FINAL
2008 Klamath River Nutrient Summary Report

Yurok Tribe Environmental Program:
Water Division

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Acknowledgements

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I. Introduction

This report summarizes the presence and concentration of commonly occurring nutrients on the Klamath River during water year 2008. The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites from Weitchpec to the Klamath River Estuary on a bi-weekly interval starting in mid-May and ending in mid-October. This sampling was performed in an effort to track both temporal and spatial patterns on the lower reaches of the Klamath River during the sampling period. This data was added to previous years' nutrient data as part of an endeavor to build a multi-year database on the Lower Klamath River. This nutrient summary is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner.

II. Background

The Klamath River Watershed

The Klamath River system drains much of northwestern California and south-central Oregon (Figure 2-1). Thus, even activities taking place on land hundreds miles off the Yurok Indian Reservation (YIR) can affect water conditions within YIR boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the YIR is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages because of inadequate dam releases from water diversion projects along the Klamath and Trinity Rivers. The releases contribute to lower mainstem levels and excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the Lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen levels are inadequate for migrating fish. The Klamath River is on California State Water

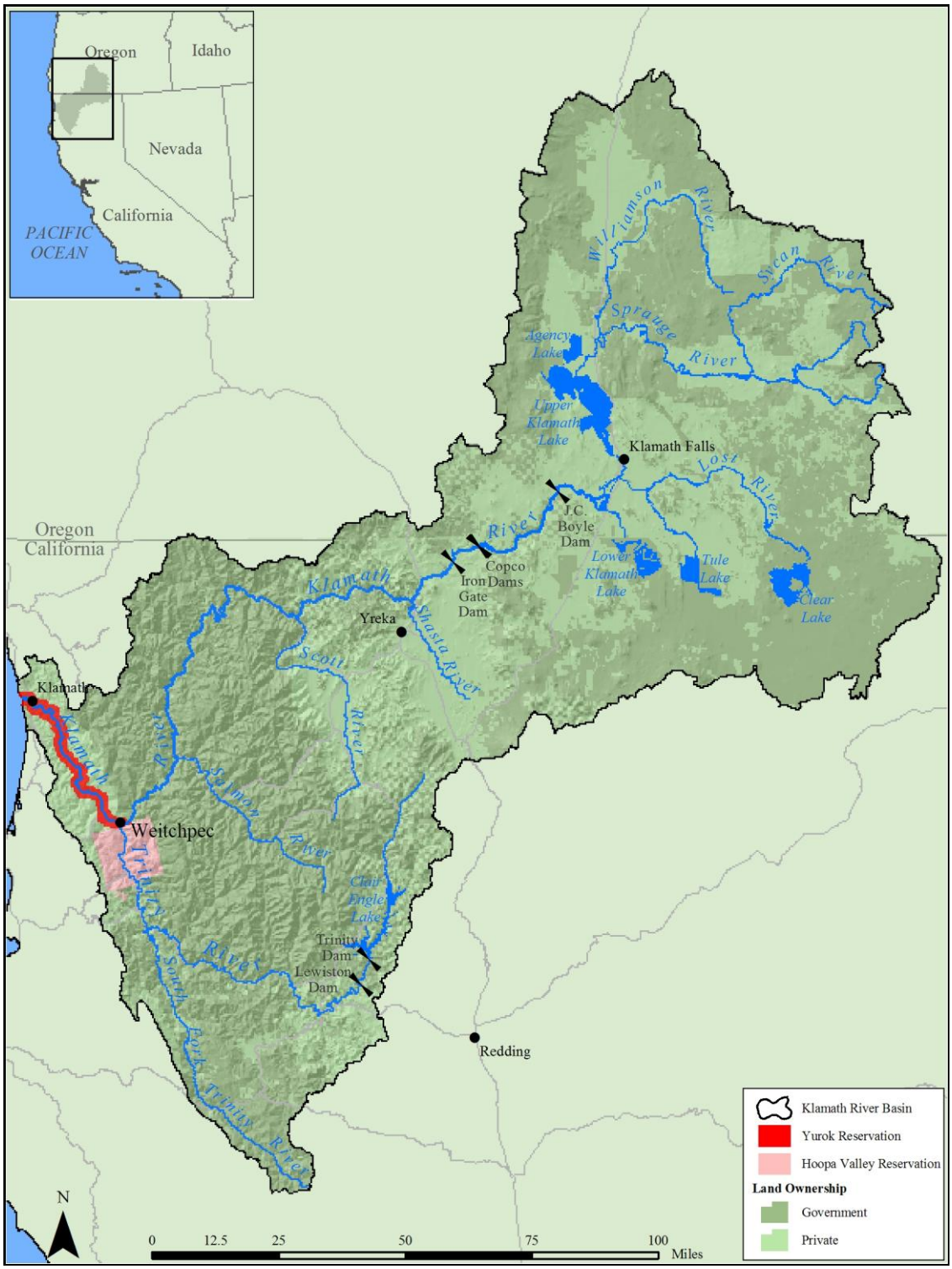

Figure 2-1. Klamath River Basin Map

Resource Control Board's (SWRCB) 303(d) List as impaired for temperature, dissolved oxygen, and nutrients and portions of the Klamath River were recently listed as impaired for microcystin and sedimentation in particular reaches.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest.

The Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for north or east, but rather spoke of direction in terms of the flow of water (Kroeber 1925). The Yurok word for salmon, *nepuy*, refers to "that which is eaten". Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land covers about 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific Coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

The Yurok Indian Reservation

The current YIR consists of a 59,000-acre corridor extending for one mile from each side of the Klamath River from just upstream of the Trinity River confluence to the Pacific Ocean, including the channel and the bed of the river (Figure 2-2). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are as much as 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes.

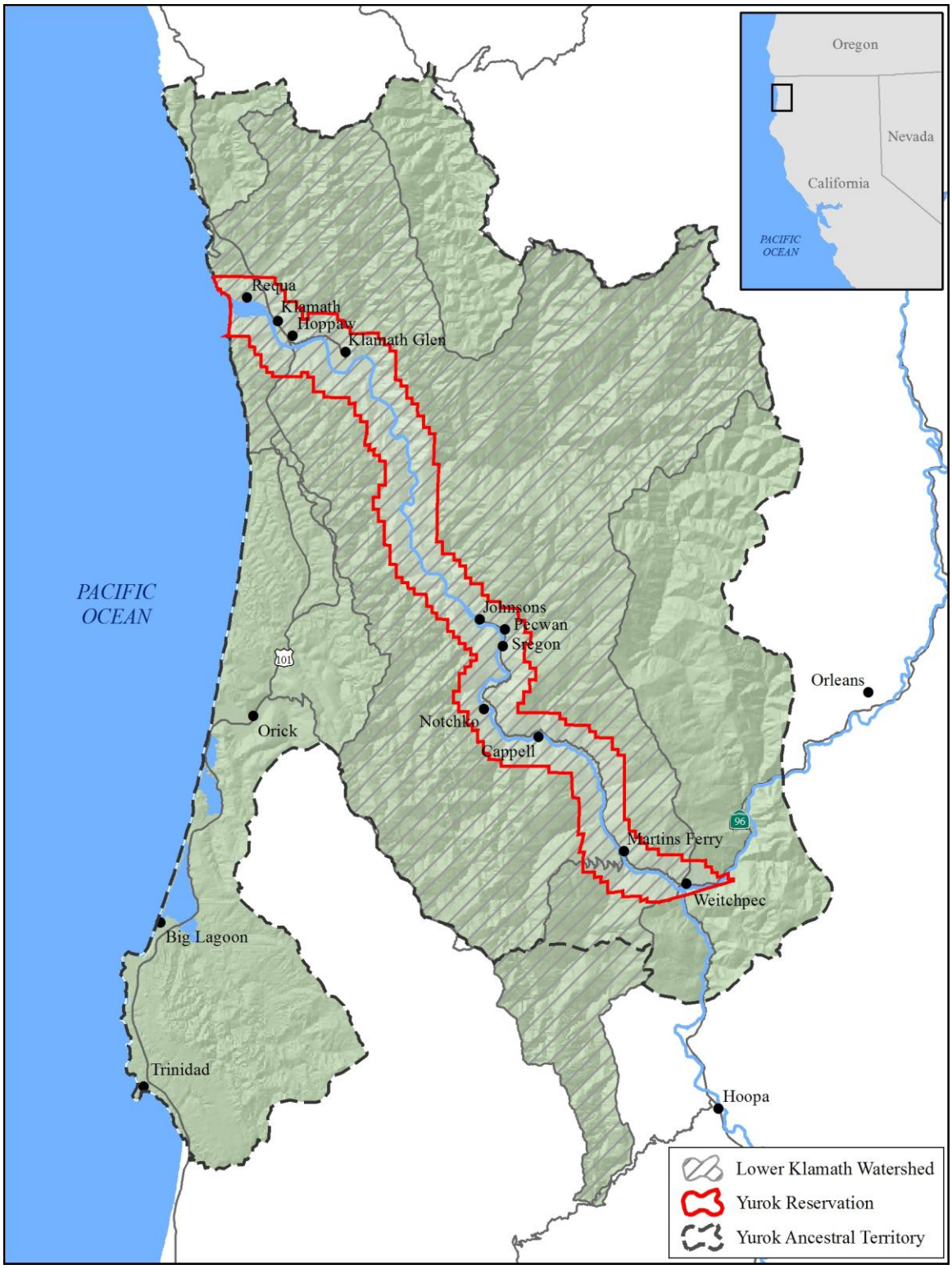

Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

The vegetation is principally redwood and Douglas fir forest with little area available for agricultural development. Historically, prevalent open prairies provided complex and diverse habitat.

At this time within the reservation, 3,653 acres are held in trust status, 115 acres are Tribal Housing, 4,222 acres are Tribal fee lands and 3,499 acres are allotments (Yurok Tribal Planning Department). The majority of the remaining lands in the YIR are fee lands, (mostly owned by Green Diamond Resource Company), which are managed intensively for timber products. A small portion of the YIR consists of public lands managed by Redwood National/State Parks (RNSP), the United States Forest Service (USFS) and private landholdings.

Yurok Tribe Water Monitoring Division

In 1998, YTEP was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Yurok Tribe Fisheries Program (YTFP), US Fish and Wildlife Service (USFWS), the United States Environmental Protection Agency (USEPA), Green Diamond Resource Company, the NCRWQCB, and the United States Geological Survey (USGS). A USEPA General Assistance Program (GAP) Grant and funding allocated under the Clean Water Act Section 106 and funding from the State of California primarily fund YTEP's water monitoring activities.

III. Methods

Grab samples, discreet surface water samples, were collected during the sampling season twice a month beginning in May and ending in October. Samples were delivered to the same lab during the 2008 season in an effort to maintain consistency in laboratory methods. Samples were delivered to Aquatic Research Inc. in Seattle, WA. The parameters sampled are shown in Table 3-1.

Upon arrival at each site, a sampling churn was rinsed three times with distilled water. After rinsing with distilled water, the churn was rinsed three times with stream

water. The churn was then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allowed for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guaranteed the water was well mixed before the sample was collected. The churn was stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second. This mixing continued while the bottles were being filled. If filling had stopped for some reason, the stirring rate was resumed before the next sample was drawn from the churn.

The sample bottles and chemical preservatives used were provided by the contract lab and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn once before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples were placed in coolers on wet ice for transport to the contract lab for analysis.

Additional quality control measures were included in the sampling. At one site per sampling event a duplicate split sample were sent to the laboratory to assess laboratory precision and to gain improved confidence in the data.

Table 3-1. Parameters sampled on the Klamath River during WY08

Analytes
Nitrate + Nitrite
Total Nitrogen
Ammonia
Total Phosphorus
Soluble Reactive Phosphorous
Total Alkalinity
Calcium
Chlorophyll-a
Pheophytin-a
Magnesium
Non-Filterable Residue
Total Dissolved Solids
Total Organic Carbon

Environmental information was also recorded at the time water samples were collected. The data included water temperature, pH, specific conductance, dissolved oxygen and other observational notes. Chain-of-custody (COC) sheets were also filled out to document the handling of the samples from the time of collection to the time of laboratory analysis. This is a standard procedure for handling samples.

IV. Site Selection

In general, the various sampling locations were chosen in order to represent the average ambient water conditions throughout the water column. The sites listed below in bold indicate established sampling locations for the collection of water samples for nutrient analysis May through October.

YTEP collected water samples for nutrient analysis at the following mainstem Klamath River locations (Figure 4-1) (river miles are approximate):

- **WE - Klamath River at Weitchpec (upstream of Trinity River) – RM 43.5**
- **TC - Klamath River above Tully Creek – RM 38.5**
- **TG - Klamath River at Turwar Boat Ramp – RM 6**
- **LES - Lower Estuary Surface – RM 0.5**

YTEP collected water samples for nutrient analysis at the following major tributary locations:

- **TR - Trinity River near mouth (above Klamath River confluence) – RM 0.5**

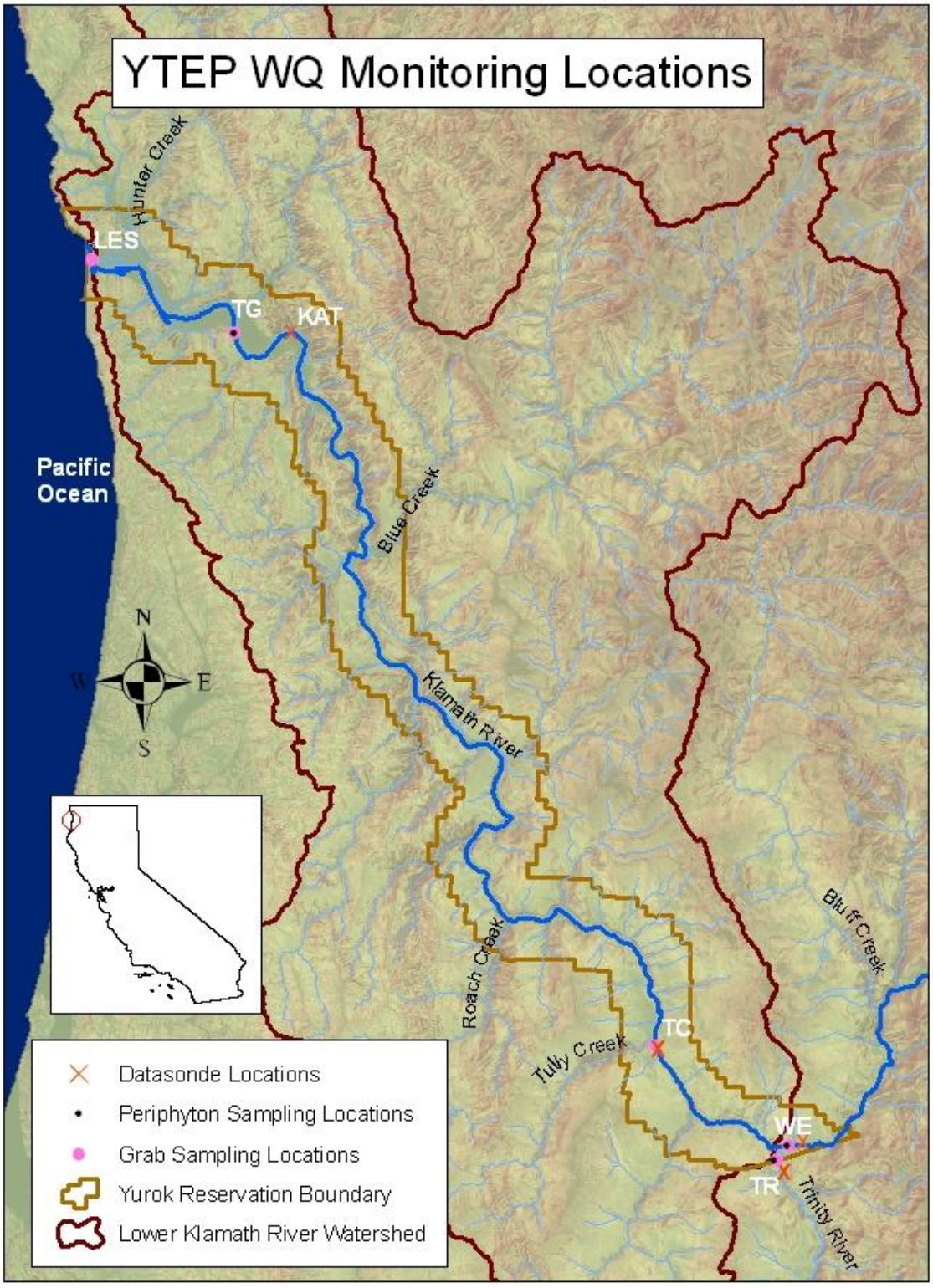

Figure 4-1. Nutrient "Grab" Sampling Sites for WY08 as indicated by the pink dots

V. Quality Assurance

During this study, many quality assurance and quality control (QA/QC) measures were undertaken to ensure the grab sample data that was collected was of the highest quality. YTEP performs all surface water quality monitoring activities consistent with its Quality Assurance Program Plan that was approved by the USEPA in April 2001. In June of 2008 USEPA approved YTEP's *Lower Klamath River Nutrient, Periphyton, Phytoplankton and Algal Toxin Sampling and Analysis Plan (SAP).* This document characterizes the quality control of the collection, preparation and analysis of water samples for presence of nutrients and related analytes. QA/QC was achieved by following a standard water sample collection protocol using a churn sampler and submitting samples to labs that follow strict protocol that have QA/QC measures.

All field personnel that were involved in collection of water samples have been trained appropriately by the Water Division Program Manager and are properly supervised to ensure proper protocol is followed consistently throughout the monitoring season. Each field visit requires that staff fill out field data sheets and label samples appropriately in the field. Sampling is always conducted by at least two staff for safety reasons and to maintain consistency. Field crews collecting samples ensured representativeness of samples by selecting sites that have free-flowing water from established sampling locations and using a churn splitter to mix sample water once collected. All samples were transported to the appropriate laboratories following chain of custody procedures to ensure proper handling of the samples.

The collection and analysis of field replicate samples were performed on a monthly basis to determine the labs' precision of data. Field replicates were collected by splitting samples in the field using the churn splitter. One of the split samples was sent with its' associated split with a different ID code for analysis of both nutrients and related analytes so as to not alert lab staff of the fact that the samples were replicates. Replicate sample results indicate the lab's precision is within the stated goals of this sampling project with 90% of samples meeting the relative percent difference of + or – 20%.

Equipment blank samples were not collected in 2008 due to limited resources. It is not believed that cross contamination between sites influences results because the stream sample will overwhelm any minute presence of nutrients and related analytes that

could be present after the churn is rinsed three times with distilled water and with stream water at the next sampling site. True blank samples were prepared in 2008 by pouring distilled water into sample containers provided by the laboratory and sent with a different ID code for analysis of both nutrients and related analytes so as to not alert lab staff of the fact that the samples were a true blank. True blank sample results from the 2008 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory.

QA reference standards were submitted to the laboratory for purposes of evaluating the accuracy of their results. These QA reference standards were for Total Nitrogen, nitrite + nitrate, ammonia nitrogen, total phosphorus and orthophosphate phosphorus. QA reference standards were purchased from Hach prior to the sample event and prepared the day prior to the sampling event. QA reference samples were transported along with the other samples for the duration of the sampling event until they were mailed off overnight to the laboratory. QA reference samples were prepared in 2008 by pouring the reference standard straight into sample containers provided by the laboratory and sent with a different ID code for analysis of the specific nutrient analyte so as to not alert lab staff of the fact that the samples were a reference standard. QA reference standard sample results indicate the lab's accuracy is within the stated goals of this sampling project with all samples meeting the percent recovery of + or – 20%.

Data is thoroughly reviewed once received from the laboratory. YTEP is the primary organization responsible for data review, although the professional laboratories analyzing water quality samples will also note potential problems with outliers or other anomalies in sample results. Information regarding QA/QC procedures for the laboratory is available upon request. One hundred percent of laboratory-generated data was checked on receipt by the Project Manager for consistency and acceptability, including whether replicates are within specified targets and meet data quality objectives. Data is reviewed and finalized once data are merged or entered into a database,

The data manager will visually inspect all entered data sets to check for inconsistencies with original field or laboratory data sheets. Where inconsistencies are encountered, data will be re-entered and re-inspected until the entered data is found to be satisfactory or results will be discarded. Any unusual values outside the range of norm

will be flagged and all aspects of field data sheets, shipping handling and laboratory handling and testing will be reviewed. Outliers will be identified and removed from the dataset if deemed necessary by the QA Officer. The Project Manager will maintain field datasheets and notebooks in the event that the QA Officer needs to review any aspect of sampling for QA/QC purposes. Water temperature, conductivity, pH and dissolved oxygen are measured in the field when samples are collected and values of these hand-held measurements can be used to check field conditions at the time of sampling.

The Yurok Tribe received a grant under the Environmental Information Exchange Network Program and used it to develop the Yurok Tribe Environmental Data Storage System (YEDSS). Nutrient data covered in this report have been entered in YEDSS, and will be uploaded to USEPA's WQX database. The metadata associated with each data type are also stored within the system and can be easily accessed when questions arise.

VI. Results

Nitrite + Nitrate

Nitrite plus nitrate levels for all sites fluctuated very little from mid-May to early October with most sites yielding results of less than 0.050 mg/L during this period (Table 6-1, Figure 6-1). After October 1st, concentrations at all sites except TR began to increase sharply with the highest concentrations for all sites except TR returned on the last day of sampling in mid-October.

Nitrite plus nitrate concentrations at the 2008 monitoring sites ranged from less than 0.010 mg/L to 0.267 mg/L. The site with the lowest reportable concentration was the Trinity River above the mouth (TR) on June 25, 2008, with a reading of 0.011 mg/L. The site that yielded the highest concentration was the Klamath River at Weitchpec (WE) on October 15, 2008, with a reading of 0.267 mg/L. The reporting limit for nitrate plus nitrite was 0.010 mg/L. If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred.

Total Nitrogen

All sites except TR exhibited similar trends for total nitrogen with concentrations generally rising throughout the sampling season and peak concentrations occurring when sampling was suspended in mid-October (Table 6-1, Figure 6-2). TR exhibited concentrations below the reporting limit of 0.050 mg/L during all sampling events except for the following dates: May 14 and 28, and June 11, 2008. In general, but especially after mid-September, upriver sites yielded higher concentrations of total nitrogen than lower reaches; with the WE site exhibiting the highest concentrations and LES the lowest concentrations at certain times of the monitoring season. Later in the season LES exceeded the TG total nitrogen concentrations by a small amount. Again, the exception was TR, which consistently tested below the reporting limits.

Total nitrogen concentrations at the 2008 monitoring sites ranged from less than 0.050 mg/L to 0.686 mg/L. The site with the lowest reportable concentration was the Trinity River above the mouth (TR) on May 28, 2008, with a reading of 0.060 mg/L. The site with the highest concentration was the Klamath River at Weitchpec (WE) on October 15, 2008, with a reading of 0.686 mg/L. The reporting limit for total nitrogen was 0.050 mg/L. If a site generated a reading below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.025 mg/L) was used when this occurred.

Ammonia

Ammonia results for all sites except for the Lower Estuary Surface (LES) exhibited concentrations below the reporting limit of 0.010 mg/L for the majority of the season (Table 6-1, Figure 6-3). If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred. The anomalies were LES with peaks on June 25, July 23, August 20, and October 1, 2008; TG, with peaks on June 25 and August 18; and TC with a peak on August 20, 2008. The highest reportable concentration for the

sampling season was at LES on July 23, 2008. The lowest reportable concentration for the 2008 season was 0.010 mg/L on August 18, 2008, at TC.

Total Phosphorous

Total phosphorous trends were similar for WE, TC, TG, and LES, with rising concentrations from mid-May until concentrations peaked in mid-August. After mid-August, concentrations fell until early October, at which time they began rising and continued to climb until sampling was suspended in mid-October (Table 6-1, Figure 6-4). One inconsistency was TG, which produced results that continued to fall into October. Trinity River above the mouth (TR) yielded results that were near the reporting limit of 0.002 mg/L and fluctuated very little throughout the sampling season except for the sampling event on May 14, 2008 in which TR total phosphorus concentration exceeded all the other sampling sites.

Total phosphorous concentrations at 2008 monitoring sites ranged from 0.004 mg/L at TR on August 14, to 0.095 mg/L at WE on August 20. As with total nitrogen, upriver sites tended to yield higher concentrations than downriver sites, especially after mid-July, with WE exhibiting the highest concentrations and LES or TG the lowest concentrations. As with most parameters in this report, the anomaly in this pattern occurred at TR, which consistently yielded the lowest results. No sites produced results below the reporting limit of 0.002 mg/L for this parameter.

Soluble Reactive Phosphorous (SRP)

SRP for all sites except TR showed comparable trends with rising concentrations occurring throughout the summer, peaks in late August to early September, decreasing concentrations until early October, and rising concentrations until sampling was ended in mid-October, at which time concentrations for all sites except TR were at their highest (Table 6-1, Figure 6-5).

SRP concentrations at the 2008 sites ranged from less than 0.001 mg/L to 0.080 mg/L. WE yielded the highest concentration during the 2008 season on October 15, with a reading of 0.080 mg/L, while TR produced the lowest reportable concentration of 0.002 mg/L on June 25, July 9, August 7, and September 17, 2008. Throughout the sampling

season upriver sites generally yielded higher SRP concentrations than downriver sites with WE yielding the highest concentrations and LES or TG the lowest. As with most parameters the exception was TR, which returned the lowest results at every sampling event throughout the season with concentrations hovering around the reporting limit for most of the season.

Alkalinity

Trends and results for alkalinity concentrations during the 2008 monitoring season were very similar throughout the entire monitoring term, with concentrations generally rising throughout the sampling period (Table 6-1, Figure 6-6). Alkalinity concentrations at the 2008 sites ranged from a low of 48.5 mg/L $CaCO_3$ at TR on May 14 to a high of 93.6 mg/L $CaCO_3$ at WE on October 1, 2008. No sites produced results below the reporting limit of 1.0 mg/L $CaCO_3$ for this parameter.

Calcium

Trends and results for calcium concentrations at all sites except LES were similar and fluctuated very little throughout the sampling period (Table 6-1, Figure 6-7). During the 2008 season, LES produced similar concentrations to the other sites during the early part of the sampling period, but yielded a sharp peak of 90.9 mg/L on July 23, which was the highest concentration for all sites during the 2008 season. After this spike, alkalinity concentrations at LES fell sharply and generally continued to fall throughout the remainder of the sampling season, but remained well above concentrations at the other sites during this time. The highest calcium concentrations for all sites except LES were exhibited in early August and mid-September. The lowest concentrations were displayed at the beginning of the monitoring season with a low reading of 8.03 mg/L recorded at TR on May 14, 2008. No sites produced results below the reporting limit of 0.1 mg/L for this parameter.

Chlorophyll-a

Chlorophyll-*a* trends were broadly similar for all sites with a peaks in early July and late August/early September (Table 6-1, Figure 6-8). During the first peak in July, the downriver sites (TG and LES) had higher chlorophyll-*a* concentrations than the upriver sites, but WE had higher concentrations than TC. During the second peak, however, WE yielded the highest concentrations and LES some of the lowest concentrations. As with most parameters, the anomaly for cholorphyll-*a* was TR, which consistently produced the lowest concentrations throughout the sampling period.

Chlorophyll-*a* concentrations for the 2008 sampling season ranged from less than 0.1 µg/L to 8.3 µg/L. TG produced the highest concentration of 8.3 µg/L on July 9, 2008, while TR produced the lowest reportable concentration of 0.8 µg/L on August 20, 2008. The reporting limit for chlorophyll-*a* was 0.1 µg/L. If a site generated a reading below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.050 mg/L) was used when this occurred.

Pheophytin-a

Pheophytin-*a* results and trends were broadly similar for all sites except TR during the 2008 sampling season. Concentrations declined from the beginning of the sampling period until late May. At this time, concentrations at all sites except TG generally rose until they peaked in late August. After this, concentrations at all sites except TG and TR fell until early September, at which time they increased until they peaked again in early October. When sampling was ceased in mid-October, all sites except LES returned declining concentrations. TG, after initially declining in concentration, continued to rise until early October, at which time concentrations declined until the end of the sampling season. TR, as with most parameters, consistently returned the lowest concentrations during the 2008 sampling season. After its highest concentrations in mid-May, concentrations declined until late June. Subsequently, concentrations gradually rose until mid-August, at which time they declined until the end of the sampling period.

Pheophytin-*a* concentrations for the 2008 sampling season ranged from less than 0.1 µg/L to 6.6 µg/L. The lowest reportable concentration 0.2 µg/L was produced at TR on June 25, while the highest concentration of 6.6 µg/L was returned at TC on May 14, 2008. The reporting limit for pheophytin-*a* was 0.1 µg/L. If a site generated a reading below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.05 µg/L) was used when this occurred.

Magnesium

Trends and results for magnesium concentrations during the 2008 monitoring season were similar among most sites with very little variation throughout the sampling period (Table 3-1, Figure 6-9). The anomaly for this parameter is LES, which peaked quite sharply in mid to late July, followed by a sharp decrease in concentrations until early August. Following this decline, LES then produced a long, broad rise in concentrations that peaked in late August/early September. This pattern is very similar to the one observed for calcium during the 2008 sampling season.

Magnesium concentrations for the 2008 sampling season ranged from a low of 5.10 mg/L at WE on May 14, to a high of 173 mg/L at LES on July 23, 2008. No sites produced concentrations below the reporting limit of 0.1 mg/L during the 2008 sampling season.

Non-Filterable Residue (TSS)

Non-filterable residue, also known as total suspended solids (TSS), trends for all sites were similar with the highest concentrations produced at the beginning of the sampling season, followed by declining concentrations until late June/mid-July, at which time concentrations leveled out and fluctuated very little for the remainder of the sampling period (Table 6-1, Figure 6-10).

TSS concentrations for the 2008 sampling season ranged from a low of less than 0.50 mg/L to a high of 28.00 mg/L at TR on May 14, 2008. The lowest reportable concentration for the sampling period was 0.50 mg/L at TR on July 23, 2008. The reporting limit for TSS was 0.50 mg/L. If a site generated a reading below this number,

ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.25 mg/L) was used when this occurred.

Total Dissolved Solids (TDS)

TDS concentrations for all sites except LES varied very little throughout the sampling season (Table 6-1, Figure 6-11). LES peaked quite sharply in mid to late July, followed by a sharp decline in concentrations until early August. Concentrations then increased quite rapidly until mid to late August, after which concentrations declined until early October. This pattern is very similar to the one observed for calcium and magnesium during the 2008 sampling season.

TDS concentrations for the 2008 sampling season ranged from a low of 54.5 mg/L at TR on October 1, to a high of 4477 mg/L at LES on July 23, 2008. No sites produced concentrations below the reporting limit of 5 mg/L during the 2008 sampling season.

Total Organic Carbon (TOC)

TOC trends were broadly similar for all sites except TR throughout the sampling period with the lowest concentrations produced in mid-May, followed by gradually rising concentrations with a broad peak of concentrations from early to mid-September (Table 6-1, Figure 6-12). TG highest results, however, were produced during a short, early spike in late June. As with most parameters, TR consistently produced the lowest concentrations and fluctuated very little throughout the sampling period. Throughout most of the 2008 sampling season, but especially after late July, upriver sites produced higher concentrations than downriver sites with WE yielding the highest results and LES or TG the lowest. As with most parameters the exception was TR, which returned the lowest concentrations at every sampling event throughout the season.

TOC concentrations for the 2008 sampling season ranged from a low of 0.496 mg/L at TR on August 14, to a high of 2.890 mg/L on August 20, 2008. No sites produced concentrations below the reporting limit of 0.250 mg/L during the 2008 sampling season.

Table 6-1. Nutrient Results for Yurok Reservation, 2008

Nutrients															
		Date													
Nitrate +Nitrite	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.010	**WE**	0.013	0.047	0.032	0.012	ND	ND	ND	ND	DNS	0.023	ND	ND	0.065	0.267
	TC	0.020	0.039	0.014	ND	ND	ND	ND	DNS	DNS	0.018	ND	ND	0.038	0.196
	TG	0.037	0.059	0.024	0.021	0.014	0.036	0.023	DNS	0.018	0.029	0.014	0.014	ND	0.113
	LES	0.024	0.041	0.016	0.016	ND	0.030	0.012	DNS	DNS	0.025	0.027	0.025	ND	0.114
	TR	0.026	0.016	ND	0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Nitrogen	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit 0.050	**WE**	0.161	0.188	0.202	0.228	0.269	0.277	0.261	0.295	DNS	0.346	0.388	0.396	0.464	0.686
	TC	0.166	0.226	0.129	0.170	0.144	0.172	0.208	DNS	DNS	0.294	0.313	0.296	0.330	0.512
	TG	0.203	0.137	0.162	0.140	0.246	0.195	0.208	DNS	0.223	0.230	0.249	0.256	0.277	0.388
	LES	0.141	0.117	0.119	0.144	0.197	0.251	0.258	DNS	DNS	0.248	0.263	0.267	0.263	0.394
	TR	0.178	0.060	0.061	ND	ND	ND	ND	ND	DNS	ND	ND	ND	ND	ND
Ammonia Nitrogen	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.010	**WE**	ND	ND	ND	0.012	ND	ND	ND	ND	DNS	ND	ND	ND	ND	ND
	TC	ND	ND	ND	ND	ND	ND	ND	DNS	DNS	0.013	ND	ND	ND	ND
	TG	ND	0.011	ND	ND	ND	ND	ND	DNS	0.010	ND	ND	ND	ND	ND
	LES	ND	ND	ND	0.012	ND	0.019	ND	DNS	DNS	0.014	0.011	ND	0.017	0.013
	TR	ND	0.012	ND	ND	ND	ND	ND	ND	DNS	ND	ND	ND	ND	ND
Total Phosphorous	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.002	**WE**	0.025	0.027	0.034	0.045	0.048	0.048	0.058	0.068	DNS	0.095	0.094	0.083	0.08	0.092
	TC	0.032	0.027	0.027	0.031	0.025	0.033	0.046	DNS	DNS	0.069	0.067	0.06	0.058	0.065
	TG	0.029	0.020	0.024	0.016	0.027	0.029	0.031	DNS	0.041	0.050	0.048	0.046	0.046	0.042
	LES	0.027	0.019	0.024	0.025	0.033	0.028	0.033	DNS	DNS	0.050	0.053	0.048	0.044	0.05
	TR	0.038	0.009	0.009	0.006	0.006	0.008	0.007	0.004	DNS	0.007	0.007	0.007	0.006	0.005
Soluble Reactive Phosphorous	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.001	**WE**	0.010	0.017	0.024	0.030	0.040	0.031	0.044	0.048	DNS	0.065	0.066	0.060	0.055	0.0800
	TC	0.007	0.012	0.017	0.020	0.016	0.021	0.031	DNS	DNS	0.045	0.046	0.045	0.041	0.0550
	TG	0.010	0.013	0.015	0.016	0.009	0.016	0.019	DNS	0.023	0.028	0.028	0.029	0.024	0.0300
	LES	0.007	0.012	0.015	0.015	0.013	0.015	0.021	DNS	DNS	0.031	0.036	0.032	0.029	0.0410
	TR	0.004	0.003	0.003	0.002	0.002	0.003	0.002	ND	DNS	ND	ND	0.002	ND	ND

Table 6-2. Other Analytes Results, Yurok Reservation, 2008

Other Analytes															
		Date													
Alkalinity	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L CaCO3; Report Limit: 1.0	**WE**	49.4	49.3	56.5	78.5	81.1	86.9	89.5	91.3	DNS	89.9	89.2	90.3	93.6	92.6
	TC	49.9	50.2	55.0	72.4	71.8	83.6	88.3	DNS	DNS	86.5	86.9	86.5	89.7	92.3
	TG	52.1	52.7	57.0	73.1	74.5	85.0	89.1	DNS	92.5	89.1	89.0	89.6	92.3	93.1
	LES	49.9	50.3	55.4	72.2	73.3	86.9	89.9	DNS	DNS	89.0	89.2	91.7	93.3	92.0
	TR	48.5	51.0	51.7	61.5	61.5	75.7	83.6	81.8	DNS	81.0	78.1	78.4	79.7	80.2
Calcium	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.1	**WE**	8.50	10.4	10.7	12.5	14.4	14.0	13.8	DNS	DNS	12.6	12.0	14.4	12.4	14.1
	TC	8.14	10.7	10.7	11.8	13.0	13.7	14.3	DNS	DNS	13.2	12.2	12.4	12.7	14.1
	TG	8.63	11.2	11.4	12.0	13.4	13.5	14.5	DNS	DNS	13.3	12.1	15.0	13.3	13.6
	LES	8.40	10.6	11.1	12.0	16.6	90.9	27.4	DNS	DNS	40.2	33.3	34.6	21.3	24.1
	TR	8.03	10.2	10.6	9.89	10.4	13.2	15.4	DNS	DNS	13.7	12.5	14.4	13.9	14.3
Chlorophyll a	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
µg/L; Report Limit: 0.1	**WE**	3.7	2.7	2.4	5.3	7.5	2.4	2.7	4.8	DNS	5.6	6.7	3.7	3.2	3.6
	TC	0.5	2.1	1.6	3.9	5.3	1.6	2.5	DNS	DNS	4.5	5.6	2.7	3.2	2.8
	TG	2.1	1.9	1.9	3.0	8.3	3.5	2.3	DNS	3.5	4.8	5.9	3.5	4.5	3.7
	LES	1.9	1.6	1.9	2.0	8.0	2.1	1.8	DNS	DNS	4.0	4.0	2.4	1.1	1.2
	TR	1.6	1.1	1.3	1.2	2.1	1.6	0.9	1.1	DNS	0.8	1.2	1.9	1.3	1.1
Pheophytin a	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
µg/L; Report Limit: 0.1	**WE**	3.0	0.9	1.7	2.8	1.9	2.3	2.3	3.6	DNS	6.2	2.9	2.8	4.8	2.9
	TC	6.6	1.2	1.6	2.1	1.6	2.1	2.7	DNS	DNS	4.4	2.6	2.0	3.5	2.5
	TG	2.3	1.3	1.5	1.2	1.8	2.9	2.4	DNS	2.9	3.2	3.7	3.6	6.1	4.1
	LES	2.6	1.0	1.7	1.7	1.9	2.7	2.0	DNS	DNS	2.7	2.2	1.7	1.9	2.2
	TR	3.3	1.4	0.7	0.2	0.5	0.6	0.6	0.8	DNS	2.0	0.5	ND	ND	ND

Table 6-2(contd.). Other Analytes Results, Yurok Reservation, 2008

Magnesium	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.1	**WE**	5.10	5.76	5.71	7.40	8.06	7.55	7.33	DNS	DNS	7.36	7.45	7.24	7.65	8.80
	TC	5.49	6.33	5.85	7.37	8.17	7.31	7.31	DNS	DNS	7.51	7.43	6.99	7.66	8.51
	TG	5.87	6.72	6.24	7.49	8.38	7.44	7.57	DNS	DNS	7.82	7.49	7.56	8.05	8.31
	LES	5.81	6.37	6.06	7.43	18.8	173	31.1	DNS	DNS	64.2	64.5	55.8	30.2	39.1
	TR	5.97	6.66	6.04	6.85	7.6	7.01	7.23	DNS	DNS	7.39	7.33	6.85	7.97	8.00

Non-Filterable Residue (TSS)	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.50	**WE**	5.80	9.00	3.00	4.10	3.30	3.30	1.90	DNS	DNS	3.50	3.5	2.40	2.00	2.40
	TC	16.00	8.00	3.50	4.30	2.50	1.90	2.00	DNS	DNS	3.10	2.8	2.10	1.60	2.10
	TG	15.00	9.90	5.10	1.50	4.80	2.30	1.90	DNS	DNS	2.00	3.3	3.00	4.60	2.40
	LES	15.00	7.30	4.50	3.10	5.00	2.90	1.90	DNS	DNS	2.60	3.10	1.80	1.30	1.90
	TR	28.00	6.80	3.00	3.50	1.60	0.50	0.75	DNS	DNS	0.75	ND	0.88	0.75	ND

Total Dissolved Solids (TDS)	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 5	**WE**	77.0	89.5	100	76.5	114	104	128	DNS	DNS	131	119	119	103	130
	TC	77.5	68.5	108	71.5	91.5	93	118	DNS	DNS	93	112	111	110	132
	TG	92.0	86.5	109	130	124	120	116	DNS	DNS	136	107	108	103	77.5
	LES	79.5	87	126	110	113	4477	976	DNS	DNS	2974	1997	1531	736	980
	TR	65.5	92	99.5	77.5	114	98	117	DNS	DNS	90.5	100	99.5	54.5	102

Total Organic Carbon	**Site**	5/14/2008	5/28/2008	6/11/2008	6/25/2008	7/9/2008	7/23/2008	8/7/2008	8/14/2008	8/18/2008	8/20/2008	9/3/08	9/17/08	10/1/08	10/15/08
mg/L; Report Limit: 0.250	**WE**	1.32	1.56	1.86	2.09	1.86	2.03	2.33	2.2	DNS	2.890	2.74	2.80	2.74	2.67
	TC	1.15	1.94	1.31	1.60	1.40	1.52	1.78	DNS	DNS	1.870	2.07	2.15	2.17	2.12
	TG	0.992	1.47	1.20	2.51	1.41	1.61	1.37	DNS	1.40	1.380	1.59	1.66	1.71	1.6
	LES	1.08	1.73	1.68	1.44	1.28	1.38	1.63	DNS	DNS	1.740	1.64	1.84	1.74	1.82
	TR	0.836	0.914	0.731	0.752	0.698	0.533	0.734	0.496	DNS	0.709	0.740	0.757	0.710	0.604

DNS = Did not Sample ND=No Detect

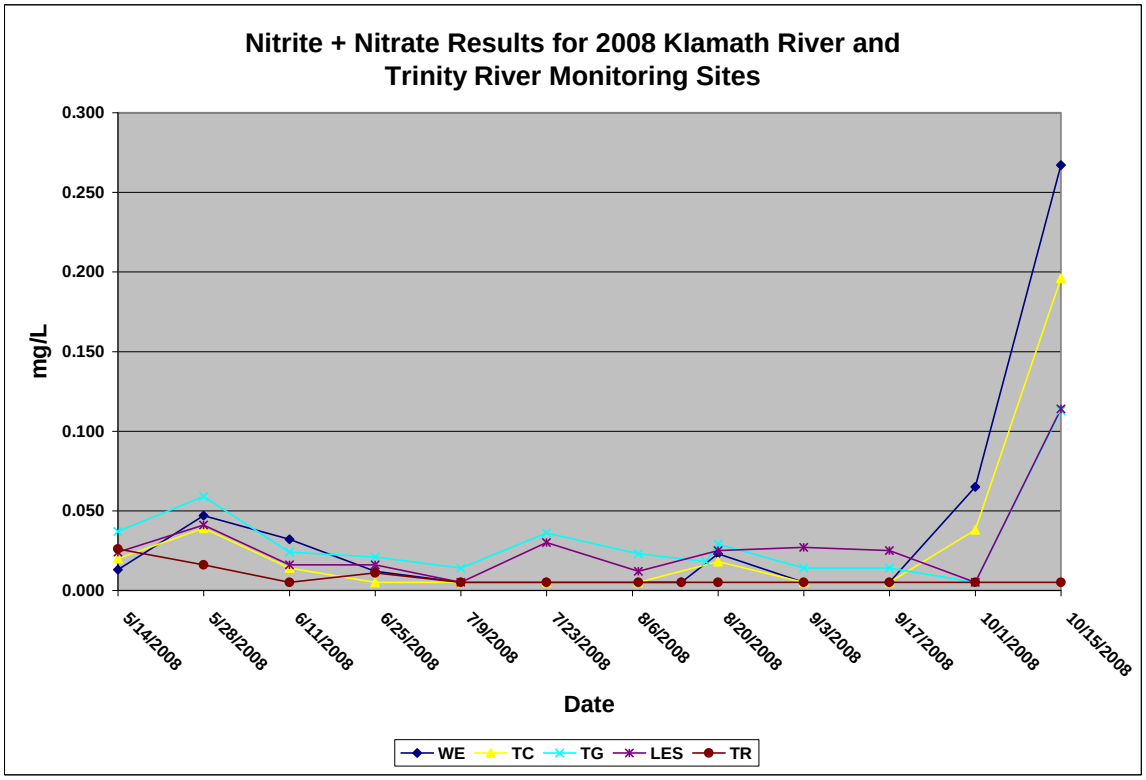

Figure 6-1. Nitrite and Nitrate Results 2008

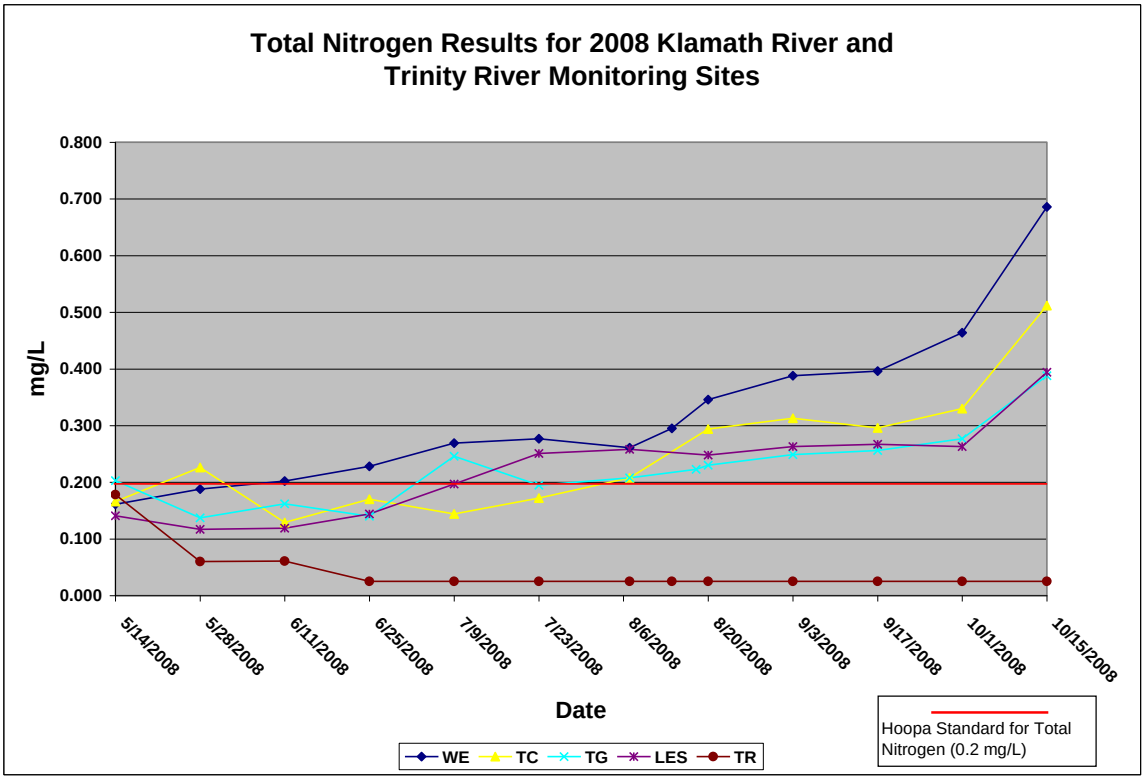

Figure 6-2. Total Nitrogen Results 2008

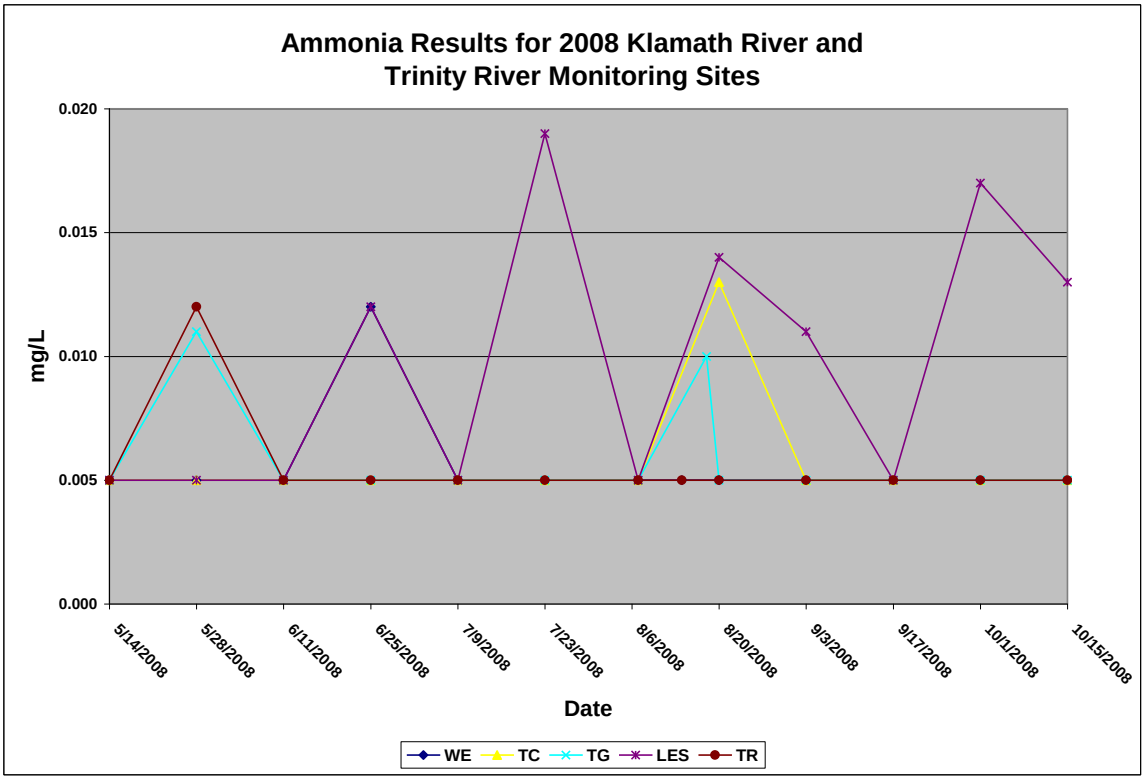

Figure 6-3. Ammonia Results 2008

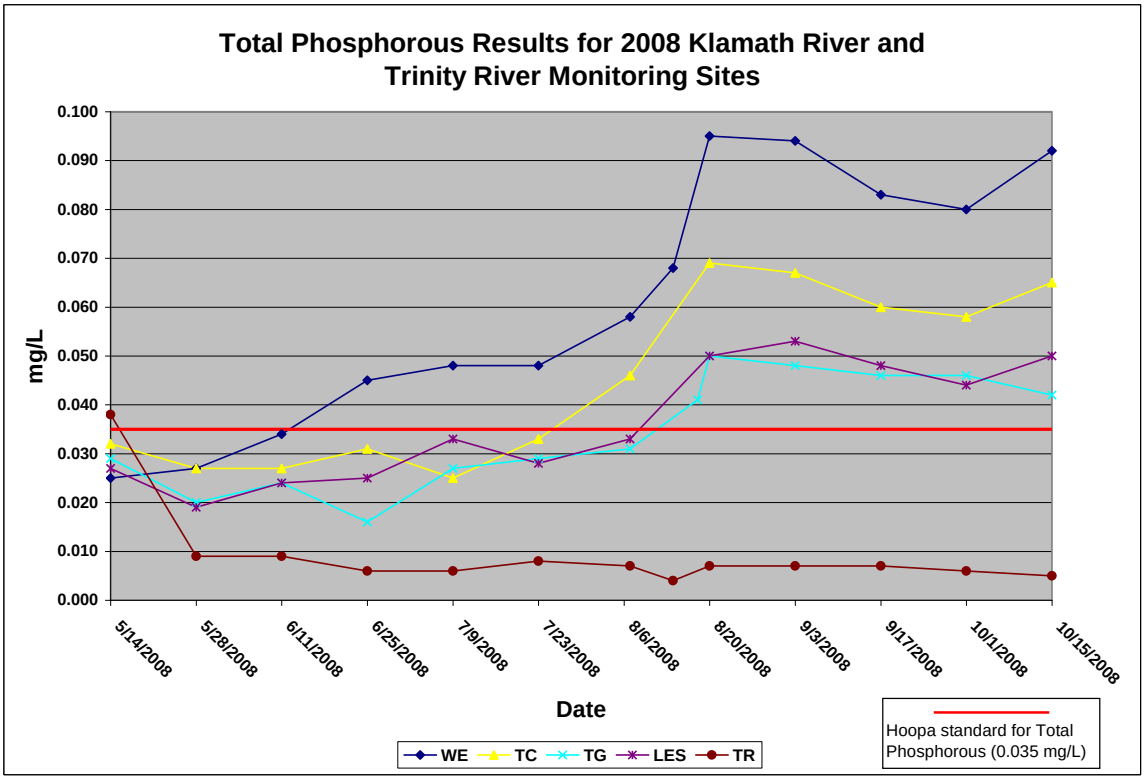

Figure 6-4. Total Phosphorous Results 2008

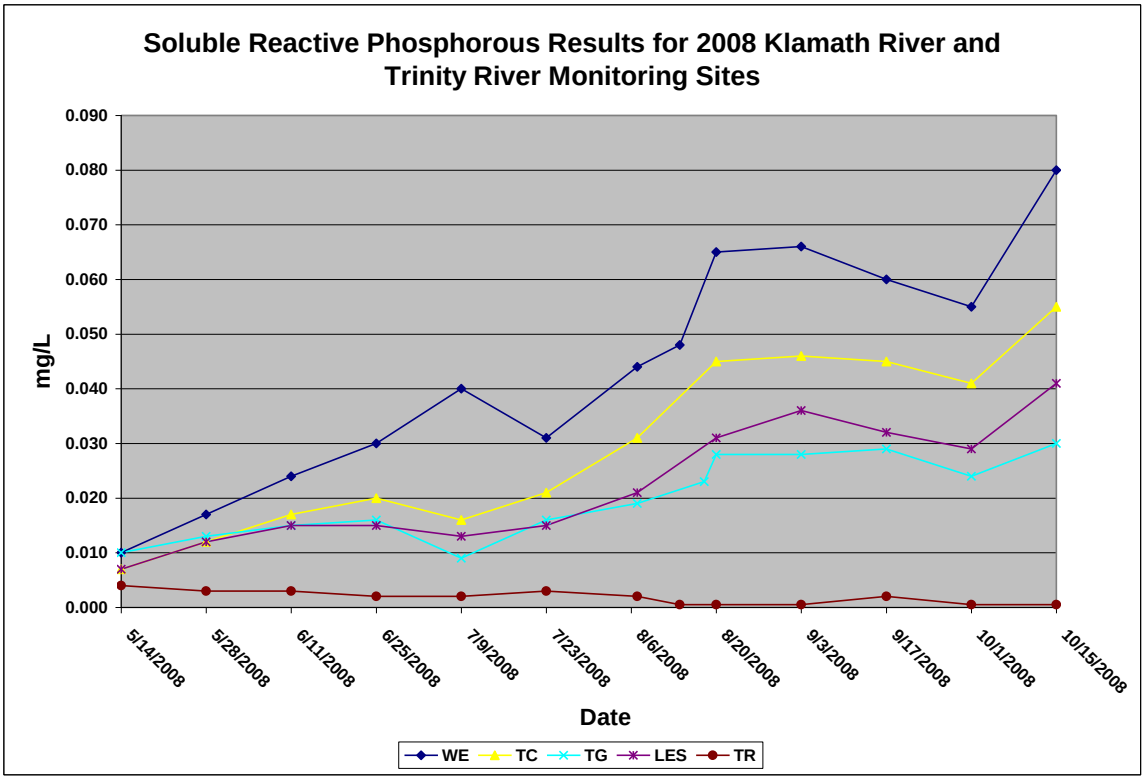

Figure 6-5. Soluble Reactive Phosphorous Results 2008

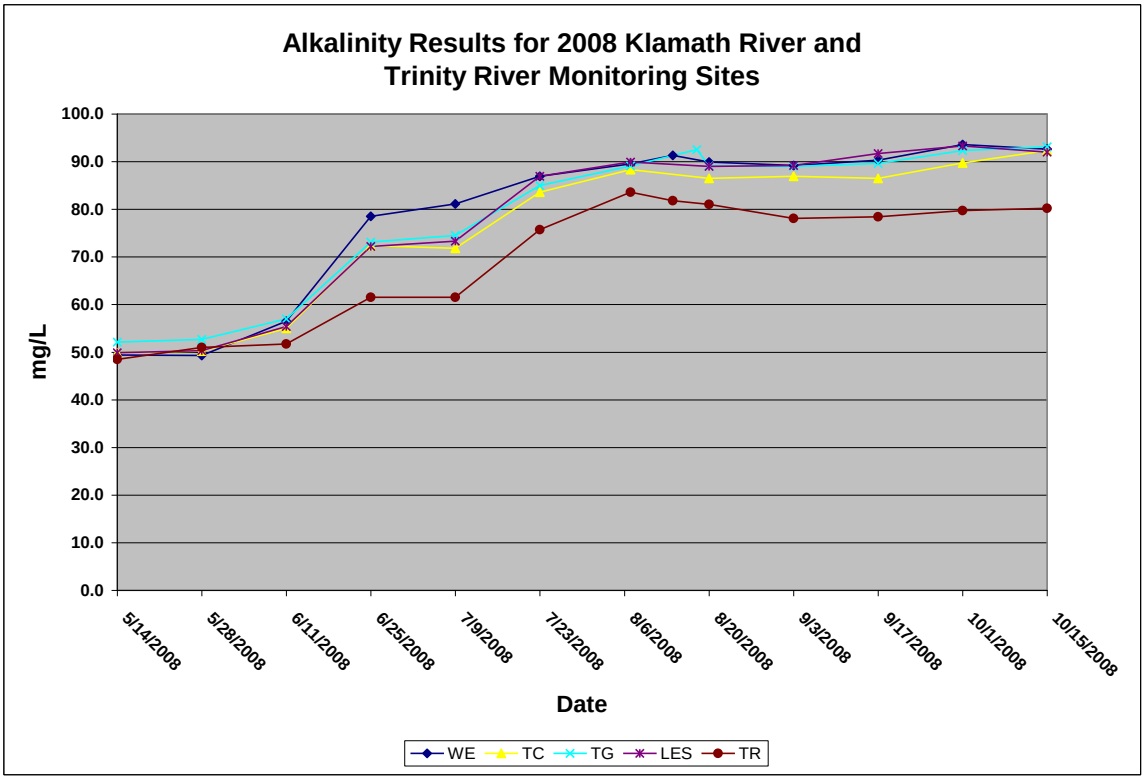

Figure 6-6. Alkalinity Results 2008

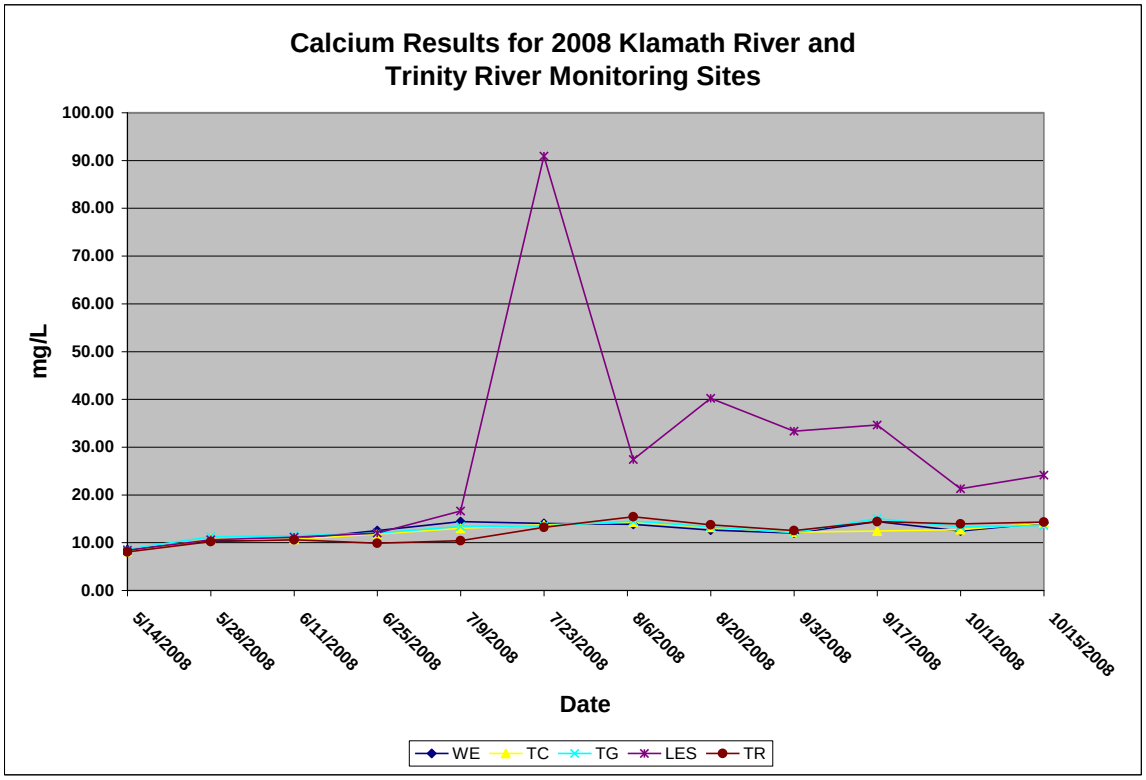

Figure 6-7. Calcium Results 2008

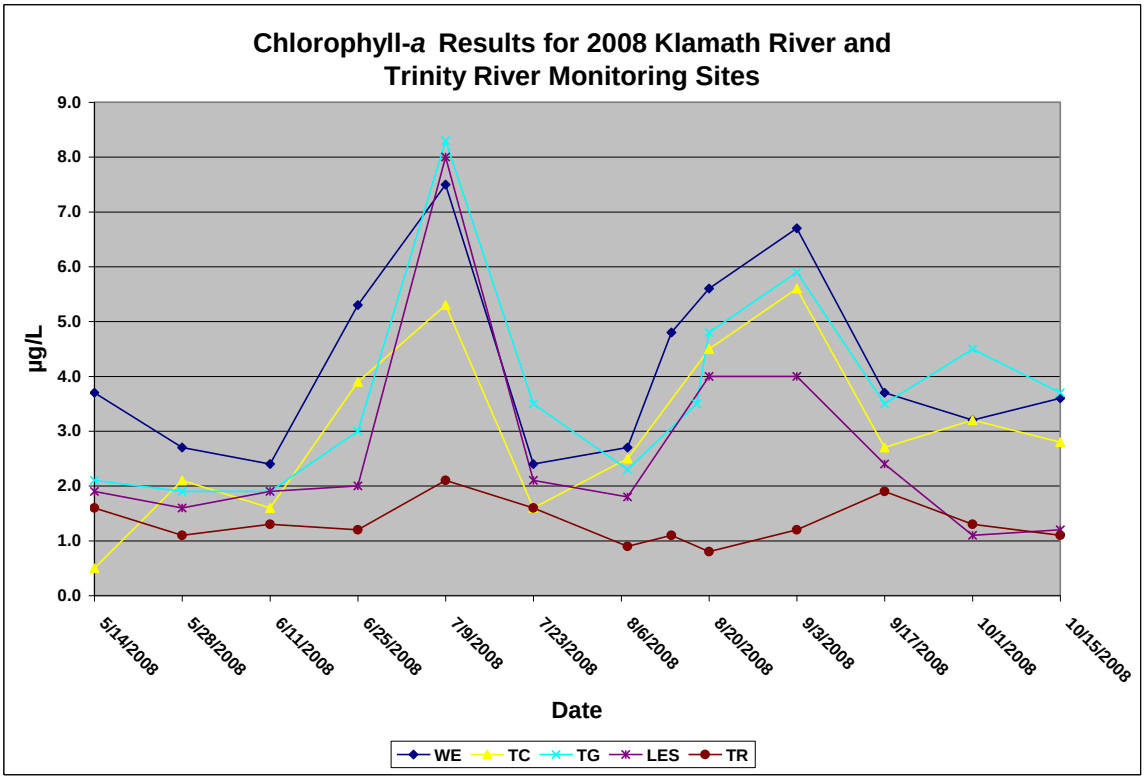

Figure 6-8. Chlorophyll-a Results 2008

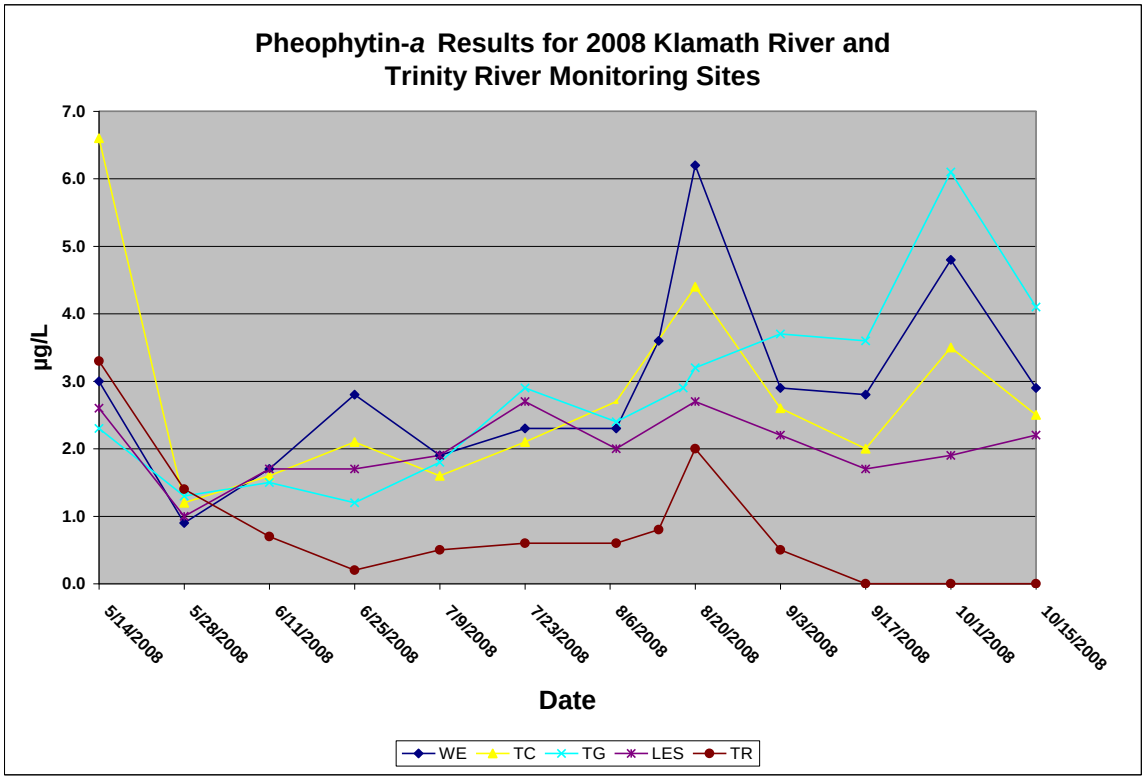

Figure 6-9. Pheophytin-a Results 2008

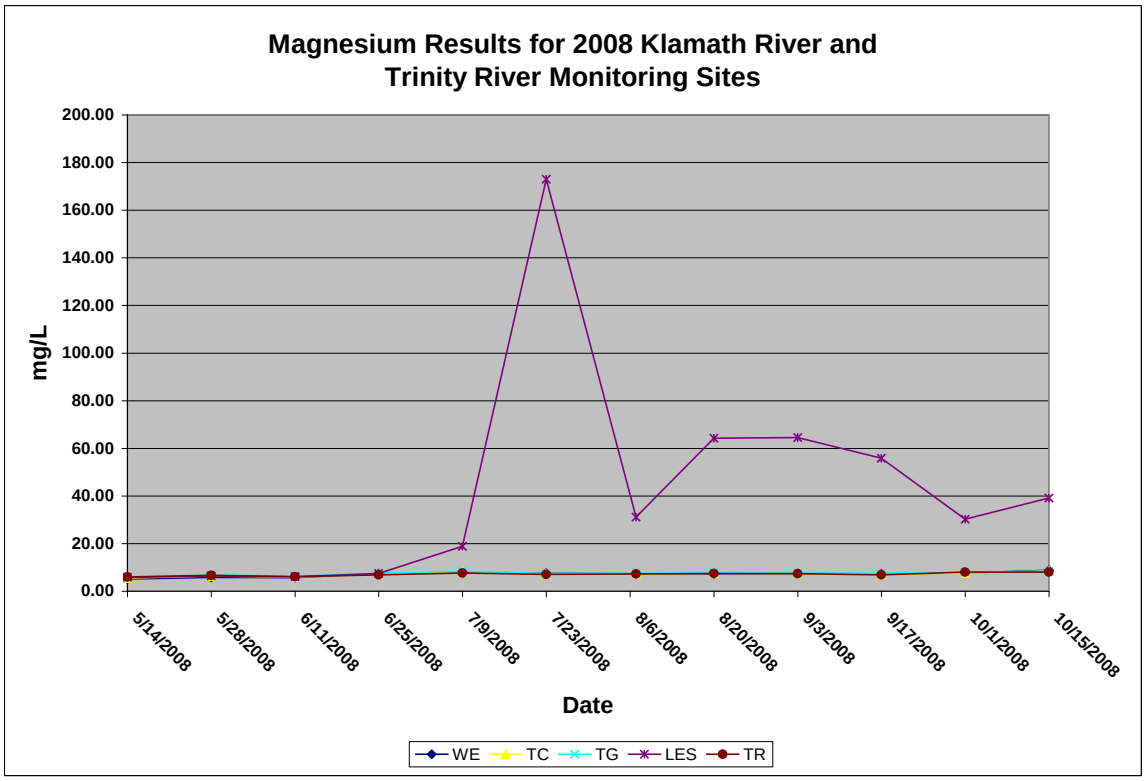

Figure 6-10. Magnesium Results 2008

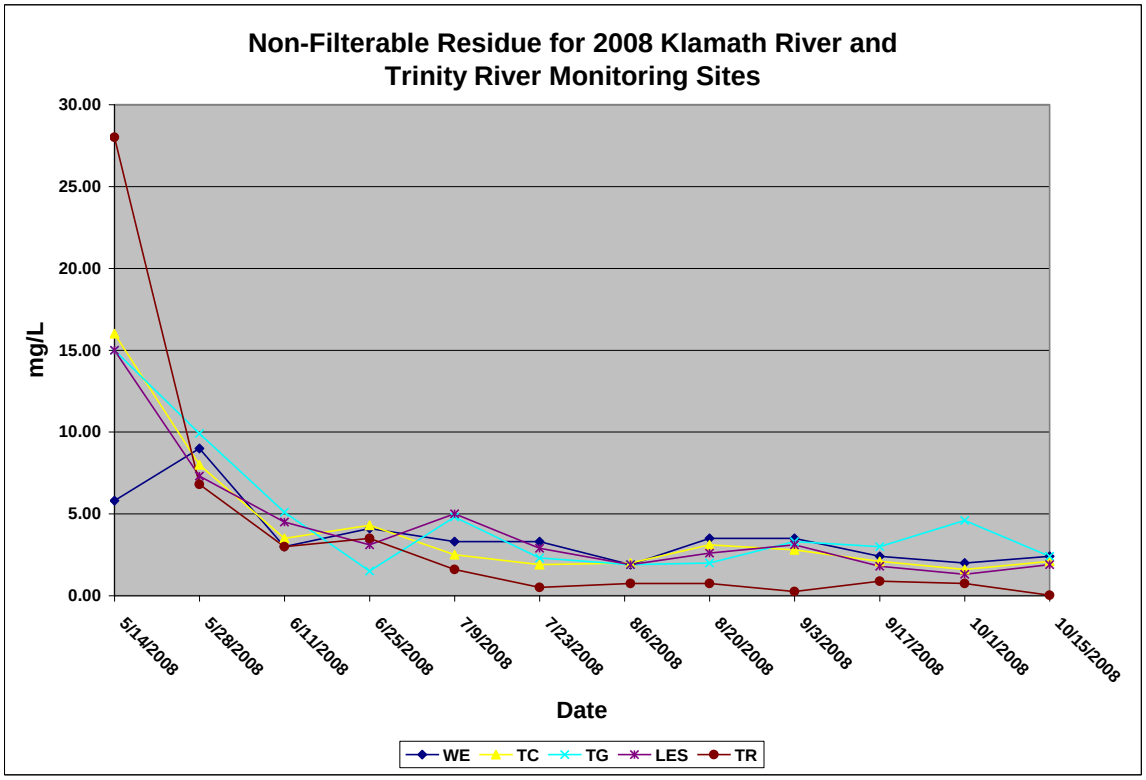

Figure 6-11. Non-Filterable Residue Results 2008

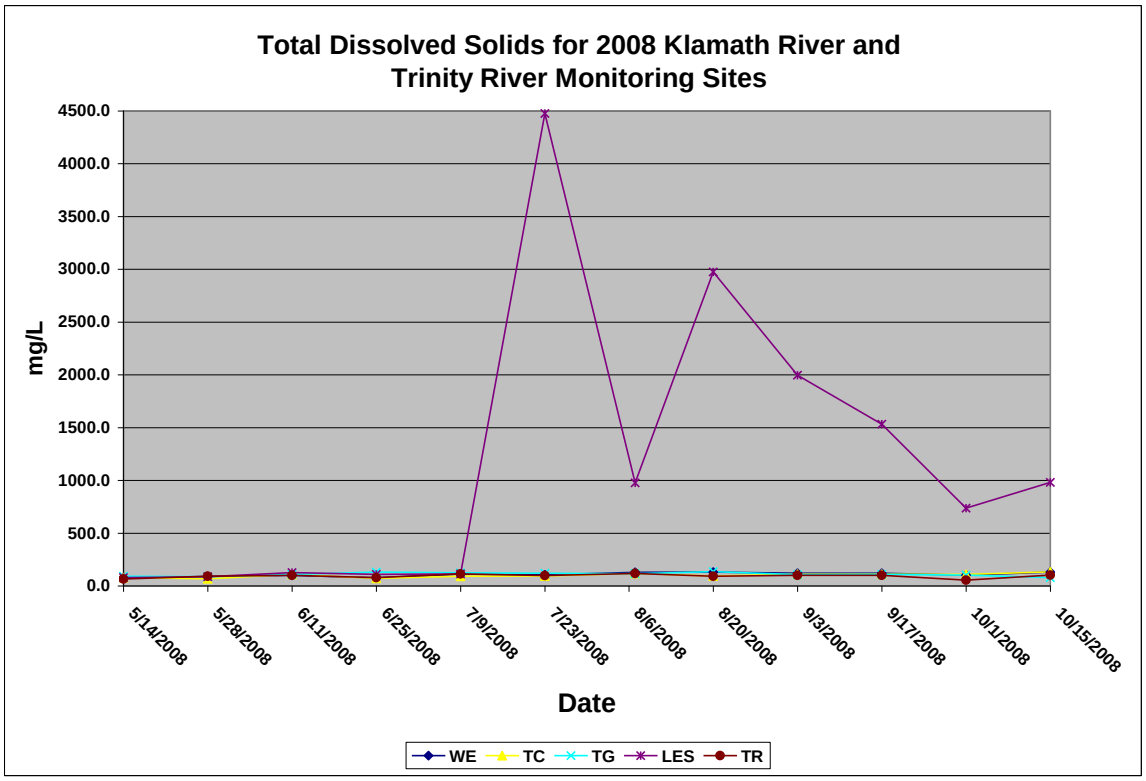

Figure 6-12. Total Dissolved Solids Results 2008

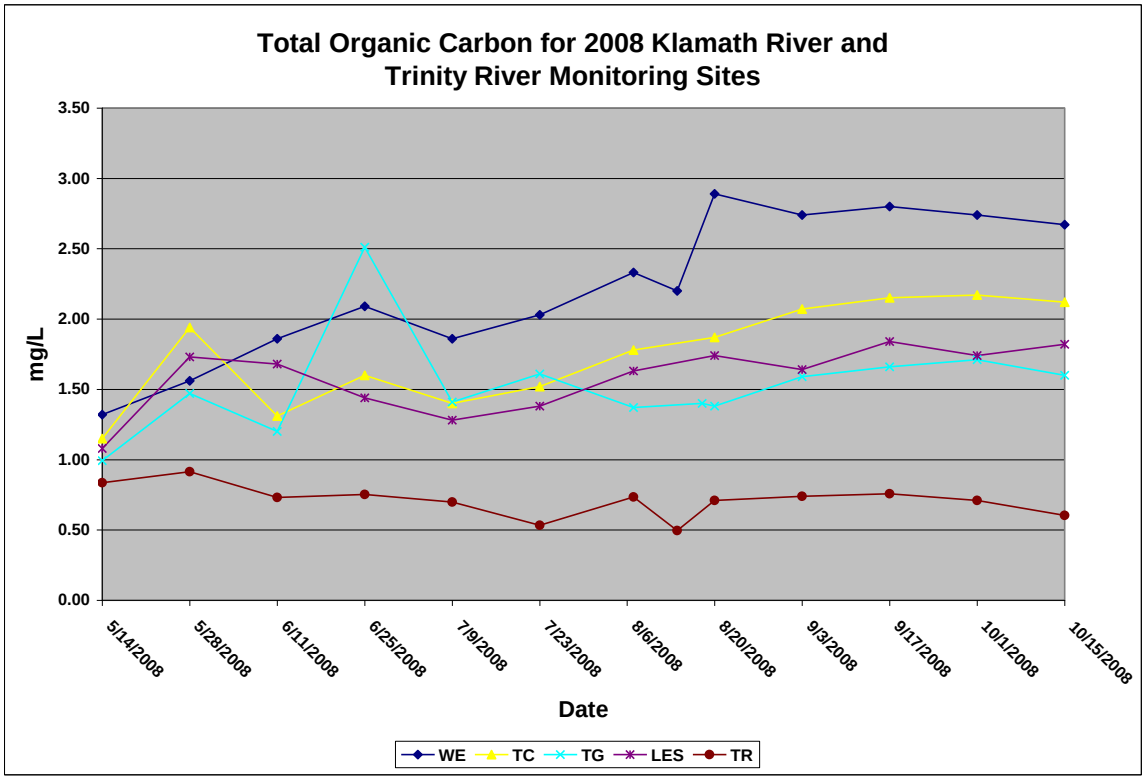

Figure 6-13. Total Organic Carbon Results 2008

VII. Discussion

Spatial Patterns

In a large watershed such as the Klamath Basin, in which water coming out of Upper Klamath Lake and that being released from upriver dams in the summer is very low quality, full of algae, and high in nutrients; nutrient concentrations decline as the river flows downstream. This decline in nutrient concentration occurs for three reasons: dilution, periphyton growth, and denitrification.

Dilution

This process has the largest affect on the concentration of nutrients in the Klamath River. Even if nutrients were not being used by other components of the river system, nutrient concentrations would still decline as the river flows downstream due to an influx of cleaner, cooler, higher-quality water from tributaries into low-quality Klamath River water (Water Quality Control Plan: Hoopa Valley Reservation, 2008).

Periphyton Growth

Periphyton, also known as benthic or attached algae, removes nutrients dissolved in water and uses them to facilitate biochemical processes involved in cellular growth. While periphyton can improve water quality by removing nutrients from the water, it can also contribute to water quality degradation by re-releasing the nutrients into the river system during decomposition (Water Quality Control Plan: Hoopa Valley Reservation, 2008). Luxuriant periphyton growth also causes large swings in pH and dissolved oxygen over the course of the day as biochemical processes increase and decrease in accordance with the rise and fall of the sun. Such small-scale changes, however, are out of the scope of this report due to two week, and not hourly, sampling intervals.

Denitrification

Denitrification occurs when certain organisms convert nitrate (NO_3) to atmospheric nitrogen (N_2). This change from a usable form of nitrogen (nitrate) into an unusable form (atmospheric nitrogen) limits and reduces productivity for organisms that

require the usable form of nitrogen for growth and reproduction (Water Quality Control Plan: Hoopa Valley Reservation).

Temporal Patterns

The Klamath River's nutrient concentrations also vary by time of year. During winter and spring, concentrations are low due to high flows from Upper Klamath Lake, and subsequently, released water from upriver dams; and high flows in the tributaries that feed the Klamath River throughout its course to the ocean. These concentrations rise throughout the summer and peak in the fall as flows decrease throughout the summer and rainfall is at it lowest in the late summer/early fall.

Nutrient Criteria

In order to determine when water quality has reached detrimental levels, agreed upon baseline criteria must be established by those involved in the analysis of the collected data. To address this need, the Hoopa Valley Indian Reservation Riparian Review Committee, in conjunction with the Hoopa Valley Tribal EPA, has established nutrient criteria standards (Table 7-1) for surface waters on the Hoopa Valley Reservation. This includes the Klamath River, which intersects the northwest corner of the reservation. In this report, these nutrient criteria standards are applied to the information collected in 2008. The Hoopa Valley Tribe has not set standards for all nutrients analyzed by YTEP, therefore, nutrient standards to be discussed will be limited to total nitrogen and total phosphorous.

Total Nitrogen

The Hoopa Valley Reservation has set the proposed standard for total nitrogen at 0.2 mg/L (Table 7-1, red line in Figure 6-2). As can be seen in Table 7-1 and Figure 6-2, after late July, all sites except TR sampled exceeded this standard. By early October, the sites were yielding results that were 2-3 times greater than the minimum concentration of 0.2 mg/L. WE, however, crossed this threshold by mid-June, preceding the other sites by nearly one month.

Total Phosphorous

The Hoopa Valley Reservation has set the proposed standard for nitrogen at 0.035 mg/L (Table 7-1, red line in Figure 6-4). As can be seen in Table 7-1 and Figure 6-4, most sites, except TR, tested above this standard by mid-August. From mid-August on, the sites were at concentrations that were 3-4 times greater than the minimum standard of 0.035 mg/L set by the Hoopa Valley Tribe.

Table 7-1. Nutrient Standards for the Klamath River (based on data from Hoopa Valley Indian Reservation)

Parameter	Proposed Standard (mg/L)
Total Nitrogen	0.2
Total Phosphorous	0.035

The results from total nitrogen and total phosphorous indicate that nutrient levels in the Lower Klamath River are much higher than water quality standards recognized as acceptable levels to meet beneficial uses.

Works Cited

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Norton, Ken, Pliny McCovey Jr., Curtis Miller, Louisa McConnell, Mike Orcutt, Nolan Colgegrove, Mark Higley. *Water Quality Control Plan: Hoopa Valley Indian Reservation*. 2008

Appendix

Grab Sample Protocol

'Grab sampling' refers to water samples obtained by dipping a collection container into the upper layer of a body of water and collecting a water sample (USGS File Report -00213). For quality assurance/quality control (QA/QC) purposes replicate, and blank bottle sets will be prepared and collected for one site each sampling period. These additional bottle sets will be handled, prepared and filled following the same protocol used for regular bottle sets and samples. General water quality parameters will also be measured with a freshly calibrated portable multi-probe water quality instrument during grab samples and recorded onto data sheets.

Upon arrival at each site, the sampling churn will be rinsed three times with distilled water. The goal of rinsing is 'equipment decontamination – the removal from equipment, residues from construction and machining and the removal of substances adhering to equipment from previous exposure to environmental and other media' (USGS Open File Report 00213). After rinsing with D.I. water, the churn will be rinsed three times with stream water. The churn is then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allows for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guarantees the water is well mixed before the sample is collected. The churn should be stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second (Bel-Art Products, 1993). This mixing must continue while the bottles are being filled. If filling is stopped for some reason, the stirring rate must be resumed before the next sample is drawn from the churn. As the volume of water in the churn decreases, the round trip frequency increases as the velocity of the churn splitter remains the same. Care must be taken to avoid breaking the surface of the water as the splitter rises toward the top of the water in the churn.

Sample bottles and chemical preservatives used were provided by associated laboratories and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn 2-3 times before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples will be placed in coolers on ice or dry ice for transport to contracted laboratories for analysis.

QA/QC – Duplicate, Blank and QA Reference Standard Bottle Sets

To ensure laboratory and sampling accuracy, one site every sampling period was randomly selected to receive two additional QA/QC bottle sets. These bottle sets contains duplicate and blank water samples. Duplicate samples are obtained using the same process as regular samples. This information is used to assure the laboratory maintains precision within results. These are disguised so the lab does not know which samples are duplicates. Blank samples in 2006 were collected in two separate ways to evaluate field crew and lab contamination potential. Equipment blanks were collected by pouring distilled water into the sampling churn after it was rinsed three times with distilled water. Sample bottles were filled with distilled water from the sampling churn using the same process as regular samples. True blank samples were collected by pouring distilled water straight into the sample bottles. These are disguised so the lab does not know which samples are blank samples. All bottle sets are then placed on ice and are transported to the associated laboratories by mailing a cooler via Fed Ex. All grab samples were processed within 24 hours or within known laboratory holding periods.

QA reference standards were submitted to the laboratory to evaluate the lab's accuracy for nutrient and phosphorus analytes. QA reference samples were transported along with the other samples for the duration of the sampling event until they were mailed off overnight to the laboratory. These QA reference standards were for Total Nitrogen, nitrite + nitrate, ammonia nitrogen, total phosphorus and orthophosphate phosphorus. QA reference samples were prepared in 2008 by pouring the reference standard straight into sample containers provided by the laboratory and sent with a different ID code for analysis of the specific nutrient analyte so as to not alert lab staff of the fact that the samples were a reference standard. QA reference standard sample results percent recovery must be within + or – 20% of the standard value.

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Lurry,D.L. and C.M. Kolbe. Interagency field manual for the collection of Water Quality Data. USGS Publication, Open File Report 00-213.