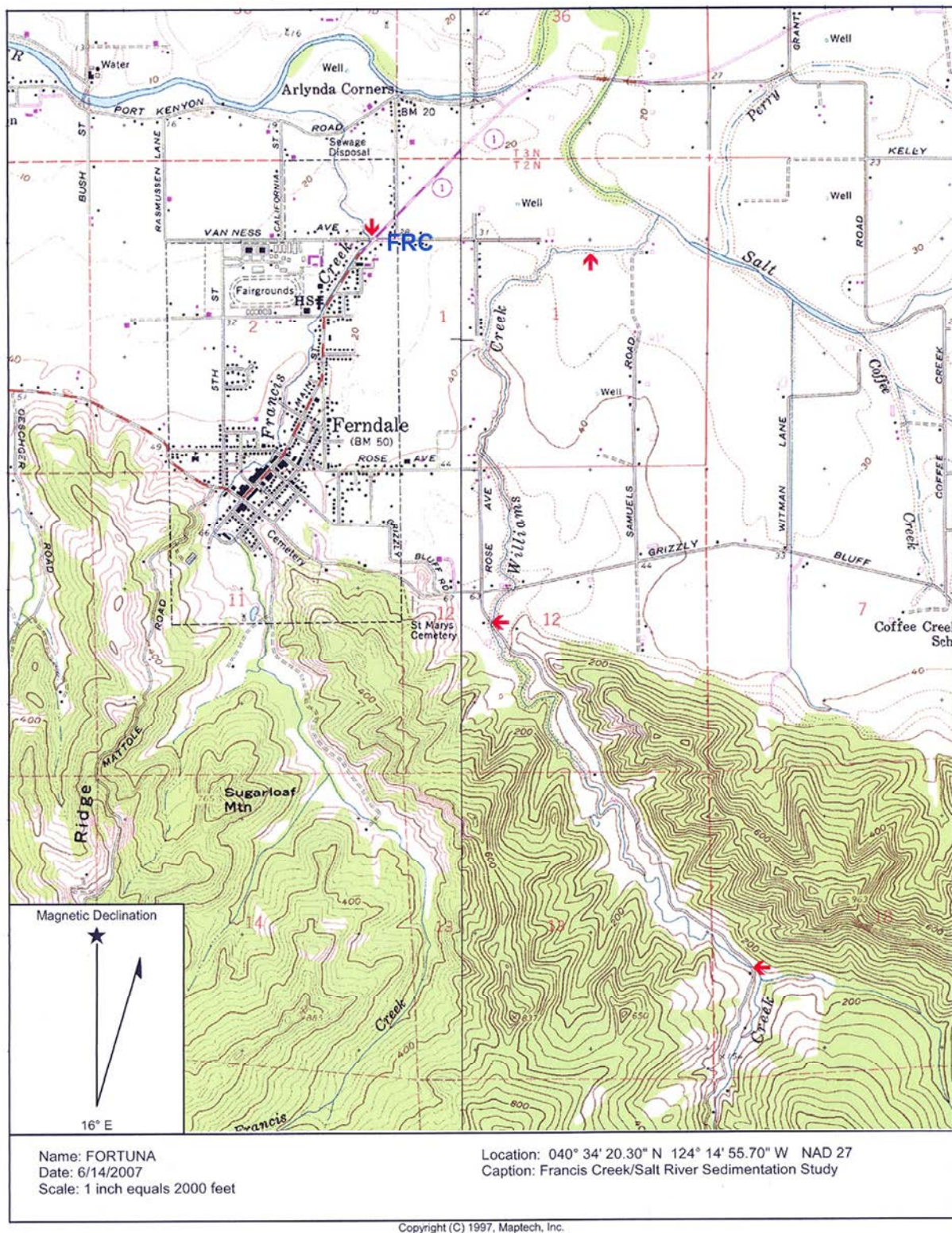


Figure # 1 Francis and Williams Creek monitoring locations

Turbidity Threshold Sampling (TTS)

Jack Lewis and Rand Eads at Redwood Sciences Lab developed turbidity Threshold Sampling over 10 years ago (Lewis, Eads, 2002). Redwood Sciences Lab is a research station for the USFS and deploys a network of these stations on Caspar Creek to monitor long-term sediment transport in the Jackson State Forest and other locations across Northern California. Redwood Sciences Lab provides all information and software for TTS sampling for free on their website. Implementation files, sampling software and TTS literature should be found at <http://www.fs.fed.us/psw/topics/water/tts/>.

TTS is used to calculate annual suspended sediment loads using turbidity measurements every 10 minutes as a surrogate for suspended sediment measurements every 10 minutes. A Druck 1830 pressure transducer and an in-stream OBS-3+ turbidimeter are installed in conjunction with an ISCO pump sampler to take water samples at direction from TTS sampling software. An algorithm is used to trigger an ISCO pump sampler to take water samples at rising and falling turbidity thresholds. The final 10-minute data file is called a flo file and displays raw and corrected stage and turbidity data side by side for easy comparison. The flo files for Site FRC 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015 are included in Appendix 5. **On-line real time plotting should be available on the HSU website** http://nrs-isa.humboldt.edu/rsl/tts_plot.html.

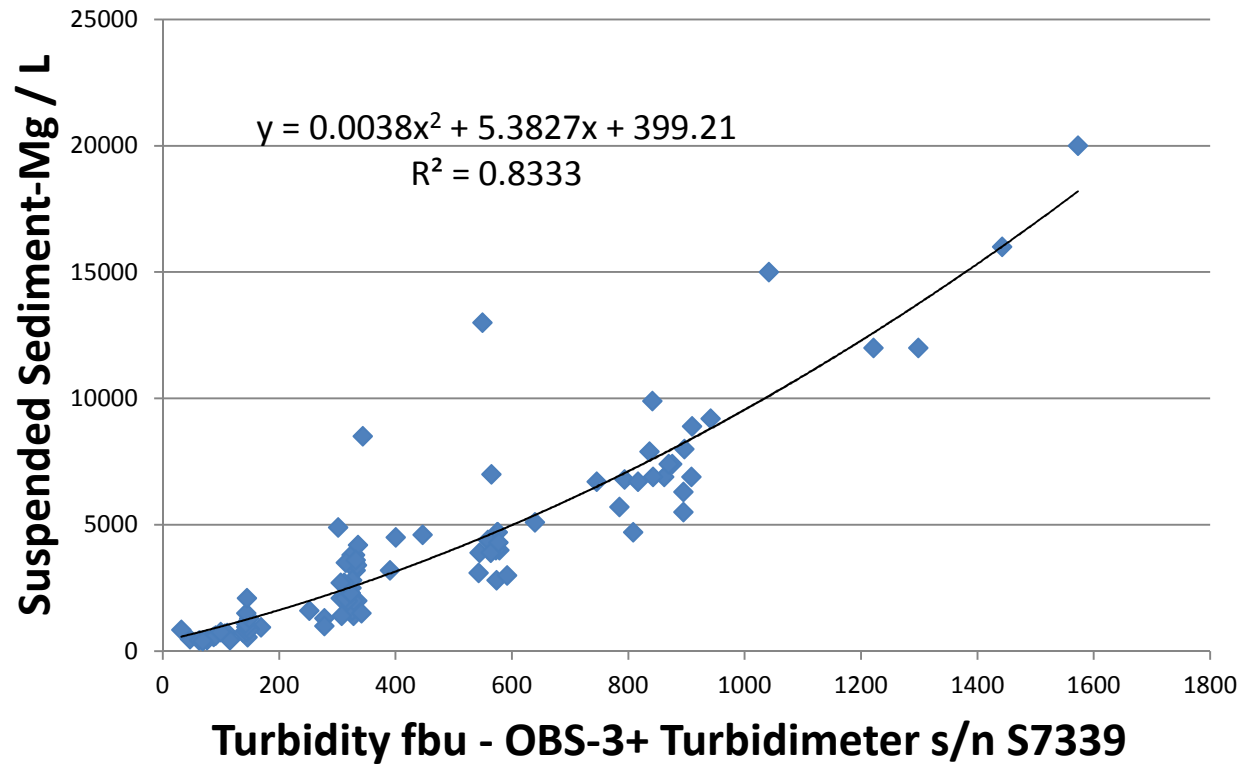
TTS water samples for HY 2015 were sent to the EPA Region 9 Laboratory by Summer Daughterty of the HCRCd for suspended sediment concentration determination by subtracting filtering (SSC / Sand Fraction - ASTM D3977 -02). A regression is developed for OBS-3+ turbidity versus suspended sediment concentration. The 10-minute turbidity data is converted to 10 minute calculated suspended sediment concentration. A discharge-rating curve is developed so flow is known for the every 10 min stage data. By multiplying flow / cfs and suspended sediment concentration, pounds of sediment passing by the station are calculated. TTS Adjuster software is used to do data correction and R Sed software is used to calculate suspended sediment loads. The best equation fit for the turbidity vs. suspended sediment concentration from **bottles sampled from each storm is used to calculate loads for each storm** and the loads are summed up for the year.

Francis Creek - Site FRC - Hydrologic Year 2015

Suspended Sediment vs. Turbidity

1099 Van Ness Avenue Ferndale California

By C. Fenton 7-27-15



Plot # 2 - Turbidity vs. Suspended Sediment Concentration

of Site FRC HY 2015 ISCO pump samples.

2. Francis Creek Ranch Slide – March 2011

During a set of 5 rainfall events starting 3-23-11 and ending 4-1-11 a large debris torrent occurred approximately 3.4 river miles upstream of the station. The forester of the upstream property, Chris Carroll, estimates the slide to be roughly 100,000 cubic yards in size.

The California Geological Survey visited the site on April 7, 2011. Details from their report by Don R. Braun dated April 18, 2011 include that a bridge was removed from its abutments by the debris. At the slide site bedrock materials “consisted predominantly of soft to moderately dark gray siltstone with minor amounts of fine sub rounded gravel. Significant precipitation in the area during the month of March may have been the main contributor to the recent failure. The debris is estimated to consist of about 50% wood or logs and about 50% dark gray silt. Information supplied by Mr. Mark Distefano of TRC suggests that the destroyed former bridge over Francis Creek was approximately 15 to 20 feet above the channel and that the current debris in the channel is about 4 to 5 feet above the height of the old bridge suggesting that the debris thickness at this location may be about 19 to 25 feet. Francis Creek will likely remain turbid with suspended sediment during future rainy seasons until a stable channel and side slopes develop.” (CGS, 2011)



Photo # 2 Francis Creek Ranch Slide April 2011

Using turbidity threshold sampling analysis Sarah Wilson estimated that approximately **11 million kilograms / 24 million pounds / 10,600** cubic yards of suspended sediment presumably came from the Francis Creek Ranch Slide during this period. The suspended sediment is mainly fine sand and silt and totals do not include bed load gravel. During this slide event, the TTS station sucked over 40 water samples from Francis Creek, including 14 water samples over 35,000 milligrams/liter. Eight of those 14 bottles had over 65,000 mg/l, one bottle had 100,000 mg/l and one bottle had 180,000 mg/l.

This event in HY 11 contributed in 6 days almost the same amount of suspended sediment yield as all of Hydrologic Year 2010. The slide itself has already sent twice the amount as all of Water Year 2009 suspended sediment yield downstream.

After the large storm events in 2012, Tom Stephens, a local geologist, visited the slide and gave analysis and recommendations to the Ferndale City Council. His main recommendations were to continue close monitoring of the slide during storm events and encourage HSU students and faculty to survey cross sections annually to document changes.

His 2012 report said that the toe of the slide is migrating upstream as it erodes but most of the slide is still a slowly settling mass of trees and sediment. Some tree planting slide stabilization efforts by the CCC have been washed away but other revegetation efforts are holding. The stream is cutting down and widening and the previous waterfall at the base of the slide has disappeared. There is still a lot of sediment and debris in the stream channel above Ferndale and large storm events will continue to mobilize that sediment.

Sarah Wilson did not do a breakdown of the proportion of slide suspended sediment versus the total annual suspended sediment yield this year. As each year passes the slide's contribution gets more difficult to discern as the slide changes and annual rainfall totals change. The slide suspended sediment regime is now **baseline**.

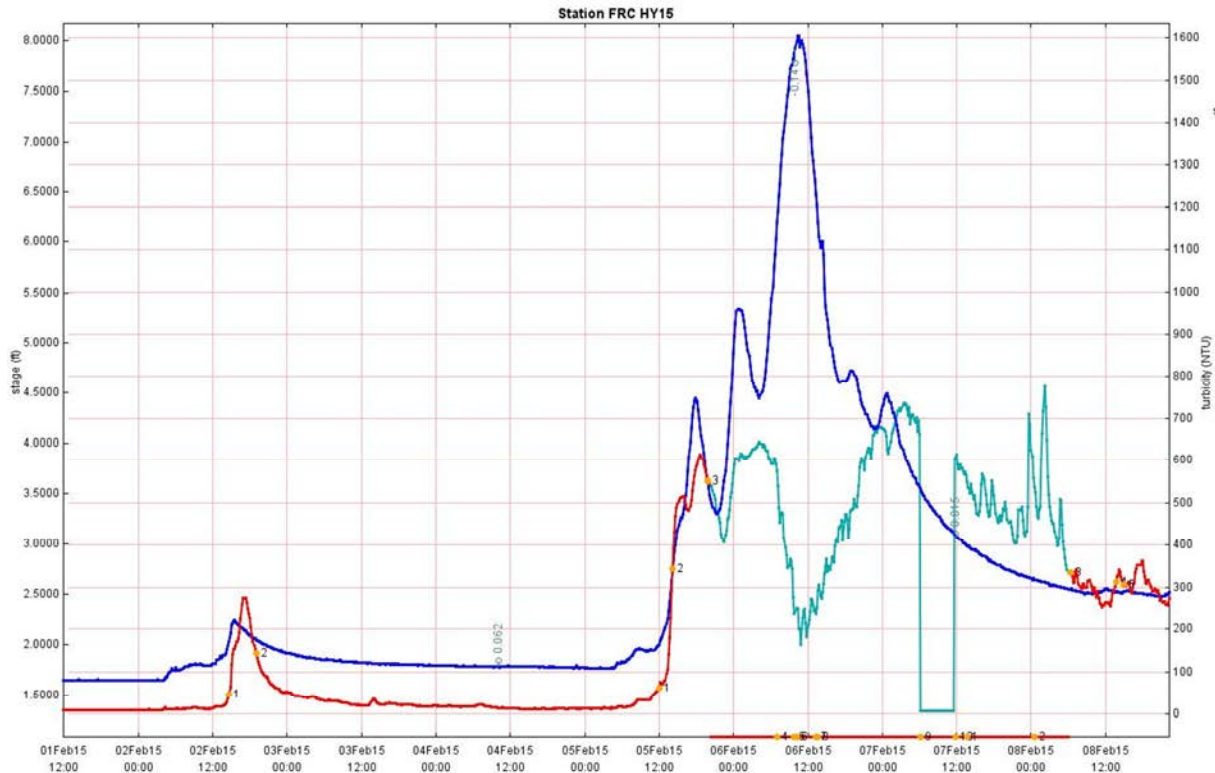
3. February 6th 2015 Large Storm Event

The largest storm event of Hydrologic Year 2015 occurred on February 5th, 6th and 7th 2015. Water level started rising on Francis Creek at the Van Ness Culvert at noon on Monday 2-5-15. This was storm period 7 in Sarah Wilson's annual suspended sediment yield analysis. Storm Period 7 totaled 20,380,963 kg, 44,916,642 pounds, 19,571 cubic yards and was 53% of the HY 2015 annual suspended sediment yield total. The Ferndale Enterprise reported on February 12th that rainfall for the week ending February 8th was 6.37" of rain.



Photo # 3

On 2-12-15 Ferndale Enterprise reported that "Francis Creek was just as furious as Williams Creek on Friday, with a rapid rise and force that hasn't been seen in at least the last two decades. While the creek behaved itself up behind Francis Street-where homeowners and volunteers were filling sandbags near the city's public works barn-when it roared past the commercial district on Main Street and hit the Fern Street Bridge, it exploded." "And then, as quick as the water rose, it seemed to drop. By mid-afternoon, the recession was visible and the sun emerged before high winds picked up that night." "As for the first phase of the Salt River restoration project-stretching from the mouth of the Salt near the Eel River to just past Dillon Road Bridge - watershed advisor Doreen Hansen of the Humboldt County Resource Conservation District (HCRCD) reported Tuesday that the channel worked and newly planted vegetation remained intact."



Plot # 3. A plot of the largest storm of HY 2015 from February 1st, 2015 to February 8th, 2015 showing water depth as blue peaking at an 8.04 feet stage at 488 cfs. This single storm event carried 44 million pounds / 19,000 cubic yards of suspended sediment past Station FRC. Woody debris catching on the boom interfered with turbidity readings.



Photo # 4

Water level peaked about a foot below the floor of the TTS Monitoring station enclosure. The water level came up to the top of the Van Ness Culvert. Turbidity levels went far above the capacity of the OBS-3+ turbidimeter. Existing in-stream turbidimeter capabilities cannot determine turbidity at these high levels. Discharge vs. SSC was used instead to calculate the quantity of suspended sediment flowing past the station. Clark Fenton manually triggered several ISCO samples during the peak stages that greatly helped calculate the suspended sediment yield.

Woody debris quickly collected on the instrument boom and interfered with the OBS-3+ turbidimeter readings. The instrument boom needs to be modified to be more streamlined.



Photo # 5



Photo # 6.
Stream bank aggradation decreasing channel carrying capacity
after 2-6-15 storm event.

4. Hydrologic Year 2015 Suspended Sediment Yield

The Francis Creek TTS Station (Site FRC) is located at 1099 Van Ness Avenue in Ferndale, California. Francis Creek is the second largest tributary to the Salt River watershed at 3.2 square miles (Buffleben, 2007). The Williams Creek watershed is the largest at 5.7 square miles. TTS Monitoring commenced at Site FRC on Francis Creek on 1-23-07.

Sarah Wilson continues to do suspended sediment analysis with Redwood Sciences Lab TTS Adjuster and R Sed analysis software. Sarah Wilson received her Bachelors of Science in Biology from San Jose State University and a Master's of Science in Watershed Management from Humboldt State University. Her husband is an active duty member of the US Coast Guard. They have a son and a daughter and currently live in Dublin Ca.

The annual suspended sediment yield from the 3.2 square mile Francis Creek watershed above Site FRC for **Hydrologic Year 2015** from 7-2-14 to 6-30-15 was **84,450,445 pounds / 38,316,899 kg / 36,798 cubic yards** or **13,195 tons per square mile per year** of suspended sediment. The largest suspended sediment estimation period of HY 2015 was storm period 7, the 2-6-15 storm event, yielding 44.7 million pounds or 53% of HY 15 suspended sediment annual yield. See the summary Table #1 in section 1 for a comparison of the Hydrologic Years suspended sediment amounts.

The annual suspended sediment yield from the Francis Creek watershed above Site FRC for **Hydrologic Year 2014** from May 6th, 2013 to July 1st, 2014 was 2.4 million pounds or 1,097,578 kilograms or 1054 cubic yards or **378 tons / square mile**. The annual suspended sediment yield from the Francis Creek watershed above Site FRC for **Hydrologic Year 2013** from October 2nd, 2012 to May 6th 2013 was 139.3 million pounds or 63,209,938 kilograms or 60,720 cubic yards or **21,774 tons / square mile**.

The Ferndale Enterprise on July 16th 2015 reported that at a meeting of the Salt River Watershed Council on July 14th 2015, Curtis Ihle of the Humboldt County Resource Conservation District stated that the contractor Hanford was on-site and starting up this year's excavation project. An estimated 90,000 cubic yards of sediment is planned to be excavated from a section of the Salt River that extends for a mere 1,200 feet. This is the most clogged portion of the Salt River from Dillon Bridge to just downstream from Ferndale's waste water treatment plant. "The ecosystem restoration project is projected to clear out a total of 7 miles of Salt River. It began in 2013 with a 2 ½ mile section starting at the mouth of the Salt when a reported 170,000 cubic yards of sediment were removed and relocated, and continuing with another 1.2 miles of improvements last year, when 80,000 cubic yards were removed."

Since the start of the project in 2013 a total of 250,000 cubic yards of sediment has been removed and another 90,000 estimated to be removed this year. The TTS station at the Van Ness Culvert on Francis Creek has measured in HY 12 – 28,000 cubic yards / HY 13 – 60,000 cy / HY 14 – 1054 cubic yards / HY 15 – 36,000 cubic yards of suspended sediment flowing past the Francis Creek TTS Station for a total of **125,000 cubic yards of suspended sediment in the last 4 years and over 195,000 cubic yards since 2007**.

The **Eel River at Scotia** carries an almost incredible **4,330 tons of suspended sediment every year from every square mile** of its drainage basin. On average, 4 to 8 inches of soil is washing off the slopes every hundred years. That is the highest regional rate of erosion ever measured in the United States, more than 13 times the national average. Most of that phenomenal load goes down the river in about 6 days of the largest discharges during the winter floods. (Roadside Geology of Northern and Central California – D. Alt / D. Hyndman – 2000)

The average annual suspended load for the **Mad River** is about 1,751,500 tons, or about **3,600 tons /sq. mi/yr.** for Qss. (Klein, R. 2007, Personal Communication.)

Summary of sediment load estimates for Station FRC, Water Year 2015

By Sarah Wilson

The table below is from the Sarah Wilson suspended sediment report for FRC **HY 2015**. Her complete report is in Appendix 1. The hydrologic year was broken up into storm-by-storm time periods and the suspended sediment load was calculated for each period. Ms. Wilson has done this same analysis for Redwood Sciences Lab.

Summary of sediment load estimates for station FRC, water year 2015

Each estimate is given one of five grades: **excellent**, **very good**, **good**, **fair** and **poor**.

Grading is based on the quality within the following categories:

Number of sample bottles within the period and the coverage of bottles across the entire period.

The strength of the relationship between the surrogate variable (stage or turbidity) and sample ssc, as measured by CV and r2.

The complexity and number of models and object used to calculate the estimate for each period.

The quality of the surrogate variable data (usually turbidity).

An estimate cannot receive a high grade if the quality of the underlying data is questionable.

Discharge rating equation: $\text{Discharge} = (9.8848 \cdot \text{stage}^2 - 19.996 \cdot \text{stage} + 10.582)$

Same discharge equation as HY13

Period	Dates and Times	Dump: Bottles	Sediment Load (kg)	% of Total Load	Grade
01	140702,1300,141022,1800	none processed	18,292	0.05%	poor
02	141022,1810,141121,0800	3:1	33,477	0.09%	poor
03	141121,0810,141210,1000	4:1-6	591,803	1.54%	good
04	141210,1010,141218,2000	8:1-8, 9:1	3,030,377	7.91%	very good
05	141218,2010,150114,1200	9:2-17, 10:1-5	3,167,256	8.27%	very good
06	150114,1210,150201,1200	12:1-4	60,977	0.16%	good
07	150201,1210,150208,2100	13:1-2, 14:1-10, 15:1-5	20,380,963	53.19%	good
08	150208,2110,150313,0000	15:6-8, 16:1-3, 17:1-4	1,018,603	2.66%	good
09	150313,0010,150412,1200	18:1-2	7,665,203	20.00%	fair
10	150412,1210,150630,1300	none processed	2,349,948	6.13%	poor
Total Load (kg)			38,316,899		

Table # 2 – HY 2015 Storm Period Suspended Sediment yields

4. Field Operations HY 2015

The station on Francis Creek – Site FRC – was made possible by funding from the Humboldt County Resource Conservation District, 5 Counties Salmonid Conservation Program, City of Ferndale and the Road Fund of the Humboldt County Public Works Department. The City of Ferndale Public Works constructed the Site FRC Equipment Enclosure Shed, and the equipment was installed in January of 2007.



Photo # 7 - Site FRC at 1099 Van Ness Avenue

The TTS station uses an ISCO Model 6700 automatic pump sampler, a Campbell CR101X data logger, Druck 1830 pressure transducer, and an OBS-3+ turbidity probe. The data logger and pressure transducer were up and running on 1-18-07. The OBS-3+ in-stream turbidimeter hangs from a boom off the ceiling of the culvert and has been operational since 1-23-07. The equipment has been mostly trouble free and the turbidimeter is sent in for calibration each summer.

Field Operations still include upgrading TTS station equipment, taking discharge measurements, making TTS Station FRC data dumps / sample bottle swaps, repairing storm damage to equipment and removing sediment and debris covering the pressure transducer pipe tip and/or hanging on the turbidimeter boom. Streambed aggradation has forced raising the boom and turbidimeter housing and pressure transducer pipe every year as the streambed rises to touch the housing.

A data logger modem was also purchased so that real time stage (water level) and turbidity data could be posted on the Redwood Sciences Lab website, which could function as part of an early warning network for flooding. This real time on-line data plotting has been available since the beginning of HY 2008 and will continue. Humboldt State University and Redwood Sciences Lab are upgrading plotting servers and software. This plotting should be accessible at http://nrs-isa.humboldt.edu/rsl/FrancisCreek_DetailView.gif

Turbidity:

Francis Creek continues to maintain a high turbidity response levels with the Francis Creek Ranch landslide upstream.

Turbidity is a number derived from the amount of light suspended sediment blocks from passing through water. Turbidity is usually caused by rising water flow transporting increasing levels of suspended sediment. Chronic turbidity is the tendency for streams to remain at elevated levels of turbid water for long periods. Causes of chronic turbidity can include landslides into a stream bleeding sediment for long periods to several storms in a row hitting a watershed in close intervals and keeping flow and turbidity and suspended sediment concentrations elevated. Land use in a watershed can contribute to chronic turbidity. Elevated levels of turbidity can cause harm to aquatic species.

This watershed has a very energetic and long lasting elevated turbidity response compared to other North Coast watersheds. Sediment is mobilized fast and available longer after the peak of a storm event. Anomalous turbidity spiking may be land management activities or discrete bank failures or activity at the Francis Creek Ranch slide or some sediment delivery mechanism that keeps turbidity levels elevated.

The OBS-3+ Turbidimeter was chosen for this application because of the expected very high turbidities. The OBS-3+ sensor consists of a high intensity infrared emitting diode, which shines out into the water flow and a detector to measure light bounced back from the suspended sediment. The more infrared light bounced back the higher the turbidity. FBU turbidity units are used per the USGS turbidimeter nomenclature table from May 2012. The OBS-3+ has a stated range of 4000 fbu but has a practical high range of about 2900 fbu for Francis Creek Sediments, which is the highest available for an in-stream turbidimeter. Flow based suspended sediment loads will be used for turbidities above the range of the OBS-3+ Turbidimeter or where debris has pushed the turbidimeter instrument boom out of the water.

Discharge Measurements HY 2015:

A single discharge rating curve was used for HY 15. No new discharges were taken in HY 2015. Fortunately a solid discharge rating curve was obtained in HY 2013 and will be used for the foreseeable future.

A lack of high flow discharge measurement equipment, the challenge of catching high flow events and only Clark Fenton to take the measurements has hampered timely updating of the discharge rating curve.

The highest stage for Hydrologic Year 2014 was **3.15 feet @ 46 cfs on March 14th, 2014.**

The highest stage for Hydrologic Year 2015 was **8.04 feet @ 488 cfs on February 6th 2015.**

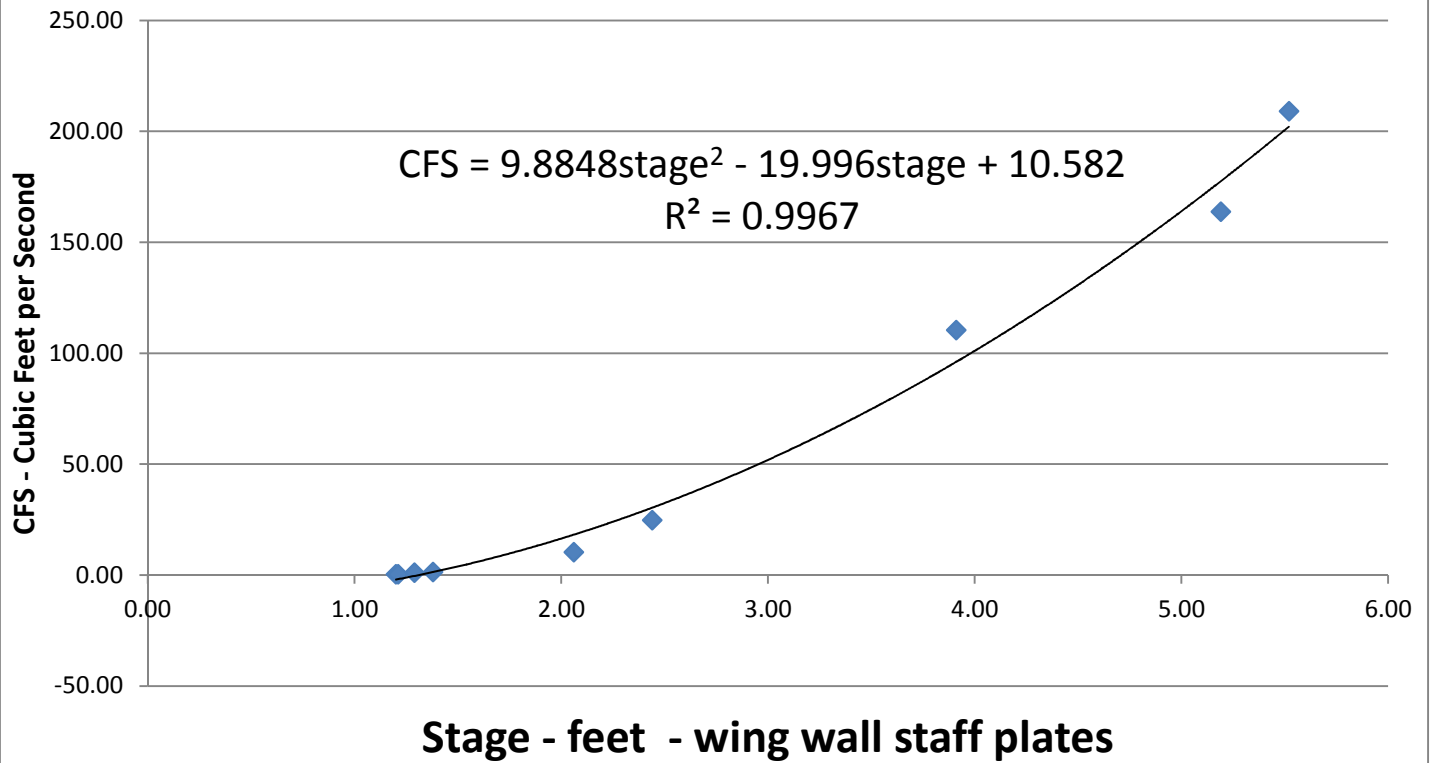
USFS / USGS methods were used for obtaining flow measurements. (Harrelson 1994, USGS). Low flows were measured with a Wading Rod using either a Pygmy current meter or a Price AA current meter. For higher flows an A-55 Reel, 30 lb. Columbus Weight, Price AA current meter and a bridgeboard were used. An accurate estimate of stream discharge is vital to accurate suspended sediment load calculations. See Appendix 3 for discharge sheets and rating curves.

Aggradation or rising of the streambed around the staff plates from bedload mobilization is still being observed. The streambed is mobile gravels and annual discharges are needed in this location to ensure representative discharge measurements.

More low flow discharges will be taken in HY 16 to record any low flow changes.

Francis Creek - Site FRC - HY 2013 - Discharge Rating Curve

By C. Fenton 12-22-12 - all HY 13 data only - final



Plot # 4. FRC HY 2015 Discharge Rating Curve

5. Lab Operations 2015

The United States Environmental Protection Agency – Region 9 Laboratory ran the Francis Creek suspended sediment concentration samples for Hydrologic Year 2014. Suspended sediment concentration determination by subtracting filtering (SSC / Sand Fraction - ASTM D3977 -02) was used.

Thanks to Valentina Cabrera-Stagno, Duane James, Lucrina Jones, Greg Nagle and Peter Husby of the United States Environmental Protection Agency – Region 9 Laboratory for running the Francis Creek suspended sediment concentration samples for Hydrologic Year 2015.

The Francis Creek TTS sampling software triggered **100** ISCO Pump samples in HY 2015, **34** ISCO Pump samples in HY 2014 and **193** ISCO pump samples for HY 2013. The suspended sediment concentration of each bottle is compared to the corresponding OBS-3+ Turbidity and a regression is developed for each storm period. See the FRC 2015 turbidity / suspended sediment concentration regression chart / Plot #2 in Section 1.

EPA Region 9 Laboratory reports are on file at the Humboldt County Materials Testing Lab.

6. Closing Summary:

Completion of Phase 1 and Phase 2 of the Salt River Ecosystem project should allow better flushing of suspended sediment through the system. Detention basins that were constructed in the lower reaches should capture suspended sediment to the side instead of the main Salt River channel during high flows.

The large difference between last years and this year's annual suspended sediment yield illustrates the large effect of timing and duration of rainfall on the quantities of suspended sediment being mobilized each year.

The biggest field challenge is still to keep the instrument boom at proper depth during large storm events so turbidity data is not lost. Francis Creek has plentiful woody debris in stream and debris snagging on the boom can push the boom and turbidimeter out of the water. 40 or 50 pounds of lead have been attached to the lower end of the boom to keep it in the water during high flows. Even that is not enough at times. The instrument boom needs to be strengthened and streamlined so no debris can't catch and build up.

The Francis Creek Slide will continue to elevate and dominate the suspended sediment regime on Francis Creek.

The Port Kenyon / Francis Creek culvert replacement this year will alleviate backing up of Francis Creek and deposition of sediment at that location.

Thanks to Summer Daughterty of the HCRCDD for convincing the EPA to run our ssc samples this year.

7. References / Bibliography

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10-m DEM and calculated the upland area to be 82,955 cells which translates to:
8,295,500 square meters or 2,050 acres or 3.2029 square miles.

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