FINAL
2007 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 2007. The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites from Weitchpec to the Klamath River Estuary starting at the end of May and ending in mid-October 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 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

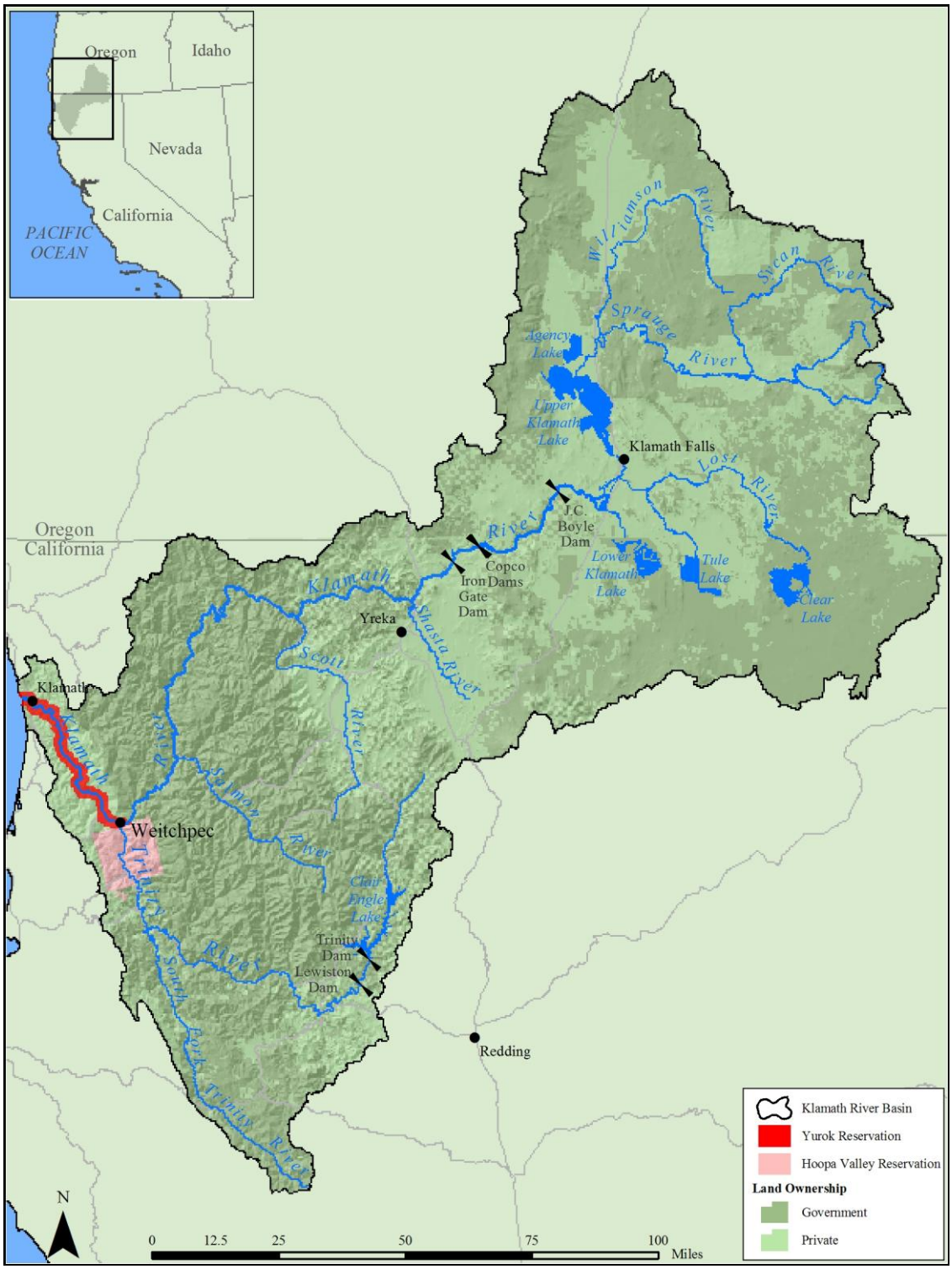

Figure 1. Klamath River Basin Map

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.

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). 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.

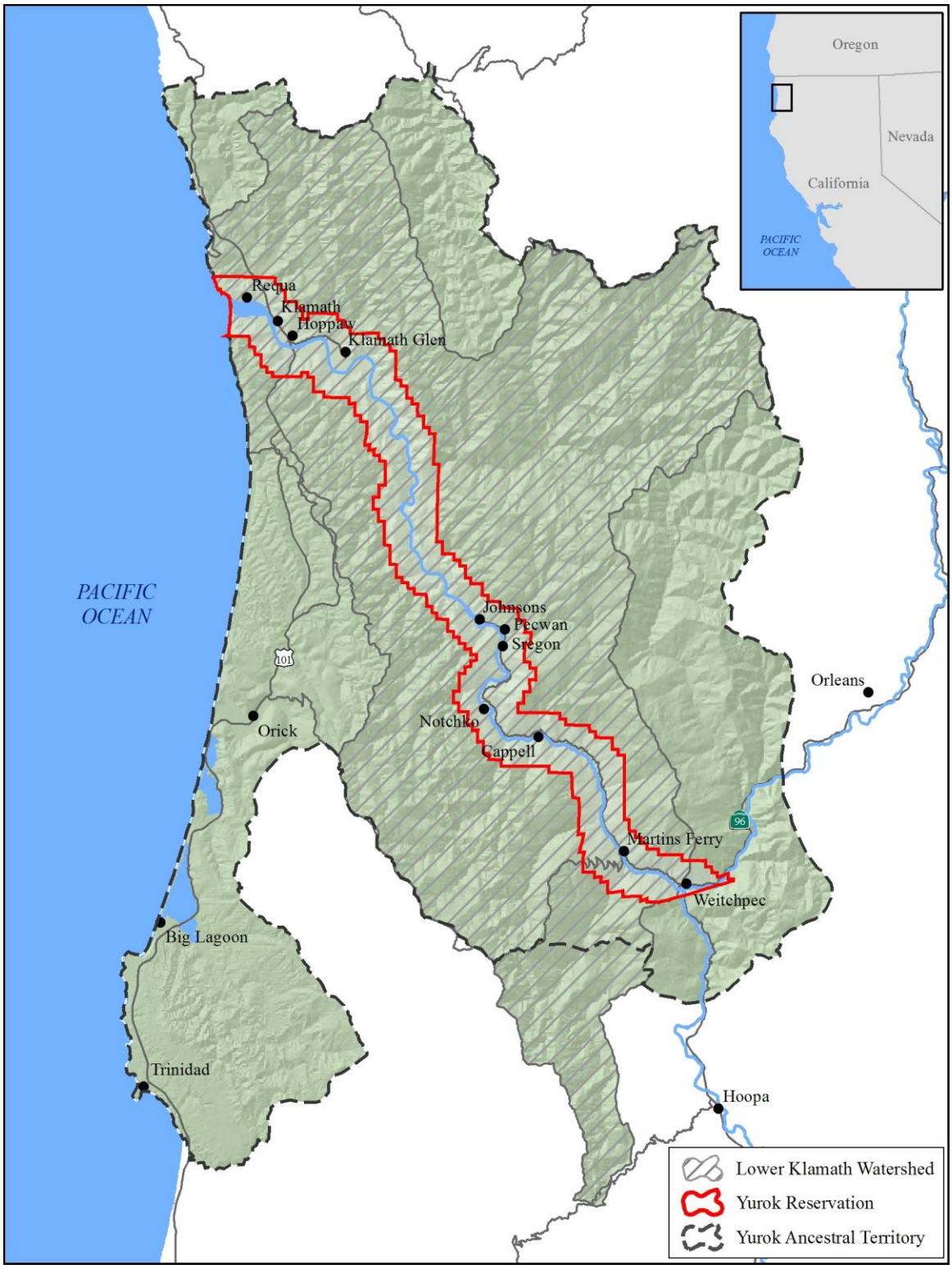

Figure 2. Yurok Indian Reservation and Yurok Ancestral Territory Map

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 2007 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 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 1. Parameters sampled on the Klamath River during WY07

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. The Klamath River monitoring site below the confluence with the Trinity River (KBW) was relocated downstream approximately four miles to the Klamath River above Tully Creek monitoring site (TC) on September 5, 2007. This monitoring site was relocated due to YTEP's access being denied by the landowner. The data from both of these sites are considered comparable and representative of the conditions downstream of the Klamath and Trinity River confluence. Therefore, the discussion of results treats the KBW and TC sites as the same site because they both reflect conditions downstream of the Klamath Trinity River confluence in a well mixed location.

YTEP collected water samples for nutrient analysis at the following mainstem Klamath River locations (Figure 3) (river miles are approximate):

- **WE - Klamath River at Weitchpec (upstream of Trinity River) – RM 43.5**
- **KBW - Klamath River below Weitchpec RM 42.5**
- **TG - Klamath River at Turwar Boat Ramp – RM 6**
- **LES - Lower Estuary Surface – RM 0.5**
- **TC - Klamath River above Tully Creek – RM 38.5**

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**

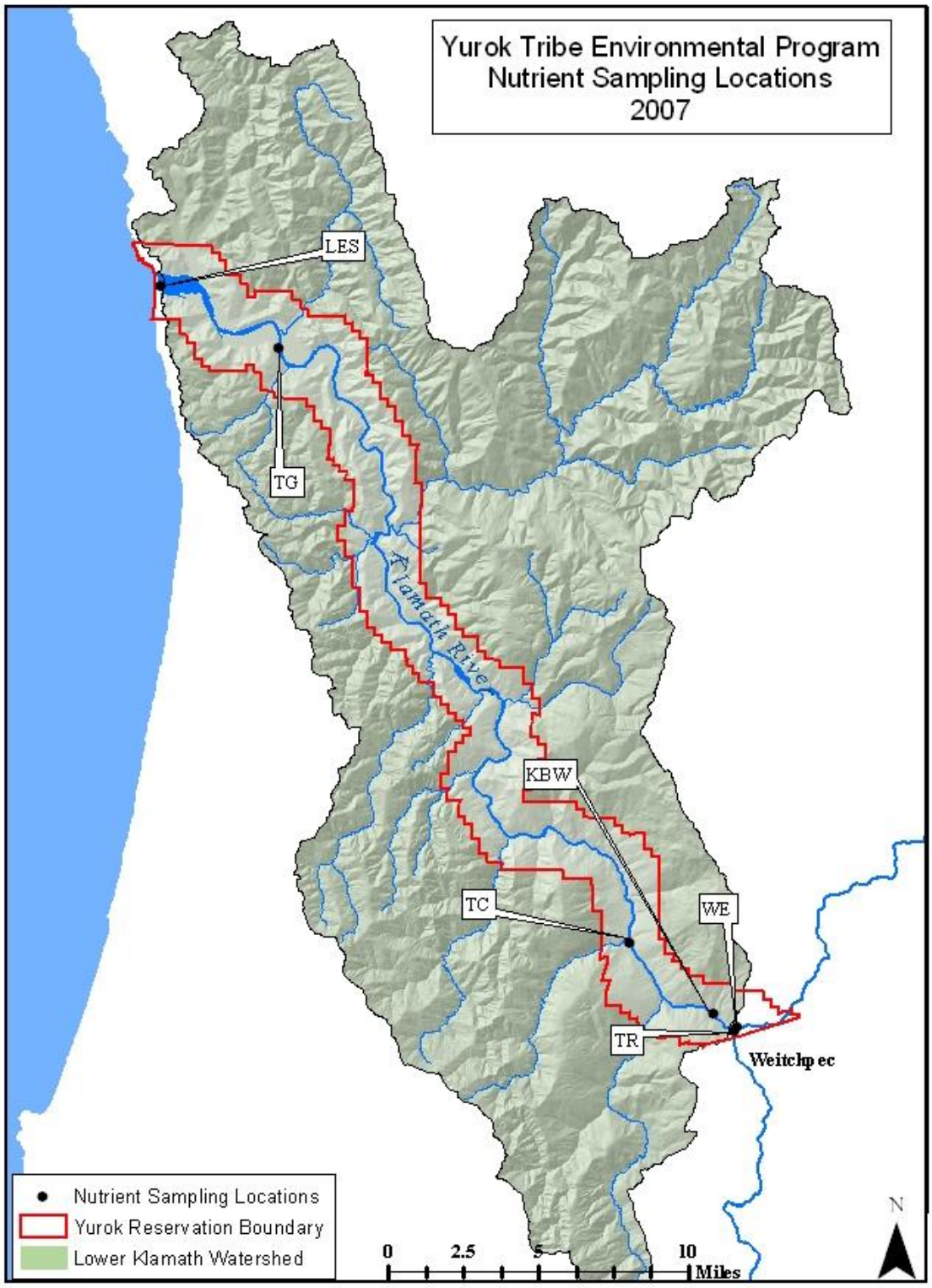

Figure 3. Nutrient Sampling Sites for WY07

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. Quality control of the collection, preparation and analysis of water samples for presence of nutrients and related analytes 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.

Rinsate blank samples were not collected in 2007 due to limited resources. Blank results from the 2006 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory. 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.

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. Once data are merged or entered into a database, charting tools will be used to further check for data anomalies or errors. 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. 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 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. 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.

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, which has automatic QA/QC screening so that data entries that fall outside excepted ranges are automatically flagged. Raw data and data that have under-gone further

QA/QC are automatically archived separately and metadata associated with each data type are also stored within the system and can be easily accessed when questions arise.

VI. Results

Nitrite + Nitrate

The Klamath River at Weitchpec (WE) and the Klamath River below Weitchpec (KBW/TC) sites nitrite plus nitrate results show a trend with peaks from early to mid-June with WE showing another small peak in early September (Table 2, Figure 4). Klamath River at the Turwar boat ramp (TG) and the Lower Estuary Surface (LES) had peaks occurring in early July, while KBW/TC had another small peak during this period. Trinity River near the mouth (TR) showed little change in nitrite plus nitrate with a small peak in mid to late July. All sites revealed decreasing concentrations after mid to late July, with the sharpest decreases coming in late August and early September. Subsequently, all sites except for TR showed rising concentrations from mid-September to mid-October, at which time sampling was suspended for the season. Overall, the upriver sites (WE, KBW/TC, TR) returned lower concentrations throughout the year, with TG consistently returning the highest concentrations throughout the sampling period.

Nitrite plus nitrate concentrations at the 2007 monitoring sites ranged from less than 0.010 mg/L to 0.054 mg/L. The site with the lowest concentration was the Klamath River at Weitchpec (WE) on October 2, 2007. The site that yielded the highest concentration was the Klamath River at Turwar boat ramp (TG) on July 10, 2007. 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 exhibited similar trends for total nitrogen with peaks occurring in mid-September (Table 2, Figure 5). The one exception was TR, which exhibited concentrations below the reporting limit of 0.100 mg/L until mid-October. At the end of

the field season; WE, LES, and TR had rising concentrations, while KBW/TC and TG's results were falling. During peak concentrations from early to late September, the upriver sites yielded higher concentrations of total nitrogen than lower reaches, with the WE site exhibiting the highest concentrations and LES the lowest concentrations. Again, the exception was TR, which consistently tested below the reporting limits until mid-October.

Total nitrogen concentrations at the 2007 monitoring sites ranged from less than 0.100 mg/L to 0.679 mg/L. The site with the lowest concentration was the Trinity River above the mouth (TR) on October 15, 2007. The site with the highest concentration was the Klamath River at Weitchpec (WE) on September 18, 2007. 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.

Ammonia

Ammonia results for all sites exhibited concentrations below the reporting limit of 0.010 mg/L for the majority of the season (Table 2, Figure 6). 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 a peak on 0.020 mg/L on August 21, 2007 and rising concentrations at the end of the season; and TG, with a small peak in mid-September. The lowest measureable concentration for the 2007 season was 0.011 mg/L on September 18, 2007, at both WE and TG.

Total Phosphorous

Total phosphorous trends were similar for WE, TG, KBW/TC, and LES, with peaks occurring in mid-September (Table 2, Figure 7). A total phosphorus sample collected at KBW had the highest concentration, on June 12, 2007 with a result of 0.162 mg/L. While this total phosphorus point is quite a bit higher than the next highest total

phosphorus result for a mainstem site in 2007, there is a May 2006 total phosphorus result at TR that is almost as high. If the high total phosphorus result on 6/12/07 was due to particulate phosphorus soil particles (Hoopa flow was about 2000 cfs) one would expect to see a high total suspended total suspended solids (TSS) value for the same but it is very low (in contrast TSS is very high at the May 2006 TR high total phosphorus result).

When a review of 1996-2004 total phosphorus collected in the Lower Klamath River data points was performed there are quite a few points around 0.160 mg/L. However, if the high total phosphorus value was due to inorganic particulates, there should be high TSS but is very low. If the high total phosphorus value was due to high dissolved phosphorus, there should be high soluble reactive phosphorus but it is low, as are the other mainstem sites for the same sample date. If the high total phosphorus value was due to high organic P (e.g. algal fragments in sample), we should see high total organic carbon (TOC) or total nitrogen (TN) results but those are low, as well. Therefore, the 6/12/07 KBW total phosphorus data point has been removed from the 2007 data set.

TR showed very little change during the sampling period, consistently returning the lowest readings throughout the sampling season with a low reading of 0.007 mg/L on August 21, 2007. All sites except TR had falling concentrations at the end of the sampling season. Total Phosphorus followed a similar trend as total nitrogen, upriver sites tended to generate higher concentrations of total phosphorous than downriver sites, with WE generally returning the highest concentrations and LES the lowest concentrations.

Soluble Reactive Phosphorous (SRP)

SRP for all sites showed comparable trends with rising concentrations occurring throughout the summer with peaks in early to mid-September, and decreasing SRP concentrations thereafter (Table 2, Figure 8). WE yielded the highest concentration during this time with a result of 0.102 mg/L on September 18, 2007. The one exception was TR, which changed very little, exhibiting results slightly above the reporting limit for

the season and displaying a low concentration of 0.001 mg/L on August 21, 2007. As with total nitrogen and total phosphorous concentrations, the upriver sites generally yielded higher SRP concentrations than downriver sites.

Alkalinity

Trends and results for alkalinity concentrations during the 2007 monitoring season were very similar throughout the entire sampling season (Table 3, Figure 9). There was a minor, mid-July peak for all sites except TR, which peaked in late June. All sites returned rising concentrations when sampling was suspended on October 15, 2007, at which time WE produced the highest concentration of the 2007 monitoring season with a reading of 85.0 mg/L. The lowest concentration recorded during the 2007 sampling season was 57.9 mg/L at TR on May 30, 2007.

Calcium

Trends and results for calcium concentrations at all sites except LES were similar and fluctuated very little throughout the sampling season (Table 3, Figure 10). The lowest concentrations were displayed at the beginning of the monitoring season with low readings of 11.8 mg/L recorded at LES and TR on May 30, 2007. LES had a small peak in mid to late August with a result of 18.2 mg/L. The highest calcium concentrations for all sites were exhibited from mid-September to mid-October, with the highest concentration of 25.1 mg/L recorded at LES on October 15, 2007.

Chlorophyll-a

Chlorophyll-*a* trends were broadly similar for all sites except TR, with the largest peaks occurring between early and late September (Table 3, Figure 11) and the largest concentration of 21.0 µg/L recorded at WE on September 18, 2007. TG yielded a small, early peak in mid-June, while also having an early, broad peak from early to mid-September. TR maintained a consistent chlorophyll-a concentration and returned the lowest results throughout the sampling period, with a low reading of 0.9 µg/L on May 30, 2007. Upriver sites, with the exception of TR, tended to have higher concentrations than downriver sites, especially during peak concentrations.

Pheophytin-a

Pheophytin-*a* results and trends differed considerably throughout the sampling season (Table 3, Figure 12). The WE sampling site returned one large, main peak of 11.0µg/L on September 18, 2007. TC also yielded a smaller peak of 4.7µg/L during this time. TG generated a small peak in mid-June, and a large peak of 10.0µg/L in early September. LES did not fluctuate as much as the other sites, but did have a small peak in mid-August. TR changed the least of all sites throughout the sampling season, yielding the lowest concentration of the 2007 sampling season with a result of 0.4 µg/L, but did have a small peak in late June. All site concentrations were on the rise when sampling ended in mid-October. 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 2007 monitoring season were similar among most sites yielding results between a low of 6.56 mg/L at TR on May 30 and August 21, 2007 and 8.5 mg/L (Table 3, Figure 13). The one anomaly was LES, the most downriver site sampled, which had a peak in mid-August, and was on the rise with its highest concentration of 33.7 mg/L in mid-October.

Non-Filterable Residue (TSS)

Non-filterable residue, also known as total suspended solids (TSS), trends for WE, TG, LES were similar with peaks coming in mid-September (Table 3, Figure 14). TG yielded the highest concentration, with a result of 16.0 mg/L on September 18, 2007. KBW/TC had a somewhat similar result, with a larger peak in mid-September, but also a smaller peak in mid-June. TR returned a small peak in late June, but otherwise fluctuated very little throughout the sampling season, producing the lowest concentration of 0.83 mg/L on September 18, 2007. All sites except TR had falling concentrations at the end of the sampling season. 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 3, Figure 15). LES yielded a small peak in mid-August and exhibited the highest concentration of 1459 mg/L in mid-October. The lowest concentration of 85.5 mg/L was recorded at TR on May 30, 2007.

Total Organic Carbon (TOC)

TOC trends were similar for all sites except TR throughout the sampling period with a peak in mid-September (Table 3, Figure 16). WE yielded the highest concentration of 3.38 mg/L on September 18, 2007, while TR generated the lowest reading of 0.532 mg/L on May 30, 2007. TR fluctuated very little throughout the sampling season with values ranging from 0.532 mg/L to 0.870 mg/L. TOC concentrations at all sites except TR were falling when sampling was suspended in mid-October.

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 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 2) 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 2007. 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 2, red line in Figure 5). As can be seen in Table 1 and Figure 5, after late July, all sites except TR sampled exceeded this standard. By September, the sites were yielding results that were 2-3 times greater than the minimum concentration of 0.2 mg/L.

Total Phosphorous

The Hoopa Valley Reservation has set the proposed standard for nitrogen at 0.035 mg/L (Table 2, red line in Figure 7). As can be seen in Table 1 and Figure 7, most sites, except TR, tested above this standard for most of the year. During September, 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 2. 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 recognize as acceptable levels to meet beneficial uses.

Table 3. Nutrient Results for Yurok Reservation, 2007

Nutrients

Nitrate +Nitrite	**Site**	**Date** 5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.010	WE	0.026	0.036	ND	ND	ND	ND	ND	0.013	ND	0.011	0.04
	KBW	0.018	0.026	ND	0.012	ND	ND	ND	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.011	ND	0.012	0.034
	TG	0.037	0.033	0.025	0.054	0.026	0.026	0.028	0.016	ND	0.012	0.045
	LES	0.029	0.019	0.015	0.026	0.015	0.014	0.020	0.012	ND	0.015	0.031
	TR	ND	DNS	ND	DNS	0.012	DNS	ND	DNS	ND	DNS	ND

Total Nitrogen	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit 0.100	WE	0.202	0.226	0.258	0.261	0.257	0.323	0.419	0.531	0.679	0.459	0.512
	KBW	0.156	0.164	0.241	0.206	0.183	0.239	0.317	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.374	0.485	0.399	0.340
	TG	0.196	0.195	0.199	0.192	0.162	0.218	0.429	0.372	0.507	0.392	0.339
	LES	0.149	0.126	0.163	0.240	0.164	0.246	0.327	0.311	0.423	0.313	0.362
	TR	ND	DNS	ND	DNS	ND	DNS	ND	DNS	ND	DNS	0.117

Ammonia Nitrogen	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.010	WE	ND	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND
	KBW	ND	ND	ND	ND	ND	ND	ND	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	ND	ND	ND	ND
	TG	ND	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND
	LES	ND	ND	ND	ND	ND	ND	0.020	ND	ND	ND	0.015
	TR	ND	DNS	ND	DNS	ND	DNS	ND	DNS	ND	DNS	ND

Table 3 (contd.) Nutrient Results for Yurok Reservation, 2007

Total Phosphorous	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.002	WE	0.036	0.057	0.056	0.056	0.054	0.072	0.078	0.109	0.153	0.1	0.088
	KBW	0.025	FLAG	0.051	0.040	0.041	0.051	0.056	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.076	0.099	0.073	0.054
	TG	0.023	0.043	0.034	0.035	0.038	0.037	0.056	0.082	0.109	0.069	0.050
	LES	0.025	0.028	0.036	0.049	0.032	0.036	0.041	0.071	0.098	0.059	0.045
	TR	0.011	DNS	0.008	DNS	0.008	DNS	0.007	DNS	0.008	DNS	0.008

Soluble Reactive Phosphorous	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.001	WE	0.023	0.036	0.042	0.040	0.039	0.043	0.057	0.081	0.102	0.074	0.060
	KBW	0.015	0.025	0.030	0.030	0.028	0.030	0.037	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.058	0.059	0.055	0.042
	TG	0.012	0.019	0.023	0.021	0.018	0.016	0.017	0.046	0.045	0.045	0.032
	LES	0.013	0.020	0.025	0.024	0.022	0.019	0.030	0.047	0.058	0.047	0.032
	TR	0.004	DNS	0.003	DNS	0.002	DNS	0.001	DNS	0.003	DNS	0.003

Table 4. Other Analytes Results, Yurok Reservation, 2007.

Other Analytes												
		Date										
Alkalinity	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L CaCO3; Report Limit: 1.0	WE	65.8	DNS	77.0	DNS	81.7	DNS	75.8	DNS	79.9	DNS	85.0
	KBW	62.8	DNS	73.0	DNS	77.5	DNS	73.3	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	76.0	DNS	80.6
	TG	63.6	DNS	77.0	DNS	78.2	DNS	76.8	DNS	79.1	DNS	81.7
	LES	63.2	DNS	71.0	DNS	75.9	DNS	75.4	DNS	77.5	DNS	82.5
	TR	57.9	DNS	71.0	DNS	69.5	DNS	66.4	DNS	64.0	DNS	70.7
Calcium	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.1	WE	12.0	DNS	12.3	DNS	13.2	DNS	12.8	DNS	14.4	DNS	14.2
	KBW	11.9	DNS	12.4	DNS	13.6	DNS	13.0	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	14.8	DNS	15.1
	TG	11.9	DNS	12.6	DNS	13.8	DNS	13.5	DNS	16.0	DNS	15.6
	LES	11.8	DNS	12.3	DNS	13.2	DNS	18.2	DNS	15.4	DNS	25.1
	TR	11.8	DNS	14.0	DNS	14.7	DNS	13.6	DNS	15.0	DNS	16.5
Chlorophyll a	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
µg/L; Report Limit: 0.1	WE	1.9	1.9	1.2	1.6	3.5	6.9	11	11	21	8	9.6
	KBW	1.1	1.1	2.1	1.6	2.4	5.6	8.0	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	9.1	15	7.5	6.9
	TG	1.6	4.5	1.3	3.2	3.7	4.0	11	16	16	9.6	4.3
	LES	1.6	1.1	1.3	2.8	2.9	2.4	3.7	6.9	15	6.9	1.6
	TR	0.9	DNS	1.1	DNS	1.3	DNS	1.3	DNS	1.9	DNS	2.1
Pheophytin a	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
µg/L; Report Limit: 0.1	WE	0.9	1.1	0.9	1.1	1.2	3.7	3.7	5.6	11	4.0	8.0
	KBW	1.2	1.5	0.9	0.8	0.8	2.6	3.2	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	3.3	4.7	3.4	5.8
	TG	0.8	3.1	0.9	1.2	1.1	4.2	7.5	10	4.9	2.3	6.2
	LES	0.6	1.2	1.1	1.1	ND	2.6	3.4	1.3	1.9	2.0	3.6
	TR	ND	DNS	1.4	DNS	ND	DNS	ND	DNS	0.4	DNS	2.3

Table 4(contd.). Other Analytes Results, Yurok Reservation, 2007.

Magnesium	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.1	WE	6.85	DNS	7.90	DNS	8.34	DNS	6.94	DNS	7.20	DNS	7.57
	KBW	6.81	DNS	7.64	DNS	8.03	DNS	6.80	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	7.05	DNS	7.41
	TG	6.83	DNS	7.98	DNS	8.30	DNS	7.62	DNS	7.99	DNS	7.81
	LES	6.99	DNS	8.09	DNS	13.4	DNS	19.2	DNS	7.85	DNS	33.7
	TR	6.56	DNS	7.26	DNS	7.52	DNS	6.56	DNS	6.78	DNS	6.90

Total Suspended Solids (TSS)	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.50	WE	2.8	DNS	1.4	DNS	2.1	DNS	5.0	DNS	9.5	DNS	8.5
	KBW	2.9	DNS	5.6	DNS	1.5	DNS	3.8	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	8.5	DNS	3.2
	TG	3.6	DNS	2.0	DNS	2.1	DNS	7.0	DNS	16	DNS	7.3
	LES	3.6	DNS	1.5	DNS	1.4	DNS	2.2	DNS	9.0	DNS	3.2
	TR	1.5	DNS	2.3	DNS	ND	DNS	1.0	DNS	0.83	DNS	1.4

Total Dissolved Solids (TDS)	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 5	WE	97.5	DNS	130	DNS	144	DNS	124	DNS	133	DNS	149
	KBW	96.5	DNS	135	DNS	114	DNS	121	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	131	DNS	135
	TG	95.5	DNS	136	DNS	135	DNS	145	DNS	126	DNS	130
	LES	102	DNS	153	DNS	303	DNS	563	DNS	135	DNS	1459
	TR	85.5	DNS	112	DNS	98.5	DNS	128	DNS	96.0	DNS	115

Total Organic Carbon	**Site**	5/30/07	6/12/07	6/26/07	7/10/07	7/24/07	8/7/07	8/21/07	9/5/07	9/18/07	10/2/07	10/15/07
mg/L; Report Limit: 0.250	WE	1.32	DNS	2.29	DNS	2.57	DNS	2.65	DNS	3.38	DNS	2.91
	KBW	0.887	DNS	1.77	DNS	1.79	DNS	2.14	DNS	DNS	DNS	DNS
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	2.45	DNS	2.31
	TG	0.824	DNS	1.45	DNS	1.38	DNS	1.68	DNS	1.95	DNS	1.97
	LES	0.828	DNS	1.50	DNS	1.46	DNS	1.83	DNS	2.57	DNS	2.01
	TR	0.532	DNS	0.775	DNS	0.671	DNS	0.827	DNS	0.809	DNS	0.870

DNS = Did not Sample ND=No Detect FLAG = Outlier was removed

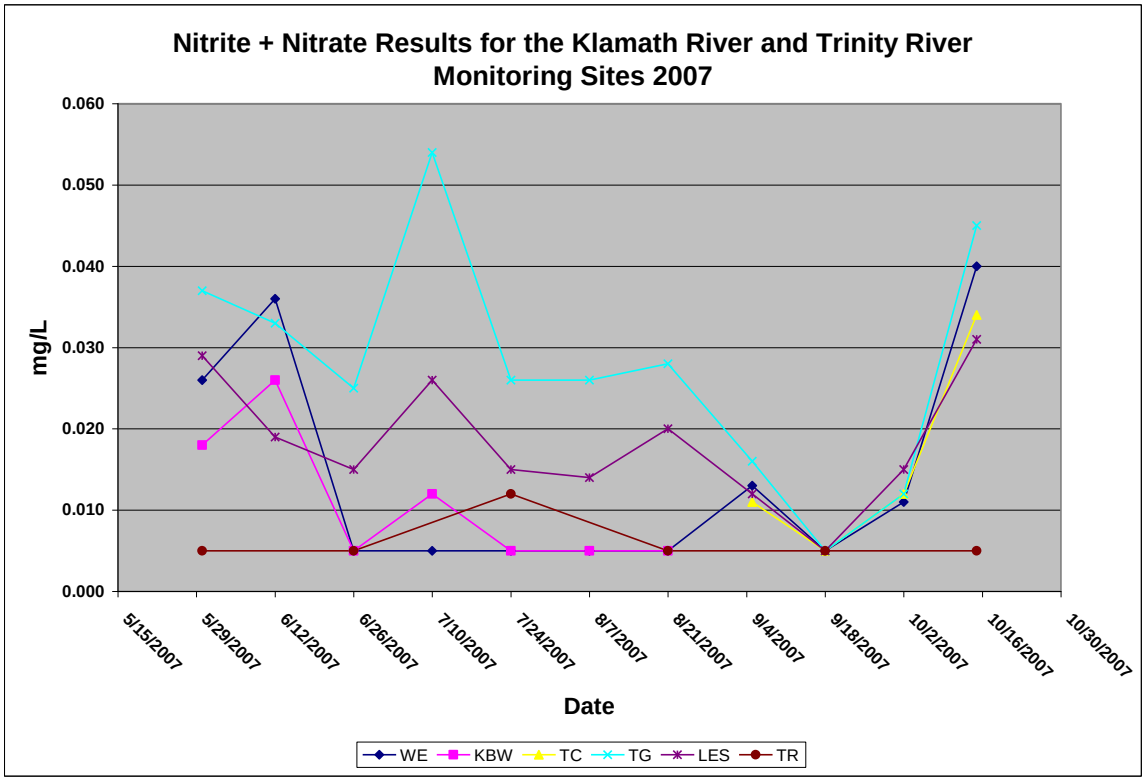

Figure 4. Nitrite and Nitrate Results 2007

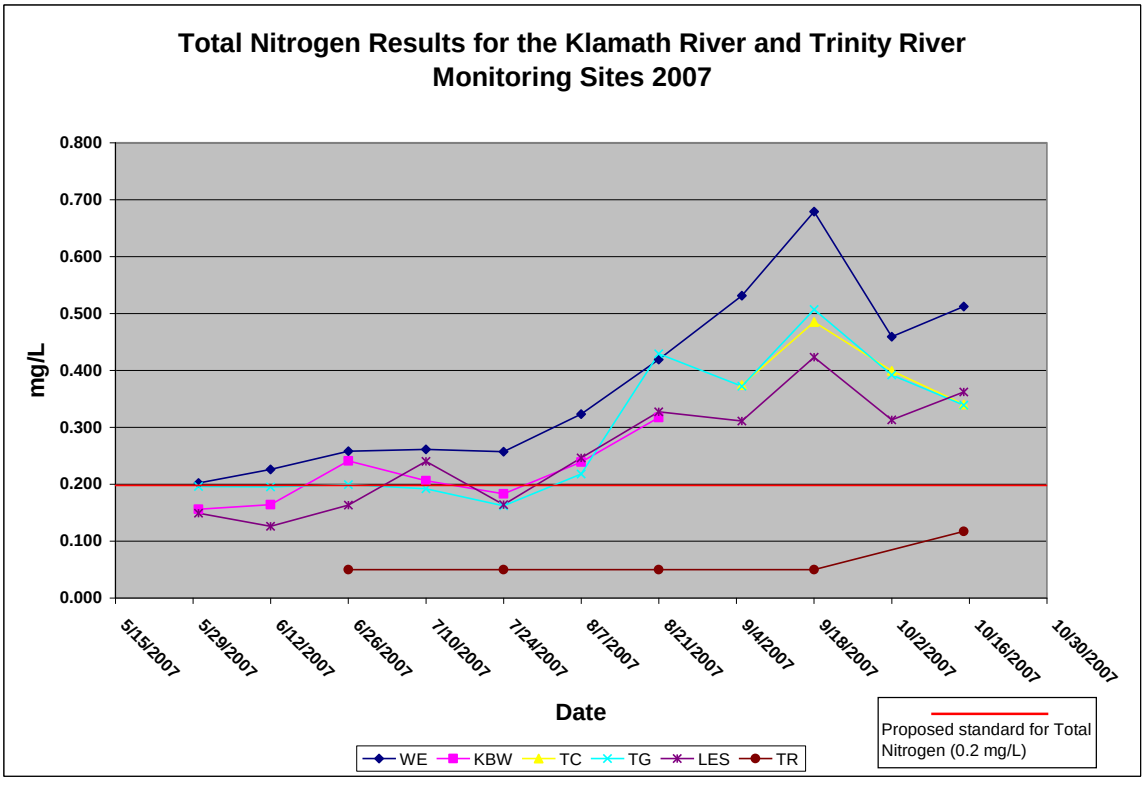

Figure 5. Total Nitrogen Results 2007

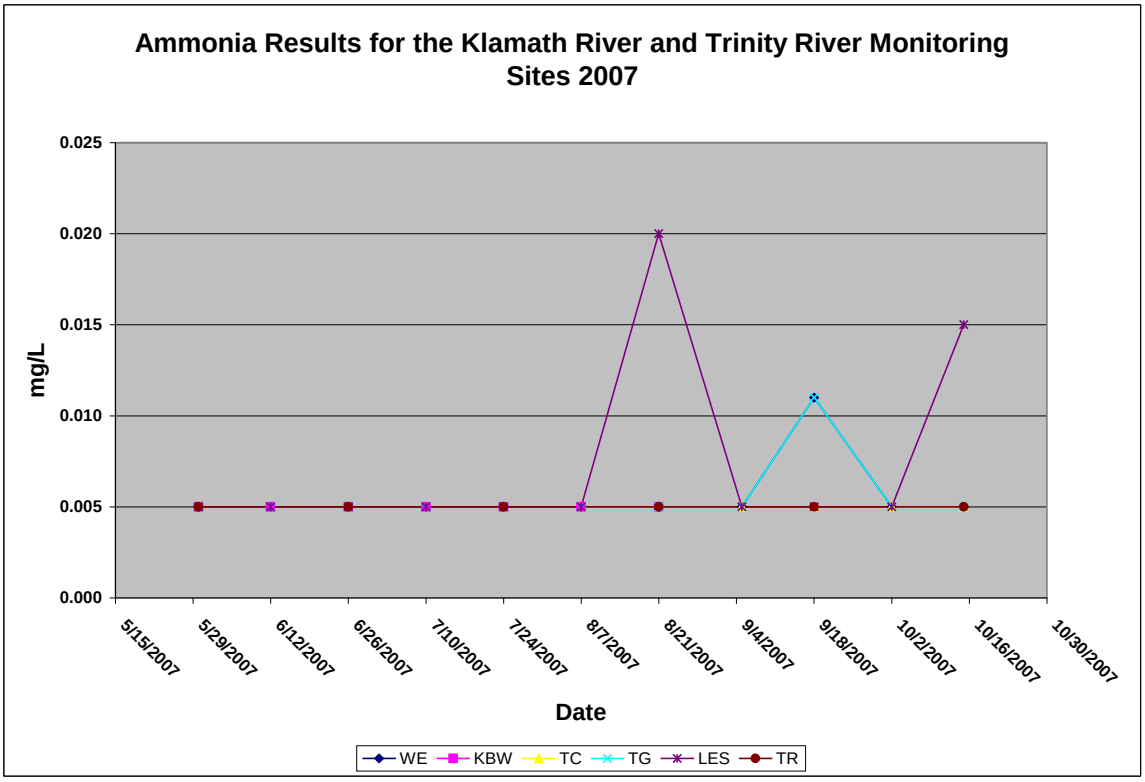

Figure 6. Ammonia Results 2007

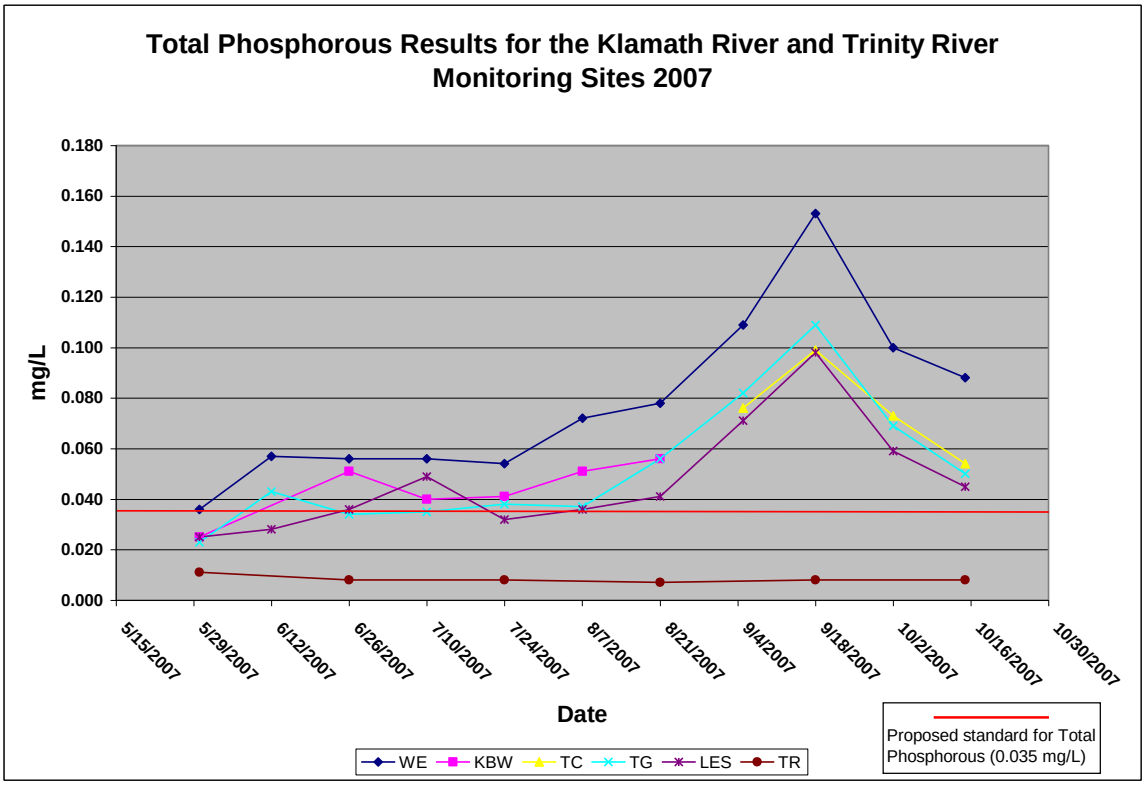

Figure 7. Total Phosphorous Results 2007

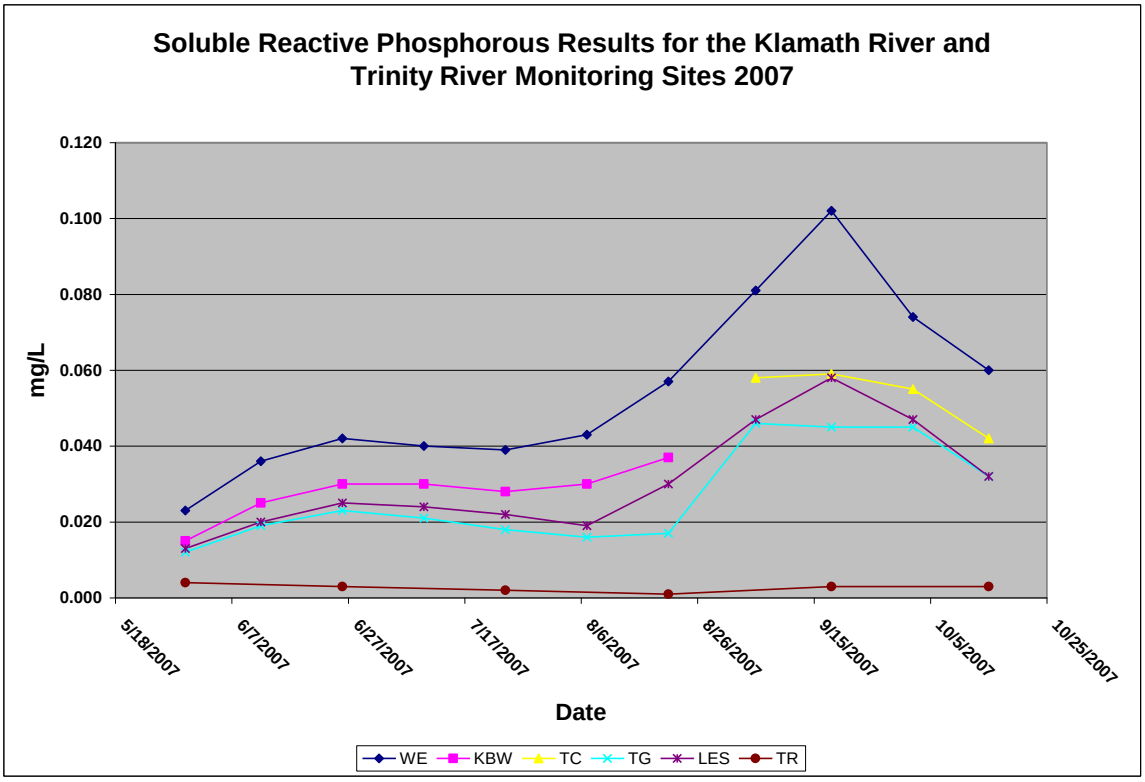

Figure 8. Soluble Reactive Phosphorous Results 2007

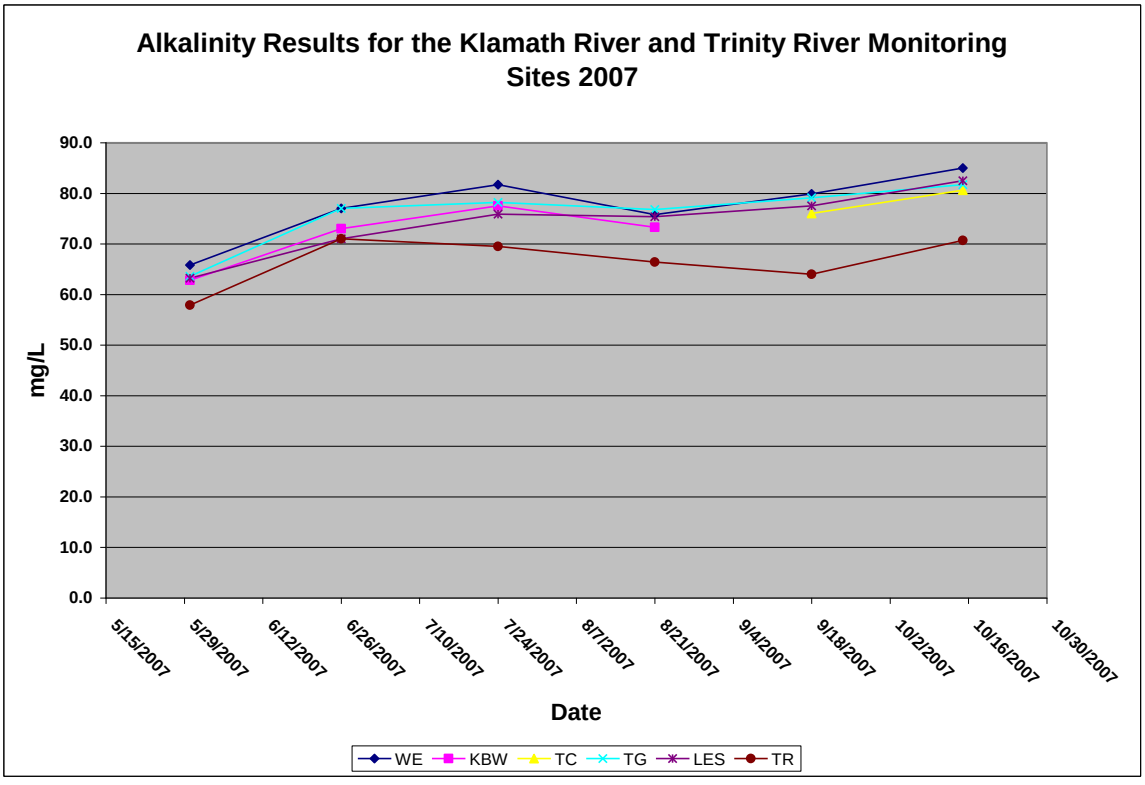

Figure 9. Alkalinity Results 2007

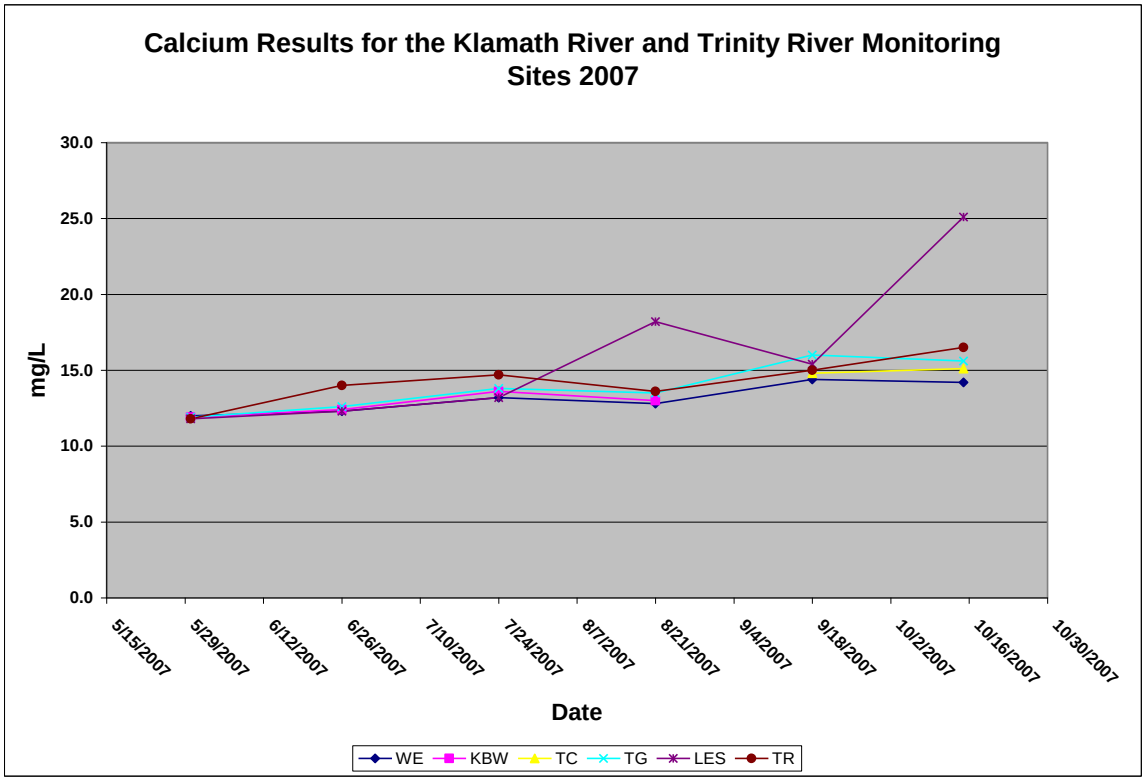

Figure 10. Calcium Results 2007

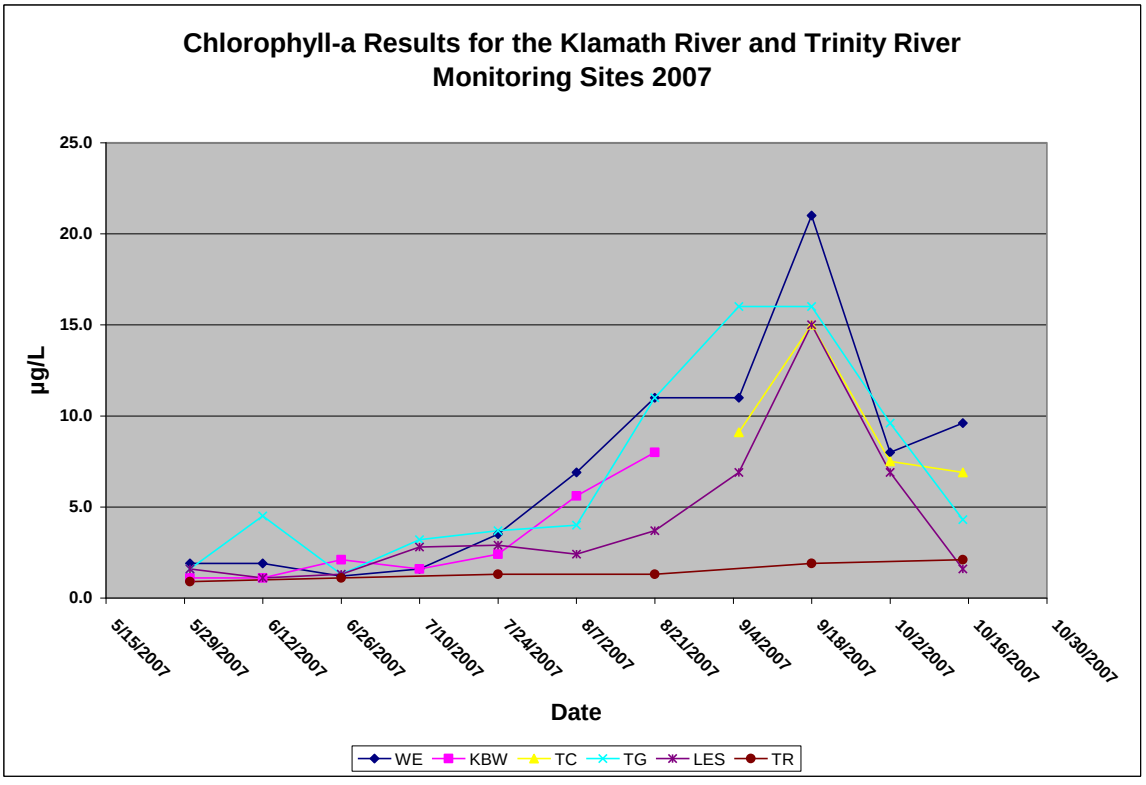

Figure 11. Chlorophyll-*a* Results 2007

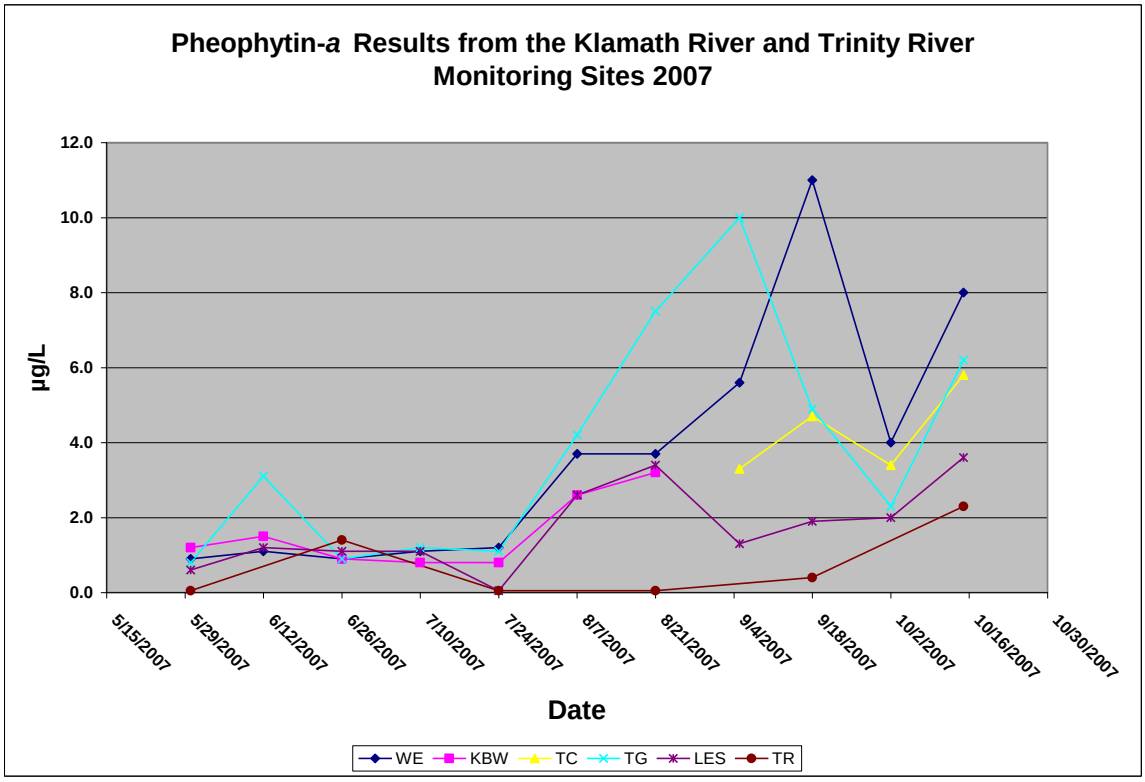

Figure 12. Pheophytin-*a* Results 2007

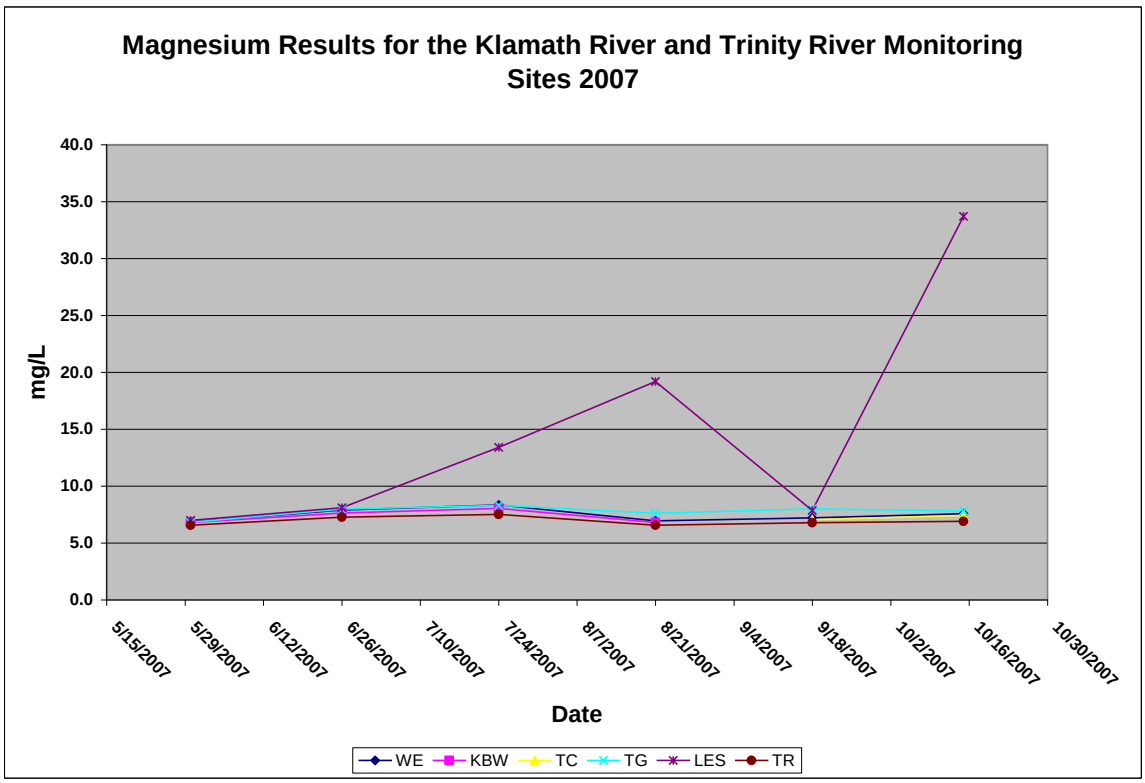

Figure 13. Magnesium Results 2007

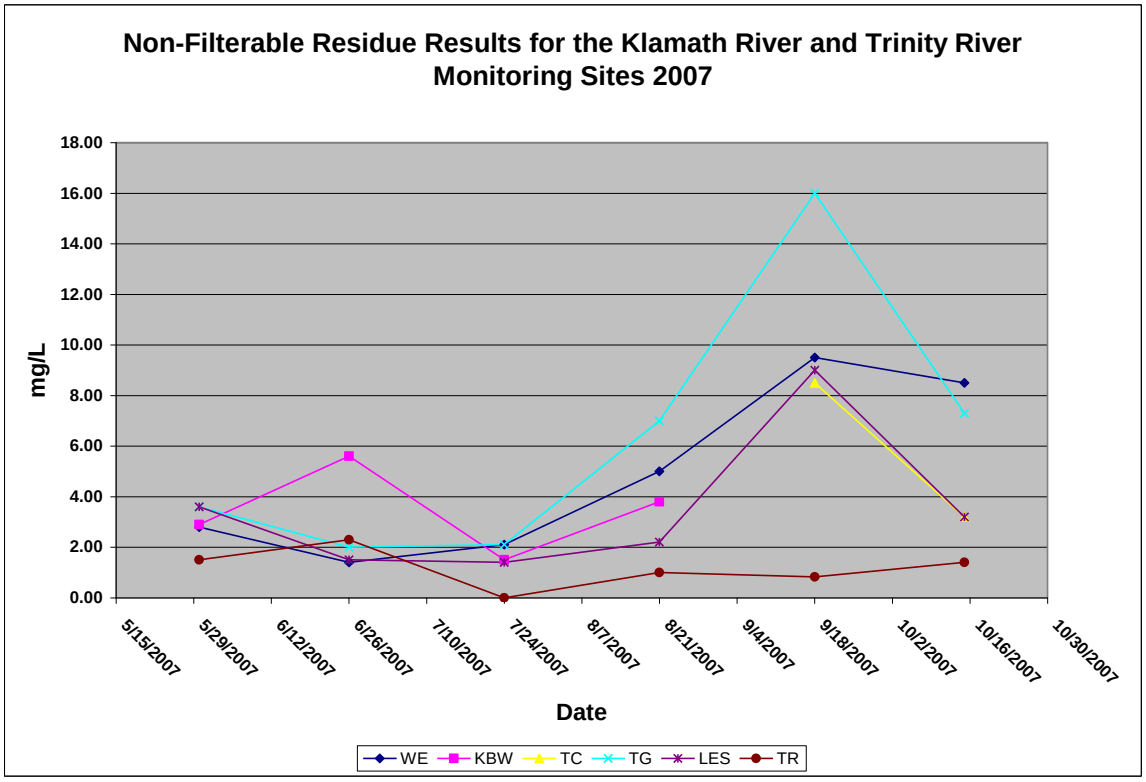

Figure 14. Non-Filterable Residue Results 2007

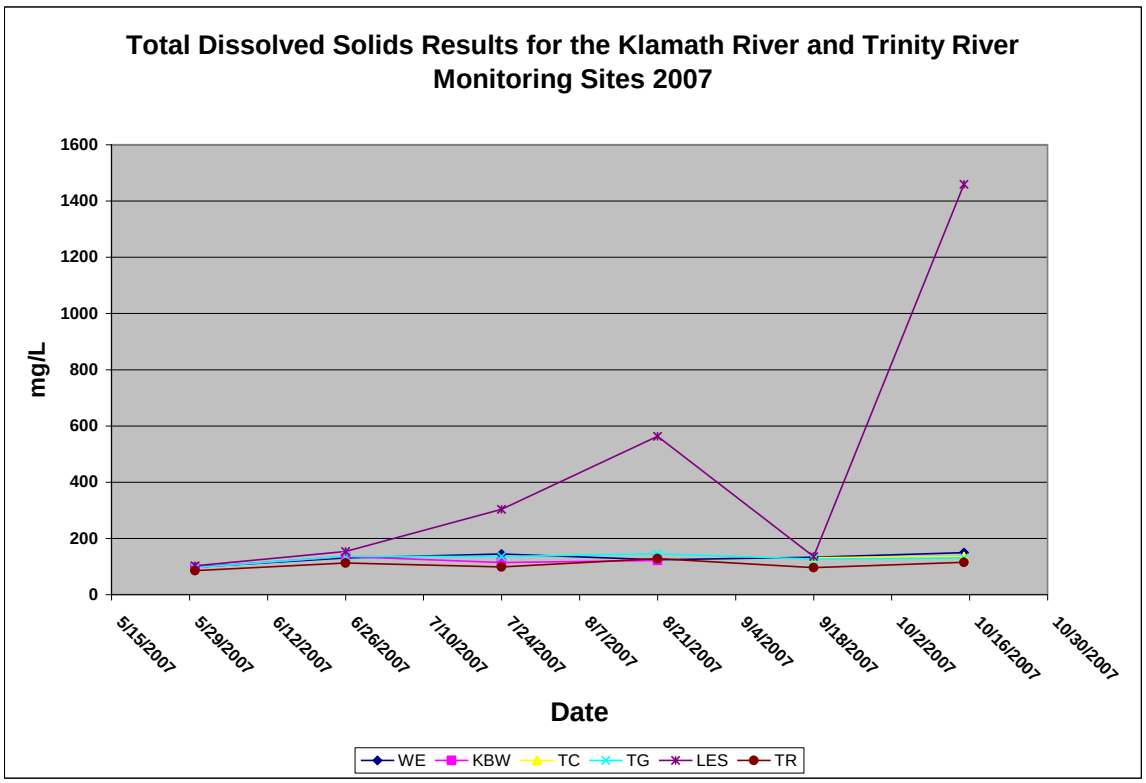

Figure 15. Total Dissolved Solids Results 2007

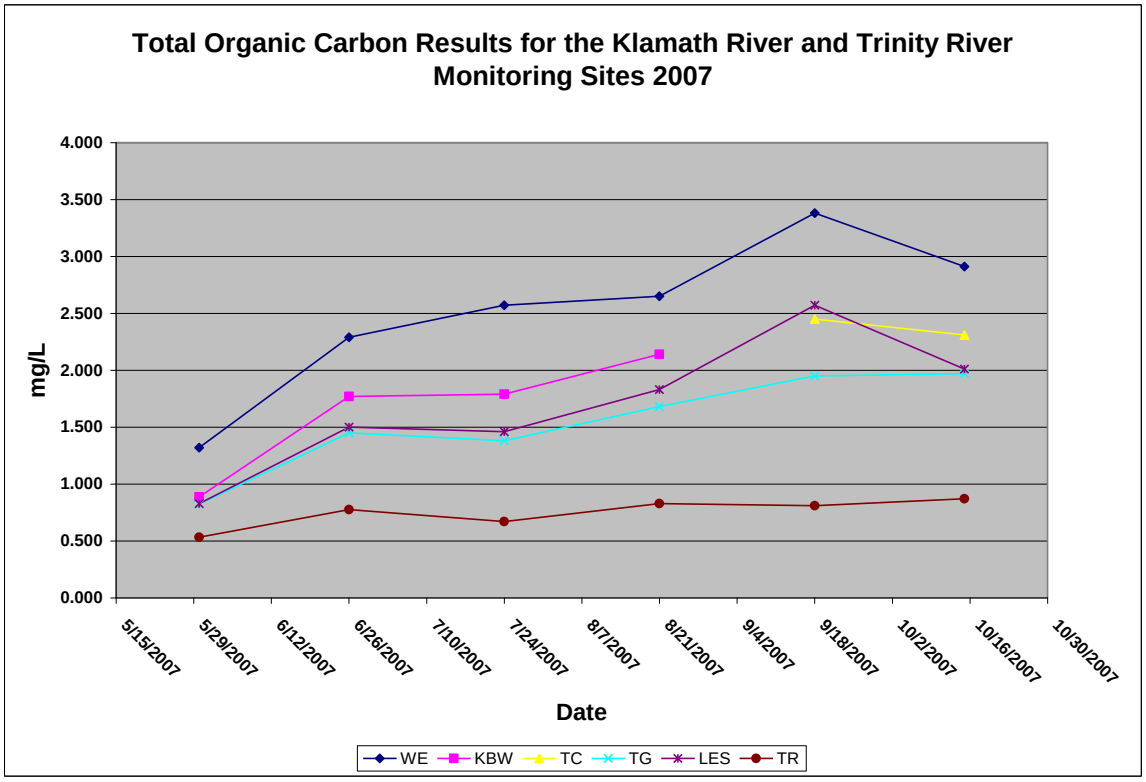

Figure 16. Total Organic Carbon Results 2007

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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 – Replicate Bottle Sets

To ensure laboratory and sampling accuracy, one site every sampling period was randomly selected to receive one additional QA/QC bottle set. This bottle set contains duplicate water samples. Duplicate samples are obtained using the same process as regular samples. These are disguised so the lab does not know which samples are duplicates. This information is used to assure the laboratory maintains precision within results. All bottle sets are then placed on ice and are transported to the associated laboratories. All grab samples were processed within 24 hours or within known laboratory holding periods.

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