The Dellanina Nature Area

(Storm-Water Overflow Diversion Marsh alongside Alliance Rd.)

A Water Quality and Fish Habitat Monitoring Analysis Conducted by:

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1. Jolly Giant Creek Background Information

Jolly Giant Creek is one of nine creeks within the City of Arcata that flows into Humboldt Bay. The headwaters are located in the Arcata Community Forest, and the entire watershed includes 690 acres. Due to early development within the City, much of the Creek was culverted and channelized. These changes to the Creek resulted in increased flooding and almost a complete loss of fish and wildlife habitat in the surrounding areas of the Creek. Perhaps the greatest damage caused by the culverted Creek was the loss of once-native fish populations, including Coho and Chinook Salmon, and Steelhead Trout. In order to repair the damage done to the Creek and its surrounding habitat, the City of Arcata has been undergoing restoration projects on the creek since 1990.

The first restoration project the City completed was mitigation for a senior housing development off Union St. in Arcata. The development was going to cover approximately 25,000 square feet of wetlands. In order to replace the wetland area lost from the development the City investigated wetland sites that could be restored. Since Jolly Giant Creek was already an issue of concern for the City, they picked a section to restore. During this time a teacher from Arcata High School expressed interest in developing an outdoor ecology laboratory somewhere in the City. The teacher approached the City and they decided the restoration project could serve as the outdoor laboratory. The high school students along with many other volunteers installed a sediment trap and a downstream wetland area. The total area restored was approximately 50,000 square feet. Directly downstream from this project, the City of Arcata, Department of Water Resources (DWR), and Redwood Community Action Agency (RCAA), completed another restoration project for Jolly Giant Creek. The banks of the creek were widened, wood and rocks were place in the stream channel, native plants were planted, and off-channel overflows and basins were created.

In order to continue the restoration of Jolly Giant Creek the City of Arcata proposed a project in 1998 named, "The Dellanina-Jolly Giant Creek Fish Habitat and Riparian

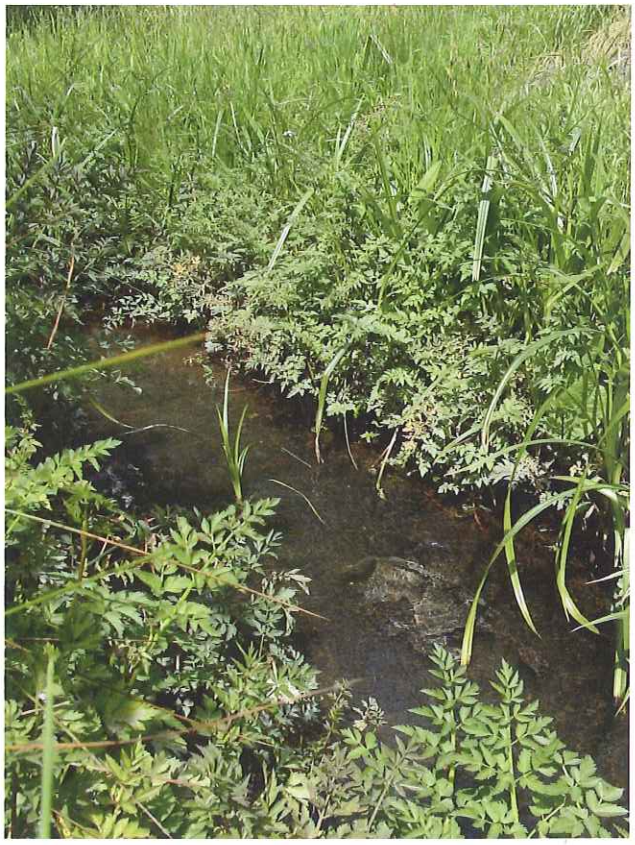
Restoration Project." This project was designed to continue Arcata's efforts to improve water quality and fish habitat, as well as to stop flooding of Alliance Road (adjacent to Jolly Creek). In 1999, the City of Arcata with the help of a California Department of Fish and Game (DFG) grant, completed the Dellanina Nature Area on the Jolly Giant Creek, located just west of Alliance Road. This area created a high-flow channel/backwater wetland. With this diversion they removed 15,000 yards of soil to widen the stream banks, added logs to the river channel, and planted native riparian plant species. In addition, the culvert under the railroad tracks was replaced and was set a foot below grade to allow easier fish passage. The primary goal of the diversion marsh was to eliminate flooding of Alliance Rd, while reducing sediment loads during high flows and creating beneficial native fish habitat (Coho Salmon and Steelhead Trout) through riparian enhancement. As a stipulation of the grant received from DFG, monitoring was required after completion of the diversion marsh. Currently the City of Arcata would like to understand how this channel affects water quality and if in fact, native fish habitat has or has not been improved by the Dellanina restoration project.

(Picture #1; Jolly Giant Creek mile marker at Dellanina site)

2 Dellanina Nature Area Monitoring Project Description

Our ENVS 410 senior project focused on studying the Dellanina Nature Area's effect on improving water quality and fish habitat with regard to Jolly Giant Creek. This essentially entailed that we conduct a three month-long water quality monitoring project with respect to three pre-chosen sites in this section of Jolly Giant Creek alongside Alliance Rd. It was already known to the City of Arcata that the diversion marsh had been quite effective in stopping the flooding of Alliance Rd. after major storm events. What was still unknown was whether the diversion marsh had improved water quality and fish habitat within Jolly Giant Creek. In order to answer this question:

Our group monitored the creek at a site before the diversion marsh, labeled as Site #1



(Picture #2: overhead photograph of the first sampling site)

We then chose a site within the diversion marsh itself, labeled as Site #2

(Picture #3: overhead photograph of the second sampling site)

Last, we chose a site after the diversion marsh flow mixed with the un-diverted portion of the creek, labeled as Site #3

(Picture #4: overhead photograph of the third sampling site)

This essentially allowed our group to obtain a good idea of what the creek's water quality looked like before the city intervened with the marsh (Site #1), then we compared those parameters to what was going on within the marsh itself (Site #2), and last, we looked at whether or not the overall water quality was improved when the two water columns mixed together at the third monitoring site (Site #3).

Our monitoring group obtained general, base-line data for the three chosen sites in the creek. The purpose of this was to obtain the general water quality parameters associated with these three sites in the absence of a storm, or any form of precipitation. The basic water quality parameters that we measured for our baseline data and during storm events were: temperature, pH, conductivity, turbidity, dissolved oxygen (DO), and total suspended solids (TSS). We wanted to find out to what effect these storm events had on water quality of the creek and the marsh, and whether or not fish could survive in the

diversion marsh before, during, and after a particular storm. In addition, we were also able to re-affirm the city's assertion that the diversion marsh had been successful concerning the prevention of the flooding of Alliance Rd. due to an overflow from the creek during a storm. In the discussion portion of our analysis of the Dellanina project area, we compared our data from the three tested sites to known published water quality parameters, which effectively identified beneficial Coho Salmon and Steelhead Trout habitat. The effectiveness of the nature area was assessed through a holistic process, involving the comparison of our assessment of the effectiveness of the diversion marsh with potential options for improving its design in order to meet the original goals of the City of Arcata.

3 Goals and Objectives of Monitoring Project

- **Goal #1:**

  To analyze the effectiveness of the Dellanina Nature Area along Jolly Giant Creek with regard to general water quality and fish habitat.

  Associated Objectives:

  Test all three sites for water quality parameters, including temperature, pH, conductivity, turbidity, DO, and TSS.

  Compare all obtained water quality data to published values for "ideal habitat and water quality conditions."

- **Goal #2:**

  To develop a streamlined template for future implementation of such storm water diversion marshes that simultaneously improve water quality and fish habitat.

  Associated Objectives:

  To present a clear template for constructing future related projects that can be easily understood and followed.

  To show the feasibility of a storm-water diversion marsh for other parts of Jolly Giant Creek, or other creeks in northern Humboldt County.

  To identify which physical/environmental conditions need to be present in order to warrant the need for a storm-water diversion marsh.

Goal #3:

If our data were to identify that there has not been any significant improvements concerning the overall water quality and fish habitat of the Dellanina project area, we will issue specific recommendations for helping the City of Arcata to meet their original goals associated with the construction of the diversion marsh.

4 Alternatives for Improving the Dellanina Nature Area

Brainstorm of Alternatives:

1. Monitoring of overflow diversion depth.
2. Monitor project sites up-stream.
3. Monitor two project areas and compare results.
4. Monitor other similar city creek projects.
5. Using biological oxygen demand (BOD), to determine stream life carrying capacity.
6. Work with fisheries department to do total fish count.
7. Perform alkalinity and hardness analysis.
8. Perform organic matter analysis (nitrate, ammonia, phosphate)
9. Perform coliform counts (both fecal and total).

Alternatives rejected:

Alternatives 1-6 were rejected on the basis of lack of time and resources. Alternatives 7-9 were rejected because they did not meet our goals and objectives; they are not pertinent with regard to fish habitat.

Detailed look at alternatives:

Alternative A: Smaller Project

Three sites would be monitored along Jolly Giant Creek. The first site is approximately 15 feet before the diversion. The second site is as close to the middle of the diversion as possible. The last site would be after the diversion and creek main channel water columns have recombined approximately 10 feet down stream.

These sites will be monitored for water quality parameters after each storm event (rain for 2+ hours). The monitoring will occur at the same time every day. The parameters measured include: conductivity, temperature, and dissolved oxygen.

After data has been collected it will be analyzed to establish the effectiveness of the diversion. Diversion results will be compiled and presented to the city by way of power point presentation.

Alternative B: Medium Project *[Our Choice]*

Three sites would be monitored along Jolly Giant Creek. Site one is approximately 25 feet before the diversion, marked by a boulder protruding into the main creek channel. Site two is within the diversion, directly across from the large three-stem tree. The final and third site is approximately 15 feet after the creek has recombined into the main channel. The water level will also be measured by means of a yard stick inserted into the culvert before the creek crosses Alliance Road in order to determine the flow rate of the creek.

These sites will be monitored for water quality parameters after each storm event (rain for 2+ hours). The monitoring will occur at the same time every day. The parameters measured include: total solids, dissolved oxygen, pH, turbidity, conductivity, and temperature.

After data has been collected it will be analyzed to establish the water quality effectiveness of the diversion. Data will also be compared to optimum Coho and Steelhead habitat. Diversion results will be compiled and presented to the city by way of power point presentation.

Alternative C: Large Project

The same three sties would be monitored as shown for Alternative B, as well as three additional sites upstream. The additional site to be monitored include: site 4, which is 10 feet before the upstream diversion; site 5, directly in the middle of the upstream diversion; and site 6, 10 feet after recombination of creek.

The water level will also be measured by means of a yard stick at three different sites: site (a) is in the middle of the upstream diversion; site (b) is inserted into the culvert before the creek crosses Alliance Road; and site (c) is in the middle of the Dellanina Diversion.

These sites will be monitored for water quality parameters after each storm event (rain for 2+ hours). The monitoring will occur at the same time every day. The parameters measured include: total solids, dissolved oxygen, pH, turbidity, conductivity, and temperature.

After data has been collected it will be analyzed to establish the water quality effectiveness of each diversion as well as used to compare/contrast each diversion. Data will also be compared to optimum Coho and Steelhead habitat. Diversion results will be compiled and presented to the city by way of power point presentation.

5 Monitoring and Evaluation Plan for Future Monitoring of Project Site

The implementation and monitoring for this project is based on two factors: the recommendations made for the city by our monitoring group, and further assessments of other wetland diversions in the Arcata area. The recommendations made will be monitored based on if they are accepted and acted upon by the City of Arcata, or if our advice/data was disregarded. Further monitoring should occur if in fact our recommendations were taken into consideration and implemented. This would involve a sampling regime for all the water quality parameters that we previously tested for. In specific, concerning dissolved oxygen, future monitoring groups would have to use the same time of day to sample for this parameter as our group used (13:00-14:00) in order to maintain accuracy. The implementation/monitoring aspect of further assessments will probably involve future ENVS 410 students. Future monitoring done by other students should occur as a storm related monitoring regime during those times precipitation is highest in the fall, winter and spring. In addition, future baseline data for our three pre-chosen sampling sites should be continually monitored throughout all seasons. Unfortunately, our group only obtained data from February to April of 2004. Thus, we are lacking storm and baseline data associated with all other months of the year. This is one of the main reasons for the need of future monitoring projects associated with the Dellanina Nature Area in order to find out if in fact water quality and fish habitat has been improved by the city's diversion marsh project year-round.

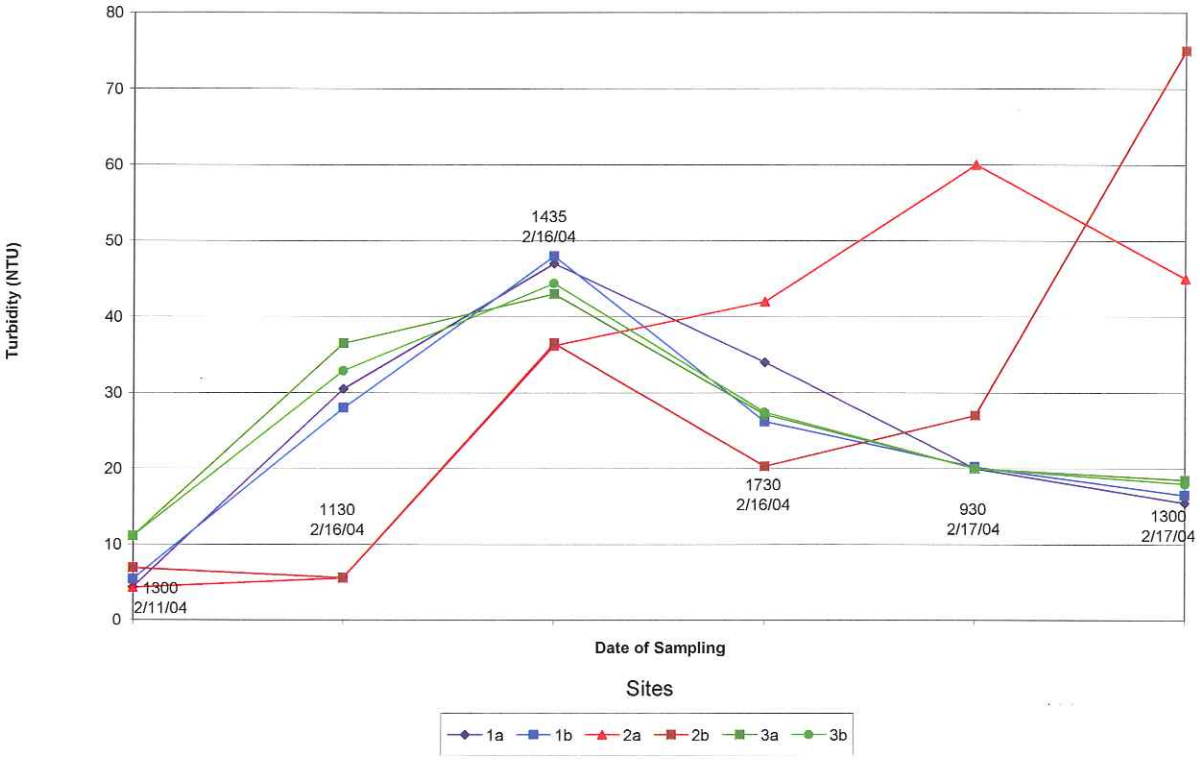


Table 2: Turbidity readings from sites 1a, 1b, 2a, 2b, 3a, 3b; between 2/11/04 and 2/17/04. Turbidity values increased over the first 3 sample dates. Sites 1 and 3 saw a decrease in turbidity and site 2 saw an increase in turbidity.

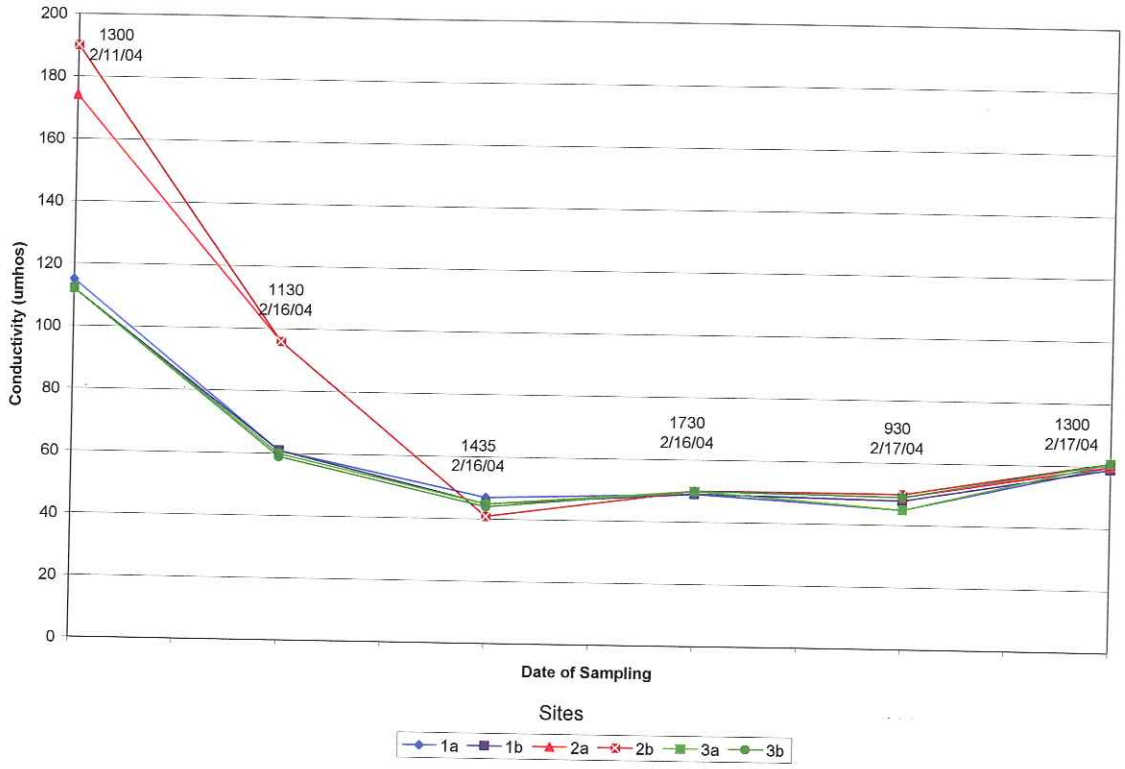


Table 3: Conductivity readings from sites 1a, 1b, 2a, 2b, 3a, 3b; between 2/11/04 and 2/17/04. Conductivity values all saw a steady decrease over the sampling regime. No sites showed alternate bahavior.

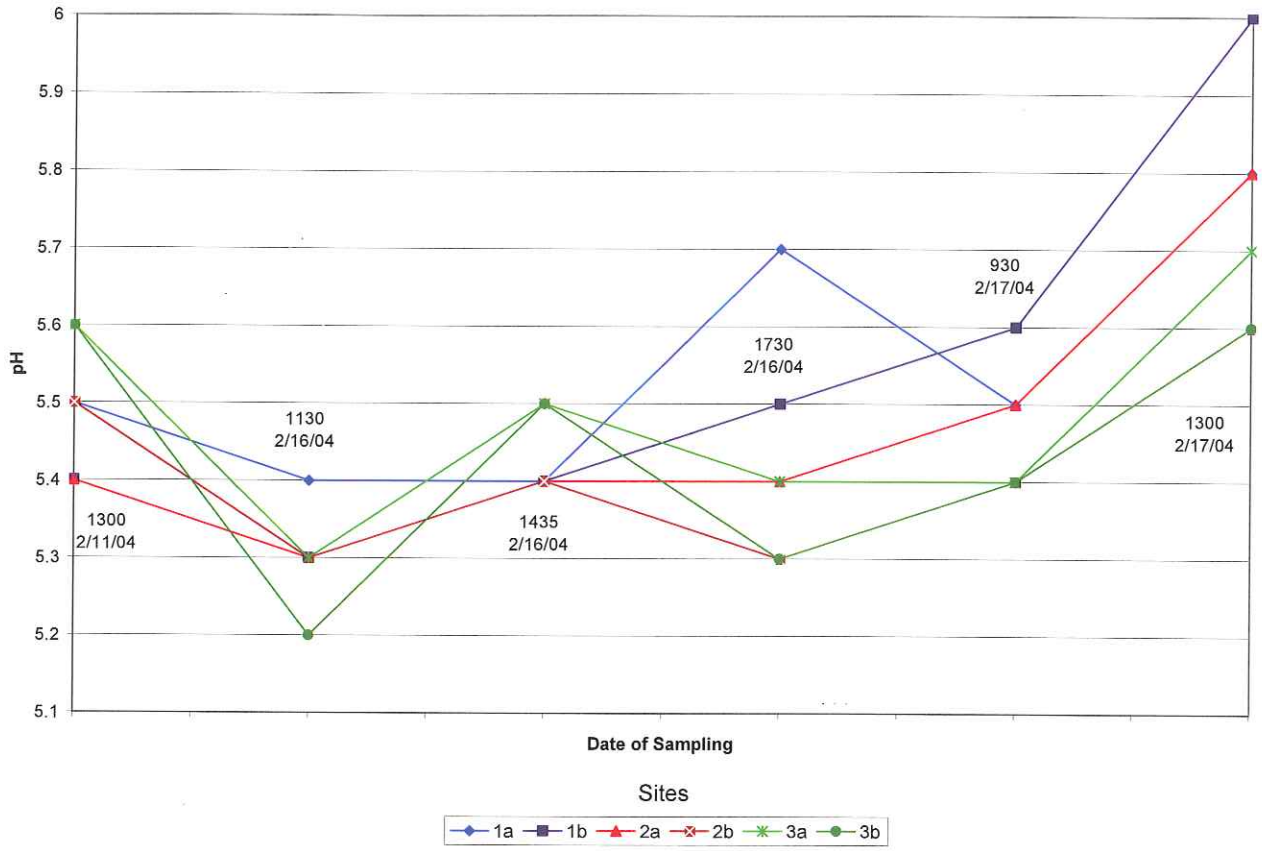


Table 4: pH readings from sites 1a, 1b, 2a, 2b, 3a, 3b; between 2/11/04 and 2/17/04. pH values increased over the sampling regime. No sites showed alternate behavior.

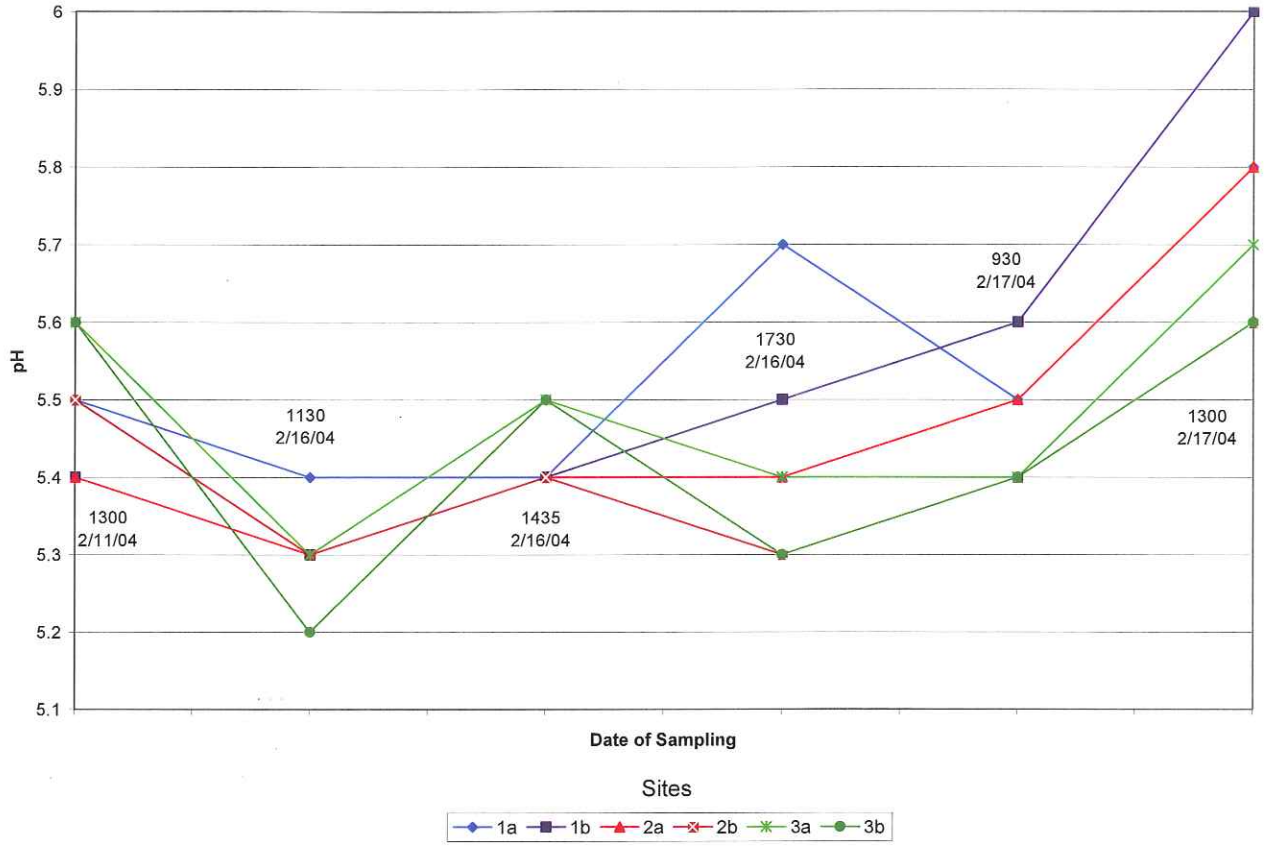


Table 4: pH readings from sites 1a, 1b, 2a, 2b, 3a, 3b; between 2/11/04 and 2/17/04. pH values increased over the sampling regime. No sites showed alternate behavior.

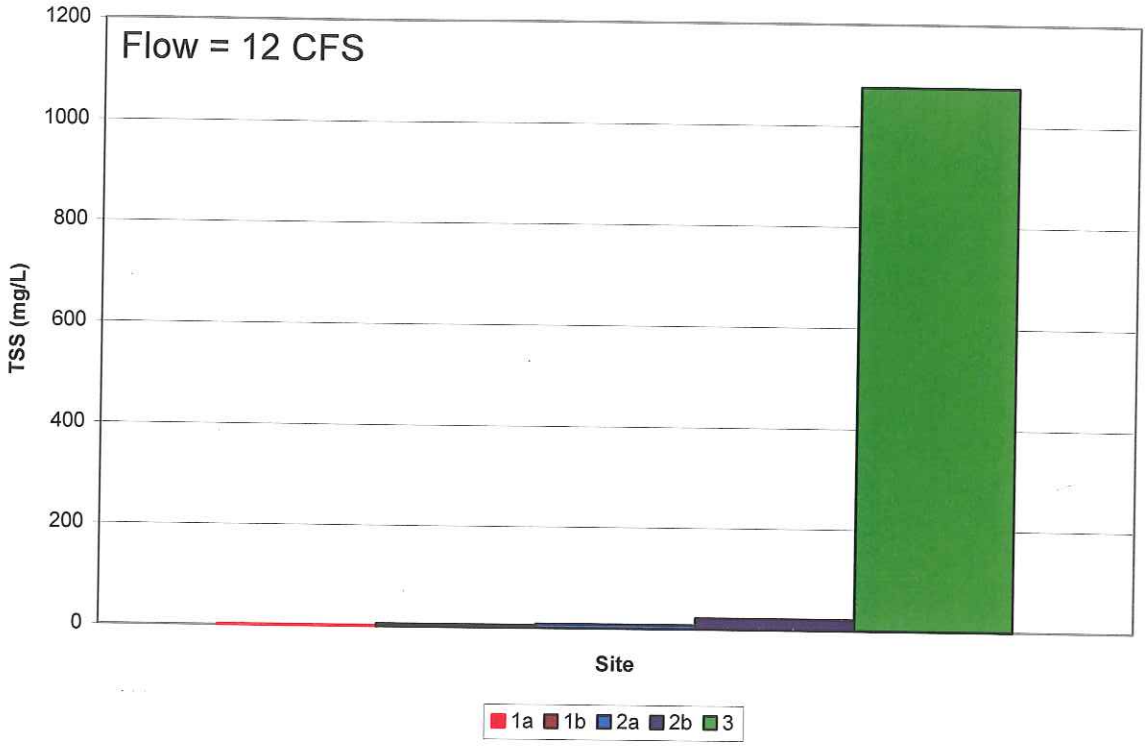


Table 5: Baseline Total Suspended Solids (TSS) data from sites 1a, 1b, 2a, 2b, 3a, 3b; 2/11/04. Site 3 has a distorting effect on the other data.

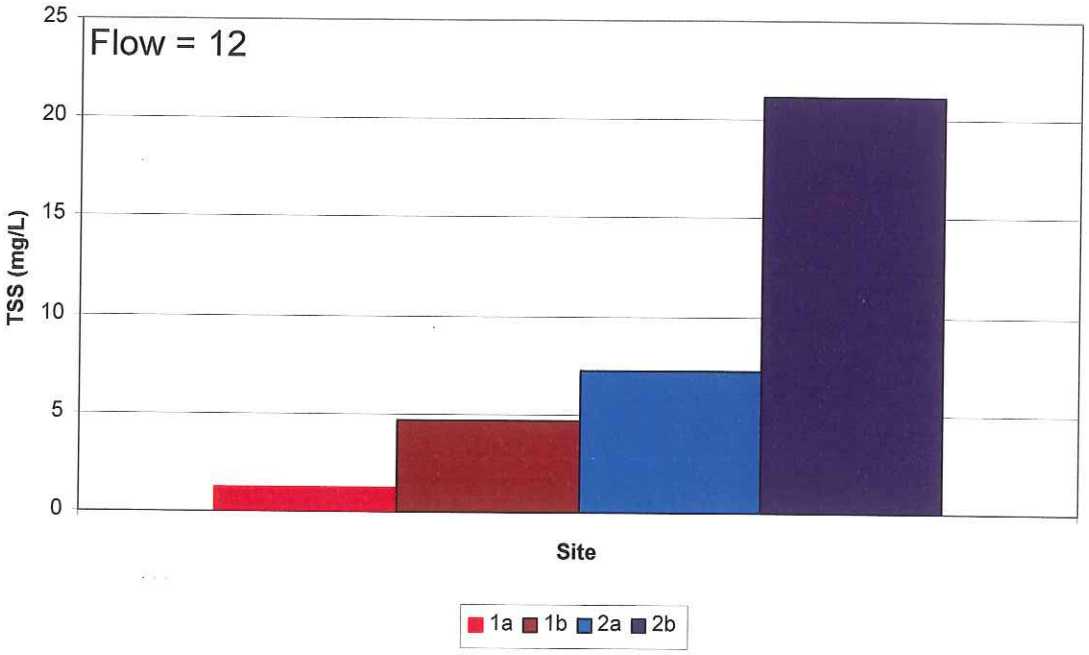


Table 6: Baseline Total Suspended Solids (TSS) data from sites 1a, 1b, 2a, 2b (without sample sites 3a and 3b); 2/11/04. Baseline data showing site 1 with less solids than site 2.

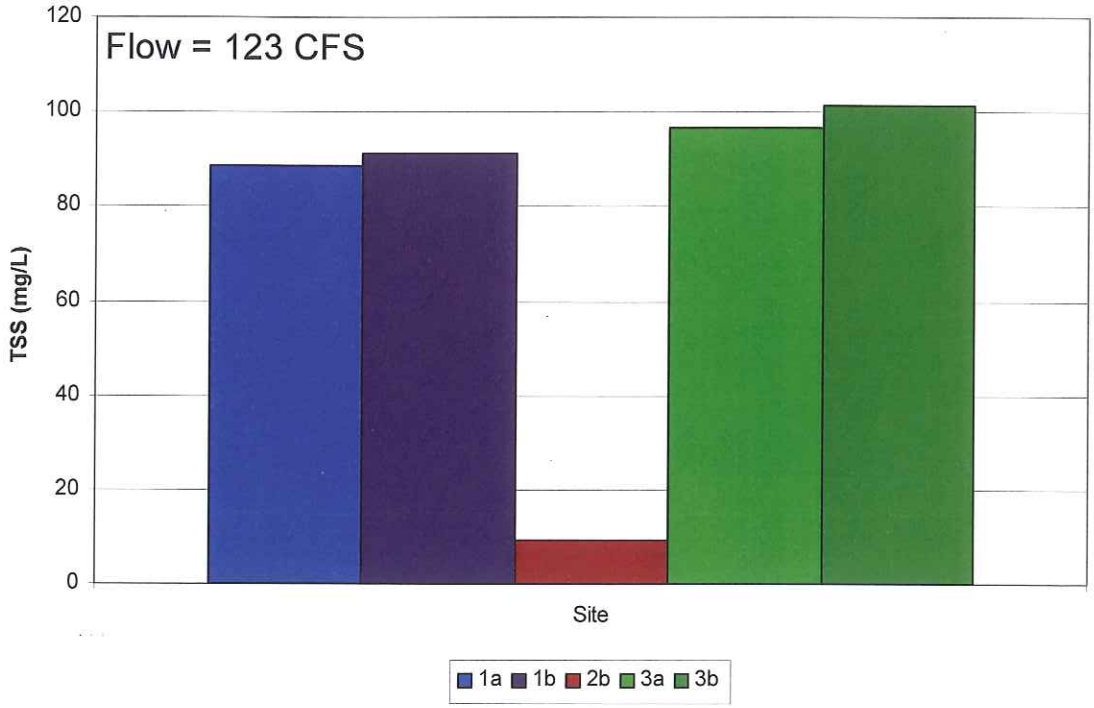


Table 7: Total Suspended Solids (TSS) data from sites 1a, 1b, 2b, 3a, 3b; 2/16/04 at 11:30. Sites 2 and 3 are much greater than site 2 at 123 CFS.

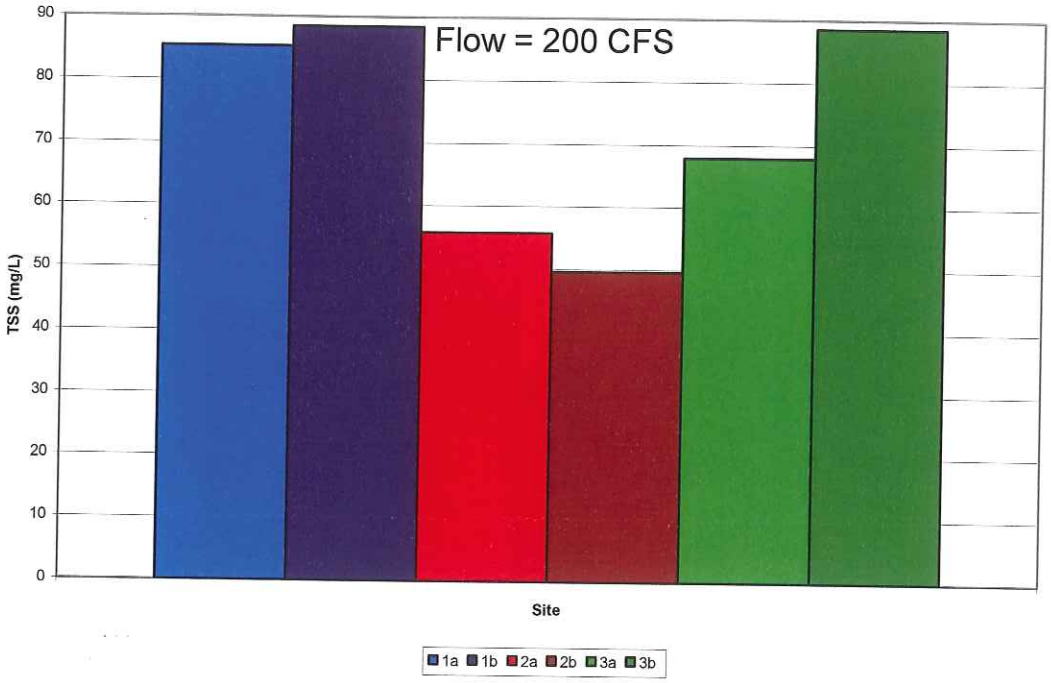


Table 8: Total Suspended Solids (TSS) data from sites 1a, 1b, 2b, 3a, 3b; 2/16/04 at 14:30. Sites 2 and 3 slightly higher than site 2 at 200 CFS.

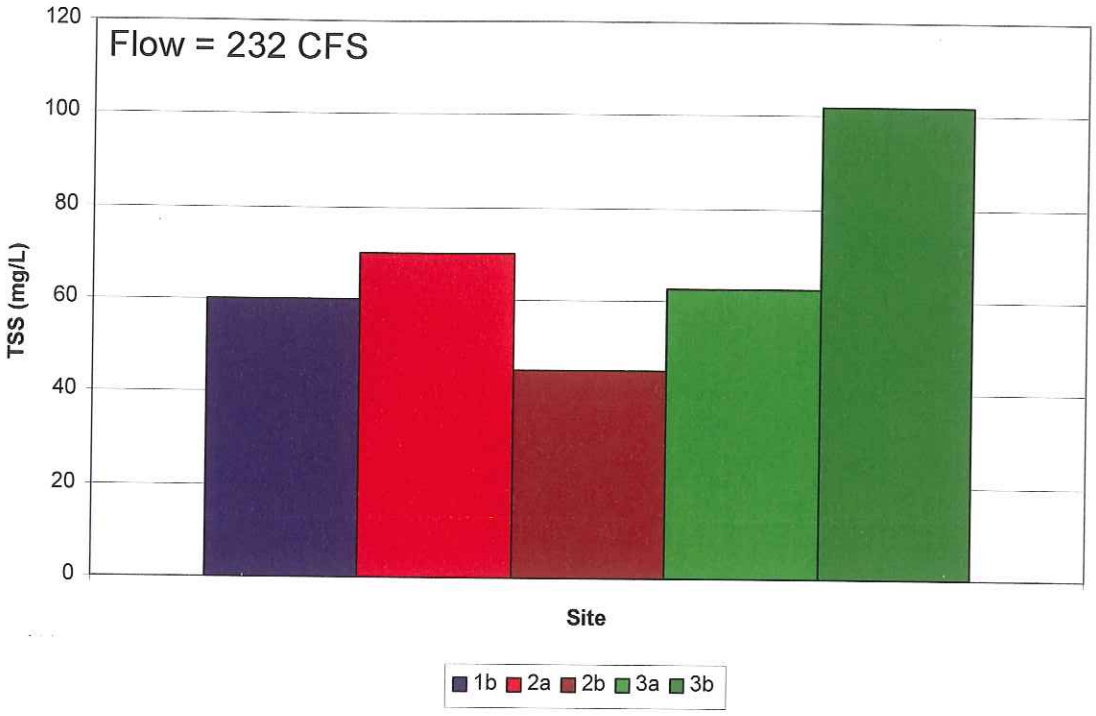


Table 9: Total Suspended Solids (TSS) data from sites 1a, 2a, 2b, 3a, 3b; 2/16/04 at 17:30. All sites about equal at 232 CFS.

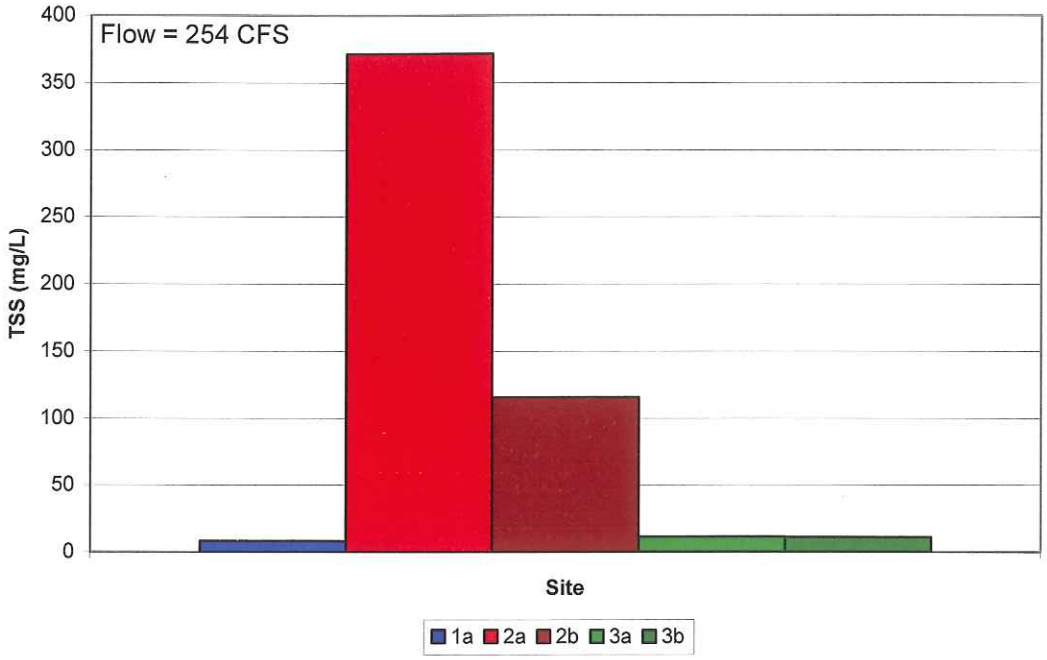


Table 10: Total Suspended Solids (TSS) data from sites 1a, 2a, 2b, 3a, 3b; 2/17/04 at 13:00. Site 2 much greater than sites 1 and 3 at 254 CFS.

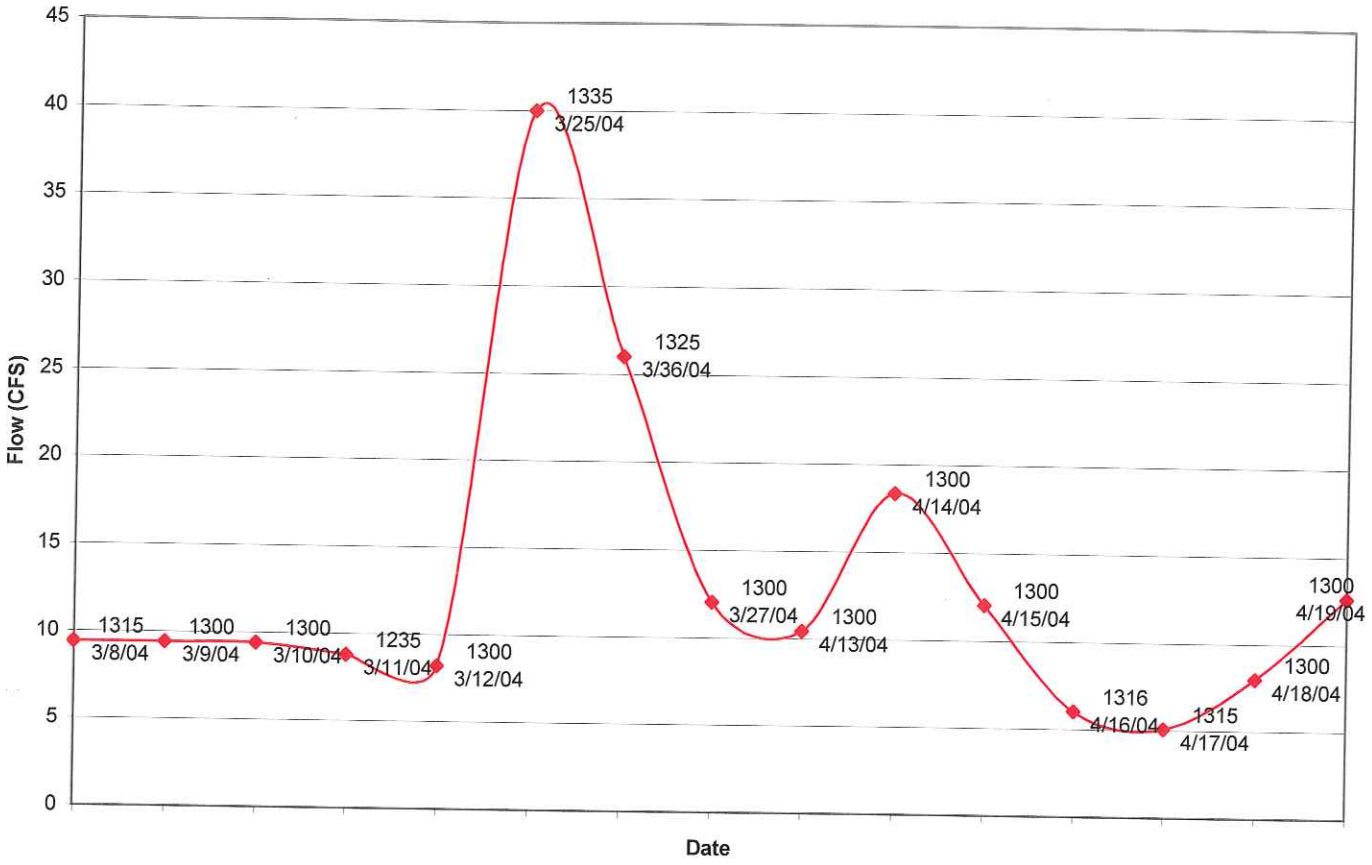


Table 11: Interpolated flow between 3/8/04 and 4/19/04/04. The flows on JGC reacted expectedly to storm events as the sampling regime progressed giving us a variably sloping curve. We are able to use this curve to determine what behavior the other water quality parameters exhibit.

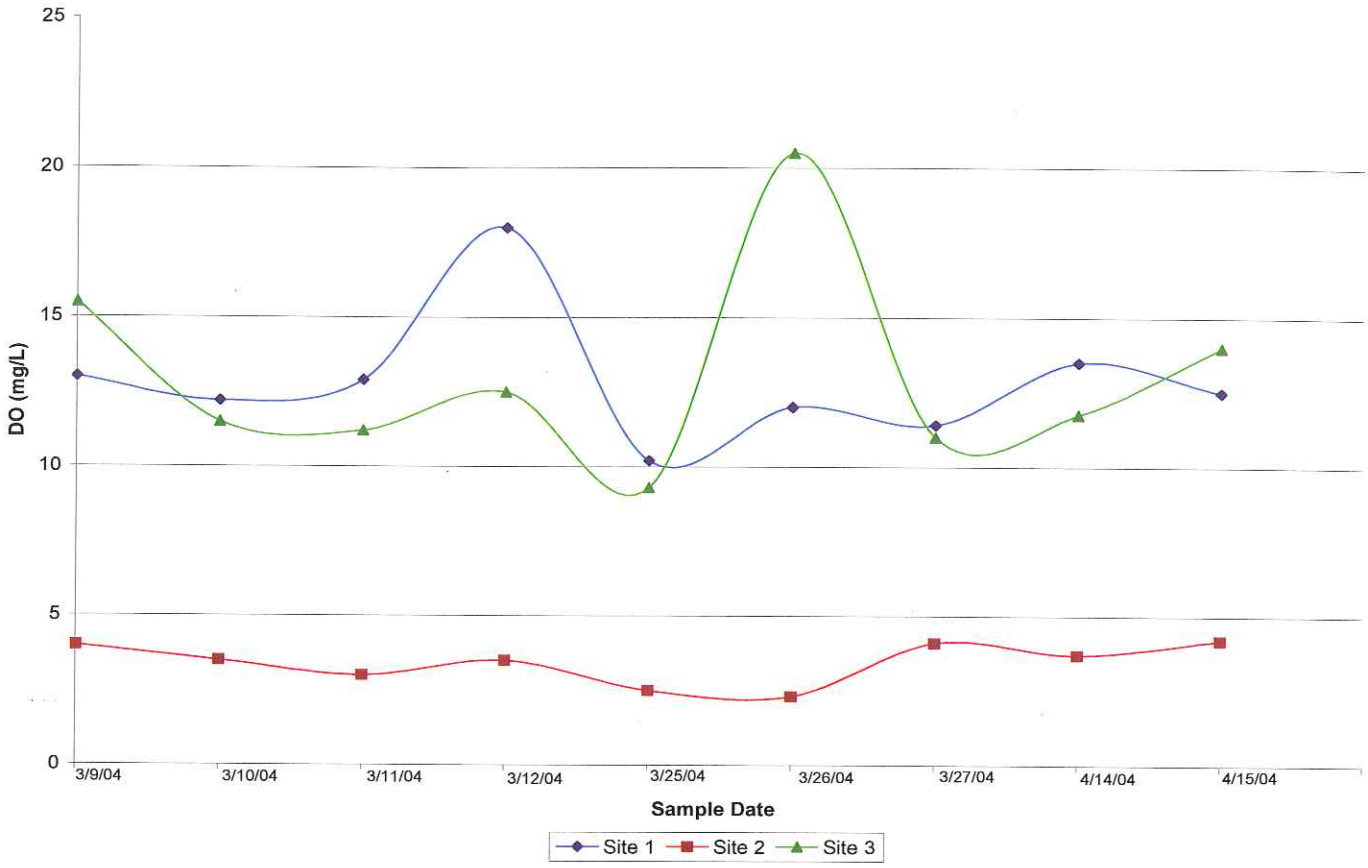


Table 12: Dissolved Oxygen (DO) data from sites 1, 2, 3. All data obtained between 3/09/04 and 4/15/04 at 13:00 each day.

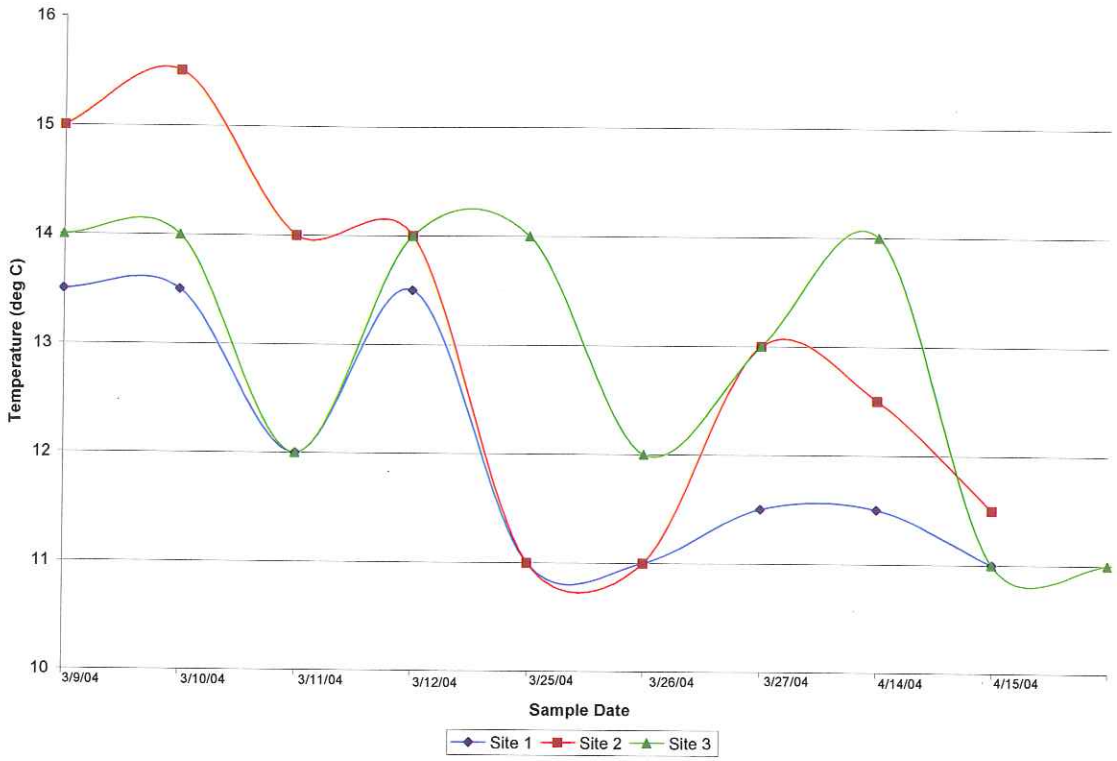


Table 13: Temperature readings associated with Dissolved Oxygen (DO) data from sites 1, 2, 3. All data obtained between 3/09/04 and 4/15/04 at 13:00 each day.

7 Discussion of Results

Water Quality

The Dellanina Nature area on Jolly Giant Creek is classified as cold freshwater habitat according to the regional water quality control board (RWQCB). This habitat is characterized generally with low temperature, <15 degrees C and high DO, >6 mg/L. It is good habitat for many freshwater invertebrates, salmonids, and other wildlife. The plants and animals that live in these habitats are sensitive to minor changes in habitat and water quality. The water quality of the Dellanina nature preserve was assessed through the following parameters.

Flow

Flow was back-calculated from a depth measurement taken during each sampling. This is the background data used to base all other parameter's behavior on. The flow had some predictability in when it rained flows increased but not always immediately. There was some lag time between rain and full flows. Our samples were not taken at often enough intervals to determine the lag time

Total Suspended Solids

Total suspended solids are those solids, not dissolved, which are readily filtered out of a sample of water. They give a general measure in mg/L of the sediment load in a sample. The data used for our TSS calculations had some holes. A number of the filter paper weights, used to determine sediment, were misplaced. This effected about 1/3 of our overall results. The total data there is enough to show trends in sediment loads, but not enough to go show any sort of detail. The data recorded between the 3 sites in our storm related monitoring of sediments showed that the diversion did indeed work for its intended purpose of reducing sediment load in the stream as flow increases. The difference is obvious between the sample taken on 2/16/04 at 1130 (123 CFS) and the sample taken on 2/17/04 at 1300 (234 CFS). The TSS values for sites 1&3 were around 80-100 mg/L while sample site 2 had a value about 10 mg/L at 123 CFS. At 234 CFS sites 1&3 had decreased to around 10 mg/L while the diversion (site 2) had sediment

levels upwards of 100 mg/L. The first sample (2/11/04) has an erroneous value for site 3. Low water levels caused us to get sediments from the stream bed in the sample bottle/ This shows that as flow rates go up the amount of sediment in the main channel decreases while the diversion has an increase of sediment load effectively working as a sediment trap.

Conductivity

Conductivity is the measurement over a membrane of the electrical conductive capacity of a water sample. Conductivity is measures in umhos. As the graph shows conductivity values decreased overall as flows went up. This follows as there is more sediment in the water decreasing its electrical potential.

pH

pH is the negative log of the concentration of hydrogen ions in a sample of water. It is generally thought of as determining whether a water sample is basic (high pH) or acidic (low pH). The pH of waters in the local area is naturally low. This is due to a low alkalinity, buffering capacity of water, and a large amount of coniferous plants contributing to acidic soils. The RWQCB recommends a pH of 6-9 for cold water habitat. Only when flows were the highest did the pH values recorded in all three sites come close to attainment of these standards. This is not good for fish habitat, but there not much in the way of habitat restoration to improve this. Mainly a non-point source needs to be identified for the abundance of hydrogen ions.

How do the numbers compare to other coastal streams?

Turbidity

Turbidity is the measurement of how perturbed a water sample is, and is measured from the light diffraction of the sample in a column. Turbidity is measured on a nephalometer and is measured in NTU. The values for turbidity mimicked the sediment results. As the flow went up at first all sites saw an increased turbidity, but over time turbidity in sites 1 and 3 went down while turbidity in site 3 increased. This further exemplifies that the diversion acted as a sediment trap.

Dissolved Oxygen

Dissolved oxygen, or DO, is the concentration of oxygen in the water column. It is highly influenced by temperature and the concentration is based on how near to total saturation a sample it. DO is measured in mg/L. The samples show how DO is definitely effected by flow. The RWQCB recommend values no lower than 6mg/L as a minimum for cold water fish habitat. Sites 1 and 3 stayed above this value the entire duration of sampling while site 2 stayed below this action level. Looking at the diversion as beneficial to fish habitat is not valid, something would have to change in order for fish to be able to survive in the backwater diversion.

Temperature

Temperature is measured with DO because the temperature of a water sample highly affects the DO. As temperature goes up DO goes down and visa versa. Temperature was slightly variable between sampling dates but overall it seemed as though the higher flows had lower temperatures…probably because of a shorter residence time in the stream.

Problems

There were many problems involved in our process that inhibited fully reaching our goals and objectives. On the first sample taken, 2/11/04, water levels were too low to get an effective baseline reading. Too much bottom sediment ended up in our sample bttles and skewed results. The water sample 2a from2/16 at 1130 was dropped in the lab. When weighing and recording sediments, the final filter weight for many filters above filter #67 were misplaced. This accounted for a loss of almost 1/3 of our data severely limiting the amount of interpretation involved in the TSS discussion. We also lost all data, except conductivity, from the sample taken on 2/12/04. These lab errors helped the group learn the future importance of practicing proper lab skills. When interpreting/comparing the data we found there was no baseline data. No monitoring was performed on the creek site before remediation; thus, no improvement can be definitively shown.

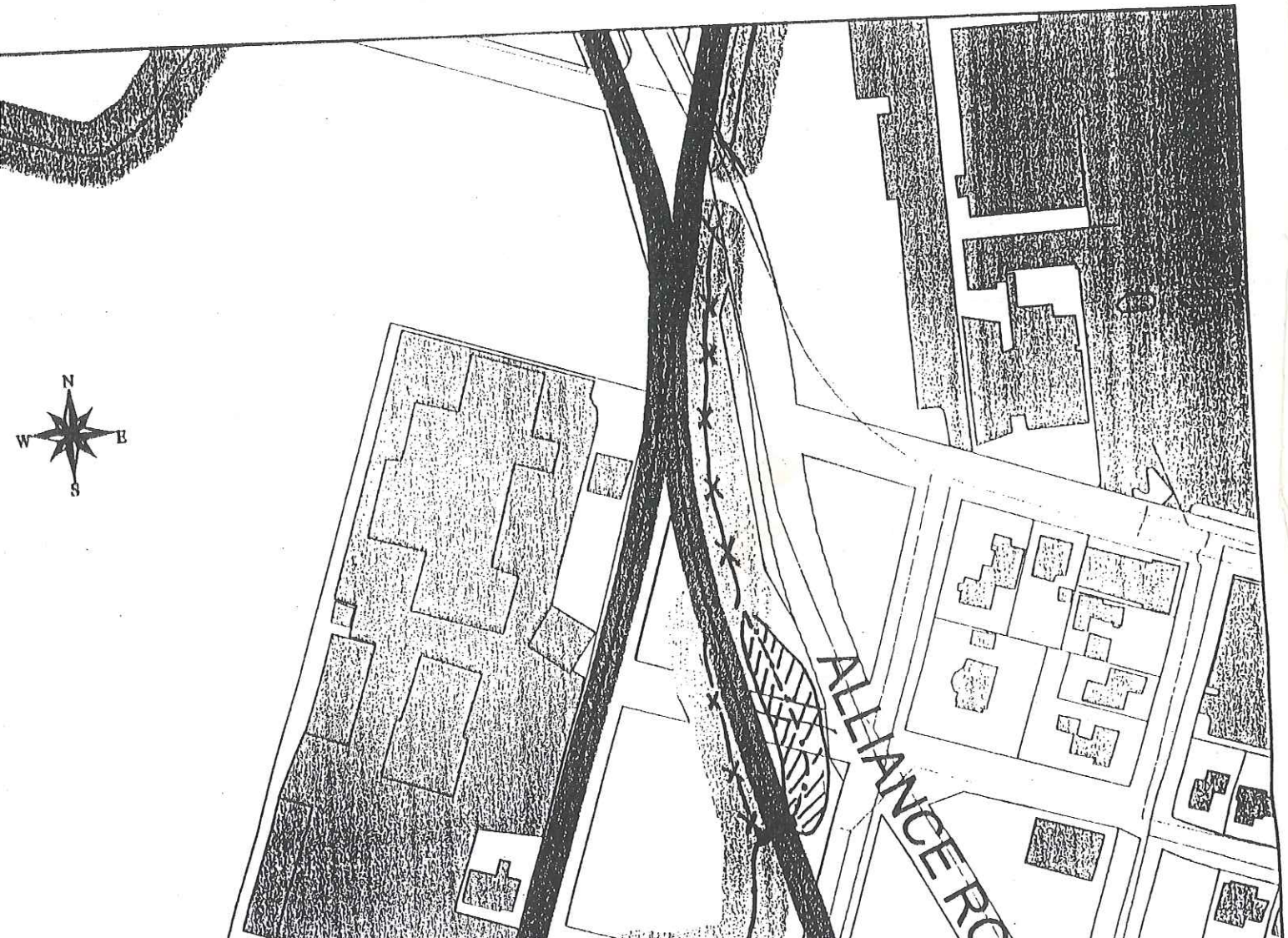
8 Conclusions and Future Recommendations

The parameters that most affected the streams ability to support Coho Salmon and Steelhead Trout, DO, temperature, and pH were supportive of the idea that the creek is cold water freshwater habitat. The pH values were low but that is an anomaly of this geographical area. The data did not support the idea that the backwater diversion is beneficial salmonid habitat. The diversion only helps improve the sediment load of the stream. It does not improve temperature, pH, or DO.

Our recommendations to the city regarding the diversion would be to further alter the habitat to be beneficial to fish. This would involve increasing the flows through the diversion in order to keep DO and temperature levels higher, while maintaining the diversions ability to minimize flooding on Alliance Rd. Increasing the flows would be a combination of: increasing the size of the inlet, split flow so flows are 50% in the diversion and 50% in current streambed, and increasing grade of the diversion to decrease residence time. This diversion was effective in removing sediment and also for flooding. If those two are primary problems in a similar project area it would be who of the city to go forward with another of its like. We feel that if done in the future the city needs to have baseline data for these restoration sites and monitor more of the results.

By slowing the water down in the diversion, sediment is dropped. Will your measures result in increased sediment in the main stream?

DELLANINA - JOLLY GIANT CREEK
FISH HABITAT
AND
RIPARIAN RESTORATION PROJECT



Appendices

Appendix #1: Map of Dellanina Nature Area, including the three sites where we took water quality samples

Appendix #2: Materials and Methods

Sites were selected after consulting with Dr. Margaret Lang, a water quality professor at Humboldt State University. The sites were selected according to their location along the Creek in relation to the diversion and easily referenced landmarks. The first site is located next to the log structure approximately feet from the western Alliance Rd. culvert. The second site is located directly across from the largest tree along the western bank in approximately the middle of the diversion. The third site is located approximately 20 feet after the diversion merges with the main channel; there is an opening in the riparian vegetation at that site.

Baseline data was collected for total suspended solids, conductivity, pH, and turbidity during a sunny week on February 11, 2004.

Baseline data was collected for dissolved oxygen (DO) and Temperature, during a sunny week on March 9, 2004.

Water height was measured to extrapolate the flow of the creek using calculation bellow:

$$Q = \frac{1.49}{0.013} * A * R_h^{2/3} * 0.013^{1/2}$$

$$A = \frac{1}{8} * (\theta - \sin\theta) * d_0^2$$

$$R_h = \frac{1}{4} * (1 - \frac{\sin\theta}{\theta}) d_0$$

Q = flow rate in cubic feet per second (CFS)
A = intermediate variable
R_h= intermediate variable
Θ = water elevation angle in radians
d_0= diameter of culvert
Note: Our culvert was ellipsoidal (42"x60") and to account for this difference a circular culvert with the nearest area (d=50") was estimated.

The height was measured to the nearest 16^{th} of an inch using a yardstick inserted parallel with the flow during each monitoring (identified on map, Appendix #1).
Two sample bottles were taken at the three sites. The volume of each sample bottle ranged from 0.40 Liter (L) to 0.95 L. The samples were then either taken directly back to the lab, or taken to a house, and put into a refrigerator for future analysis.

Conductivity was measured using a YSI Model 33 S-C-T Meter. The probe was rinsed with deionized water between each sample. The probe was immersed in the sample bottles and gently oscillated.

PH was measured using an Oorning pH meter model 57. The process is almost identical to the conductivity process shown above. The probe was rinsed with deionized water between each sample, then immersed in the sample bottle and gently oscillated.

Turbidity was measured in the laboratory using a Turbidimeter HF Scientific DRT 100B. A small amount of the sample was used to rinse the vile; it was then filled near the top and loaded into the turbidimeter. The reading was recorded after four seconds had passed.

Sediment samples were taken and evaluated according to the following method: http://www.fs.fed.us/psw/topics/water/tts/manuals/sedlab_manual.doc

The membrane filter technique used was from Standard Methods to analyze total suspended solids. Sample bottles were weighted before and after filtering to derive filtered volume.

After February 18, 2004 above monitoring ended. Beginning March 9, DO, temperature, and additional water height measurements were taken until April 13, 2004.

The DO and temperature analysis was completed on site using a YSI oxygen meter model 7. Monitoring was conducted between 1 and 2pm during storm events. The oxygen meter was first calibrated in the lab using an air stone inserted into a beaker of deionized water. The probe was covered with a wet paper towel and taken to the sites. The probe was fully inserted into the creek channel at each site and gently oscillated while taking both temperature and DO readings. Water height measurements were taken as described above.

Appendix #3: Implementation strategy for monitoring project

Monitoring: Complete by 4/15/04
- Rick
- Meredith
- Chris

Obtain Information for the History of Project: Complete by 4/12/04
- Meredith

Calculations associated with Monitoring Data: Complete by 4/12/04
- Rick

Locate Data associated with Proper Coho/Steelhead Habitat: Complete by 4/15/04
- Rick

Meeting with Mark/Matt/Julie: Complete by 4/19/04
- Rick
- Meredith
- Chris

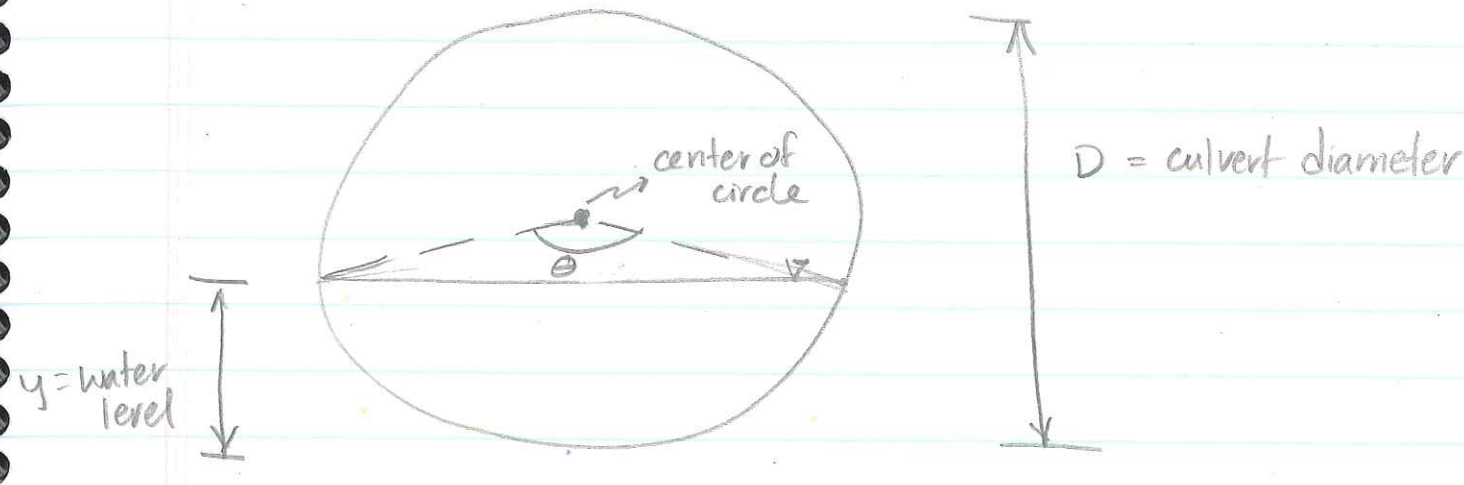
Meeting with Robert Gearhardt: Complete by 4/19/04
- Chris
- Rick

Obtain Digital Photographs of the Dellanina Project Area: Complete by 4/23/04
- Chris

Evaluate our Results and Formulate Final Paper: Complete by 5/1/04
- Rick
- Meredith
- Chris

Formulation of Final Presentation: Complete by 5/3/04
- Rick
- Meredith
- Chris

Estimating flow in a culvert w/circular cross-section



θ = water elevation angle in radians

$$Q = \frac{1.49}{n} A R_h^{2/3} S_o^{1/2}$$

S_o can measure probably close to 0.03

$n = 0.013$

$$A = \frac{1}{8}(\theta - \sin\theta) d_o^2$$

$$R_h = \frac{1}{4}\left(1 - \frac{\sin\theta}{\theta}\right) d_o$$

Appendix #4b

Date Sampled	Time	Site	Dup	Conductivity (umhos)	pH	Turbidity (NTU)
2/11/2004		1	a	115	5.5	4.34
			b	112	5.4	5.38
		2	a	174	5.4	4.31
			b	190	5.5	6.9
		3	a	112	5.6	11.1
2/12/2004	1445	1	a	115		
			b	112		
		2	a	179		
			b	190		
		3	a	112		
			b	112		
2/16/2004	1130	1	a	61	5.4	30.5
			b	61	5.3	28
		2	b	96	5.3	5.6
		3	a	60	5.3	36.5
			b	59	5.2	32.9
	1435	1	a	47	5.4	47
			b	45	5.4	48
		2	a	41	5.4	36.2
			b	41	5.4	36.5
		3	a	45	5.5	43
			b	44	5.5	44.4
	1730	1	a	49	5.7	34
			b	49	5.5	26.2
		2	a	50	5.4	42
			b	50	5.3	20.3
		3	a	50	5.4	27.1
			b	50	5.3	27.4
2/17/2004	930	1	a	45	5.5	20
			b	48	5.6	20.2
		2	a	49	5.5	60
			b	50	5.4	27
		3	a	45	5.4	20
			b	49	5.4	20
	1300	1	a	60	5.8	15.5
			b	59	6	16.5
		2	a	60	5.8	45
			b	61	5.6	75
		3	a	61	5.7	18.5
			b	61	5.6	18

Appendix #5: Permitting and legal requirements flow chart

The Dellanina project was authorized under the law according to 33 C.F.R. § 1344.

To have a proposed project approved, and to obtain the necessary permits the following template may be followed.

- First a detailed project description should be written up by the city, and approved by the city council. This should included a background of the area/issue(s), the objective of the project, description of the project site, an estimated budget, and an estimated schedule, as well as any other pertinent information.

- If the project site incorporates any privately owned land, a land owner consent agreement must be filled out.

- Any grants that are being requested should be filled.

- A pre-construction notification needs to be sent to the nearest district of the Army Corps of Engineers. If approved, permit will be granted with specific permit number and conditions that must be followed to insure compliance. Approximate permit price $250.00.

- Contact nearest region of the Department of Fish and Game (DFG) to receive notification form to be filled out concerning stream/lake alteration. Project will be assigned a warden to review the project in order to assure compliance with the California Environmental Quality Act (CEQA) (Pub. Resources Code §21000-21177). Approximate permit cost $132.00.

- If necessary authorization certificates may needed to be obtained from CA Regional Water Quality Control Board, North Coast Region. As well as from the CA Coastal Commission.

- If hiring a contractor, there are special provisions including insurance requirements, as well as signing a list of conditions, agreements etc.

- Finally after the project has been completed there will usually be a "Certification of Completion" form that will need to be signed and returned to the permitting agencies.

Appendix #7: References

http://www.watershedrestoration.water.ca.gov/urbanstreams/pastproj/projreview.cfm

http://www.huduser.org/periodicals/fieldworks/1201/fworks5.html

http://students.washington.edu/strange/intro.htm

http://notes.tetratech-ffx.com/newsnotes.nsf/0/6374b9d7c0fbd628852566ac006a6826?OpenDocument

http://www.watershedrestoration.water.ca.gov/urbanstreams/pastproj/spr01proj$2m.cfm

http://www.arcataeye.com/top/000314top03.shtml

http://www.epa.gov/ednnrmrl/publish/book/handbook/hirezhandbook.pdf

http://www.epa.gov/bioindicators/pdf/CA_WQS_final.pdf

http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_wqcp.pdf

http://www.epa.gov/ost/standards/wqslibrary/ca/ca_9_north_coast.pdf

Consulted with:

Dr. Margaret Lang, Environmental Resources Engineering, HSU.
Julie Neander, Environmental Services Dept., City of Arcata.

2/16/04 → time 11:30 am
Conditions: raining very hard
off & on throughout last night; steady
since early morning.
Samples a & b taken from all 3 sites
Culvert depth before alliance: ?
" " " after " " : ?

2/16/04 → time 2:35 pm
Conditions: raining steadily
Since 11:30 (last sample)
Samples a & b taken from all 3 sites
culvert depth before alliance: 14"
" " " after " " : 17"
increase in flow into diversion marsh
~~* Tests from 11:30 - 2/16/04~~
~~samples~~
(1A)
~~conductivity: 61 umhos~~
~~temp: 11°C~~
~~pH:~~

- Baseline DO Data
- Last rain was 3/5/04 (Not enough to use diversion though prob just enough to freshen water.)
- Weather has been sunny for last 2 days.
~~E side Depth: 4"~~
W side Depth: 1.5"

3/9/04 → 1:00

- Depth → 4" @ culvert
- DO @ site 1 → 13 mg/L (13.5°C)
DO @ site 2 → 4 mg/L (15.0°C)
DO @ site 3 → 14 mg/L (14.0°C)
(Temp → ~~14~~ 12°C @ culvert)

Base-line reading: 2/11/04: 2:15 pm
- sunny → low flow

* Depth measurement
- Across Alliance: 4 1/2"
- Our side of Alliance: 1 1/2" *

* Site 1: before mixing of JGs & diversion marsh (tree & log)

Site 2: tree w/ 4 trucks

Site 3: stake & telephone pole

* stream level low & diversion is low → higher chance of getting sediment from the bottom or the top into bottles

2/6/04 → last storm

samples taken
steadily raining since last sample
water depth: 18"

* 2/17/04 @ 9:30
samples taken
water depth: ~~18"~~ 19.5"
little bit of sun come out,
only sprinkling,
flow mellowed out a bit into marsh
high winds

* 2/17/04 @ 1:00
samples taken
water depth 20.5"
sunnier, sporadic rain

3/12/04 → @ 1:00

Temp: 13°C w/ DO = 19 mg/L
Depth: 3 3/4"

DO site 1: ~~21~~ 18 mg/L @ 13.5°C
DO site 2: 3.5 mg/L @ 14.0°C
DO site 3: 20.5 mg/L @ 14.0°C

It has been partially raining & drizzling all day & morning.

DO calibration: 9.2 mg/L @ 19°C

Water level: 6.5"

Site 1: 12.0 mg/L @ 11°C

Site 2: 2.3 mg/L @ 11°C
(water flowing into diversion)

Site 3: 12.5 mg/L @ 11°C

3/10/04 → Cal 1:00
DO: 8.72 Temp: 22

~~Time~~ 1:21
- Depth 4 inches
- Sunny & warm

Site 1 Temp: 13.5°C
DO: 12.2 mg/L

Site 2 Temp: 15.5°C
DO: 3.5 mg/L

Site 3 14.0°C
11.75 mg/L

1335

Weather is rain. has been raining steadily this morning since 8 or 9 AM.

DO2 Do meter used
Cal: 9.1 mg/L @ 20°C

Water level in culvert: 8 in

Site 1: Temp: 11°C
DO: 10.2

Site 2: Temp 11°C
DO: 2.5 mg/L

Site 3: Temp 11°C
DO: 9.3 mg/L

4/16/04
1316

DO 2
DO calibration Temp 20.76
DO 9.1
Depth of Culvert 3.25"

Site 1 12°c
8.8 mg/L

Site 2 13 °C
4.8 mg/L

site 3 12 °C
6.75 mg/L

4/16/04

- raining on & off since middle of night
- cloudy night now, but no rain
- depth at culvert = 3.7"

- site #1: 11.8 °C @ 9.5 mg/L
site #2: 11.3 °C @ 4.1 mg/L
site #3: 10.8 °C @ 10.5 mg/L

- Diversion observation: not much water flowing in

3/27/04 13:00

CONDITION: EARLY CLOUDS APPROX. 11:00 A.M. SUNNY. SEMI-WARM

H_2O level = 4.7/10

SITE #1
TEMP: 11.5°C
O_2: 11.4 mg/l

SITE #2
TEMP: 13.0°C
O_2: 4.1 mg/l

SITE #3
TEMP: 11.2°C
O_2: 11.2 mg/l

Do meter #2 → 13:15
20°C @ 9.1°C

Depth at culvert: 3.0"

Site #1: 13.8°C @ 12.1 mg/L
site #2: 12.1 @ 3.4 mg/L
site #3: 11.8 @ 8.2 mg/L

Diversion observation: not much water flowing into it at all

Thurs → 4/13/04 @ 1:00

- rain has stopped → sun barely shining
- in general, it has rained since early morning (drizzled)
- DO meter #1 used → calib. @ 20°C → 9.3 mg/L
- Depth at culvert → 4.2"
- Site #1: 11°C @ 11 mg/L
- Site #2: 11°C @ 4.5 mg/L
- Site #3: 11°C @ 12.5 mg/L
- description of ~~culvert~~ diversion:
  Small amount of H2O going into culvert

4/19/04

- very cloudy; not raining now; rained a lot before
- depth at culvert → 4.6"
- Site #1: 12.2°C @ 12.2 mg/L
  Site #2: 12.0°C @ 3.8 mg/L
  Site #3: 11.1°C @ 10.7 mg/L
- description of ~~culvert~~ diversion: small, but steady flow into the marsh

* Wed → 4/14/04

- rain has stopped recently, but been off & on drizzling all morning
- DO meter # 2 used → calib @ 20°C → 9.3 mg/L
- Depth at culvert → 5½"
- Site # 1: 11.5°C @ 13.5 mg/L
  Site # 2: ~~12~~ 12.5°C @ 3.7 mg/L
  Site # 3: ~~11.5~~ 12.0°C @ 11.5 mg/L
- Description of diversion: water steadily flowing in

* Thurs 4/15/04

- Cloudy, but no rain → not much since last night / early morning
- DO meter # 1 used → 20°C @ 9.3 mg/L
- Depth at culvert: 4¾"
- Site #1: 11°C @ 12.5 mg/L
  Site #2: 11.5°C @ 4.2 mg/L
  Site # 3: 10.5°C @ 15.5 mg/L
- Description of diversion: not as much water flowing into it as yesterday

Appendix #6 Sample Notebook

- see attached papers