Quality Assurance Project Plan

WRIA 31

Implementation and Monitoring Project

Agreement: G1400520

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Each study, funded in whole or in part with Ecology funding, must have an approved Quality Assurance Project Plan. This plan describes the objectives of the study and the procedures to be followed to achieve those objectives.

This report is available on the Department of Ecology website at http://fortress.wa.gov/ecy/publications/1410062.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm.

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WRIA 31 Implementation and Monitoring Project

February 2014

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2.0 Abstract

Ecology awarded Grant G1400520 to the Eastern Klickitat Conservation District (EKCD) to conduct temperature monitoring for the watersheds within WRIA 31. These watersheds include Alder Creek, Chapman Creek, Pine Creek, Rock Creek, Sixprong Creek, and Wood Gulch.

The most recent 303(d) list was approved by the Environmental Protection Agency (EPA) in December 2012 and Rock Creek is the only stream in this study that has a section listed as category 5. This section ID identification is 7967 and is listed for temperature. The location of this section of stream is in the upper Rock Creek watershed. The other streams in the WRIA are not listed on the 303(d) list but some have threatened species in a portion of the stream. Streams that have been identified as spawning streams for salmon and steelhead and have been given new temperature requirements of 55° F from Feb 15 to June 1 by EPA. However, it is pointed out in the *Rock Creek Water Quality Report* for WRIA 31 (Aspect Consulting 2005) that high temperatures in Rock Creek “may be natural for a small creek in a hot, sunny summer climate”, but that more monitoring and assessment is required to set a baseline standard for the creek.

3.0 Background Information

3.1 Study area and surroundings

The study area is located within eastern Klickitat County and Watershed Resource Inventory Area (WRIA) 31, in the south-central region of Washington State. It includes six adjacent basins: Rock Creek and its main tributaries (Luna Gulch, Squaw Creek and Quartz Creek), as well as Alder Creek, Chapman Creek, Pine Creek, Sixprong Creek, and Wood Gulch. See Figure 1 for watershed locations. The study area streams are tributaries to the Columbia River, which is on the 303(d) list for several factors, including temperature and sedimentation. They are all characterized as intermittent (lacking dry season flow) except in localized spring-fed reaches.

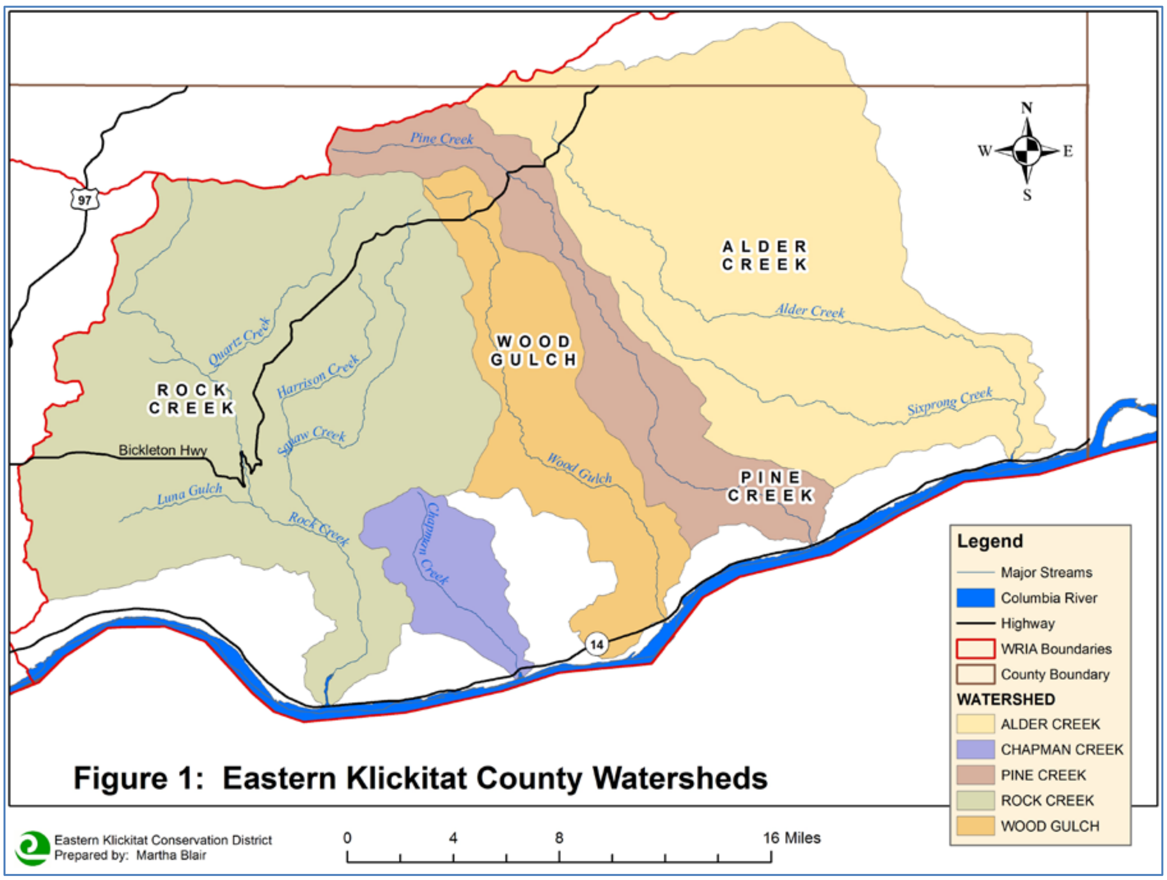

Figure 1. Eastern Klickitat County watersheds.

Average Annual rainfall (1951 – 2006) ranges from 8 inches in the southeast portion of the study area to 24 inches in the northwest portion of the study area. The region typically receives precipitation in the form of snowfall during November through March, with peak snowfall occurring in January. The snowfall period can extend October through May for the higher elevations. Average minimum daily temperatures are typically at or below freezing for December through February, and longer in the mountainous areas. Average daily temperatures are generally highest in July each year with daily maximum temperatures typically exceeding 90 degrees Fahrenheit during much of the summer at lower elevations in study area watersheds.

The WRIA 31 region is underlain by bedrock of the Columbia River Basalt Group (CRB) and interbedded terrestrial sediments deposited during time periods between sequential basalt flows. The CRB includes (from oldest to youngest) the Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Much of the eastern portion of WRIA 31 is covered with thin (generally less than 50 feet thick) deposits of Quaternary loess, alluvium, and flood deposits of sands, gravels, and silts (WRIA 31 Planning Unit 2008).

The Horse Heaven Hills, a broad east-west ridge, forms the Rock Creek watershed's northern boundary, and the Columbia River gorge forms the southern boundary. The watershed (248 square miles in size) slopes from an elevation of approximately 4,700 feet to the north to approximately 270 feet in the Columbia Gorge. With its deeply incised canyons, the Rock Creek watershed has the most topographic relief with correspondingly higher stream velocities and erosion potential than the other watersheds in WRIA 31. Streamflow in the watershed has a relatively "flashy" nature (high intensity, short duration flows). Following precipitation events, there is rapid streamflow response as a result of the bedrock terrain and relatively steep slopes in the watershed. Snowmelt runoff in the higher elevation headwaters helps sustain flows into early spring. Although there are numerous springs mapped in the Rock Creek watershed, groundwater discharges from the Wanapum Basalt, through which the creek incises, provide insufficient baseflow to sustain flows into the dry season.

The predominant land cover in the Rock Creek watershed is shrubland. This non-forested rangeland occurs throughout the watershed except in the highs elevation of the northern portion. The Rock Creek watershed is the only subbasin within WRIA 31 with a substantial proportion (approximately 26 percent) of forestland. The forestland occurs in the higher elevation areas of the upper watershed and is mostly privately owned. The dominant use of much of the shrubland and forest land in the watershed is for livestock grazing. Many of the riparian corridors are also forested, except in the lower elevation reaches. Stream banks in the lower portion consist largely of cobbles with little to no riparian vegetation. Agricultural cropland comprises a small percentage of the watershed area, with 4 percent of the area reported to be in dryland farming and 0 percent in irrigation. All of the cultivated land occurs within the lower half of the subbasin. Developed land accounts for less than 1 percent of the total subbasin area (WRIA 31 Planning Unit 2008).

The Pine Creek watershed occupies a 63 square mile area, with Pine Creek flowing approximately 28 miles from the headwaters in the Horse Heaven Hills southeast to the Columbia River. Coyote Creek and Juniper Canyon are the two major tributaries, but it also has several unnamed tributaries. The headwaters of Pine Creek are primarily pine forest, with the uppermost area on the Yakama Indian Reservation. Most of the drainage area below the pine forest is agricultural cropland, of which a high percentage is in the Conservation Reserve Program (CRP), which establishes permanent cover native grasses on cropland for a period of 10 years at a time. As the creek moves south to the Columbia River, more cropland is still in production, primarily wheat in an annual crop no-till seeding rotation. Historically, the older farming methods of summer fallow & wheat rotations added large amounts of sediment to all the creeks, however the newer farming methods such as no-till seeding and annual cropping, coupled with CRP and pasture/range management has significantly decreased the amount of non-point source sedimentation.

The Wood Gulch watershed is situated between Rock Creek and Pine Creek, occupying approximately 65 square miles. The headwaters are formed at the east flank of the Bickleton Ridge, just south of the Horse Heaven Hills. The small town of Cleveland is located along the stream in the headwaters, and the town of Roosevelt is located at the mouth of Wood Gulch. Agricultural land use is predominant in the watershed, including land in cultivation as well as shrubland and grassland. Farming practices are similar to those described for Pine Creek.

The Alder Creek watershed occupies approximately 200 square miles in the easternmost portion of this study area. It includes the Sixprong Creek drainage area, which joins Alder Creek in the lower watershed. The headwaters fall in Yakima County, originating in the Horse Heaven Hills. Similar to Pine Creek and Wood Gulch, agricultural land use is predominant in the watershed and includes both rangeland and cropland. Wineries and acres of land in grape production are becoming increasingly present in the Alderdale area.

The Chapman Creek watershed is the smallest included in this study, being approximately 24 square miles in size. Agricultural land use is predominant, consisting almost entirely of shrubland and pastureland used for livestock grazing.

3.1.1 Logistical problems

The creeks in WRIA 31 flow through rural land with a limited number of access roads. The landscape also includes steep canyons, which are inaccessible by vehicle, and time consuming to access on foot. High fire danger prevents use of many access roads from June through September. Logistically, this makes it difficult to transport the necessary equipment to stream sites. EKCD will visit sites with difficult access at least twice per year, but not monthly. Temperature data continues to download onto the data logger at 30 minute intervals. From this information it is easy to tell when flow stops and the streams pool. Data gathered from sites easier to access shows how pH and conductivity change when the stream pools.

The streams in eastern Klickitat County cease flowing and become pooled by mid-summer, except localized spring-fed reaches. Stream parameters will be collected when streams are flowing, and observations will be recorded if the stream has pooled. Ecology does not want information entered into the Environmental Information Management database (EIM) from pools.

Other areas, namely upper Rock Creek and Quartz Creek may not be measured for the entire season, because of marijuana grow operations in the vicinity. If a grow operation is found by law enforcement we will discontinue our monitoring because of safety concerns for our technician.

The location of each logger site is documented and photographed at each visit. The technician uses waterproof paper and ink to record the information. In addition, EKCD maintains temperature survey information for each monitoring site in Aquarius (our data management system), which includes a detailed sketch illustrating data logger placement. The sketch also indicates site location relative to the nearest roadway, parking available, trail access and landmarks.

Another logistical problem that occurs occasionally is loss of data loggers to vandalism, high flow events or stream sediment movement. We try to find monitoring sites that will reduce the likelihood of vandalism but it is very difficult to completely eliminate this threat.

Based upon past history of monitoring in WRIA 31, we can accept up to 10% lost data from each site. We try to prevent lost data by monthly data download and review to catch data loss due to equipment malfunction. We secure the data loggers as tightly as possible in a discrete location if possible to avoid loss of the logger in high flow events or vandalism.

3.1.2 History of study area

The *Habitat Limiting Factors Analysis* (LFA) for WRIA 31 (Rock - Glade Watershed areas), indicates that indigenous Rock Creek summer steelhead have potential spawning and rearing habitat in the lower reaches of most of the creeks in the District (Lautz 2000). Rock Creek summer steelhead are the only fish indigenous to the WRIA; this stock belongs to the Mid-Columbia Evolutionarily Significant Unit (ESU) for steelhead, which has been listed as “threatened” under the Endangered Species Act. Known utilization includes the lower and middle portions of Rock Creek, lower Quartz Creek, Squaw Creek, lower Chapman Creek and lower Wood Gulch. Potential spawning and rearing habitat has been identified in Pine Creek and Alder Creek.

Habitat limiting factors in the WRIA have been identified in the Limiting Factors Analysis. These include water access, widening of the channel from livestock grazing and flooding, water quantity and quality from degraded riparian areas, and information data gaps. Cattle grazing and trampling in and near stream banks was recognized as a land use practice that has caused accelerated channel entrenchment and downcutting, which results in a reduction in the quality and amount of available existing or potential fish habitat. However, this has not been identified and quantified, according to the WRIA 31 *Rock Creek Water Quality Report* (Aspect Consulting 2005). In that report cattle usage and effects is identified as a data gap. A later study, the *WRIA 31 Instream Habitat Assessment*, (WPN 2009) noted that livestock grazing occurs within the Rock Creek, Wood Gulch and Pine Creek subbasins. Observations made (*WRIA 31 Instream Habitat Assessment, 3.4.4, page 16*) suggested that in most locations, grazing was not intense enough to contribute substantial amounts of sediment to streams.

It is assumed that barrier culverts across State Route 14 on Pine Creek will be removed in the future, allowing summer steelhead access to improved spawning and rearing habitat. According to the *WRIA 31 Instream Habitat Assessment* (WPN, 2009) the limiting factor in Pine Creek is the lack of access to available habitats. If this were remedied (culverts removed) the limiting habitat factors in this basin would likely be flow and temperature but more temperature data is needed to estimate the carrying capacity of rearing habitat in this basin, according to the assessment.

High stream temperatures throughout the watersheds during the summer and early fall limit mobility of juveniles of all salmonid species. Temperature is a critical element of rearing habitat. High water temperatures can cause mortality in juvenile salmonids (WPN 2009). A riparian area is the land adjacent to the stream that interacts with the stream and its environment. Trees and vegetation along the stream provide a canopy, which shades the water and helps cool the water temperature. Cooler water entering the Columbia River can eventually help cool the waters of the river as required by the TMDL. Other limiting habitat factors stated in the LFA for WRIA 31 include the channel widening and obliteration of riparian zones caused by the 75 to 100 year flood event in 1996. This has resulted in locally poor habitat quality and riparian conditions. The LFA states, "there may be opportunity to accelerate habitat recovery and improve stability against smaller, more frequent floods through channel and riparian restoration activities."

3.1.3 Parameters of interest

Parameters of interest include dissolved oxygen, pH, and turbidity. These parameters have a direct relationship to temperature. A healthy riparian zone stabilizes stream banks and prevents sedimentation. Changes to the riparian area from various uses can have a profound impact on the health of a stream and its water quality. Listed below are agricultural-related water quality risks.

- An increase in agricultural land use can often alter streamside vegetation and sometimes the shape of the stream channel. These changes to stream and riparian area can have a direct and profound impact on the health of streams and water quality. An agricultural activity such as grazing can increase the amount of sedimentation in the stream, cause eroding of stream banks, and decrease streamside vegetation which in turn decreases shade to the stream and increase the number of pollutants that the vegetation would otherwise be able to filter. Alteration of riparian areas can directly influence the stream system. Riparian plant communities provide the following:
    - Shade
    - Fine or large woody material
    - Nutrients
    - Organic and inorganic debris
    - Terrestrial insects
    - Habitat for riparian associated wildlife
- Storm water runoff carries pollutions such as livestock manure, soil, fertilizer, and pesticides downstream into creeks and rivers. This can create a health problem for both humans and for aquatic life (Ecology 2012a).

3.1.4 Results of previous studies

EKCD began collecting baseline stream temperature data in WRIA 31 watersheds in 1995. In 1995-1996, Ecology in cooperation with EKCD conducted an evaluation of high water temperature, including the influence of riparian canopy cover in Rock Creek (Ehinger, 1996). The study concluded that the high water temperatures in upper Rock Creek "may be natural for a small creek in a hot, sunny summer climate". The outcome of the Ehinger's study, *Evaluation of*

High Temperature in Rock Creek (Klickitat County), was a set of management recommendations to reduce water temperatures and thus improve instream habitat. A Memorandum of Agreement (MOA) was subsequently established between Ecology and EKCD outlining measures to be implemented and reporting requirements. In accordance with the MOA, riparian vegetation was planted along portions of the Rock Creek drainage and EKCD began to monitor water temperatures.

A few years later, the *WRIA 31 Limiting Factors Analysis* (Lautz 2000) identified several factors potentially limiting fish production in Rock Creek. These included water access, widening of the channel from livestock grazing and flooding, and water quality affected by degraded riparian areas. Technically, some of these factors are not limiting factors but processes affecting habitat quality. There is very little publicly available information regarding fish habitat in the WRIA. The Limiting Factors Analysis recognized that conclusions were largely speculative and recommended that "More detailed information should be collected to more precisely define these factors, and to identify specific areas where restoration activities will best address them."

Temperature data collected by EKCD was later evaluated by Aspect Consulting in the *Rock Creek Water Quality Report* (2005). In this report they also examined aerial photographs to look for changes in the extent of vegetation within the Rock Creek valley bottom over time. The study evaluated total vegetation acreage in the valley bottom irrespective of location relative to the stream; it was not a study of stream shed. The study reviewed four sets of aerial photos from 1938 to 2002 and concluded that total vegetation cover increased in each period. Additionally, the rate of increase gradually accelerated over the period of record. Fire suppression was identified as a potential cause for the increase in vegetation in the watershed. Localized losses in vegetation were attributed to floods (particularly in 1964) and wild fires. The study also examined channel migration in the lower reach of Rock Creek over the same 1938 to 2002 period. This lower portion has a shallow, rocky channel, braided in segments, with little to no riparian cover. The channel is fairly dynamic, having changed courses multiple times over the time period examined.

Two more recent studies were conducted by EKCD in WRIA 31 watersheds, including the Pine Creek Enhancement Phase II project and the WRIA 31 Water Quality Remediation and Evaluation project. The former funded the District to monitor stream flow, temperature and other water quality parameters from 2007 – 2008 at five sites in the Pine Creek watershed. A second project allowed the District to maintain a network of 20 water quality monitoring sites in WRIA 31 watersheds from 2008 - 2012, in an effort to expand the quantity of baseline information for water quality and temperature. Parameters measured included stream and air temperature, pH, dissolved oxygen, turbidity, conductivity, and flow. Both of these projects were grant funded through the Department of Ecology and included project implementation in addition to water quality monitoring.

During this same time frame, the WRIA 31 Watershed Planning Unit completed the *Rock-Glade Watershed Management Plan for WRIA 31* (WRIA 31 Planning Unit, 2008). This effort was made possible through an Ecology Watershed Planning grant. It includes a summary of existing watershed conditions, water quality and habitat issues, and recommended actions.

In 2009, the *WRIA 31 Instream Habitat Assessment* was performed by Domoni Glass with Watershed Professionals Network. This study was performed in response to the identified need (during the planning process) for quantitative information on fish habitat across the WRIA. The project focused on spawning and rearing habitat for steelhead. This information can be used to help identify actions that can be taken to improve fish habitat and water quality.

A *Canopy Closure and Channel Morphology Study for Rock Creek* was completed in 2011 (Environ 2011). The purpose of this study was to fill information gaps to support implementation of the Watershed Management Plan. It develops baseline information for tracking changes in canopy closure, evaluates depositional areas for stream sediment to determine the feasibility of implementing channel condition improvement projects, and identifies priority areas for restoration work.

Yakama Nation Fisheries, Washington State Department of Ecology, United States Geological Society, and Washington Department of Fish and Wildlife have been actively involved in watershed monitoring and habitat studies in WRIA 31 watersheds (particularly Rock Creek), and these efforts have certainly yielded additional information and reports not specifically mentioned above.

The monitoring component of this grant will allow a continuation of the monitoring previously done in the watersheds by EKCD. The data collected for this grant period will add to the baseline information already collected. Data collected from 2007 to present has been entered into Ecology's EIM Database (Study ID numbers: G0700165, G0800298, and EKCD_WRIA31_WQ), as will the data collected during this study. Historical data is available to the public at the District office.

3.1.5 Regulatory criteria or standards

WAC 173-201A-600 (WAC 2012) designates the default uses of fresh water s in Washington State as:

All surface waters of the state not named in Table 602 are to be protected for the designated uses of: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

WAC (2012) Table 602 lists the following streams as Core Summer Salmonid Habitat:

- Squaw Creek and unnamed tributary at latitude 45.8758 longitude -120.4324 (Section 33 T5N R19E): all waters above confluence.
- Rock Creek and Quartz Creek: all waters above confluence.

The associated criteria for the WRIA 31 designated uses addressed by this QAPP are listed in Table 1.

Table 1. Regulatory criteria standards for selected fish species (WAC 2006).

Fish Species	Water Temp 7-DADMax[2]	pH	Turbidity Maximum	Dissolved Oxygen Lowest 1 Day Minimum
Salmon & Trout Spawning	13° C (55.4° F)	pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units.	≤ 5 NTU over back ground when background is ≤ 50 NTU. Or ≤10% over background when background is >50 NTU	9.5mg/L
Salmonid Spawning, Rearing, Migration	17.5° C (63.5 ° F)	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units.	Same as Above	8.0 mg/L
Salmonid Rearing and Migration Only	17.5° C (63.5 ° F)	Same as Above	≤ 10 NTU over back ground when background is ≤ 50 NTU. Or ≤20% over background when background is >50 NTU	6.5 mg/L
Indigenous Warm Water Species	20° C (68° F)	Same as Above	≤ 10 NTU over back ground when background is ≤ 50 NTU. Or ≤20% over background when background is >50 NTU	6.5 mg/L

[1]Surface Water Criteria for Class AA and A waters
[2]7-day average of the daily maximum temperatures

In addition to the Designate Use criteria listed above, the following supplemental criteria for Salmon and Trout Spawning apply to the highlighted freshwaters in WRIA 31 (Figure 2) (Ecology 2011).

- ≤ 13° C from February 15th – June 1st.

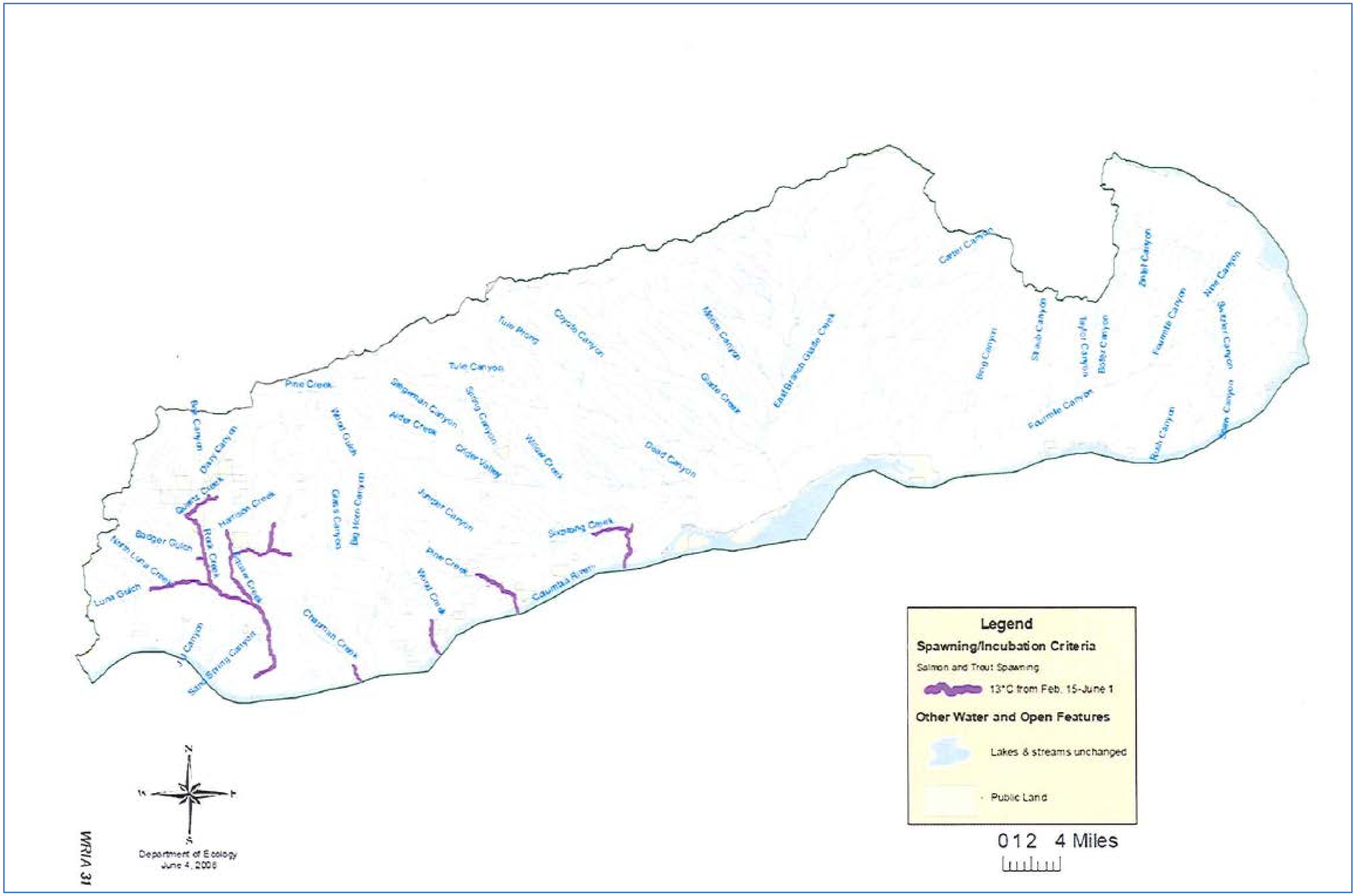

Figure 2. Supplemental spawning and incubation criteria for WRIA 31.

4.0 Project Description

4.1 Project goals

This project is designed to help provide data and assessment information to fill data gaps and to help determine the natural conditions for the tributaries to the Columbia located in the Eastern Klickitat Conservation District and WRIA 31. It will collect data relating to water quality, including water temperature, air temperature at selected sites, conductivity, dissolved oxygen, pH, and turbidity. Dissolved oxygen will now be collected using a LDO probe which was recommended by Ecology and approved by the EPA (ProODO Handheld Optical Dissolved Oxygen Meter). Standard operating procedures for the new instrument will be followed as directed by the manufacturer and are shown in Appendix A.

This is an implementation project that will continue activities that were initiated with previous grants. This project focuses primarily on Rock Creek, a Category 5 stream, but will also address water quality issues in other streams in WRIA 31 within the District. NOAA Fisheries has designated portions of Rock Creek, Chapman Creek, Wood Gulch and Alder Creek as critical habitat. Rock Creek is the only WRIA 31 stream on the 303(d) list for violations of water temperature criteria.

This project supports the completed Watershed Management Plan and the Straight to Implementation Plan in progress, which place a high priority on implementing projects with the potential to reduce water temperature, as well as ensuring that human effects on temperature are within acceptable levels under the state water quality regulation. Our ultimate goal is the removal of Rock Creek from the 303(d) list by reducing stream temperatures and improving habitat for salmonids. Actions identified during the planning process include:

- Monitor stream flow and temperature at locations best positioned to determining the effects of land use on water quality, and delineate between existing and natural conditions.
- Continue or implement programs such as cost-sharing for landowner vegetation efforts, no-tell seeding, protection or enhancement of riparian areas that assist landowners in implementing BMP’s which enhance canopy cover and encourage channel stabilization.
- Prioritize riparian planting to target areas that can be successfully vegetated, recognizing natural channel migration etc., and that have been impacted by land use practices such as livestock grazing.
- Advise and assist landowners in the upper watershed with BMP’s to ensure road stability and protect against impacts from vegetation control activities.
- Look for opportunities to implement BMPs for grazing and forestry practices that enhance riparian areas, stabilize soils, improve water quality and capability of soils to retain water. This could include construction of off-channel livestock watering locations and other livestock management actions.
- Develop and implement practical options to increase instream flows in Rock Creek.

- Regularly report on completion of activities required by the water quality improvement and protection plan, and progress toward stated objectives of the plan.

Water quality issues in the study area have been identified in the WRIA 31 Watershed Management Plan (WRIA 31 Planning Unit 2008) and the WRIA 31 Watershed Assessment (Aspect 2004). This project will implement practices where solutions to quality issues are likely to be successful, including shade, pooling and augmentation, Large Woody Debris (LWD), or other BMPs consistent with temperature reduction. We will assess project potential in the upper-forested Rock creek watershed. Water quality monitoring will continue at 20 sites in WRIA 31 streams, building upon the database of information gathered to date. Better understanding of the stream hydrology will be important for water quality management and habitat conservation in this area. To augment the baseline information and help fill data gaps, Klickitat County Natural Resources (KCNR) will install two gauging stations on Rock Creek. EKCD will be responsible for collecting and maintaining the data from those stations.

The monitoring portion of this project will expand baseline water quality data for WRIA 31 watersheds and will monitor the effects of the implementation of Best Management Practices (BMPs) from previous grants as well as the implementation task of this grant. The baseline data collected under this grant can be used by EKCD and other agencies and individuals in future watershed studies. It identifies the condition of stream sites with respect to water quality and stream temperature, including the degree to which water quality is impaired. This information will guide agencies as they seek to establish projects that will effectively address watershed concerns. As ESA listing pressures increase we are expecting that the baseline stream trend information will provide us with a historical reference of where we’ve been and will help achieve the stated goals for water quality in the watershed.

The BMPs implemented as a result of this grant when completed will improve habitat and may help induce spawning and rearing of summer steelhead on the lower reaches of the creeks in the District. Livestock exclusion fencing and riparian plantings have been identified as tasks for this grant. These practices will help cool late spring waters, and prevent sedimentation during higher flow periods. Increased sediment is identified as a cause for elevated temperature in the watersheds of WRIA 31. The sediment deposits increase the width and decrease the depth of the streams. This increase in the width: depth ratio leads to the rapid increase in temperature during the summer’s critical flow period. The BMPs implemented by the grant will address these issues at many different sites in the watershed, leading to improved water quality and, ultimately, lowered temperatures.

4.2 Project objectives

Five project objectives will be carried out in this grant:

1. Develop a Quality Assurance Project Plan (QAPP) and submit to Ecology for review, comment, and approval by 4/20/2014. Follow QAPP and submit all data to Ecology through EIM annually.
2. Install data loggers at 20 sites and monitor for temperature, flow, pH, conductivity, and turbidity monthly (April – November).

3. Take over operation and maintenance (O&M) of the permanent gauging station at Highway 8 Bridge on Rock Creek. Negotiate needed tasks with Ecology and assume responsibility when abandoned by USGS, to operate through October 31, 2016.
4. Assume O&M of two new gauging stations installed by KCNR, to begin upon completion of installation in 2014. QAPP to be supplied by KCNR for data collected with these two gauging stations.
5. Monitor for stream discharge, pH, conductivity, and turbidity to establish baselines for these parameters.

The project objectives will be to expand the inventory of baseline monitoring data for WRIA 31 watersheds. All data collected will be submitted to the Department of Ecology EIM database as appropriate. Data loggers will be downloaded into EKCD computers and organized by Aquarius software prior to submittal to the EIM database.

4.3 Information needed and sources

This project is designed to measure temperature of the WRIA 31 watersheds in eastern Klickitat County. All parameters that may affect temperature will also be measured, including depth, stream flow, and turbidity. Other factors associated with temperature will be measured in an effort to establish baseline data for those parameters. Parameters taken at each monitor site will include water temperature, air temperature at some locations, stream discharge, pH, conductivity and turbidity. See Table 2, Table 4, and Table 5 for parameters and site information.

This project will build upon data that have been previously collected in the EKCD watersheds and will track water quality trends that may result from implemented BMP's. Trends will be tracked by taking flow measurements and other data monthly. Trends may begin to show based upon the long record of data collection.

To determine whether the data quality objectives have been achieved, total and analytical precision will be calculated and compared to the requirements whenever applicable. If the total precision does not meet the stated objectives, outliers will be documented and flagged in the database according to the extent of deviation. Outlier data will be analyzed through an iterative process and assessed to determine the extent of deviation from the stated objectives of the project precision. Only valid data will be used in the final analysis. In some cases, late summer readings may be affected at certain sites when the creek goes dry. These variations are easy to differentiate and will not be used as water temperature data.

4.4 Target population

The project will track water temperature and the other parameters as outlined. The Target Population will be the data gathered at each monitoring site during each sample event for conductivity, flow (cfs), pH, temperature, and turbidity. Measurements of the target populations are intended to be representative of water in the reach upstream of the sampling points. Sites were chosen to be a representative sample of the conditions in any particular reach. Data gathered will help establish baseline data for the parameters measured.

4.5 Study boundaries

The data logger stations have been placed in such locations in each sub-watershed as logistical constraints have permitted and where the purpose of the monitoring program can be accomplished. The majority of the stations have been monitored under EKCD's ambient monitoring program for nearly two decades. Each station was initially chosen to be representative of typical stream conditions and surrounding land use practices. Site accessibility, including landowner permission required for EKCD staff to conduct long-term monitoring activity on privately owned property and the physical ease of access to the stream, was also taken into consideration during the site selection process. EKCD feels that it is important for our study to utilize pre-existing monitoring sites, so that data collected during the course of this grant can be compared directly to historical data collected at the same locations.

4.6 Tasks required

All of the Onset Water Temp Pro v2 temperature data loggers, the ProODO Handheld Optical Dissolved Oxygen Meter, the YSI ProPlus field meter, and the Turbidimeter are calibrated and checked according to the schedule in Table 3. The temperature data loggers cannot be calibrated, but are checked for drift twice annually: before deployment and following removal at the end of the monitoring season. This is done using a NIST certified mercury thermometer to verify the temperature following a well-mixed ice bath, which checks the temperature recorded at 0°C. In addition to the ice bath method, a room temperature calibration procedure is also performed. See the SOP's in Appendix A for calibration procedures.

Any temperature data loggers that do not calibrate within the accepted standards are either discarded or sent in for repair. At the end of the season, when the units are brought in, the calibration is checked again. Each monitor site is visited monthly and the temperature data downloaded, brought back to the office and loaded onto the computer of the monitor technician. During the site visit when the shuttles are downloaded, the other monitor parameters are taken. Temperature will also be taken with a calibrated NIST thermometer to check QA and validate the temperature readings taken by the temperature data loggers and field meter.

The parameters sampled for each site are listed in Table 2. It is important to note that not all sites will be sampled for air temperature. Air temperature loggers will be deployed in enough locations to represent the overall air temperature conditions in the basin. This is an important step for quality control because eleven of the sites are considered seasonal. These seasonal sites often expose the data logger to air because streams stop flowing during the season. Using the data from the air temperature loggers it makes it easier to detect exactly when the stream went dry and when the water logger was then exposed to air.

Table 2. Sites and parameters sampled.

Sites Monitored		Analytes						
ID	Monitor Site	Conductivity	Dissolved Oxygen	Flow	pH	Air Temperature	Water Temperature	Turbidity
AC1	Alder Creek #1	✓	✓	✓	✓	✓	✓	✓
AC2	Alder Creek #2	✓	✓	✓	✓		✓	✓
AC3	Alder Creek #3	✓	✓	✓	✓		✓	✓
CH1	Chapman Creek #1	✓	✓	✓	✓		✓	✓
LG2	Luna Gulch #2	✓	✓	✓	✓		✓	✓
PC1	Pine Creek #1	✓	✓	✓	✓		✓	✓
PC2	Pine Creek #2	✓	✓	✓	✓		✓	✓
PC3	Pine Creek #3	✓	✓	✓	✓		✓	✓
PC5	Pine Creek #5	✓	✓	✓	✓		✓	✓
PC6	Pine Creek #6	✓	✓	✓	✓		✓	✓
PC7	Pine Creek #7	✓	✓	✓	✓		✓	✓
RC1	Rock Creek #1	✓	✓	✓	✓		✓	✓
RC3	Rock Creek #3	✓	✓	✓	✓		✓	✓
RC6	Rock Creek #6	✓	✓	✓	✓	✓	✓	✓
RC7	Rock Creek #7	✓	✓	✓	✓		✓	✓
RC8	Rock Creek #8	✓	✓	✓	✓		✓	✓
RC9	Rock Creek #9	✓	✓	✓	✓	✓	✓	✓
SPC1	Sixprong Creek #1	✓	✓	✓	✓		✓	✓
SPC2	Sixprong Creek #2	✓	✓	✓	✓		✓	✓
WG2	Wood Gulch #2	✓	✓	✓	✓		✓	✓

4.7 Practical constraints

The most likely constraints on the monitoring will be high water flows in the spring or fall that will restrict access to the streams. High stream flows will not allow the technician to enter the water safely. While it may be possible to install the Onset Water Temperature Data Loggers, it may not be possible to take flow measurements and stream width and depth measurements. Care will need to be taken to not install the temperature loggers too shallow or they may be out of the stream when the flow subsides. As the season progresses and flow decreases, it may be necessary to reposition the data loggers to assure they remain in the stream. Many of the streams cease to flow and pool later in the summer. Care will be taken to document the data loggers that are located in pools.

4.8 Systematic planning process

The Performance and Acceptance Criteria (PAC) process is the systematic planning process being used. Since decision making is not the primary focus or intended outcome of the data collection, if we are unable to begin all the monitoring because of high flow, we will wait until the water levels recede to a safe level before beginning the monitor season. The data collected may be used for a water quality improvement plan, may be part of adaptive management for this project or the DIP, or it may be used to identify the best locations for BMPs for implementation projects, or to implement monitoring strategies to achieve the goals of the project.

5.0 Organization and Schedule

5.1 Key individuals and responsibilities

The Eastern Klickitat Conservation District (EKCD) is located at 1107 South Columbus Avenue, Goldendale, Washington (509) 773-5823, is the implementing agency for the Centennial Clean Water Fund. EKCD will be responsible for water quality monitoring for field measurements of conductivity, flow (cfs), pH, temperature, and turbidity.

EKCD staff: Jim E. Hill - District Manager, and Jess Davenport - Monitoring and Water Quality Technician will be responsible for collecting and compiling all data from all relevant sources for analysis and planning. EKCD will ensure that appropriate water quality sampling training is provided to EKCD staff members prior to sampling. EKCD staff will be responsible for delivering data assessment.

The EKCD is the agency responsible for implementation, development, and management of WRIA 31 Implementation and Monitoring Project grant #G1400520. EKCD will be responsible for maintaining communications with the funding agency and ensuring compliance with specifications outlined in the project plan.

The Washington State Department of Ecology, P.O. Box 47600 Olympia, Washington, is the funding agency for the WRIA 31 Implementation and Monitoring Project grant G1400520. The responsibility of the funding agency is to ensure that all project requirements are met and that the data collection program as outlined here meets project requirements. Currently, Heather Simmons of Ecology's Central Regional Office, 15 W. Yakima Ave. Suite 200 Yakima, Washington (509) 574-3991, is the project manager for this grant.

5.2 Special training and certificates

The Public Works Laboratory (accreditation # M1485) is located in Goldendale, Washington. Accredited parameters for this lab include *Fecal Coliform – count*, using the standard method 9222 D.

5.3 Organizational chart

Chain of communication between EKCD, Ecology, and partners is shown in Figure 3.

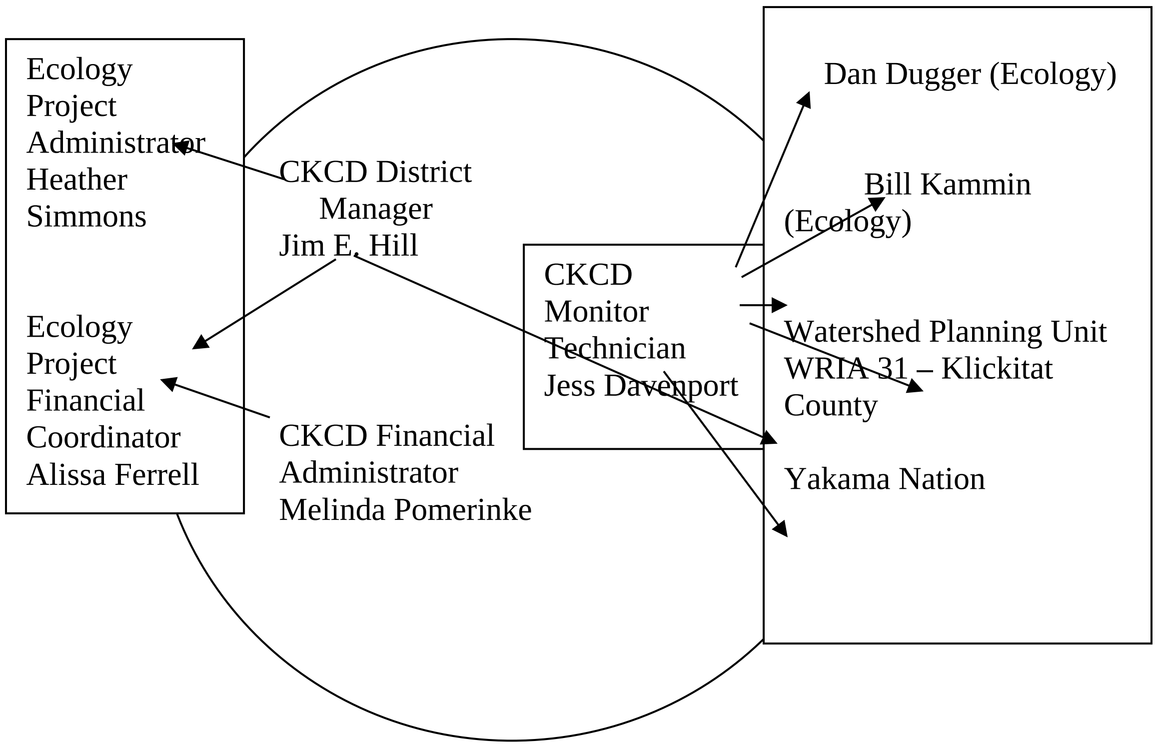

Figure 3. Chain of communication between EKCD, partners, and Ecology.

5.4 Project schedule

The monitoring phase of this project will begin in April 2014 and is funded until October 31, 2016.

- Annual Sampling, April 2014 – October 31, 2016
  - April to November — Field work conducted
  - November — Data analyses completed and data reported to project lead
  - December to February — EIM data entry completed
  - March — Equipment calibration, monitoring preparation
- February 2017 — Final report completed

5.5 Limitations on schedule

Sampling under this plan is scheduled to begin in April 2014. High spring flows may not allow the full extent of the monitors to be placed at that time, but subsequent site visits will allow the full complement of loggers to be placed and stream flow readings taken.

5.6 Budget and funding

This project is funded by Department of Ecology, Grant G1400520, and the monitoring task is funded for the length of the grant. A total of $110,000 is available for the monitor technician and necessary equipment purchases in Task 2 of the grant contract.

6.0 Quality Objectives

6.1 Decision quality objectives

Quality objectives for this study are:

- Collect in-situ measurements and samples from sites in WRIA 31 that are representative of the selected reaches.
- Obtain analytical results that minimize uncertainty and can be used to measure progress in meeting water quality standards.

Objectives will be achieved through careful planning and execution of analysis, and through quality control (QC) procedures presented in this plan. The plan was developed with direction found in *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Lombard and Kirchmer 2004). This will ensure data credibility and usability, in compliance with the Water Quality Data Act (RCW 90.48.570-590) and Water Quality Program-Environmental Assessment Program Policy 1-11, Chapter 2: "Ensuring Credible Data for Water Quality Management" (Ecology 2006, Ecology 2012a). Valid data collected for this project will accurately represent the water quality of the targeted stream reaches spatially and temporally.

6.2 Measurement quality objectives

Ecology may use the temperature data from this study to assess compliance with state water quality standards, and also provide information on streams in an effort to identify a trend in water quality. The data collected from these water monitoring stations will also be used to establish and supplement permanent baseline databases. These results will be used now and in the future to assist landowners in making intelligent and informed decisions about the water that flows on and through their property.

When calibration is performed on the data loggers before deployment, the field meter (YSI multiparameter thermometer) will be checked against the NIST thermometer. This will also be done following the removal of data loggers from the field during post calibration. Weekly temperature checks using the NIST thermometer against the YSI multiparameter instrument will be performed at the office and recorded. Care will be taken in the field to take YSI temperature measurements on the hour or half hour and record them on the field sheet. These will coincide with readings taken by the data loggers which take record measurements on the hour and half hour. Following these QC procedures in the field will allow us to compare one data set to another and estimate corrections based upon those readings taken.

6.2.1 Precision and Bias

Precision and bias together express data accuracy. Other data quality indicators include representativeness and completeness. Quality objectives apply to laboratory and field data collected for this study.

6.2.1.1 Precision

Precision is a measure of the ability to consistently reproduce results. Precision will be evaluated by field checks of temperature loggers with field thermometers.

When applicable, precision will be presented as standard deviation and relative standard deviation, and bias as relative percent bias. Calculations will be made using the equations presented in *Guidelines and Specifications for Preparing Quality Assurance Project Plans*, (Lombard and Kirchmer 2004).

Experience at the Department of Ecology has shown that duplicate field thermometer readings consistently show a high level of precision, rarely varying by more than 0.2º C. Therefore, replicate field thermometer readings were deemed not necessary and will not be taken (Brock and Stohr 2000).

Table 3. Quality assurance sample and calibration schedule.

Parameter	QA sample type	Frequency
Water Temperature	N site field thermometer checks of instream data logger temperature	1 per site visit
Stream Flow	Duplicate measurement	1 per sample month
Turbidity	Calibration	Before each monitoring season
pH	Calibration	Before each sample day
	Standard check	Before and after each sample day
Specific Conductivity at 25° C	Calibration	Before each sample run (minimum once per month)
	Standard check	Before each sample day
Dissolved oxygen (luminexcent)	Calibration	Before each sample run (minimum once per month)
	Standard check	After each sample week

Table 4. Measurement Quality Objectives for field measurements.

Parameter	Method/ Equipment	Replicates[1]	Method Lower Reporting Limit and/or Resolution	Expected Range
Continuous Water and Air Temperature	Onset Tidbit v2	+/-0.2°C	0.01°C	0 - 30° C
Water Temperature (field meter)	YSI 556 MPS	+/-0.2°C	0.01°C	0 - 30° C
pH	YSI 556 MPS	NA	0.01 s.u.	6.5 to 9.0 s.u.
Specific Conductivity at 25°C	YSI 556 MPS	NA	1 µS/cm	20 – 1000 uS/cm
Water Temperature (field meter)	ProPlus Handheld Multiparameter Instrument	+/-0.2°C	0.01°C	0 - 30° C
pH	ProPlus Handheld Multiparameter Instrument	NA	0.01 s.u.	6.5 to 9.0 s.u.
Dissolved Oxygen (luminescent)	ProPlus Handheld Optical Dissolved Oxygen Meter	NA	0.1 mg/L	0.1 – 15 mg/L
Specific Conductivity at 25°C	ProPlus Handheld Multiparameter Instrument	NA	1 µS/cm	20 – 1000 uS/cm
Turbidity	Hach 2100P	10% RSD	0.5 NTU	0 – 100 NTU
Streamflow	SonTek FlowTracker ADV	NA	0.01 cfs	0.01 – 1,000 cfs

[1] N/A is not applicable.

6.2.1.2 Bias

Bias is the systematic error due to contamination, sample preparation, calibration, or the analytical process. Most sources of bias are minimized by adherence to established protocols for the collection, preservation, transportation, storage, and analysis of samples. For field measurements, IDCD staff will:

- Minimize bias in the field meter measurements by pre-calibrating before each sample run. A sample run is defined as monthly run to all monitoring sites.
- Assess any potential bias from instrument drift in probe measurements:

- For pH and conductivity, post-checking the probes against National Institute of Standards and Technology (NIST) certified pH and conductivity standards.
- For DO, post-checking the probe against 100% air saturated water.
- For temperature, checking the probe's temperature readings before and after each sample run using a NIST certified thermometer.

Table 5 contains the data quality bias objectives for both instrument drift and fouling checks.

Table 5. Measurement Quality Objectives for field meter post-deployment checks.

Parameter	Units	Accept	Qualify[1]	Reject
pH	std. units	< or = + 0.2	> + 0.2 and < or = + 0.5	> + 0.5
Conductivity[2]	µS/cm	< or = + 5%	> + 5% and < or = + 15%	> + 15%
Temperature	° C	< or = + 0.2	> + 0.2 and < or = + 0.5	> + 0.5
Dissolved Oxygen	% saturation	< or = + 5%	> + 5% and < or = + 10%	> + 10%

[1] In Ecology's EIM database, data that is qualified by calibration check is coded 'E' (Reported result is an estimate because it exceeds the calibration range.)

[2] Criteria expressed as a percentage of readings; for example, bufrer = 100.2 µS/cm and Hydrolab = 98.7 µS/cm; (100.2-98.7)/100.2 = 1.49% variation, which would fall into the acceptable data criteria of less than 5%.

All data that does not meet total precision and relative bias objectives will be flagged to indicate such. Upon completion of the monitoring project, a paired estimate of the standard deviation will be used to assess total precision for the project. If the total precision does not meet the stated objectives, outliers will be documented and flagged in the database according to the extent of deviation, and a second analysis will be done to verify whether the data should be used. The differences will be analyzed to ascertain the reasons for the outcome variables. Only valid data will be used.

6.2.2 Sensitivity

As a data quality indicator in this document, sensitivity can be defined as the lowest concentration of a substance that can be detected, or the lower limit of detection. The measurement quality objective for sensitivity is the smallest concentration of interest. See Appendix A for instrument accuracy and ranges.

6.2.3 Comparability

Data generated during this project will use approved methodologies (APHA Standard Methods 1989) and therefore will be comparable to data collected by Ecology staff during routine core station monitoring. There have also been numerous studies completed within this planning area and data collected under this project may be compared to other results.

6.2.4 Representativeness

To assess representativeness, the EKCD Manager will review field monitoring documentation to determine if external circumstances may have affected the field measurements. The monitoring sites were chosen for their location to be a representative example of a certain reach of the stream (e.g., placed in the main flow, but not in a backwater or eddy, and not placed too near the substrate in a groundwater upwelling reach). Water that flows past the monitor points when no reading is being taken cannot be used to form conclusions. Temperature readings taken every 30 minutes will be as representative a sample as is practicable. Over time, other parameter readings, taken monthly at a different time over the course of the season, will give an idea of the overall quality of the water in that particular reach. Since the data loggers are placed to be in a representative location for a particular reach, readings taken over time, at different times of day, should be a representative sampling of the target population.

6.2.5 Completeness

Completeness will be determined by dividing the number of measurements collected by the number of measurements scheduled to be collected. The project will be considered successfully completed if the resulting value is at least 90% for each parameter and perennial monitoring station. Temperature data is considered 100% complete when data loggers have collected data from May 1 to October 31 at 30 minute intervals. Other data is completed at 100% if readings and measurements are taken monthly from May through October. The completeness value of 90% was arrived at from past history with loggers and data collection. Sometimes high or low stream flow levels may prevent collection of discharge data. Additional circumstances may prevent data collection, including equipment malfunction and the loss of data loggers.

7.0 Sampling Process Design

7.1 Study design

7.1.1 Field measurements

Measurements and samples will be taken monthly starting in late April and ending in early November of each year. The temperature data loggers are set to record temperature data every 30 minutes.

7.1.2 Sampling location and frequency

There are twenty monitoring stations in the WRIA 31 study area (Table 6, Figure 4). The stations have been placed in such locations in each sub-watershed as logistical constraints have permitted and where the purpose of the monitoring program can be accomplished. Each station was chosen to be representative of typical stream conditions and surrounding land use practices within each watershed.

7.1.3 Parameters to be determined

Physical parameters to be determined include air temperature, water temperature and flow. Field measurements will be collected for conductivity, flow, pH, stream temperature, air temperature, and turbidity. Photographs of the stream will also be taken at each site visit to document conditions.

7.2 Maps or diagrams

Refer to Figure 1, Figure 2, and Figure 4.

7.3 Assumptions underlying design

For any particular sample in any particular reach it is difficult to be 100% accurate. The project is designed to be a representative sample and provide representative data for the parameters gathered. Every effort is taken to assure accuracy, but for trend data collected by EKCD, we do not expect triple redundancy.

7.4 Relation to objectives and site characteristics

The water quality monitoring strategy relates to the study objectives and to the characteristics of the study area. The proposed frequency of measurements is intended to capture the expected temporal variability of the parameters of interest. The proposed monitoring locations take into account spatial variability. Locations monitored by EKCD were chosen based on physical characteristics that represent those found throughout the reaches. Watersheds within the WRIA 31 study area are represented.

Table 6. Monitoring locations.

ID	Monitoring Site	Coordinates
AC1	Alder Creek #1	N 45º 51' 25.1" W 119º 55' 19.2"
AC2	Alder Creek #2	N 45º 52' 00.3" W 119º 55' 22.9"
AC3	Alder Creek #3	N 45°59’ 29.3” W 120°16’ 26.0”
CH1	Chapman Creek #1	N 45º 43' 22.1" W 120º 18' 53.2"
LG2	Luna Gulch #2	N 45º 48' 24.7" W 120º 37' 07.9"
PC1	Pine Creek #1	N 45° 49’ 30.8” W 120° 11’ 16.4”
PC2	Pine Creek #2	N 45° 59’ 40” W 120° 19’ 22.1”
PC3	Pine Creek #3	N 45° 00’19.5” W 120° 25’ 43.1”
PC5	Pine Creek #5	N 45° 56’ 12.5” W 120° 15’ 43.6”
PC6	Pine Creek #6	N 45º 47' 29.8" W 120º 05' 07.5"
PC7	Pine Creek #7	N 45º 59' 40.0" W 120º 19' 22.1"
RC1	Rock Creek #1	N 45º 58’ 11.4” W 120º 27’ 14.7”
RC3	Rock Creek #3	N 45º 55' 05.9" W 120º 37' 31.9"
RC6	Rock Creek #6	N 45º 50' 32.6" W 120º 31' 53.6"
RC7	Rock Creek #7	N 45º 47' 49.0" W 120º 27' 51.6"
RC8	Rock Creek #8	N 45º 47' 36.6" W 120º 27' 40.8"
RC9	Rock Creek #9	N 45º 43' 22.3" W 120º 27' 26.9"
SPC1	Six Prong Creek #1	N 45º 52' 00.5" W 119º 55' 23.0"
SPC2	Six Prong Creek #2	N 45°51’ 23.8” W 120° 02’ 02.1”
WG2	Wood Gulch #2	N 45º 50’ 19.4” W 120º 17’ 58.3”

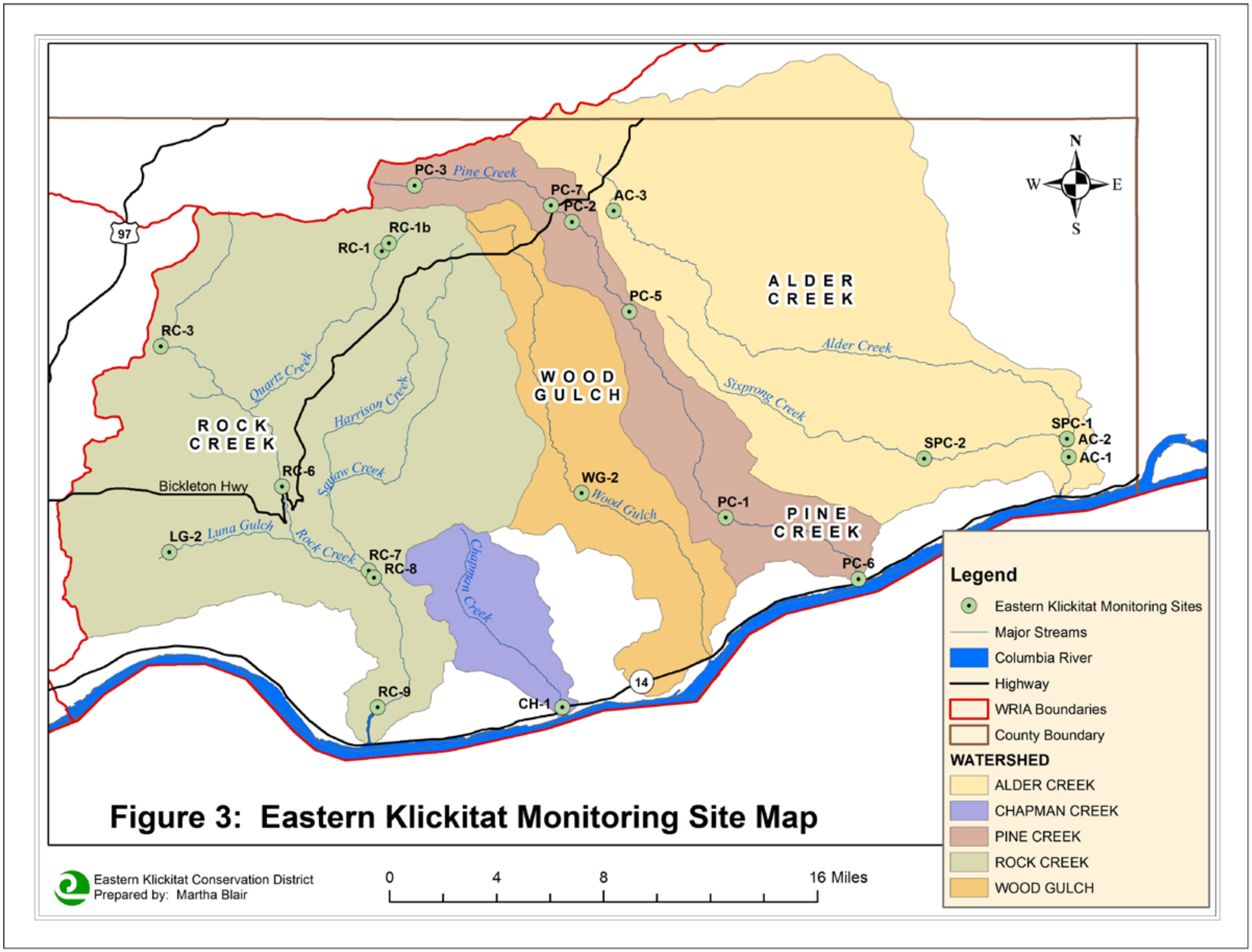

Figure 4. Monitoring locations.

7.5 Characteristics of existing data

Stream monitoring has been performed at the majority of the site locations indicated for this study since 1995. Sources for existing data at these sites include EKCD's ambient monitoring program as well as two previous Centennial Clean Water Fund grant studies implemented by EKCD (Grant #0700165 and Grant #0800398). Historical data includes stream temperature and flow. The Department of Ecology and Yakama Nation Fisheries have also performed monitoring activity in the study area watersheds.

8.0 Sampling Procedures

8.1 Field measurement and sampling SOPs

EKCD staff will follow EKCD's *Standard Operating Procedures for Water Quality Monitoring* for field measurements collected. See Appendix A for EKCD SOPs and instrument calibration techniques.

8.2 Measurement and sample collection

On a monthly basis, parameter readings will be taken, data logger information will be downloaded, and photographs will be taken at the designated sites. Stream flow readings are taken using a SonTek FlowTracker Handheld ADVPortable Flowmeter. Turbidity will be measured using a Hach 2100P Turbidimeter. All other parameters will be taken by an YSI 556 water quality monitor. Readings will be manually recorded on field sheets.

Turbidity samples will be duplicated at one site per sample month. And the results will be compared to the replicate criteria in Table 4.

Water temperature readings from a NIST thermometer verified field thermometer will be compared during site visits to the temporally closest temperature data logger readings after download. The values will be compared to the criteria for temperature replication in Table 4.

HOBO U22 Water Temp Pro v2 data loggers will be used as the primary temperature data logger, with readings taken and stored at 30 minute intervals. The manufacturer specifications report an accuracy of ± 0.2° C.

A representative cross section for velocity measurements is selected at the monitoring site, the location of which may vary depending upon flow conditions. Measurements will be made using the USGS standard mid-section method. This method involves measuring the channel cross sectional area and water velocity at multiple cells across the channel. Each channel cross-section is established by stringing a tape measure across the channel perpendicular to the flow direction. Each cross section will be divided into approximately 25 to 30 cells, varied in width, such that the discharge in each cell is limited to 5% to 10% of the total discharge measurement. The goal will be to have five or fewer cells with greater than 5% of the total discharge and zero cells with greater than 10% of the total discharge. However, the number of cells in particularly narrow sections may be limited by a standard minimum spacing for velocity measurements of 0.3 feet. The characteristics for each cell are measured at observation points by recording:

8.3 Invasive species evaluation

Field staff will attempt to minimize spread of invasive species by inspecting and cleaning field gear following procedures outlined in Ecology's publication *Standard Operating Procedures to Minimize the Spread of Invasive Species* (Ecology 2012b).

8.4 Equipment decontamination

The YSI 556 MPS instrument is used to measure pH, conductivity, and temperature during field visits. The instrument probes will be triple rinsed with stream water before and after collection of parameters at each monitoring site. The turbidimeter cell will also be triple rinsed with stream water before and after sample collection.

8.5 Sample ID

Not applicable.

8.6 Chain of custody, if required

Sample bottles will not leave the possession of the EKCD technician until they are left with the laboratory technician. A Chain-of-Custody will not be used given these circumstances. If the procedure for delivering sample bottles is altered, EKCD will use a Chain-of-Custody that includes documentation of sample site, time of collection, date, preservation methods used, authorized personnel, name of sample collector and contact phone number, testing methods, and list of parameters to be tested on each sample.

8.7 Field log requirements

Corrections to the field log are made by drawing a single line through the error so it remains legible, writing the corrections adjacent to the errors, and initialing the correction.

Table 7 shows the information the monitor technician will enter for each monitor site on each visit:

Corrections to the field log are made by drawing a single line through the error so it remains legible, writing the corrections adjacent to the errors, and initialing the correction.

Table 7. Field collection documentation.

FIELD DOCUMENTATION
Field documentation will consist of a journal entry and data entry on standard data entry forms, upon each site visit. Journal entries will contain: ✓ Weather Observation ✓ Antecedent Weather Conditions ✓ General Observations ✓ Personnel Performing Tasks ✓ Field Instrument Calibration and Maintenance ✓ Deviations from Standard Operating Procedures, Problems Encountered, Corrective Action Taken ✓ Date and Time Field data entries will contain:

- ✓ Water Temperature
- ✓ Conductivity Reading
- ✓ pH Reading
- ✓ Stream Velocity Reading
- ✓ Turbidity Reading
- ✓ Stream Discharge Reading

8.8 Other activities

Other activities may include:

- Periodic maintenance for field instrumentation.
- Trainings for field staff.

9.0 Quality Control (QC) Procedures

10.1 Field quality control

Problems with field quality control will be reported immediately to the EKCD Manager, who will determine and implement the proper corrective action.

When coordination is possible, the Department of Ecology field staff may conduct water quality measurements with EKCD staff as an additional field quality control measure. The data received from this quality control effort will be recorded but not reported with the final assembled data.

10.2 Corrective action

The Manager and/or Monitor Technician will deal with any problems associated with field data collection. Water quality measurement procedures and instrument calibration procedures will be documented and conducted in a manner to comply with the quality control and operation standards. If necessary, corrective action will be taken to address field quality control problems.

10.0 Data Management Procedures

10.1 Data management

The field technician will be responsible for data management. The following steps should be followed:

1. Field measurements will be recorded with standardized field data collection forms.

2. Recorded field measurements will be manually entered into EKCD's internal Aquarius database, designed to accommodate historic and current water quality monitoring data collected by EKCD staff.

3. Temperature data logger files will be offloaded from the Onset shuttle to a EKCD computer. Files are then uploaded to the Aquarius database.

4. Stream discharge, velocity, temperature, depth and width measurements will be recorded in the Flowtracker instrument and offloaded into the Aquarius data management system. Measurements are also recorded in the field on the standardized field collection form.

5. While entering the field measurements results, the technician will compare recorded measurements to the expected range of results in Table 8. When applicable if the results fall outside the expected range of results, the technician will investigate the problem and report the problem and possible reasons for error to the EKCD Manager.

6. An automatic back-up system is in place for electronic data files. They are stored off-site by Carbonite[2].

[2] 2 http://www.carbonite.com/

Table 8. Manufacturer's meter specifications.

Analyte	Method/ Equipment	Accuracy	Resolution	Expected Range of Results
Conductivity	ProPlus Handheld Multiparameter Instrument	±0.5% of reading or 0.001 mS/cm, whichever is greater (1-,4-m cable)	0 to 0.500 mS/cm = 0.001; 0.501 to 50.00 mS/cm = 0.01; 50.01 to 200 mS/cm – 0.1 (range dependent)	0 to 1000 µS/cm
Flow	SonTek FlowTracker ADV	±1% of Measured Velocity ±0.25 cm/s	0.0003 ft/sec	±0.003 to 13.00 ft/sec
pH	ProPlus Handheld Multiparameter Instrument	±0.2 units	0.01 units	6.5 to 9.0 units
Temperature °C	ProPlus Handheld Multiparameter Instrument	+/- 0.15°C	0.1 °C	-5 to 70°C
Temperature °C	Hobo Water Pro V2	±0.2°C	-5°C to 45°C	0 to 28°C
Dissolved Oxygen	ProODO Handheld Optical Dissolved Oxygen Meter	0 to 20 mg/L, ± 0. mg/L or ± 1% of reading, whichever is greater; 20 to 50 mg/L, ± 10% of the reading	0.01 or 0.1 mg/L (auto-scaling)	0 to 50 mg/L
Turbidity (NTU)	Hach 2100P	+/- 2% of reading	0 to 1000 NTU	0 to 100 NTU

10.2 Lab data package requirements

Not applicable.

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10.3 Electronic transfer requirements

Data for all parameters will be transferred to Ecology's EIM Database annually, following the monitoring season. This process will involve exporting data from Aquarius to Excel spreadsheets, where it is re-formatted according to EIM requirements. The data spreadsheets are submitted to the Department of Ecology's EIM database using the online process.

10.4 Acceptance criteria for existing data

EKCD will not be utilizing data from existing databases and literature to accomplish grant tasks. Acceptance criteria for existing data are therefore not being established for this study.

10.5 EIM data upload procedures

Data will be transferred to Ecology's EIM system annually per online submittal guidelines. The EIM data coordinator will be consulted if data submittal problems arise. The field technician will complete EIM training offered by the Department of Ecology.

11.0 Audits and Reports

11.1 Performance, system reports, and audits

System audits will be conducted monthly on the field activities. Field activity audits will determine whether procedures are being followed and documented. All fieldwork activities are documented using field water quality monitoring sheets. The field data that will be recorded on the water quality monitoring sheets are listed below:

- ✓ Weather Observation
- ✓ Antecedent Weather Conditions
- ✓ General Observations
- ✓ Personnel Performing Tasks
- ✓ Field Instrument Calibration and Maintenance
- ✓ Deviations from Standard Operating Procedures, Problems Encountered, Corrective Action Taken
- ✓ Date and Time

Field data entries will contain:

- ✓ Verification of Sampling (including sample bottle label information and QC samples collected or measurements taken)
- ✓ Water Temperature
- ✓ Conductivity Reading
- ✓ Dissolved Oxygen Reading
- ✓ pH Reading
- ✓ Stream Discharge Reading
- ✓ Turbidity Readings

The field water quality-monitoring sheet is to be completed by the field team leader and provided to the project coordinator. The project coordinator will record the data in the project database after checking the field sheets for completeness and consistency.

11.2 Responsible personnel

The Monitor Technician for EKCD will be responsible for all reporting and audits in connection with this project.

11.3 Frequency and distribution of reports

Grant progress reporting for this project will be completed according to the requirements outlined in G1400520 between EKCD and Ecology. Quarterly grant progress reports will be completed by the following schedule:

- January 1 through March 31

- April 1 through June 30
- July 1 through September 30
- October 1 through December 31

Yearly water quality progress reports will be submitted between December and February following the conclusion of the monitoring season.

A final report will be submitted at least 45 days before the grant end date and a final, approved report will be submitted before the grant end date.

11.4 Responsibility for reports

For G1400520, the EKCD District Manager, Administrative Assistant, and Resource Technician are responsible for writing all reports associated with all tasks other than the water quality task. The Water Quality Monitoring Technician will be responsible for writing reports associated with water quality monitoring.

12.0 Data Verification

12.1 Preventive maintenance

Equipment manuals and standard operating procedures for field instruments will be followed closely regarding suggested routine and preventive maintenance. Equipment will be checked upon return to the office after every sampling period and will be stored in such a way to minimize damage between sampling periods. Refer to EKCD's SOP (Appendix A) for storage and maintenance procedures.

12.2 Field data verification, requirements, and responsibilities

Field data will be examined for errors or omissions, as well as, for compliance with QC acceptance criteria. Field sheets will be reviewed for errors or omissions before leaving the site where measurements were made. A data quality assessment will be performed annually, following completion of a monitoring season. The field records will be organized and reviewed for accuracy and completeness. At this time it will also be determined if the measurement quality objectives for precision and bias have been met. Temperature loggers will be calibrated to a NIST Thermometer prior to placement, and again upon retrieval in the fall. Each day a periodic check of the meter and probe will be completed. A check will be done after the first station, midday and after the final station. If the meter is beyond tolerance at any check, the data collected prior to that time and after the last completed check will be qualified as an estimate.

Accuracy of field measurements is ensured by proper equipment calibration per the standard operating procedures indicated for the project. Equipment manuals and standard operating procedures for field instruments will be followed closely regarding suggested routine and preventive maintenance will be checked upon return to the office after every sampling period and will be stored in such a way to minimize damage between sampling periods. Refer to the District's SOPs (Appendix A). Dissolved oxygen will now be collected using an EPA approved LDO probe which was recommended by Ecology. (ProODO Handheld Optical Dissolved Oxygen Meter standard operating procedures for the new instrument will be followed as directed by the manufacturer and are shown in Appendix A.)

12.3 Validation

The EKCD Manager and/or natural resource technician will examine the complete data package in detail to determine whether the procedures in the methods, SOPs, and QA Project Plan were followed.

13.0 Data Quality Assessment Procedure

13.1 Process for determining whether project objectives have been met

If measurement quality objectives have been met, the quality of the data should be useable for meeting project objectives. We will assess the data to determine if they are the right quality and quantity to support the project objectives. This will include an assessment of whether the requirements for representativeness and comparability have been met. The number of valid measurements completed will be compared with those established.

13.2 Data analysis and presentation methods

The purpose of sampling in select areas of WRIA 31 is to help supplement and establish a baseline for water quality trends in the watersheds of the WRIA. Data collected will be compared to historical watershed data, when available. Historical data referenced will have been the result of Department of Ecology, US Geological Survey, or EKCD's previous water quality studies and sampling in WRIA 31 watersheds.

Completeness will be determined by dividing the number of samples collected by the number of samples scheduled to be collected. The project will be considered successfully completed if the resulting value is at least 90% for each parameter and perennial sampling station. To assess representativeness, the EKCD Manager will review field sampling documentation to determine if external circumstances may have affected the results of the sampling. A unique characteristic of this project is that the study area streams are characterized as intermittent (lacking dry season flow) except in localized spring-fed reaches. Certain areas remain pooled, but occasionally data loggers become exposed to air. These data spikes are easy to ascertain and will not be included in the data summary. Data collected will be compared to the water quality standards to help determine if the baseline data for these WRIA 31 streams is above, below, or at the State standards for water quality.

13.3 Treatment of non-detects

Non-detect sample results are not anticipated for this study. If a non-detect sample result does occur, it will be reported accordingly. During data analysis, the non-detect sample result will be valued as a split between the lower detection limit and zero.

13.4 Sampling design evaluation

The data will be evaluated to determine if the sampling design has been adequate and if it needs modification for future use. The sampling design is established in section 8.0. The aspects to be evaluated include: sampling locations, frequency of sample collection, parameters to be determined, and field measurements collected. The evaluation will be based on whether or not study questions were addressed with the data collected using the established sampling design.

13.5 Documentation of assessment

The EKCD Manager and Water Monitoring Technician will be responsible for the data quality assessment. The data kept in spreadsheets and databases will be available for Ecology review. The water quality summary report will include a quality assurance section that will summarize quality control results and the procedures used to ensure data quality during the monitoring project. Monthly updates of data results, problems, corrections and results of any performance and systems audits will be included in the quarterly grant report to the Department of Ecology.

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Appendix A. Water Quality Monitoring SOP

Parameter Measured: Turbidity

Equipment: Hach 2100P Turbidimeter
Range: 0 – 1000 NTU with automatic decimal point placement
Resolution: 0.01 NTU on lowest range

Calibration Procedure

The manufacturer recommends instrument recalibration with formazin once every three months, using StablCal® Stabilized Formazin standards to achieve consistent results. Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. The calibration steps are as follows:

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This consists of oiling the vial and marking the vial to maintain the same orientation in the sample cell compartment. This step will eliminate any optical variations in the sample vial.
5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.
6. Insert the StablCal <0.1NTU standard sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.
7. Press **CAL**. The **CAL** and **S0** icons will be displayed, as well as the value of the S0 standard for the previous calibration.
8. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.
9. The display will show the **S1** and 20 NTU or the value of the S1 standard for the previous calibration. After editing, insert a StablCal 20NTU standard sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.
10. Press **READ**. The instrument will count from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
11. Repeat steps 9 and 10 for the **S2** – 100 NTU and **S3** – 800 NTU StablCal standard samples.
12. Press **CAL** to accept the calibration.

Measurement Procedure

Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). The following instructions are given by Hach for the use of their kit:

1. Collect a representative sample in a clean container. Fill a sample cell to the line taking care to handle the sample cell by the top. Cap the cell.
2. Wipe the cell with a soft, lint free cloth to remove water spots and fingerprints.
3. Apply a thin film of silicone oil to the outside of the cell. Wipe with a soft cloth to obtain an even film over the entire surface.
4. Press I/O. The instrument will turn on. Place the instrument on a flat, sturdy surface.
5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in from the cell compartment. **Close the lid.**
6. Select manual or automatic range selection by pressing the RANGE key. The display will show AUTO RNG when the instrument is in automatic range selection.
7. Select signal averaging mode by pressing the SIGNAL AVERAGE key.
8. Press READ. The display will show -----NTU, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Parameter Measured: pH

Instrument: YSI 556 MPS using the YSI 5565 PH sensor
Sensor Type: Glass combination electrode
Range: 0-14 units
Accuracy: ±0.2 units
Resolution: 0.01 units
Calibration Procedure

To prevent the electrode from drying out, the sensor is stored in a storage solution for long term storage (i.e. between monitoring seasons). It is stored with a small amount of moisture in the transport/ calibration cup for short term storage (between monitoring outings). The sensor is calibrated using a 3 point calibration by the following procedure:

1. Begin by rinsing the sensor with a small amount of previously used PH buffer solution. Using new buffer solution in a clean, dry calibration cup, starting with the 7 PH solution, fully immerse the sensor in the solution, making sure all bubbles are shaken loose.
2. Allow the temperature to come to equilibrium, then using the temperature/PH included with the buffer, determine the temperature correction for the buffer solution.
3. After ensuring that the PH reading has fully stabilized for at least 30 seconds, enter the proper PH value at the prompt on the instrument.
4. Repeat the above steps as prompted using the PH4 and PH10 buffer solutions to complete the 3 point calibration.

Measurement Procedure

Assuming the Ph sensor has been properly calibrated, the following procedure is used:
1. Place the PH sensor in the water to be analyzed.
2. Allow the PH and Temperature readings to stabilize, such that there is no change in the readings for at least 10 seconds.
3. Record the measurement.

4. Place the PH sensor in the transportation/calibration cup to prevent the electrode from drying out between monitoring sessions.

Parameter Measured: Conductivity

Instrument: YSI 556 MPS using the YSI 5560 Conductivity/Temperature sensor
Sensor Type: 4 electrode cell with auto-ranging
Range: 0-200 mS/cm
Accuracy: ±0.5% of reading or ±0.001mS/cm, whichever is greater
Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependent)

Calibration Procedure

Measuring conductivity provides a measure of the dissolved salts in a water sample, such as salts used to deice roads. The calibration procedure involves exposing the sensor to a solution of known salinity. The salinity of the solution used for the calibration depends on whether the water to be monitored is fresh, brackish, or saltwater. In our district the water is exclusively fresh water, thus we use a Conductivity Standard that has a value of .1 mS/cm, in order that the calibration is performed near the range of expected values. The following procedure is used for calibration.

1. Fill a clean dry Transportation/Calibration cup with approximately 55mL of conductivity standard. Pre-rinse the sensor with conductivity standard, ensuring there are not salt crystals on the sensor that could affect the solution.
2. Place the sensor in the Transportation/Calibration cup, take care to eliminate all air bubbles on the sensor.
3. Allow the temperature to reach equilibrium, such that the readings do not change for 30 seconds.
4. Enter the value of the conductivity standard at 25ºC
5. Rinse the sensor and cup with tap water.

Parameter Measured: Velocity

Instrument: SonTek FlowTracker Handheld ADV® with top-setting wading rod
Sensor Type: Acoustic Doppler Velocimeter
Range: ±0.003 to 13 ft/sec
Accuracy: ±1% of measured velocity, ±0.25 cm/sec
Resolution: 0.0003 ft/sec
Calibration Procedure:
Simple diagnostic procedures are provided to verify system operation. ***BeamCheck*** requires anexternal computer. The **Auto QC Test** procedure requires only a few minutes and can be performed in the field from the keypad interface. These should be performed before each data run.

BeamCheck is a diagnostic program that is used to verify FlowTracker performance. This is the same diagnostic program used at SonTek; it provides you with a powerful tool for understanding and verifying system performance. We recommend you become familiar with this software and use it on a regular basis. To run *BeamCheck*:

- Hold the FlowTracker in a bucket of water (or a natural environment) such that the probe is submerged and there is a boundary (surface, side, or bottom) within view.
    - Ideally, the boundary should be placed 20-30 cm (8-12 in) from the probe.
    - You may need to add a small amount of fine dirt or other seeding material and stir the bucket well for good test conditions. Regular tap water usually does not have enough scatterers (seeding) for a valid test.
- Connect the FlowTracker to the PC and turn the system on.
- Run the *FlowTracker* software (click **Start | Programs | SonTek Software | FlowTracker**).
- Click **Connect**.
- Select **BeamCheck** on the left side of the screen; now:
    - Click **Start**.
    - Click **Record** to save all data to a file. Typically, a minimum of 20 pings is required for proper data analysis.
    - Click **Averaging** to average multiple pings together.

In ***BeamCheck***, the FlowTracker sends a pulse of sound and outputs the return signal strength for each receiver as a function of time. Features in the signal strength profile verify different aspects of system performance.

- The horizontal axis indicates the range from the FlowTracker probe (in cm).
- The vertical axis is in internal signal strength units called counts (1 count = 0.43 dB).
- *Ringing* from the transmit pulse appears on the left side of the graph.
- The location of the *sampling volume* is indicated by increased signal strength in a bell-shaped curve.
    - The sampling volume curve corresponds to the transmit pulse passing through the focal point of the receivers.
    - The peak of this curve corresponds to the center of the sampling volume.
    - The location of the sampling volume varies, but is typically 10-12 cm.
    - All receivers (2 or 3) should see the peak in the same location, although there will be variation in the height and shape of the curve.
- A sharp spike indicates a *boundary reflection* (if a boundary is within range).
    - If the probe is close to a boundary, a sharp reflection should be seen.
    - The size and shape of this reflection will vary depending on the nature of the boundary and its distance from the FlowTracker.
- Signal strength decreases to the electronic *noise level* past the boundary.

When using ***BeamCheck***, it is important to understand that the output plot will vary considerably because of the nature of acoustic scattering.

- Each of the above items should be visible.
- If no sampling volume peak can be seen, try adding some fine dirt or other seeding material and stirring the water to increase the signal strength.
- If the *BeamCheck* output differs significantly from the sample shown here, refer to the *FlowTracker Technical Manual* for more details about interpreting this data.

The **Auto QC Test** is an automated version of the *BeamCheck* software (§4.1). It is performed in the field just prior to collecting a measurement. The procedure is as follows:

1. Place the probe in moving water away from underwater obstacles.

2. Data collection and analysis takes ≈30 seconds.
3. If any warnings are issued, you are given an option to repeat the test.
    a. We recommend repeating the test once, after first checking that the probe and sampling volume are well away from any underwater obstacles.
    b. If multiple warnings are received, run *BeamCheck* from a PC (§4.1) to evaluate Flow-Tracker performance in more detail.

Measurement Procedure

In choosing a representative cross section for velocity measurements, the following characteristics are sought: a relatively straight length of channel approximately 300' long with a suitable measurement section approximately in the middle, or slightly downstream of the middle, a channel clear of vegetative matter and other obstructions such as large rocks, the flow should not have eddies or dead zones, avoid converging or diverging flow areas. When a suitable measurement site has be chosen the following procedure is used to obtain the velocity readings used to create a velocity profile.

Measurements will be made using the USGS standard mid-section method. This method involves measuring the channel cross sectional area and water velocity at multiple cells across the channel.

1. Establish channel cross-section by stringing a tape measure across the channel perpendicular to the flow direction.
2. Divide cross section in to approximately 25 to 30 cells, varied in width, such that the discharge in each cell is limited to 5% to 10% of the total discharge measurement. The goal will be to have five or fewer cells with greater than 5% of the total discharge and zero cells with greater than 10% of the total discharge. The number of cells in particularly narrow sections may be limited by a standard minimum spacing for velocity measurements of 0.3 feet. The characteristics for each cell are measured at observation points by recording:
    a. Horizontal position (read from the measuring tape);
    b. Depth to the channel bottom (measured vertically down from the water surface); and
    c. Average velocity (measured with the flow meter).
3. Velocity measurements will be taken at six-tenths the stream depth when the total stream depth is less than 1.5 feet and at two-tenths and eight-tenths of the total depth when the stream depth is 1.5 feet and greater. The average of the two velocity measurements is used for cells with a total depth greater than 1.5 feet.

Parameter Measured: Temperature

Instrument: YSI 556 MPS using the YSI 5560 Conductivity/Temperature sensor
Sensor Type: Thermistor
Range: -5º to 45ºC
Accuracy: ±0.15 ºC
Resolution: 0.01 ºC

Calibration Procedure

The precision thermistor used in the temperature cannot be calibrated in the instrument software. As a yearly check of the thermistor's accuracy the thermistor reading should be checked at several temperatures against a NIST certified mercury thermometer. If such a reference thermometer is unavailable, a well-mixed ice bath may be used to check the thermistor at the 0 ºC point. If error is found in the ice bath calibration check, a check with a NIST certified thermometer will be used to determine the nature of the drift. If the drift is found to be of a non-constant or excessive nature (see Table 5 for criterion), the thermistor sensor will be replaced, as it provides data which affects the results of other parameters being monitored with the YSI 556 MPS, such as PH and DO.

Measurement Procedure

The measurement of temperature is done concurrently with the other parameters being measured by the YSI 556 MPS. Every attempt is made to take these measurements in a representative section of the stream. The following procedure is used:

1. Immerse the sensor in the main channel, in an area out of direct sunlight, if possible.
2. Allow the temperature to come to equilibrium, such that the reading does not change for at least 15 seconds.
3. Record the measurement in the instrument memory.

Parameter Measured: Temperature with respect to time

Instrument: HOBO U22 Water Temp Pro v2 logger
Sensor Type: Thermistor
Range: **-**20º to 50ºC
Accuracy: ±0.2ºC over 0º to 50ºC
Resolution: 0.02ºC at 25ºC
Drift: 0.1ºC per year
Real-time clock: ±1 minute per month at 0 ºC to 50ºC

Calibration Procedure

The logger cannot be calibrated, but should be checked for drift twice annually: before deployment and following removal at the end of the monitoring season. This is best done using a NIST certified mercury thermometer to check the temperature recorded at several temperatures. In the event that a NIST thermometer is not available, a well-mixed ice bath may be used to check the temperature recorded at 0ºC.

Measurement Procedure

Temperature measurement is taken at 30 minute intervals throughout the period of interest. Loggers are typically placed in April, and removed for the season in early November. The monitoring sites are visited monthly for data downloading and measurement of other water quality parameters. The placement of the loggers requires that they measure a representative temperature for the stream. In placing the loggers, effort is made to place them where they will not be exposed by receding water levels. It is also desired that they be placed in a shaded area to eliminate possible radiation heating from affecting the readings. Air temperature loggers are distributed at selected sites to give local air temperature readings for correlation purposes. Before heading into the field to download the loggers, the data shuttle clock is synchronized with that of the PC, so that the clocks on the loggers will also be synchronized when they are re-launched after download.