FALL RIVER WATER QUALITY REPORT
2003-2005

Prepared for the Fall River Resource Conservation District and the Pit River Alliance by:

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FALL RIVER WATER QUALITY MONITORING STUDY, 2003 - 2005

1. BACKGROUND

The Fall River Resource Conservation District (RCD), in collaboration with agencies, landowners, and other stakeholders is implementing a program to protect and enhance water quality, fisheries, and aquatic habitat in Fall River and the surrounding watershed area. Fall River is a major tributary to the Pit River and a nationally renowned trout fishing stream. Beneficial uses of Fall River water also include domestic supply for residents living along the River and irrigation/stock water supply for agricultural operations in the valley. Historically, there have been concerns over potential decline in water quality, fish populations, and aquatic habitat conditions (from sedimentation and most recently from invasive weed species). The river is currently designated under Section 303(d) of the federal Clean Water Act for impairment from sedimentation. In recent years, the RCD and other stakeholders have implemented a number of on-the-ground projects to address watershed concerns. These include channel and meadow restoration projects on tributary streams, livestock enclosure fencing with watering access ramps for cattle, riverbank revetment, muskrat control, and improvements in application and control of agricultural irrigation water.

In 2003, funding for a Fall River water quality monitoring program was provided to the RCD and the Pit River Watershed Alliance from the State Water Resource Control Board's (SWRCB) Surface Water Ambient Monitoring Program (SWAMP). The Fall River Technical Advisory Committee, composed of agencies, landowners, and other stakeholders, provided guidance to the design and implementation of the monitoring program.

Objectives of this two-year study were as follows:

1. Implement a monitoring program on Fall River to document existing conditions of water quality.
2. Determine if and to what extent, beneficial uses are limited or impaired by water quality.
3. Establish a monitoring program that is repeatable and can be used to compare with past and future conditions to evaluate water quality trends in Fall River.
4. Provide the RCD, resource agencies, and other stakeholders with additional environmental information to assist in the development of a river management plan.

In addition to the collection of water quality data, SWAMP funds were used for a University of CA., Davis study on aquatic weed conditions and macroinvertebrate populations in the river. Results of this study are contained in a separate report entitled Fall River 2005 Macroinvertebrate and Channel Cross Section Monitoring, March 2006 (available on request from the Fall River RCD).

This report summarizes the methods and results of Fall River water quality monitoring carried out during the period Sept. 2003 to Sept. 2005. The primary purpose of the report is to present the data and establish baseline water quality conditions for that period. A secondary purpose is to compare the 2003-2005 findings with water quality data from previous monitoring in the Fall River drainage in order to begin the evaluation of long-term trends. Data collected as part of the 2003-2005 monitoring program were also used by the Northeastern CA Water Association to fulfill monitoring requirements for the Regional Board's Conditional Waiver of Waste Discharge for Discharges from Irrigated Lands (the Ag.Waiver Program).

2. MONITIORING SITES, PARAMETERS, AND METHODS

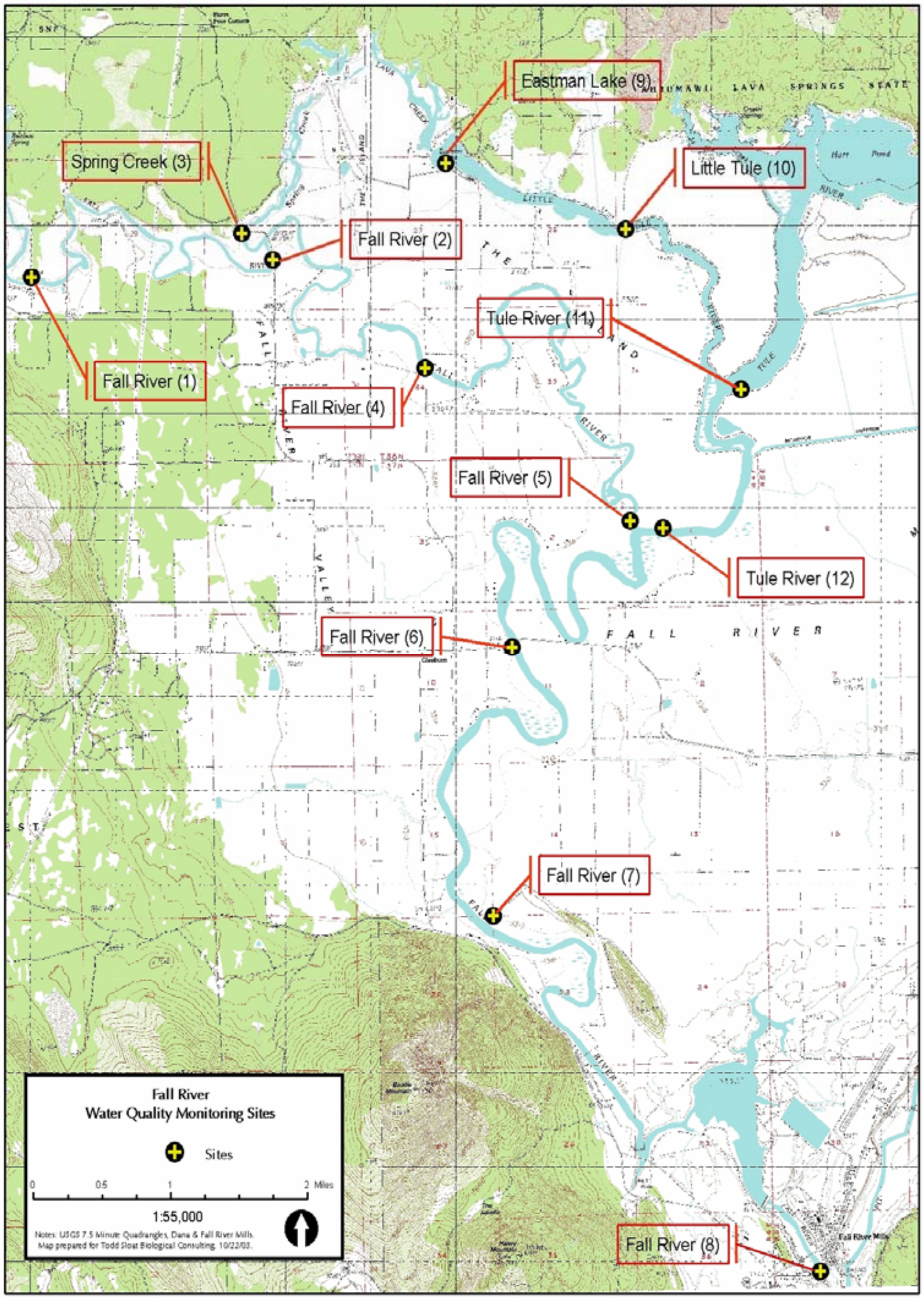
<u>Sites</u>

Twelve monitoring sites were located on Fall River and the principal tributary drainages, (i.e. Spring Creek, Tule River and Little Tule River). These sites are described in Table 1 and shown on Figure 1.

Table 1. Location of Monitoring Sites

Station No. and Location		**UTM (E)**	**UTM (N)**
FR1	Fall River @ Fletchers Bridge	622007	4550446
FR2	Fall River @ Spring Creek confluence	624841	4550636
SC3	Spring Creek @ Fall River confluence	624482	4550917
FR4	Fall River @ Island Rd. Bridge	626636	4549484
FR5	Fall River @ Tule River confluence	629042	4547863
FR6	Fall River @ Glenburn Bridge	627657	4546519
FR7	Fall River @ Fall River Ranch Bridge	627440	4543673
FR8	Fall River @ Fall River Pond (in Fall River Mills)	631277	4539899
EL9	Eastman Lake near mouth of Lava Creek	626873	4551660
LT10	Little Tule River @ State Park Bridge	628992	4550962
TR11	Tule River upstream from Little Tule confluence	630344	4549258
TR 12	Tule River @ Fall River confluence	629429	4547790

Figure 1. Fall River Water Quality Monitoring Sites



Parameters & Frequency

Water quality constituents sampled and sampling frequency are shown in Table 2.

Table 2. Monitoring Parameters and Sampling Frequency at Fall River and Tributary Sites

Parameter	Sampling Frequency
Temperature	Continuous (reported once/hour)
Electrical Conductivity (EC)	Monthly
pH	Ibid
Turbidity	Ibid
Total Coliform Bacteria	Ibid
Fecal Coliform Bacteria	Ibid
E. coli Bacteria	Ibid
Nitrate Nitrogen	Ibid
Total Suspended Solids (TSS)	Ibid
Total Phosphorous	Ibid
Total Organic Carbon (TOC)	Periodically at selected sites
Flow	Flow records from PGE Pit 1 Hydropower project (at PGE Fall River Diversion)

Methods

At each site, surveyors used field meters to measure pH, conductivity, and turbidity. Water samples for laboratory analysis were collected as "grab samples" by filling bottles by hand below the surface of the water or by lowering an integrated depth sampler (DH 48 Integrated Depth Sampler) from a rope off a bridge to collect a one-liter sample. Samples collected in the one-liter bottles were poured into the appropriate sample container for laboratory analyses (one-liter sample containers were thoroughly rinsed prior to taking the next sample). Water samples were transported to the laboratory in Redding (Basic Laboratory, Inc.) each day of sampling. In the lab, samples were analyzed for nitrates, total phosphorus, total suspended solids, bacteria (fecal/total coliforms and E. coli), and total organic carbon.

All data were recorded in the field on standardized data sheets, checked for accuracy and omissions in the field, and checked again by the Project Director before being entered into the computer database. All data sheets and field notebooks were kept in order to check for accuracy in the database.

All sampling, transport, and handling, and analyses followed SWAMP quality assurance protocols (as described in the Pit River Quality Assurance Plan – 2004).

2.1 Water Temperature

Temperature affects the rates of biological and chemical processes. Aquatic organisms from microbes to fish are dependent on certain temperatures for optimal health. Fish are affected by both short-term maximum temperatures and longer term average temperatures. Effects vary according to species and life cycle stage. Temperature can also affect dissolved oxygen content, photosynthesis by aquatic plants, metabolic rates of aquatic organisms and their sensitivity to toxic waste, parasites, and diseases. Temperature in Fall River is influenced principally by factors such as; weather (air temperature and solar radiation), streamside canopy cover, channel configuration (width/depth ratio), discharge of irrigation tail water, and inflowing ground and surface water.

Temperature was recorded continuously using Optic Stowaway and Stowaway Tidbit submersible loggers. Loggers were placed in moving water and were anchored to trees, bridge pilings, or other stable objects at the river edge. The data loggers were programmed to record an average temperature for each hour, based on 100 readings and were retrieved monthly to download data. If possible, data was transferred to an optic shuttle while in the field and the logger was re-started and placed back in its original location. Data were transferred from the shuttle to a laptop or office PC using Box Car Pro 4.3.

2.2 Conductivity (EC)

Conductivity measures the ability of water to pass an electrical current. It is useful as a general measurement because most streams have a relatively constant range and significant changes can indicate that a discharge or pollutant has entered water. In streams and rivers, conductivity is primarily affected by the geology of the watershed. Lower EC occurs in streams with bedrock composed of more inert materials that do not dissolve into ionic components when washed into the water. Conversely, clay soils have materials that ionize, raising conductivity when washed into water. Conductivity can also increase due to the presence of inorganic dissolved solids; such as positively charged nitrate and phosphate anions or negatively charged calcium and iron (EPA 2006). Since conductivity increases with rising water temperature, conductivity is often reported at 25 degrees Celsius which is known as “temperature compensated conductivity or Specific Conductance.” In general, conductivity of rivers in the US ranges from 50 to 1500 micromhos per centimeter (µmhos/cm). Inland fresh waters with healthy aquatic life generally have a range of 150 to 500 µmhos/cm.

Conductivity was measured using a YSI Model 63 meter in areas of moving water. All multi-parameter meters were calibrated to the manufactures specifications prior to data collection and were checked against prepared standards at least quarterly.

2.3 pH

pH measures the alkalinity or acidity of a substance on a scale from 1.0 to 14.0, with increased acidity as pH decreases. The pH scale measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions, which make up water ($H+ + OH- = H_20$). Measured on a logarithmic scale, a drop in pH by 1.0 equals a 10-fold increase in acidity. Aquatic animals generally prefer a pH range of 6.5-8.5. Outside of this range, diversity decreases due to increased stress on physiological systems. Low pH can make toxic elements more available for uptake by aquatic plants and animals. Changes in acidity can be caused by acid rain, soil/rock leachate, and wastewater discharges including feedlot and pasture run-off.

pH was measured using multi-parameter meters (YSI Model 63 and YSI Model 556) in areas of flowing water.

2.4 Total Coliforms

Total coliforms are a group of bacteria that are widespread in nature and commonly occur in human feces, animal manure, soil, wood, and plant debris. They indicate the possible presence of pathogenic bacteria, viruses and protozoans. It is a standard parameter to test drinking water quality, because the presence of total coliforms indicates potential contamination from an outside source.

For all coliform analyses, surveyors collected grab samples by lowering a laboratory-prepared bottle directly into the water or using an integrated depth sampler Samples collected with the depth sampler were poured into lab provided bottles. Bottles were labeled, placed in an ice chest with ice, and transported to the lab within their designated “hold time.” Hold time for bacteria analysis is eight hours. Total coliforms were analyzed using the SM 9221B/E and SM 9221B methods.

2.5 Fecal Coliforms

Fecal coliforms are a subset of total coliforms and include a number of bacteria that are more specific in origin relative to total coliform, but share common characteristics. They are used as an indicator of contamination from warm-blooded animals (including livestock and humans) and indicate the possible presence of pathogenic bacteria, viruses and protozoans. In rivers and streams coliform die-off rate is fairly rapid, so concentrations tend to be highest close to the source. Fecal coliforms were analyzed using the SM 9221B/E laboratory methods.

2.6 Escherichia coli (E. coli)

E. coli is a bacteria species found in the fecal coliform group that is specific to fecal material from humans and other warm-blooded animals. Results are used to determine the health risk of water supplies and water contact recreation, which can include digestive system illness. E. coli were analyzed using the SM 9221B laboratory method.

2.7 Nitrate Nitrogen (NO_3)

Nitrates are essential plant nutrients, but in excess amounts can accelerate aquatic plant growth which affects dissolved oxygen and temperature. Nitrates can become toxic to warm-blooded animals at high concentrations (10 mg/L or higher). The natural level of nitrate in surface water is typically low (less than 1 mg/l)). Sources of nitrates include municipal and industrial wastewater discharge, runoff from fertilized cropland, individual septic systems, and runoff from livestock feedlot and pasture areas. Nitrates from land sources that end up in rivers and streams dissolve in water more readily than phosphates, which have an attraction for soil particles. As a result, nitrates are generally considered as the likely source of nuisance growths of plants and algae.

Laboratory analysis for nitrates was conducted from water samples collected by surveyors. Grab samples were collected by lowering a bottle in the water or by using an integrated depth sampler. Samples collected with the depth sampler were poured into bottles prepared by the laboratory. Bottles were labeled, placed in an ice chest with ice, and transported to the lab within their designated “hold time” which is seven days for both nitrate and phosphorous. Nitrate as nitrogen was analyzed using the EPA 353.2 laboratory method. Nitrate values were entered into summary results as zero when levels were not detected (minimum detection level =0.05 mg/L) in order to calculate averages through time and across sites.

2.8 Total Phosphorus (P)

Phosphorus is an essential nutrient for plants and animals. It can enter waterways from many sources, including naturally from soils and rocks, municipal and industrial wastewater discharge, runoff from agriculture and animal manure areas, individual septic systems, areas of soil erosion, and wetlands. In aquatic systems, phosphorus can either be dissolved in water or suspended (i.e., attached to soil particles), and tends to be taken up by plants or bound to particles that settle to the stream bottom. In most fresh waters, phosphorus increase can have a detrimental effect from accelerated plant growth, algae blooms, and low DO.

Water was collected for both nitrate and phosphorus analysis (*see sampling method for nitrate*). Total phosphorous as P was analyzed using the SM 4500P laboratory method. Phosphorous values were entered into summary results as zero when levels were not detected (minimum detection level=0.02 mg/L) in order to calculate averages through time and across sites.

2.9 Turbidity

Turbidity measures how much the material suspended in water prevents passage of light. Increased turbidity can result from soil erosion, wastewater discharge, eroding stream banks, stream bottom disturbances, and algal growth. Turbidity generally increases during heavy rainfall/runoff events. Since sediment particles which cause turbidity absorb more heat, high turbidity increases water temperatures, which reduces the concentration of dissolved oxygen.

A US DH 48 Integrated Depth Sampler was used to collect a sample through the water column. Turbidity was tested in a portable turbidimeter (Orbeco-Hellige Model 966). The water sample was poured into three separate vials and each was tested for turbidity. Turbidity values represent the average of these three readings. The turbidimeter was checked and calibrated the morning of sampling and prior to each sampling location using portable standards.

2.10 Total Suspended Solids (TSS)

In water, suspended solids consist of silt and clay particles, plankton, algae, fine organic debris and other particulate matter that will not pass through a 2-micron filter. TSS can be a useful indicator of the effects of construction, agriculture, logging and other land disturbing activities. High concentrations of suspended particles can carry toxins, such as pesticides and can clog irrigation devices and impact water treatment systems. High concentrations affect water clarity, raise water temperatures, and decrease availability of light to aquatic plants. Suspended solids that subsequently settle out on the river or stream bottom can adversely affect aquatic life.

Surveyors collected grab samples by lowering a bottle in the water column or by using an integrated depth sampler. Collected samples were poured into a lab-provided bottle. Bottles were labeled, placed in an ice chest with ice, and transported to the lab within their designated “hold time.” Hold time for total suspended solid analysis is seven days. TSS was analyzed using the SM 2540D laboratory method.

2.11 Total Organic Carbon (TOC)

TOC is a measure of dissolved and particulate organic carbon. Most organic carbon in water is composed of humic substances and partly degraded plant and animal material that is resistant to microbial degradation. TOC generally ranges from 1-30 mg/L in natural waters. Sources are both natural and human in origin. Elevated TOC concentrations are a concern for water treatment operations and municipal water supplies due to the chemical complexes that occur during chlorination.

TOC samples were collected by surveyors as grab samples in the same manner as previously described. Bottles were labeled, placed in an ice chest with ice, and transported to the lab within their designated 'hold time' of 7.5 days. TOC was analyzed using the EPA 415.1 laboratory method.

2.12 Flow Volume

Flow in lower Fall River was determined from records at the PG&E Pit 1 Powerhouse. Flows diverted to the powerhouse were added to bypass flows that enter Fall River Lake and the Pit River to determine total flow volume in lower Fall River.

3. RESULTS AND DISCUSSION

3.1 Data Presentation and Analysis

Non-statistical approaches are used to present and interpret data in this report. The use of tables and graphs allows for efficient display and interpretation of large data sets. All water quality data collected from this study are shown in the table in Appendix A (Fall River 2003-2005 Water Quality Data). Data are summarized and shown graphically in Figures 2 through 24.

3.2 Water Temperature

Temperature monitoring results for 2003/2004 and 2004/2005 are summarized in Tables 3A and 3B, and shown graphically in Figures 2 through 8.

<u>Mainstem Fall River</u>

As shown in Figures 2 and 3, both daily maximum and maximum 7-day average temperatures increased progressively from upstream stations to downstream. During the 2005 summer season, there was as much as a 23°F increase in the maximum 7-day average water temperature from the most upstream site (Fletcher's Bridge – FR1) to the most downstream site (Fall River Mills – FR8). Summer maximum temperatures in upper Fall River (i.e. upstream of the Tule River confluence) ranged from 56.5F (FR1) to 63.7F (FR5). As evidenced in Figures 2 and 3, there were minor differences in temperature during the 2003/2004 and 2004/2005 monitoring periods. This would be expected given that the annual water temperature regime in this spring-fed system is very consistent relative to other typical surface water bodies. The anomaly of a 75.4 °F reading at the FR4 site in the spring of 2004 was likely caused by removal of the temperature unit from the water column.

In terms of temperature tolerance for aquatic species, all Fall River sites above the Tule River confluence were suitable for rainbow trout tolerance, while below the Fall/Tule River confluence, summer temperatures would be considered 'marginal' for trout species (i.e. maximum temperatures ranged from 68.4 to 71.4F).

TABLE 3A. FALL RIVER WATER TEMPERATURE 2004

Station	Dec Jan Feb		Mar Apr May		Jun Jul Aug		Sep Oct Nov					
	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	No. of 7-day Aver. >66F	No. of Day Max >75F	Max Summer Daily Fluc	Data Days
FR1	53.1	50.2	56.7	52.6	56.7	53.3	55.6	52.4	0	0	6.4	243
FR2	51.9	49.9	59.2	53.7	58.9	55.8	57.2	52.3	0	0	7.2	238
SC3	53.7	51.9	58.5	54.8	59.6	57.8	58.5	55.7	0	0	6.1	242
FR4	51.1	49.5	58.4	55.9					0	0		148
FR5	50.8	49.2	61.4	57.7	63.7	62	59.4	58.4	0	0	4.8	297
FR6			64.3	60.6	68.4	68	63.8	62.8	16	0	2.6	176
FR7	48.6	47.5	75.4	62					0	0		150
FR8			67.7	64.5	76.1	73.7	69.2	66.8	57	9	5.2	152
EL9	53	51.6							0	0		46
LT10	57.7	50.9	60.1	57.7	60.9	60.2	58.7	58.2	0	0	1.4	247
TR11	50	47	68.5	65.1	73.2	71.6	67.9	66.9	96	0	3.5	356
TR12	50.5	50.1			74.3	71.9	68.6	65.8	37	0	6.3	138

TABLE 3B. FALL RIVER WATER TEMPERATURE 2005

Station	Dec Jan Feb		Mar Apr May		Jun Jul Aug		Sep Oct Nov					
	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	Absolute Daily MAX	MAX 7-day Aver.	No. of 7-day Aver. >66F	No. of Day Max >75F	Max Summer Daily Fluc	Data Days
FR1	53.1	50.0	57.6	53.5	56.5	53.1	54.8	52.2	0	0	5.9	309
FR2	52.2	49.6	59.5	55.0	58.9	55.6	56.4	53.5	0	0	7.2	309
SC3	54.3	51.7	58.5	55.5	59.6	57.0	57.3	55.2	0	0	5.6	309
FR4	52.0	50.2	58.4	56.3	60.1	58.4	56.7	55.8	0	0	3.9	309
FR5			61.7	58.2	62.5	60.9	58.3	57.6	0	0	4.5	79
FR6	51.9	50.5	65.8	62.5	69.0	67.9	62.3	62.3	35	0	3.7	309
FR7	51.6	50.7	66.1	63.6	71.4	69.9	63.8	63.7	53	1	3.2	307
FR8	49.0	47.4	70.1	66.5	79.3	76.3	69.8	68.3	88	46	5.8	309
EL9	54.3	52.3	58.0	55.7	58.5	57.0	56.6	55.3	0	0	3.6	301
LT10	52.3	51.8	58.1	57.2	60.1	59.6	57.8	58.1	0	0	2.0	314
TR11	54.2	50.7	72.8	68.2	76.2	73.5	67.7	67.8	86	3	5.5	314
TR12	52.3	50.8	69.2	65.6	74.3	70.1	69.2	66.7	57	0	6.3	302

"Absolute Daily Max" = Highest maximum temp.
"Max 7-day Average" = Average the day & 6 previous days Mean values, then find the highest temp.
"Number of 7-day average >66F" = Number of days that the 7-day average is over 66 degrees Fahrenheit.
"Diel Fluc" = (Maximum daily temp) - (Minimum daily temp)

Tributaries

Figures 4 thru 8 show daily maximum and maximum weekly average temperatures for Spring Creek, Eastman Lake, Lt. Tule River, and Tule River.

Summer temperatures at these sites were well within tolerance levels for trout and other cold water species except for the Tule River sites (TR11 and TR12) where summer daily maximum temperatures reached 76 F.

KEY FINDINGS

- Fall River summer temperatures show significant warming from near the headwaters (Fletchers Bridge – FR1) to near the PG&E Diversion (Fall River Ranch Bridge – FR7). Daily maximum river temperatures increase through this reach by about 15°F.
- All Fall River and tributary sites monitored show year round temperature regimes supportive of trout and other cold water species except for Tule River above the Fall River confluence, and Fall River pond in the town of Fall River Mills.
- Both seasonal and diel (daily) temperature variation in the Fall River and tributaries is low relative to other typical surface water bodies (diel temperature variation ranged from 3 to 7°F during the summer period).

3.3 Conductivity

Specific conductance data are shown in Figure 9. Readings generally ranged from 100 to 200 μmhos/cm, which is relatively low compared to other northern CA surface waters. There was little conductivity variation both seasonally and between stations. Some elevated conductivity levels were noted in Feb 2004 and this corresponded to the sampling date when high turbidity was also present in the river.

KEY FINDING

- Conductivity in Fall River and tributaries was relatively low (100 to 200 μmhos/cm) and showed little seasonal or spatial variation.

3.4 pH

pH data is show graphically in Figures 10 and 11. Readings for both Fall River and tributary sites generally ranged from 8.0 to 9.0. This pH range is relatively high but is consistent with the alkaline conditions found in other eastside watersheds. pH readings at the Spring Creek site were generally lower than all other sites, ranging from 7.0 to 8.0. There was minimal seasonal and spatial (upstream to downstream) variation in pH.

KEY FINDINGS

- pH at Fall River and tributary sites was relatively constant (8.0 to 9.0) showing little seasonal or spatial variation.
- pH at Fall River sites was somewhat higher than the Basin Plan water quality objective for this constituent (6.5 to 8.5) but this is typical of the more alkaline conditions of eastside watersheds.

- pH in Spring Creek was somewhat lower than other Fall River and tributary sites, ranging from 7.0 to 8.0.

3.5 Turbidity

Results of turbidity monitoring are shown on Figures 12 and 13.

Mainstem

As would be expected in a spring-fed river, turbidity in Fall River remained consistently low through the study period. Turbidity was less than 5 NTUs at all monitoring sites except for the 19 February 2004 sample date when all sites were above 15 NTUs and FR6 (Glenburn Bridge) reported 67 NTUs. The cause for this turbidity increase was likely heavy rainfall on 19 February and preceeding day.

In general, turbidity increased slightly in a trend from upstream to downstream.

Tributaries

There were occasional spikes in turbidity at FR12 and FR11 (Tule River), probably related to blooms of planktonic algae. The least turbid site was Spring Creek (FR3) with levels of more than 2 NTU occurring only once (June 2004).

KEY FINDINGS

- Turbidity in Fall River generally ranged from 0 to 5 NTU and is typically less than 2 NTU.
- One elevated turbidity event occurred on 19 Feb 2004 throughout Fall River from a heavy rainfall event in the watershed.
- Elevated turbidity at the Tule River sites probably results from the presence of algae rather than soil particles in the water column.

3.6 Total Suspended Solids (TSS)

Total suspended solids in Fall River are low relative to most ambient waters. As seen in Figure 14, TSS concentrations are typically 0 to 5 mg/l with occasional readings of 5 to 10 mg/l. One ‘event’ of elevated TSS in Fall River occurred on 19 Feb 2004. On this day, TSS concentrations throughout the River averaged 19 mg/l (ranging from 13 to 26 mg/l). TSS levels in tributary waters (Spring Cr., Lt. Tule River, and Tule River) were low throughout the study period.

Figure 15 plots average TSS and turbidity for all sites throughout the study period. With the exception of the Feb, 2004 event, this figure illustrates the relatively low and relatively constant levels of these two parameters throughout Fall River and its tributaries.

KEY FINDINGS

- TSS levels in the Fall River and tributaries are low compared to other ambient waters that are not predominantly spring-fed.
- One episode of elevated TSS in Fall River was detected on 19 Feb 2004, likely from a heavy rainfall in the watershed.

3.7 Fecal Coliform Bacteria

Fecal coliform bacteria data are shown graphically in Figures 16 and 17 and all individual sample results are included in the water quality data table in Appendix A.

Water quality objectives[1] for protection of contact recreation (i.e. REC-1 Beneficial Use) state that fecal coliform bacteria shall not exceed a maximum or 400 MPN (most probable number) or a mean of 200 MPN. Of the 271 total samples taken during the study period in Fall River and tributaries, 10 were in excess of 200 MPN and 2 were in excess of 400 MPN. Fecal coliform bacteria concentrations in Fall River and Tule River are frequently in the range of 20 to 100

[1] From the Water Quality Control Plan for the Sacramento River Basin, CA RWQCB

MPN. Residents using Fall River directly for domestic household supplies should be aware of these elevated concentrations and be sure they have adequate treatment systems. The state standard for safe drinking water is less than 2 MPN total coliform bacteria (however, state drinking water standards do not apply to ambient, untreated surface waters).

With one exception, fecal coliform bacteria in Eastman Lake ranged from 0 to 9 MPN and was typically 4 or less. On 19 July 2005, Eastman Lake concentrations were at 79 MPN.

As shown in Figure 18, there was a seasonal trend in elevated fecal coliform concentrations (i.e. higher in the summer and lower in the winter). Figure 18 also shows that when all sites are averaged, there were no monthly exceedences of the Basin Plan standard of 200 MPN.

KEY FINDINGS

- Fall River and tributary sites infrequently exceeded the Basin Plan fecal coliform objective (maximum of 400 MPN for protection of contact recreation). Only 2 of 271 samples exceeded 400 MPN. There were 10 individual exceedences of the 200 MPN (mean) objective, however, when all sites are averaged, none of the monthly sample dates exceeded 200 MPN during the study period.
- Fecal coliform bacteria concentrations in Fall River are commonly in the range of 20 to 100 MPN and this should be a concern for residents that take their domestic water supply directly from the River. Management practices that minimize bacteria transport to the River should continue to be promoted.
- A seasonal trend in fecal coliform bacteria showed higher levels in summer and lower levels in winter.
- The levels and duration of fecal coliform exceedance of the Basin Plan objective do not appear to justify listing the Fall River system as ‘water quality impaired’ for this parameter.

3.8 E. Coli Bacteria

E. coli data are charted in Figures 19 and 20 and also shown in Appendix A.

The Regional Board is currently considering a recommendation to modify the bacteria water quality objective from fecal coliform to E. coli (i.e. establish an E. coli objective of 235 MPN maximum and 126 MPN mean). The frequency of exceedences of the recommended total and mean E. coli objective closely paralleled that of the fecal coliform data. E. coli concentrations also showed a trend towards high levels in summer and lower in winter.

Of the tributary sites, Spring Creek had the highest E. coli levels ranging from 10 to 260 MPN. Eastman Lake concentrations never exceeded 7 MPN. The Lt. Tule and Tule River sites ranged from 0 to 10 MPN.

KEY FINDINGS

- As with fecal coliform bacteria, E. coli infrequently exceeded recommended water quality criteria for protection of contact recreation, however the levels and frequency of exceedance do not appear to justify an impaired waterbody listing for E. coli concentrations.
- E. coli findings are similar to that for fecal coliform bacteria, i.e. seasonal trends show higher summer concentrations as compared to winter, and typical Fall River E. coli concentrations are at levels which should at least be a concern to those taking domestic household water supplies directly from the river.
- Bacteria concentrations (both fecal coliform and E. coli) in ambient waters are highly variable and one must use caution in determining the significance of any single sample results.

3.9 Nitrate Nitrogen

Nitrate nitrogen concentrations for Fall River sites are shown graphically in Figures 21 and for tributary sites in Figure 22.

Mainstem

Nitrate concentrations were similar for all sites throughout the monitoring period, ranging from 0.05 to 0.2 mg/l, except for the Glenburn Bridge site (FR6) where a one-time anomalous spike of 0.37 mg/L was reported on 19 February 2004 (as previously noted, this sample date also showed high conductivity and turbidity levels in Fall River). Nitrate levels were somewhat higher in fall/winter months than spring/summer months, probably the result of nutrient uptake by aquatic vegetation. This would also explain why nitrate levels in the upper River were somewhat higher as compared to lower River sites. When all River sites are averaged, overall concentrations were somewhat higher in 2004 than in 2005.

Tributaries

Highest nitrate levels were reported for Spring Creek at the Fall River confluence (FR3) where nitrate ranged from about 0.07 to 0.27 mg/L. The Eastman Lake site (FR9) averaged about 0.15 mg/L. As with the main stem Fall River, levels were higher in 2004 as compared to 2005. The lowest concentrations were found at the Tule River sites (FR11 and FR12). In general, in can be expected that higher weed and algae growth will result in lower dissolved nitrate concentrations in the water column.

KEY FINDINGS

- Nitrate levels were about twice as high in the fall/winter months as the spring/summer months at the River and tributary sites. This likely results from weed and algae uptake during their period of high growth.

- Upstream Fall River sites (FR1, FR2, & FR4) averaged about twice the levels of nitrates as downstream sites (FR 6, FR7, & FR8), based on limited data from the latter sites. This again is probably the result of nutrient uptake from weed growth.
- The relatively low nitrate values - sometimes non-detectable - indicates that nitrogen may be a major limiting factor in growth of weeds and algae.

3.10 Total Phosphorous

Total phosphorous (P) concentrations are shown for Fall River sites in Figure 23 and tributary sites in Figure 24. Throughout the study period, P concentrations ranged from 0.02 to 0.08 mg/L at all Fall River sites. At Glenburn Bridge (FR6), occasional spikes in P concentrations ranging from 0.12 to 0.23 mg/l were detected (Feb 04, Sept 04, Oct 04 and May 05). This Feb 04 spike at FR 6 was also seen in elevated P concentrations downstream at FR 7 and FR 8, and may have been due to increased TSS in the river at that time (phosphorus tends to absorb onto sediment particles). Other than the above anomalies, there was no apparent seasonal P fluctuation during the monitoring period.

Tributary sites generally ranged from 0.05 to 0.1 mg/l throughout the study period. One elevated reading (0.21 mg/l) occurred at Eastman Lake in Oct 2003.

KEY FINDINGS

- Phosphorous concentrations were similar throughout the monitoring period at Fall River and tributary sites, generally ranging from 0.02 to 0.1 mg/l.
- Occasional spikes in phosphorous concentrations were detected at the Glenburn Bridge monitoring site.
- Monitoring results indicate that both phosphorous and nitrate nitrogen may be limiting factors for weed and algae growth in the system. As seen in Figure 25, late spring/summer P levels in 2004 and 2005 dropped somewhat compared to levels at other times of the year. Both nutrients are reduced in heavy vegetative growth months and increase in low-growth months. The drop in nitrate levels in the spring/summer of 2005 by a factor of four indicates that nitrate may be a more limiting factor than phosphorous in the system.

3.11 Total Organic Carbon (TOC)

TOC was measured at Fall River Ranch (FR7) during 11 of the monthly sample events and once at the Glenburn Bridge site (FR6). As shown in Appendix A, TOC levels ranged from 0.86 to 2.6 mg/L. There was no consistent seasonal difference in monitoring results.

KEY FINDING

- The level of TOC monitored is not indicative of a water quality problem in Fall River caused by an organic compound.

3.12 Flow

Figure 26 shows monthly maximum, minimum, and average flow in Fall River at the PG&E diversion.

Fall River flows were similar for 2004 and 2005 with an average monthly flow of 1,096 cfs and 1131 cfs, respectively. Flow peaked in March and April and was lowest in July, August, and September. Unlike most rivers fed by surface runoff from rain and snow, Fall River flows are a reflection of its spring-fed nature in that summer flows were only marginally diminished from wintertime flows.

Flow relationship with rainfall was examined using 2004 and 2005 data reported by PG&E (Pit 1 Powerhouse station). Total rainfall was 18.5 inches in 2004 and 18.75 inches in 2005 as shown in Figure 27. The only indication that rainfall and flow are related was in December 2005 when monthly rainfall of almost six inches may have increased Fall River average monthly flow by some 300 cfs (see Figure 26).

4. COMPARISON OF 2004-2005 MONITORING DATA WITH HISTORIC INFORMATION

Several previous monitoring studies on Fall River were examined for a comparison with results from the 2003-2005 data. The following past Regional Water Quality Control Board monitoring studies were included in this analysis:

- Bacteriological Survey Data from Fall River and Eastman Lake, 1979 and 1980, CA RWQCB
- Fall River Water Quality Monitoring Survey, 1981, CA RWQCB
- Monitoring of Wild Rice Drainage and Receiving Waters in the Fall River Drainage of California, 1985, CA RWQCB
- Upper Fall River Water Quality Monitoring Study, Summer 1997, CA RWQCB
- Miscellaneous CA RWQCB File Memorandum

Other studies and monitoring data used in this analysis include:

- Fall River Aquatic Plants Study, 1996-97, USDA Ag. Research Service, UC Davis
- PG&E Pit 1 Power Project, Water Quality Monitoring Reports, 2004,2005,2006

Given their importance to aquatic life and other beneficial uses of Fall River, the following three parameters were chosen for this historical comparison; temperature, fecal coliform bacteria, and nutrients.

4.1 Water Temperature

Water temperatures were compared only for those sites and years where constant recording equipment was in use, thus allowing for the calculation of average monthly maximum temperatures. As shown in Table 4, those sites and years were Fletcher's Bridge (1997, 2004/05), Island Road Bridge (1984, 1997, 2005), Glenburn Bridge (1984, 2004/05), and the PG&E Diversion (1984, 2004/05). During the period of record, average monthly maximum water temperature varied by not more than 3ºF at any individual site monitored. In the upper reach of Fall River (Fletcher's Bridge to Island Rd. Bridge), maximum summer temperatures consistently stay within the range of 55° to 60°F. In the lower river (downstream to the PG&E Diversion), this range is 60° to 70°F.

Table 4 - Fall River Historical Tempature[1] Comparison						
Site	**Year**	**May**	**June**	**July**	**August**	**September**
Fletcher Bridge	1997		56	56	55	55
	2004	55		57	56	55
	2005	54	53	54	55	54
Island Road Bridge	1984	54	55	56	57	56
	1997	53	54	56	53	55
	2005	55	56	59	59	55
Glenburn Bridge	1984	61	65	66	64	61
	2004	61		68	65	60
	2005	59	63	68	65	59
PG&E Diversion	1984	59	66	69	66	62
	2004[2]		71	72	70	61
	2005	60	64	70	67	60
	2005[2]		68	71	69	63

[1] Average Monthly Maximum (ºF)

[2] Data From PG&E

Based on the available data record, there is no apparent trend of temperature change in Fall River over the past 20 years. Given the importance of this water quality parameter to the Fall River aquatic ecosystem, temperature should continue to be periodically monitored to evaluate any long-term trends.

4.2 Fecal Coliform Bacteria

Table 5 shows fecal coliform bacteria data collected by the Regional Board in 1980/81, 1997, and 2004/05. Since the most comprehensive sampling was performed in 1980/81 and in 2004/05, the results of those studies are summarized and compared in Table 6. This table shows the average fecal coliform concentration when all samples for all Fall River sites are combined.

The historic record shows periodic exceedence of the Regional Board’s water quality objective of 400 MPN maximum (for protection of contact recreation). Current elevated coliform levels appear to occur principally during the summer months. However, the 1981 data show that high concentrations were previously common during the fall and winter months also. Although elevated fecal coliform concentrations continue to periodically occur, summary comparison of the 1981 and 2004/05 data indicates that there has been a significant decline in fecal coliform numbers in Fall River over the past 20 years.

Table 5 - Fall River Fecal Coliform Bacteria Data, 1981-2005[1]													
Site	Year	January	February	March	April	May	June	July	August	September	October	November	December
Fletchers Bridge	1981	<2		9	15		93	7	43	4	15	1100	
	1997					26	30	30	30	4			
	2004	8	17	14		23	30	7	30	17	8	64	9
	2005	5	2	<2	<2	79	79	33		2			
Fall River Above Spring Creek	1981	<2	50	9	43		240	240	460	240	43	2400	
	1997					170	50	30	30	23			
	2004	11	50	22		70	80	13	50	79	17	23	17
	2005	2	2	<2	2	23	1600	220		17			
Island Road Bridge	1997	50		13		30	30	50		23			
	2004	50	30	13		50	300	27	130	49	33	21	
	2005	8	11	8	2	240		920		17			
Glenburn Bridge	1981	8		21	75		43	93	240	240	460	2400	
	2004	2	27	17		22	50	23	140	79	11	6	
	2005	8	5	<2	2	79	23	13		4			
Fall River Ranch Bridge	1981	2		9	93		240	23	93	240	240	2400	
	1997				26		30	30	30	4			
	2004	30	500	8		13	17	7	8	11	13	8	4
	2005	13	<2	6	2	79	220	23		8			
PG&E Intake	1981	4	50	23	23		240	43	240	43	240	2400	
	2004	8	50	8		283	8	2	8	17	5	2	
	2005	<2	2	5	4	350		8		8			
Spring Creek	1981	2	<2	4	43	80	1100	43	240	240	43	2400	
	1997					110	4	23	130	23			
	2004	17	30	11			170	540	90	49	33	23	<2
	2005	23		<2	13	170	9	140		13			
Eastman Lake	1981	4		9	<3		43	43	150	93	43	2400	
	2004	4	4	<2		13	<2	<2	4	<2	2	4	
	2005		<2	8	2	7	5	79					
Little Tule River	1981	2		<3	9	4	43	<3	75	43	210	240	
	2004	7	8	<2		4	7	<2	4	5	2	5	
	2005		2	13	<2	5	2	240					
Tule River	1981	<2		150	15		43	23	240	240	460	2400	
	2004	<2	190	17		8	<2	16	11	1	1	2	3
	2005		<2	4	5	3	2	25					

[1]MPN/100 ml

Table 6 - Fecal Coliform Bacteria Summary Comaprision[1]	
Year	**Annual Average For All Fall River Sites**
1981	338
2004/2005	66

[1]MPN/100 ml

4.3 Nutrients (Nitrate Nitrogen and Total Phosphorous)

Historic comparison of nutrient monitoring data in Fall River is difficult due to the inconsistent nature of sampling times and location. The 2004/05 study showed little upstream-downstream variation, so for purposes of a summary analysis, all the nutrient data for all Fall River sites was combined and averaged for three different time periods, i.e. (1) all RWQCB data from 1977-85, (2) data from 1996/97 studies by the RWQCB and by USDA, and (3) data from the 2004/05 RWQCB study. This comparison is shown in Table 7.

Table 7 shows nitrate nitrogen data for the three time periods compared (1977-85, 1996-97, and 2004-05). Nutrient concentrations are similar and there is no apparent upward or downward trend. For unknown reasons, total phosphorus data from the 1996 USDA study showed substantially higher concentrations compared to RWQCB data collected from the earlier and later time periods. RWQCB total phosphorus data from 1977-85 and from 2004-05 showed similar concentration levels.

Table 7 - Fall River Historical Nutrient Comparision				
Time Period	**No3-N**		**Total P**	
	Mean	Range	Mean	Range
1977-1985	0.11	0.02 - 0.27	0.08	0.05 - 0.14
1996-1997	0.15	0.06 - 0.36	0.21	0.03 - 0.5
2004-2005	0.12	0.07 - 0.18	0.06	0.03 - 0.23

[1] Data in mg/l

FIGURES

FIGURE 2. MAXIMUM DAILY WATER TEMPERATURE AT FALL RIVER & TRIBUTARY SITES 2004 & 2005

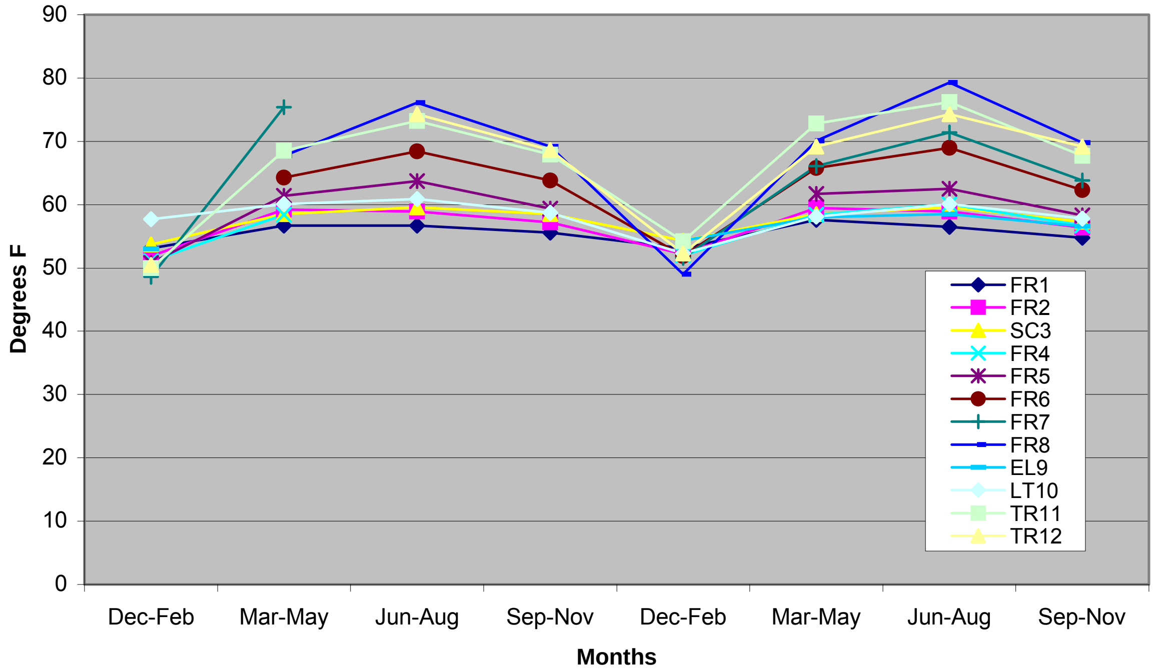


FIGURE 3. MAXIMUM 7-DAY AVERAGE WATER TEMPERATURE AT FALL RIVER & TRIBUTARY SITES DURING WINTER, SPRING, SUMMER, & FALL OF 2004 & 2005

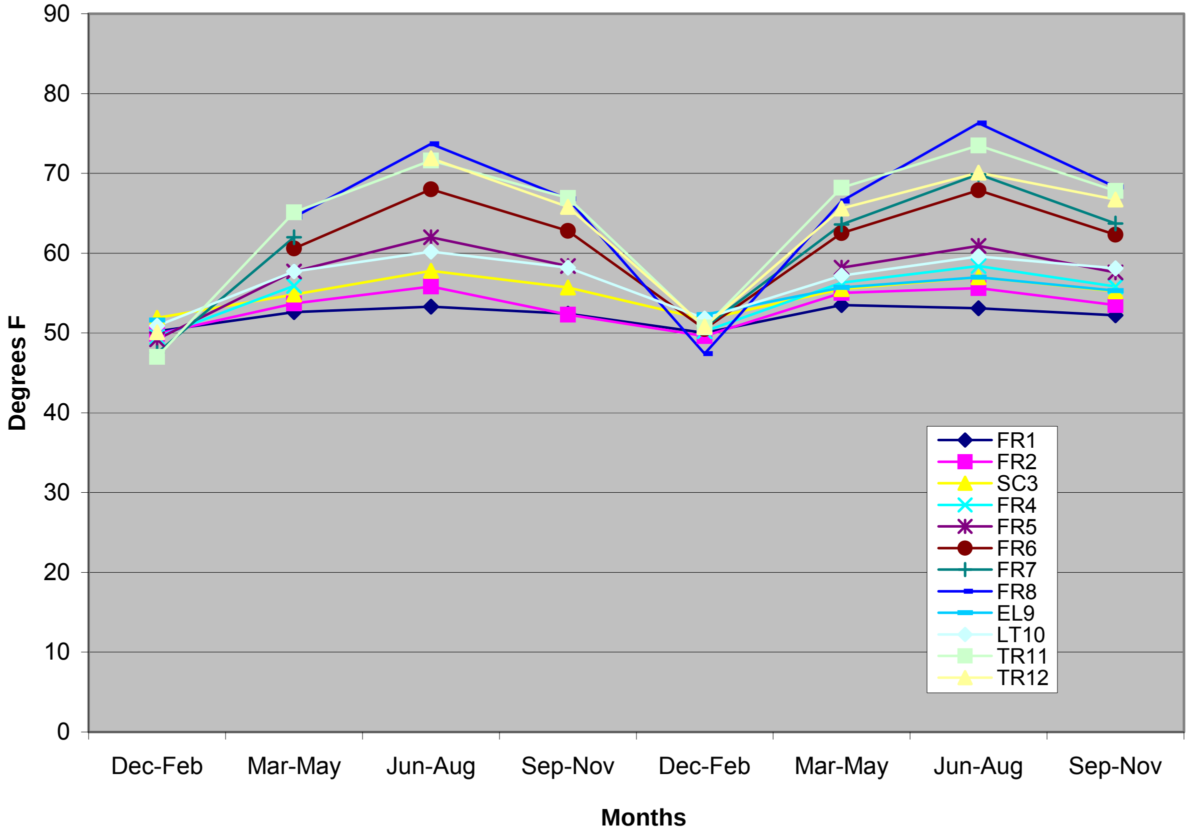


FIGURE 4. DAILY & 7-DAY AVERAGE MAXIMUM WATER TEMPERATURE AT SPRING CREEK SITE (SC3) 2005

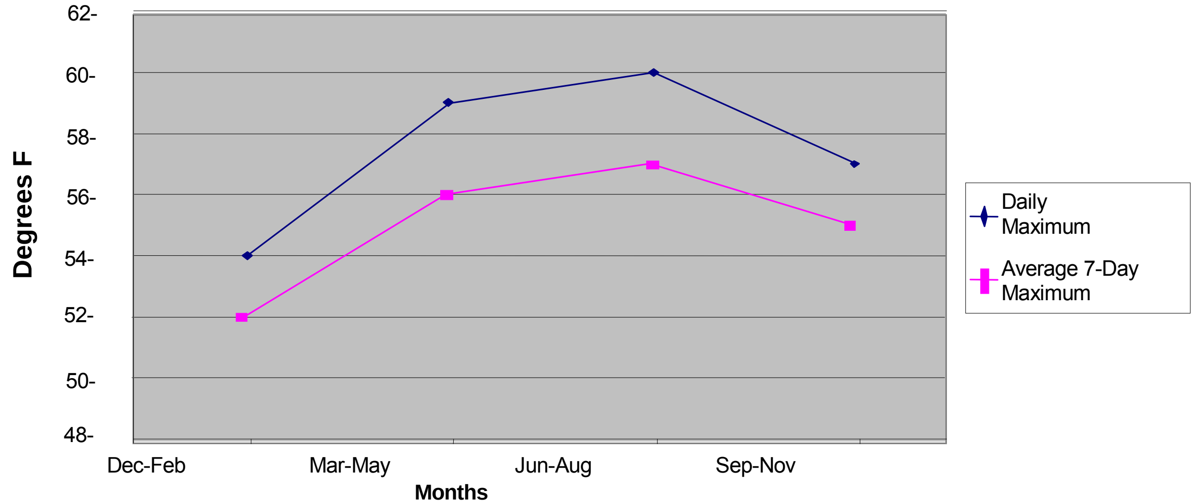


FIGURE 5. DAILY AND 7-DAY AVERAGE MAXIMUM WATER TEMPERATURE AT EASTMAN LAKE (EL9) SITE 2005

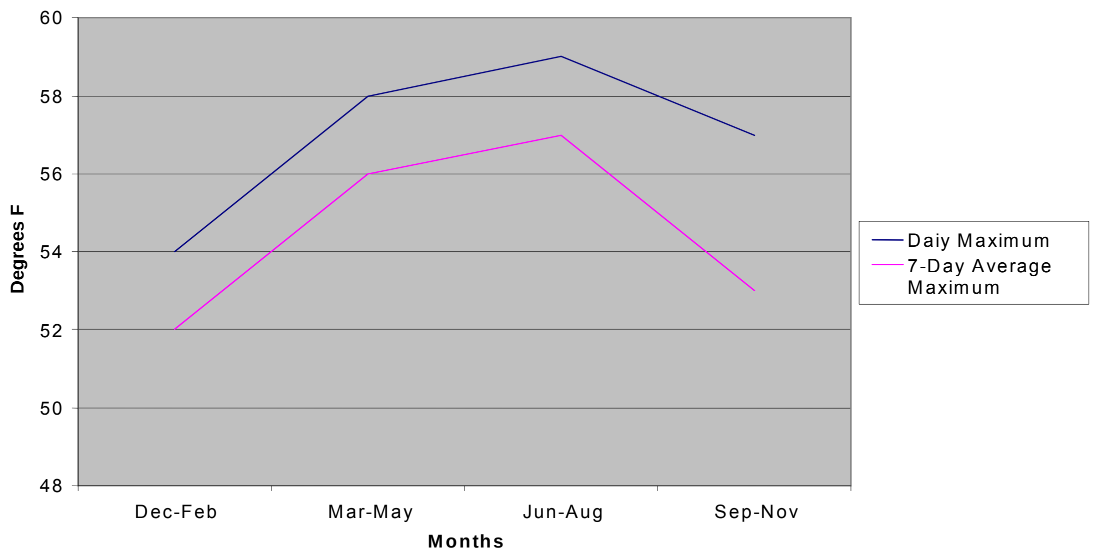


FIGURE 6. DAILY AND 7-DAY AVERAGE MAXIMUM WATER TEMPERATURE AT LITTLE TULE SITE (LT10) 2005

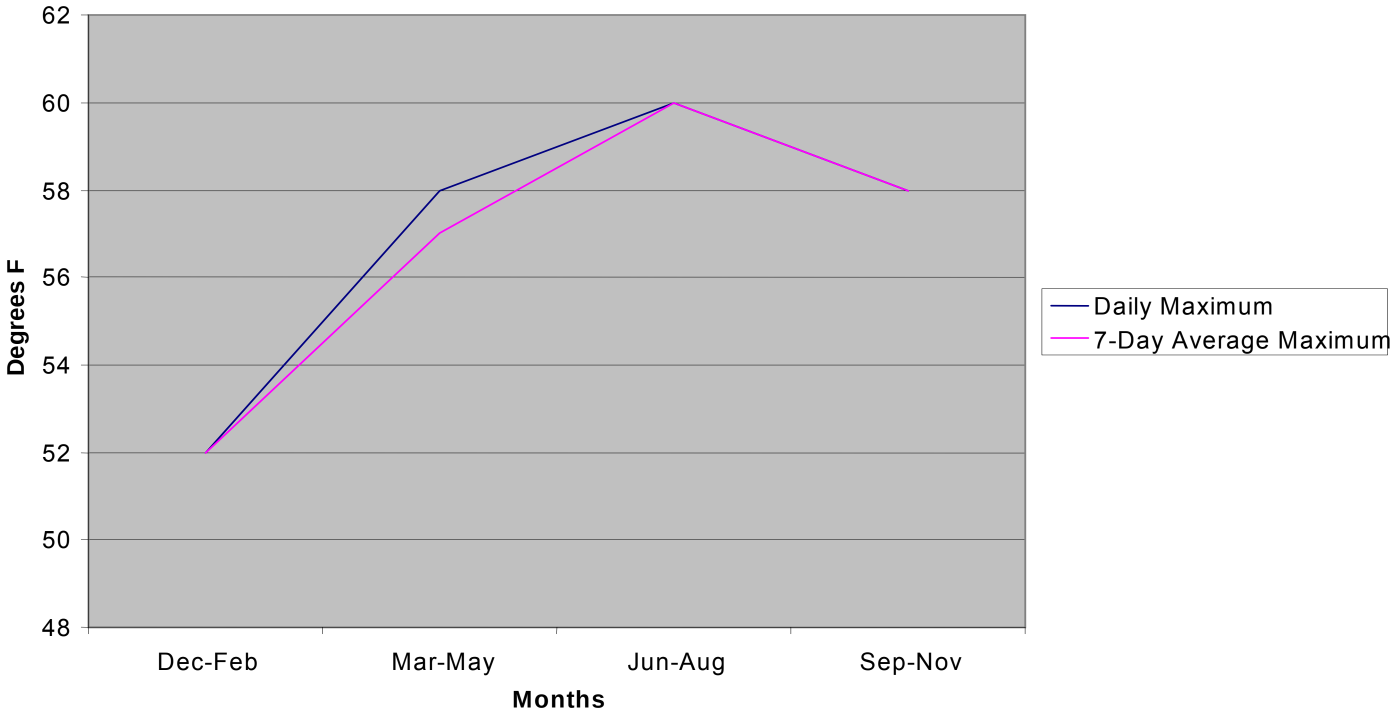


FIGURE 7. DAILY AND 7-DAY MAXIMUM WATER TEMPERATURE AT TULE RIVER SITE (TR11) 2005

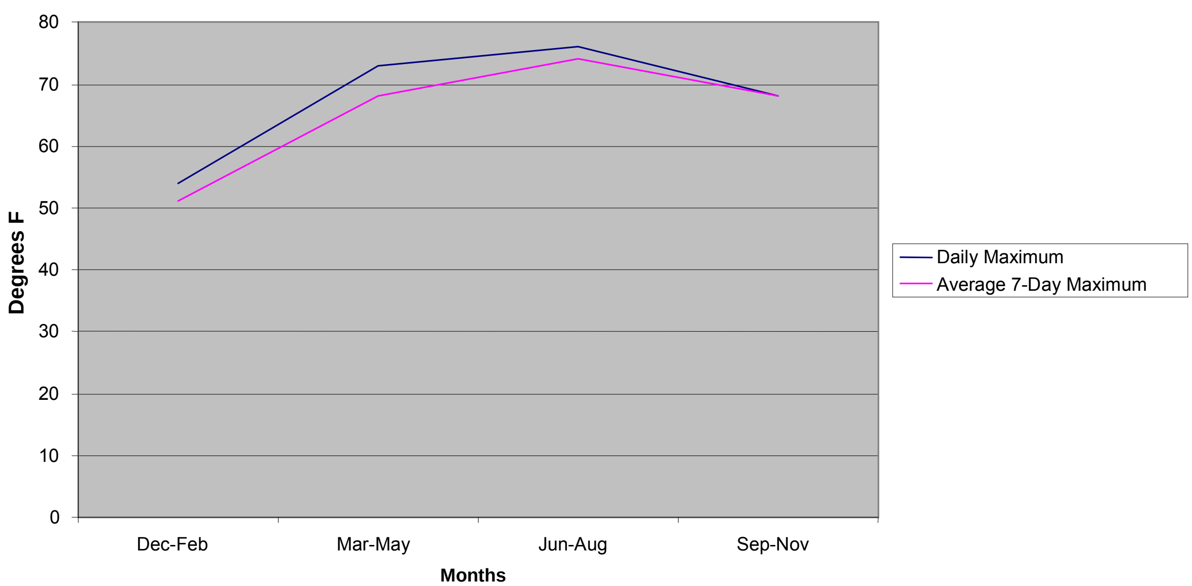


FIGURE 8. DAILY AND 7-DAY AVERAGE MAXIMUM WATER TEMPERATURE AT TULE RIVER SITE (TR12) 2004-2005

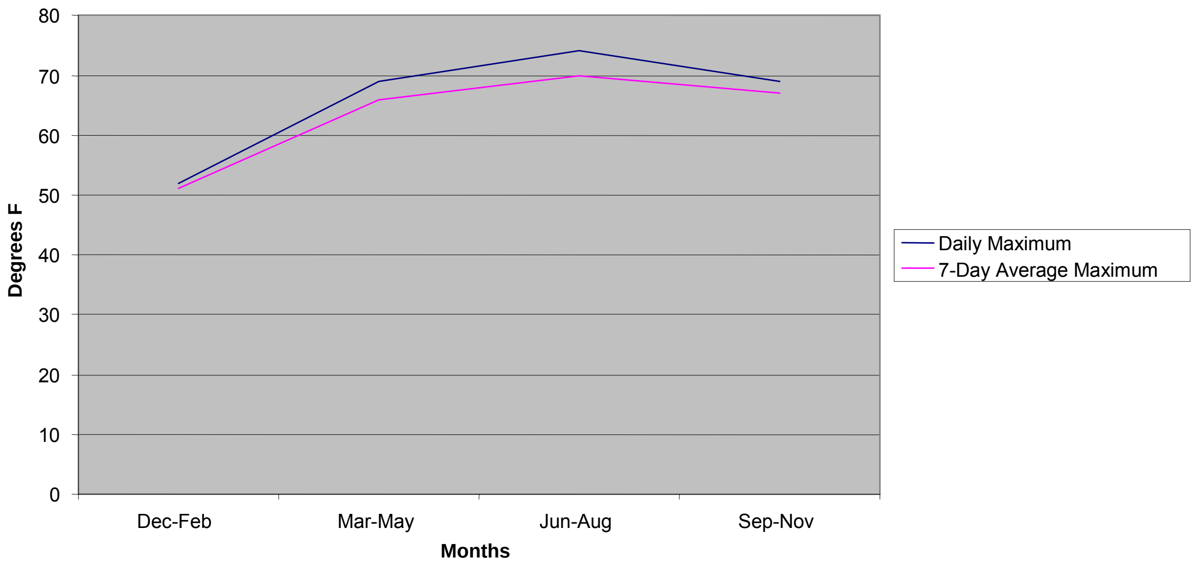


FIGURE 9. CONDUCTIVITY AT FALL RIVER & TRIBUTARY SITES 2004-2005

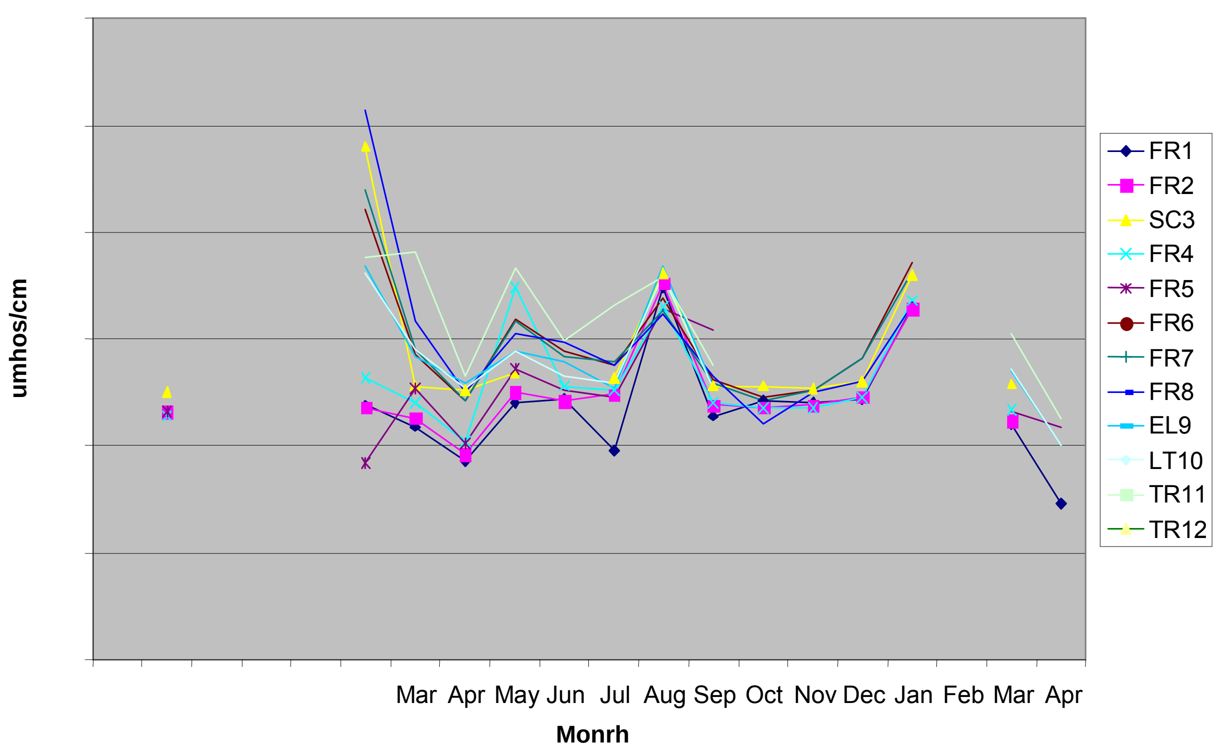


FIGURE 10. pH AT FALL RIVER SITES 2004-2005

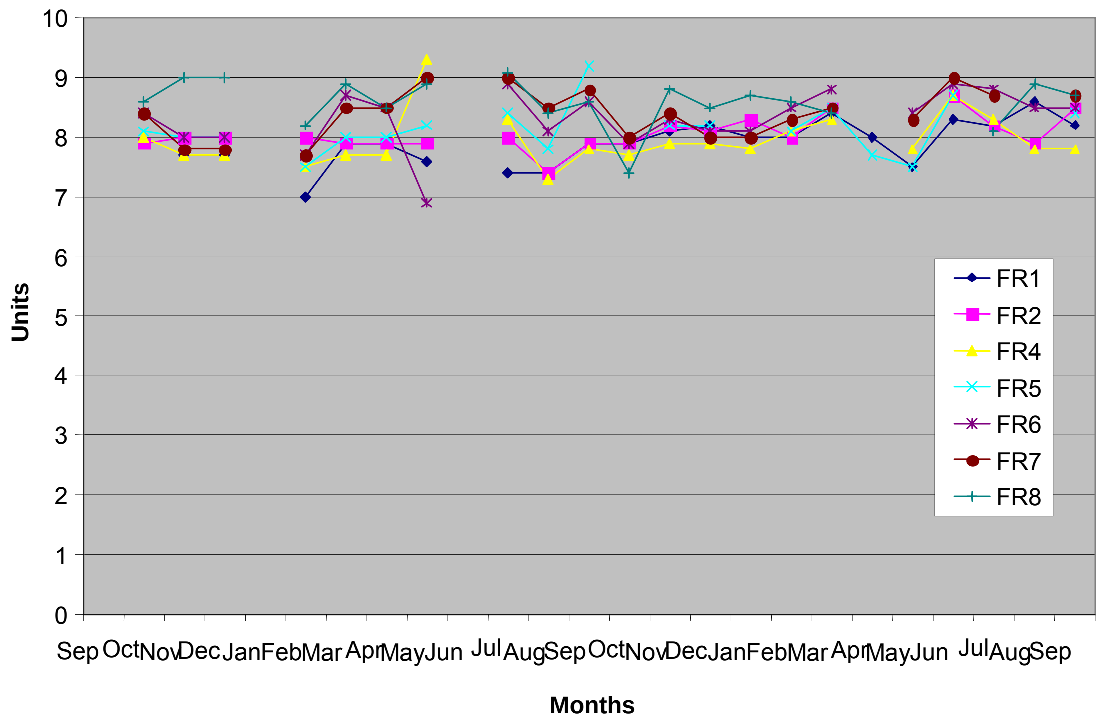


FIGURE 11. pH AT FALL RIVER TRIBUTARY SITES 2004-2005

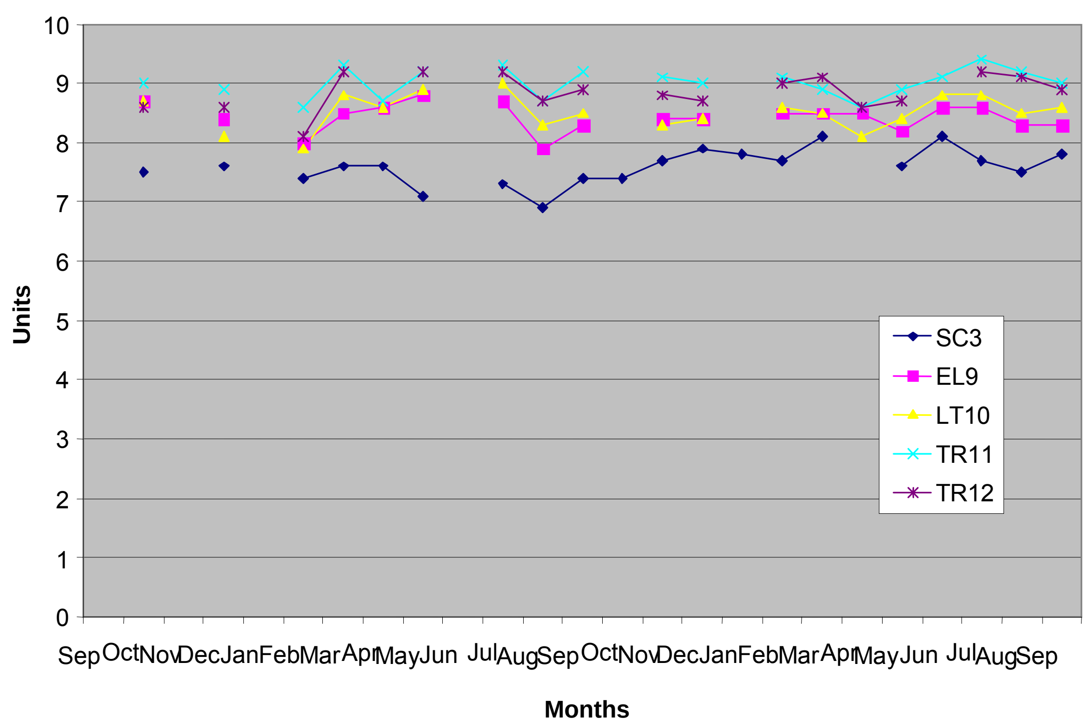
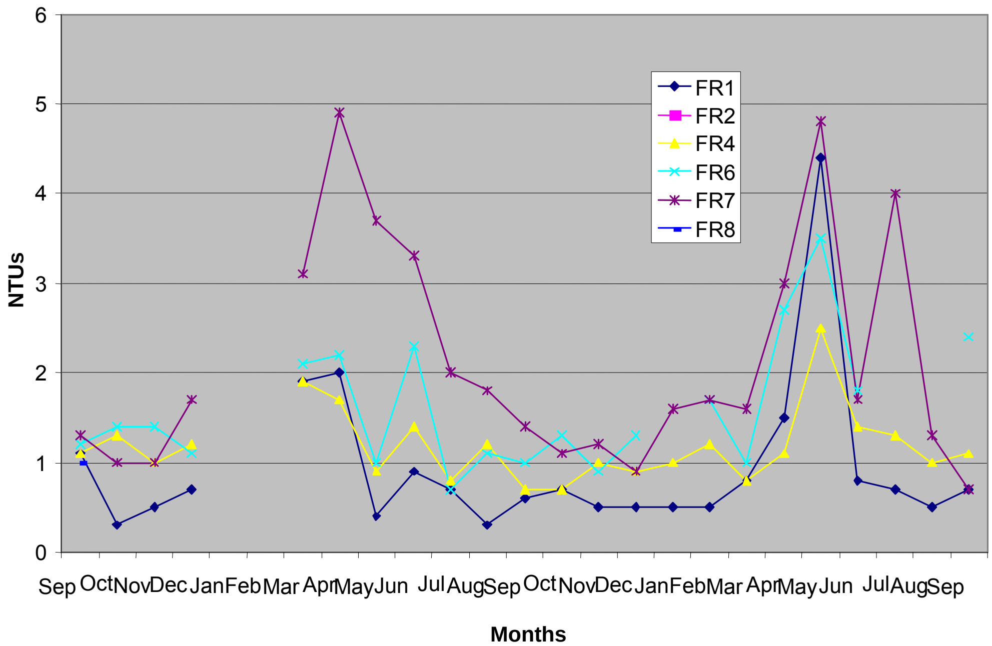


FIGURE 12. TURBIDITY AT FALL RIVER SITES
2003-2005



Note: Turbidity at Sites 1, 2, 4, 6, 7, & 8 were 15.4, 23.5, 23.2, 67.2, 40,2, & 21.5 NTUs during the February 19, 2004 sampling.

FIGURE 13. TURBIDITY AT FALL RIVER TRIBUTARY SITES
2003-2005

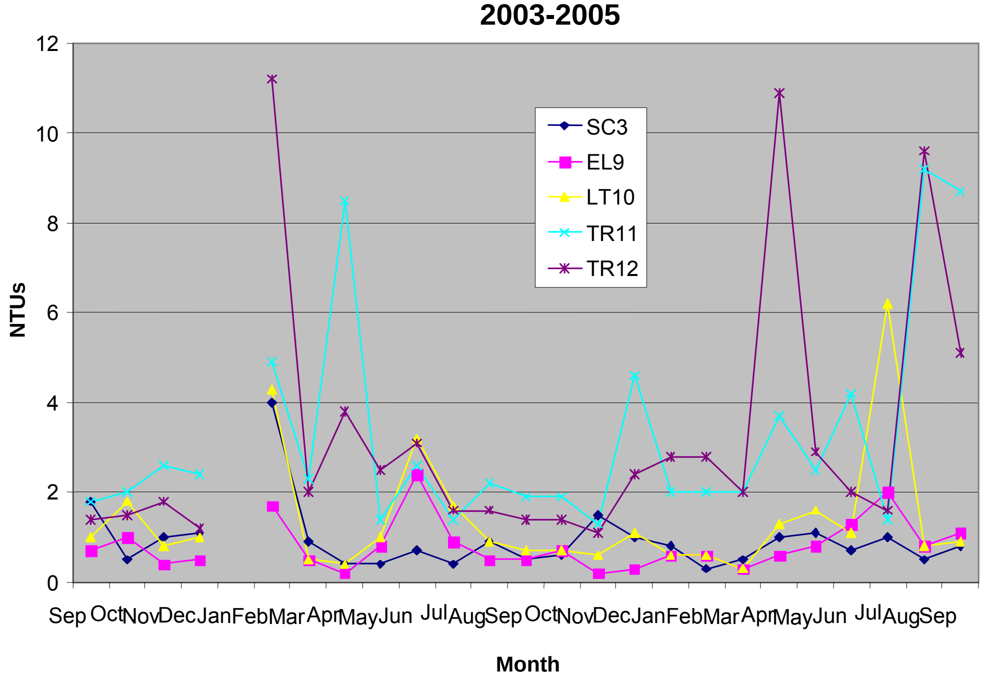
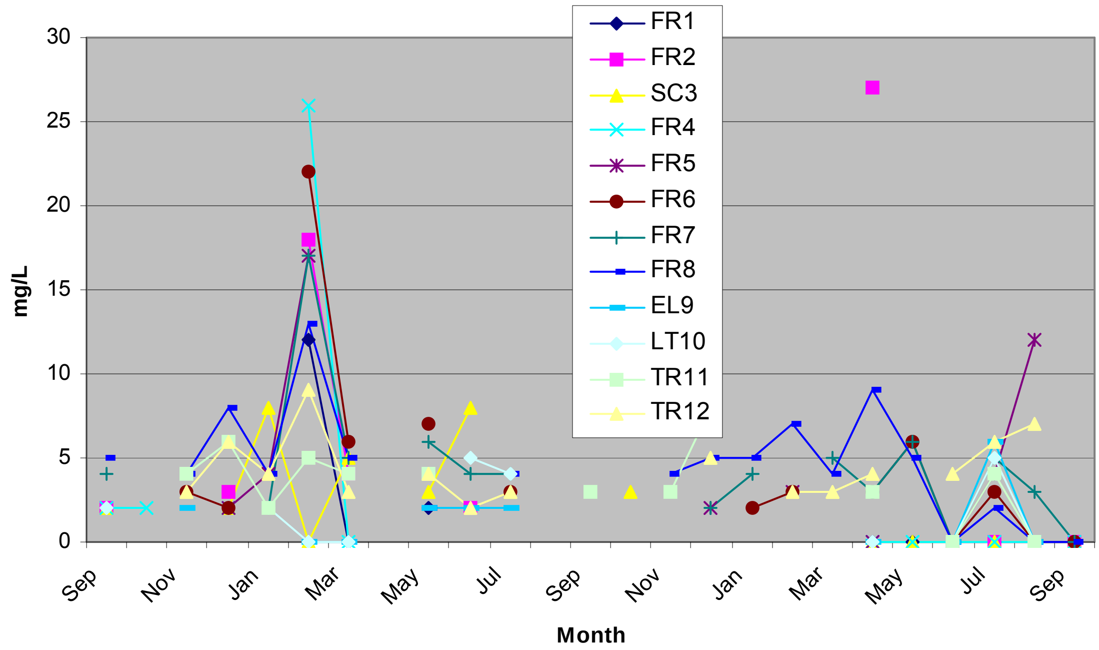


FIGURE 14. TOTAL SUSPENDED SOLIDS AT FALL R. & TRIBUTARY SITES 2003-2005



Note: The August 2005 value for Site FR5 was 122 mg/L.

FIGURE 15. TSS/TURBIDITY MONTHLY AVERAGE AT FALL RIVER & TRIBUTARY SITES 2003-2005

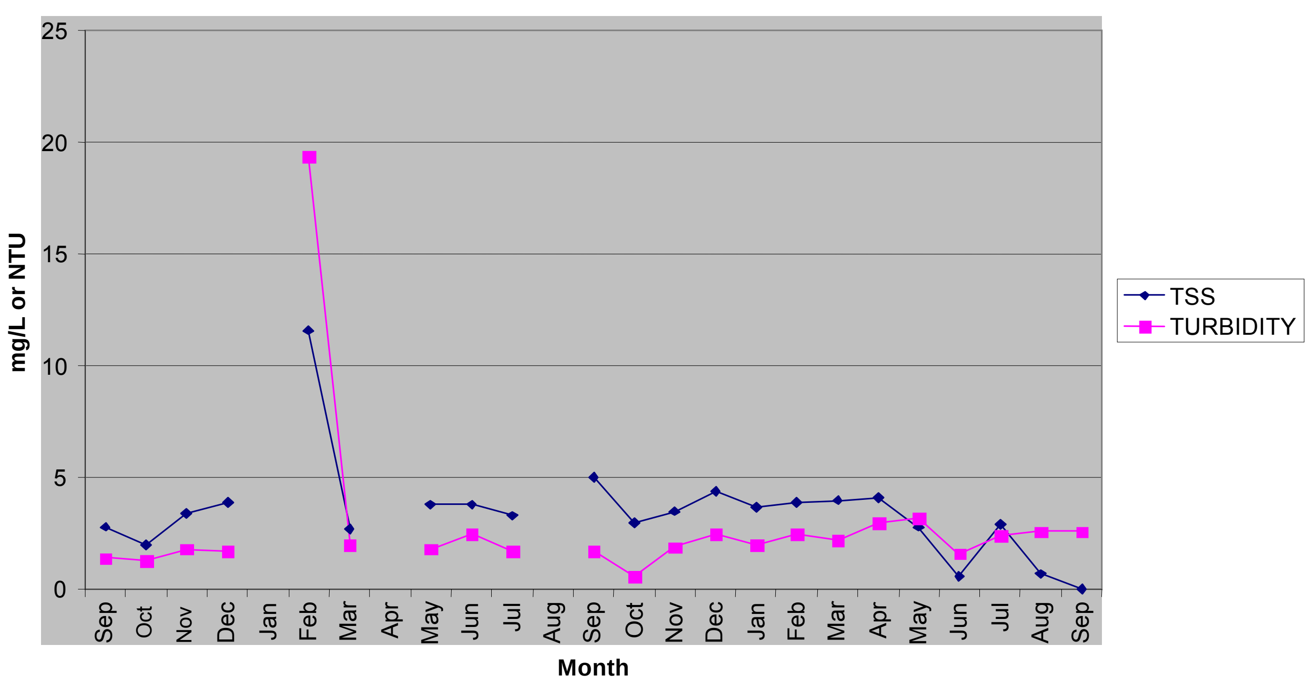


FIGURE 16. FECAL COLIFORM AT FALL RIVER SITES 2003-2005

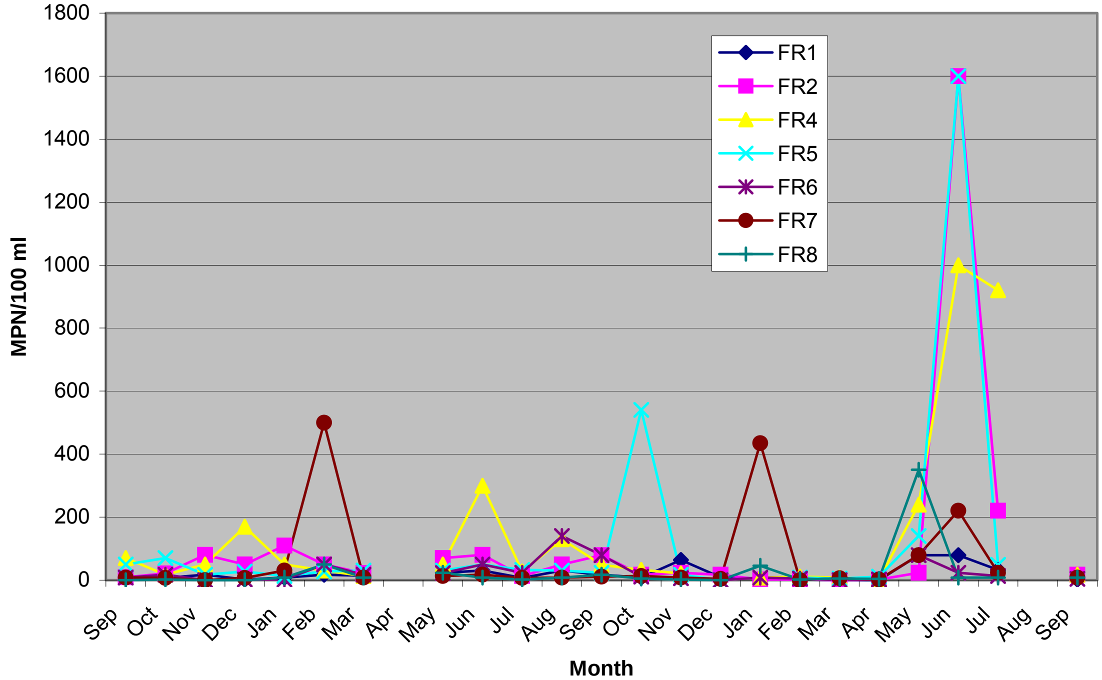
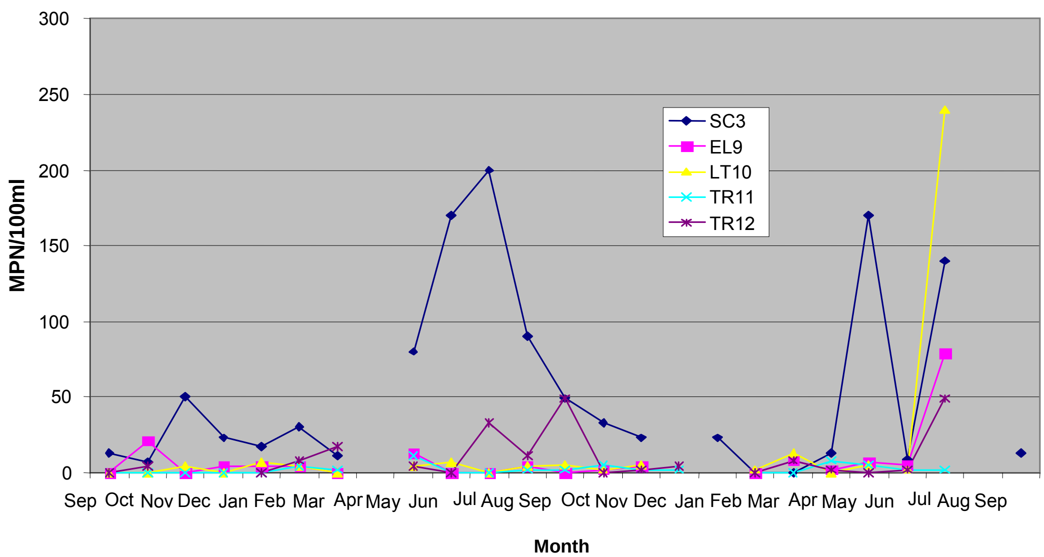


FIGURE 17. FECAL COLIFORM AT FALL RIVER TRIBUTARY 2003-2005



Note: The value for July 2004 at site SC3 is 540 MPN/100ml.

FIGURE 18. AVERAGE FECAL AND E. COLI BACTERIA AT FALL R. & TRIBUTARY STATIONS DURING 2004-2005

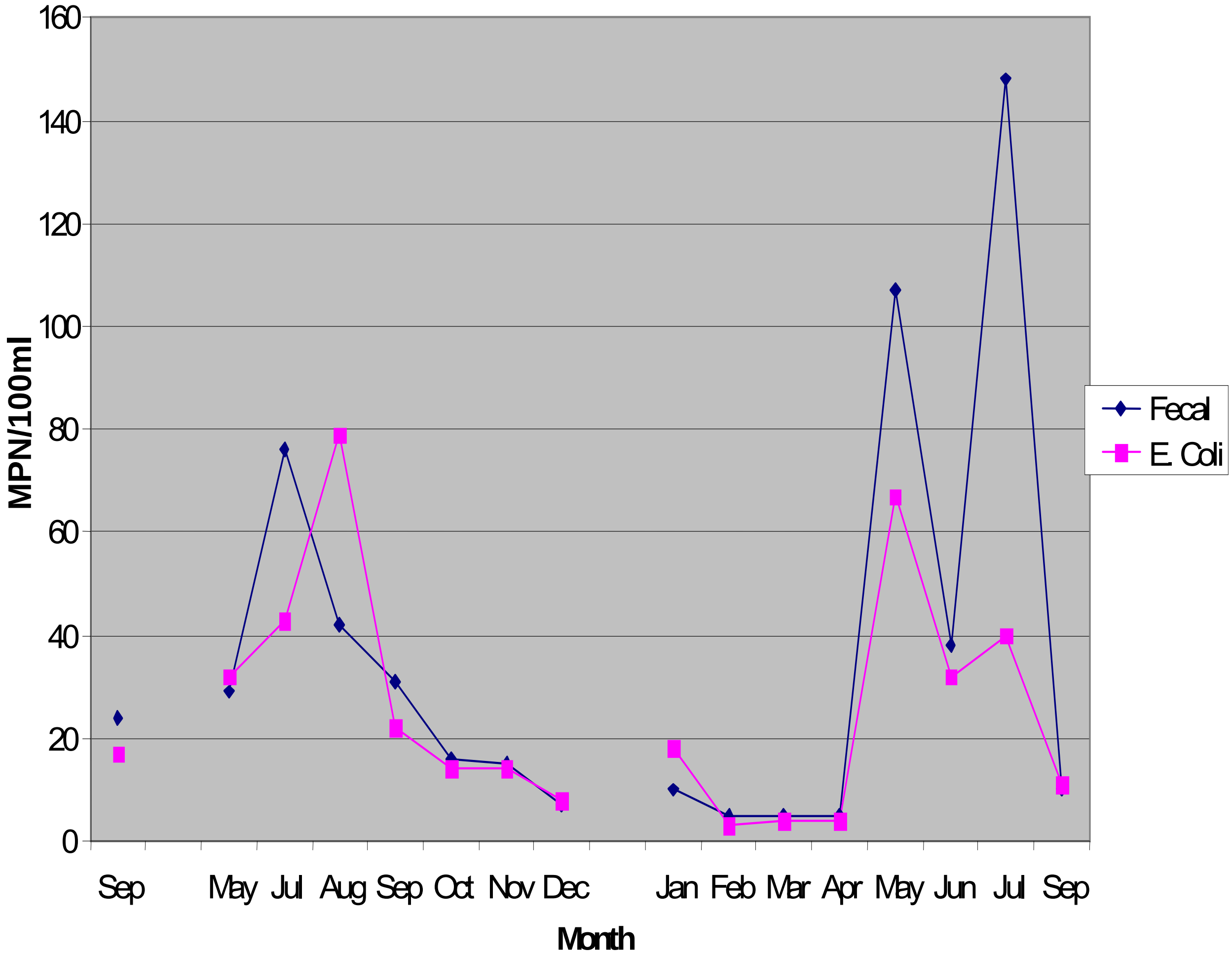
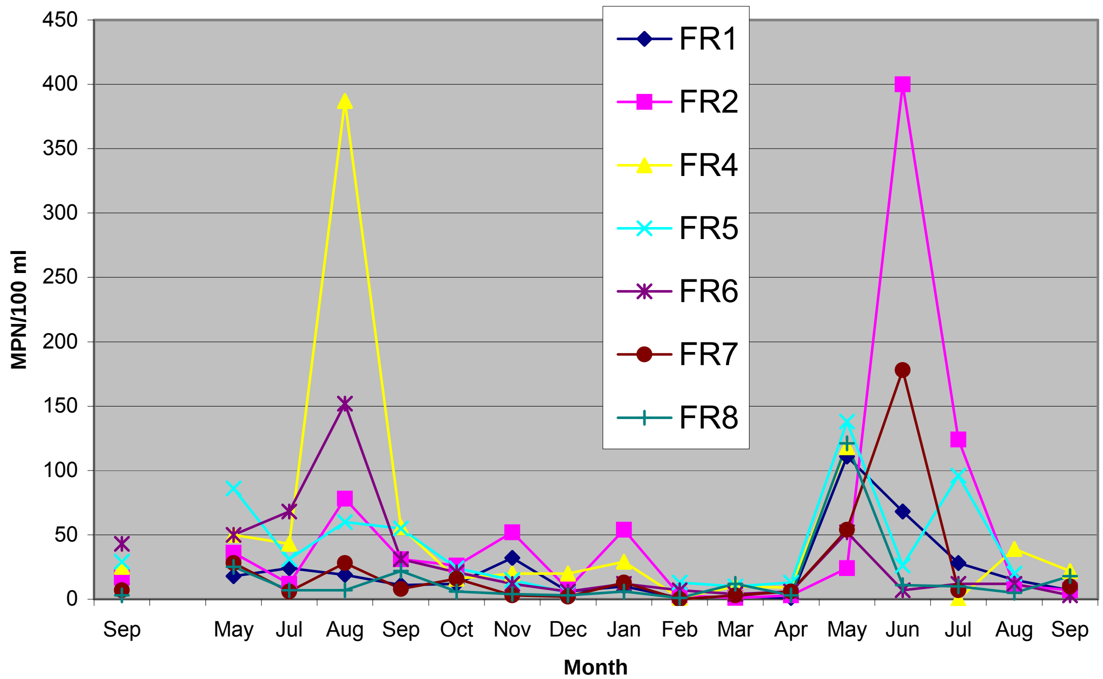


FIGURE 19. E. COLI AT FALL RIVER SITES 2003-2005



Note: E. Coli levels on 23 June 2005 were >1600 mpn/100 ml at Sites 1 & 5.

FIGURE 20. E. COLI AT FALL RIVER TRIBUTARY SITES 2003-2005

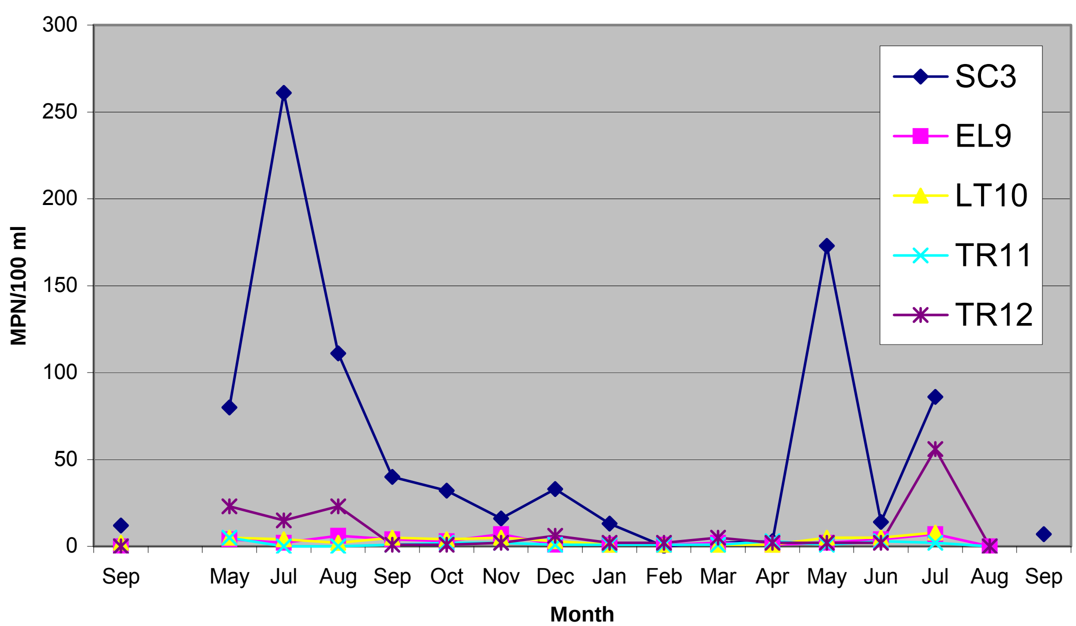


FIGURE 21. NITRATE NITROGEN AT FALL RIVER SITES 2003-2005

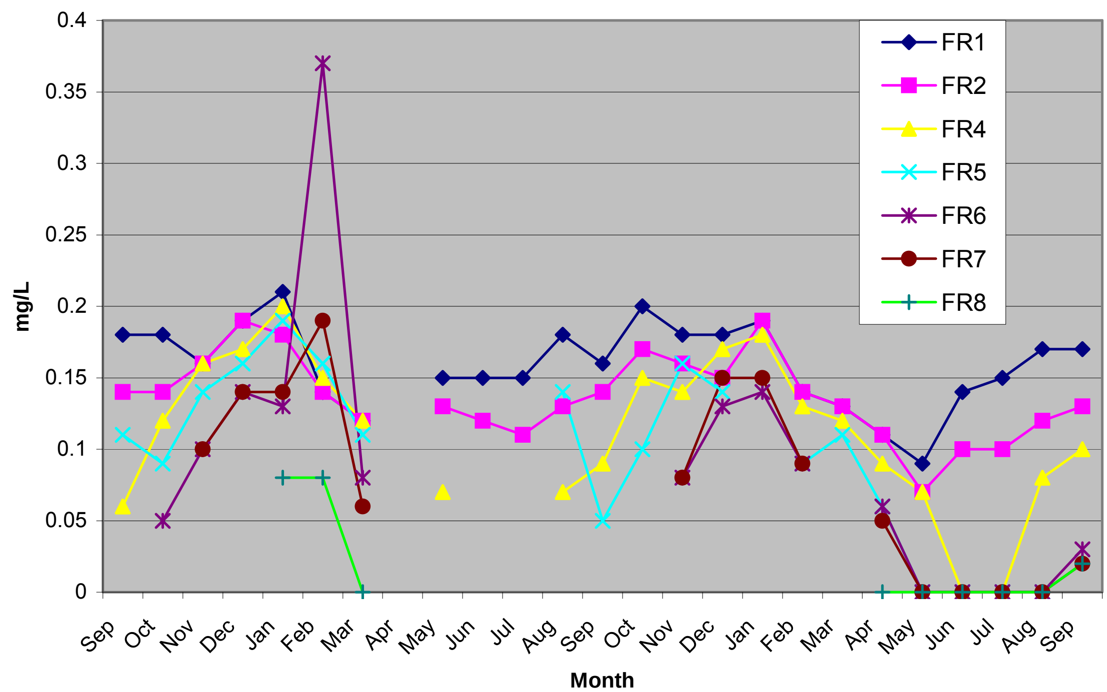


FIGURE 22. NITRATE NITROGEN AT FALL RIVER TRIBUTARY SITES 2003-2005

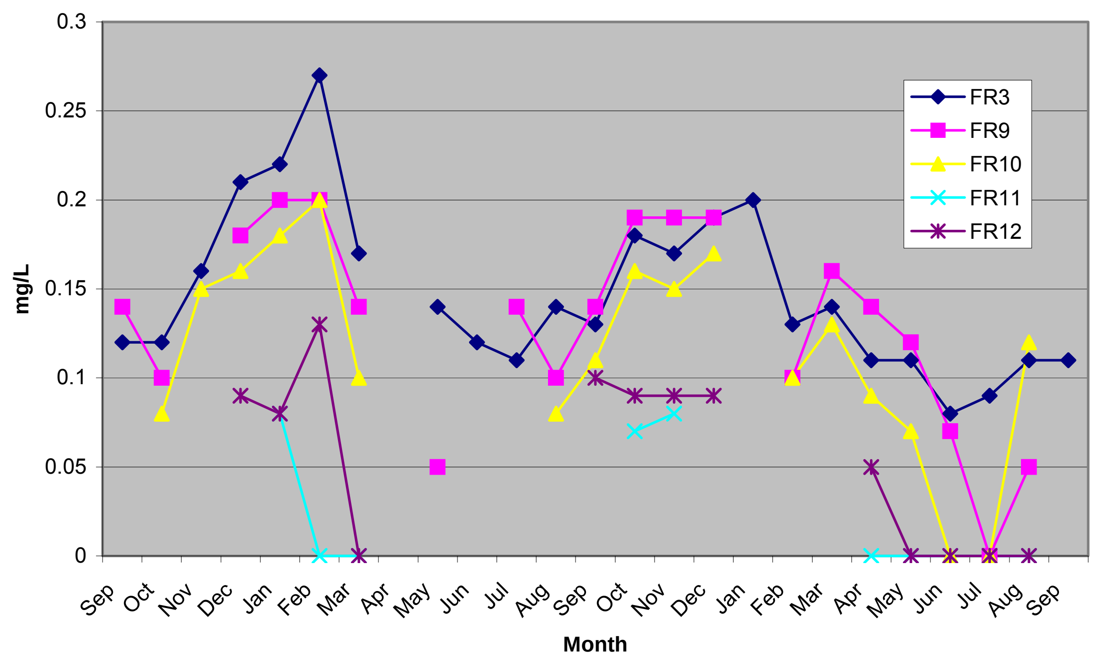


FIGURE 23. PHOSPHOROUS AT FALL RIVER SITES 2003-2005

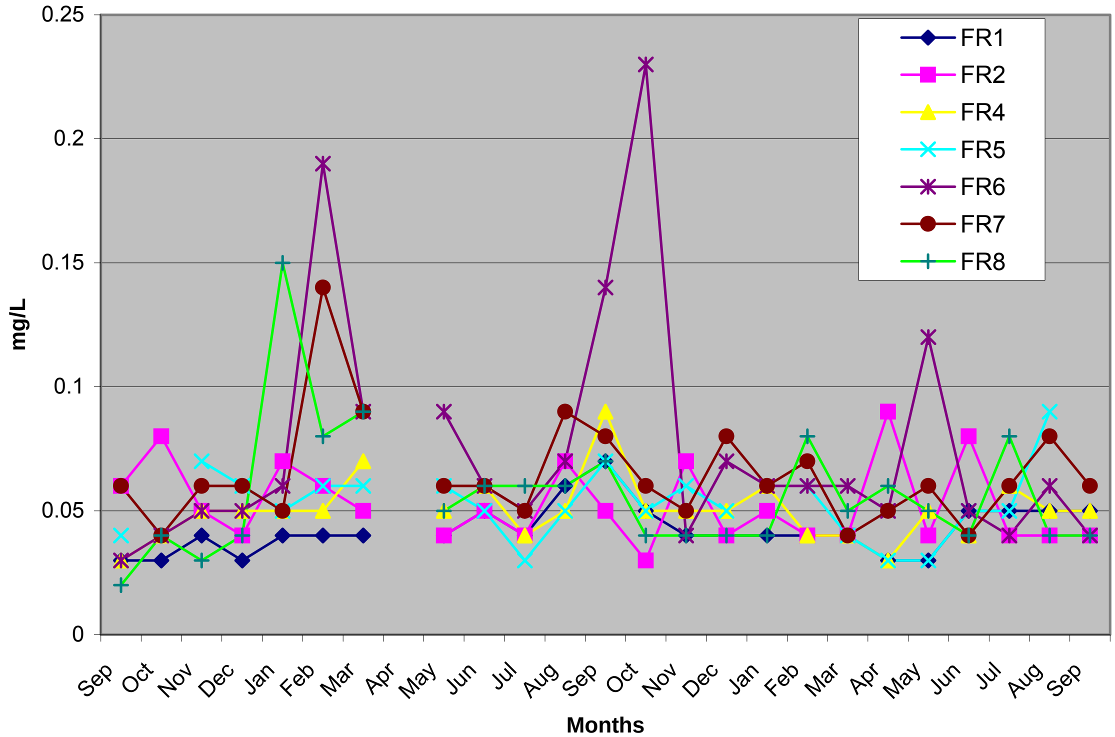


FIGURE 24. PHOSPHOROUS AT FALL RIVER TRIBUTARY SITES 2003-2005

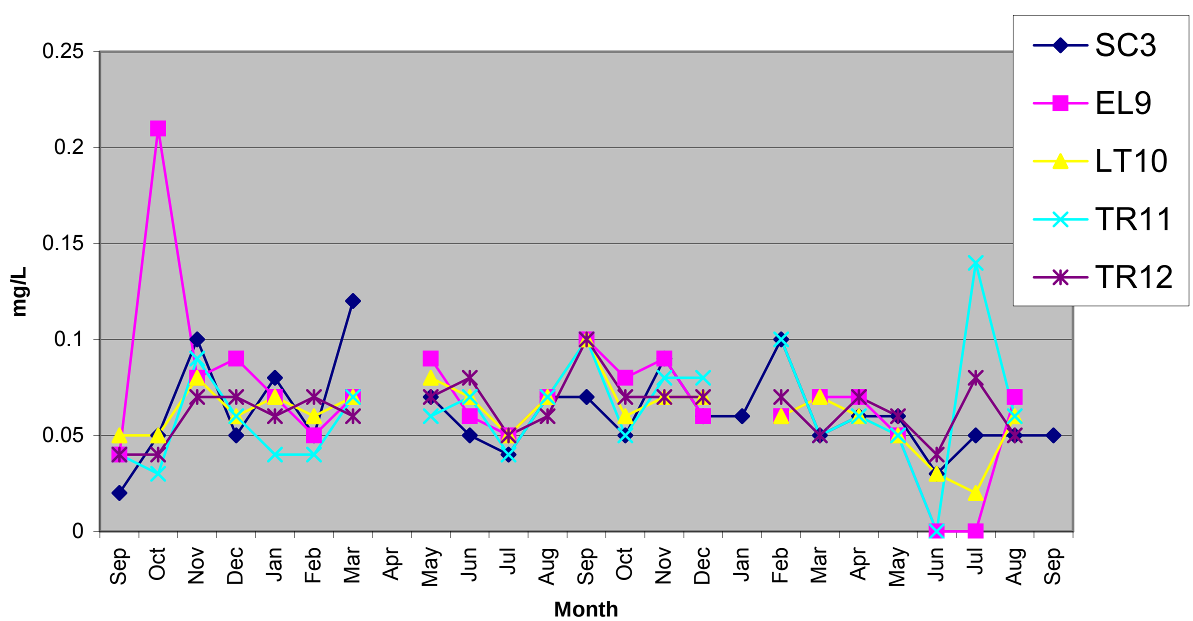


FIGURE 25. NITRATE/PHOSPHOROUS MONTHLY AVERAGE AT FALL RIVER AND TRIBUTARY SITES 2003-2005

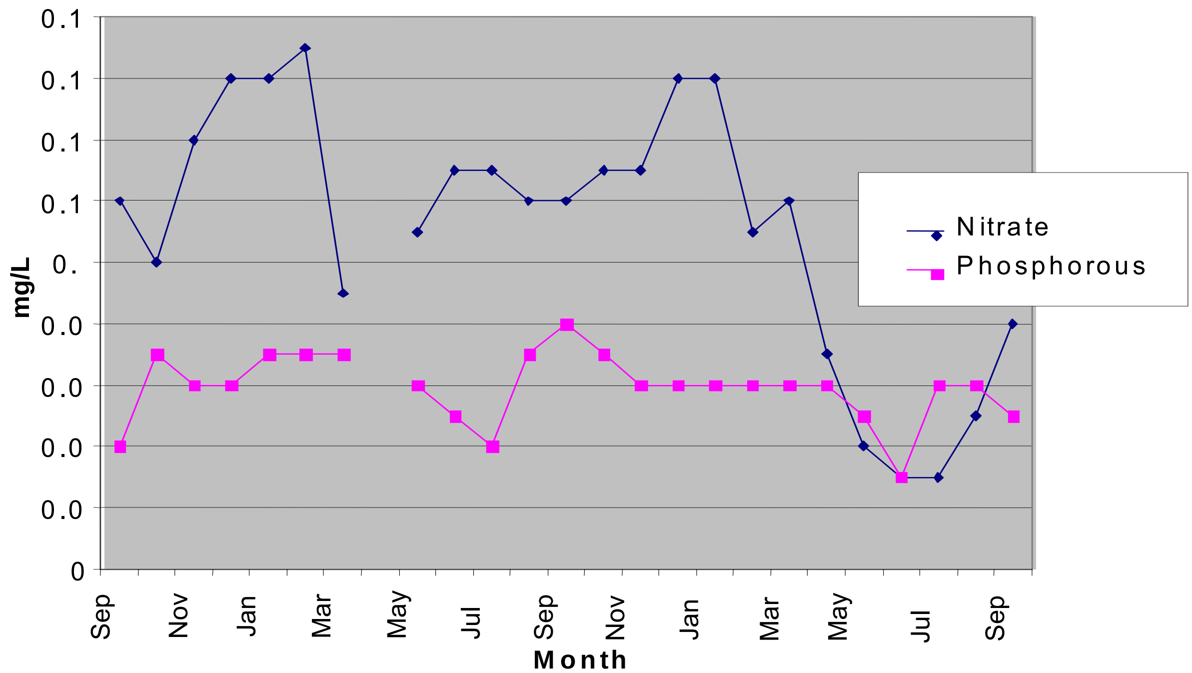


FIGURE 26. FALL RIVER FLOW FOR 2004 & 2005 - PG&E PIT 1 POWERHOUSE DIVERSION PLUS BYPASS

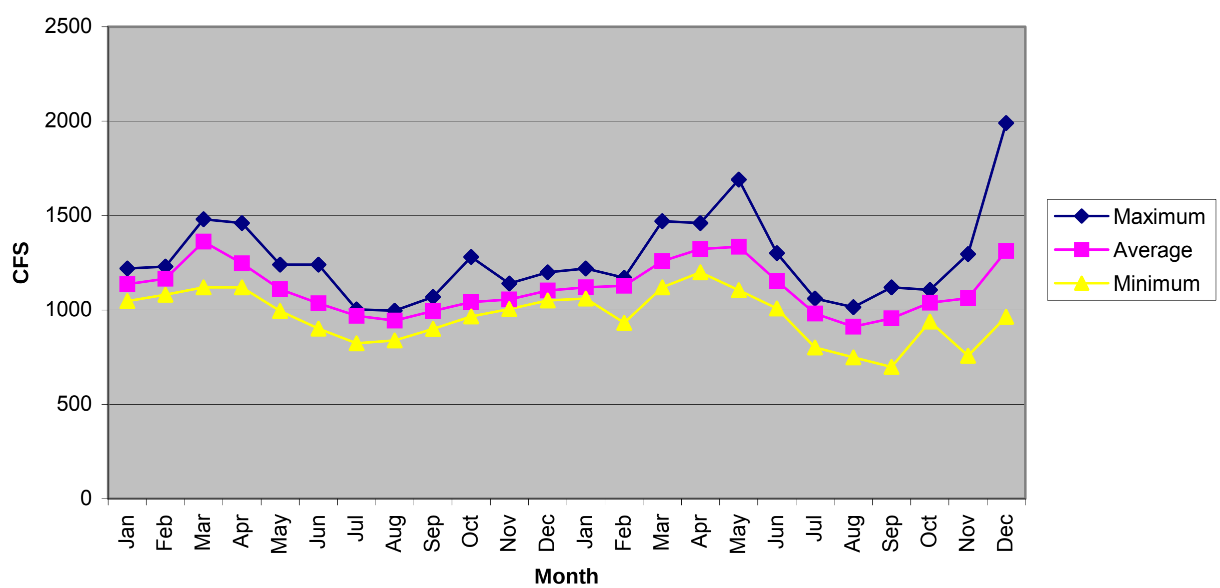
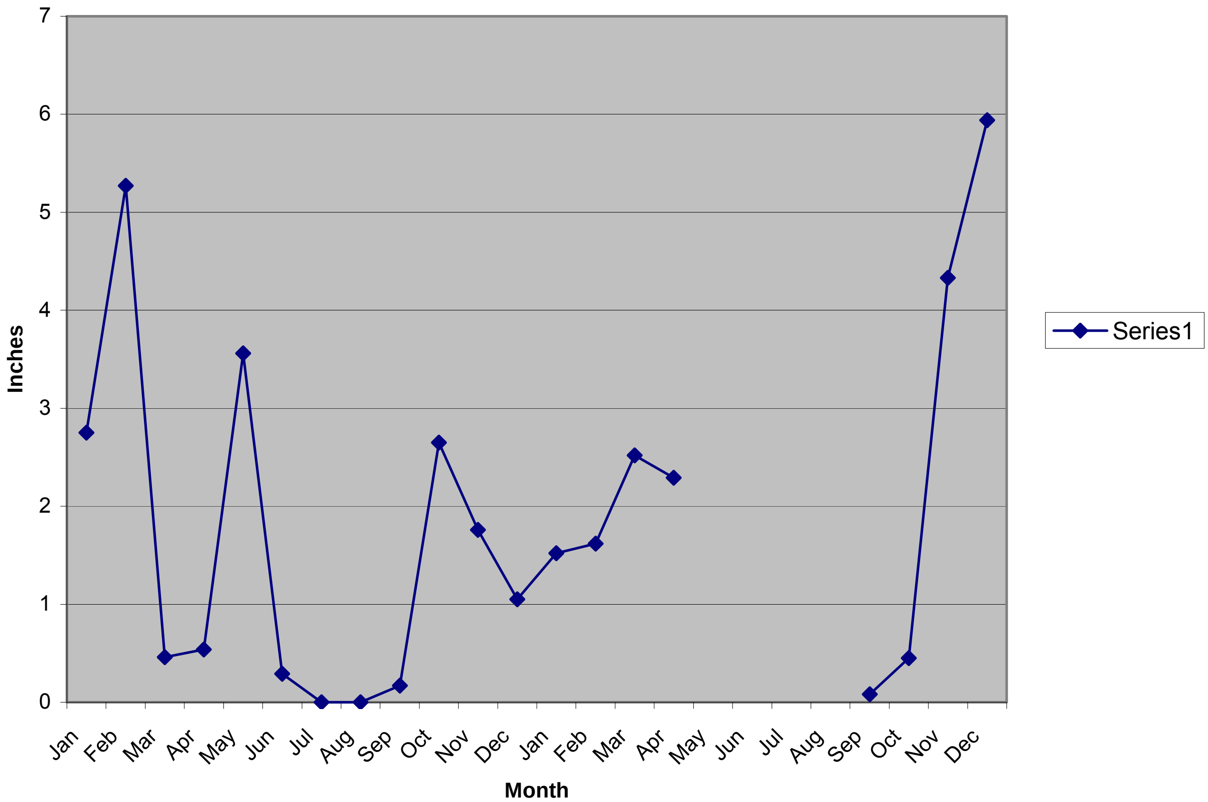


FIGURE 27. TOTAL MONTHLY RAINFALL FOR 2004-2005 AT PG&E PIT 1 POWERHOUSE



Appendix A. Fall River Water Quality Data 2003-2005

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	µmhos/cm	pH	NTU's	MPN/100ml	MPN/100ml	MPN/100ml	MPN/100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
9/15/2003	10:10	1	53			1.1			8	12	0.18		0.03	
9/15/2003	10:45	3	54			1.8			13	12	0.12	2	0.02	
9/15/2003	11:00	2	52			0.8			9	17	0.14	2	0.06	
9/15/2003	11:30	4	55			1.1			70	25	0.11	2	0.03	
9/15/2003	13:30	9	58			0.7			<2	<1	0.14		0.04	
9/15/2003	14:00	10	58			1.0			<2	2	0.08	2	0.05	
9/15/2003	14:20	11	65			1.8			<2	<1			0.04	
9/15/2003	14:45	5	58			1.2			50	29	0.06		0.04	
9/15/2003	15:00	12	63			1.4			<2	<1			0.04	
9/15/2003	15:30	6	60			1.3			8	43			0.03	
9/15/2003	16:00	7	63			1.7			8	7		4	0.06	
9/15/2003	16:30	8	67			1.7			<2	3		5	0.02	
10/21/2003	8:35	4	49	114	8.0	0.3	110		7		0.18		0.03	
10/21/2003	8:55	3	51	125	7.5	0.5	240		7		0.12		0.05	
10/21/2003	9:15	2	49	116	7.9	0.8	390		21		0.14		0.08	
10/21/2003	9:40	4	51	118	7.8	1.3	1600		17		0.12	2	0.04	
10/21/2003	10:25	6	54	128	8.4	1.0	1600		17		0.05		0.04	
10/21/2003	10:45	7	54	123	8.4	1.1	900		7				0.04	
10/21/2003	11:15	8	55	119	8.6	1.8	110		2				0.04	
10/21/2003	13:00	11	58	142	9.0	2.0	50		<2				0.03	
10/21/2003	13:15	10	55	131	8.7	1.8	4		<2		0.08		0.05	
10/21/2003	13:30	9	54	129	8.7	1.0	22		2		0.10		0.21	
10/21/2003	14:00	12	57	134	8.6	1.5	23		4				0.04	
10/21/2003	14:15	5	53	116	8.1	1.4	220		70		0.09		0.05	
11/24/2003	9:30	1				0.5	90		17		0.16		0.04	
11/24/2003	9:55	3				1.0	80		50		0.16		0.10	
11/24/2003	10:15	2				0.8	80		80		0.16		0.05	
11/24/2003	11:00	4				1.0	50		8		0.16		0.05	
11/24/2003	11:30	6				1.0	17		<2		0.10	3	0.05	
11/24/2003	11:45	7				1.3	130		<2		0.10		0.06	
11/24/2003	12:00	8				2.0	240		<2			3	0.03	
11/24/2003	13:10	11				2.6	11		<2			4	0.09	
11/24/2003	13:30	10				0.8	17		4		0.15		0.08	
11/24/2003	13:50	9				0.4	4		<2		0.18	2	0.08	
11/24/2003	14:15	12				1.8	130		<2			3	0.07	
11/24/2003	14:30	5				1.4	130		17		0.14	4	0.07	
12/22/2003	9:10	3	50		7.6	1.1	80		23		0.21	2	0.05	
12/23/2003	8:39	1	49		7.7	0.7	17		2		0.19		0.03	
12/23/2003	8:39	2	47		8.0	1.2	80		50		0.19	3	0.04	
12/23/2003	9:50	4	48		7.7	1.2	220		170		0.17	2	0.05	
12/23/2003	10:10	6	46		8.0	1.7	500		2		0.14	2	0.05	
12/23/2003	10:35	7	46		7.8	1.6	80		7		0.14		0.06	
12/23/2003	11:00	8	43		9.0	3.8	170		<2			8	0.04	
12/23/2003	13:45	11	44		8.9	2.4	17		<2			6	0.06	
12/23/2003	14:00	10	50		8.1	1.0	17		<2		0.16		0.06	

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
12/23/2003	14:30	9	51		8.4	0.5	80		4		0.18		0.09	
12/23/2003	14:55	12	46		8.6	1.2					0.09	6	0.07	
12/23/2003	15:05	5	48		8.0	1.1	240		27		0.16	2	0.06	
1/19/2004	8:45	1					50		8		0.21		0.04	
1/19/2004	9:05	3					70		17		0.22	8	0.08	
1/19/2004	9:10	11					7		<2		0.08	2	0.04	
1/19/2004	9:25	2					300		110		0.18		0.07	
1/19/2004	9:30	10					170		7		0.18	2	0.07	
1/19/2004	9:45	4					110		50		0.20		0.05	
1/19/2004	9:45	9					30		4		0.20		0.07	
1/19/2004	10:00	6					500		2		0.13		0.06	
1/19/2004	10:10	12					90		<2		0.08	4	0.06	
1/19/2004	10:15	5					>1600		13		0.19	4	0.05	
1/19/2004	10:30	7					130		30		0.14	2	0.05	
1/19/2004	10:45	8					220		8		0.08	4	0.15	
2/19/2004	8:30	5	42	92	7.5	15.8	1600		27		0.16	17	0.06	
2/19/2004	8:45	12	46	186	8.1	11.2	350		8		0.13	9	0.07	
2/19/2004	9:00	11	45	188	8.6	4.9	30		4		nd	5	0.04	
2/19/2004	9:30	10	49	181	7.9	4.3	300		4		0.20	nd	0.06	
2/19/2004	9:40	9	50	184	8.0	1.7	240		4		0.20	nd	0.05	
2/19/2004	13:20	3	51	240	7.4	4	220		30		0.27	nd	0.05	
2/19/2004	14:30	1	42	119	7.0	15.4	1600		17		0.14	12	0.04	
2/19/2004	14:50	2	41	118	8.0	23.5	900		50		0.14	18	0.06	
2/19/2004	15:00	4	42	132	7.5	23.2	>1600		30		0.15	26	0.05	
2/19/2004	15:30	6	46	211	7.7	67.2	500		50		0.37	22	0.19	
2/19/2004	17:15	7	46	220	7.7	40.2	>1600		500		0.19	17	0.14	
2/19/2004	17:45	8	45	257	8.2	21.5	1600		50		0.08	13	0.08	
3/22/2004	7:00	1	48	109	7.9	1.9	500		14		0.12	nd	0.04	
3/22/2004	7:20	3	51	128	7.6	0.9	50		11		0.17	5	0.12	
3/22/2004	7:40	2	48	113	7.9	2.0	240		22		0.12	4	0.05	
3/22/2004	8:10	4	49	120	7.7	1.9	300		13		0.12	nd	0.07	
3/22/2004	8:25	6	55	143	8.7	3.1	220		17		0.08	6	0.09	
3/22/2004	8:50	7	55	145	8.5	3.4	50		8		0.06	5	0.09	
3/22/2004	9:10	8	57	158	8.9	3.1	17		8		nd	5	0.09	
3/22/2004	10:40	11	61	191	9.3	2.3	4		2		nd	4	0.07	
3/22/2004	10:50	10	55	145	8.8	0.5	7		<2		0.10	nd	0.07	
3/22/2004	11:05	9	55	142	8.5	0.5	13		<2		0.14	nd	0.07	
3/22/2004	11:25	12	59	171	9.2	2.0	30		17		nd	3	0.06	
3/22/2004	11:35	5	53	127	8.0	2.1	130		30		0.11	nd	0.06	
4/?/2004		1	48	93	7.9	2.0								
4/?/2004		2	48	96	7.9	3.0								
4/?/2004		3	51	126	7.6	0.4								
4/?/2004		4	48	102	7.7	1.7								
4/?/2004		5	50	101	8.0	2.2								
4/?/2004		6	50	121	8.5	4.9								
4/?/2004		7	51	121	8.5	3.5								

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosporus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
4/?/2004		8	55	125	8.5	3.7								
4/?/2004		9	52	129	8.6	0.2								
4/?/2004		10	53	127	8.5	0.4								
4/?/2004		11	51	133	8.6	8.5								
4/?/2004		12	51	112	8.7	3.8								
5/27/2004	8:15	1	50	120	7.6	0.4	108		23	18	0.15	2	0.04	
5/27/2004	8:25	3		134	7.1	0.4	186		80	56	0.14	3	0.07	
5/27/2004	8:45	2	52	125	7.9	0.7	291		70	36	0.13		0.04	
5/27/2004	9:00	4	55	174	9.3	0.9	649		50	50	0.07		0.05	
5/27/2004	9:15	6	62	159	6.9	3.7	345		22	50		7	0.09	2.0
5/27/2004	9:40	7	63	158	9.0	3.1	435		13	28		6	0.06	
5/27/2004	9:55	8	65	153	8.9	1.9	461		23	25		2	0.05	
5/27/2004	11:10	11	65	183	9.2	1.4	214		11	5		4	0.06	
5/27/2004	11:25	10	58	144	8.9	1.0	1200		4	5			0.08	
5/27/2004	11:35	9	56	142	8.8	0.8	124		13	4	0.05	2	0.09	
5/27/2004	12:00	12	64	174	9.2	2.5	138		4	23		4	0.07	
5/27/2004	12:05	5	59	136	8.2	1.0	816		30	86			0.06	
6/23/2004	8:00	3	54			0.7	500		170		0.12	8	0.05	
6/23/2004	8:30	2	52	121		1.7	>1600		80		0.12	2	0.05	
6/23/2004	9:00	1	51	122		0.9	>1600		30		0.15		0.04	
6/23/2004	9:20	4	58	128		1.4	>1600		300				0.06	
6/23/2004	9:50	7	67	142		4.0	500		17			4	0.07	1.4
6/23/2004	10:15	8	71	148		3.4	500		8				0.06	
6/23/2004	11:15	5	61	126		2.3	>1600		50				0.05	
6/23/2004	11:45	12	70	158		3.1	50		<2			2	0.08	
6/23/2004	12:00	10	62	133		3.2	50		7			5	0.07	
6/23/2004	12:30	9	59	139		2.4	<2		<2			2	0.06	
6/23/2004	13:00	11	71	149		2.6	17		<2				0.07	
6/23/2004	13:30	6	67	144		3.3	1600		50				0.06	
7/20/2004	10:00	1	54	98	7.4	0.7	313		7	24	0.15		0.04	
7/20/2004	10:30	3	55	132	7.3	0.4	>2419		540	261	0.11		0.04	
7/20/2004	10:45	2	53	124	8.0	0.5	1990		13	12	0.11		0.04	
7/20/2004	11:15	4	59	126	8.3	0.8	378		27	43			0.04	
7/20/2004	11:30	6	69	138	8.9	2.0	1990		23	68		3	0.05	
7/20/2004	12:00	7	68	139	9.0	1.9	1120		7	6		4	0.05	0.86
7/20/2004	12:20	8	71	138	9.1	2.2	1730		2	7		4	0.06	
7/21/2004	8:30	9	57	127	8.7	0.9	231		<2	2	0.14	2	0.05	
7/21/2004	8:45	10	59	129	9.0	1.7	1550		<2	4		4	0.05	
7/21/2004	9:30	5	60	123	8.4	0.7	2420		33	31			0.03	
7/21/2004	9:45	12	70	150	9.2	1.6	2420		33	15		3	0.05	
7/21/2004	10:20	11	73	166	9.3	1.4	1990		<2	<1			0.04	
8/19/2004	8:00	1	51	174	7.4	0.3	50	214	30	19	0.18		0.06	
8/19/2004	8:20	2	51	176	7.4	1.0	130	1990	50	78	0.13		0.07	
8/19/2004	10:15	11	69	179	8.7	2.2	80	461	2	<1			0.07	
8/19/2004	10:40	10	58	180	8.3	0.9	30	1730	4	2	0.08		0.07	
8/19/2004	10:55	9	56	184	7.9	0.5	11	1300	4	6	0.10		0.07	

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/19/2004	11:35	12	68	176	8.7	1.6	130	2420	11	23			0.06	
8/19/2004	11:45	5	59	164	7.8	1.1	300	1200	30	60			0.05	
8/20/2004	8:00	3	54	181	6.9	0.9	1600	>2419	90	111	0.14		0.07	
8/20/2004	8:45	4	57	165	7.3	1.2	500	>2419	130	387	0.07		0.05	
8/20/2004	9:10	6	65	169	8.1	1.8	1600	>2419	140	152			0.07	
8/20/2004	10:30	8	70	162	8.4	1.0	280	>2419	8	7			0.06	
8/20/2004	11:20	7	66	163	8.5	1.8	900	1990	8	28			0.09	0.95
9/22/2004	8:00	1	50	114	7.9	0.6	49	105	17	11	0.16		0.07	
9/22/2004	8:00	9	53	128	8.3	0.5	13	435	<2	4	0.14		0.10	
9/22/2004	8:10	10	54	127	8.5	0.7	13	1200	5	5	0.11		0.10	
9/22/2004	8:20	11	57	138	9.2	1.9	49	1200	2	1		3	0.10	
9/22/2004	8:30	3	53	128	7.4	0.5	540	866	49	40	0.13		0.07	
9/22/2004	8:30	12	57	133	8.9	1.4	95	866	5	1	0.10		0.10	
9/22/2004	8:40	5	52	154	9.2	1.0	220	2420	23	55	0.05		0.07	
9/22/2004	8:50	2	50	119	7.9	0.5	350	1120	79	31	0.14		0.05	
9/22/2004	9:10	4	54	120	7.8	0.7	130	613	49	56	0.09		0.09	
9/22/2004	9:30	6	59	131	8.6	1.4	1600	>2419	79	31		7	0.14	
9/22/2004	10:10	7	59	129	8.8	1.5	920	2420	11	8			0.08	0.97
9/22/2004	10:20	8	65	133	8.6	1.4	350	>2419	17	22			0.07	
10/22/2004	8:05	8	52	110	7.4	1.3	280	>2419	5	6			0.04	
10/22/2004	8:20	7	50	121	8.0	1.3	170	436	13	16	0.13		0.06	
10/22/2004	8:40	4	51	118	7.7	0.7	240	365	33	16	0.15		0.05	
10/22/2004	9:00	1	50	121	7.9	0.7	46	74	8	12	0.20		0.05	
10/22/2004	9:15	3	51	128	7.4	0.6	350	722	33	32	0.18	3	0.05	
10/22/2004	9:40	2	49	118	7.9	0.8	130	225	17	26	0.17		0.03	
10/22/2004	9:55	6	50	123	7.9	1.1	540	1410	11	21	0.12		0.23	
10/22/2004	11:00	11				1.9	17	120	5	2	0.07		0.05	
10/22/2004	11:10	10				0.7	33	452	2	4	0.16		0.06	
10/22/2004	11:20	9				0.7	23	727	2	3	0.19		0.08	
10/22/2004	11:50	12				1.4	33	272	<2	1	0.09		0.07	
10/22/2004	12:00	5				1.3	540	816	46	24	0.10		0.05	
11/19/2004	10:25	11	47		9.1	1.3	130	126	2	2	0.08	3	0.08	
11/19/2004	10:30	10	50		8.3	0.6	17	1550	5	5	0.15		0.07	
11/19/2004	10:40	9	51		8.4	0.2	49	201	4	7	0.19		0.09	
11/19/2004	11:00	12	48		8.8	1.1	140	2420	2	2	0.09		0.07	
11/19/2004	11:05	5	48		8.2	0.9	130	270	17	15	0.16		0.06	
11/22/2004	8:35	1	49	120	8.1	0.5	64	86	64	32	0.18		0.04	
11/22/2004	8:55	3	50	127	7.7	1.5	23	344	23	16	0.17		0.09	
11/22/2004	9:10	2	47	119	8.2	1.0	70	131	23	52	0.16		0.07	
11/22/2004	9:30	4	47	118	7.9	1.0	350	134	21	20	0.14		0.05	
11/22/2004	9:45	6	44	126	8.3	1.2	240	1050	6	12	0.08		0.04	
11/22/2004	10:00	7	44	126	8.4	1.0	240	51	8	3	0.08		0.05	
11/22/2004	10:15	8	45	125	8.8	2.5	70	1990	2	4		4	0.04	
12/21/2004	8:23	8	41	130	8.5	3.3	6	156	<2	3		5	0.04	
12/21/2004	8:50	7	45	141	8.0	1.0	500	1410	4	2	0.15	2	0.08	
12/21/2004	9:13	6	44	141	8.1	0.9	687			6	0.13		0.07	

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
12/21/2004	9:30	4	47	123	7.9	0.9	145			20	0.17		0.05	
12/21/2004	10:15	1	49	122	8.2	0.5	80	59	9	6	0.18		0.04	
12/21/2004	10:35	3	49	130	7.9	1.0	260			33	0.19		0.06	
12/21/2004	10:50	2	47	123	8.1	0.8	22	43	17	8	0.15		0.04	
12/21/2004	12:25	5	47	118	8.2	1.3	80	108	<2	5	0.14	2	0.05	
12/21/2004	12:40	12	44	140	8.7	2.4	300	2400	4	6	0.09	5	0.07	
12/21/2004	13:00	11	42	136	9.0	4.6	4	24	2	1		8	0.08	
12/21/2004	13:13	10	48	134	8.4	1.1	365			3	0.17		0.07	
12/21/2004	13:25	9	50	134	8.4	0.3	124			1	0.19		0.06	
1/26/2005	7:45	8	44	166	8.7	2.8	170	46	<2	6		5	0.04	
1/26/2005	8:10	7	46	182	8.0	1.6	240	435	13	13	0.15	4	0.06	2.6
1/26/2005	8:35	4	49	169	7.8	1.0	95	86	8	29	0.18		0.06	
1/26/2005	9:00	1	50	165	8.0	0.5	64	48	5	10	0.19		0.04	
1/26/2005	9:15	3	51	180	7.8	0.8	49	99	23	13	0.20		0.06	
1/26/2005	9:30	2	49	164	8.3	1.2	130	124	2	54	0.19		0.05	
1/26/2005	10:00	6	47	186	8.1	1.6	920	980	8	12	0.14	2	0.06	
2/23/2005	10:30	9	52		8.5	0.6	5	44	<2	1	0.10		0.06	
2/23/2005	10:55	10	51		8.6	0.6	11	30	2	1	0.10		0.06	
2/23/2005	11:10	11	50		9.1	2.0	5	1	<2	1			0.10	
2/23/2005	11:25	5	51		8.1	1.7	130	68	8	13	0.09	3	0.06	
2/23/2005	11:40	12	51		9	2.8	14	70	<2	2		3	0.07	
2/24/2005	10:55	1	50		8	0.5	17	41	2	1	0.14		0.04	
2/24/2005	11:15	3	52		7.7	0.3	11	34	<2	<1	0.13		0.10	
2/24/2005	11:30	2	50		8	2.0	130	72	2	3	0.14		0.04	
2/24/2005	11:45	4	49		8.1	1.2	70	61	11	1	0.13		0.04	
2/24/2005	12:00	6	50		8.5	1.7	220	1990	5	7	0.09	3	0.06	
2/24/2005	12:15	7	50		8.3	1.8	220	1200	<2	<1	0.09		0.07	
2/24/2005	12:35	8	48		8.6	5.5	49	153	2	1		7	0.08	
3/18/2005	8:45	11	49	153	8.9	2	5	76	<2	1			0.05	
3/18/2005	9:00	10	50	136	8.5	0.3	23	140	13	1	0.13		0.07	
3/18/2005	9:10	9	51	135	8.5	0.3	13	142	8	2	0.16		0.07	
3/18/2005	9:30	12	50	153	9.1	2	23	86	8	5		3	0.05	
3/18/2005	9:35	5	49	116	8.5	1	79	179	5	10	0.11		0.04	
3/18/2005	10:40	8	52	140	8.4	3.3	95	1550	5	12		4	0.05	
3/18/2005	11:00	7	50	135	8.5	1.3	240	185	6	3	0.06	5	0.04	
3/18/2005	11:30	3	52	129	8.1	0.5	11	79	<2	2	0.14		0.05	
3/18/2005	12:00	4	49	117	8.3	0.8	46	152	8	10	0.12		0.04	
3/18/2005	12:30	1	51	110	8.4	0.8	49	96	<2	2	0.13		0.04	
3/18/2005	13:00	2	49	112	8.5	0.6	79	184	<2	1	0.13		0.04	
3/18/2005	13:00	6	50	135	8.8	1.6	220	156	<2	4			0.06	
4/19/05	13:20	1	51	73	8.0	1.5	21	69	<2	1	0.11	0	0.03	
4/20/05	10:11	2	48			4.0	26	387	2	3	0.11	27	0.09	
4/20/05	9:35	3	51			1.0	49	53	13	3	0.11	0	0.06	
4/20/05	10:50	4	50			1.1	79	131	2	9	0.09	0	0.03	
4/19/05	11:35	5	50	109	7.7	2.7	95	192	11	13	0.06	0	0.03	
4/20/05	11:25	6	52			3.0	27	74	2	6	0.06	3	0.05	

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
4/20/05	12:00	7	52			2.2	17	88	2	6	0.05	3	0.05	1.1
4/20/05	12:22	8	55			3.5	21	>2420	4	3	0	9	0.06	
4/19/05	10:22	9	52	100	8.5	0.6	13	67	2	1	0.14	0	0.07	
4/19/05	11:07	10	52	100	8.1	1.3	2	6	<2	1	0.09	0	0.06	
4/19/05	11:50	11	53	113	8.6	3.7	23	25	8	3	0	3	0.06	
4/19/05	12:10	12	53	117	8.6	10.9	8	22	2	2	0.05	4	0.07	
5/16/05	11:54	1	51		7.5	4.4	920	1120	79	111	0.09	0	0.03	
5/17/05	14:40	2					540	649	23	24	0.07		0.04	
5/16/05	12:24	3	53		7.6	1.1	1600	1550	170	173	0.11	0	0.06	
5/16/05	13:07	4			7.8	2.5	1600	1120	240	118	0.07	0	0.05	
5/17/05	12:35	5	52		7.5	3.5	>=1600	1990	140	138	0		0.03	
5/16/05	13:42	6	54		8.4	4.8	920	727	79	52	0	6	0.12	
5/19/05	14:25	7	55		8.3	7.3	220	770	79	54	0	6	0.06	2.2
5/16/05	14:52	8				6.8	920	>2420	350	121	0	5	0.05	
5/17/05	9:46	9	53		8.2	0.8	130	>2420	7	2	0.12		0.05	
5/17/05	10:04	10		12	8.4	1.6	70	>2420	5	5	0.07		0.05	
5/17/05	13:45	11	58		8.9	2.5	79	1410	5	1	0		0.05	
5/17/05	13:01	12	57		8.7	2.9	49	84	<2	2	0		0.06	
6/23/05	12:05	1	55		8.3	0.8	920	866	79	68	0.14	0	0.05	
6/23/05	13:04	2	56		8.7	0.9	>=1600	>2420	>=1600	>2420	0.10	0	0.08	
6/23/05	12:40	3	57		8.1	0.7	350	687	9	14	0.08	0	0.03	
6/23/05	13:50	4	57		8.7	1.4					0	0	0.04	
6/23/05	10:54	5	58		8.7	1.8	350	866	33	26	0	0	0	
6/29/05	8:05	5					>=1600	>2420	>=1600	>2420				
6/23/05	14:03	6	53		8.9	1.7	110	1420	23	7	0	0	0.05	
6/23/05	14:23	7	65		9.0	2.2	1600	>2420	220	178	0	0	0.04	1.7
6/23/05	14:23	8					110	2420	8	11	0	0	0.04	
6/23/05	9:42	9	56		8.6	1.3	46	248	5	4	0.07	0	0	
6/23/05	10:05	10	58		8.8	1.1	5	579	2	5	0	0	0.03	
6/23/05	10:33	11	66		9.1	4.2	27	308	2	3	0	4	0	
6/23/05	8:55	12	67			2.0	33	201	2	2	0	3	0.04	
7/18/05	12:02	1	54		8.2	0.7	220	387	33	28	0.15	0	0.05	
7/18/05	11:36	2	54		8.2	1.0	>=1600	>2420	220	124	0.10	0	0.04	
7/18/05	11:10	3	56		7.7	1.0	>=1600	>2420	140	86	0.09	0	0.05	
7/18/05	12:58	4	59		8.3	1.3	>=1600	<1	920	<1	0	0	0.06	
7/18/05	14:26	5					920	1300	49	96	0	4	0.05	
7/18/05	10:23	6	69		8.8	4.0	79	>2420	13	12	0	3	0.04	
7/18/05	9:42	7	69		8.7	3.9	1600	>2420	23	7	0	5	0.06	1.8
7/18/05	8:46	8	72		8.1	3.1	920	>2420	8	10	0	2	0.08	
7/19/05	9:25	9	56		8.6	2.0	>=1600	579	79	7	0	6	0	
7/19/05	9:50	10	58		8.8	6.2	>=1600	2420	240	9	0	5	0.02	
7/19/05	10:51	11	66		9.4	1.4	26	980	2	2	0	4	0.14	
7/19/05	10:25	12	68		9.2	1.6	140	>2420	49	56	0	6	0.08	
8/30/05	8:35	1	50		8.6	0.5		248		15	0.17	0	0.05	
8/30/05	10:00	2	51		7.9	0.6		>2420		11	0.12	0	0.04	
8/30/05	9:30	3	53		7.5	0.5					0.11	0	0.05	

				SC		Turbidity	Total Coliforms		Fecal	*E. coli*	Nitrates	TSS	Phosphorus	TOC
Date	Time	Station ID	Temp (F)	mS/cm	pH	NTU's	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	MPN/ 100ml	(mg/L)	(mg/L)	(mg/L)	(mg/L)
8/30/05	10:35	4	55		7.8	1.0		1730		39	0.08	0	0.05	
8/30/05	14:45	5						2420		20	0	122	0.09	
8/30/05	11:05	6	62		8.5	1.3		980		12	0	0	0.06	
8/30/05	11:40	7									0	3	0.08	0.9
8/30/05	12:20	8	66		8.9	1.2		1410		5	0	0	0.04	
8/30/05	14:15	9	59		8.3	0.8		93		<1	0.05	0	0.07	
8/30/05	14:05	10	56		8.5	0.8					0.12	0	0.06	
8/30/05	14:35	11	71		9.2	9.2		792		1	0	0	0.06	
8/30/05	13:45	12	69		9.1	9.6		298		<1	0	7	0.05	
9/20/05	13:50	1	54		8.2	0.7	14	1120	2	7	0.17	0	0.05	
9/20/05	13:18	2	52		8.5	1.8	130	770	17	7	0.13	0	0.04	
9/20/05	12:50	3	55		7.8	0.8	110	816	13	7	0.11	0	0.05	
9/20/05	11:25	4	54		7.8	1.1	130	866	17	22	0.10	0	0.05	
		5	56		8.4	2.4								
9/20/05	10:50	6	58		8.5	0.7	64	31	4	3	0.03	0	0.04	
9/20/05	9:50	7	58		8.7	1.7	220	649	8	10	0.02	0	0.06	1.3
9/20/05	9:00	8	60		8.7	2.0	540	1120	8	18	0.02	0	0.04	
		9	57		8.3	1.1								
		10	57		8.6	0.9								
		11	64		9.0	8.7								
		12	65		8.9	5.1								