Preliminary Data Review of the Effluent Study Phases I and II

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2010 DR-10-01

Introduction

Data was collected to document water and periphyton chemistry in five Hill Country streams near wastewater treatment plants under a range of conditions (Table 1, Figure 1). An eastern Blackland Prairie creek was added for comparison. The project QAPP is documented in Appendix B.

Site reconnaissance and one sample visit have been completed. There were four sites in most watersheds: one upstream, one at the WWTP outfall, and two downstream of the plant (Table 2). From the data collected, two watersheds are to be selected for additional sampling. The data from these two watersheds will be used for WASP model calibration.

Table 1. Wastewater Treatment Plant Locations

Treatment Plant	Land Type	Watershed	Comments
Liberty Hill Regional WWTP (LCRA&BRA)	North, Edwards	South Fork San Gabriel (S)	Good plant, lots of dilution
City of Georgetown (Berry Creek) WWTP	North, Edwards	Berry Creek (B)	High TP, no upstream flow
Anderson Mill MUD WWTP	North, Edwards	Lake Creek (L)	High TP, upstream flow
City of Taylor WWTP	East, Blackland	Mustang Creek (M)	High TP, upstream flow, Blackland Prairie
New Braunfels (Gruene Road) WWTP	South, Edwards	Guadalupe River (G)	Perennial stream, 100:1 dilution
Johnson City WWTP	West, Edwards	Pedernales River (P)	High dilution, but natural flow regime

Table 2. Distance in miles from WWTP outfall

Watershed	Upstream Site	Downstream Site 1	Downstream Site 2
South Fork San Gabriel (S)	1.0	0.1	2.0
Berry Creek (B)	0.5	0.8	2.2
Lake Creek (L)	0.3	0.6	1.3
Mustang Creek (M)	0.7	1.8	5.0
Guadalupe River (G)	0.01	1.5	2.2
Pedernales River (P)	0.01	1.0	

The data were visually examined and the plots are in Appendix A. The plots in the appendix include:

Surface Water

- **Nutrients**: PO4, TP, NO3, TKN, NH3

- **Algae:** Chlorophyll *a*, Pheophytin
- **Physical**: DO, BOD, Temperature, Turbidity, TSS, Optical Brighteners

Benthic Periphyton Cover

- **Nutrients**: TP, TN, C:N, C:P, N:P
- **Algae:** AFDW, Chlorophyll *a*, Pheophytin, Pheophytin/Chlorophyll *a* ratio, AFDW/Chlorophyll *a* Ratio

Visual Algae Cover: Cover, Thickness

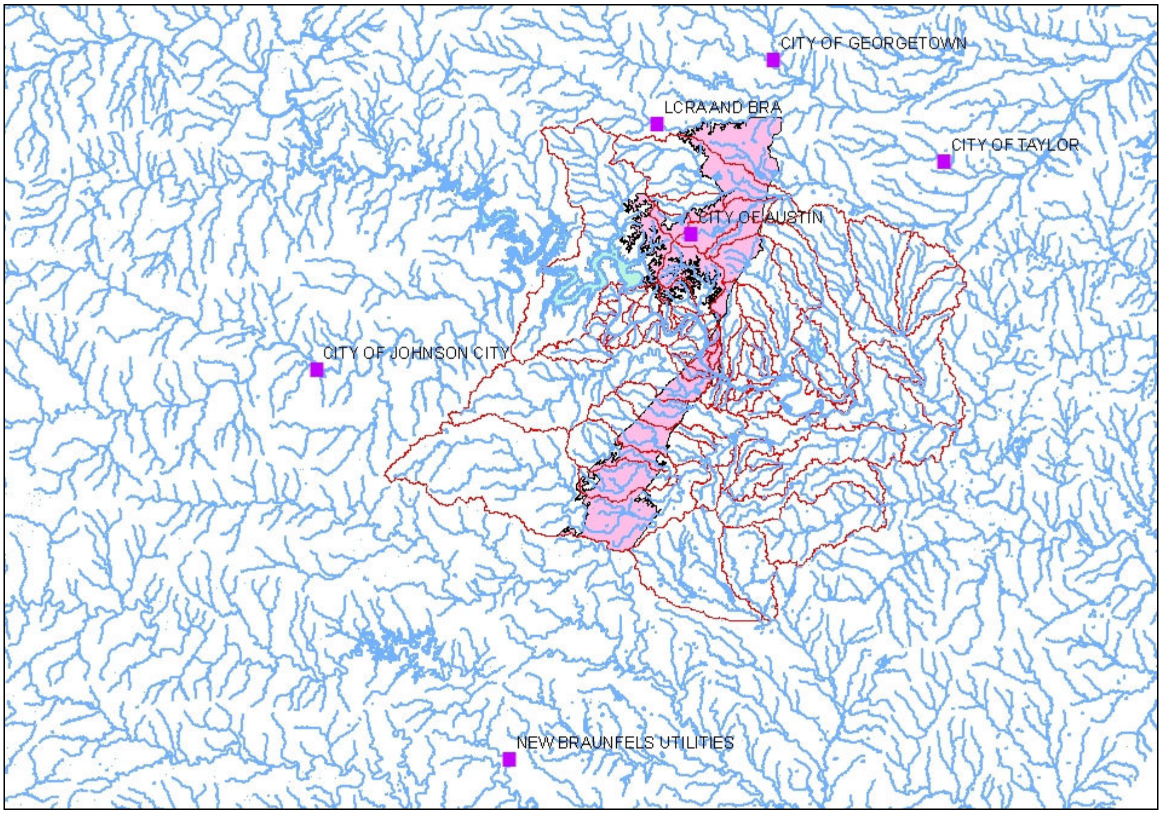


Figure 1. Wastewater Treatment Plant Locations

Results

The relative ordering of concentrations at the different watersheds are summarized in Table 3 (B = Berry Creek, G = Guadalupe river, L = Lake Creek, M = Mustang Creek, P = Pedernales River, S= South Fork San Gabriel River).

Orthophosphorus concentrations in the surface water differ only in Lake and Mustang Creek, where they increase at the WWTP and then decrease with distance downstream of the WWTP. Total phosphorus in surface water also increases only in Lake and Mustang Creeks but unlike orthophosphorus it does not decrease with distance from the plant. Periphyton phosphorus concentrations are different in each creek and increase below the WWTP, indicating a likely transfer of nutrients from the surface water to the benthos. Thus it appears that periphyton phosphorus levels may be used to identify plant impacts whereas surface water phosphorus levels frequently can not. In three of the four watersheds with two sites below the WWTP, periphyton phosphorus decreases with distance from the plant. The exception is Lake Creek.

The nitrate levels are distinct in each creek, and are not affected by the WWTP except in Lake and Mustang Creeks where they increase below the WWTP and then decrease with distance from the plant. Total periphyton nitrogen levels rank the same from creek to creek as nitrate except for the Guadalupe River which has low surface water nitrate concentrations but the highest periphyton nitrogen. The periphyton nitrate levels increase below the plant only for the two watersheds with the lowest periphyton nitrogen, Berry Creek and the South Fork San Gabriel River.

The carbon to phosphorus and nitrogen to phosphorus ratios decrease at the first site downstream of the plant. There is more phosphorus in the algae relative to the carbon and nitrogen amounts downstream of the WWTP than there is upstream the plant. However, at the second site downstream of the WWTP the results vary, with some staying the same, some increasing and some continuing to decrease. The carbon to nitrogen ratio does not show any consistent patterns.

Surface water chlorophyll *a* and pheophytin are highest in Mustang and Lake Creek. The concentrations do not increase downstream of the plant, and indeed in Mustang Creek they decrease. Periphyton chlorophyll *a* does not show a consistent pattern, but periphyton pheophytin increases at the first site downstream of the WWTP. At the second downstream site there is no consistent pattern. Surface water patterns are atypical in Mustang Creek and periphyton patterns are atypical in the Guadalupe River with both very high and very low levels. Periphyton AFDW increases in some watersheds and decreases in others with effluent discharge. However the ratio of pheophytin to chlorophyll *a* increases with effluent discharge except in the San Gabriel River, where it decreases slightly at the first site downstream of the WWTP and then increases. The AFDW to chlorophyll ratio decreases at the first site after the WWTP except in Mustang Creek and then increases again by the second downstream site.

Benthic periphyton percent cover and thickness are the highest in Lake Creek and the Guadalupe River. Percent cover increases with effluent discharge in the San Gabriel River, Mustang Creek and the Guadalupe River but decreases in Lake and Berry Creeks. Thickness increases at the first site after the WWTP in all but Lake Creek. Perhaps Lake Creek is reaching nutrient saturation levels.

Dissolved oxygen drops and temperature increases at the WWTP outfalls, and then they rebound. The exception is Mustang Creek where DO increases at the outfall and then drops again. BOD is highest in Mustang Creek. Turbidity, TSS and optical brighteners are not changed by the WWTPs except in Mustang Creek and they are highest in Mustang Creek. Turbidity and TSS are also high in the Guadalupe River.

East vs. West

Mustang Creek in the Blackland Prairie behaves somewhat differently than the creeks and rivers on the Edwards Plateau. It has high PO4, TP, NO3, and TKN (Lake Creek also has high PO4, TP, NO3). It has high planktonic chlorophyll *a*, pheophytin, BOD, TSS, and turbidity all of which decrease after the treatment plant. It has the lowest temperatures and DO (except for the upstream site on Berry Creek). The optical brighteners are highest in Mustang Creek. For periphyton nutrient concentrations as well as for periphyton chlorophyll a and pheophytin it falls in the middle rather than at the extremes in concentrations. The C:P, C:N and N:P ratios are all low although the AFDW is high. For percent algae cover and thickness, it is fairly low.

Watershed Selection for Additional Sampling – Pick Two

Table 4. Watershed Selection

Watershed	Comments	Acceptable site?
S. Fork San Gabriel	Least impacted creek	Yes
Berry Creek	Moderately impacted creek	Maybe
Lake Creek	Most impacted creek	Yes
Mustang Creek	Different from Edwards Plateau Creeks	No
Guadalupe River	Odd values in periphyton chlorophyll *a* and pheophytin, higher TSS and turbidity	No
Pedernales River	Insufficient data for review, only reconnaissance data	No

Table 3. Relative Ordering of Concentrations

	Parameter Type	Parameter	location Upstream	Outfall	Downstream	Downstream > Upstream
Surface Water	**Nutrients**	PO4	same		L>M>B=G=S	yes in L, M
		TP	same	L=B=G=P>M>S	L=M>B=G=P=S	yes in L, M
		NO3	B>G>S=M>L		L>M>B>G>S	yes in L, M
		TKN	M>S=L=B>G		M>S=B=G>L	yes in G, M?
		NH3	same		same	
Periphyton	**Nutrients**	TP	M=L>G>B>S		G>M>L>B>S	yes in all
		TN	L>G>M>B>S		G>L>M>B>S	yes except L, M
		C:P	G>S=B>M=L		S>B>G>L>M	yes in S
		C:N	B=G>S>M>L		S>B>G>M>L	yes in L
		N:P	G>L>S>B>M		S>B>G>L>M	yes in S
Surface Water	**Algae**	Chlorophyll *a*	M>L>S=B=G		L>M>B=S>G	
		Pheophytin	M>L>G>S=B		L>M=B=S=R	
Periphyton	**Algae**	Ash Free Dry Weight	M=G=L>B>S		G>M>L=B=S	yes in G, S
		Chlorophyll *a*	G>M>L>B>S		G>B>M=L>S	
		Pheophytin	G=L=M>B>S		G>L>M>B>S	yes in B, S
		Pheophytin/Chlorophyll *a* Ratio	L>M>G>S>B		L>M>G>B>S	yes in all
		AFDW/Chlorophyll *a* Ratio	S>L>M>B>G		G>M>S>L>B	yes in M, G
	Visual Algae	Percent Cover	L>G>B>M>S		G>L=M=B>S	yes in G, M, S**
		Thickness	L>G>B=S=M		G>L>B=M>S	yes in G, B, M**
Surface Water	**Physical**	DO	G>P>S>L>M>B	G=M>P=B>S=L	G>B>S>L>M	yes, except M
		BOD	M>B=G=L=S		M>B=G=L=S	
		Temperature	S=P>L=B=G>M	L>G>B=M=S>P	L>S>G>B>M	yes in L, S
		Turbidity	M>G>S=B=L		M>G>S=B=L	
		TSS	M>G>S=B=L		M>G>S=B=L	
		Optical Brighteners	M>L>B>G		M>L>S>B>G	

**statistically significant (only visual algae parameters had enough data for statistical analysis)

Table 5. Mean Benthic Algae Ratios

Watershed	Parameter (mg/M2: mg/M2)	N	Mean	Std Dev	Minimum	Maximum
Berry	Nitrogen:Carbon	3	0.63	0.11	0.57	0.76
	Phosphorus:Carbon	3	0.08	0.01	0.06	0.09
	Nitrogen:Phosphorus	3	8.24	1.61	6.38	9.22
	Ash Free Dry Weight:Carbon Ratio	3	6.59	0.41	6.34	7.07
	Chlorophyll a:Carbon Ratio	3	0.07	0.01	0.05	0.08
Guadalupe	Nitrogen:Carbon	3	0.71	0.14	0.58	0.85
	Phosphorus:Carbon	3	0.09	0.05	0.04	0.12
	Nitrogen:Phosphorus	3	9.63	5.36	5.80	15.75
	Ash Free Dry Weight:Carbon Ratio	3	6.81	1.44	5.85	8.47
	Chlorophyll a:Carbon Ratio	3	0.06	0.06	0.00	0.12
Lake	Nitrogen:Carbon	3	1.51	0.31	1.23	1.84
	Phosphorus:Carbon	3	0.18	0.05	0.13	0.23
	Nitrogen:Phosphorus	3	8.94	4.28	6.42	13.89
	Ash Free Dry Weight:Carbon Ratio	3	9.76	2.86	7.56	12.98
	Chlorophyll a:Carbon Ratio	3	0.07	0.00	0.06	0.07
Mustang	Nitrogen:Carbon	2	0.99	0.17	0.88	1.11
	Phosphorus:Carbon	2	0.21	0.13	0.12	0.30
	Nitrogen:Phosphorus	2	5.46	2.53	3.67	7.25
	Ash Free Dry Weight:Carbon Ratio	2	15.98	5.52	12.07	19.89
	Chlorophyll a:Carbon Ratio	2	0.09	0.01	0.08	0.10
San Gabriel	Nitrogen:Carbon	3	0.64	0.11	0.52	0.74
	Phosphorus:Carbon	3	0.06	0.02	0.04	0.09
	Nitrogen:Phosphorus	3	10.99	2.32	8.60	13.23
	Ash Free Dry Weight:Carbon Ratio	3	9.83	0.31	9.62	10.19
	Chlorophyll a:Carbon Ratio	3	0.06	0.04	0.04	0.11

Appendix A: Plots of water and periphyton chemistry and visual benthic periphyton cover at six Locations with WWTPs

Nutrients

- Surface Water
  - PO4
  - TP
  - NO3
  - TKN
  - NH3
- Periphyton
  - TP
  - TN
  - C:N
  - C:P
  - N:P

Algae

- Phytoplankton
  - Chlorophyll *a*
  - Pheophytin
- Periphyton
  - AFDW
  - Chla
  - Pheophytin
  - Pheophytin/Chlorophyll a ratio
  - AFDW/Chlorophyll a Ratio

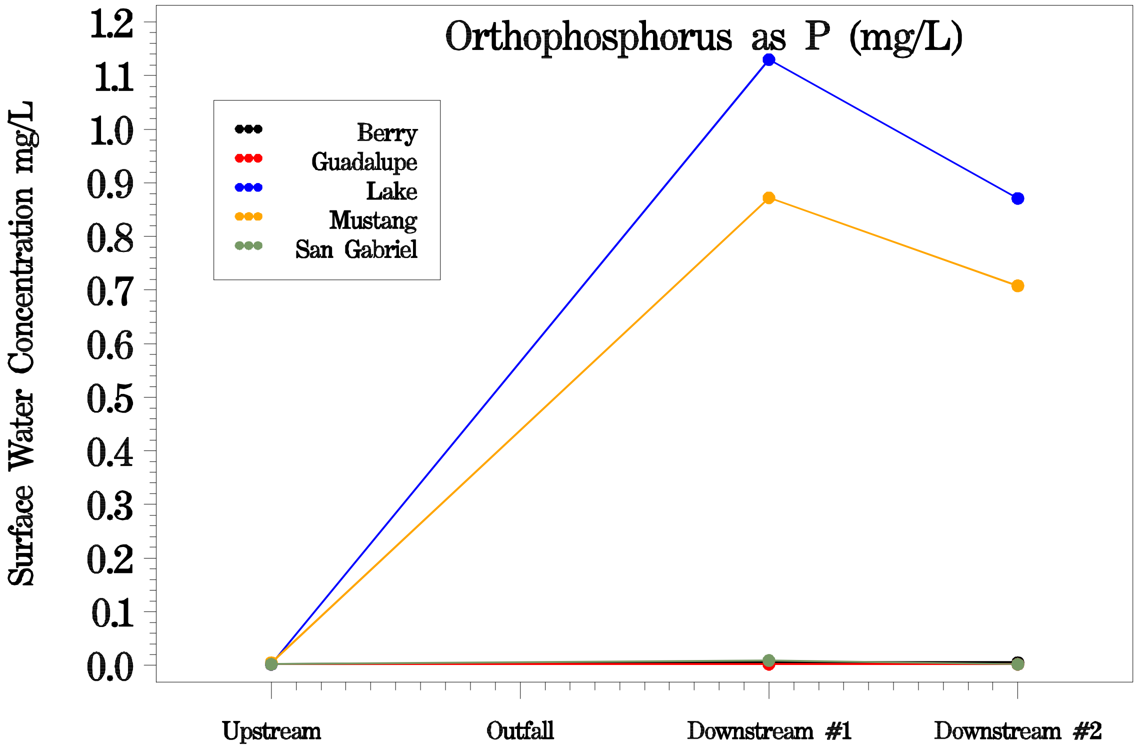
Visual BenthicPeriphyton Cover

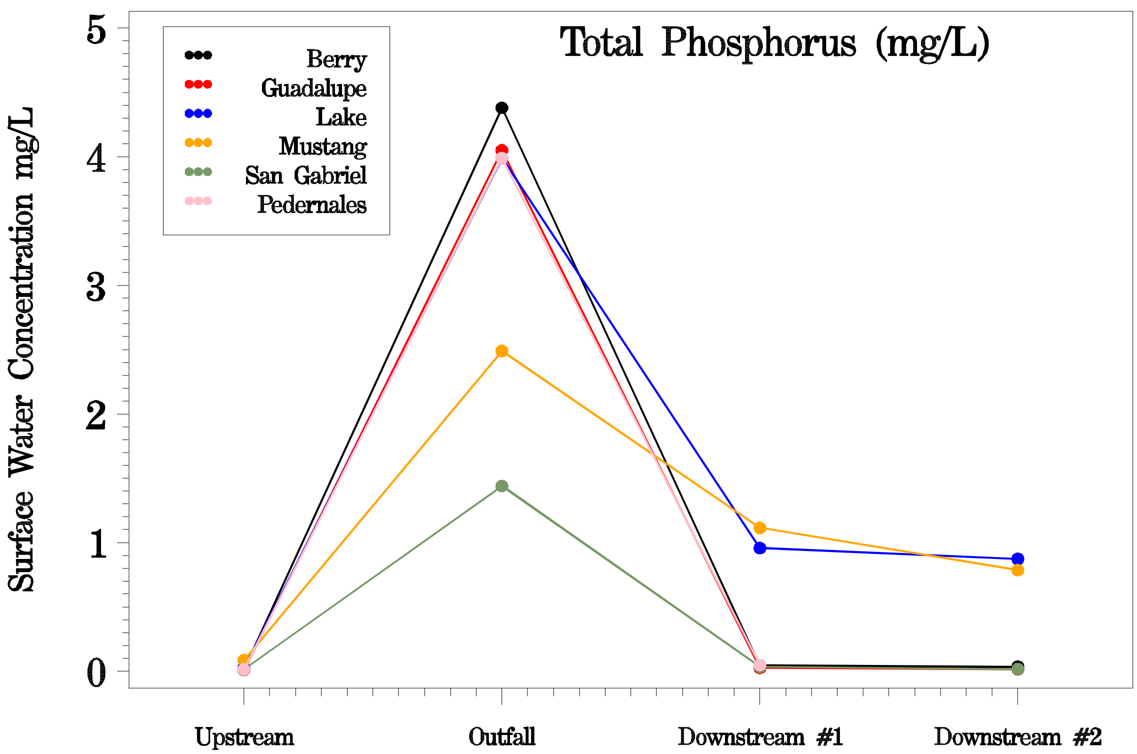
- Cover
- Thickness

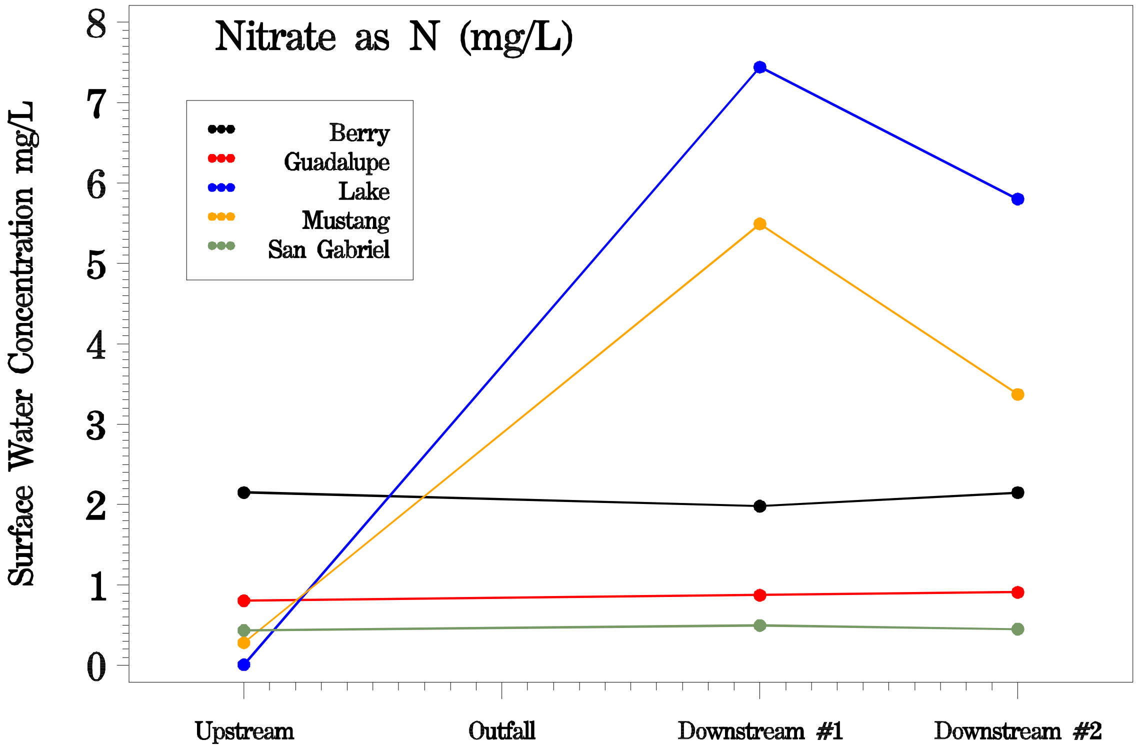
Surface Water Physical

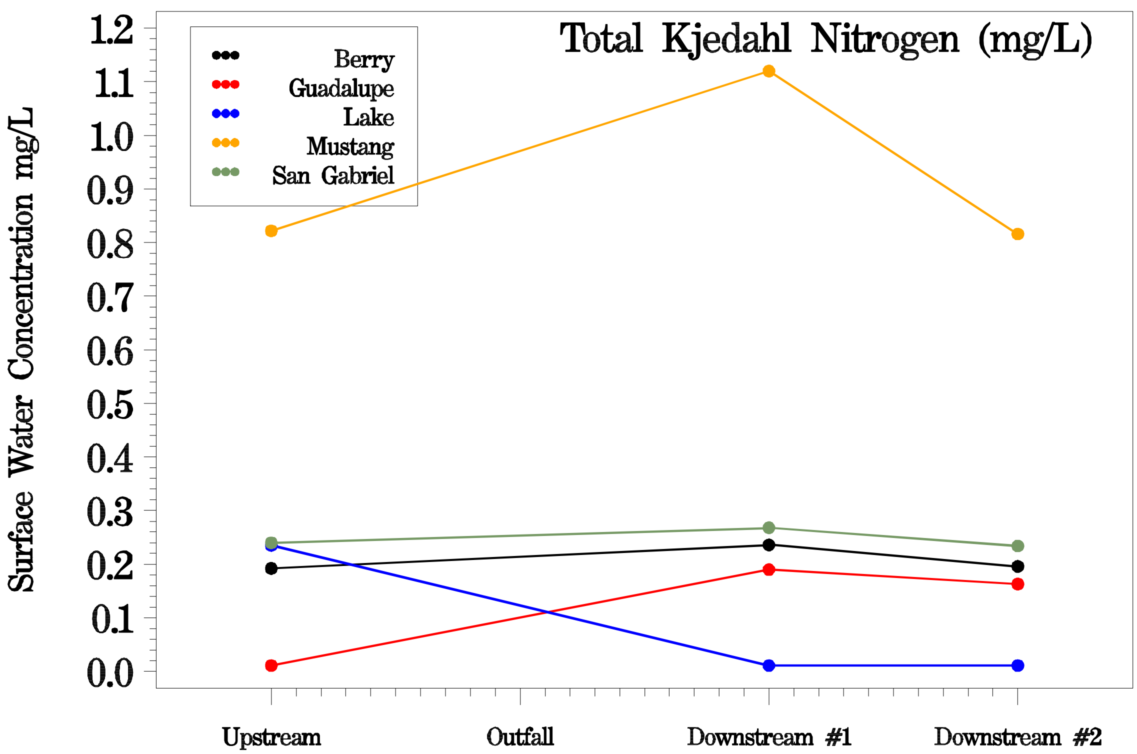
- DO
- BOD
- Temp
- Turbidity
- TSS
- Optical Brighteners

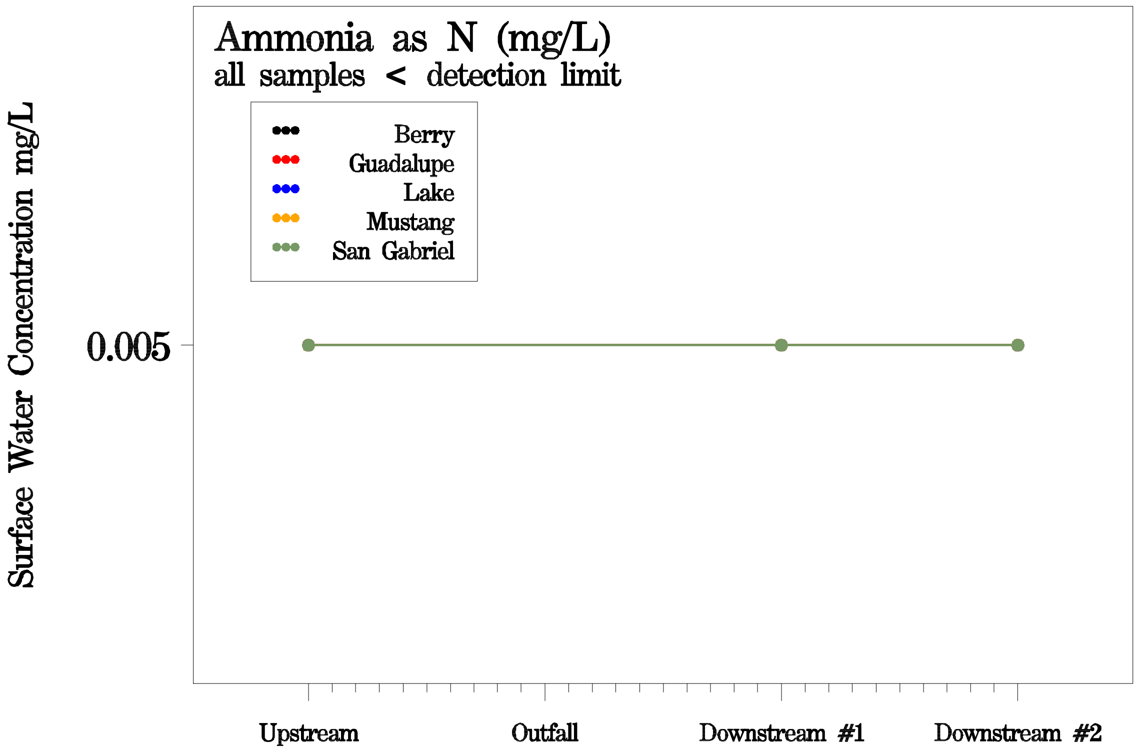
Nutrients in Surface Water



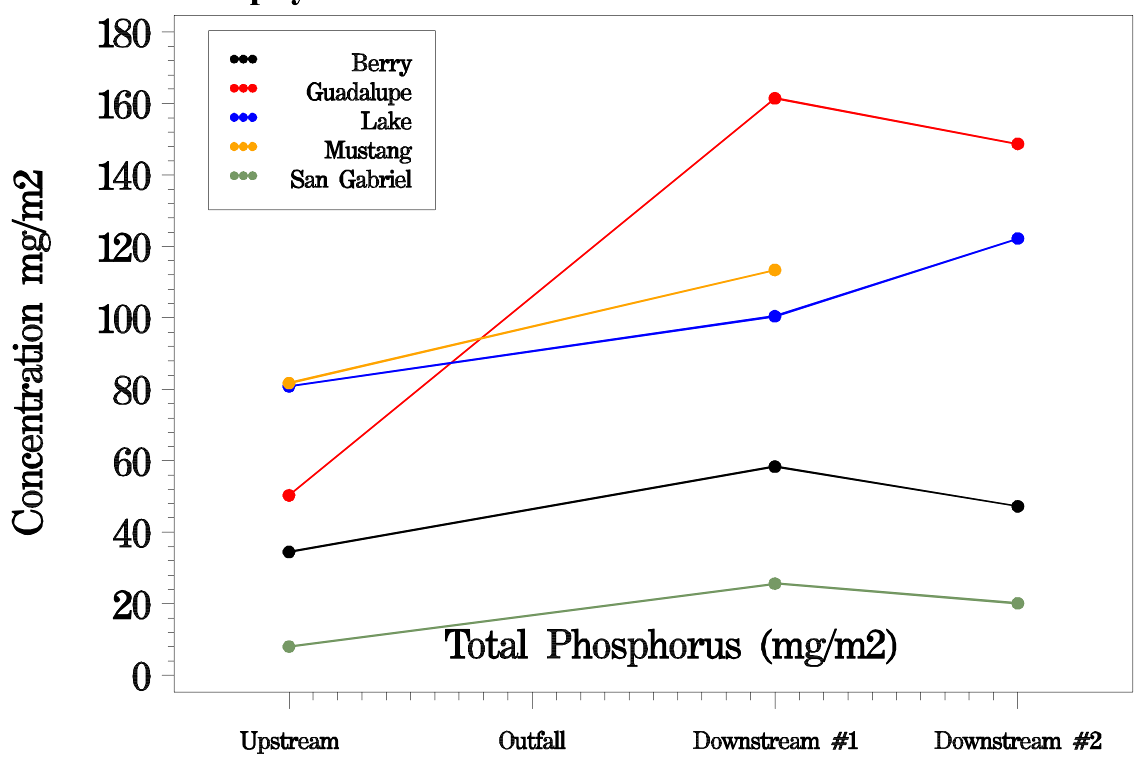


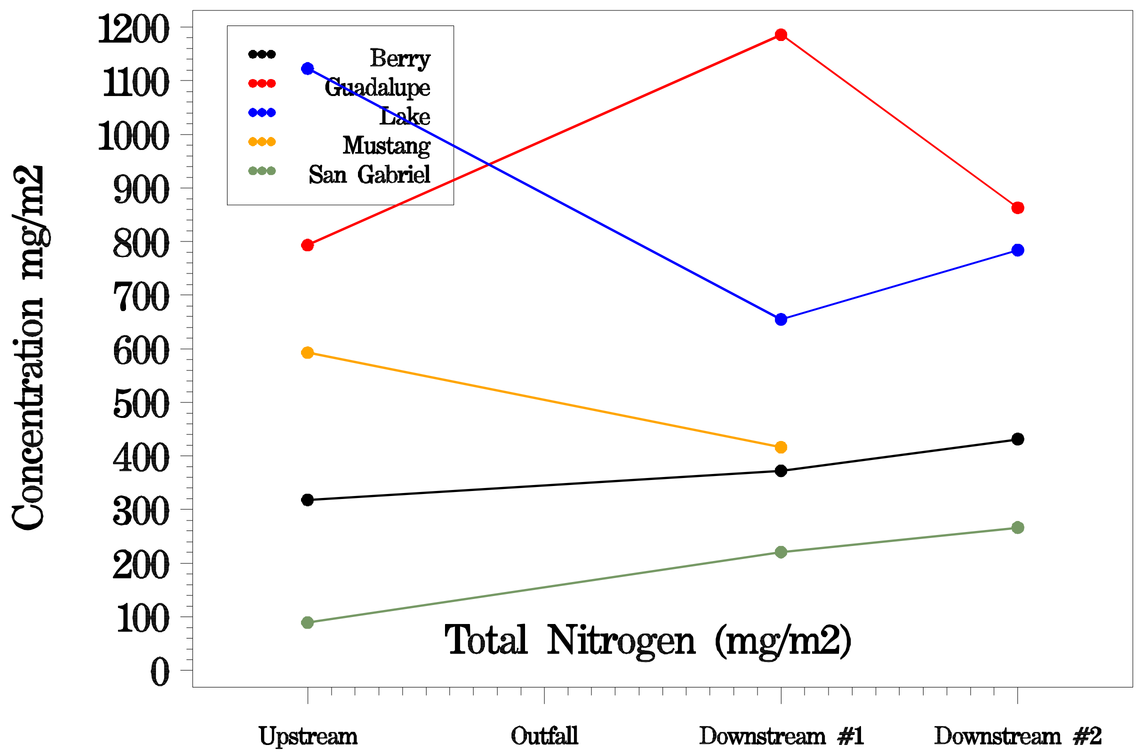

Nitrate as N (mg/L)
Surface Water Concentration mg/L
8
7
6
5
4
3
2
1
0
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2


Total Kjedahl Nitrogen (mg/L)
Surface Water Concentration mg/L
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2

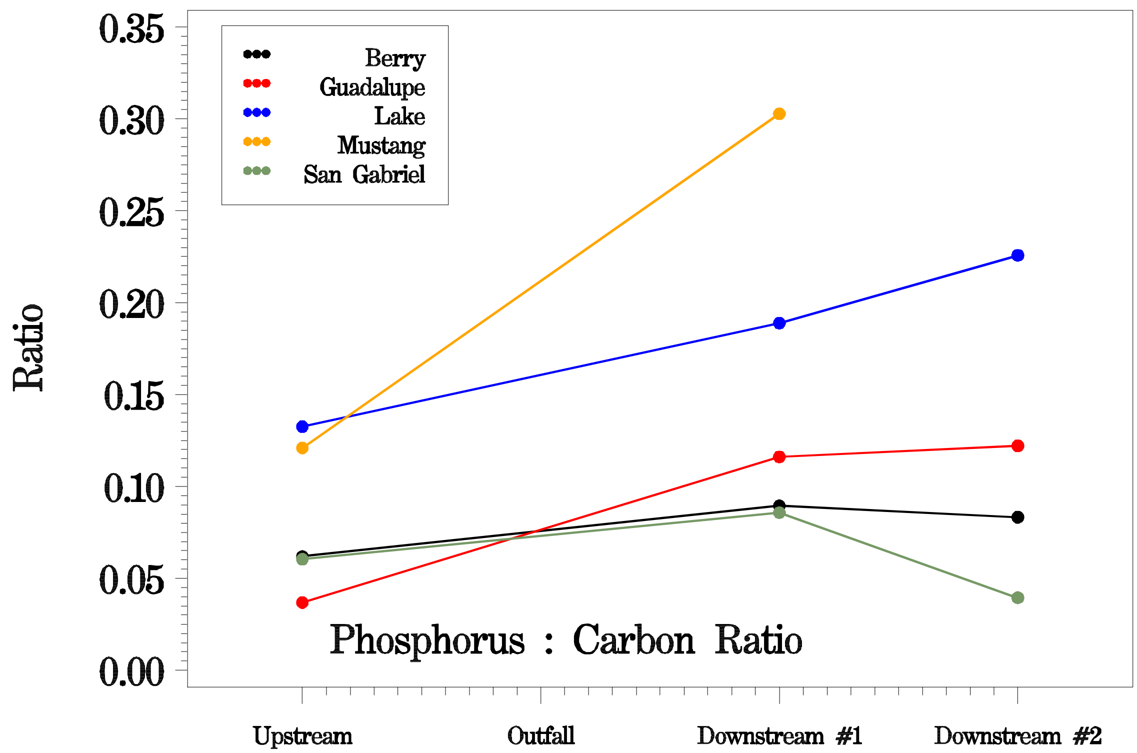


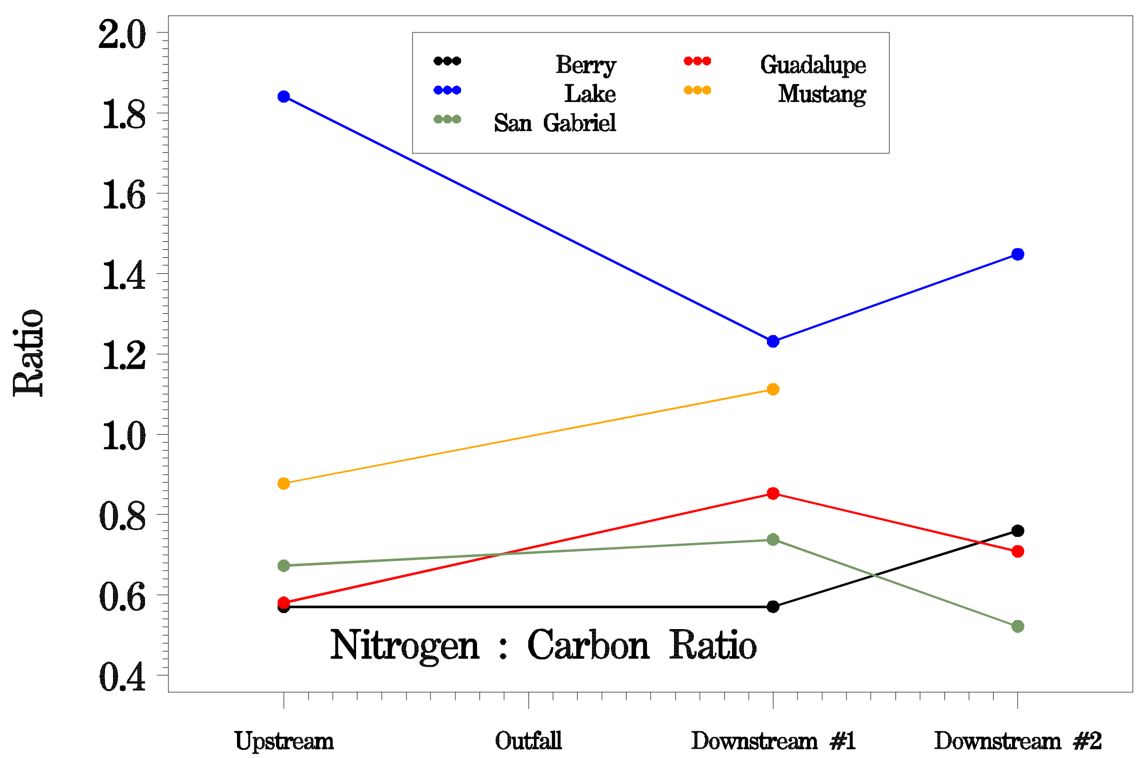
Nutrients in Periphyton

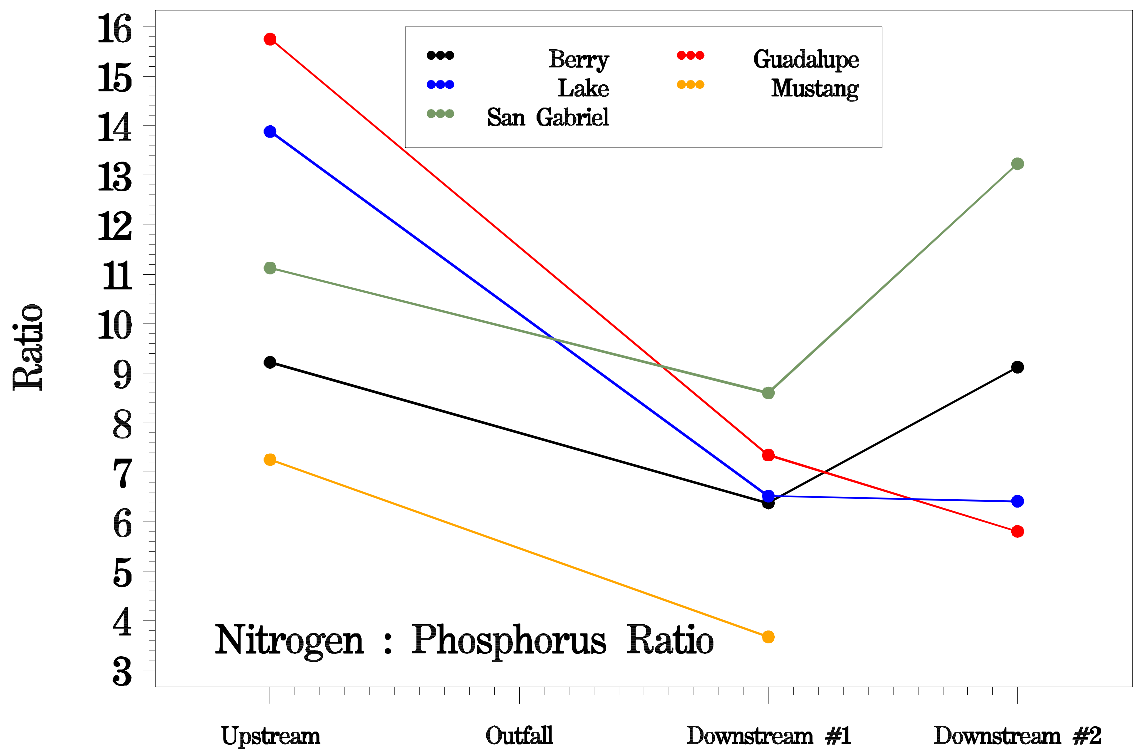



Concentration mg/m2
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Berry
Guadalupe
Lake
Mustang
San Gabriel
Total Nitrogen (mg/m2)
Upstream
Outfall
Downstream #1
Downstream #2

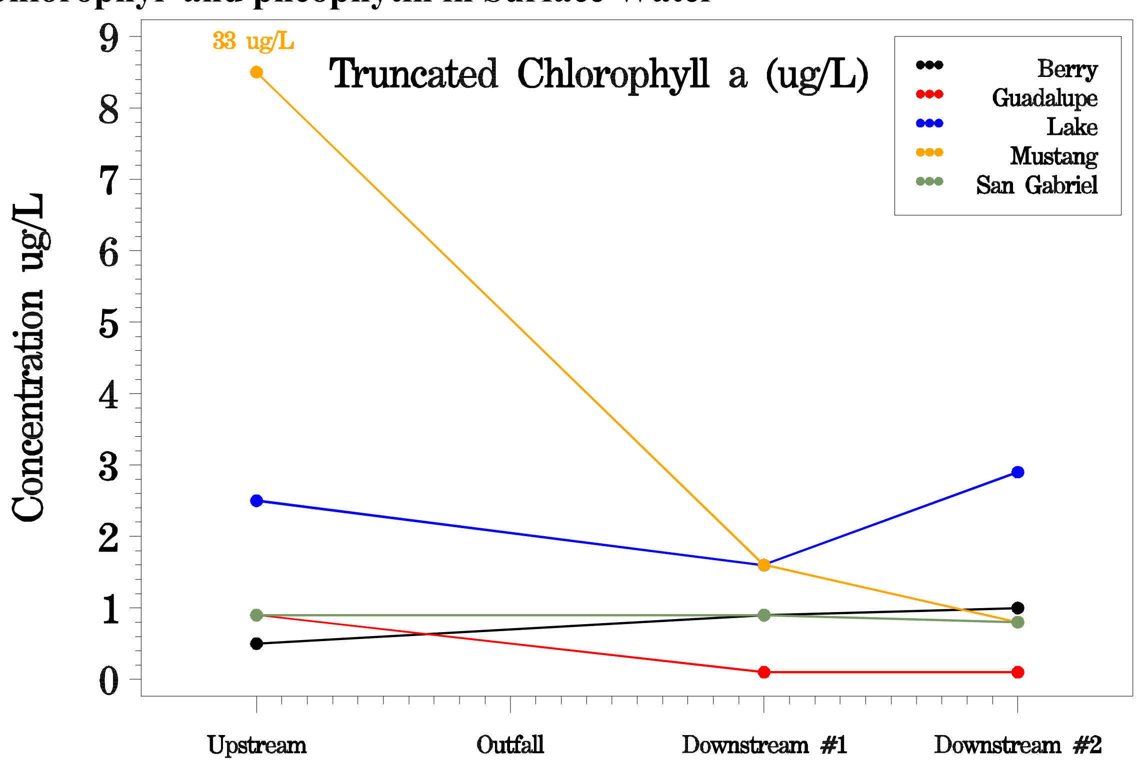
Nutrient Ratios in Surface Water (?)

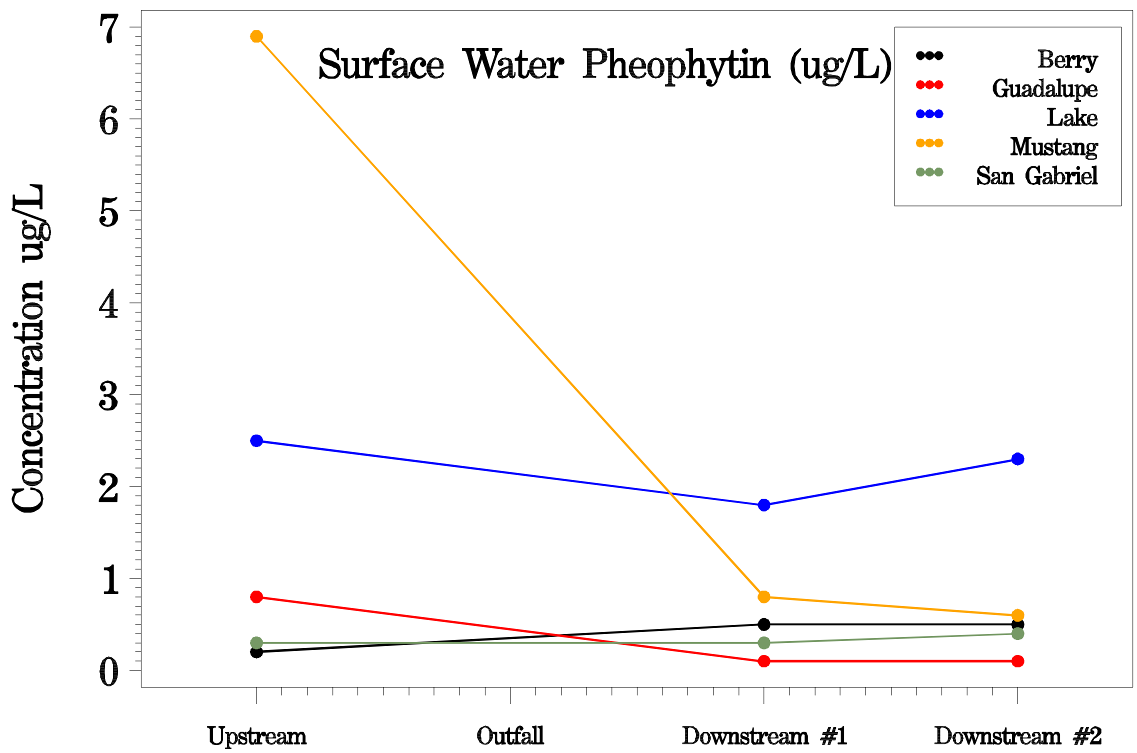




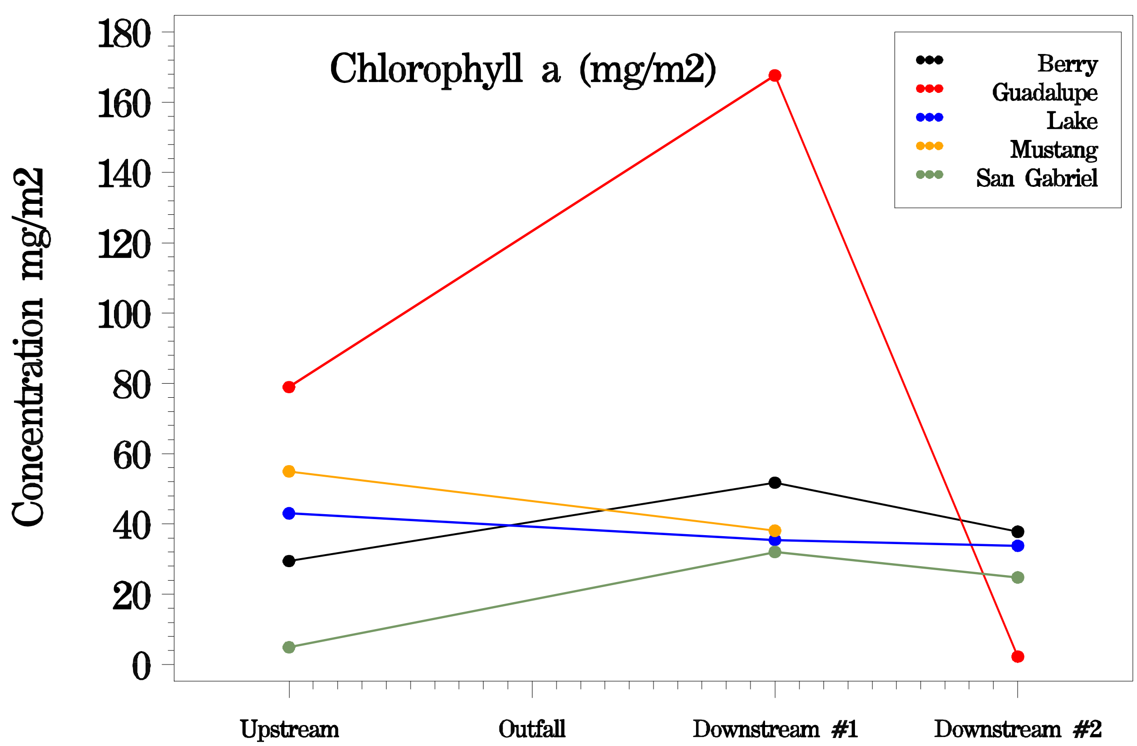


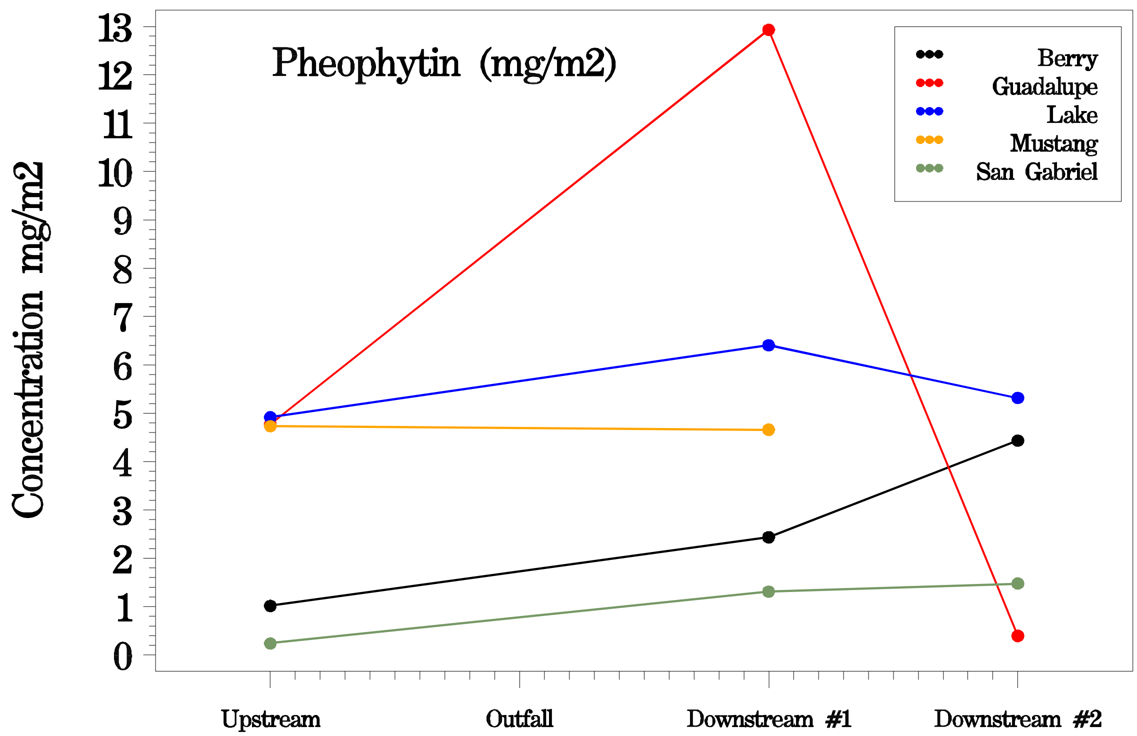
Chlorophyl and pheophytin in Surface Water

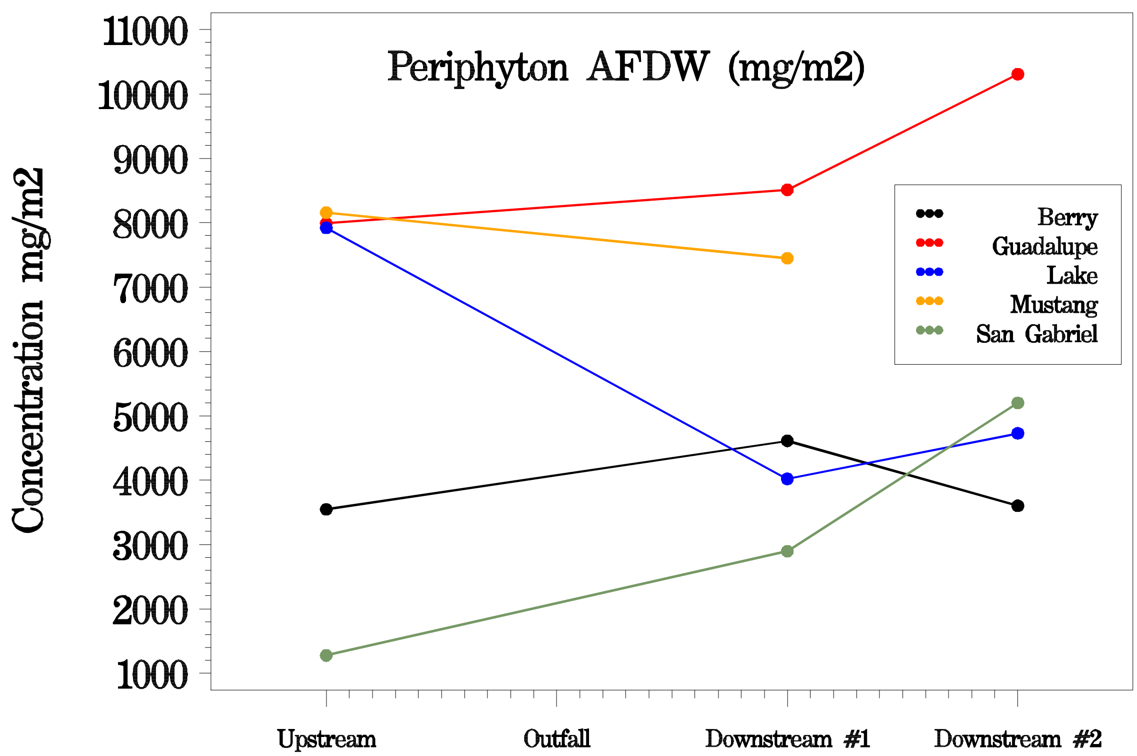




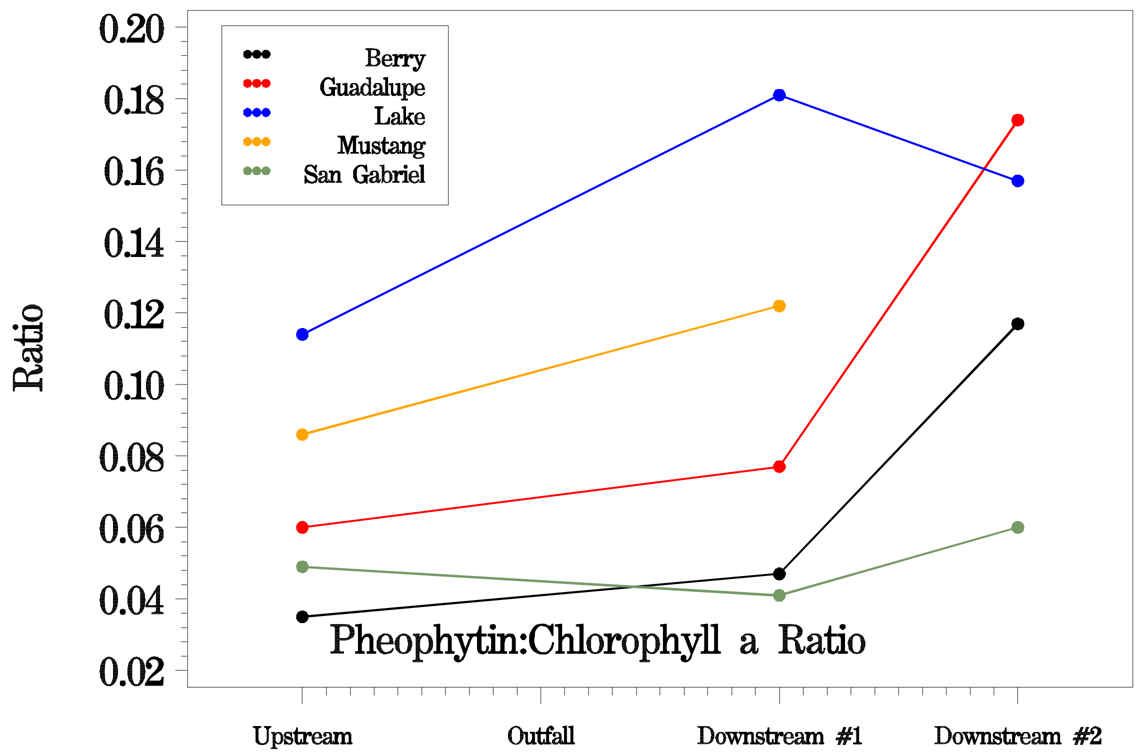
Chlorphyl a, pheophytin and ashe-free-dry-weight in periphyton cover

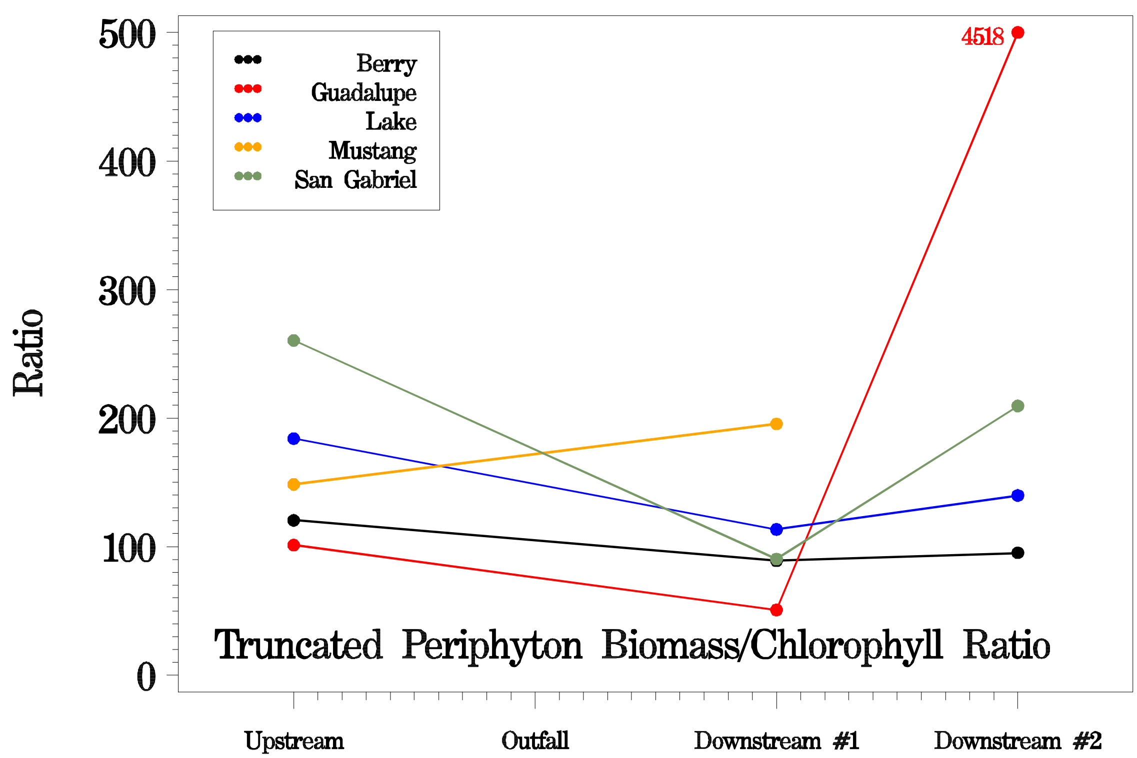


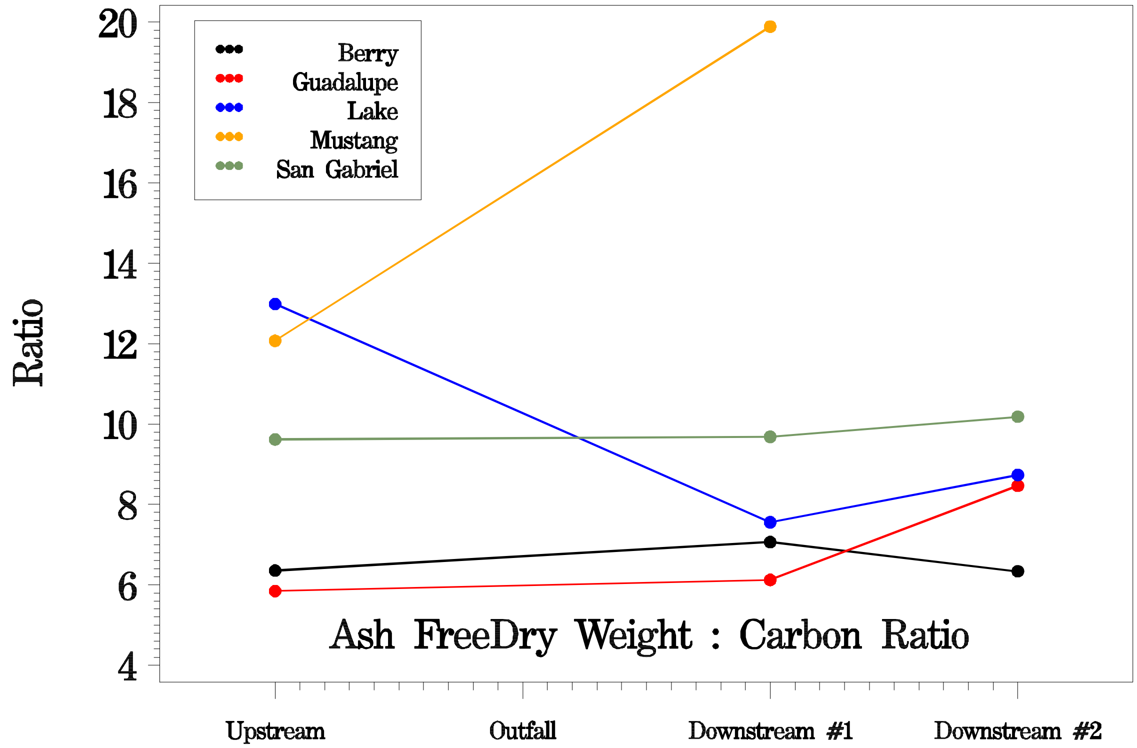


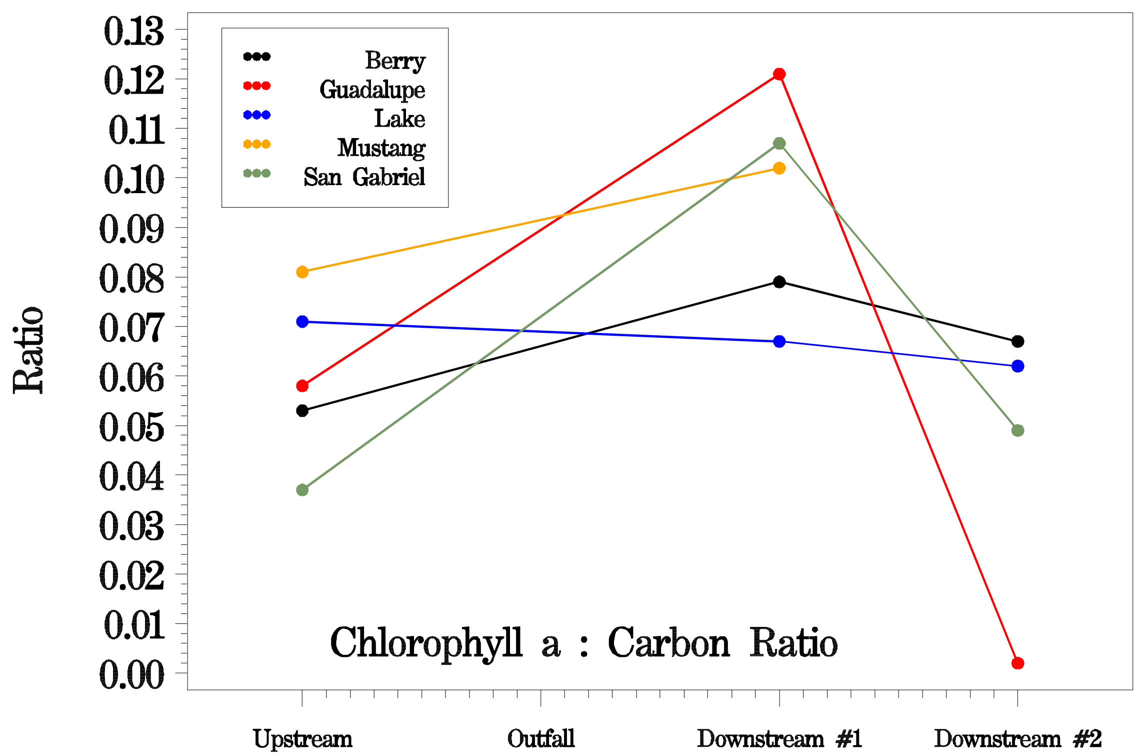


Ratio's in periphyton cover

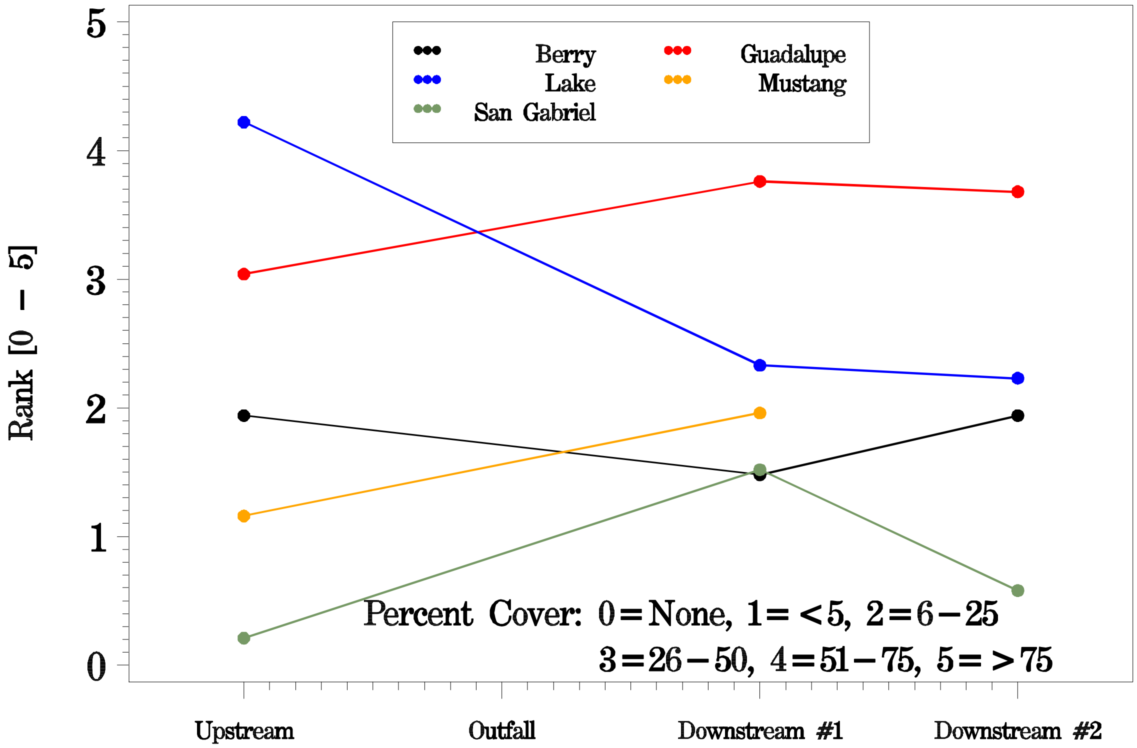

Pheophytin:Chlorophyll a Ratio
Ratio
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2

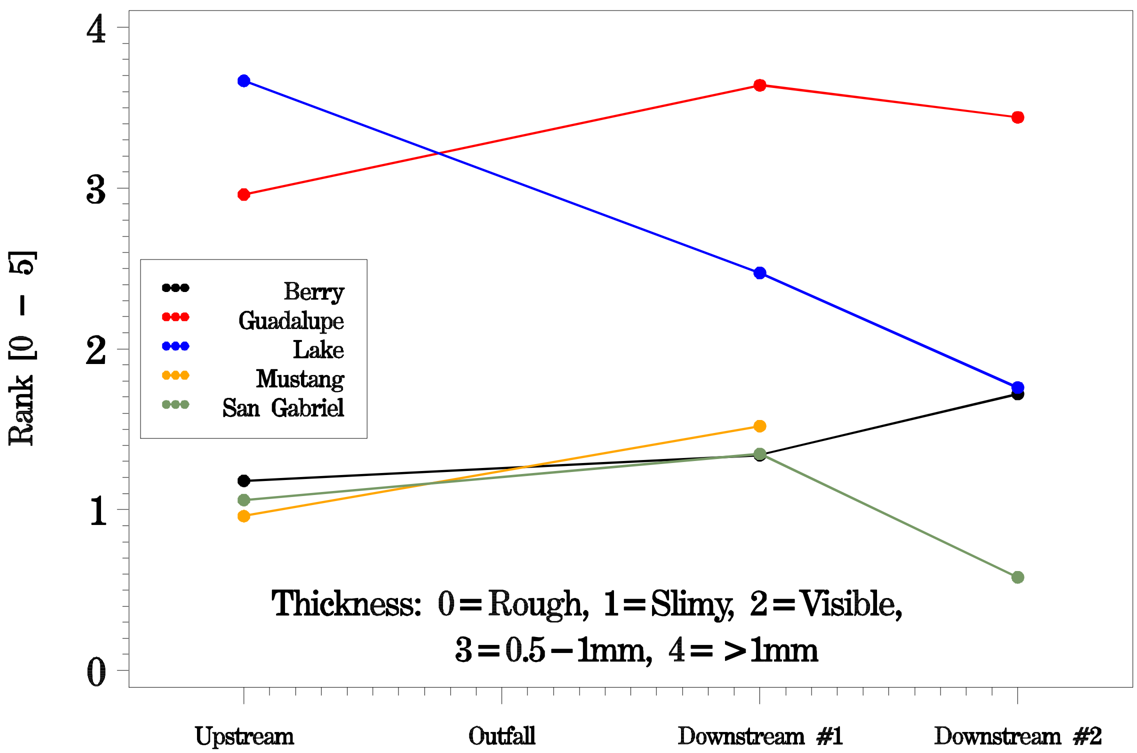

Truncated Periphyton Biomass/Chlorophyll Ratio
Ratio
500
400
300
200
100
0
4518
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2


Berry
Guadalupe
Lake
Mustang
San Gabriel
Ratio
20
18
16
14
12
10
8
6
4
Ash FreeDry Weight : Carbon Ratio
Upstream
Outfall
Downstream #1
Downstream #2

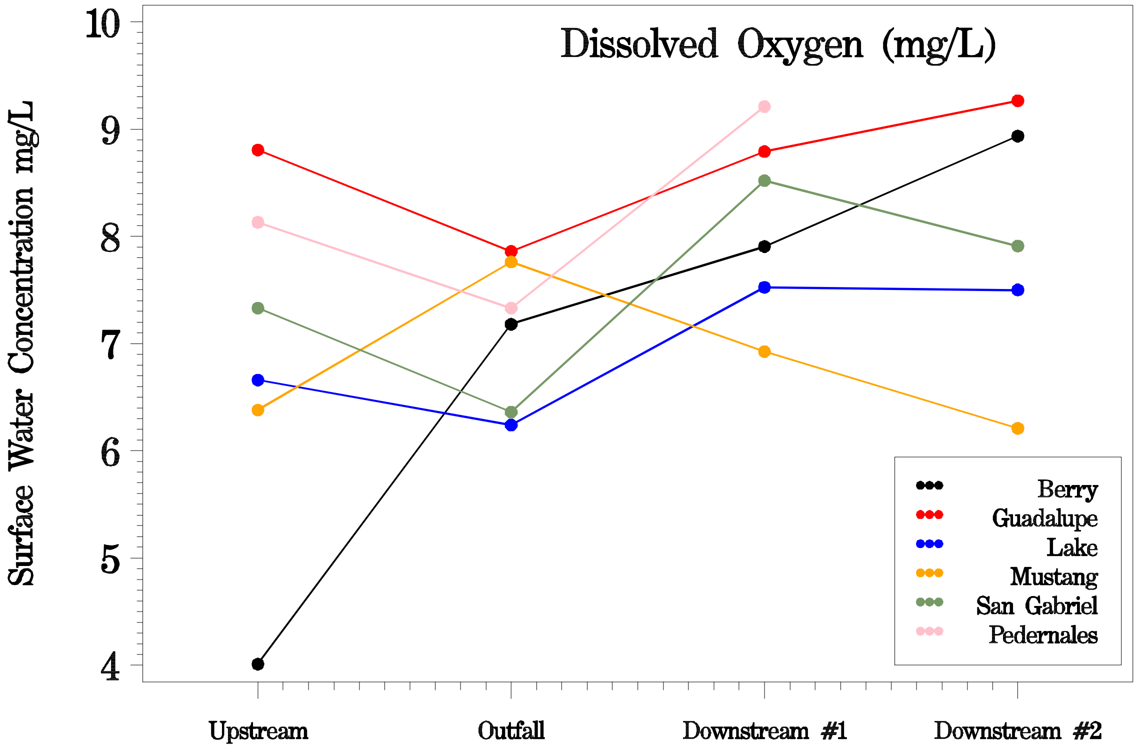

Berry
Guadalupe
Lake
Mustang
San Gabriel
Ratio
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Chlorophyll a : Carbon Ratio
Upstream
Outfall
Downstream #1
Downstream #2

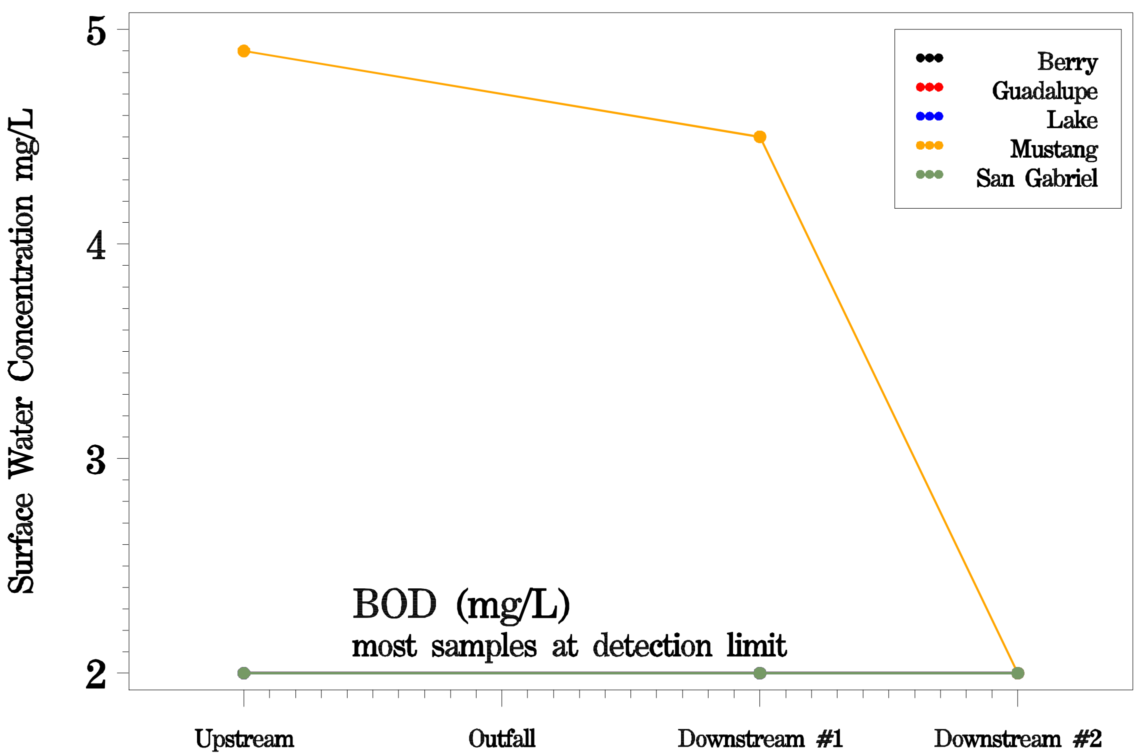
Visual Periphyton Cover

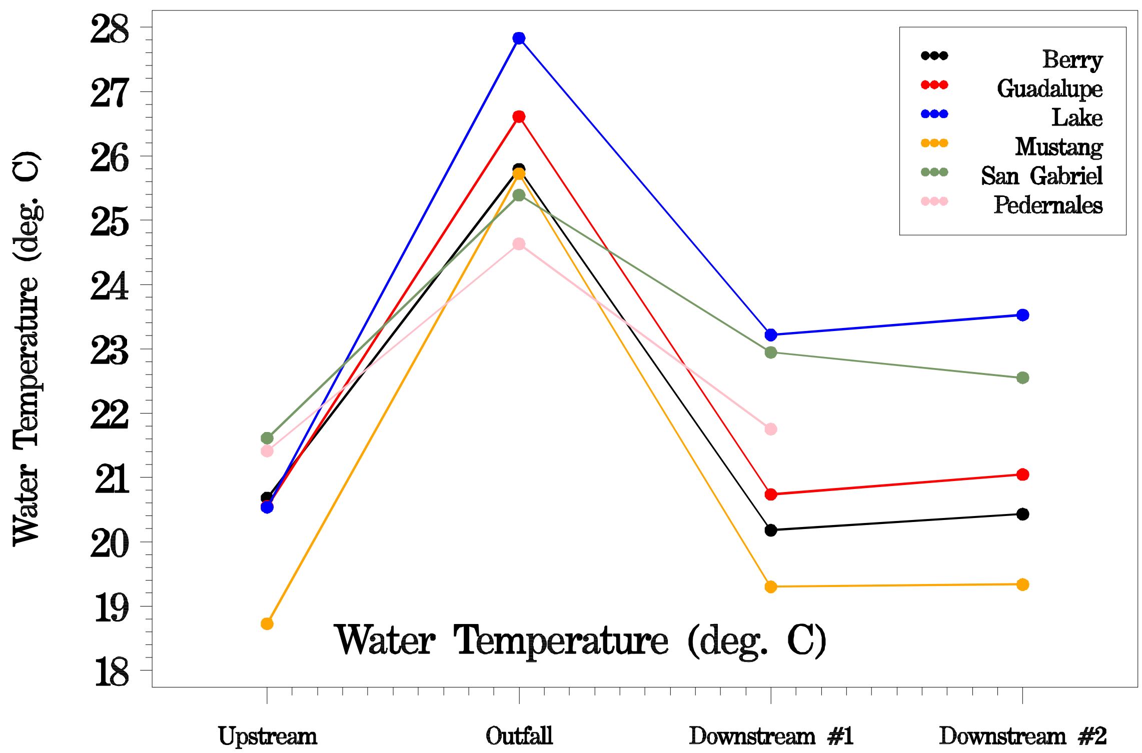




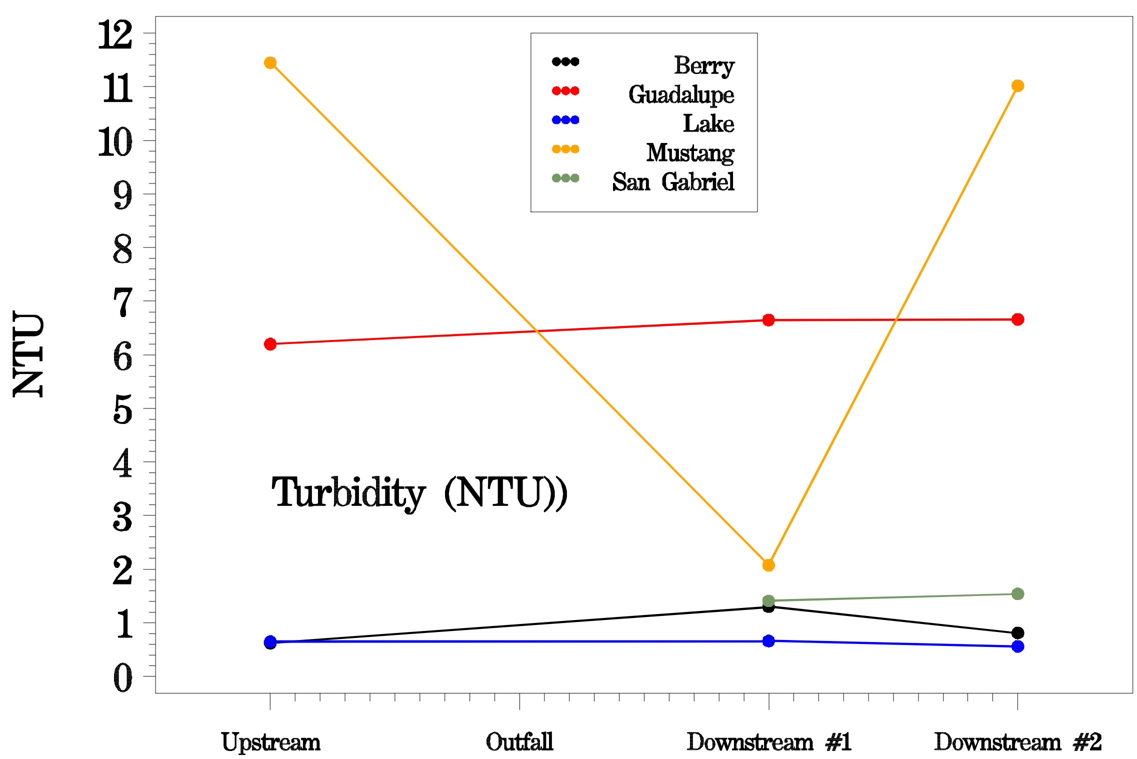
Surface Water Physiochemical



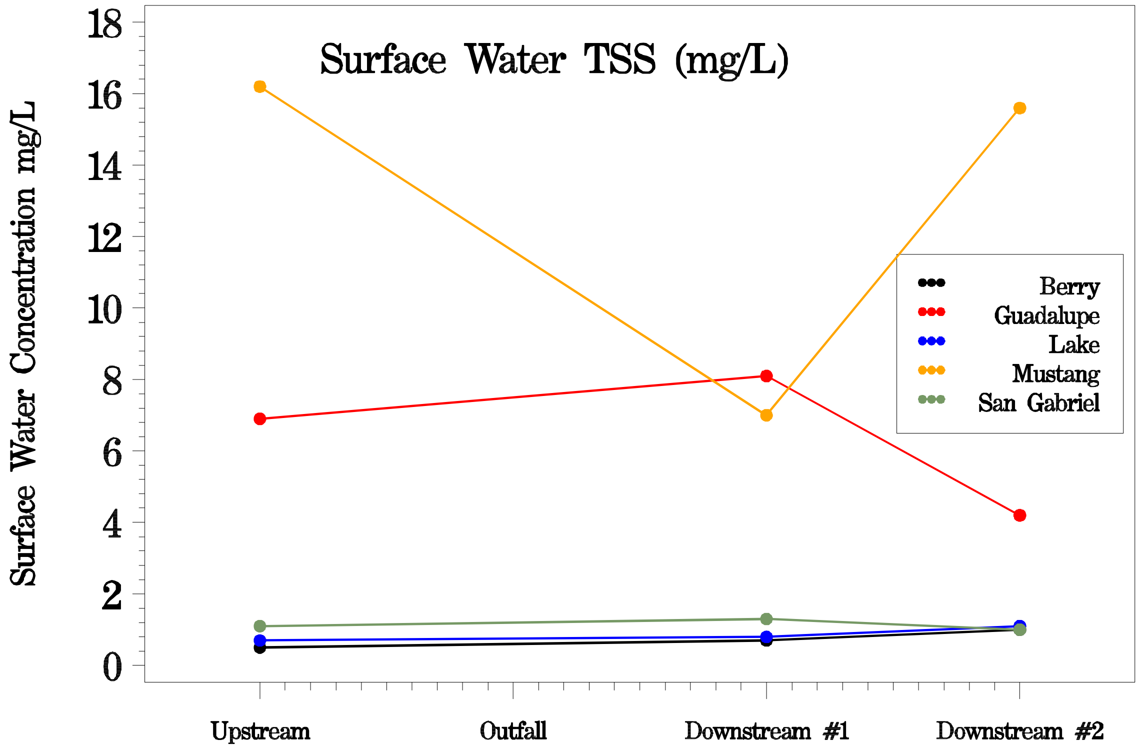


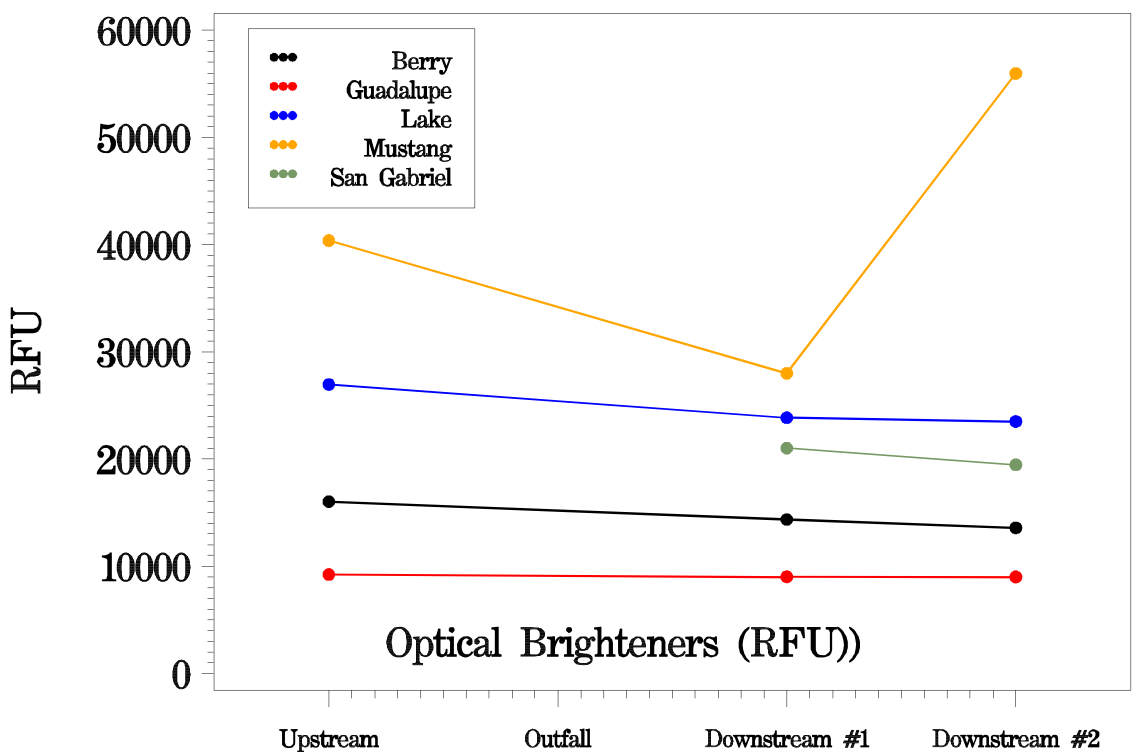


Water Temperature (deg. C)
Berry
Guadalupe
Lake
Mustang
San Gabriel
Pedernales
Water Temperature (deg. C)
Upstream
Outfall
Downstream #1
Downstream #2



NTU
Berry
Guadalupe
Lake
Mustang
San Gabriel
Turbidity (NTU))
Upstream
Outfall
Downstream #1
Downstream #2


Surface Water TSS (mg/L)
Surface Water Concentration mg/L
18
16
14
12
10
8
6
4
2
0
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2


Optical Brighteners (RFU))
RFU
60000
50000
40000
30000
20000
10000
0
Berry
Guadalupe
Lake
Mustang
San Gabriel
Upstream
Outfall
Downstream #1
Downstream #2

Appendix B: Effluent Study Quality Assurance Project Plan Project #533

Introduction

A WASP model exists for Bear Creek to assess the impact of planned wastewater discharges from Belterra, but there is an immediate need for calibration data from wastewater influenced streams. Additionally, local data should be assessed against conclusions from King study (2009) to verify patterns.

Project Management

1. Who is the project manager?
   Mateo Scoggins

2. Who is the WMA team representative?
   Chris Herrington

3. What other WPDRD staff are on the committee for this project?
   Aaron Richter, Martha Turner

4. When will the annual WMA review be completed?
   February 2010

5. When will the project begin/end?
   October 2009 – October 2010

Data Objectives

6. What are the study objective(s)?
   Provide water chemistry, periphyton taxonomy, and periphyton C:N and C:P ratio data to calibrate WASP models in receiving water streams under a range of phosphorus impacts.

   Add to understanding of wastewater impacts to streams in Edwards Plateau.

7. In addition to the project committee, who else is interested in the data?
   Ryan King, USGS (Jeff Mabe), TCEQ staff

8. What decision(s) will be made from the information obtained? When will the decision(s) be made?
   WASP model results will be used to predict impacts from wastewater effluent nutrient enrichment.

9. What has been done in the past? Describe project history, list previous related reports or available data.
   USGS study (Mabe)
   King study
   COA modeling studies (WASP, Qual-TX) in Bear Creek

10. What could be done in the future? List and prioritize potential special studies.

Laboratory bioassays could identify critical instream nutrient concentration thresholds (Ks) for algal stimulation

Data generation

11. Describe the sampling. What sites will be sampled? In addition to the core parameter list in the SOP manual, what other parameters will be collected? When will sampling occur?
    Phase I: Site Reconnaissance
    A one-time visit to 6 receiving water streams (Table 11.1) will be conducted by field staff in October 2009. Total phosphorus samples and field parameters will be collected at all sites. Field notes, including visual flow assessments, and site photos will be taken. Information from recon will be used to determine site list for phase II. An attempt should be make to visibly locate the outfall to confirm it's location relative to the specified sites and collect a sample directly from the outfall to confirm current phosphorus loading.

    Phase I Bottle Set = 18 x 250 mL plastic with H_2SO_4 preservative for TP and Hydrolab

Table 11.1. Phase I/II site list.

Receiving Stream	Plant/Permit	USGS Gage	Sites
Lake Creek	Anderson Mill MUD (11459-001)	n/a	U/S = 4505 Lake Creek @ Mellow Meadows Out = 4494 Anderson Mill MUD Outfall D/S1 = 4506 Lake Creek @ Lake Creek Pkwy D/S2 = 4507 Lake Creek @ Broadmeade Ave
San Gabriel South Fork	Liberty Hill (14477-001)	08104900	U/S = 4511 SF San Gabriel at US 183 Out = 4498 Liberty Hill WWTP Outfall D/S1 = 4512 SF San Gabriel at S. Gabriel Dr D/S2 = 4513 SF San Gabriel at CR268
Berry Creek	Georgetown WWTP (10489-006)	08105095	U/S = 4514 Berry Creek at Airport Rd Out = 4495 Berry Creek WWTP Outfall D/S1 = 4515 Berry Creek at IH35 D/S2 = 4516 Berry Creek at CR152
Mustang Creek	Taylor WWTP (10299-001)	n/a	U/S = 4510 Mustang Creek at 79 Out = 4499 City of Taylor WWTP Outfall D/S1 = 4509 Mustang Creek at CR619 D/S2 = 4508 Mustang Creek at CR448
Guadalupe River	Gruene Rd (10232-002)	08168500	U/S = 4500 Guadalupe River @ Gruene Rd Out = 4497 Gruene Rd WWTP Outfall D/S1 = 4501 Guadalupe River @ Loop 337 D/S2 = 4502 Guadalupe River @ Common St
Pedernales River	Johnson City (10198-001)	08153500	U/S = 4503 Pedernales River @ US281 Out = 4496 Johnson City WWTP Outfall D/S1 = 4504 Pedernales River nr Bradford

Phase II: One-time full sampling
All sites deemed suitable during phase I based on flow and measurable difference in phosphorus concentrations will be sampled for the parameters specified (Table 11.2) one time as soon as phase I lab results are available and projected in late October 2009. Outfalls will

not be sampled for this phase. Algae scrapings should be done on an increased # of rocks (9-25, see item 13).

Table 11.2. Parameter suites to be sampled.

#	Description	Lab	Parameters	Bottles	$ Cost /sample
1	Water quality	LCRA	NO3+NO2, NH3, TKN, OP, TP, Chl-A, TSS, BOD	250mL unpreserved 250mL H2SO4 250mL amber plastic 2x 1L plastic	130
2	ERM in-house	ERM	In-vivo chl-a, optical brighteners, turbidity	Whirlpak	0
3	Algae taxonomy	B.W.	soft bodied and diatom taxonomic id	500mL amber plastic	90
4	Algae nutrients	LCRA	NO3+NO2, NH3, TKN, OP, TP, chl-a, TSS, VSS, TOC	2x 250mL unpreserved 250mL H2SO4 250mL amber plastic	133
5	Field parameters	field	DO, pH, cond, temp, flow and chlorine*	n/a	0
6	Visual habitat	field	EPA HQI and canopy cover	n/a	0
7	Visual algae	field	100-pt USGS method	n/a	0

*chlorine to be done with HACH portable field test kit if available

Phase III: Additional sampling for WASP model calibration.
Pending the site recon, additional sample events will be collected for parameter suites 1, 2, 4 and 5 from two sites, preferably Lake Creek and SF San Gabriel, every other month for 1 year beginning in October 2009. Additionally, periphytometers will be deployed and benthic macroinvertebrate samples will be collected in the spring 2011 at the selected sites.

12. Describe special sample conditions. List only deviations from routine non-storm conditions as described in the SOP manual.
Sites will be sampled in non-storm flow conditions and at least 2 weeks from large scour events. Sites with ambient upstream flows are needed (i.e., drop sites with no upstream flows from phase II).

13. Describe special collection methods. List only deviations from routine sample collection methods as listed in the SOP manual.
Visual algae cover and composition will be determined using the 100-sample point zig-zag method following the methods of Mabe (USGS reference)

Algae scrapings will be done following routine methods EXCEPT for an increase in the number of rocks sampled and composited per site (9-25 rocks). Staff need to determine appropriate replication.

14. List special laboratory analytical methods. Include details on CRP requirements, non-EPA approved methods and in-house analyses (Ohmicron).
    Verify sample bottle volume for algae C:N,P ratios with LCRA

15. Where will the samples be analyzed?
    See Table 11.2

16. How much will samples cost?
    See Table 11.2 for individual sample costs.

    Phase I total cost (assuming 6 streams) = $360.00 (or $60/stream)
    Phase II total cost (assuming 6 streams) = $2,118 (or $353/stream)
    Phase III total cost (assuming 2 streams) = $4,236(or $353/stream/event for 6 events)

    Total cost for the whole project (excluding periphytometers) = $6,714.00

    Periphytometers could be analyzed in-house using the fluorometer pending review of safety concerns with necessary acid extraction to reduce costs.

17. What possible problems may arise in sample collection and what actions can be taken to mitigate their impact?
    Upstream sites may be dry during phase I. Sites should most likely be dropped.

    Consult flow gauges when possible to determine appropriate sampling conditions prior to sampling day.

    Lab holding times should be considered, and sampling may need to occur on 2 consecutive days due to travel times.

Validation

18. What type, how often and where will QA/QC samples will be collected? Include QA/QC samples names in the FSDB if applicable.
    No additional QA/QC samples are required, but may be considered for phase III rock scrapings as a measure of additional variability.

19. In addition to the automated data flagging process, how will QA/QC results be used to validate data quality?
    N/A

20. In case of QA/QC failure, what corrective action will be taken?
    N/A

Assessment

21. By what specific methods will the data be analyzed?
    Upstream concentrations to be compared to downstream concentrations by appropriate paired analysis methods given resulting distribution and small # of samples.

Data will be included in WASP model calibration.

Streams will be compared qualitatively.

22. What hypotheses will be tested?
    There is no difference between upstream and downstream of the effluent outfalls.

23. When and/or how often will the data be analyzed?
    Following completion of each phase.

24. How will it be determined that the study objectives have been met?
    Sufficient data for calibration of WASP model.

Reporting

25. When and what type of reports will be generated? Who will generate the report?
    Short reports by Chris Herrington and Mateo Scoggins for in-stream sampling. Short reports on WASP model outputs and calibration procedures by Aaron Richter and Martha Turner.

26. Who will review the reports prior to publication?
    Committee.

References

<INSERT TEXT>

Appendix: Effluent Study Monitoring Proposal and Additional Site Info

Phase I: Site Recon and Grab Sampling

- Visit all sites to check proposed locations for suitability, access
- Collect TN, TP grab samples for confirmation; verify flow
- Select periphytometer sites
- Modify site locations as necessary

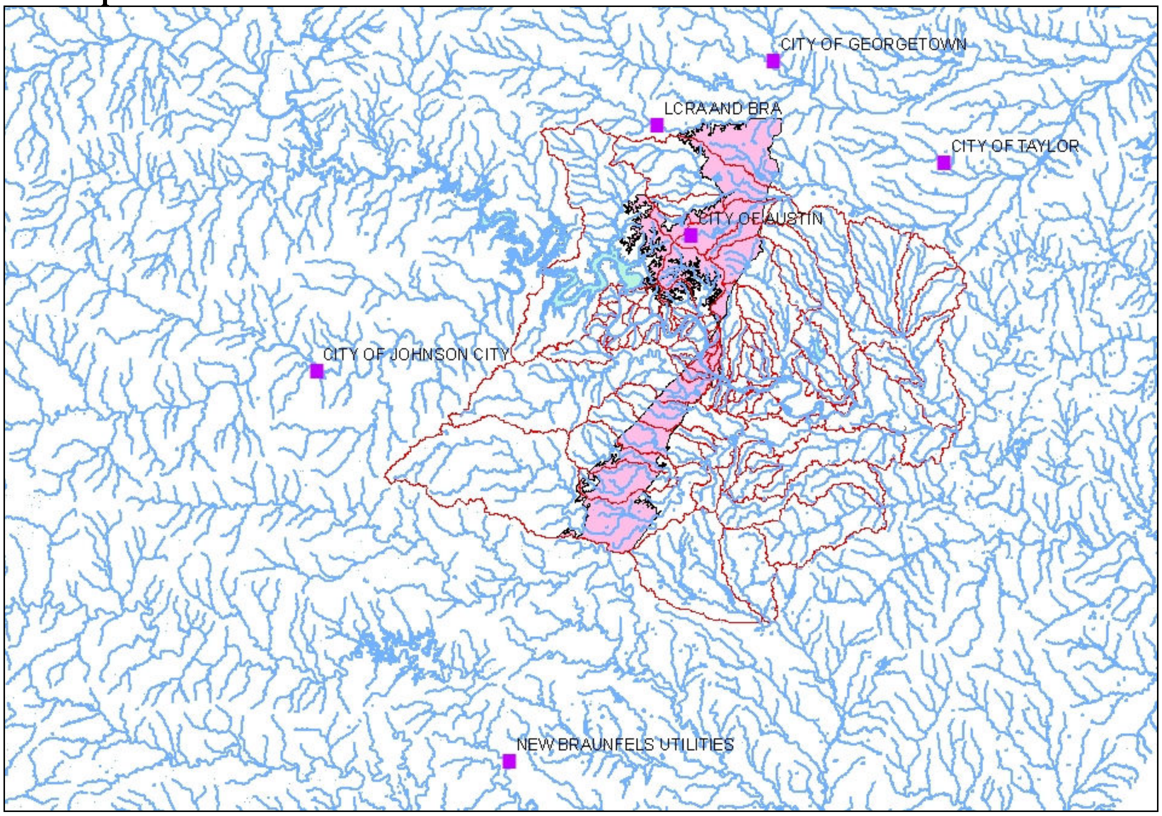
Phase II: Fall 2009 sampling

- Sampling upstream (where feasible) and downstream of wastewater outfalls to provide data on nutrient enrichment, algal response for use in calibration of current and future models
- Water Quality (LCRA): TN, TP, field parameters (including chlorine), Chl-a, TSS, BOD
- Water Quality (ERM): in-vivo chlorophyll-a, optical brighteners, turbidity
- Algae scrapings (LCRA): chl-a, TOC, TP, TN, TSS, VSS
- Algae scrapings (BW): diatom and soft-bodied algal taxonomy
- Visual algae survey (field): 100-point USGS method
- Visual habitat and canopy cover
- Periphytometers: can only deploy 2 simultaneously, optimally upstream/downstream
- ?Benthic macroinvertebrates (timing at end of index period, after long drought with recent rains)

Additional considerations:

- One-time special study in October 2010, but could be repeated in spring under different conditions
- Must increase number of rocks for scrapings (9-25/site)
- Should additional samples (replicates) be collected at every site?

Site Map



General Comments on Sites

Liberty Hill	North, Edwards	Good plant, lots of dilution
Berry Creek	North, Edwards	High TP, no upstream flow
Anderson Mill	North, Edwards	High TP, ? upstream flow
Taylor	East, Blackland	High TP, ? upstream flow
Gruene Rd	South, Edwards	Perennial stream, 100:1 dilution so instream phosphorus probably 0.03 mg/L at max
Johnson City	West, Edwards	High dilution, but natural flow regime

Liberty Hill Regional WWTP (14477-001, TX0126195)

- Operated by LCRA and BRA
- Discharges to San Gabriel South Fork (segment 1250) near 183 in Williamson County
- Permit also requires a study of nutrients and algae in the receiving stream
- Existing SWQMIS in-stream data upstream and downstream of discharge, but no obvious impacts from discharge other than conductivity increase (downstream site is more than 11 miles d/s of discharge).
- USGS gauge (08104900) approximately 10 miles downstream of discharge (1987-present) http://waterdata.usgs.gov/tx/nwis/inventory/?site_no=08104900& Creek was dry as recently as August 25, 2009.
- http://oaspub.epa.gov/enviro/pcs_det_reports.pcs_tst?npdesid=TX0126195&npvalue=1&npvalue=2&npvalue=3&npvalue=4&npvalue=5&npvalue=6&rvalue=13&npvalue=7&npvalue=8&npvalue=10&npvalue=11&npvalue=12
- Recommended sites:

  Upstream = SF San Gabriel at US 183 (1 mile u/s of outfall)
  Downstream1 = SF San Gabriel at S. Gabriel Dr (450 ft d/s of outfall)
  Downstream2 = SF San Gabriel at CR268 (2 miles d/s of outfall)

TPDES Permit Summary (http://www.epa.gov/npdescan/TX0126195FP.pdf)

Phase	Interim I	Interim II	Final
Flow, mgd / Flow, cfs	0.4 / 0.62	0.8 / 1.24	1.2 / 1.86
BOD, mg/L	5	5	5
DO, mg/L	5	5	5
TSS, mg/L	5	5	5
NH3, mg/L	2	2	2
TP, mg/L	0.5	0.5	0.5
TN, mg/L	report	report	report
Fecal coliform, col/dL	200	200	200
Disinfection	UV	UV	UV

Effluent Monitoring Summary (n=33, 2006-2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	6.4	0.68
avg TSS, mg/L	1.703	1.413
avg TN, mg/L	27.804	28.433
avg NH3, mg/L	0.636	1.453
avg TP, mg/L	0.315	0.166
avg Q, mgd	0.044	0.020

Instream Flow Summary (1967-09/2009)

Stat	Flow, cfs
min	0
max	18400
median	11
mean	53.3
q25	1.5
q75	46
7q2	0.25

Berry Creek WWTP (10489-006, TX0119172)

- Operated by City of Georgetown; plant still in interim phase
- Discharges to Berry Creek (segment 1248A) near 183 in Williamson County
- NOTE: site can only be sampled up to 2.5 miles downstream of outfall
- NOTE: creek appears to be highly intermittent, and is currently dry
- No existing SWQMIS in-stream data upstream or immediately downstream
- USGS gauge (08105100) approximately 0.4 miles downstream of discharge (1967-2003) http://waterdata.usgs.gov/tx/nwis/inventory/?site_no=08105100& USGS gage (08105095) approximately 0.5 miles upstream of discharge (2003-present). http://waterdata.usgs.gov/tx/nwis/inventory/?site_no=08105095&
- http://oaspub.epa.gov/enviro/pcs_det_reports.pcs_tst?npdesid=TX0119172&npvalue=1&npvalue=2&npvalue=3&npvalue=4&npvalue=5&npvalue=6&rvalue=13&npvalue=7&npvalue=8&npvalue=10&npvalue=11&npvalue=12
- Recommended sites:

  Upstream = Berry Creek at Airport Rd (visible pond, 0.5 miles u/s of outfall)
  Downstream1 = Berry Creek at IH35 (0.8 miles d/s of outfall)
  Downstream2 = Berry Creek at CR152 (2.2 miles d/s of outfall)

TPDES Permit Summary

Phase	Interim I	Final
Flow, mgd / Flow, cfs	0.2 / 0.31	
BOD, mg/L	10	
DO, mg/L	4	
TSS, mg/L	15	
NH3, mg/L	10	
TP, mg/L	monitor	
TN, mg/L	n/a	
Fecal coliform, col/dL	n/a	
Disinfection	chlorine	

Effluent Monitoring Summary (n=6, 2008-2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	5.65	0.83
avg TSS, mg/L	2.46	0.66
avg TN, mg/L	?	
avg NH3, mg/L	0.11	0.01
avg TP, mg/L	5.10	0.31
avg Q, mgd	0.05	0.01

Instream Flow Summary (2003-09/2009)

Stat	Flow, cfs
min	0
max	6630
median	0
mean	26.4
q25	0
q75	8.1
7q2	0

City of Taylor WWTP (10299-001; TX0020443)

- Operated by City of Taylor; potentially limited natural flow with upstream drainage area of only 24,000 acres
- Plant operating in final phase
- Site representative of Blackland prairie ecoregion
- Discharges to Mustang Creek (segment 1244), a tributary of Brushy Creek, near Taylor in Williamson County
- No existing SWQMIS in-stream data upstream or immediately downstream
- No existing USGS gauges
- http://oaspub.epa.gov/enviro/pcs_det_reports.pcs_tst?npdesid=TX0020443&npvalue=1&npvalue=2&npvalue=3&npvalue=4&npvalue=5&npvalue=6&rvalue=13&npvalue=7&npvalue=8&npvalue=10&npvalue=11&npvalue=12
- Recommended sites:
  - Upstream = Mustang Creek at Hwy 79 (0.7 miles u/s of outfall)
  - Downstream1 = Mustang Creek at CR619 (1.8 miles d/s of outfall)
  - Downstream2 = Mustang Creek at CR448 (5 miles d/s of outfall)

TPDES Permit Summary

Phase	Final
Flow, mgd / Flow, cfs	4 / 6.19
BOD, mg/L	10
DO, mg/L	4
TSS, mg/L	15
NH3, mg/L	2
TP, mg/L	n/a
TN, mg/L	n/a
Fecal coliform, col/dL	200
Disinfection	UV

Effluent Monitoring Summary (n=3, 2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	7.55	0.31
avg TSS, mg/L	3.17	0.40
avg TN, mg/L	?	
avg NH3, mg/L	0.14	0.07
avg TP, mg/L	?	
avg Q, mgd	1.44	0.18

Instream Flow Summary

?

Gruene Rd WWTP (10232-002; TX0070939)

- Operated by New Braunfels; permit originally issued in 1983
- Discharges to Guadalupe River (segment 1812), approximately 20 miles downstream of Canyon Lake near Gruene in Comal County
- USGS gauge (08168500) located 2 miles d/s of outfall (1927-present) (http://waterdata.usgs.gov/tx/nwis/inventory/?site_no=08168500&); current flow is 100 cfs
- Plant operating in final phase
- Approximately 100:1 dilution factor in current conditions
- No existing SWQMIS in-stream data upstream or immediately downstream
- Recommended sites:

    Upstream = Guadalupe River at Gruene Rd (immediately u/s of outfall)
    Downstream1 = Guadalupe River at Loop 337 (1.15 miles d/s of outfall)
    Downstream2 = Guadalupe River at Common St (2.15 miles d/s of outfall)

TPDES Permit Summary

Phase	Final
Flow, mgd / Flow, cfs	1.1 / 1.7
BOD, mg/L	5
DO, mg/L	4
TSS, mg/L	10
NH3, mg/L	3
TP, mg/L	n/a
TN, mg/L	n/a
Fecal coliform, col/dL	n/a
Disinfection	chlorine

Effluent Monitoring Summary (n=49, 2005-2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	6.81	0.75
avg TSS, mg/L	3.05	1.12
avg TN, mg/L	?	
avg NH3, mg/L	0.16	0.13
avg TP, mg/L	?	
avg Q, mgd	0.40	0.06

Instream Flow Summary (1975-09/2009)

Stat	Flow, cfs
min	2.6
max	62600
median	293
mean	652
q25	151
q75	724
7q2	112

Johnson City WWTP (10198-001; TX0052973)

- Permit originally issued in 1974; plant operating in final phase
- Discharges to Town Creek, then to Pedernales River (segment 1414) near in Blanco County; there is another discharge approximately 30 miles upstream
- USGS gauge (08153500) located u/s of outfall (1939-present) (http://waterdata.usgs.gov/tx/nwis/inventory/?site_no=08153500&); current flow is 65 cfs
- Potentially problematic access issues
- SWQMIS in-stream data downstream but not upstream. Elevated chlorophyll-a (18±30 µg/L) but no nutrient data???
- Recommended sites:

  Upstream = Pedernales River at US281 (pool immediately u/s of confluence)
  Downstream1 = Pedernales River nr Bradford (1 miles d/s of outfall)
  Downstream2 = ?private property access

TPDES Permit Summary

Phase	Final
Flow, mgd / Flow, cfs	0.303 / 0.47
BOD, mg/L	10
DO, mg/L	5
TSS, mg/L	15
NH3, mg/L	3
TP, mg/L	n/a
TN, mg/L	n/a
Fecal coliform, col/dL	n/a
Disinfection	chlorine

Effluent Monitoring Summary (n=39, 2006-2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	6.58	0.60
avg TSS, mg/L	3.94	1.90
avg TN, mg/L	?	
avg NH3, mg/L	0.67	0.68
avg TP, mg/L	?	
avg Q, mgd	0.09	0.03

Instream Flow Summary (1975-09/2009)

Stat	Flow, cfs
min	0
max	50200
median	72
mean	242.3
q25	31
q75	156
7q2	4.32

Anderson Mill MUD (11459-001; TX0034207)

- Discharges to headwaters of Lake Creek in Williamson County near US183 and Pecan Park Drive
- Permit originally issued in 1976; plant in final phase
- Limited flow from 1300 ac upstream drainage area
- No USGS gauge on Lake Creek
- EII site (Lake below Meadowheath downstream); NH3 = 0.03 mg/L, NO3 = 4.4 mg/L, OP > 0.9 mg/L
- Recommended sites:

  Upstream = Lake Creek at Mellow Meadows (0.3 miles u/s of outfall)
  Downstream1 = Lake Creek at Lake Creek Pkwy (0.6 miles d/s of outfall)
  Downstream2 = Lake Creek at Broadmeade Ave (1.3 miles d/s of outfall)

TPDES Permit Summary

Phase	Final
Flow, mgd / Flow, cfs	1.3 / 2.0
BOD, mg/L	7
DO, mg/L	4
TSS, mg/L	15
NH3, mg/L	3
TP, mg/L	n/a
TN, mg/L	n/a
Fecal coliform, col/dL	n/a
Disinfection	chlorine

Effluent Monitoring Summary (n=65, 2003-2009, monthly monitoring)

Param	Mean	Stdev
min DO, mg/L	5.86	6.25
avg TSS, mg/L	2.5	1.45
avg TN, mg/L	?	
avg NH3, mg/L	0.59	0.81
avg TP, mg/L	?	
avg Q, mgd	0.63	0.08

Instream Flow Summary

?