

KARUK TRIBE

DEPARTMENT OF NATURAL RESOURCES

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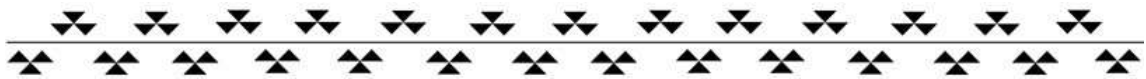
Quality Assurance Project Plan

For Water Quality Sampling and Analysis

CWA 106 grant identification # BG-97991217

Prepared by

Karuk Tribe Water Quality Program



Karuk Tribe Water Quality Program

Quality Assurance Project Plan

For Water Quality Sampling and Analysis

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1.0 PROJECT MANAGEMENT

This Quality Assurance (QA) Project Plan has been prepared for the monitoring of surface water by the Karuk Tribe located in Humboldt and Siskiyou County, California. The surface water monitoring program is part of the Tribe's water quality management program developed under Section 319 of the Clean Water Act. This section of the QA Project Plan describes how the project will be managed, organized and implemented.

1.1 Title and Approval Page - See Pages 1-2.

1.2 Table of Contents - See Pages 3 - 8.

1.3 Distribution List

The following is a list of individuals who will receive copies of the approved QAPP and any subsequent revisions or changes.

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1.4 Project Organization

Table 1 lists key players and contractors, including those collecting samples, contractors that will process samples and Karuk Tribe Water Quality Program (KTWQP) staff that will oversee quality control (QC) procedures. Laboratories that will process samples are 1) Aquatic Research Inc. in Seattle, Washington, 2) Aquatic Analysts Inc. in Friday Harbor, Washington, 3) the U.S. Environmental Protection Agency Region IX Laboratory in Richmond, California, 4) Chesapeake Biological Laboratory in Solomons, Maryland, 5) GreenWater Laboratories in Palatka, Florida, and 6) Bartholomew Laboratory in Corvallis, Oregon.

The KTWQP is completing this QAPP to define how QC procedures are implemented and to define how the KTWQP and its staff will work together on quality assurance (QA) to insure that data are properly collected and analyzed, managed and stored for on-going use, and results published in a timely fashion. Because of the systematic planning process documented in this QAPP, the KTWQP will supply quality assured data for management decisions related to the aquatic environment within Karuk Ancestral Territory (KAT) and surrounding areas.

The KTWQP is organized as shown in Figure 1. The KTWQP Project Manager has ultimate control over and responsibility for the WQ program. The KTWQP Project Manager is responsible for program coordination, budget management, technical oversight and overall program quality.

The QA Officer will have responsibility and authority for:

- Ongoing review of monitoring methods and equipment calibration,
- Report Preparation,
- Auditing field notebooks, databases, chain of custody forms, and
- Insuring adherence to field and laboratory QA/QC programs.

In short, the QA Officer will insure that QC procedures developed in this QAPP are carried out. The Data Manager and Water Quality Technicians will work under the supervision of the QA Officer and follow procedures as defined in this QAPP.

The Data Manager will:

- Transfer results from the field or laboratory into databases,
- Properly store data and archive to insure against loss,
- Run preliminary analysis of data, and provide charts for reports, and
- Assist with report preparation.

The WQ Technicians will:

- Collect field samples,
- Fill out forms to record results and field conditions,
- Care for and calibrate equipment, and
- Properly fix and ship samples needing laboratory analysis.

Any time there are problems perceived by the Data Manager or the WQ Technician with any part of the WQ Monitoring Program, they are to notify the KTWQP Project Manager so they can work collaboratively on resolving issues. The QA Officer will also periodically conduct audits to detect QA/QC problems or deficiencies.

If any tests of surface water exceed tribally adopted water quality standards, then the KTWQP Project Manager will be notified so that they can inform the Karuk Tribal Council. Following notification of the Tribal Council, the KTWQP would then inform the North Coast Regional Water Quality Control Board staff and work cooperatively with that agency for abatement of problems.

The KTWQP will send water quality samples needing laboratory analysis to Aquatic Research Inc., and to Chesapeake Biological Lab. Phytoplankton and algae samples will be sent to Jim Sweet of Aquatic Analysts to be processed and analyzed. Samples to be tested for microcystin toxins will be sent to the US EPA Region 9 Lab and GreenWater Lab. Samples to be analyzed for ceratonova shasta (c.shasta) will be sent to Bartholomew Lab.

1.5 Background and Problem Definition

This section states background information to provide a historical, scientific, and regulatory perspective for the project, and articulates specific problems to be solved.

1.5.1 Background

The Karuk Tribe is the second largest Tribe in California, with over 3,700 Tribal members currently enrolled. The Karuk Tribe is located along the middle Klamath River in northern California. Karuk Ancestral Territory covers over 90 miles of the mainstem Klamath River and numerous tributaries (Figure 2, Table 2). The Klamath River system is central to the culture of the Karuk People, as it is a vital component of our religion, traditional ceremonies, and subsistence activities. Degraded water quality and quantity has resulted in massive fish kills, increased occurrences of toxic algae, and outbreaks of fish diseases. Impaired water quality conditions also apply extreme limitations and burdens to our cultural activities.

1.5.1.1 Decline of the fishery

What was once a historically productive fishery has now declined to numbers precluding tribal members from utilizing their fishing rights on ancestral waters and limiting their take for sustenance throughout the Klamath River watershed. The Indian people of the Karuk Tribe traditionally depended on the land and waters to provide for their physical and cultural needs. The state of the watershed today prevents this dependency.

Historically, spring-run Chinook salmon were abundant in the rivers of the Klamath Basin, considerably outnumbering the fall Chinook run (Hume in Snyder 1931). “Salmon ascend the river in large numbers, before the waters subside in the spring”, remarked Gibbs in 1851 (SRWC SAP 2005). Fall Chinook, winter and summer steelhead were also widespread in the Klamath Basin. (Maria, personal communication in SRWC SAP 2005). Today, the spring Chinook and summer steelhead run is virtually nonexistent in the Klamath River (KRBFTF, 1991. p. 2-87, 2-99, and 4-15; USFS, 2000b, p.3-9; USFS, 2000a).

Coho salmon would have flourished in the numerous ponds created by beavers in Mid-Klamath tributaries and the mainstem Klamath (SRWC SAP 2005 & Belchik, personal communication). Brown et al. (1994) state that California coho populations are probably less than 6% of what they were in the 1940s, and there has been at least a 70% decline since the 1960s. Coho salmon occupy only 61% of the SONCC Coho ESU streams that were previously identified as historical coho salmon streams (CDFG, 2002, p.2)

1.5.1.2 Land Use Factors

Consideration of factors limiting salmon and steelhead production, water quality and attainment of other beneficial uses in Mid-Klamath region must be tiered. Flow depletion in tributaries and water diversions cause secondary water quality problems as transit time increases and stagnation of water occurs. This alteration of timing and flow volume subsequently affects sediment dynamics and the hydro-morphology of these water ways. Limiting factors are most often linked to the land use activities of logging, agriculture, and historical mining.

Historical Mining: Historically, gold was mined in the Mid-Klamath region. The type of mining performed in Northern California during the late 1800s was hydraulic mining, not chemical (like cyanide-leach mining), so less chemical contamination is associated with it. Surface and groundwater in the MidKlamath could potentially be contaminated with heavy metals, such as arsenic, that naturally occur in association with gold but are discarded in mine tailings. The use of mercury to separate gold from concentrates was

common place. Dredge tailings from hydraulic mining can also serve as a source of sediment pollution. Current mining practices are being evaluated by CDFG at present.

Agriculture: Beginning around 1850, ranching became a prevalent use of land on the Klamath River and its tributaries. Grazing of cattle is still performed by landowners adjacent to the Klamath River and its tributaries. This could contribute to erosion of streams and bacterial contamination of surface waters where cattle are permitted access to streams. Agricultural practice near waterways may contribute contaminants such as pesticides, nitrates, and phosphates to the surface water.

In the Shasta River and the Scott River, two major Klamath River tributaries, the flow depletion due to water extraction for agriculture causes warming as the water volume is reduced. Decreasing flows also causes the formation of isolated pools, which can and do strand juvenile fish. Warming water temperatures and nutrient rich agricultural return water increases the amount of periphyton growth on stream substrate, which has been demonstrated in the Shasta River. High rates of photosynthesis by algae in low flow conditions can cause large nocturnal and diurnal fluctuations in pH and dissolved oxygen. The secondary effects related to high photosynthetic activity in stagnant, de-watered reaches are not targeted because loss of flow is an over-riding impact.

Logging: Much of the land in Siskiyou County was logged, beginning in the latter half of the 19th century. Historic timber practices could result in herbicide and pesticide contamination of surface and ground water. Erosion due to clear-cutting and logging roads (whether still used and maintained, or abandoned) contributes significant amounts of sediment to the Klamath River system and has altered the natural hydrograph.

Upland areas of the Klamath River which have been extensively logged have high road densities prompting multiple Regional Water Board TMDLs across the Klamath basin. Compaction of soils and changes in routing of storm water on logged areas and logging roads are known to:

- Increase peak discharge (Montgomery and Buffington, 1993; Jones and Grant, 1996),
- Increase sediment yield (Hagans et al., 1986, de la Fuente and Elder, 1998), and
- Decrease large wood available for recruitment to streams (Reeves et al., 1993; Schuett-Hames et al., 1999).

The potential changes in aquatic conditions related to upland disturbance are described below.

Increased Peak Discharge: Elevated peak discharge can increase median particle size distribution to those greater than optimal for salmonid use, wash out large wood, and trigger bank failures and channel scour. Channel changes can include decreased pool frequency and depth (Buffington and Montgomery, 1993). Wider and shallower channels are also more subject to warming. Although less well-studied, hydrologic changes associated with compaction of a watershed can also lead to decreased summer base flows.

Increased Sediment Yield: Sediment yield is a noted problem in tributaries to the Klamath River mainstem (NCRWQCB, 2003; 2005). Fine sediment comes primarily from surface or gully erosion. Sommarstrom et al. (1990) identified road cuts and road fills on decomposed granitic soils as a major source of fines within the Scott River watershed, a major tributary to the Klamath River.

Fine Sediment: High levels of sand and fine sediment can fill interstitial spaces in stream gravels, decrease salmonid egg and alevin survival and reduce aquatic insect habitat. Decreased aquatic invertebrate production can diminish food resources for juvenile salmonids. Smaller sediment particles are highly mobile and may cause diminished pool frequency and depth, thus reducing salmonid juvenile carrying capacity and adult salmonid holding habitat.

Mass Wasting: The coarse and fine sediment yielded by mass wasting can cause channel aggradation, loss of pool habitat, changes in median particle size, decreased spawning gravel quality and channel adjustments that facilitate stream warming.

Large Wood Depletion: Changes in riparian conditions can increase ambient air temperature over streams and reduce relative humidity, thus leading to stream warming (Bartholow, 1989; Pool and Berman, 2001). Cold air moving down slope from Marble Mountain peaks in winter may also cause elevated risk for the formation of anchor ice along streams where canopy is lacking. Pools formed by large wood are extremely important as nursery areas for coho salmon juveniles (Reeves et al., 1988) that must spend one year in freshwater before migrating to the ocean. Large wood depletion can therefore cause diminished aquatic habitat complexity, reduced pool frequency and lower carrying capacity for juvenile coho. Large coniferous trees in riparian zones may take decades or centuries to grow to sufficient size to be useful in buffering air temperatures and providing wood of sufficient size to provide lasting habitat value (Shuett-Hames et al., 1999).

1.5.1.3 Purpose of Water Quality Investigations

It is the mission of the Karuk Tribe to protect, promote, and preserve the cultural resources, natural resources, and ecological processes upon which the Karuk People depend. This mission requires the

protection and improvement of the quality and quantity of water flowing through Karuk Ancestral Territory and Tribal trust lands. The Karuk Tribe's Department of Natural Resources has been monitoring daily water quality conditions in the Klamath River since January of 2000 and tributaries to the Klamath River since 1998. The Karuk Tribe has been collaboratively involved in maintaining water quality stations along the Klamath River and its tributaries with the United States Environmental Protection Agency (USEPA), the United States Geological Survey (USGS), the Bureau of Reclamation (BOR), the Yurok Tribe, Quartz Valley Indian Reservation, Hoopa Tribe, and Resighini Rancheria, Oregon State University and PacifiCorp.

The data produced is indispensable in monitoring water quality conditions within the Klamath River System. We are building a long-term monitoring data set that allows us to track these conditions and monitor them for improvement. This data is important to state and federal processes currently underway and provides information for Tribal Council and resource managers to make informed decisions. The water quality data the Karuk Tribe collects is essential to providing quality data regarding processes that involve and affect the Karuk Tribe.

The goal of the KTWQP is to provide the Karuk Tribe with a quantitative assessment of water quality effecting KAT, and to further expand the Tribe's scientific knowledge for tribal members, fisheries, future planning, and watershed activities. Additionally, these analyses will help identify any surface water contamination problems that could affect fish habitat, since wild salmon are an important resource to the Karuk Tribe and a vital piece of the Tribe's cultural heritage.

The data was collected in accordance with this QAPP will be used to develop baseline information in order to document water quality changes over time, screen for potential water quality problems, and to provide a scientific foundation in order to actively participate in the management of the Mid-Klamath watershed.

1.5.2 Problem Definition

1.5.2.1 Nutrient and Toxic Algae Pollution

The Klamath River in California is listed as an impaired water body under the Clean Water Act (CWA) Section 303(d) list for temperature, nutrients, dissolved oxygen (DO), sediment, and microcystin (NCRWQCB, 2009). The mid-Klamath River can have elevated water temperatures, low dissolved oxygen levels, elevated sediment loads, loading from organic matter, and high levels of the cyanotoxin microcystin. These detrimental conditions are caused by a variety of factors including hydrological modification, agricultural use, timber harvesting, mining activities, and fire suppression (NCRWQCB, 2009). Some of the beneficial uses that are important to the Karuk Tribe and impacted by poor water

quality conditions are, cultural use, subsistence fishing, cold freshwater habitat, recreation, commercial and sport fishing, shellfish harvesting, rare, threatened, or endangered species, migration of aquatic organisms, spawning, reproduction, and/or early development, and wildlife habitat (NCRWQCB, 2007).

The presence of *Microcystis aeruginosa* (MSAE) contributes to not only fish health problems, but also to human health problems. As MSAE cells die and decay the hepatotoxin microcystin is released, which can cause a range of reactions in humans and/or animals: rash, irritation, conjunctivitis, nausea, vomiting, diarrhea, liver damage, tingling, numbness, paralysis, and death (Chorus and Bartram 1999; Chorus 2001). Once ingested, microcystin is not excreted and instead it bioaccumulates and can cause liver damage, decreased liver function, and eventually mortality (WHO, 1998). Mortality in fish, domestic animals, and humans has been recorded following from both single-dose events and long-term exposure to microcystin (Carmichael 1994).

Nutrient and toxic algae pollution in the Klamath River is causing stressful conditions for Pacific salmonid species and their juveniles and providing an environment that fosters an increase in disease organisms (YTEP, 2006). The reduced salmon production and loss of access to salmon as a food resource has had major health consequences for Native Peoples in the Klamath River basin (Norgaard, 2005).

1.5.2.2 *Ceratonova Shasta*

Stable river channel conditions, abundant algae beds and deposits of benthic organic matter in the Klamath River just below Iron Gate Dam provide ideal habitat for a polychaete worm that plays host to one of the Klamath River's most deadly fish diseases, *Ceratonova shasta* (Stocking and Bartholomew, 2004; Stocking, 2006). This myxozoan parasite infects the intestine of salmonid fishes, which can lead to enteronecrosis and mortality. *Ceratonova shasta* cycles between two hosts and two spore stages: waterborne actinospores released from freshwater polychaete worms infect salmonids and develop into myxospores, which are then infectious to polychaetes (Bartholomew, 2016). The combination of direct stress to fish from water pollution in combination with increased abundance of pathogens has led to more than 40% of downstream migrant juvenile Chinook salmon dying before they reach the ocean in some years (Foot et al., 2003; Nichols and Foot, 2005). The Bartholomew Lab at Oregon State University has been monitoring the spatial and temporal abundance of the parasite in the Klamath River basin since 2006 using sentinel fish exposures, river water sampling, and polychaete sampling. The KTWQP assists with water sample collection and filtration.

1.5.3 Principal data users/decision makers who will use the data to make decisions

The first step to fulfill the goal of this QAPP is the collection of baseline data for water bodies in the Mid-Klamath watershed. Quality assured water quality data collected by the KTWQP will be used in management decisions regarding the watershed. Data will be shared with the U.S. EPA

and NCRWQCB staff through timely reports on findings, including for use in TMDL updates. Other agencies and entities cooperating in Klamath watershed management, including the U.S. National Forest (Klamath and Six Rivers), may also receive KTWQP data after it has undergone QA/QC and analysis. The KTWQP will also share data with tribal members through annual reports and with the public upon request.

1.5.4 Brief Summary of Existing Information

Klamath River nutrient pollution has been widely recognized since the 1950's (Phinney and Peak, 1962; CH2M Hill, 1985; Kier Associates, 1991). The adult salmon kill in September 2002 (CDFG, 2003; Guillen, 2003), chronic high mortality of juvenile salmon (Nichols and Foot, 2005) and discovery of problems with toxic algae in KHP (Klamath Hydroelectric Project) reservoirs (Kann and Corum, 2006) all point to a water quality crisis. As noted above, sources of pollution include upstream agricultural operations and nitrogen fixing algae in Upper Klamath Lake, Lost River, Lower Klamath Lake and KHP reservoirs.

In 1989 the Karuk Tribe formed the Department of Natural Resources which primarily focused on fisheries work. About ten years later, the KTWQP was started. Water quality data was collected in coordination with USGS and USFWS and generally focused on the KAT but also occurred upstream of the KAT. In 1995, USFWS monitored Klamath River water quality as linkages between water pollution and fish health became more apparent. Data have included grab samples for nutrients and those derived from continuous recording data probes that capture parameters such as pH, D.O., temperature and conductivity.

The Klamath River Water Quality Monitoring Coordination Workgroup that includes Tribes and State and federal agencies was formed after the September 2002 adult salmon kill and coordinated increased water quality sampling. Asarian and Kann (2006) used existing nutrient data to construct a nutrient budget by reach for the Klamath River and their study lists all nutrient related water quality samples collected between 1996 and 2004. They pointed out data gaps for nutrient sampling using adequate laboratory detection limits and the need for more periphyton samples. The Hoopa Tribal Environmental Protection Agency (TEPA, 2008) used existing data to characterize Klamath River nutrient pollution and to set limits on their Reservation waters just upstream of Weitchpec where they have been granted Treatment in the Same Manner as a State (TAS) and set water quality standards.

In 2004, the Yurok Tribe, NCRWQCB, and PacifiCorp conducted a Klamath River periphyton study that included sites above and within the KAT, with results summarized by Eilers (2005) and Hoopa TEPA (2008).

The Karuk Tribe began cooperative water quality sampling, including nutrients, with USFWS in 2001.

The KTWQP has operated continuous water quality datasondes at several locations above and within KAT since that time for temperature, D.O., pH, and conductivity. Monitoring for toxic algae species began in 2005 and is ongoing. Periphyton sampling occurred in 2008 and 2011-2014. The KTWQP has been responsible for all of its sample collection, transportation to applicable laboratories, data storage, and data analysis related to nutrients since 2007. The KTWQP has been assisted by Aquatic Ecosystems for analysis of phytoplankton and toxic algae data. Nutrient data collected from 2001-2006 by KTWQP

underwent extensive QA/QC examination. Starting in 2016 all nutrient data has been submitted to the California Environmental Data Exchange (CEDEN) and then cross walked to EPA's STORET. Data will also be added to the comprehensive TMDL database, which is shared and augmented by the Klamath River Water Quality Monitoring Coordination Workgroup and used by the U.S. EPA and NCRWQCB for the Klamath River TMDL.

1.6 Project/Task Description

This section provides a summary of all work to be performed, products to be produced, and the schedule for implementation. This is most easily discussed in sections: Nutrient Sampling, Public Health Sampling, Continuous Monitoring, and C. Shasta sampling.

1.6.1 Nutrient Sampling

A total of eight sites will be sampled for a complete nutrient suite. Table 3 lists the KTWQP sampling sites for nutrients. The sampling area includes 147 river miles of the mainstem Klamath River upstream and within KAT and the Salmon, Scott, and Shasta Rivers above their confluence with the Klamath River. The Salmon River is within KAT, whereas the Scott and Shasta Rivers are upstream of KAT. Scott and Shasta provide excellent spawning habitat for salmonids that are harvested on the KAT, thereby serving as important tributaries to the tribe's fishery. Although the Klamath River is bordered mostly by forests and wildlands, nutrient pollution and now toxic algae are creating water quality problems in KAT. A map of specific locations of the sampling sites is shown in Figure 3.

The KTWQP will collect biweekly samples (every other week) between May and October and monthly samples between November and April, excluding the months of January and February. This schedule was selected because May-October is when nutrients impair water quality in the mainstem Klamath River. Late spring through fall are important times for juvenile salmonid (Chinook, Coho, steelhead) migration, adult spring and fall Chinook migration into the Klamath basin, and migration and rearing of lamprey and green sturgeon, which are all of great importance to the Karuk People. Water quality conditions may impact these species of importance and may also impact the use of the river for subsistence fishing, ceremonial use, other cultural use, and recreation. Although year-round biweekly sampling is preferred to understand the nutrient dynamics of the Klamath River (Asarian and Kann, 2006; Kann and Asarian, 2007), funding availability limits sampling in certain months.

At the locations previously selected, water samples will be collected with a churn splitter to ensure that the sample is homogeneously mixed before the sample bottles are filled. Depending on location, two collection methods may be used. For all sites except for WA, the churn is fully submerged into the stream

and filled to the lid with flowing water, not stagnant water. For WA, a site sampled from a bridge, a Van Dorn sampler is used to collect 3 samples from across the channel. The samples are poured into the churn and treated the same as all other sites.

Sample bottles and chemical preservatives used will be provided by Aquatic Research Inc. and Aquatic Analysts, and are considered sterile prior to field usage. Sample bottles without chemical preservatives will be rinsed with stream water from the churn three times before filling with sample water. In the case of bottles that contain chemical preservatives, bottles are not rinsed before sample collection and care is taken to avoid over-spillage that would result in chemical preservative loss. Sample bottles used for Chesapeake Biological Laboratory will be cleaned prior to the sampling event using the procedures listed in Appendix E-7. Collected samples are placed in coolers on ice for transport to contracted laboratories for analysis or to KTWQP office for filtering.

Samples being sent to Chesapeake Biological Laboratory will first be filtered at the KTWQP office according to procedures listed in section 11.1.1 of Appendix E-7.

Samples sent to Aquatic Research Inc. will be analyzed for the following parameters: Total Phosphorus, Ortho-Phosphorus, Total Nitrogen, Nitrate+Nitrite, Ammonia, Chlorophyll *a*/Phaeophytin *a*, Dissolved Organic Carbon, Total Suspended Solids, Volatile Suspended Solids, Turbidity, and Alkalinity. Samples sent to Aquatic Analysts will be analyzed for Phytoplankton. Samples sent to Chesapeake Biological Laboratory will be analyzed for Particulate Organic Carbon, Particulate Organic Nitrogen, Particulate Inorganic Phosphorus, and Particulate Organic Phosphorus.

General water quality parameters (temperature, dissolved oxygen, conductivity, and pH) will also be simultaneously measured at each site with a YSI datasonde and the data will be recorded onto the grab sample datasheet. The YSI datasonde will have been calibrated using the procedures in Appendix E-4.

1.6.2 Public Health Sampling

A total of five sites will be sampled for microcystin and one site will be sampled for anatoxin-a. Table 3 lists the KTWQP sampling sites for public health. To best monitor public health risks, water samples are collected at locations used for public access and recreation.

Public health sampling occurs biweekly (every other week) starting in June. Once high levels of microcystin are detected, sampling increases to a weekly interval. MSAE blooms and those of other toxic algae species

occur in late summer and early fall, when fishing for subsistence and ceremonial use is at its peak. Public health sampling is continued through October, or until microcystin is no longer detected.

Samples will be collected as grab samples using the same sampling protocol at all locations. At each sampling location, samplers should conduct an initial visual survey of the public access area to identify where surface grab samples would be collected to represent a reasonable maximum exposure at that public access location. Because cyanobacteria can accumulate and dissipate rapidly, depending on sun and wind conditions, a location having a greater presence of cyanobacteria should be identified within each designated public access area, where the public is likely to come into contact with cyanotoxins. This requires subjective selection by the sampler, but should be limited to locations within the public access area (e.g., roughly 50 meters). When possible, sampling crew field trainings should be conducted before the sampling season begins, and involve comparing where different samplers subjectively select to sample in an effort to normalize the selection process.

Grab samples will be performed using a clean wide-mouth jar (about 8 cm diameter and 10 cm depth) that is turned on its side and then submerged into the upper 10 cm of the water. KTWQP will follow Environmental Sampling of Cyanobacteria for Cell Enumeration, Identification and Toxin Analysis Standard Operating Procedures (Appendix E-2) to complete this sampling.

Sample bottles will be 4 oz. pre-cleaned glass thick-walled jars and are considered sterile prior to field usage. Collected samples will be labeled and promptly placed in a cooler with ice to both protect from sunlight and chill until shipped. Double-bagged wet ice or blue ice is acceptable as long as the maximum threshold temperature (6°C) for samples is not exceeded. Block ice is discouraged to protect sample bottles from breaking during shipping. The ice supply will be replenished as often as needed to maintain samples at or below 6°C, and prior to preparing coolers for shipping to the appropriate laboratories. For shipping, glass samples bottles will be protected from breakage using bubble wrap.

Samples sent to the U.S. EPA Region IX Laboratory will be analyzed for microcystin toxin using the enzyme linked immunosorbent assay (ELISA) method. Samples sent to GreenWater Laboratories will be analyzed for microcystin variants and anatoxin-a using liquid chromatography/mass spectrometry (LCMS/MS).

General water quality parameters (temperature, dissolved oxygen, conductivity, and pH) will also be simultaneously measured at each site with a YSI datasonde and the data will be recorded onto the grab sample datasheet. The YSI datasonde will have been calibrated using the procedures in Appendix E-4.

The Karuk Tribe standard for public health protection and limit of microcystin pollution level is <0.8 µg/L and anatoxin-a pollution level is <90 µg/L. KTWQP will issue warnings and communicate with all appropriate agencies should Klamath River samples exceed these thresholds.

1.6.3 Continuous Monitoring

A total of six sites will be continuously monitored using YSI datasondes. Table 3 lists the KTWQP sonde monitoring sites. Three of these stations are located at fixed points along the mainstem Klamath River (Orleans, Seiad Valley, and Iron Gate) and the other three stations are located at fixed points in tributaries (Shasta River, Scott River, and Salmon River). Figure 3 shows the locations of the sampling stations. These stations create a longitudinal profile of water entering and exiting the Mid-Klamath region. The tributary sites are located near their mouths to highlight their influence on the mainstem Klamath River. These tributaries also support abundant runs of spring and fall chinook, coho, steelhead, lamprey, and sturgeon (Salmon River only).

Water quality parameters to be sampled for each site are Temperature, Specific Conductivity, pH, and Dissolved Oxygen. In addition to these parameters, the mainstem stations will monitor Turbidity and Blue Green Algae (using a phycocyanin probe). Two of the tributary stations, Scott River and Salmon River, will also monitor Turbidity.

All of the stations will continuously monitor using a YSI datasonde. The sondes will be fixed to a cable and protected by a metal pipe which will suspend the probes to avoid damage to equipment. The stations at Orleans, Salmon River, Scott River, and Shasta River will deploy a YSI 6600 V2 datasonde. The stations at Seiad Valley and Iron Gate will deploy a YSI EXO2 datasonde.

This sampling focuses around the summer base flow (the growing season), which is generally from May to October. All six sites will be deployed during these months. A reading will be taken every 30 minutes and the data will be available real-time on the KTWQP website. The Iron Gate site and the Salmon River site will be deployed year-round with plans to implement year round monitoring at all Klamath River mainstem sites Fall of 2018.

Datasondes will be calibrated at a biweekly (every other week) interval following YSI instructions and other standard procedures for calibration (U.S. EPA, 2001) that are attached as Appendices E-4 and E-5. Every winter the YSI datasondes will be sent back to the factory for preventative maintenance and any defective sensors will be replaced.

This monitoring will help discover whether there are water quality problems with waters within or adjacent to the KAT and the KTWQP will report any findings of action levels of contaminants and work to abate any identified problems.

1.6.4 Ceratonova Shasta

The Karuk Tribe collects c.shasta water samples at five monitoring stations. These sites are termed Orleans (KOR), Seiad Valley (KSV), Kinsman Fish Trap (KMN), Beaver Creek (KBC), and I-5 Bridge (KI5) and their locations are shown in Figure 4. Water collection will occur at the following sites according to the following schedule:

- (1) Weekly all year at Beaver Creek and Seiad Valley (to encompass previous and current spring parasite ‘hot spots’)
- (2) Weekly from March through October at I-5 Bridge and Orleans
- (3) March through mid-June at Kinsman Fish Trap

Water samples will be collected using an ISCO automatic sampler. The ISCO will be programmed to begin sampling at 8 am and collect 1 L of water from the river every 2 hours for 24 hours. After the completion of the program, the total sample will be mixed manually and 4 x 1 L samples will be poured into clean 1 L sample bottles. All samples will be transported back to the KTWQP office in a cooler with ice. KTWQP will filter the samples within 24 hours of collection according to protocols found in Appendix E-8.

Samples will be sent overnight to Bartholomew Lab at Oregon State University for molecular analysis.

1.7 Quality Objectives and Criteria for Measurement Data

This section discusses the quality objectives for the project and the performance criteria to achieve those objectives.

1.7.1 Project Objectives

The primary goal of this *QAPP* is to ensure that high quality data be generated by the KTWQP that this data can be used to answer questions about the quality of waters within KAT and to foster their protection or improvement over time. Specific questions to be answered through these studies include:

- 1) What are current in-river conditions?

- 2) What are current nutrient levels?
- 3) Are there nutrient levels indicative of pollution in the Klamath River, including reaches within the KAT?
- 4) What are the levels of MSAE and microcystin toxin in the Klamath River, including reaches within the KAT?
- 5) Are there other potentially toxic blue-green species present in the Klamath River and algal toxins other than the most common microcystin variant?
- 6) What is the Ceratonova Shasta parasite density during salmonid spring out-migration and fall inmigration?

KTWQP investigations occur within and above KAT. YTEP and Hoopa will provide data to answer the same questions for downstream reaches. In the longer term, these samples will show pollution variation between water years and provide a basis to judge effectiveness of short-term and long-term management and regulatory actions taken to abate pollution throughout the Klamath River Basin. This will also allow participation of Tribes as resource co-managers and as full partners in adaptive management. Within the KAT specifically, the data may be used as justification for improvement of standards needed to protect Tribal members, the public and other beneficial uses.

Evidence gathered will help regulating agencies make informed decisions off of the 401 certification of the KHP and Klamath TMDL and prompt further action on non-point source pollution from agriculture through mechanisms such as the Klamath River and Lost River TMDL implementation. In the short term, action will be taken immediately to inform appropriate agencies and the public when dangerous levels of blue-green algae cell counts or toxins are discovered.

The Tribe's primary concern with surface water is to minimize the effects of human activity in the watershed, to bolster the health of the ecosystem, to preserve cultural resources, and to return fish populations to a sustainable level enabling tribal members to utilize their fishing rights. Current numbers of returning salmonids will not support a fishery on KAT as it once did.

1.7.2 Decisions to be made using the data

The surface water monitoring program is designed to characterize the surface water resources of MidKlamath. The baseline data generated from 2005-present provides valuable information about the current condition of the Klamath River Basin's water resources. On-going monitoring allows the Tribe to begin to track changes in water quality over time and to assess current and potential future environmental impacts to Klamath River water quality.

Decisions to be made with the data include:

- If data for any analyte or field parameter (from an individual location or single quarterly sampling event) are found to exceed the project action limits, then the Tribal Council will be notified.
- If data are found to exceed the project action limits and appear to be increasing with time, then the Tribal Council will be notified and a plan for future investigations of potential sources will be discussed.
- If waters flowing onto KAT are impaired (i.e., exceed project action limits or the national water quality standards), then the issue will be brought to the attention of the Tribal Council for possible discussion with the US EPA Project Officer.

The Karuk Tribe will determine if any action is needed to reduce surface water pollution from tribal lands. Some examples of actions that could result from findings of poor water quality on KAT are:

- Remediation activities for point sources to stop contamination if a single point source is suspected.
- Stream and watershed restoration activities (e.g. planting native flora for erosion control).
- Pollution prevention planning and establishment of educational programs on KAT to reduce anthropogenic sources of pollution.

The Karuk Tribe will also use this information to act as co-managers in the Klamath River Watershed with federal, state, and local agencies. The information will be shared with these agencies in order to track changes over time and to ultimately improve the quality and quantity of fish populations in the watershed.

1.7.3 Action Limits/Levels

Specific water quality limits and levels are found in tables 5-8.

1.7.4 Measurement Performance Criteria/Acceptance Criteria

Data quality indicators (DQI) include accuracy, precision, comparability, completeness, representativeness, and sensitivity. The quality control criteria established by KTWQP for data gathering, sampling, and analysis activities assures that important data gaps regarding Klamath River nutrient and toxic algae pollution can be filled with scientifically accurate data.

The general approach to assessing each DQI is described below. Some DQIs will be assessed quantitatively, while others will be assessed qualitatively. For quantitative assessments, example calculations have been provided and the QC samples (to assess each DQI) have been identified.

The frequency of the QC samples and the measurement performance criteria for each QC sample for each type of analysis are provided in Table 12. For quantitative assessment of laboratory methodology, the laboratory's QA Manual and analytical SOPs have been reviewed by the Karuk Tribe's project team, and the associated laboratory QC (types & frequencies of QC samples and QC acceptance limits) have been determined to be adequate in meeting the data quality needs of the project. As such, the laboratory QC has been accepted as the project's measurement performance criteria for the analytical component, while project-specific criteria have been defined to assess the field sampling component.

For field measurements, the DQIs to be assessed quantitatively include precision and accuracy alone. The associated acceptance criteria (types & frequencies of QC checks and acceptance limits) for the project are summarized in Table 12 and 13.

Data quality will be assured by:

- Proper study design,
- Following standard methods,
- Using well calibrated equipment,
- Taking and maintaining good field records,
- Following chain of custody procedures for laboratory analysis,
- Prompt data entry in standard programs and formats, □ Data archiving with back-ups to insure against loss, and □ Proper oversight of QA/QC procedures.

The primary DQI specific to this project is whether uncertainty associated with each measurement is low enough to provide sufficient resolution to determine values relative to the above references.

Accuracy: *Accuracy* is the degree of agreement of a measurement with the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) that result from sampling and analytical operations. Accuracy of water quality and quantity measurements contained in this QAPP is a function of the equipment used during sampling.

Accuracy/bias will be assessed as related to recovery, as well as in regards to potential contamination sources. Both of these terms will be evaluated quantitatively.

Accuracy/bias related to recovery is an assessment of the laboratory analytical methods alone. For Laboratory Control Samples (LCS), it will be expressed as % Recovery by the following equation:

$$\% \text{ Recovery} = \frac{X}{Y} \times 100$$

T

where,

X = Measured concentration

T = True spiked concentration

or, for Matrix Spike (MS) samples, by the following equation:

$$\% \text{ Recovery: } \frac{X_{ms} - X_{fs}}{X_a} \times 100$$

where,

X_{ms} = the amount of target analyte measured in the matrix spike sample

X_{fs} = the amount of target analyte measured in the corresponding field sample

X_a = the amount of target analyte spiked (into the matrix spike sample)

The frequency of the LCS and/or MS samples associated with the analytical parameters will be one for every 20 samples or 5%. No LCS or MS samples will be analyzed as part of the field measurements.

Accuracy/bias as related to contamination involves both a field sampling and laboratory component. To assess all steps of the project (from sample collection through analysis), field blanks will be collected and analyzed. Field blanks are planned to be collected at a frequency of 5% (or 1 blank/20 field samples) for off-site analysis of metals and anions. To assess potential laboratory contaminant sources alone, laboratory blanks will be prepared and analyzed at a one per batch or 5% frequency. No blanks will be analyzed as part of the field measurements.

Precision of field results will be tested using duplicate samples, taken as field splits, with a target of less than 20% relative percent difference (RPD).

Precision: *Precision* is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions.

Precision will be assessed quantitatively with duplicate samples and expressed as relative percent difference (RPD) by the following equation:

$$\text{RPD (\%)} = \frac{|X_1 - X_2|}{X} \times 100$$

$$(X_1 + X_2)/2$$

where,

RPD (%) = relative percent difference

X_1 = Original sample concentration

X_2 = Duplicate sample concentration

$|X_1 - X_2|$ = Absolute value of $X_1 - X_2$

To assess precision associated with all steps of the project (from sample collection through analysis) field duplicates will be collected and analyzed. Field duplicates will be collected at a frequency of 10% (1 duplicate/10 field samples) for each analytical parameter and 5% (1 duplicate each of 2 days/10 field samples) for each field measurement parameter. To assess laboratory precision alone, laboratory duplicates will be prepared and analyzed at a 5% frequency.

Comparability: Samples will be taken with comparable methods across the universe of samples on the Klamath River and its tributaries so the results will be comparable within each year. Methods are also consistent with previous samples that make up baseline and trend data for nutrients, phytoplankton, periphyton and algal toxins.

Completeness: Given the high quality of past samples taken by KTWQP, completeness on this project is expected to be over 90%, which is highly desirable because samples will only be taken bi-weekly.

Representativeness: This is the expression of the degree to which data accurately and precisely represent a characteristic of an environmental condition or a population. Field crews collecting samples will ensure representativeness of samples by selecting free-flowing water from established sampling locations and using a churn splitter to mix sample water once collected (Lurry and Kolbe, 2000) and by following protocols for public health sampling and c. Shasta sampling.

See Table 10 for comparability measures and detection limits for nutrient samples, including U.S. EPA or American Public Health Association (APHA) (Eaton et al., 1995) approved sampling methods.

Sensitivity: The ability of a method to detect and quantify an analytical parameter of concern at the concentration level of interest will be assessed semi-quantitatively. No actual QC samples are involved. Instead, the laboratory to perform the analyses has provided their QLs and DLs and demonstrated that these are lower than the project action limits (as shown in Tables 5, 6, 7 and 8) for the majority of the analytical parameters. For field measurements, the sensitivity is defined by the instrument manufacturer (Table 9).

1.8 Special Training Requirements/Certificates

No special training of field personnel is required for this project. The WQPM is an experienced scientist who has been leading and training employees in conducting water quality investigations since 2004. She has been trained by and/or worked with the US Forest Service, the Pacific Southwest Field Station, US Geological Survey, the North Coast Regional Water Quality Control Board, the Klamath Basin Monitoring Program, the Klamath Blue Green Algae Work Group, and the California Harmful Algae Bloom to standardize water quality monitoring protocols. Equipment used includes HOBO temp loggers, flow meters, and hydrolabs / data sondes and sampling includes nutrient and phytoplankton grabs, public health monitoring for harmful algae blooms, and periphyton surveys. The KTWQP Project Manager will oversee initial sampling events to ensure that field staff is following the guidelines of this QAPP.

The WQ Technician will keep clear records about how instructions from the Program Manager were followed and make notes about any conditions that might cause anomalies in data. The KTWQP QA Officer will inspect the field and sampling equipment and periodically audit the WQ Technician to make sure that proper maintenance is taking place and is being documented.

The collection of all surface water samples using hand held equipment will use standard field methods as described in this QAPP, which are derived from recognized U.S. EPA (1983; 2004) and U.S. Geologic Survey (USGS, 1998) protocols.

1.9 Documents and Records

This section describes the process and responsibilities for ensuring the appropriate project personnel have the most current approved version of the QA Project Plan, including version control, updates, distribution, and disposition.

1.9.1 QA Project Plan Distribution

It is the responsibility of the KTWQP Program Manager/QA Officer to prepare and maintain amended versions of the QA Project Plan and to distribute the amended QA Project Plan to the individuals listed in Section 1.3. This QAPP, once approved, will be kept in printed form for ease of reference of the WQ Technician, QA Officer and KTWQP Program Manager. When updated plans are approved, one copy of an older version will be retained in the KTWQP library, but clearly stamped to indicate that it is no longer current. In addition, each page of the QAPP will be clearly labeled as to the version and date of revision.

1.9.2 Field Documentation and Records

In the field, records will be documented in several ways, including field logbooks, photographs, preprinted forms (such as labels and chain-of-custody forms), corrective action reports, and field audit checklists and reports. Field activities must be conducted according to this QAPP. All documentation generated by the sampling program will be kept on file in the office of the Karuk Tribe Water Quality Program.

1.9.2.1 Field Notebooks

Bound field logbooks will be used to record field observations, sampling site conditions, and on-site field measurements. These books will be kept in a permanent file in the KTWQP office. At a minimum, information to be recorded in the field logbooks at each sample collection/measurement location includes:

- Sample location and description,
- Sampler's names,
- Date and time of sample collection,
- Designation of sample as composite or grab,
- Type (media or matrix) of sample (for this project, all are surface water samples),
- Type of sampling equipment used,
- Type of field measurement instruments used, along with equipment model and serial number,
- Field measurement instrument readings,
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, color),
- Preliminary sample descriptions (e.g., clear water with strong ammonia-like odor),
- Sample preservation,
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes,
- Shipping arrangements (overnight air bill number), and Name(s) of recipient laboratory(ies).

In addition to the sampling information, the following specific information will also be recorded in the field logbook for each day of sampling:

- Team members and their responsibilities,
- Time of arrival/entry on site and time of site departure,

- Other personnel on site,
- Deviations from the QAPP or SOPs required in the field, and
- Summary of any meetings or discussions with tribal, contractor, or federal agency personnel.

Separate instrument/equipment notebooks or logbooks will be maintained for each piece of equipment or instrument. These logbooks will be used to record field instrument calibration and maintenance information. Each logbook will include the name, manufacturer, and serial number of the instrument/equipment, as well as dates and details of all maintenance and calibration activities.

1.9.2.2 Photographs

Digital photographs will be taken at each sampling location and at other areas of interest near the sampling area for every sampling event. The photographs will serve to verify information entered into the field logbook. Photographs will include a date and time stamp on each picture. Digital photographs will be archived in a permanent digital file to be kept in the KTWQP office.

For each photograph taken, the following information will be written in the field logbook or recorded in a separate field photography logbook:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Direction in which the picture was taken
- Name and affiliation of the photographer

1.9.2.3 Labels

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The Laboratory will provide sample labels (see Appendix A1) for this project. The samples will have pre-assigned, identifiable, and unique numbers. At a minimum, the sample labels will contain the following information:

- Sampling location or name,
- Unique sample number,
- Sample description (e.g., grab, composite),
- Date and time of collection,

- Initials/signature of sampler,
- Analytical parameter(s), and ☐ Method of preservation.

Each sample for a given parameter will have a unique identifier. The sample identification numbering scheme is site, date, and method of collection (e.g. open water composite or surface grab).

Example sample label SA032211-OC

SA = site identification

032211 = date

OC = Open Channel

1.9.2.4 Field Quality Control Sample Records

Field QC samples (duplicates and blanks) will be labeled as such in the field logbooks. They will be given unique (fictitious) sample identification numbers and will be submitted “blind” to the laboratory (i.e., only the field logbook entry will document their identification and the laboratory will not know these are QC samples). The frequency of QC sample collection will also be recorded in the field logbook.

1.9.2.5 Chain-of-Custody Forms and Custody Seals

Chain-of-custody forms and custody seals (see Appendix A-2) will be provided by the laboratory. The forms will be used to document collection and shipment of samples for off-site laboratory analysis, while the seals will serve to ensure the integrity of (i.e., there has been no tampering with) the individual samples.

All sample shipments will be accompanied by a chain-of-custody form. The forms will be completed and sent with each shipment of samples to the laboratory. If multiple coolers are sent to a laboratory on a single day, forms will be completed and sent with the samples for each cooler. The original form will be included with the samples and sent to the laboratory. Copies will be sent to the KTWQP Program Manager/QA Officer.

The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone's physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of the field

personnel, who will sign the chain-of-custody form in the "relinquished by" box and note the date, time, and air bill number.

The shipping containers in which samples are stored will also be sealed with self-adhesive custody seals any time they are not in someone's possession or view before shipping, as well as during shipping. All custody seals will be signed and dated.

1.9.3 Laboratory Documentation and Records

The analytical laboratory will keep a sample receiving log and all completed chain-of-custody forms submitted with the samples collected for this project. The analytical laboratory will also keep records of all analyses performed, as well as associated QC information, including: laboratory blanks, matrix spikes, laboratory control samples, and laboratory duplicates. Hard copy data of the analytical results will be maintained for six years by the laboratory.

The data generated by the laboratory for each sampling event will be compiled into individual data packages/reports. The data packages will include the following information:

- Project narrative including a discussion of problems or unusual events (including but not limited to the topics such as: receipt of samples in incorrect, broken, or leaking containers, with improperly or incompletely filled out chain-of-custody forms, with broken chain-of-custody seals, etc.; receipt and/or analysis of samples after the holding times have expired; summary of QC results exceeding acceptance criteria; etc.),
- Sample results and associated QIs,
- Copies of completed sample receiving logs and chain-of-custody forms, and
- QC check sample records and acceptance criteria (to be included for all QC samples listed in Table 12, including the temperature blank check).

All data packages will be reviewed by the Laboratory QA Officer to ensure the accurate documentation of any deviations from sample preparation, analysis, and/or QA/QC procedures; highlights of any excursions from the QC acceptance limits; and pertinent sample data. Once finalized, the Laboratory QA Officer will

provide the data packages/reports to the Laboratory Project Manager who will sign them and submit them to the KTWQP Program Manager/QA Officer. Laboratories will provide the following QC data for each parameter analyzed; laboratory duplicate results and associated RPD, spike results and associated % recovery, blank results, and QC check information. Any problems identified by the Laboratory QA Officer will be documented in the narrative part of the tribe's report.

Information about the documentation to be provided by the analytical laboratory is also contained in each laboratory's QA Manual (Appendix A-3).

1.9.4 Technical Reviews and Evaluations

As part of the QA efforts for the project, on-going technical reviews will be conducted and documented. These reviews are associated with both field activities and the data generated by the off-site laboratory.

1.9.4.1 Field Audit Reports

The KTWQP Program Manager/QA Officer will observe selected sampling events to ensure that sample collection and field measurements are going according to plan. The results of the observations will be documented in a designated QA Audit Logbook. Once back in the office, the KTWQP QA Officer will formalize the audit in a Field Audit Report to be forwarded to the KTWQP Program Manager and the KTWQP Water Quality Technician/Field Sampler.

1.9.4.2 Corrective Action Reports (following Field Audits)

Corrective action reports will be prepared by the KTWQP Water Quality Technician/Field Sampler in response to findings identified by the KTWQP Program Manager/QA Officer during field visits and audits. The reports will focus on plans to resolve any identified deficiencies and non-compliance issues that relate to on-going activities and problems of a systematic nature, rather than on one-time mistakes. Corrective Action reports do not have a specific format, but will be handled as an internal memorandum.

1.9.4.3 Field Activities Review Checklist

At the end of each sampling event, a technical review will be conducted of field sampling and field measurement documentation to ensure that all information is complete and any deviations from planned methodologies are documented. This review is described in Section 3.1.1.3. The review, as well

as comments associated with potential impacts on field samples and field measurement integrity, will be documented on a Field Activities Review Checklist (as provided in Appendix B-1).

1.9.4.4 Laboratory Review Checklist

Following receipt of the off-site laboratory's data package for each sampling event, The KTWQP QA Officer/Data Manager will conduct a technical review of the data to ensure all information is complete, as well as to determine if all planned methodologies were followed and QA/QC objectives were met. The results of this review, as well as comments associated with potential impacts on data integrity to support project decisions, will be documented on a Laboratory Data Review Checklist (as provided in Appendix B-2).

1.9.5 Project Document Backup and Retention

Hardcopies of field notebooks, checklists, laboratory results and other paperwork will be maintained in the KTWQP office water quality file for six years. After six years, project files will be placed in long term storage. The Tribe's policy is to maintain records indefinitely.

Electronic data will be backed up on two separate external hard-drives. One external hard-drive will be stored in the Karuk Tribe Department of Natural Resources office and the second external hard-drive will be stored in a fireproof safe in the KTWQ office.

1.9.6 Annual Reports

The KTWQP Program Manager/QA Officer is responsible for the preparation of annual reports (summarizing the year's activities) to be submitted to the US EPA Grants Project Officer.

The annual reports should include, at a minimum:

- Description of the project,
- Table summarizing the results (of all project data collected to date, including both laboratory data and field measurements),
- Final laboratory data package (including QC sample results),
- Discussion of the field and laboratory activities, as well as any deviations or modifications to the plans,
- Trends observed as a result of the year's monitoring efforts,
- Copies of Field Audit Reports and any associated Corrective Action Reports,
- Copies of Field Activities Review Checklists and Data Review Checklists,

- Evaluation of the data in meeting the project objectives, including data exceeding Action Levels,
- Recommendations to the Tribal Council regarding exceedance which are occurring on an ongoing basis, and
- Recommendations/changes for future project activities (e.g., adding/deleting sampling locations and/or analyses, modifications to SOPs, amendments to the QA Project Plans, etc.).

2.0 DATA GENERATION AND ACQUISITION

This section of the QA Project Plan describes how the samples will be collected, shipped, and analyzed.

2.1 Sampling Design

2.1.1 Nutrient Sampling Design

A total of eight locations will be sampled for the surface water monitoring program. These locations will be along the Klamath River and at the mouths of major tributaries. Sample sites are in locations that provide a longitudinal profile of the Klamath River from Iron Gate Reservoir to Orleans. Also included are inputs from the Shasta, Scott and Salmon Rivers. Sampling locations are depicted in Figure 3. The sample parameters to be collected at each site are summarized in Table 4. The sample locations, names, and rationale for selecting each site are summarized in greater detail as follows:

- OR (Klamath River at Orleans) – Located just upstream of the USGS gauge. Conditions are indicative of the Klamath River at the downriver end of the KAT.
- SA (Salmon River near mouth) – Conditions of the Salmon River, an important tributary that enters the Klamath River near the center of the world for the Karuk Tribe. Site of a USGS gauge. Major tributary that provides habitat for all Tribal Trust fish species.
- HC (Klamath River below Happy Camp) – About a ¼ mile upstream of Oak Flat Creek.
- SV (Klamath River below Seiad Valley) – This site is just downstream of Seiad Valley but upstream of the USGS gauge. This is near the upstream end of the KAT thereby indicative of water quality conditions entering the KAT.
- SC (Scott River at Johnson’s Bar) – This site is about one mile up from the confluence of the Scott and Klamath Rivers. It represents water quality conditions coming out of the lower canyon reach of the Scott River.
- WA (Klamath River at Walker Bridge) – This site is located between two major tributaries, the Scott and Shasta Rivers and is downriver of the town of Klamath River. This site

provides water quality information after the effects of the KHP have been reduced but before entering the KAT where more minor tributaries enter the River.

- SH (Shasta River at USGS Gauge) – This site is located at the USGS gauge and is upstream of the confluence about 300 meters.
- IG formerly KRBI (Klamath River below Iron Gate) – This site is located immediately downstream of Iron Gate dam and upstream of the USGS gauge. It is the start of the free-flowing River below the KHP.

The baseline monitoring program will include monthly to bimonthly analyses throughout the year at 8 locations identified shown in Figure 3. Analyses will include alkalinity, total phosphorus (TP), orthophosphate (SRP), ammonia, nitrate and nitrite, total nitrogen (TN), chlorophyll a, pheophytin, total organic carbon (TOC), dissolved organic carbon (DOC), total dissolved solids (TDS), and volatile suspended solids (VSS). Sample locations will also be field tested for temperature, pH, dissolved oxygen, conductivity (as specific conductance), turbidity in the winter, and BGA in the summer. Additionally, photo documentation will occur at each sampling location during every sampling event.

Site specific analyses are found in Table 4.

Samples will be collected throughout each calendar year. In addition, a parameter may be removed from the monitoring program if the sampling results indicate it is not of concern or added if new land uses develop after the monitoring program begins or the monitoring data indicates other potential parameters to include. If the sample collection changes, this will be noted in the quarterly reports to the US EPA Grants Project Manager and documented in an amendment to the QA Project Plan.

2.1.2 Public Health Sampling Design

A total of five sites will be sampled for microcystin and one site will be sampled for anatoxin-a. Table 3 lists the KTWQP sampling sites for public health and Figure 3 identifies the specific locations. The site specific analyses are listed in Table 4. To best monitor public health risks, water samples are collected at locations used for public access and recreation. The sample locations, names, and rationale for selecting each site are summarized in greater detail as follows:

- OR (Klamath River at Orleans) – Located just upstream of the USGS gauge. Conditions are indicative of the Klamath River at the downriver end of the KAT.
- HC (Klamath River below Happy Camp) – About a ¼ mile upstream of Oak Flat Creek.
- SV (Klamath River below Seiad Valley) – This site is just downstream of Seiad Valley but upstream of the USGS gauge. This is near the upstream end of the KAT thereby indicative of water quality conditions entering the KAT.
- BB (Brown Bear River Access) – Labeled USFS river access sign in the town of Klamath River.

- IB-This site is located at the Colliers rest stop by the I-5 bridge.

Public health sampling occurs biweekly (every other week) starting in June. Once high levels of microcystin are detected, sampling increases to a weekly interval. MSAE blooms and those of other toxic algae species occur in late summer and early fall, when fishing for subsistence and ceremonial use is at its peak. Public health sampling is continued through October, or until microcystin is no longer detected.

2.1.3 Continuous Monitoring Sampling Design

The KTWQP will conduct year round continuous monitoring at three mainstem Klamath River sites (OR, SV, IG) and Salmon River (SA) and six sites during the spring, summer and fall months (OR, SA, SV, SC, SH, and IG). Monitoring locations are summarized in Figure 3. The sample locations, names, and rationale for selecting each site are summarized in greater detail as follows:

- OR (Klamath River at Orleans) – Located at the USGS gauge. Conditions are indicative of the Klamath River at the downriver end of the KAT.
- SA (Salmon River near mouth) – This site is located at a USGS gauge. Conditions of the Salmon River, an important tributary that enters the Klamath River near the center of the world for the Karuk Tribe. Major tributary that provides habitat for all Tribal Trust fish species.
- SV (Klamath River below Seiad Valley) – This site is located at the USGS gauge and is downstream of Seiad Valley. This is near the upstream end of the KAT and is thereby indicative of water quality conditions entering the KAT.
- SC (Scott River at Roxbury Bridge) – This site is about 1/2 mile up from the confluence of the Scott and Klamath Rivers. It represents water quality conditions coming out of the lower canyon reach of the Scott River.
- SH (Shasta River at USGS Gauge) – This site is located at the USGS gauge and is upstream of the confluence about 300 meters.
- IG (Klamath River below Iron Gate) – This site is located at the USGS gauge and is immediately downstream of Iron Gate. It is the start of the free-flowing River below the KHP.

For the continuous monitoring project, a reading will be taken every 30 minutes by a YSI datasonde. Each reading will include the parameters: temperature, conductivity (as specific conductance), pH, dissolved oxygen (% saturation and mg/L), turbidity (at all sites except SH), and BGA (at OR, SV, IG).

2.1.4 Ceratonova Shasta Sampling Design

The KTWQP will conduct C.Shasta monitoring at five sites along the Klamath River. The sites are determined by Bartholomew Laboratory at Oregon State University. These sites are Orleans (KOR), Seiad Valley (KSV), Kinsman Fish Trap (KMN), Beaver Creek (KBC), and I-5 Bridge (KI5) and their locations are shown in Figure 4. Water collection will occur at the following sites according to the following schedule:

- (1) Weekly all year at Beaver Creek and Seiad Valley (to encompass previous and current spring parasite 'hot spots')
- (2) Weekly from March through October at I-5 Bridge and Orleans
- (3) Weekly from March through mid-June at Kinsman Fish Trap

Water samples will be collected using an ISCO automatic sampler. The ISCO will be programmed to begin sampling at 8 am and collect 1 L of water from the river every 2 hours for 24 hours. After the completion of the program, the total sample will be mixed manually and 4 x 1 L samples will be poured into clean 1 L sample bottles. All samples will be transported back to the KTWQP office in a cooler with ice. KTWQP will filter the samples within 24 hours of collection according to protocols found in Appendix E-8. Additionally, temperature loggers (Hobos) attached to each ISCO will record river temperature every 15 minutes.

2.2 Sampling Methods

2.2.1 Nutrient Sampling Methods

KTWQP follows standard water quality grab sample procedures for nutrients sampling using a churn to mix samples and following an appropriate regimen of blanks, duplicates and other steps to assure quality.

Equipment/Materials Field equipment for nutrient samples include a churn splitter, van dorn sampler, bottles provided by laboratories, and a YSI datasonde.

The following are the items on the KTWQP nutrient sampling check list that staff refer to before going into the field to collect nutrient or phytoplankton data:

1. Portable Water Quality instrument = YSI datasonde,
2. Ice (in bottles or packs),
3. Sample Bottles,
4. Camera,
5. Extra labels for sample bottles,
6. Coolers,
7. Churn splitter,
8. Van Dorn sampler,
9. Clip board,
 - a. Data sheet
 - b. Pencils
 - c. Permanent markers
 - d. Field notebook
 - e. Chain of Custody forms
 - f. Protocol Instructions
 - g. Shipping forms
10. Watch,
11. Waders and boots,
12. Distilled Water- 5+ gallons, and
13. Shipping boxes, packing material, packing tape.

Decontamination For all samples collected to be sent to Aquatic Research Inc., samples will be collected directly into sample bottles/containers provided from the laboratory. As such, no field decontamination of these bottles (used as the sampling equipment) is necessary. The bottles will be provided and certified clean by the laboratory according to procedures described in the laboratory's QA Manual provided in Appendix A-3.

For all samples collected to be sent to Aquatic Analysts, samples will be collected directly into sample bottles provided from the laboratory. Sample bottles contain a chemical preservative (Lugols Iodine) and are considered sterile prior to field usage.

For all samples collected to be sent to Chesapeake Biological Laboratory, samples will be collected directly into sample bottles which have previously been cleaned in the KTWQP office. As such, no field decontamination of these bottles is necessary. The bottles will be cleaned using the following procedure:

- Non-phosphate detergent and tap water wash (using a brush, if necessary),
- Tap-water rinse,
- 10 % HCl rinse (twice), and
- Deionized/distilled water rinse (three times).

Decontamination of the field equipment, churn splitter and van dorn sampler, will be completed in the KTWQP office prior to the sample event. They will be cleaned according to US EPA Region 9 recommended procedures using the following washing fluids in sequence:

- Non-phosphate detergent and tap water wash (using a brush, if necessary),
- Tap-water rinse, and
- Deionized/distilled water rinse (twice).

The churn splitter requires cleaning with distilled water in the field after use at each sampling location (see Churn Cleaning SOP, Appendix E-3).

In the case that there is a need to collect surface water samples by an alternative method, decontamination of reusable sampling equipment coming in direct contact with the samples will be necessary. Decontamination will occur prior to each use of a piece of equipment and after use at each sampling location. Disposable equipment (intended for one-time use) will not be decontaminated but will be packaged for appropriate disposal. All reusable/non-disposable sampling devices will be decontaminated according to US EPA Region 9 recommended procedures using the following washing fluids in sequence:

- Non-phosphate detergent and tap water wash (using a brush, if necessary),
- Tap-water rinse, and
- Deionized/distilled water rinse (twice).

Equipment will be decontaminated in a predesignated area on plastic sheeting. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

Procedures

1. Upon arriving at a sampling location, a field measurement will be taken using a YSI datasonde and recorded on the data sheet. The parameters recorded will be temperature, conductivity, pH, dissolved oxygen, and turbidity or BGA.

2. Photos will be taken looking upriver and downriver of the sampling location.
3. Water samples will be collected with a churn splitter to ensure that the sample is homogeneously mixed before the sample bottles are filled. Depending on location, two collection methods may be used. For all sites except for WA, the churn is fully submerged into the stream and filled to the lid with flowing water, not stagnant water. For WA, a site sampled from a bridge, a Van Dorn sampler is used to collect 3 samples from across the channel. The samples are poured into the churn and treated the same as all other sites. Prior to filling the churn for nutrient sampling, the churn will be rinsed three times with distilled water. The goal of rinsing is to remove substances adhering to equipment from previous exposure to environmental and other media (Lurry and Kolb, 2000). After rinsing with distilled water, the churn is rinsed three times with stream water. Samples are collected from uniformly mixed water by wading out into the water channel from the bank and the churn is fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allows for all sample bottles to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guarantees that the water is well mixed before the sample is collected. The churn should be stirred at a uniform rate by raising and lowering the splitter at approximately 9 inches per second while bottles are being filled (Bel-Art Products, 1993). 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 without chemical preservatives will be rinsed with stream water from the churn three times before filling with sample water. In the case of bottles that contain chemical preservatives, bottles are not rinsed before sample collection and care is taken to avoid overspillage that would result in chemical preservative loss.

4. Clearly label each sample container so that each sample is uniquely identified and includes the following information: the water body name, station location, date and time collected, sampler's name, type of sample (e.g. open churn), sample depth, and type of analysis.
5. Collected samples are placed in coolers on ice for transport to contracted laboratories for analysis or to KTWQ office for filtering.

Field Variances As conditions in the field vary; it may become necessary to implement minor modifications to the sampling procedures and protocols described in this QA Project Plan. If/when this is necessary; the KTWQP Technician will notify the KTWQP Project Manager/QA Officer of the situation to obtain a verbal approval prior to implementing any changes. The approval will be recorded in the field logbook. Modifications will be documented in the Annual Report to the US EPA Grants Project Officer.

2.2.2 Public Health Sampling Methods

For public health sampling, KTWQP follows the Cyanobacteria Sampling SOP prepared by the Blue Green Algae Working Group (Appendix E-2).

Equipment/Materials The following are the items on the KTWQP public health sampling check list that staff refer to before going into the field to collect algal toxin data:

1. Portable Water Quality instrument = YSI datasonde,
2. Ice (in bottles or packs),
3. Sample Bottles,
4. Camera,
5. Extra labels for sample bottles,
6. Coolers,
7. Wide-mouth sampling jar (about 8 cm diameter and 10 cm depth),
8. Clip board,
 - a. Data sheet
 - b. Pencils
 - c. Permanent markers
 - d. Field notebook
 - e. Chain of Custody forms
 - f. Protocol Instructions
 - g. Shipping forms
9. Watch,
10. Waders and boots,
11. Distilled Water- 1 gallon, and
12. Shipping boxes, packing material, packing tape.

Decontamination For all samples collected for public health sampling, sample bottles will be 4 oz. precleaned thick-walled glass jars and are considered sterile prior to field usage. As such, no field decontamination of these bottles is necessary.

Decontamination of the wide-mouth sampling jar will be completed in the KTWQP office prior to the sample event. It will be cleaned according to recommended procedures using the following washing fluids in sequence:

- Non-phosphate detergent and tap water wash (using a brush, if necessary),
- Tap-water rinse, and
- Deionized/distilled water rinse (twice).

The wide-mouth sampling jar requires cleaning with distilled water in the field after use at each sampling location.

Procedures

1. Upon arriving at a sampling location, an initial visual survey of the public access area is conducted. The exact collection location is then identified to best represent the maximum toxic algae exposure.
2. A field measurement will be taken using a YSI datasonde and recorded on the data sheet. The parameters recorded will be temperature, conductivity, pH, dissolved oxygen, and turbidity or BGA.
3. Photos will be taken looking upriver and downriver of the sampling location.
4. Open clean wide-mouth sampling jar. Tip opening of jar towards the water (at approximately a 45 angle) and slowly break water surface and begin to dip jar into the water. Turn the sampling container so that bottom side of jar is 8 cm below and horizontal to the surface. In other words, the jar will fully enter the water, but the top rim and side will not go below the surface. If in flowing water, when turning the bottle upright, turn it so that the opening faces upstream. The sampling bottle should not be moved along the surface to fill. Because of the wide mouth and shallow depth, it will be immediately filled.
5. Tilt the full jar upright as it is slowly removed.
6. Carefully raise the full jar from the water.

7. Cap the container, tightening securely. Invert the jar gently three times, uncap the jar and pour to aliquot a portion into the first sample bottle, re-cap the jar and again gently invert the jar three times. Now uncap the jar and pour to aliquot a portion into the second sample bottle. The second sample bottle may be a replicate for the same lab, a different lab, or a non-replicate for different analyses at the same or a different lab. Any additional sub-dividing of the sample in the jar must be done by recapping and gently reinverting the collection jar three times.
8. Clearly label the sample container, so that each sample is uniquely identified and includes the following information: the water body name, station location, date and time collected, sampler's name, type of sample (e.g. public health shoreline grab), sample depth (for example, 0 to 10 cm), and type of analysis (for example, cyanotoxin by ELISA).
9. Promptly place the labeled sample container in a cooler with ice to both protect from sunlight, and chill, until shipped. Double-bagged wet ice or blue ice is acceptable as long as the maximum threshold temperature (6°C) for samples is not exceeded. Block ice is discouraged to protect sample bottles from breaking during shipping.
10. Replenish ice supply as often as needed to maintain samples at or below 6°C, and prior to preparing coolers for shipping to the appropriate laboratories.

Field Variances As conditions in the field vary; it may become necessary to implement minor modifications to the sampling procedures and protocols described in this QA Project Plan. If/when this is necessary; the KTWQP Technician will notify the KTWQP Project Manager/QA Officer of the situation to obtain a verbal approval prior to implementing any changes. The approval will be recorded in the field logbook. Modifications will be documented in the Annual Report to the US EPA Grants Project Officer.

2.2.3 Continuous Monitoring Methods

The continuous monitoring will be done using a YSI datasonde. The sondes will be fixed to a cable and protected by a metal pipe which will suspend the probes to avoid damage to equipment. The stations at Orleans, Salmon River, Scott River, and Shasta River will deploy a YSI 6600 V2 datasonde. The stations at Seiad Valley and Iron Gate will deploy a YSI EXO2 datasonde.

Each field datasonde will be calibrated every two weeks according to the procedures in Appendix E-4 and Appendix E-5. The calibration standards will be supplied by Aurical Company and Fondriest Environmental for turbidity standards.

Equipment/Materials The following are the items on the KTWQP datasonde calibration check list that staff refers to before going into the field to calibrate:

1. 1L 1,000 uS/cm Conductivity Standard,
2. 1L pH 7 Standard,
3. 1L pH 10 Standard,
4. 1L 12.4 FNU Turbidity Standard (April – October),
5. 1L 124 FNU Turbidity Standard,
6. 1L 1000 FNU Turbidity Standard (Nov – March),
7. Clipboard,
 - a. Data sheet
 - b. Pencils
8. Towel for DO calibration,
9. Reference Sonde,
10. Handheld,
11. 1 Gallon Distilled Water,
12. Sonde Tool Kit, 13. 5 Gallon Bucket, and
14. Crate.

Procedures The procedures for calibrating are in the SOPs in Appendix E-4 for the YSI 6600 V2 datasondes and Appendix E-5 for YSI EXO2 datasondes.

Field Variances As conditions in the field vary; it may become necessary to implement minor modifications to the sampling procedures and protocols described in this QA Project Plan. If/when this is necessary; the KTWQP Technician will notify the KTWQP Project Manager/QA Officer of the situation to obtain a verbal approval prior to implementing any changes. The approval will be recorded in the field logbook. Modifications will be documented in the Annual Report to the US EPA Grants Project Officer.

2.2.4 Ceratonya Shasta Sampling Methods

For C. Shasta sampling, KTWQP follows the C. Shasta SOP (Appendix E-8). All samples are collected using an ISCO automatic sampler.

Equipment/Materials The following are the items on the KTWQP C. Shasta sampling check list that staff refer to before going into the field to collect C. Shasta water samples:

1. 4 clean 1L bottles per site, and
2. Clipboard.

- a. Data sheet
- b. Pencils

Decontamination Decontamination of the 1L sample bottles will be completed in the KTWQP office prior to the sample event. They will be cleaned according to recommended procedures by rinsing three times with tap water and using a brush if necessary.

Decontamination of the ISCO collection bottle will be completed in the field by rinsing three times with tap water.

Procedures

1. Upon arriving at a sampling location, remove the top of the ISCO and verify that the screen reads Sample Complete. If so, continue to step 2. If not, scroll through the menu to determine why the previous sampling event did not occur correctly. Record on datasheet.
2. Reprogram the ISCO to start the next program at 8 am for the following week.
3. Secure the top of the ISCO taking care not to press any more buttons.
4. Open the middle part of the ISCO to reveal the large collection bottle.
5. Remove the lids of the 4 clean 1L sample bottles.
6. Manually mix the water in the large collection bottle and carefully pour into the 4 1L sample bottles, mixing between each pour. Tighten the lids on each of the 4 1L sample bottles.
7. Dump out the remaining water from the large collection bottle.
8. Rinse the large collection bottle three times with tap water.
9. Return the large collection bottle to the ISCO and secure the sampler by restacking the ISCO and hooking all three latches.

In the event that the previous sampling event did not occur correctly, a surface grab must be taken. This is recorded on the datasheet. The following steps are for collecting a surface grab:

1. Remove the lid of the clean 1L sample bottle.
2. Fill from the surface of the water by tilting the bottle.
3. Tighten the lid on the 1L sample bottle and repeat the process for the remaining 3 clean 1L sample bottles. All four samples should be taken from the same location.

Field Variances As conditions in the field vary; it may become necessary to implement minor modifications to the sampling procedures and protocols described in this QA Project Plan. If/when this is necessary; the KTWQP Technician will notify the KTWQP Project Manager/QA Officer of the situation to obtain a verbal approval prior to implementing any changes. Modifications will be documented and approved by the Bartholomew Laboratory at Oregon State University.

2.3 Field Health and Safety Procedures

A brief tail-gate safety meeting will be held the first day of each sampling event to discuss emergency procedures (e.g., location of the nearest hospital or medical treatment facility), local contact information (e.g., names and telephone numbers of local personnel, fire department, police department), as well as to review the tribe's contingency plan.

When wading, care will be taken to avoid slipping on rocks and algae. Also, due to weather conditions during the sampling events and the possibility of health concerns (e.g., heat stress) from working in high temperatures, field personnel will be advised to drink plenty of water and wear clothing (e.g., hat, long-sleeved shirt) that will cover and shade the body.

Potential routes of exposure related to field sampling and measurement activities are through the skin (e.g., from direct contact from the surface water) and/or by ingestion (e.g., from not washing up prior to eating).

2.4 Disposal of Residual Materials

This section does not apply to any type of sampling conducted under this QAPP.

2.5 Quality Assurance for Sampling

Detailed instructions for collection of all field QC samples are discussed in Section 2.8 and listed in Table 12.

Additional deviations from the QA Project Plan may be implemented as field variances or modifications. These deviations will be communicated to the KTWQP Program Manager/QA Officer by the KTWQP Technician/Field Sampler for approval. Documentation any deviations is the responsibility of the KTWQP

QA Officer. Deviations noted during the field audit will be documented in the QA Audit Logbook, recorded in the Field Audit Reports, and discussed in the annual reports.

2.6 Sample Handling and Custody

This section describes the sample handling and custody procedures from sample collection through transport and laboratory analysis. It also includes procedures for the ultimate disposal of the samples. All samples will be fully documented and complete notes will accompany every sampling event, including photo monitoring.

2.6.1 Field Notes and Logbooks

Sampling from each day of data collection will be recorded in the field notebook, which includes:

1. Survey crew identification,
2. Date and time,
3. Station ID,
4. Sample ID,
5. Ambient water quality measurements (temperature, pH, D.O., conductivity)
6. Number of bottles collected of each sample type (nutrients, phytoplankton, and toxins),
7. Sample collection device,
8. Details of undocumented sample locations, and
9. Note fields for recording site conditions.

All ambient water quality information is recorded with a YSI datasonde that is calibrated prior to going in the field. Since this is the only source of field-recorded water quality data, YSI instrument calibration is not noted on sampling data sheets.

2.6.2 Photographs

Photographs will be taken at each sampling location during each sampling event. They will serve to verify information entered in the field logbook. For each photograph taken, the following information will be written in the logbook:

- Time, date, location, and weather conditions,
- Description of the subject photographed, and

- Name of person taking the photograph.

2.6.3 Labeling

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. At a minimum, the sample labels will contain the following information: station location, date of collection, analytical parameter(s), and method of preservation. Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number

2.6.4 Chain of Custody

All sample shipments for analyses will be accompanied by a KTWQP Nutrient, Phytoplankton, or Algal Toxin Chain of Custody Form (Appendix A2). These forms will be completed and sent with each sample for each laboratory and each shipment (i.e., each day). If multiple coolers are sent to a single laboratory on a single day, duplicate forms will be completed and sent in each cooler.

Until the samples are shipped, the custody of the samples will be the responsibility of KTWQP staff assigned to collection and shipment of samples and the Project Manager. The chain of custody form includes date and time of transfer to carrier and carrier shipping number. Each laboratory listed above will be responsible for chain of custody once they have received the cooler from the shipping company.

2.6.5 Sample Packaging and Shipment

Sturdy coolers suitable for secure sample transit are provided by the laboratories and KTWQP staff makes sure that packing materials and ice are supplemented to protect samples in transit. The KTWQP Algal Toxin Chain of Custody Form supplies U.S. EPA staff at the Region 9 Richmond Laboratory with a Regional Analytical Program (RAP) number. Shipment of samples will not include a copy of the KTWQP field notebook, so that labs cannot introduce bias because locations are unknown to them.

1. All samples are removed from coolers
2. Place bubble wrap around the inside edge of the cooler to prevent breakage during shipment, and/or wrap bottles individually.
3. Prepare bags of ice to be used to keep the samples cool during transport when wet ice is used.

- Pack the ice in doubled, zip-locked plastic bags.
4. Check the sample bottle screw caps for tightness.
 5. Ensure sample labels are affixed to each sample container and protected by a cover of clear tape.
 6. Wrap all glass sample containers in bubble wrap to prevent breakage.
 7. Samples are placed in cooler and entered on COC
 8. Place the bagged ice or blue ice on top and around the samples to chill them to the correct temperature.
 9. Fill the empty space in the cooler with bubble wrap, Styrofoam peanuts, or any other available inert material to prevent movement and breakage during shipment.
 10. Enclose the appropriate chain-of-custody(s) in a zip-lock plastic bag 1. Close the lid of the cooler.
Tape the cooler shut

Daily, the KTWQP Field Samplers will notify the Laboratory Project Manager of the sample shipment schedule. The laboratory will be provided with the following information:

- Sampler's name,
- Name and location of the site or sampling area,
- Names of the tribe and project,
- Total number(s) and matrix of samples shipped to the laboratory,
- Carrier, air bill number(s), method of shipment (e.g., priority next day),
- Shipment date and when it should be received by the laboratory,
- Irregularities or anticipated problems associated with the samples, and
- Whether additional samples will be shipped or if this is the last shipment.

2.6.6 Sample Custody

The field sampler is responsible for custody of the samples until they are delivered to the laboratory or picked up for shipping. (Note: As few people as possible will handle the samples to ensure sample custody.) Chain-of-custody forms must be completed in the field. Each time one person relinquishes control of the samples to another person, both individuals must complete the appropriate portions of the chain-of-custody form (see Appendix A2) by filling in their signature as well as the appropriate date and time of the custody transfer.

During transport by a commercial carrier, the air bill will serve as the associated chain-of-custody. Once at the laboratory, the sample receipt coordinator will open the coolers and sign and date the chain-of-custody form. The laboratory personnel are then responsible for the care and custody of samples. The analytical laboratory will track sample custody through their facility using a separate sample tracking form, as discussed in the laboratory QA Manual included in Appendix A3.

A sample is considered to be in one's custody if:

- The sample is in the sampler's physical possession,
- The sample has been in the sampler's physical possession and is within sight of the sampler,
- The sample is in a designated, secure area, and/or
- The sample has been in the sampler's physical possession and is locked up.

2.6.7 Sample Disposal

Following sample analysis, each laboratory will store the unused portions for an established length of time (see lab QA/QC Manual's in Appendix A-3). At that time, the laboratory will properly dispose of all the samples (if applicable). Sample disposal procedures at the laboratory are discussed in the laboratory's QA Manual included in Appendix A-3.

2.7 Analytical Methods

The field measurement and off-site laboratory analytical methods are listed in Tables 9, 10, and 11 and discussed below.

2.7.1 Field Measurement Methods See Section 2.2

2.7.2 Laboratory Analysis Methods

Surface water samples will be analyzed at Aquatic Research Inc., Chesapeake Bay Laboratory, EPA Region 9 Lab, Aquatic Analysts, GreenWater Laboratories, and Bartholomew Laboratory. Analyses will be performed following either EPA-approved methods or methods from *Standard Methods for the*

Examination of Water and Wastewater, 20 Edition, as summarized in Tables 10 and 11. SOPs for the analytical methods are included in Appendix A-3. The Laboratory QA/QC Officer must notify the Laboratory Project Manager if there is any knowledge of the SOPs not being followed.

Both the laboratory and consultant will summarize the data and associated QC results in a data report, and provide this report to the KTWQP Program Manager. The KTWQP Program Manager/QA Officer will review the data reports and associated QC results to make decisions on data quality and usability in addressing the project objectives.

2.8 Quality Control Requirements

This section identifies the QC checks that are in place for the sample collection, field measurement, and laboratory analysis activities that will be used to assess the quality of the data generated from this project.

2.8.1 Field Sampling Quality Control

Field sampling QC consists of collecting field QC samples to help evaluate conditions resulting from field activities. Field QC is intended to support a number of data quality goals:

- Combined contamination from field sampling through sample receipt at the laboratory (to assess potential contamination from field sampling equipment, ambient conditions, sample containers, sample transport, and laboratory analysis) - assessed using field blanks;
- Sample shipment temperature (to ensure sample integrity and representativeness that the sample arriving at the laboratory has not degraded during transport) - assessed using temperature blanks; and
- Combined sampling and analysis technique variability, as well as sample heterogeneity - assessed using field duplicates.

For the current projects, the types and frequencies of field QC samples to be collected for each field measurement and off-site laboratory analysis are listed in tables 12. These include field blanks, temperature blanks (as included in a footnote to the table), and field duplicates.

Field Blanks

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sample collection due to exposure from ambient conditions or from the sample containers themselves. Field blank samples will be obtained by pouring deionized water into a sample container at the sampling location. Field blanks will not be collected if equipment blanks have been collected during the sampling event. If no equipment blanks are collected (and none are planned because samples will be collected directly into sample containers), one field blank will be collected for every 10 samples or a frequency of 10%. Field blank frequency is outlined in Table 12.

Field blanks will be preserved, packaged, and sealed in the same manner described for the surface water samples. A separate sample number and station number will be assigned to each blank. Field blanks will be submitted blind to the laboratory for invalidation of results, greater attention to detail during the next sampling event, or analysis of metals, hardness, and anions. No field blanks are planned for phytoplankton identification/enumeration. Field duplicates will be used to assess laboratory results.

If target analytes are found in field blanks, sampling and handling procedures will be reevaluated and corrective actions will be taken. These may consist of, but are not limited to, obtaining sampling containers from new sources, training of personnel, discussions with the laboratory, or other procedures deemed appropriate.

Field Duplicate Samples

Field duplicate samples will be collected to evaluate the precision of sample collection through analysis. Field duplicates will be collected at designated sample locations by alternately filling two distinct sample containers for each analysis. Field duplicate samples will be preserved, packaged, and sealed in the same manner described for the surface water samples. A separate sample number and station number will be assigned to each duplicate. The samples will be submitted as “blind” (i.e., not identified as field duplicates) samples to the laboratory for analysis.

For the current projects, field duplicates will be collected for each analytical parameter, and field measurement parameter, at the frequencies shown in Table 12. The duplicate samples will be collected at random locations for each sampling event. Criteria for field duplicates for the analytical and field measurement parameters are provided in Table 12. If criteria are exceeded, field sampling and handling

procedures will be evaluated, and problems will be corrected through greater attention to detail, additional training, revised sampling techniques, or whatever appears to be appropriate to correct the problems.

2.8.2 Field Measurement Quality Control

Quality control requirements for field measurements are provided in Table 12.

2.8.3 Laboratory Analyses Quality Control (off-site)

Laboratory QC is the responsibility of the personnel and QA/QC department of the contracted analytical laboratories. Each laboratory's Quality Assurance Manuals detail the QA/QC procedures it follows. The following elements are part of standard laboratory quality control practices:

- Analysis of method blanks,
- Analysis of laboratory control samples,
- Instrument calibration (including initial calibration, calibration blanks, and calibration verification),
- Analysis of matrix spikes, and
- Analysis of duplicates.

The data quality objectives for Aquatic Analysts, Aquatic Research Inc, EPA Region 9 Lab, GreenWater Laboratories, and Chesapeake Bay Laboratory (including frequency, QC acceptance limits, and corrective actions if the acceptance limits are exceeded) are detailed in the QA Manuals and SOPs (as in Appendix A-3). Any excursions from these objectives must be documented by the laboratory and reported to the Project Manager/QA Officer.

The Karuk Tribe has reviewed each laboratory's control limits and corrective action procedures and feels that these will satisfactorily meet tribal project data quality needs. A summary of this information is included below. These include laboratory (or method) blanks, laboratory control samples, matrix spikes, and laboratory duplicates.

Method Blanks

A method blank is an analyte-free matrix, analyzed as a normal sample by the laboratory using normal sample preparation and analytical procedures. A method blank is used for monitoring and documenting

background contamination in the analytical environment. Method blanks will be analyzed at a frequency of one per sample batch (or group of up to 20 samples analyzed in sequence using the same method).

Corrective actions associated with exceeding acceptable method blank concentrations include isolating the source of contamination and re-digesting and/or re-analyzing the associated samples. Sample results will not be corrected for blank contamination, as this is not required by the specific analytical methods. Corrective actions will be documented in the laboratory report's narrative statement.

Laboratory Control Samples

Laboratory control samples (LCS) are laboratory-generated samples analyzed as a normal sample and by the laboratory using normal sample preparation and analytical procedures. An LCS is used to monitor the day-to-day performance (accuracy) of routine analytical methods. An LCS is an aliquot of clean water spiked with the analytes of known concentrations corresponding to the analytical method. LCS are used to verify that the laboratory can perform the analysis on a clean matrix within QC acceptance limits. Results are expressed as percent recovery of the known amount of the spiked analytical parameter.

One LCS is analyzed per sample batch. Acceptance criteria (control limits) for the LCS are defined by the laboratory and summarized in their associated QA Manuals (Appendix A-3). In general, the LCS acceptance criteria recovery range is 70 to 130 percent of the known amount of the spiked analytical parameter. Corrective action, consisting of a rerunning of all samples in the affected batch, will be performed if LCS recoveries fall outside of control limits. Such problems will be documented in the laboratory report's narrative statement.

Matrix Spikes

Matrix spikes (MS) are prepared by adding a known amount of the analyte of interest to a sample. MS are used as a similar function as the LCS, except that the sample matrix is a real-time sample rather than a clean matrix. Results are expressed as percent recovery of the known amount of the spiked analytical parameter. Matrix spikes are used to verify that the laboratory can determine if the matrix is causing either a positive or negative influence on sample results.

One MS is analyzed per sample batch. Acceptance criteria of the MS are defined by the laboratory and summarized in each QA Manual (Appendix A-3). In general, the MS acceptance criteria recovery range is

of 70 to 130 percent of the known amount of the spiked analytical parameter. Generally, no corrective action is taken for matrix spike results exceeding the control limits, as long as the LCS recoveries are acceptable. However, the matrix effect will be noted in the laboratory report's narrative statement and documented in the Karuk Tribe's reports for each sampling event.

Laboratory Duplicates

A laboratory duplicate is a laboratory-generated split sample used to document the precision of the analytical method. Results are expressed as relative percent difference between the laboratory duplicate pair.

One laboratory duplicate will be run for each laboratory batch or every 10 samples, whichever is more frequent. Acceptance criteria (control limits) for laboratory duplicates are specified in the laboratory QA Manual and SOPs, Appendix A-3. If laboratory duplicates exceed criteria, the corrective action will be to repeat the analyses. If results remain unacceptable, the batch will be rerun. The discrepancy will be noted in the laboratory report's narrative statement and documented in the Tribe's reports for each sampling event.

2.9 Instrument/Equipment Testing, Inspection, and Maintenance

2.9.1 Field Measurement Instruments/Equipment

Sampling equipment under the care of the KTWQP will be maintained according to the manufacturer's instructions. Maintenance logs will be kept in the office of the KTWQP Program Manager/QA Officer. Each piece of equipment will have its own maintenance log. The log will document any maintenance and service of the equipment. A log entry will include the following information:

- Name of person maintaining the instrument/equipment,
- Date and description of the maintenance procedure,
- Date and description of any instrument/equipment problem(s),
- Date and description of action to correct problem(s),
- List of follow-up activities after maintenance (i.e., system checks), and • Date the next maintenance will be needed

2.9.2 Laboratory Analysis Instruments/Equipment

Inspection and maintenance of laboratory equipment is the responsibility of the Aquatic Analysts, Aquatic Research Inc, U.S. EPA Region 9 Lab, Chesapeake Bay Laboratory, and GreenWater Laboratories and is described in each laboratory's QA Manual included as Appendix A-3.

2.10 Instrument/Equipment Calibration and Frequency

2.10.1 Field Measurement Instruments/Equipment

Calibration and maintenance of field equipment/instruments will be performed according to the manufacturer's instructions (see Appendices E-4 and E-5) and recorded in an instrument/equipment logbook. Each piece of equipment/instrument will have its own logbook.

The project-specific criteria for calibration (frequency, acceptance criteria, and corrective actions associated with exceeding the acceptance criteria) are provided in Table 13.

2.10.2 Laboratory Analysis Instruments/Equipment

Laboratory instruments will be calibrated according to the appropriate analytical methods. Acceptance criteria for calibrations are found in each of their QA Manuals included as Appendix A-3.

2.11 Inspection and Acceptance of Supplies and Consumables

2.11.1 Field Sampling Supplies and Consumables

Sample containers and preservatives will be provided by the analytical laboratories and the Karuk Tribe. Containers will be inspected for breakage and proper sealing of caps. Other equipment such as sample coolers and safety equipment will be acquired by the Karuk Tribe. For reusable sampling equipment, materials/supplies necessary for equipment decontamination will be purchased by the Karuk Tribe. Any equipment deemed to be in unacceptable condition will be replaced.

2.11.2 Field Measurement Supplies and Consumables

Field measurement supplies, such as calibration solutions, will be acquired from standard sources, such as the instrument manufacturer or reputable suppliers. Chemical supplies will be American Chemical Society reagent grade or higher. The lot number and expiration date on standards and reagents will be checked prior to use. Expired solutions will be discarded and replaced. The source, lot number, and expiration dates of all standards and reagents will be recorded in the field log books.

2.11.3 Laboratory Analysis (off-site) Supplies and Consumables

Each of the laboratory's requirements for supplies and consumables are described in its QA Manual which is provided in Appendix A-3.

2.12 Data Acquisition Requirements (Non-Direct Measurements)

To supplement field measurements and laboratory analytical activities conducted under these projects, other potential "external" data sources will be researched. These sources include, but are not limited to, the U.S. Geological Survey, the North Coast Regional Water Quality Control Board, the California Department of Water Resources, the U.S. Environmental Protection Agency, the United States Forest Service, the Hoopa Tribe, and the Yurok Tribe. The primary use of this external data will be to help focus the Karuk Tribe's data collection efforts (for example, the information may be used to identify new sites in the Klamath River watershed for future sampling).

If it appears that the "external" data might facilitate water body evaluation, the data will first be reviewed to verify that they are of sufficient quality to meet the needs of the project by examining:

1. the sample collection and location information;
2. the data to see whether they are consistent with known tribally-collected data from the same general vicinity; and
3. the QA/QC information associated with the data.

If the data are of insufficient or unknown quality, limitations will be placed on its use in supporting project decisions. In general, it is anticipated that decisions for the current project will be based on data collected by the Karuk Tribe following this current QA Project Plan.

3.0 ASSESSMENT AND OVERSIGHT

This section describes how activities will be checked to ensure that they are completed correctly and according to procedures outlined in this QA Project Plan.

3.1 Assessment/Oversight and Response Actions

During the course of the project, it is important to assess the projects' activities to ensure that the QA Project Plan is being implemented as planned. This helps to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the project when it may be too late to remedy the situation. For the current project, the ongoing assessments will include:

- Field Oversight,
- Readiness review of the field team prior to starting field efforts,
- Field activity audits,
- Review of field sampling and measurement activities methodologies and documentation at the end of each event, and
- Laboratory Oversight - evaluation of laboratory data generated for each quarterly sampling event.

Details regarding these assessments are included below.

2.13 Data Management

All data collected by the KTWQP will be maintained in appropriate bound notebooks and electronic databases. Data from the laboratory will be requested in both hard copy and electronic form. The electronic and hard copy results will be compared to ensure that no errors occurred in either format. If discrepancies are noted, the laboratory will be contacted to resolve the issues.

3.1.1 Field Oversight

3.1.1.1 Readiness Reviews

Sampling personnel will be properly trained by qualified personnel before any sampling begins and will be given a brief review of sampling procedures and equipment operation by the KTWQP Program Manager/QA Officer before each sampling event. Equipment maintenance records will be checked to

ensure all field instruments are in proper working order. Adequate supplies of all preservatives and bottles will be obtained and stored appropriately before heading to the field. Sampling devices will be checked to ensure that they have been properly cleaned (for devices which might be reused) or are available in sufficient quantity (for devices which are disposable). Proper paperwork, logbooks, chain of custody forms, etc. will be assembled by the sampling technician. The KTWQP Project Manager/QA Officer will review all field equipment, instruments, containers, and paperwork to ensure that all is in readiness prior to the first day of each sampling event. Any problems that are noted will be corrected before the sampling team is permitted to depart the Karuk Tribe's facilities.

3.1.1.2 Field Activity Audits

Once a month, the KTWQP Project Manager/QA Officer will assess the sample collection methodologies, field measurement procedures, and record keeping of the field team to ensure activities are being conducted as planned (and as documented in this QA Project Plan). Any deviations that are noted will be corrected immediately to ensure all subsequent samples and field measurements collected are valid. (Note: If the deviations are associated with technical changes and/or improvements made to the procedures, the KTWQP QA Officer will verify that the changes have been documented by the KTWQP Technicians in the Field Log Book and addressed in an amendment to this QA Project Plan.) The KTWQP QA Officer may stop any sampling activity that could potentially compromise data quality.

The KTWQP QA Officer will document any noted issues or concerns in a QA Audit Logbook and discuss these items informally and openly with the KTWQP Water Quality Technicians while on site. Once back in the office, they will formalize the audit findings (for each event) in a Field Audit Report which will be submitted to the KTWQP Program Manager and the KTWQP Technicians.

The KTWQP Technician will prepare a Corrective Action Report to address any audit findings discussed in the Field Audit Report. The Corrective Action Report will be issued as an internal memorandum to the KTWQP Program Manager/QA Officer in response to problems noted during on-site audits and will document steps taken to reduce future problems prior to the next sampling event.

3.1.1.3 Post Sampling Event Review

Following each sampling event, the KTWQP Data Manager will complete the Field Activities Review Checklist (Appendix B-1). This review of field sampling and field measurement documentation will help ensure that all information is complete and any deviations from planned methodologies are documented. This review will be conducted in the office, not in the field. The results of this review, as well as comments associated with potential impacts on field samples and field measurement integrity will be forwarded to the KTWQP Program Manager to be used in preparing the reports for each event and also to be used as a guide to identify areas requiring improvement prior to the next sampling event.

3.1.2 Laboratory Oversight

Following receipt of the off-site laboratory's data package for each sampling event, the KTWQP QA Officer will review the data package for completeness, as well as to ensure that all planned methodologies were followed and that QA/QC objectives were met. The results of the review will be documented on the Laboratory Data Review Checklist (Appendix B-2). (Note: The KTWQP Program Manager/QA Officer has the authority to request re-testing or other corrective measures if the laboratory has not met the project's QA/QC objectives and/or has not provided a complete data package.)

Due to the scope and objectives of the current projects, the Karuk Tribe is not planning any laboratory audits at this time. However, the Karuk Tribe will check periodically with the state of California certification agency to make sure that the laboratory remains in good standing for those methods that the Karuk Tribe is requesting.

The laboratories' QA Manuals describe the policies and procedures for assessment and response in the laboratory.

3.2 Reports to Management

Annually, the KTWQP Program Manager will prepare and submit a report on that year's sampling activities. Contents of this report have been described previously in Section 1.9.6. The prepared report will show any data trends that have occurred. The report will also discuss how any actions taken during the year may have affected the trends. This report will be submitted to the Tribal Council for approval. After approval, the report will be submitted to the US EPA Grants Project Officer.

4.0 DATA REVIEW AND USABILITY

Prior to utilizing data to make project decisions, the quality of the data needs to be reviewed and evaluated to determine whether the data satisfy the projects' objectives. This process involves technical evaluation of the off-site laboratory data, as well as review of the data in conjunction with the information collected during the field sampling and field measurement activities. This latter, more qualitative review provides for a clearer understanding of the overall usability of the projects' data and potential limitations on their use. This section describes the criteria and procedures for conducting these reviews and interpreting the projects' data.

4.1 Data Review, Verification, and Validation Requirements

The setting of data review, verification, and validation requirements helps to ensure that project data are evaluated in an objective and consistent manner. For the current project, such requirements have been defined for information gathered and documented as part of field sampling and field measurement activities, as well as for data generated by the off-site laboratory.

4.1.1 Field Sampling and Measurement Data

Any information collected during sample collection and field measurements is considered field "data." This includes field sampling and measurement information documented in field logbooks (as listed in Section 1.9.2.1), photographs, and chain of custody forms.

Once the KTWQP Technician returns to the office following a sampling event, they turn in the field data to the KTWQP Data Manager who is responsible for conducting a technical review of the field data to ensure that all information is complete and any deviations from the planned methodologies are documented. For the purpose of this project, the review will be documented using the Field Activities Review Checklist provided in Appendix B-1. This checklist comprehensively covers the items to be reviewed and leaves room to capture any comments associated with potential impacts on field samples and field measurement integrity based on the items listed.

4.1.2 Laboratory Data

For the data generated by an off-site laboratory, the laboratory is responsible for its own internal data review and verification prior to submitting the associated data results package to the KTWQP QA Officer. The details of the review (including checking calculations, reviewing for transcription errors, ensuring the

data package is complete, etc.) are discussed in the laboratory's QA Manual included as Appendix A3. Details of the information that will be included in each data package are listed in Section 1.9.3 of this QA Project Plan.

Once the laboratory data are received by the Karuk Tribe, the KTWQP QA Officer is responsible for further review and validation of each data package. For the purpose of this project, data review and validation will be conducted using the Data Review Checklist provided in Appendix B-2 in conjunction with the QC criteria (i.e., frequency, acceptance limits, and corrective actions) defined in Tables 10, 11 and 12. This review will include evaluation of the field and laboratory duplicate results, field and laboratory blank data, matrix spike recovery data, and laboratory control sample data pertinent to each analysis. The review will also include ensuring data are reported in compliance with the project action limits and quantification limits defined in Tables 5-8; the sample preparation/analytical procedures were performed by the methods listed in Table 10; sample container, preservation, and holding times met the requirements listed in Table 11; the integrity of the sample (ensuring proper chain of custody and correct sample storage temperatures) is documented from sample collection through shipment and ultimate analysis, and the data packages. The Data Review Checklist comprehensively covers the review of all these items.

The KTWQP QA Officer will further evaluate each data package's narrative report and summary tables to see whether the laboratory "flagged" any sample results based on poor or questionable data quality and to ensure that any exceedances of the laboratory's QC criteria (as listed in Table 12) are documented. If a problem was noted by the laboratory, the KTWQP QA Officer will evaluate whether the appropriate prescribed corrective action was taken by the laboratory, the action successfully resolved the problem, and the process and its resolution were accurately documented.

An effort will be made to identify whether any data quality problem is the result of laboratory issues and/or if it may be traced to some field sampling activity. If the laboratory is determined to be responsible, the KTWQP QA Officer will request information from the laboratory documenting that the problem has been resolved prior to submitting future samples. If some aspect of the field operation (e.g., sample collection, sample containers and/or preservation, chain-of-custody, sample shipment, paperwork, etc.) is identified as the possible problem, efforts will be made to retrain the KTWQP's field staff to minimize the potential of the problem recurring. If the problem is believed to be due to the sample matrix, the KTWQP Program Manager/QA Officer will discuss the use of alternative analytical methods with the

laboratory; and, if an alternative method is available that might minimize the problem, the QA Project Plan will be modified and/or amended accordingly.

If any of the QC criteria and/or the project requirements (as discussed above) is exceeded, the associated data will be qualified as estimated and flagged with a “J”. If grossly exceeded, the associated data will be rejected and the need for re-sampling will be considered. However, since the data are being generated for a baseline assessment, it is generally felt that paying special attention to some troublesome sample collection or analytical concern during the next sampling event will be sufficient and re-sampling will not be necessary.

4.2 Verification and Validation Methods

Defining the data verification and validation methods help to ensure that project data are evaluated in an objective and consistent manner. For the current projects, such methods have been described for information gathered and documented as part of the field sampling and field measurement activities, as well as the data generated by the off-site laboratories.

4.2.1 Field Sampling and Measurement Data

The methods associated with verification and validation of the field sampling and measurement data are included within the discussion provided in Section 4.1.1.

4.2.2 Laboratory Data

The methods associated with verification and validation of the laboratory data are included within the discussion provided in Section 4.1.2.

4.3 Reconciliation with User Requirements

The purpose of the continued monitoring of the KAT is to assess the surface water resources and determine whether analytes of concern exceed national and tribal water quality standards. This also provides the Karuk Tribe with the opportunity to begin efforts of co-management in the Mid-Klamath watershed. Data must fulfill the requirements of this QA Project Plan to be useful for the overall project. Information needed to support decision making under the surface water monitoring program is contained in this QA Project Plan, field documentation, the laboratory “data package” report, the Field Activities Review Checklist, the Laboratory Data Review Checklist, and the Field Audit Report and associated

Corrective Action Report. This section describes the steps to be taken to ensure data usability (after all the data have been assembled, reviewed, verified, and validated) prior to summarizing the information in the Annual Report.

Once all the data from the field and laboratory have been evaluated (as described in Sections 4.1 and 4.2), the KTWQP Program Manager/QA Officer will make an overall assessment concerning the final usability of the data (and any limitations on its use) in meeting the projects' needs. The initial steps of this assessment will include, but are not necessarily limited to:

- Discussions with the KTWQP Water Quality Technician,
- Review of deviations from the QA Project Plan or associated SOPs to determine whether these deviations may have impacted data quality (and determining whether any impacts are widespread or single incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses),
- Evaluation of the field and laboratory results and QC information,
- Review of any other external information which might influence the results, such as activities up stream, meteorological conditions (such as storm events proceeding sampling that might contribute to high turbidity readings), and data from other sources,
- Evaluation of whether the completeness goals defined in this QA Project Plan have been met,
- Examination of any assumptions made when the study was planned, if those assumptions were met and, if not, how the project's conclusions are affected.

After all this information has been reviewed, the KTWQP Program Manager/QA Officer will incorporate their perspective on the critical nature of any problems noted and, ultimately, identify data usability and/or limitations in supporting project objectives and decision making. All usable data will then be compared to the Project Action Limits (as listed in Table 5 and Table 6) to identify whether these limits have been exceeded. Decisions made regarding exceeding the Project Action Limits will follow the "...if...then..." statements included in Section 1.7.2.

In addition, the KTWQP Program Manager/QA Officer will assess the effectiveness of the monitoring program and data collection at the end of each calendar year. Sampling locations, frequency, list of analytical parameters, field measurement protocols, choice of the analytical laboratory, etc. will be

modified as needed to reflect the changing needs and project objectives of the Karuk Tribe. This QA Project Plan will be revised and/or amended accordingly.

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FIGURES

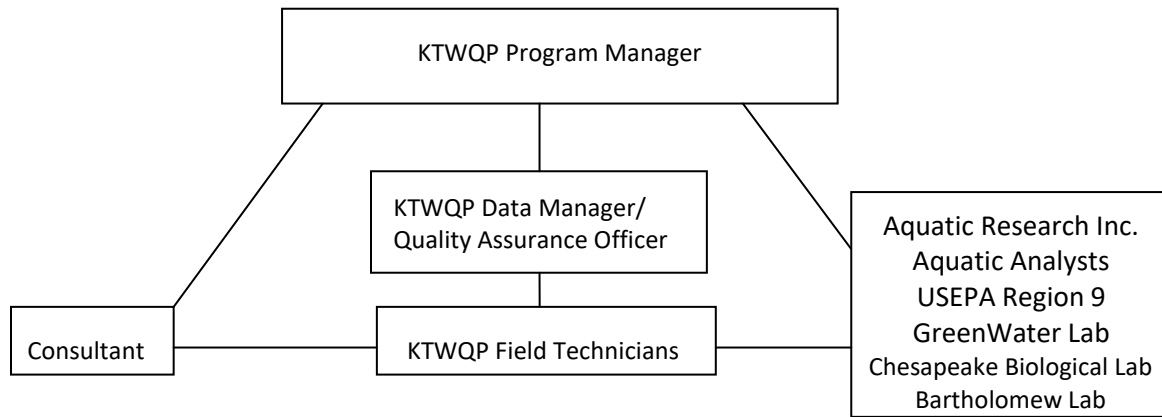


Figure 1. Program Organization.

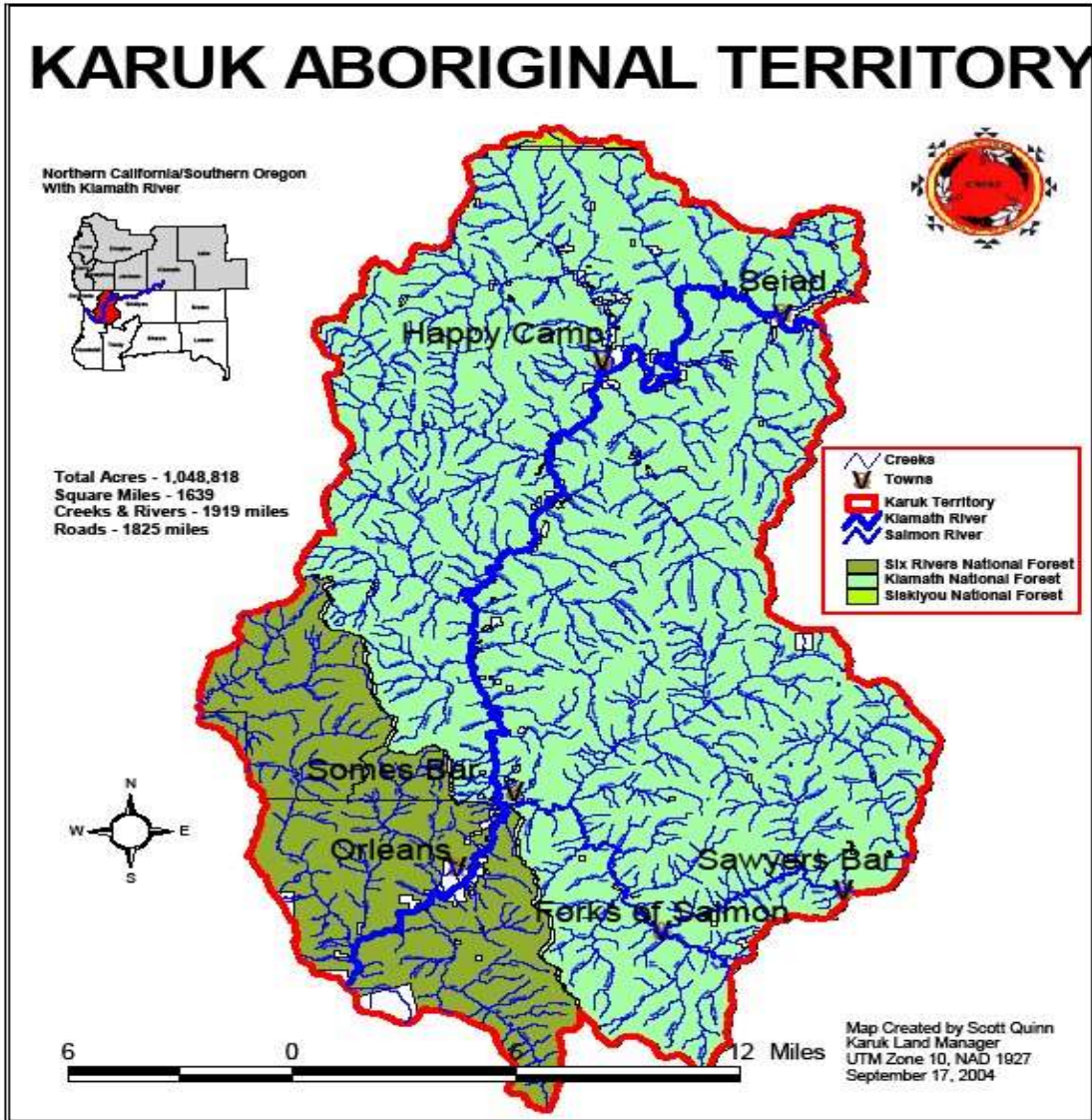


Figure 2. Map of Karuk Aboriginal Territory including towns, counties and where it is relative to the State of California and Oregon. Map from Karuk Tribe.



Figure 3. Overview of sampling sites for nutrient sampling, public health sampling, and continuous monitoring.

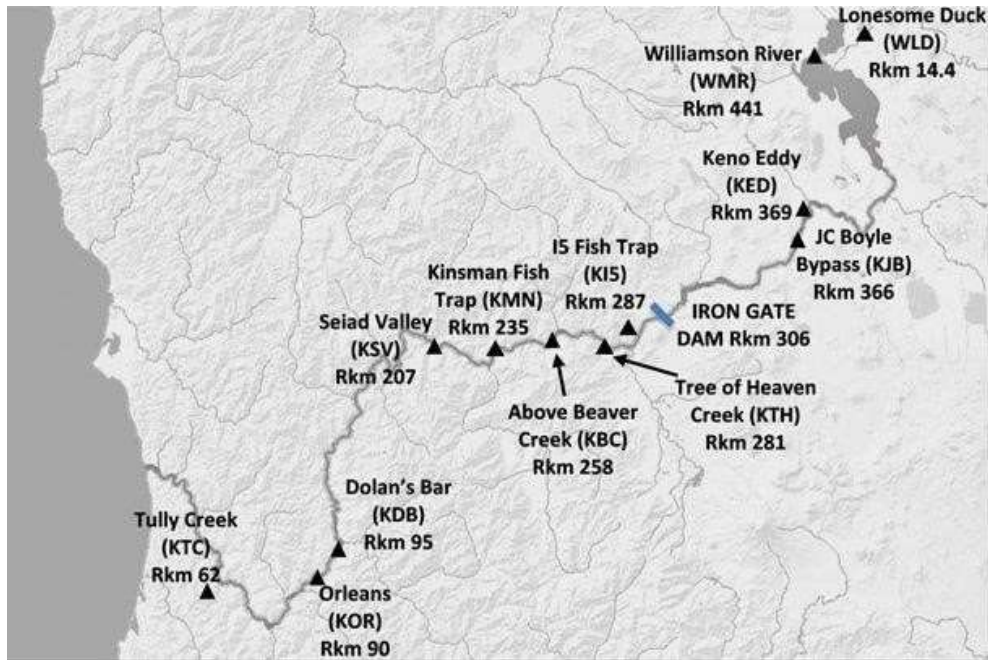


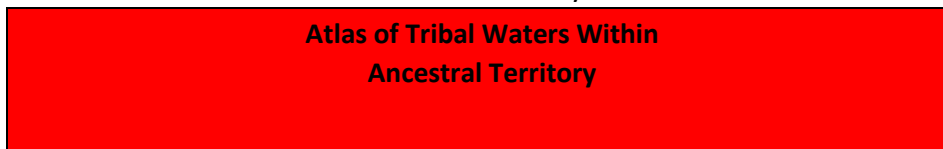
Figure 4. Klamath River Index Sites with site abbreviations and river kilometers (Rkm). Map from Oregon State University Department of Microbiology.

TABLES

Table 1. All parties participating in collection, shipping and handling, analysis of Klamath River nutrient, toxic algae, and c.shasta data by the KTWQP and those responsible for implementation of QA/QC procedures.

Title/Responsibility	Staff/Contractor	Phone Number
EPA Project Manager	Loretta Vanegas	(415) 972-3433
Program Manager	Susan Fricke	(530) 598-3414
Data Quality Manager	Grant Johnson	(530) 469-3258
Field Manager	Grant Johnson	(530) 469-3258
KTWQP Technician	Larry Alameda	(530) 469-3258
Quality Assurance Officer	Grant Johnson	(530) 469-3258
Consultant, Aquatic Ecosystems	Jacob Kann	(541) 482-1575
Consultant, Riverbend Sciences	Eli Asarian	(707) 832-4206
Contractor, Aquatic Research Inc.	Damien Gadomski	(206) 632-2715
Contractor, Aquatic Analysts	Jim Sweet	(503) 869-5032
Contractor, USEPA Region 9 Lab	Andy Lincoff	(510) 412-2389
Contractor, GreenWater Laboratories	Mark Aubel	(386) 328-0882
Contractor, Chesapeake Biological Laboratory	Jerry Frank	(410) 326-4281
Contractee, Bartholomew Laboratory	Sascha Hallet	(541) 737-4721

Table 2. Atlas of Tribal Waters within Ancestral Territory.



Total number of Klamath River miles	90
Total number of perennial stream miles	1,900
Total number of lake acres	442
Total number of wetland acres	UNKNOWN

Table 3. Site codes and locations of Karuk sampling stations for nutrients, algal toxins, and Sondes. Nutrient Suite indicates collecting nutrients, algal toxins and phytoplankton. Sonde indicates real time continuous monitoring, and public health designates surface grab sampling for phytoplankton and algal toxins.

Locations and Parameters to be Monitored							
Site ID	Latitude	Longitude	Nutrient Suite	Sonde	Public Health	Winter Turbidity	Location
OR	N 41 18.336	W 123 31.895	X	X	X		Klamath River at Orleans
SA	N 41 22.617	W 123 28.633	X	X		X	Salmon River at USGS Gage
HC	N 41 43.780	W 123 25.775	X		X		Klamath River downstream of Happy Camp
SV	N 41 50.561	W 123 13.132	X	X	X		Klamath River downstream of Seiad Valley
SC	N 41 46.100	W 123 01.567	X	X			Scott River at Johnson's Bar
BB	N 41 49.395	W 122 57.718			X		Brown Bear River Access on Klamath River
WA	N 41 50.242	W 122 51.895	X				Klamath River at Walker Bridge
SH	N 41 49.390	W 122 35.700	X	X			Shasta River at USGS Gage

IG	N 41 55.865	W 122 26.532	X	X		X	Klamath River below Iron Gate Hatchery Bridge			
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Table 4. Sample locations and parameters for nutrient sampling and public health sampling.

ID	OR	SA	HC	SV	SC	BB	WA	SH	IB	IG
Monitoring Locations	Klamath River near Orleans	Salmon River near mouth	Klamath River near Happy Camp	Klamath River near Seiad Valley	Scott River near mouth	Klamath River at Brown Bear River Access	Klamath River at Walker Bridge	Shasta River near mouth	Klamath River at I-5 bridge	Klamath River below Iron Gate
Photo Points	X	X	X	X	X	X	X	X	X	X
Temp.	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X
Conductivity	X	X	X	X	X	X	X	X	X	X
Turbidity		X			X					
DO	X	X	X	X	X	X	X	X	X	X
Total Phosphorus	X	X	X	X	X		X	X		X
Dissolved Phosphorus	X	X	X	X	X		X	X		X
Total Nitrogen	X	X	X	X	X		X	X		X
Ammonium Nitrogen	X	X	X	X	X		X	X		X
Nitrate + Nitrite	X	X	X	X	X		X	X		X
Phytoplankton	X	X	X	X	X		X	X		X
Chlorophyll	X	X	X	X	X		X	X		X
Total Organic Carbon	X	X	X	X	X		X	X		X

¹ 90% upper and lower limits represent the 90 percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit.

² 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.

³ Value may vary depending on the aquifer being sampled. This value is the result of sampling over time, and as pumped, from more than one aquifer.

⁴ The Site Specific Objectives (SSOs) for dissolved oxygen (DO) for the mainstem Klamath River are presented separately in Table 6.

Table 6. Dissolved oxygen objectives for the mainstem Klamath River.

Location	Percent DO Saturation Based On Natural Receiving Water Temperatures ¹	Time Period
Klamath River from near Doggett Creek to the Scott River	90%	October 1 through March 31
	85%	April 1 through September 30
Klamath River from Scott River to Orleans	90%	Year round

¹ Corresponding DO concentrations are calculated as daily minima, based on site-specific barometric pressure, site-specific salinity, and natural receiving water temperatures as estimated by the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009, Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of natural receiving water temperatures used in these calculations may be updated as new data or method(s) become available.

A		B Freshwater Aquatic Life		C Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
# Compound	CAS Number	Criterion Maximum Conc. (c) (ug/L) B1	Criterion Continuous Conc. (c) (ug/L) B2	Water & Organisms (ug/L) D1	Organisms Only (ug/L) D2
1. Antimony	7440360			5.6 a	640 a
2. Arsenic	7440382	340 h,l,r	150 h,l,r		

3. Beryllium	7440417				
4. Cadmium	7440439	4.3 d,h,l,r	2.2 d,h,l,r		
5a. Chromium (III)	16065831	570 d,h,l,r	74 d,h,l,r		
5b. Chromium (VI)	18540299	16 h,l,r	11 h,l,r		
6. Copper	7440508	13 d,h,l,r	9.0 d,h,l,r	1,300 k	
7. Lead	7439921	65 d,h,l	2.5 d,h,l		
8a. Mercury	7439976	1.4 h,l,r	0.77 h,l,r		

Table 7. Water quality objectives for aquatic life & organism consumption.

A		B Freshwater Aquatic Life		C Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
8b. Methylmercury	22967926				0.3 mg/kg i
9. Nickel	7440020	470 d,h,l,r	52 d,h,l,r	610	4,600
10. Selenium	7782492	o,p	5.0	170 a	4,200 a
11. Silver	7440224	3.4 d,f,h,l			
12. Thallium	7440280			0.24 a	0.47 a
13. Zinc	7440666	120 d,h,l	120 d,h,l,r	7,400 a	25,000 a
14. Cyanide	57125	22 r,s	5.2 r,s	140 a	16,000 a,j
15. Asbestos	1332214			7 million fibers/L k	
16. 2,3,7,8-TCDD (Dioxin)	1746016			5.0 E-9 b	5.1 E-9 b
17. Acrolein	107028			190	290
18. Acrylonitrile	107131			0.051 a,b	0.25 a,b

19. Benzene	71432			0.61 - 2.2 a,b	14 - 51 a,b
20. Bromoform	75252			4.3 a,b	130 a,b
21. Carbon Tetrachloride	56235			0.23 a,b	1.6 a,b
22. Chlorobenzene	108907			130 a	1,600 a,j
23. Chlorodibromomethane	124481			0.40 a,b	13 a,b
24. Chloroethane	75003				
25. 2-Chloroethylvinyl Ether	110758				
26. Chloroform	67663				
27. Dichlorobromomethane	75274			0.55 a,b	17 a,b
28. 1,1-Dichloroethane	75343				
29. 1,2-Dichloroethane	107062			0.38 a,b	37 a,b
30. 1,1-Dichloroethylene	75354			0.056 a,b	1.2 a,b
31. 1,2-Dichloropropane	78875			0.50 b	15 b
32. 1,3-Dichloropropene	542756			0.34 a,b	21 a,b
33. Ethylbenzene	100414			530 a	2,100 a
34. Methyl Bromide	74839			47 a	1,500 a
35. Methyl Chloride	74873				

A		B		C	
		Freshwater Aquatic Life		Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
36. Methylene Chloride	75092			4.6 a,b	590 a,b

37. 1,1,2,2-Tetrachloroethane	79345			0.17 a,b	4.0 a,b
38. Tetrachloroethylene	127184			0.69 b	3.3 b
39. Toluene	108883			1,300 a	15,000 a
40. 1,2-Trans-Dichloroethylene	156605			140 a	10,000 a
41. 1,1,1-Trichloroethane	71556				
42. 1,1,2-Trichloroethane	79005			0.59 a,b	16 a,b
43. Trichloroethylene	79016			2.5 b	30 b
44. Vinyl Chloride	75014			0.025 a,b	2.4 a,b
45. 2-Chlorophenol	95578			80 a	150 a
46. 2,4-Dichlorophenol	120832			77 a	290 a
47. 2,4-Dimethylphenol	105679			380 a	850 a
48. 2-Methyl-4,6-Dinitrophenol	534521			13	280
49. 2,4-Dinitrophenol	51285			69 a	5,300 a
50. 2-Nitrophenol	88755				
51. 4-Nitrophenol	100027				
52. 3-Methyl-4-Chlorophenol	59507				
53. Pentachlorophenol	87865	19 e,r	15 e,r	0.27 a,b	3.0 a,b,j
54. Phenol	108952			21,000 a	1,700,000 a,j
55. 2,4,6-Trichlorophenol	88062			1.4 a,b	2.4 a,b
56. Acenaphthene	83329			670 a	990 a
57. Acenaphthylene	208968				
58. Anthracene	120127			8,300 a	40,000 a

59. Benzidine	92875			0.000086 a,b	0.00020 a,b
60. Benzo(a)Anthracene	56553			0.0038 a,b	0.018 a,b
61. Benzo(a)Pyrene	50328			0.0038 a,b	0.018 a,b
62. Benzo(b)Fluoranthene	205992			0.0038 a,b	0.018 a,b
63. Benzo(ghi)Perylene	191242				

A		B Freshwater Aquatic Life		C Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
64. Benzo(k)Fluoranthene	207089			0.0038 a,b	0.018 a,b
65. Bis(2-Chloroethoxy)Methane	111911				
66. Bis(2-Chloroethyl)Ether	111444			0.030 a,b	0.53 a,b
67. Bis(2-Chloroisopropyl)Ether	108601			1,400 a	65,000 a
68. Bis(2-Ethylhexyl)Phthalate (x)	117817			1.2 a,b	2.2 a,b
69. 4-Bromophenyl Phenyl Ether	101553				
70. Butylbenzyl Phthalate (w)	85687			1,500 a	1,900 a
71. 2-Chloronaphthalene	91587			1,000 a	1,600 a
72. 4-Chlorophenyl Phenyl Ether	7005723				
73. Chrysene	218019			0.0038 a,b	0.018 a,b
74. Dibenzo(a,h)Anthracene	53703			0.0038 a,b	0.018 a,b
75. 1,2-Dichlorobenzene	95501			420 a	1,300 a
76. 1,3-Dichlorobenzene	541731			320	960

77. 1,4-Dichlorobenzene	106467			63	190
78. 3,3'-Dichlorobenzidine	91941			0.021 a,b	0.028 a,b
79. Diethyl Phthalate	84662			17,000 a	44,000 a
80. Dimethyl Phthalate	131113			270,000	1,100,000
81. Di-n-Butyl Phthalate	84742			2,000 a	4,500 a
82. 2,4-Dinitrotoluene	121142			0.11 b	3.4 b
83. 2,6-Dinitrotoluene	606202				
84. Di-n-Octyl Phthalate	117840				
85. 1,2-Diphenylhydrazine	122667			0.036 a,b	0.20 a,b
86. Fluoranthene	206440			130 a	140 a
87. Fluorene	86737			1,100 a	5,300 a
88. Hexachlorobenzene	118741			0.00028 a,b	0.00029 a,b
89. Hexachlorobutadiene	87683			0.44 a,b	18 a,b
90. Hexachlorocyclopentadiene	77474			47 a	1,300 a,j
91. Hexachloroethane	67721			1.4 a,b	3.3 a,b

A		B		C	
		Freshwater Aquatic Life		Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
92. Ideno(1,2,3-cd)Pyrene	193395			0.0038 a,b	0.018 a,b
93. Isophorone	78591			35 a,b	960 a,b
94. Naphthalene	91203				
95. Nitrobenzene	98953			17 a	690 a,j

96. N-Nitrosodimethylamine	62759			0.00069 a,b	3.0 a,b
97. N-Nitrosodi-n-Propylamine	621647			0.0050 a,b	0.50 a,b
98. N-Nitrosodiphenylamine	86306			3.3 a,b	6.0 a,b
99. Phenanthrene	85018				
100. Pyrene	129000			830 a	4,000 a
101. 1,2,4-Trichlorobenzene	120821			35 a	70 a
102. Aldrin	309002	3.0 f		0.000049 a,b	0.000050 a,b
103. alpha-BHC	319846			0.0026 a,b	0.0049 a,b
104. beta-BHC	319857			0.0091 a,b	0.017 a,b
105. gamma-BHC (Lindane)	58899	0.95 r		0.012 b	0.023 b
106. delta-BHC	319868				
107. Chlordane	57749	2.4 f	0.0043 f	0.00080 a,b	0.00081 a,b
108. 4,4'-DDT	50293	1.1 f	0.001 f	0.00022 a,b	0.00022 a,b
109. 4,4'-DDE	72559			0.00022 a,b	0.00022 a,b
110. 4,4'-DDD	72548			0.00031 a,b	0.00031 a,b
111. Dieldrin	60571	0.24 r	0.056 r	0.000052 a,b	0.000053 a,b
112. alpha-Endosulfan	959988	0.22 f	0.056 f	62 a	89 a
113. beta-Endosulfan	33213659	0.22 f	0.056 f	62 a	89 a
114. Endosulfan Sulfate	1031078			62 a	89 a
115. Endrin	72208	0.086 r	0.036 r	0.059 a	0.060 a,j
116. Endrin Aldehyde	7421934			0.29 a	0.30 a,j

117. Heptachlor	76448	0.52 f	0.0038 f	0.000078 a,b	0.000079 a,b
118. Heptachlor Epoxide	1024573	0.52 f	0.0038 f	0.000039 a,b	0.000039 a,b
A		B		C	
		Freshwater Aquatic Life		Human Health (10-6 risk for carcinogens) For consumption of:	
119. Polychlorinated Biphenyls (PCBs)			0.014 q	0.000064 a,b,q	0.000064 a,b,q
120. Toxaphene	8001352	0.73	0.0002	0.00027 a,b	0.00028 a,b
Total Number of Criteria (g)		23	21	96	95

- a. This criterion reflects the Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of August 28, 2000. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case (unless otherwise noted).
- b. This criterion is based on carcinogenicity of 10-6 risk.
- c. Criterion Maximum Concentration (CMC) equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. Criterion Continuous Concentration (CCC) equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. The term "ug/L" means micrograms per liter.
- d. Freshwater aquatic life criteria for metals are expressed as a function of total hardness (mg/L) in the waterbody. The equations are provided at paragraph (i) through (iv) of section 2. Values displayed in the table correspond to a total hardness of 100 mg/L.
- e. Freshwater aquatic life criteria for pentachlorophenol are expressed as a function of pH, and are calculated as follows: Values displayed in the table correspond to a pH of 7.8. $CMC = \exp(1.005(pH) - 4.869)$. $CCC = \exp(1.005(pH) - 5.134)$.
- f. This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum data requirements and derivation procedures used to derive the 1980 criteria were different from those in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
- g. These totals simply sum the number of criteria in each column. For aquatic life, there are 24 priority toxic pollutants with some type of freshwater or saltwater, acute or chronic criteria. For human health, there are 99 priority toxic pollutants with either "water + organism" or "organism only" criteria. Note that these totals count chromium as one pollutant even though EPA has developed criteria based on two valence states. In the matrix, EPA has assigned numbers 5a and 5b to the criteria for chromium to reflect the fact that the list of 126 priority pollutants includes only a single listing for chromium.
- h. Criteria for these metals are expressed as a function of the water-effect ratio, WER, as defined in paragraphs (vii) through (ix) of section 2. $CMC = (\text{column B1 or C1 value}) \times WER$; $CCC = (\text{column B2 or C2 value}) \times WER$.
- i. This criterion is a fish tissue residue criterion based on a total fish consumption weighted rate of 0.0175 kg/day. See EPA-823-R-01-001
- j. No criterion for protection of human health from consumption of aquatic organisms (excluding water) was presented in the 1980 criteria document or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow a calculation of a criterion, even though the results of such a calculation were not shown in the document.

k. The CWA 304(a) criterion for this compound is the MCL or drinking water action level.

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l. These freshwater criteria for metals are expressed in terms of the dissolved fraction of the metal in the water column. Criterion values were calculated by using EPA's Clean Water Act 304(a) guidance values (described in the total recoverable fraction) and then applying the conversion factors in (v) and (vi) of section 2.

o. The $CMC = 1/[(f1/CMC1) + (f2/CMC2)]$ where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/l and 12.82 µg/l, respectively.

p. This water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996 for the CMC, or 0.922 for the CCC) to convert this criterion to a value that is expressed in terms of dissolved metal. (See 40 CFR part 132.)

q. This criterion applies to total PCBs (that is, the sum of all homolog, all isomer, all congener, or all Aroclor analyses).

r. This criterion has been recalculated pursuant to the 1995 Updates: Water Quality Criteria Document for the Protection of Aquatic Life in Ambient Water, Office of Water, EPA-820-B-96-001, September 1996. See also Great Lakes Water Quality Initiative Criteria Document for the Protection of Aquatic Life in Ambient Water, EPA-80-B-95-004, March 1995.

s. This water quality criterion is expressed as µg free cyanide (as CN)/L.

Table 8. Limits of pollution for various nutrient parameters, MSAE, and microcystin toxins.

Water Quality Parameter	Recognized Pollution Level
Total Nitrogen (TN) (mg/L)	0.2 mg/l
Total Phosphorus (TP) (mg/L)	0.035 mg/l
Periphyton Chlorophyll <i>a</i> (mg/m ²)	150 mg/m ²
<i>Microcystis aeruginosa</i> cell count	<1,000 cells/ml
Microcystin Toxin	0.8 µg/l

Table 9. Precision of sampling equipment used by KTWQP.

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	Temperature	Onset HOBO Water Temp Pro Loggers	±0.2°C at 0° to 50°C (±0.36°F at 32° to 120°)	±0.2°C at 0° to 50°C (±0.36°F at 32° to 120°)	0° to 50°C (32° to 122°F) in water (non-freezing)
Water	Temperature	YSI 6600 MPS Multi Probe System: YSI Precision™ Thermistor	0.1°C	± 0.15°C	-5 to 60°C

Water	Temperature	YSI EXO2 MPS Multi Probe System: YSI Precision™ Thermistor	0.001°C	±0.01°C at 5° to 35°C and ±0.05°C at 35° to 50°C	-5 to 50°C
Water	pH	YSI 6600 MPS Multi Probe System: YSI Glass Combination electrode	0.01 units	±0.2 units	0 to 14 units

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	pH	YSI EXO2 MPS Multi Probe System: YSI Glass Combination electrode	0.01 units	±0.1 pH units within ±10°C of calibration temp	0 to 14 units
Water	Dissolved Oxygen	YSI 6600 MPS Multi Probe System Steady state polarographic	0.01 mg/L	±2% @ 0 to 20 mg/L ±6% @ 20 to 50 mg/L	0 to 50 mg/L
Water	Dissolved Oxygen	YSI EXO2 MPS Multi Probe System Steady state polarographic	0.01 mg/L	±1% @ 0 to 20 mg/L ±5% @ 20 to 50 mg/L	0 to 50 mg/L

Water	Conductivity	YSI 6600 MPS Multi Probe System: YSI 4electrode cell with autoranging	0.001 mS/cm to 0.1 mS/cm rangedependent	± 0.5% + 0.001 mS/cm	0 to 100mS/cm
Water	Conductivity	YSI EXO2 MPS Multi Probe System: YSI 4electrode cell with autoranging	0.001 mS/cm to 0.1 mS/cm rangedependent	±0.5% @ 0 to 100 mS/cm ±1% @ 100 to 200 mS/cm	0 to 200mS/cm
Water	Turbidity	YSI 6600 MPS Multi Probe	0.01 NTU	± 2%	0-1000 NTU
Water	Turbidity	YSI EXO2 MPS Multi Probe	.01 FNU @ 0 to 999 FNU 0.1 FNU @	±2% @ 0 to 999 FNU ±5% @ 1000	0-4000 FNU
Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
			1000 to 4000 FNU	to 4000 FNU	
Water	Blue Green Algae, Phycocyanin	YSI EXO2 MPS Multi Probe	0.01 µg/L; 0.01 RFU	Linearity: R ² >0.999 for serial dilution of Rhodamine WT solution from 0 to 100 µg/mL BGAPC equivalents	0 to 100 µg/L; 0 to 100 RFU

Table 10. Nutrient, phytoplankton, and algal toxin parameters and the laboratory to which each will be shipped for analysis.

Parameter	Laboratory	Method	Reporting Limit (mg/L)	MDL (mg/L)
Total Phosphorus	AR	SM18 4500PF	0.002	0.002
Soluble Reactive Phosphorus	AR	SM18 4500PF	0.001	0.001
Total Nitrogen	AR	SM204500NC	0.100	0.045
Nitrate + Nitrite	AR	SM 184500NO3F	0.010	0.005
Ammonia	AR	SM 184500NH3H	0.010	0.006
Chlorophyll <i>a</i> / Pheophytin <i>a</i>	AR	SM1810200H	0.0001	0.0001
Phytoplankton speciation and enumeration	AA	APHA Standards	NA	
Total Organic Carbon	AR	SM205310B	0.250	0.095
Total Suspended Solids	AR	SM20 2540D	0.50	0.30
Volatile Suspended Solids	AR	SM20 2540E	0.50	0.40
Alkalinity	AR	SM182320B	1.00	0.20
Carbonaceous Biochemical Oxygen Demand	AR	SM20 5120B	2.00	1.00
Microcystin-LR	US EPA	ELISA	1.8 µg/l	1.8 µg/l
Microcystin (LR,LA,YR,RR,LF,LW) Anatoxin-a	GreenWater Laboratories	LC-MS/MS	1.0 µg/l	1.0 µg/l

Table 11. Laboratory methodologies, containers, preservatives and holding times.

Parameter	Method	Containers (number, size/volume, type)	Preservation Requirements (chemical, temperature, light protection)	Maximum Holding Times
Total Phosphorus	SM18 4500PF	1 X 250ml, polyethylene bottle	4C	28 Days
Soluble Reactive Phosphorus	SM18 4500PF		4C	48 hours
Total Nitrogen	SM204500NC		4C	28 days
Nitrate + Nitrite	SM184500NO3F		4C	48 hours
Ammonia	SM184500NH3H		4C	48 hours
Alkalinity	SM18 2320B		4C	14 days
Chlorophyll <i>a</i> / Pheophytin <i>a</i>	SM1810200H	1 X 1L, polyethylene bottle	4C	
Total Organic Carbon	SM205310B	1 X 100ml, amber glass bottle	4C	28 day
Dissolved Organic Carbon				
Total Suspended Solids	SM20 2540D	1 X 1L, polyethylene bottle	4C	7days
Volatile Suspended Solids	SM20 2540E			
Microcystin (GreenWater)	Anatoxin, LCMS/MS	1 X 250ml, clear glass bottle	Freeze and ship at <4C	14 days
Microcystin (EPA)	ELISA	1 X 60ml, clear glass bottle	Freeze and ship at <4C	14 days
Carbonaceous Biochemical Oxygen Demand	SM20 5120B	500ml, polyethylene bottle	4C	48 hours

Table 12. Summary of Field and QC Samples for Karuk Tribe Water Monitoring Program.

Matrix/ Media	Analytical Parameter ¹	No. of Sampling Locations	Depth (surface, mid, or deep) ¹	No. of Field Duplicates ²	Inorganics No. of ⁴		No. of Field Blanks ⁵	Total No. of Samples
					Dup	MS		
Analysis:								
Surface Water	Total Phosphorus	8	Surface	4	1	1	1	49
Surface Water	Dissolved Phosphorus	8	Surface	4	1	1	1	49
Surface Water	Total Nitrogen	8	Surface	4	0	0	1	47
Surface Water	Ammonium Nitrogen	8	Surface	4	1	1	1	49
Surface Water	Nitrate + Nitrite	8	Surface	4	1	1	1	49
Surface Water	Phytoplankton	8	Surface	4	10% of samples		1	51
Surface Water	Chlorophyll	8	Surface	4	1	1	1	49
Field Measurements:								
Surface Water	Temperature	16	Surface	4			0	46
Surface Water	pH	16	Surface	4			0	46
Surface Water	Conductivity	16	Surface	4			0	46
Surface Water	Turbidity	10	Surface	4			0	46

¹ Samples will be collected at depth of 6-12 inches. If depth of water is less than 12 inches, sample will be collected at mid depth and noted in the field logbook.

² Field duplicates will be collected at a frequency of 10% of the samples collected for laboratory analysis. Field duplicates will be collected at a frequency of 10% or one per day, whichever is more frequent, for samples collected for field measurements.

⁴

Includes number of associated analytical QC samples if collection of additional sample volume and/or bottles is necessary. If the QC samples listed are part of the analysis but no additional sample volume and/or bottles are needed, include "NAS" (for

Surface Water	Dissolved Oxygen	16	Surface	4			0	46
---------------	------------------	----	---------	---	--	--	---	----

¹

All analyses will be performed at an off-site laboratory. There will be no field screening analyses. Field measurements will be performed at each sample collection location.

“no additional sample”) in the column. (Note: MS=matrix spike, MSD=matrix spike duplicate, dup=laboratory duplicate/replicate.)

⁵ Field blanks will be collected at a frequency of 10% of the samples collected, or one per day, whichever is less frequent. Field blanks will not be collected, as they were determined not to be critical, to support laboratory analysis of Total Dissolved Solids, alkalinity, total coliform, e. coli or for field measurements.

Table 13. Field Equipment Calibration, Maintenance, Testing, and Inspection

Analytical Parameter	Instrument	Calibration Activity	Maintenance & Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action
Temperature (Sensor)	6600 and EXO2 MPS Multi Probe System: YSI Precision™ Thermistor		See Manufacturer’s manual	Initial Post: Once a week check and calibrate as needed	± 0.15°C of true value at both endpoints	Remove from use if doesn’t pass calibration criteria
Temperature (Sensor)	Onset HOBO Water Temp Pro Loggers	Water bath calibration against NIST thermometer (US Fish and Wildlife Protocol)	See Manufacturer’s manual	Initial	±0.2°C of true value at both endpoints	Remove from use if doesn’t pass calibration criteria
pH (electrode)	6600 and EXO2 MPS Multi Probe System: YSI Glass Combination electrode	Initial: Twopoint calibration bracketing expected field sample range (using 7.0 and 10.0 pH buffer)	See Manufacturer’s manual	Initial and bi-weekly (every other week)	Initial: Two-point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn’t pass calibration criteria.

		Post: singlepoint check with 7.0 pH buffer			Post: ± 0.1 pH units of true value	
Dissolved oxygen	6600 and EXO2 MPS Multi Probe	Initial: Onepoint calibration	See Manufacturer's	Initial and bi-weekly (every	Initial: Onepoint calibration	Recalibrate; Qualify data. Remove from
(sensor)	Optical Sensor	with saturated air (need temp, barometric pressure).	manual	other week)	done electronically	use if doesn't pass calibration criteria.
		Post: singlepoint check at full saturation			Post: ± 0.5 mg/L of true saturated value	
Turbidity (sensor)	YSI 6600 and EXO2 MPS Multi Probe System	Initial: Onepoint calibration using 0 NTU (or deionized water)	See Manufacturer's manual	Initial and bi-weekly (every other week)	Initial: Onepoint calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria.
		Post: singlepoint check at 0 NTU			Post: ± 1 NTU of true value	
Conductivity (sensor)	YSI 6600 and EXO2 MPS Multi Probe System: YSI 4electrode cell with autoranging	Initial: One- point calibration at high end of expected field sample range (1000 mS/cm standard)	See Manufacturer's manual	Initial and bi-weekly (every other week)	Initial: one point calibration done electronically	Recalibrate; Qualify data. Remove from use if doesn't pass calibration criteria.
		Post: two-point check with high (1000 mS/cm) and low (0 mS/cm) standards			Post: high standard $\pm 5\%$ of true value and low standard $\pm 10\%$ of true value	

APPENDICES

APPENDIX A. LABORATORY DOCUMENTS

Appendix A-1: Sample bottle labels from labs



Appendix A-2: Sample Chain of Custody forms and custody seals

Chain of Custody for Klamath River Nutrient Loading Study

Karuk DNR PHONE 530-469-3258 CONTACT Grant Johnson Collected By		39051 Hwy 96 Orleans, CA 95556 EMAIL scorum@karuk.us , gjohnson@karuk.us SIGNATURE																					
Sample ID	Date	Time	Lab ID	TP	PO ₄ -P	TN	NH ₄ -N	NO ₃ -NO ₂ -N	ALK	T.O.C	DOC	C:N _{org}	Phaeo	VSS	TSS	CBOD	Chlor-a	POC	PON	Turbidity	TKN	MP	POP
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
Relinquished by:		Company:		Date:		Time:		Received by:		Company:													
Relinquished by:		Company:		Date:		Time:		Received by:		Company:													

Notes/Carrier

Circle One:

For Nutrients Ship to:
Aquatic Research Inc.
3927 Aurora Ave N
Seattle, WA 98103
(206) 632-2715

Invoices should be sent to:
Grant Johnson
Karuk Tribe
Department of Natural Resources
PO Box 282
Orleans CA 95556
(530) 469-3456

Jerry Frank
Chesapeake Biological Laboratory
1 Williams Street
Solomons, MD 20688
(410) 326-4281

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APPENIX A3. Aquatic Research Incorporated, Quality Assurance/Quality Control Plan and Aquatic Analysts, Algae Analytical and Quality Assurance Procedures

APPENDIX B. KTWQP WATER QUALITY CHECKLISTS AND WORKSHEETS

Appendix B-1: Field Activities Review Checklist

Sampling Location(s):

Date(s) of Sampling: _____

Mark each topic "Yes," "No," or "NA" (not applicable), and comment as appropriate.

_____ All required information was entered into field logbooks in ink, and logbook pages were signed & dated.
Comment:

_____ Deviations from SOPs , along with any pertinent verbal approval authorizations and dates, were documented in field logbooks. Comment:

_____ Samples that may be affected by deviations from SOPs were flagged appropriately. Comment:

_____ Field measurement calibration standards were not expired and were in the correct concentrations.
Comment:

_____ Field calibrations were performed and results were within QAPP-specified limits for all parameters (Temperature, pH, Dissolved Oxygen, Conductivity, and Turbidity). Comment:

_____ Field measurement QC samples were within the QAPP-specified limits for all parameters. Comment:

_____ Field measurement data were recorded in the appropriate logbooks(s). Comment:

_____ Samples were collected at the correct sites. Comment:

_____ The correct number of samples for each type of analysis and the correct volume was collected. Comment:

_____ Certified clean sample containers, appropriate for the intended analysis, were used. Comment:

_____ Requested/required field quality control (QC) samples (Field blanks and field duplicates) were collected, and at the correct frequency. Comment:

_____ Samples were preserved with the correct chemicals, if required. Comment:

_____ Samples were stored and/or shipped at the proper temperature. Comment:

_____ Chain-of-custody documents were completed properly. Comment:

_____ Custody seals were applied and intact when relinquishing custody of the samples. Comment:

_____ Sample holding times were not exceeded during field operations. Comment:

Reviewer's Name (print):

Reviewer's Signature: _____

Reviewer's Title: _____

Karuk Tribe Water Quality Program:

Date of Review: ___/___/____

Appendix B-2: Lab Data Review Checklist

Sampling Project: _____

Date of Sampling: _____

Analytical Laboratory: _____

Mark each topic "Yes," "No," or "NA" (not applicable), and comment as appropriate.

_____ Final data package includes chain-of-custody forms. Comment:

_____ Chain-of-custody forms were properly completed and signed by everyone involved in transporting the samples. Comment:

_____ Laboratory records indicate sample custody seals were intact upon receipt. Comment:

_____ Samples arrived at the laboratory at the proper temperature. Comment:

_____ All requested analyses were performed and were documented in the analytical report. Comment:

_____ Analyses were performed according to the methods specified in the approved QA Project Plan. Comment:

_____ Holding times for extraction and analysis were not exceeded. Comment:

_____ Method detection and/or quantitation limits were included in the report. Comment:

_____ A Narrative summarizing the analyses and describing any analysis problems was included in the final report. Comment:

_____ Data qualifiers and flags were explained in the analytical report. Comment:

_____ Method (laboratory) blank results were included for all analyses, at the appropriate frequency, and showed no laboratory contamination. Comment:

_____ Initial calibration data (if requested from the laboratory) were within QAPP, method, or laboratory SOP defined acceptance criteria for all analyses. Comment:

_____ Continuing calibration data (if requested from the laboratory) were within QAPP, method, or laboratory SOP defined acceptance criteria for all analyses. Comment:

_____ Matrix spike data were included for all pertinent analyses for every 20 samples. Comment:

_____ Laboratory Control Sample data were included for all analyses for every 20 samples. Comment:

_____ Laboratory Duplicate data were included for all analyses for every 20 samples. Comment:

_____ Field blanks do not contain analytes of interest or interfering compounds and included for all pertinent analyses for every 20 samples. Comment:

_____ Field Duplicates are within QAPP-defined acceptance criteria and included for all analyses for every 10 samples. Comment:

_____ Matrix spike results were listed and within QAPP or laboratory defined acceptance criteria. Comment:

_____ Matrix interferences were definitively identified either through a second analysis or use of Laboratory Control Sample Results. Comment:

_____ Laboratory Control Sample results were within QAPP or laboratory defined acceptance criteria. Comment:

_____ Laboratory Duplicate results were within QAPP or laboratory defined acceptance criteria. Comment:

_____ Reported results were within method detection or quantitation limits. Comment:

Reviewer's Name (print):

Reviewer's Signature: _____

Reviewer's Title: _____

Karuk Tribe Water Quality Program:

Date of Data Review: __/__/____

APPENDIX C. FIELD EQUIPMENT MANUALS AND INSTRUCTIONS

Appendix C-1: Onset HOBO Water Temp Pro Logger Manual

http://www.onsetcomp.com/files/manual_pdfs/10366-C-MAN-U22-001.pdf

Appendix C-2: Van Dorn Sampler Manual

<http://wildco.com/wp-content/uploads/2017/05/Wildco-Water-Bottle-Guide.pdf>

Appendix C-3: YSI 6600 Datasonde User Manual

<https://www.ysi.com/File%20Library/Documents/Manuals/069300-YSI-6-Series-Manual-RevJ.pdf>

Appendix C-4: YSI EXO Datasonde User Manual

<https://www.ysi.com/File%20Library/Documents/Manuals/EXO-User-Manual-Web.pdf>

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Appendix C 5: YSI EXO Handheld Operation Guide

<https://www.ysi.com/File%20Library/Documents/Manuals/E117-EXO-Handheld-Operation-MiniManual.pdf>

Appendix C-6: ISCO Automatic Sampler Manual

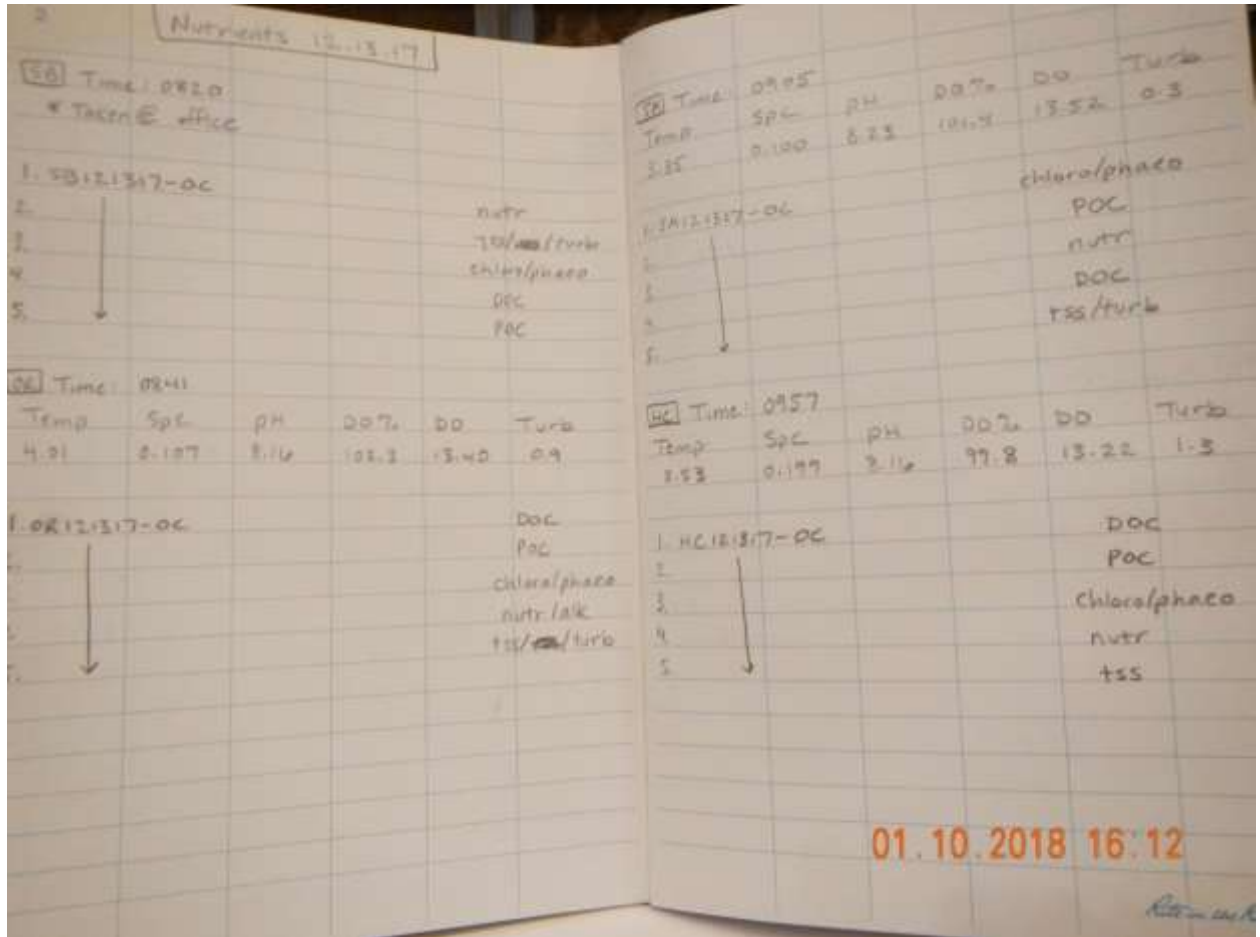
<https://www.yumpu.com/en/document/view/23528603/6700-portable-sampler-isco>

Appendix C-7: Churn Sample Splitter Instruction Manual

<https://www.belart.com/media/catalogstudio/Instructions/937805001.pdf>

APPENDIX D. DATA SHEETS

Appendix D-1: Surface Water Samples



Appendix E-3: Churn Cleaning SOP

Decontamination of Sampling Equipment and Supplies

Equipment decontamination is intended to remove residues from the environment, prior sampling, and handling or manufacturing activities adhering to equipment or other supplies that will come into contact with the sample. Equipment used for sampling (sample collection, processing, and handling) must be cleaned before being used. Sampling equipment must be cleaned before the first use each sampling day and re-cleaned before use at the next site to avoid cross contamination between sampling sites.

- Clean equipment. If the sampling equipment will not be reused during a field trip, after using triple rinse the sampler components thoroughly with clean water (tap, distilled or deionized water) before they dry and place the sampler in a plastic bag for transport to the office laboratory for cleaning. If the sampling equipment will be reused during the field trip, triple rinse the sampler components with distilled or deionized water before they dry. Field-clean the sampler at the next sampling site before use.

Generally the sequence for cleaning equipment for sampling cyanobacteria or cyanotoxins can be summarized as follows: detergent wash; tap/De-I rinse; De-I soak; and air dry.

The following detailed equipment cleaning procedures should be used:

- Use gloves, which are changed between each step.
- Scrub the equipment / tubing in tap or De-I water with a nonmetallic, non-colored brush to remove visible debris.
- Soak the equipment and tubing for 30 minutes in 0.2-percent Liquinox solution or another phosphate-free detergent
- Thoroughly rinse the equipment and tubing with tap water.
- Rinse the equipment three times with De-I water.
- Allow everything to air dry completely.

Avoid using samplers with plastic components, as the plastic may adsorb cyanotoxins and cross-contaminate samples. Do not forget to decontaminate equipment before use. Once the equipment is decontaminated, wrap inorganic equipment in plastic and organic equipment in aluminum foil for storage and transport.

Churn Splitter Cleaning and Rinsing

- For purposes of this section regarding Churn splitter cleaning and rinsing, churn splitter refers to churn splitter container, lid, and churning disk.
- At the beginning of each sampling day, triple rinse churn splitter with distilled water or de-I water. If the site is an open water baseline site (see section 3.2.4) then also rinse it one time with native (stream or reservoir) water. Do not rinse with native water before collecting public health surface grab samples (see section 3.2.3). For each rinse, water is run through the discharge spout. After collecting each sample, remove visible debris and triple rinse the churn again with distilled or de-I water.
- Rinsing with HCL is not necessary for sampling for cyanobacteria and cyanotoxins.

Appendix E-4: Calibration for YSI 6600 Datasondes

YSI Calibration SOP

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and service the Sonde. Properly filling out the calibration sheet is critical to collecting all the data that is needed for the evaluation of the sonde file. Here is an overview of a typical field tour consisting of extracting the sonde, performing scheduled maintenance and redeploying.

- Arrive on site and acclimate pH and conductivity standards and a liter of DI water to ambient stream temperature in order to accurately calibrate the Sonde. Place ice packs and calibration standard bottles in small cooler. Monitor the temperature of the standards to ensure they do not get too cold.
- Record current barometric pressure at the site along with other environmental conditions, such as; weather, changing water levels, color of water, etc on the datasheet. Reference Sonde (Quanta) should be calibrated weekly to insure accuracy. Once on site inspect Quanta DO membrane and re-calibrate the dissolved oxygen (percent saturation) to current site barometric pressure and deploy next to the sonde at least ten minutes before the half hour.

Download site sonde data

- Sonde menu
- Press enter

- Highlight File and press enter
 - Select upload and press enter
 - PC6000 Format press enter
-
- **Audit the site sonde** (datasonde that is dedicated to the site) by placing the reference sonde as close as possible to the lock box that contains the site sonde. As close to the half hour or top of the hour as possible, record the reference sonde water quality parameters on the datasheet. Remove the lock box containing the site sonde from the water approximately 5 minutes after the 30 minute or top of the hour reading. Carefully remove the site sonde from the housing trying not to disturb any fouling on the probes.
-
- Fill bucket with river water or tap water depending on time of season.
 - Connect site sonde to hand held and put in run mode by going to the sonde menu, highlight run and press enter, unattended, and look at file to ensure that it has been logging. At the bottom of the unattended setup screen highlight stop logging.
 - Press escape and highlight Discrete Sample and press enter, highlight start sampling and press enter. Sonde will stabilize for 120 seconds and then begin to show WQ parameters.
 - Place both the site sonde and reference sonde in the bucket and record pre-cleaning readings after WQ parameters have stabilized (Temp, SpCond, DO, pH) of site sonde in addition to readings of reference sonde in bucket.
 - Turn off reference sonde. Remove site sonde and thoroughly clean. Use an Alan head wrench to remove the wiper brush. Install wiper pad with no brush.
 - Take the big brush and thoroughly clean the inside and outside of the sonde lock box and clean the site sonde sensor guard with a toothbrush and Q-tips.
 - Take a Q-tip and clean out the data line connection on the datasonde and on the data line ensuring it is free of water and sand. Spread a thin coat of silicone on the o-ring on the connector.
- Cleaning site sonde: **Note: only site sonde is cleaned during cleaning process**
- **To Check Site Sonde Battery Make Sure The Option of “Power Sonde” Under The System Setup Menu On The Handheld Is Turned Off.**
 - YSI Sonde cleaning ○ Wash the outside and probe guard with towel and toothbrush

- To clean the Optical DO and BGA probes carefully wipe the surface of the probes with a moist Chem Wipe or Q-tip-DO NOT use any alcohol or Hydrogen peroxide
 - To clean Clark's DO membrane wipe softly with Q-tip Clean pH probe with spray bottle. Wipe *carefully* with Q-tip only if necessary
 - Clean Conductance probe with pipe cleaner. Rinse with spray bottle.
 - Clean Temperature probe with Q-tip. Rinse with spray bottle
 - Use Q-tip, toothbrush and spray bottle
- Replace site sonde and reference sonde in bucket and record post-clean readings of YSI site sonde and reference sonde in bucket after WQ parameters have stabilized.

Calibrate Conductivity

- Rinse probes three times with DI water.
- Rinse probes three times with specific conductivity standard.
- Fill calibration cup with fresh specific conductivity standard.
- Note temperature and look up standard correction
- Under the main menu highlight calibrate and hit enter
- Highlight Conductivity and hit enter
- Highlight SpCond and hit enter
- Enter the value of calibration standard (for 1,000 $\mu\text{S}/\text{cm}$, enter 1.0) and press enter.
- Wait at least 30 seconds until specific conductivity stabilizes and record the temperature and initial specific conductivity value onto data sheet.
- Press enter to calibrate the sonde
- Never accept an "Out of Range" message – if this occurs ensure there are no bubbles in the hole where the Sp Cond probe is located and that the standard covers the hole completely □ Record the final value of specific conductivity onto data sheet.
- Press Escape several times to go to the Main Menu and highlight Advanced and hit enter
- Highlight Cal constants and hit enter
- Record conductivity cell constant onto data sheet and verify the number ranges between 4.5 to 5.5
- Dump conductivity standard into rinse jar.

Calibrate pH

- Rinse three times with DI water
- Rinse three times with pH 7.0_ standard.
- Fill calibration cup with fresh pH 7.0_ standard ensuring that the temp probe is covered with calibration standard

- Press Escape twice to the main menu and highlight run and hit enter
- Highlight discrete sample and hit enter
- Highlight start sampling and hit enter
- Wait until temp stabilizes and record the temperature of the pH 7.0_ standard and the temperature compensated value for the pH standard, this is done to determine the temperature compensation for the pH standard, for example if the temp is 18 degrees C then determine the value of the pH 7 standard at 20 degrees C on the look up table on the datasheet and fill it out in the pH standard line on the datasheet
- Press escape 3 times to go to the Main Menu
- Highlight calibrate and hit enter
- Highlight ISE1 pH and press enter
- Highlight 2 point and press enter
- Enter the temperature compensated value for the pH 7._ calibration standard for the first calibration point and hit enter.
- Wait at least 30 seconds until pH stabilizes and record the initial pH 7._ value onto the data sheet.
- Press enter to calibrate the sonde □ **DO NOT press enter or escape!**
- Record the final value of pH onto data sheet.
- Record pH mv onto data sheet and verify that the value ranges between -50 and +50 □ Dump pH standard into rinse jar.
- Rinse three times with DI water.
- Rinse three times with pH 10._ standard.
- Fill calibration cup with fresh pH 10._ standard., ensuring that the pH probe is completely submerged
- Record the temperature of the pH 10.0_ standard and the temperature compensated value for the pH standard onto the datasheet
- Press Enter once and enter the temperature compensated pH 10.0_ value as the second point and hit ENTER.
- Wait until pH stabilizes and record the initial pH 10 value onto data sheet
- Press enter to calibrate the sonde
- Record the final value of pH onto data sheet
- Record pH mv onto data sheet and verify that the value ranges between -130 and -230
- Calculate the pH slope onto data sheet by subtracting the difference between the two numbers and enter the value onto the datasheet, ensure the value ranges between 165 and 180. A value of 165 or less indicates a failing probe.
- Dump pH 10.0_ standard into rinse jar
- Rinse three times with DI water

Calibrate BGA Probe (OR,SV,IG)

- Fill calibration cup $\frac{3}{4}$ of the way with DI water so that the BGA and temp probe are fully immersed.

- If using a short calibration cup, be sure to engage only one thread on the calibration cup during this procedure to avoid a small interference from the cup bottom □ On the 650 handheld, highlight Sonde Menu and press enter.
- Highlight Calibrate and press enter.
- Highlight BGA and press enter.
- Highlight 1 point and press enter.
- Enter BGA value as 0 and press enter.
- **After BGA has stabilized**, record initial temperature and BGA on data sheet. Press enter. Record final BGA value on data sheet.

Calibrate Turbidity Probe (SA,SC)

- Fill calibration cup $\frac{3}{4}$ of the way with DI water so that the Turbidity and temp probe are fully immersed.
- If using a short calibration cup, be sure to engage only one thread on the calibration cup during this procedure to avoid a small interference from the cup bottom □ On the 650 handheld, highlight Sonde Menu and press enter.
- Highlight Calibrate and press enter.
- Highlight Turbidity and press enter.
- Highlight 1 point and press enter.
- Enter Turbidity value as 0 and press enter.
- **After Turbidity has stabilized**, record initial temperature and Turbidity on data sheet. Press enter. Record final Turbidity value on data sheet.

Calibrate Optical DO Probe

Wrap the wet towel over the sensor guard to provide insulation. Place the entire sonde with wet towel into the DO calibration chamber (insulated cooler with ice packs) and make sure the sonde will not fall over.

- Go to the sonde main menu, highlight run and press enter, highlight discrete run, highlight interval and change it from 0.5 to 4 and highlight start sampling and press enter. **The ODO should be stable because it has been in the stable environment of the cooler.** Record initial temperature and ODO in mg/L on data sheet.
- Highlight calibrate and press enter. Highlight Optic T- Dissolved Oxy and press enter, highlight DO% and press enter. Enter the current BP, round off to the nearest whole number and press enter.
- The sonde will stabilize for 120 seconds and automatically calibrate ODO. Record the final ODO value onto datasheet in mg/L after calibration.
- Escape to the Advanced menu highlight cal constants and press enter and record the DO gain and verify range of DO gain is within 0.5 to 1.7 □ Disconnect the sonde and 650.

- Take off the wiper pad and install the clean wiper brush. Ensure that you can place a piece of paper between the bottom of the plastic wiper arm and the probe face.
- Gently press the wiper against the face of the probe until the foam pad is compressed to roughly one half of the original thickness and then tighten the setscrew.
- Install sensor guard and deploy sonde at least 5 minutes before it is set to take a measurement. Record the time of deployment

To create a new file:

On 650 handheld highlight sonde menu (it will now connect to sonde and beep. Notice small sonde icon on bottom right of 650 screen.)

Highlight run → unattended sample

Set interval to 00:30:00 and ensure that duration is 30 days.

Type filename: two letter site name then date ie IG062507

Type site name: le: Iron Gate

Write down battery voltage on audit sheet.

Start logging → are you sure? → yes

That will take you to logging screen where you will record start date/time and end date/time.

To double check that it is logging → on sonde main screen → status. Look to see if logging is active.

- Place the reference sonde next to the datasonde at least 5 minutes before it is set to take a measurement and record WQ parameters as close as possible to the half hour or top of the hour.

Appendix E-5: Calibration for YSI EXO Datasondes

YSI EXO2 Calibration SOP

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and to service the sonde. Properly filling out the calibration sheet is critical in collecting all the data that is needed for the evaluation of the sonde file. Here is an overview of a typical field tour consisting of extracting the sonde, performing scheduled maintenance, and redeploying.

- Arrive on site and acclimate pH standards, conductivity standard, and a liter of DI water to ambient stream temperature in order to accurately calibrate the sonde. Place ice packs and calibration standard bottles in small cooler. Monitor the temperature of the standards to ensure they do not get too cold.

- Record current barometric pressure at the site along with other environmental conditions, such as; weather, changing water levels, color of water, etc on the datasheet. The reference sonde should be calibrated weekly to insure accuracy.

Take the initial reading

- Place the reference sonde as close as possible to the lock box that contains the site sonde.
 - As close to the half hour or top of the hour as possible, record the reference sonde WQ parameters on the datasheet.
 - Remove the lock box containing the site sonde from the water approximately 5 minutes after the 30 minute or top of the hour reading.
 - Carefully remove the site sonde from the housing trying not to disturb any fouling on the probes.
- Fill bucket with river water or tap water depending on time of season. Place site sonde and reference sonde in the bucket.

Stop the file.

- Using the EXO handheld, go to Deploy→Stop Deployment (this also turns off sample and hold)

Take the pre-cleaned readings.

- Connect to the reference sonde and allow it to stabilize. Record WQ parameters on the datasheet.
- Connect to the site sonde and allow it to stabilize. Record WQ parameters on the datasheet.

Clean the site sonde.

- Remove the sonde from the bucket and spray outside with simple green.
 - Thoroughly scrub the sonde body and sensor guard with a brush and a bottle brush.
 - Rinse sonde.
 - Carefully clean the sensors with Q-tips and ChemWipes.
 - Clean the connections on the sonde and cable with a Q-tip and Dustoff, ensuring that they are free of water and sand.
 - Spray the sonde lock box with simple green and thoroughly clean the inside and outside with a brush.
- Note: only the site sonde is cleaned during the cleaning process**

Take the post-cleaned readings.

- Replace the site sonde in the bucket with the reference sonde.
- Connect to the reference sonde and allow it to stabilize. Record WQ parameters on the datasheet.
- Connect to the site sonde and allow it to stabilize. Record WQ parameters on the datasheet.

Calibrate the conductivity.

- Rinse probes three times with DI water.
- Rinse probes three times with specific conductivity standard.
- Fill calibration cup with fresh specific conductivity standard.
- Using the EXO handheld, click Calibrate→Conductivity→Calibrate→Sp. Conductance→enter the value of the conductivity solution as 1,000→ wait for sonde to become stable→Accept calibration→Finish calibration
- Record the temperature, value of standard, pre-calibration value, post-calibration value, and cell constant onto the datasheet.
- Click Exit→Back to get back to the calibration menu.
- Discard the conductivity standard.

Calibrate the pH.

- Rinse probes three times with DI water.
- Rinse probes three times with pH 7 standard.
- Fill calibration cup with fresh pH 7 standard.
- Using the EXO handheld, click Calibrate→pH→Change the value of the pH 7 standard based on the temperature of the pH standard. For example, if the temperature is 21 degrees C then determine the values of the pH 7 standards at 20 degrees C on the look-up table on the datasheet and input this value.
- Wait for sonde to become stable→Accept calibration □ Discard the pH 7 standard.
- Rinse probes three times with DI water.
- Rinse probes three times with pH 10 standard.
- Fill calibration cup with fresh pH 10 standard.
- Using the EXO handheld, click Calibrate→pH→Change the value of the pH 10 based on the temperature of the pH standard.
- Wait for sonde to become stable→Accept calibration→Finish Calibration
- Record the temperature, value of standard, pre-calibration value, post-calibration value, and pHmV for both pH 7 and pH 10 on the datasheet.
- Click Exit→Back to get back to the calibration menu.
- Discard the pH 10 standard.

Check the Turbidity.

- Rinse probes three times with DI water.
- Fill calibration cup with fresh DI water.
- Using the EXO handheld, connect to the sonde and allow it to stabilize.

- If the turbidity value is within -0.5 FNU and +0.5 FNU, then the probe is within spec and does not require a calibration.
- If the turbidity value does not fall within the previous range, then replace this probe with a precalibrated probe. Instructions for calibrating the probe are found below.
- Record the serial numbers of the removed turbidity probe and the replaced turbidity probe.

Calibrate the Turbidity (This is done in the office).

- Rinse probes three times with DI water.
- Fill calibration cup with fresh DI water.
- Using the EXO handheld, click Calibrate→Turbidity→NTU→enter the value of turbidity standard as 0→wait for sonde to become stable→Accept Calibration □ Fill calibration cup with 124 FNU solution.
- Enter the value of turbidity standard as 124→wait for sonde to become stable→Accept Calibration
- Rinse probes three times with DI water.
- Fill calibration cup with 1000 FNU solution.
- Enter the value of turbidity standard as 1000→wait for sonde to become stable→Accept Calibration→Finish Calibration
- Record the temperature, value of standards, pre-calibration values and post-calibration values onto the datasheet.
- Click Exit→Back to get back to the calibration menu.
- Discard the 1000 FNU solution.

Calibrate the BGA.

- Rinse probes three times with DI water.
- Fill calibration cup with fresh DI water.
- Using the EXO handheld, click Calibrate→TAL-PC→BGA PC RFU→enter the value of BGA standard as 0→wait for sonde to become stable→Accept Calibration→Finish Calibration
- Record the temperature, value of standard, pre-calibration value and post-calibration value onto the datasheet.
- Click Exit→Back to get back to the calibration menu.
- Discard the DI water. **Calibrate the DO.**
- Carefully dry the DO probe with a ChemWipe.
- Pour 1/8th inch of DI water in the bottom of the calibration cup.
- Ensure calibration cup is vented by loosening the threads (do not seal the cup to sonde).
- Place sonde in the shade out of direct sunlight and wait 10-15 minutes while it stabilizes.

- Using the EXO handheld, click Calibrate→ODO→Calibrate→DO% →wait for sonde to become stable→Accept Calibration
- Record the temperature, value of standard, pre-calibration value, post-calibration value, and DO gain onto the datasheet.
- Click Exit→Back to get back to the calibration menu.
- Discard the DI water.

Calibrate the wiper.

- Using the small allen key, remove the wiper brush from the middle probe.
- Replace with a clean wiper brush.
- Check if the wiper is in the middle of the wiper dock.
- If not, using the EXO handheld click Calibrate→Wiper→Calibrate→Move CW or Move CCW depending on which direction the wiper brush needs moved→Accept Calibration
- Take the used wiper brush back to the office. Clean with soap and comb out bristles. Secure a rubber band around the bristles and let dry.

Download the files.

- Using EXO handheld, click Data→Transfer Sonde Data→Enter the Begin date for the previous year→Transfer Sonde Data→Enter

Create a new file.

- Using the EXO handheld, click Deploy→Advanced Setup
- Under Mode, change to Sample and Hold
- Go back and click Start Deployment
- Under Deploy, change to Next Interval
- Click Start Deployment
- Ensure that the file is running by looking for a green arrow under the battery icon in the upper right corner.

Check the battery volts.

- Using the EXO handheld, click Deploy→Status □ Record the battery volts on the datasheet.
- If battery volts are below 5.83 V, replace with four new D-cell batteries. **Redeploy the sonde.**
- Reconnect site sonde to cable and place it in the lock box.
- Put the sonde back in the river.

Take the final reading.

- Place the reference sonde as close as possible to the lock box that contains the site sonde.
- As close to the half hour or top of the hour as possible, record the reference sonde WQ parameters on the datasheet.

Appendix E-6: Datalogger Instructions

H350 XL Datalogger Instructions

Equipment needed:

- Compact Data Card
- Key to enter lock box
- This SOP

To Download Data:

- Insert 256 MB Compact Flash Card with PC Card Adapter into Datalogger
- Scroll Down to 'Data Options'
- Press Arrow →
- Scroll Down to 'Copy Data to Card?'
- Press Enter
- Wait Until Datalogger reads 'Done, Press Cancel'
- Press Esc/Cancel to Main Menu
- Remove Data Card by pushing eject button next to card slot

Appendix E-7: Particulate Carbon and Nitrogen SOP

Sections 8 and 11 of Determination of *Carbon and Nitrogen in Particulates and Sediments of Fresh/Estuarine/Coastal Waters, Plant and Animal Tissue, and Soils Using Elemental Analysis.*

<http://www.umces.edu/sites/default/files/Particulate%20Carbon%20and%20Nitrogen%20Method.pdf>

Appendix E-8: C.Shasta Collecting and Filtering- Attached as a separate document.