Mid-Columbia
FISHERIES
ENHANCEMENT
GROUP

QUALITY ASSURANCE PROJECT PLAN

YAKIMA RIVER SIDE CHANNELS PROJECT

TEMPERATURE MONITORING & WATER QUALITY IMPROVEMENT

Agreement: WQC-2016-MCFEG-00215

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Quality Assurance Project Plan

Yakima River Side Channels Project
Temperature Monitoring & Water Quality Improvement

July 2016

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2.0 ABSTRACT

Mid-Columbia Fisheries Enhancement Group (MCF) will conduct an assessment of temperatures and water levels associated with anthropogenic and natural influences on an historic oxbow at river mile 25 on the lower Yakima River. Temperature loggers and level sensors will be used to continuously monitor temperatures and water levels, respectively, within a partially disconnected oxbow and its associated side channel as well as the adjacent mainstem Yakima River. The oxbow channel is no longer connected to the river at its upstream end, but still conveys water through a downstream outlet from at least two springs within the oxbow. This provides a potential source of warmer winter and cooler summer water for the Yakima River. The adjacent northerly side channel is fully-connected to the river, and is impacted by sediment accumulation and water stargrass colonization. The side channel and springs were included in the description of river features identified as high priorities for enhancement in the *Assessment of the Lower Yakima River in Benton County, Washington* (Appel et al. 2011).

The objective of the *Yakima River Side Channels Project* assessment is to determine how this oxbow and associated side channel can be enhanced to provide pockets of higher quality habitat for salmon and steelhead. Temperature and stage data will inform engineering design of side channel enhancement. Additionally, substrate condition in the connected side channel will be assessed to determine its suitability for salmon spawning.

Data collection is planned for April 2016 to April 2017. If, in the course of grant activities, additional side channels are identified for monitoring, this Quality Assurance Project Plan (QAPP) will be amended.

This QAPP is funded by the Washington State Department of Ecology (Ecology) through agreement WQC-2016-MCFEG-00215.

3.0 BACKGROUND

The lower Yakima River, WRIA[1] 37, is the focus of the *Yakima River Side Channels Project*, and is on the Clean Water Act's 303(d) list for temperature, turbidity, dissolved oxygen, pH, and other contaminants. This river plays host to anadromous runs of steelhead, sockeye salmon, coho salmon, and spring, summer, and fall chinook salmon. Water temperature is a factor in the timing of upstream migration in summer and fall. In addition, juveniles migrate downstream in the spring and use side channels as refuge from the impairments and dangers of the mainstem river. Side channels are important river features for both adult and juvenile fish because they can provide areas of cool water in the summer, clean gravel, and well-oxygenated water.

This project will assess the potential to enhance side channel influence on water temperature in a 0.24 mile section of the lower Yakima River near River Mile 25. By monitoring water temperature and flow in the side channels from groundwater discharge, MCF can determine the best course of action to increase hydrological connectivity and water quality.

3.1 Study area and surroundings

The lower Yakima River flows through Yakima and Benton counties and is located in south-central Washington State (Figure 1). It flows through an area dominated by agricultural use to its confluence with the Columbia River in Benton County.

Monitoring will be conducted on one, privately owned property (Mast Farm) within one disconnected oxbow and one currently connected side channel.

[1] Water Resource Inventory Area.

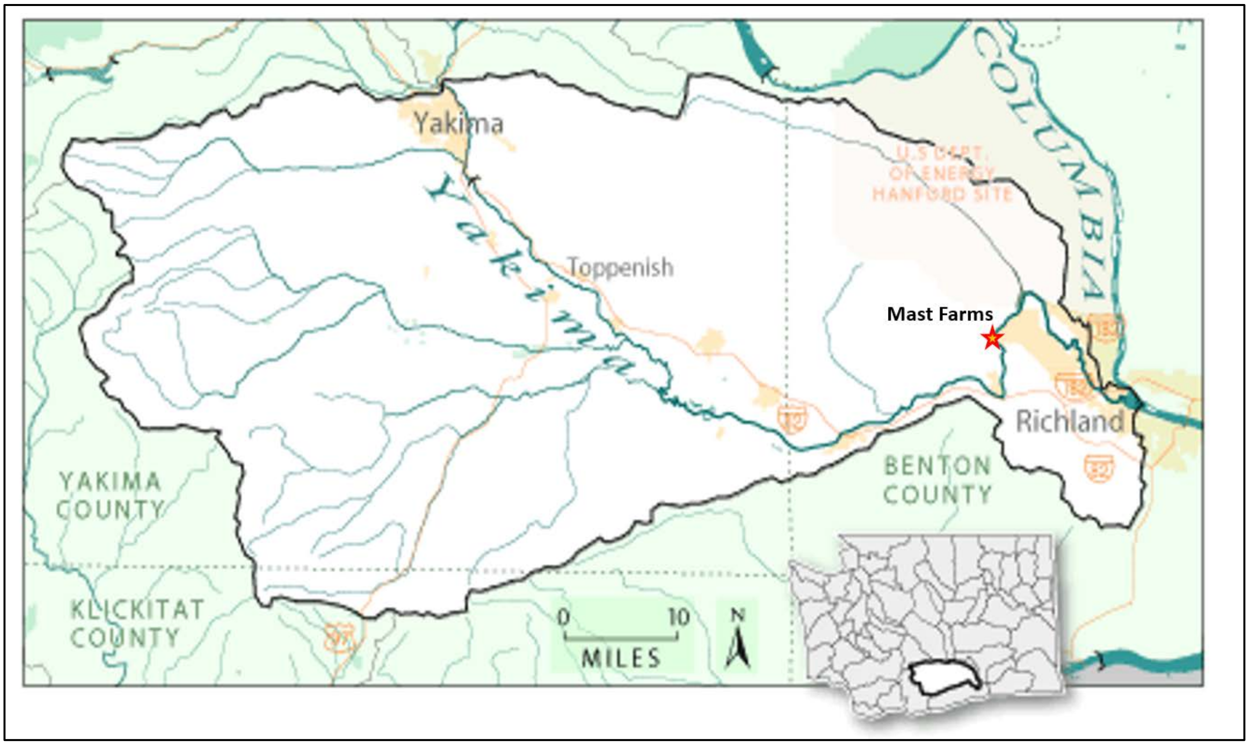

Figure 1. Project location.

The Mast Farm oxbow is located just downstream of Yakima River Mile 25, located at latitude 46.316537° and longitude -119.482935°. The 1867 General Land Office plat map displays the oxbow as the main channel of the Yakima River (Figure 2). By 1955, the oxbow had been disconnected and the river was occupying a more northerly channel (Figure 3). Following the January 1996 flood, a gravel bar established on the river's left bank, upstream of the old inlet of the oxbow (Figure 4).

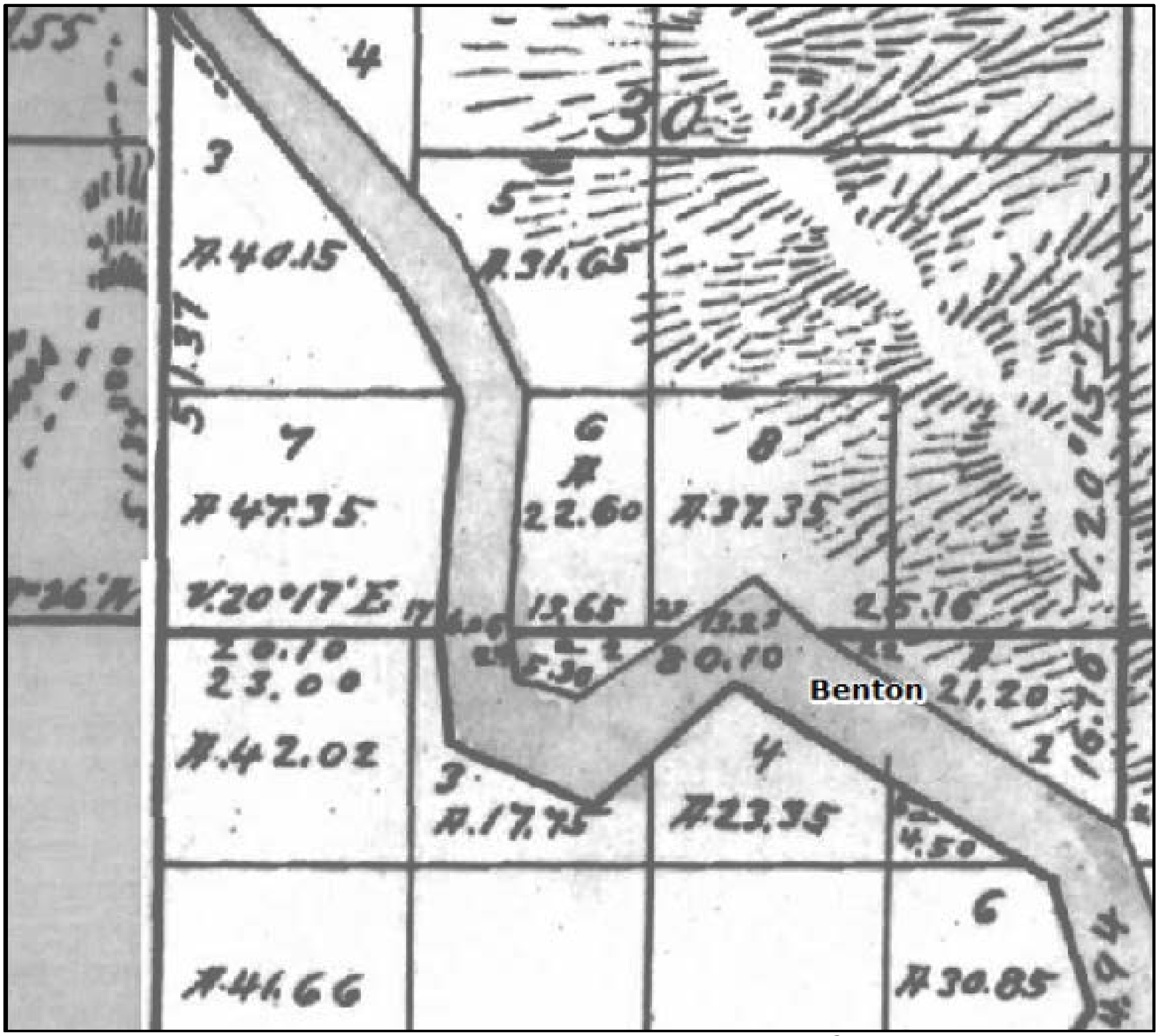

Figure 2. 1867 map of Yakima River Mile 25 in Benton County, WA[2].

[2] https://fortress.wa.gov/dahp/wisaardp3/.

Figure 3. Air photo of Yakima River Mile 25 in 1955. The oxbow had become disconnected at the upstream end by the time of this photo.

Figure 4. Air photo of Yakima River Mile 25 on July 11, 1996. Gravel deposition had begun to form a left bank side channel by the time of this photo.

Currently, the nearly 1900-ft oxbow channel is not connected to the Yakima River at the upstream end. The oxbow channel and the old island provide excellent habitat for wood ducks, beaver, deer, and coyote. The downstream end is connected via a long, narrow culvert, which is perched over the river. Within the oxbow, there are two constructed land bridges, each of which has culverts allowing flow beneath. The oxbow channel is directly fed by groundwater. The landowner reports that the groundwater influence does not appear to be dependent upon irrigation. It is likely that the impoundment behind the culvert, land bridges, and dense vegetation allows for considerable warming before the water enters the river.

A second side channel has formed to the north of the old oxbow. This channel, measured from the air photo to be approximately 900 feet long, shows evidence of sediment deposition and water stargrass colonization.

3.1.1 Logistical problems

The monitoring site was chosen based upon several criteria, including physical characteristics that represent those found throughout the reach and accessibility. Logistical problems with the monitoring site mostly involve the issue of access and data collection.

Logistical issues that could occur:

- Sites with easy access can have a high level of human activity, increasing the risk of monitors to be stolen or broken.
- Inability to measure high flows or access deployed temperature loggers during high flows. At times, some locations might not be wadeable or have safe access at high flows. If flow measurements cannot be taken, it will be noted on our field forms, and if possible, monitoring work may be rescheduled.
- Finding relatively remote locations to place temperature probes such that they can be protected from vandalism, theft, etc., while still being accessible for data retrieval. This is only expected for probes in the river channel; the private property does not experience vandalism.
- Scheduling conflicts, vehicle or equipment problems, or limited availability of personnel or equipment may interfere with monitoring. These will be dealt with as they occur.
- Sediment deposition can cover field deployed loggers and insulate the loggers from direct water temperature measurement. This can suppress measurement of daily highs and lows in the water column.
- Field-deployed loggers may become exposed to air due to dropping water levels (dewatering). BaroTroll loggers can confirm observed air temperature patterns for dewatered loggers.
- Bank erosion and bed load movement during high flows can remove loggers deployed in the mainstem or side channels. We will avoid areas with high bank erosion risk.

3.1.2 History of study area

Land use in the lower Yakima River valley is predominantly irrigated agriculture, heavily reliant on the Yakima River for irrigation water supply. For decades, high suspended solids, turbidity, DDT and other pesticides, high temperatures, and other kinds of pollution have been documented in the lower Yakima River. By the mid-1990s, water quality evaluations by the US Geological Survey (USGS) indicated that some improvements had been made, but beneficial uses were still impaired by sediment and sediment-borne pollutants, like DDT, from irrigation returns (Rinella et al., 1999). Consequently, several reaches of the lower Yakima River and several of its tributaries did not meet numerous state water quality criteria and federal guidelines. As a result, Ecology placed these water bodies on Washington State's 303(d) list.

Water quality issues in the entire Yakima River basin range from fecal coliform bacteria to suspended sediments and turbidity, as well as toxics, pH, nutrients, dissolved oxygen, and temperature. The water quality issues in the basin impact the beneficial uses of the water, potentially making it unsafe for drinking or recreation and threatening the health of aquatic animals and fish living in it.

At this time there are two fish species listed as Threatened under the federal Endangered Species Act: mid-columbia bull trout and mid-columbia steelhead. Studies in the upper and middle Yakima River (summarized in Conley et al. 2009) indicated that temperature, toxic chemicals, and lack of foraging habitat and refuge from predators were creating obstacles for survival of these species. At this time, Ecology's temperature standards are based on the current understanding of survivable temperature ranges.

There are a number of water quality improvement projects, mainly in the form of total maximum daily loads (TMDLs), in various stages of development across the watershed. Those projects in the lower Yakima River include:

Yakima River: Toxics

- Water quality monitoring of DDT, dieldrin, and other chlorinated pesticides (Johnson et al. 2010).

Lower Yakima River: Suspended Sediment and DDT

- TMDL study evaluating controls of suspended sediment which is the primary cause of turbidity and major source of DDT transport in the lower basin during irrigation season (Joy 2002).

3.1.3 Parameters of interest

The main parameter of interest for this monitoring study is water temperature. The Lower Yakima River, WRIA 37, is listed as impaired for water temperature on Washington State’s list of impaired waterbodies under Section 303d of the Clean Water Act (Category 5 temperature

Listing ID: 8311). Additionally, this study will measure substrate characteristics in the side channel, stage, flow, and, as a separate effort (not supported with Ecology funds), will partner with others to assess current fish utilization of the area. Groundwater elevations will be estimated through spring water depths and existing well levels where possible.

3.1.4 Results of previous studies

In 1997, Ecology published a TMDL evaluation report about the lower Yakima River (Joy and Patterson 1997). The Environmental Protection Agency (EPA) approved the TMDL for the protection of chronic aquatic life criteria in 1998. The report details the amount and sources of several pollutants in the lower Yakima River.

The TMDL noted that the relationship between turbidity, suspended sediment, and DDT would likely change significantly after most of the suspended sediment was removed from the river. Therefore, the TMDL intended to identify specific human health load allocations for DDT starting in 2007.

In addition to those TMDLs, temperature monitoring is performed at two lower mainstem Yakima River locations, the Prosser gage and the Kiona gage. Those gages are operated by the USGS and the U.S. Bureau of Reclamation. Temperature data from other locations and for shorter periods of record are also available from a number of sources. There has not been a TMDL drafted for temperature in the lower Yakima River.

In 2011, Benton Conservation District (BCD) summarized two years of temperature monitoring and habitat assessment in the *Assessment of the Lower Yakima River in Benton County, Washington* (Appel et al. 2011). Appel summarized the conclusion of thermal profiling as follows (p. 96):

> *With temperatures well above 21°C for the 2008 and 2009 summer floats mainstem Lower Yakima River temperatures were inhospitable for salmon as expected; however, temperature heterogeneity within the lower Yakima River was identified. Although a predominantly [losing] reach, localized areas of cooler temperatures were identified. These "cooler" areas were the result of: a) non-point source seeps that are likely discharge points for shallow groundwater seeps fed by irrigation and river recharge, b) irrigation wasteways (e.g., Spring and Snipes Wasteways, Corral Creek Wasteway, and Amon Creek Wasteway) c) and "holes" (e.g., tail of oxbow at Barker Ranch). The "cooler" areas are located along the riparian area and in some instances behind side channels (e.g., island at I-182 bridge).*

3.1.5 Regulatory criteria or standards

Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC (Ecology 2012) establish beneficial uses of waters and incorporate specific numeric and narrative criteria for parameters such as water temperature. The criteria are intended to define the level of protection necessary to support the beneficial uses. Washington Administrative Code (WAC) 173-201A-600 and WAC 173-201A 602 list the use designations for specific areas.

For the lower Yakima River, the designated uses of the waters are:

- **Aquatic Life Uses**
  - Spawning/Rearing: Salmonid spawning, rearing, and migration: The key identifying characteristic of this use is salmon or trout spawning and emergence that only occurs outside of the summer season (September 16 - June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids.
- **Recreation Uses**
  - Primary Contact Recreation: Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies /100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies /100 mL.
- **Water Supply Uses**
  - Domestic Water
  - Industrial Water
  - Agricultural Water
  - Stock Water
- **Miscellaneous Uses**
  - Wildlife Habitat
  - Harvesting
  - Commerce/Navigation
  - Boating
  - Aesthetics

Temperature Criteria

Temperature levels fluctuate over the day and night in response to changes in climatic conditions and river flows. Since the health of aquatic species is tied predominantly to the pattern of maximum temperatures, these criteria are generally expressed as the highest 7-day average of the daily maximum temperatures (7-DADMax) occurring in a waterbody.

In the Washington State water quality standards, aquatic life use categories are described using key species (e.g., salmon, warm-water species) and life-stage conditions (e.g., spawning, rearing, migration) [WAC 173-201A-200].

WAC 173-201A-602 (Ecology 2012) notes the following special criteria for the Yakima River from mouth to Cle Elum River (river mile 186).

Temperature shall not exceed a 1-DMax of 21.0°C due to human activities. When natural conditions exceed a 1-DMax of 21.0°C, no temperature increase will be allowed which will raise the receiving temperature by greater than 0.3°C; nor shall such temperatures, at any time, exceed t = 34/(T+9).

Washington State uses the criteria described above to ensure that where a waterbody is naturally capable of providing full support for its designated aquatic life uses, that condition will be maintained.

The standards recognize, however, that not all waters are naturally capable of staying below the fully protective temperature criteria. When a waterbody is naturally warmer than the above described criteria, the standards provide an allowance for additional warming due to human activities. In this case, the combined effects of all human activities must also not cause more than a 0.3°C (0.54°F) increase above the naturally higher (inferior) temperature condition.

4.0 PROJECT DESCRIPTION

4.1 Project goals

This study will help increase the understanding of the seasonal temperature conditions in the lower Yakima River and the associated side channels within the study area. Further, the study will increase the understanding of temperatures within the side channels to assess their viability for salmon rearing during migration periods. Ultimately, these data will be provided to stakeholders involved in salmon restoration in the Yakima River Basin who may use it to better understand the seasonal temperature changes and to assess the impacts that sources may have on water temperature in the Yakima River Basin.

4.2 Project objectives

The objectives of this study are to:

- Establish monitoring sites within the study site.
- Monitor established sites for continuous temperature.
- Monitor stage at selected sites.
- Assess substrate conditions in the side channels.
- Measure flow during site visits to estimate amount and variability of flow from springs that feed the side channels.
- Follow established protocols to ensure that representative stream temperatures, stage measurements, and selected flow measurements are obtained throughout the desired monitoring period (May-October) and to prevent equipment loss to vandalism or high streamflow.
- Attempt to maximize the reliability of the data through pre- and post-deployment calibration checks and quality control procedures designed to locate and remove anomalous data.

4.3 Information needed and sources

Not applicable.

4.4 Target population

Monitoring is targeting water temperature in the lower Yakima River mainstem and side channels on the Mast Farm property.

4.5 Study boundaries

A map of the study area for the lower Yakima Basin is provided in Figure 1. WRIA and 8-digit Hydrologic Unit Code (HUC) numbers for the study area are:

- WRIA 37 (Lower Yakima)
- HUC number 17030003

4.6 Tasks required

Brief summary of tasks required to complete this project:

- Do pre-calibration checks on temperature and water level loggers.
- Deploy loggers at selected monitoring sites.
- Collect temperature and water level data at monitoring sites every 6-8 weeks.
- Collect substrate condition data once.
- Collect flow and stage measurements at selected monitoring sites.
- Collect instantaneous temperature data for deployed loggers every 6-8 weeks.
- Retrieve, download, and do post-calibration checks of all loggers.
- Quality assurance check of the collected temperature, stage, and flow data.

4.7 Practical constraints

See Section 3.1.1.

4.8 Systematic planning Process

This QAPP represents the systematic planning process.

5.0 ORGANIZATION AND SCHEDULE

5.1 Key individuals and responsibilities

MCF is the implementing agency for the Ecology agreement WQC-2016-MCFEG-00215. Contact info for MCF is:

Mid-Columbia Fisheries Enhancement Group
P.O. Box 2211
White Salmon, WA 98926
(509) 925-3474

MCF and partner staff involved in this QAPP are listed in Table 1.

Table 1. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Rebecca Wassell	Yakima Basin Program Director, Mid-Columbia Fisheries Enhancement Group	Overseeing the development of QAPP and monitoring program, tracks progress of monitoring. Collection of substrate data.
Marcella Appel	Water Quality Specialist, Benton Conservation District	Pre-calibration and deployment of loggers at selected monitoring sites; collection of data; retrieval, downloading, and post-calibration checks of all loggers. Quality assurance check of the collected temperature, stage, and flow data.
Heather Simmons	Project Manager, Ecology, Water Quality	Provides initial review and feedback of QAPP, approves QAPP, reviews and approves final report.
Daniel Dugger	Technical Reviewer, Ecology, Environmental Assessment Program	Provides technical review of QAPP, reviews annual and the final reports.

5.2 Special training and certificates

The field lead and assistants for each survey will be trained in and experienced with the SOPs being used.

5.3 Organizational chart

BCD and MCF will work collaboratively on this project through a Memorandum of Understanding. Ms. Wassell and Ms. Appel will communicate about the project every two weeks. Responsible project staff and lines of communication are demonstrated in Figure 5.

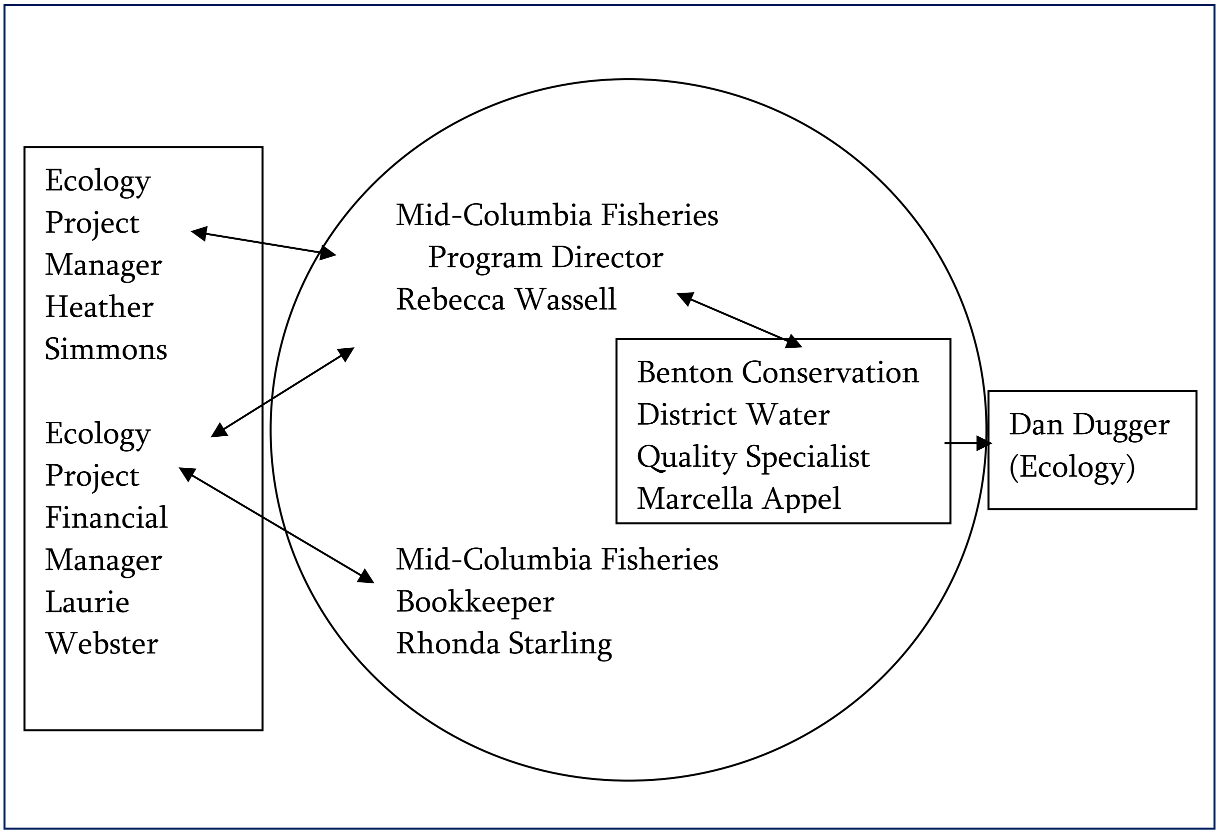

Figure 5. Organizational chart for project communication.

5.4 Project schedule

The project schedule is provided in Table 2.

Table 2. Project schedule.

Task	Timeline
Field Work	July 2016 – October 2017
Data upload	Bimonthly from July 2016 – October 2017
Verification and Validation of data	Bimonthly from July 2016 – October 2017
EIM entry	May 2017
Annual progress reports	October 2016 and October 2017
Final progress report	June 2018

5.5 Limitations on schedule

Field-related logistical issues are addressed in section 3.1.1. No limitations have been identified at this time.

5.6 Budget and funding

Project funding is provided through Ecology Agreement # WQC-2016-MCFEG-00215, as described in Table 3 below. Equipment proposed to be installed that is not included in Table 3 is being provided by BCD as in-kind contribution to the Ecology grant.

Table 3. Project budget.

Item	Qty.	Unit	Unit Price	Total Project Cost	Ecology Eligible Costs	Ecology Grant Funds	Anticipated In-Kind Match
Temperature recorders	8	Each	$64	$512	$512	$0	$512
Purchase of stage recorders	2	Each	$420	$840	$840	$840	
Purchase of calibration equipment	1	Each	$200	$200	$200	$200	
Thermometer deployment, downloading, and data synthesis -- BCD	10	Day	$300	$3,000	$3,000	$3,000	
Technical support from Anchor QEA	1	Lump	$5,700	$5,700	$5,700	$5,700	
Project oversight and coordination	80	Hourly Rate	$42	$3,360	$3,360	$3,360	
TOTAL				$13,612	$13,612	$13,100	$512

6.0 QUALITY OBJECTIVES

6.1 Decision quality objectives

Not applicable.

6.2 Measurement quality objectives – temperature loggers

Temperature logger details are summarized in Table 4, below and measurement quality objectives (MQOs) in Table 5. The accuracy and instrument bias MQOs of each temperature logger is verified through both pre- and post-deployment calibration checks, along with field temperature verification checks, following the procedures described in the *Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams* (Ward 2015). The procedures require that the temperature loggers be tested in controlled water temperature baths that bracket the expected monitoring range (near 0ºC and near 20ºC). The results are then compared to those obtained with a certified reference thermometer. Pre- and post-deployment calibration values will be recorded in EXCEL files and stored on MCF computers, then included as an appendix in the final project report.

If the mean absolute value of the temperature difference for a logger in each water bath, compared against the NIST-certified thermometer, is equal to or greater than the precision standard (Section 6.2.1.1), then a second check should be performed. Temperature loggers that fail a second pre-deployment check will not be used.

Table 4. Manufacturer meter specifications.

Equipment	Accuracy	Manufacturer's stated accuracy	Reporting Limit	Range of operation
Digi-sense 2-input data logging thermistor thermometer, NIST traceable Cal, Item# EW-20250-94	± 0.5 °C		± 0.1 °C	-40 to 125 °C
Temperature Logger (Water/Air) #UA-001-64 HOBO Pendant Onset Computer Corp.	± 0.53 °C	Not reported	0.14 °C	-20 to 50°C
In-Situ Rugged Troll 200™ (temperature) In-Situ BaroTroll™ (temperature)	± 0.3 °C		± 0.1 °C	0 - 50°C
In-Situ Rugged Troll 200™ (depth)	± 0.1% full scale (FS) typical ± 0.3% FS max		± 0.01% FS or better	5 m (16 ft)
In-Situ Rugged Troll 200™ (pressure) In-Situ BaroTroll™(pressure)	± 0.1% FS typical ± 0.3% FS max		± 0.01% FS or better	362 to 1551 mmHg; 0.5 to 2 bar
Swoffer Meter	± 0.2 ft/s		0.05	0.5-3

Table 5. Measurement Quality Objectives.

Parameter	Field replicate (median RSD)	Calibration check	Expected range of results
Temperature	±1.0 ºC	±0.4 ºC	0 to 40 ºC
Pressure	±5 mmHg	±2 mmHg	715-790 mmHg
Stage	±0.05 ft	±0.05 ft	NA
Discharge Measurements	±0.4 cfs and ±10% of Q	±0.2 cfs	0-2 cfs in culvert

Sampling bias is minimized by following the deployment procedures described in Ward (2015). These procedures specify site selection and deployment methods designed to ensure that the temperature logger results are representative of stream conditions throughout the entire monitoring period and not biased by the effects of solar radiation or low streamflow conditions.

6.2.1 Targets for precision, bias, and sensitivity

6.2.1.1 Precision

Precision is a measure of the variability in the results of replicate measurements due to random error. Precision for field replicate measurements of temperature will be expressed as the replicate median Relative Standard Deviation (RSD) between the logger temperature and the mid-deployment check temperature.

6.2.1.2 Bias

Bias is the difference between the population mean and the true value. Bias is the difference between the population calibration checks used to document logger bias and performance as described in Ward (2015).

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a method to detect a substance. It is commonly described as the detection limit and the instrument range of operation. The detection limit for field measurement of water temperature is 0.1 °C.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

To ensure comparability, field measurements will follow approved Environmental Assessment Program (EAP) SOPs. These are listed in section 8.1.

6.2.2.2 Representativeness

The study is designed to have enough monitoring sites and sufficient monitoring frequency to meet study objectives of characterizing the temperature regime in the target areas. Yakima River sites upstream and downstream of the side channels of interest were selected as well as sites on both the right and left bank of the river. Sites were selected within the mainstem side channel as well as multiple locations in the spring area. See figure 7 for the location of monitoring sites. The number and locations of monitoring locations and with the time frame for monitoring (15 months) were selected to allow us to characterize the temperature regime throughout the project area.

6.2.2.3 Completeness

The target for this study is to correctly monitor, record, and analyze 100% of the time intervals pre-set to record by the temperature loggers at all sites. Completeness will be acceptable if water temperatures monitored at each site allows the 7-DADMax and 1-DMax water temperatures to be evaluated for at least 90% of the range of time July 2016 through October 2017, measured both monthly and over the entire data collection period.

Potential problems during data collection that need to be avoided if possible include: loss of temperature loggers by flooding or vandalism, loss of valid water temperature recording due to water levels dropping below logger installations, malfunctioning of loggers, and site access problems.

6.3 Quality objectives – water level transducers

The following sections describe the calibration procedures for the pressure and temperature data loggers. All instrumentation will be calibrated based on field measurements relative to surveyed benchmark elevations.

6.3.1 Pressure-temperature transducer setup and calibration

In-Situ Rugged Troll 200TM data loggers (Rugged Troll) were selected for use on this project. Each Rugged Troll will be connected to above water or ground surface by direct-read cables and installed to depths that will capture the range of water levels expected.

Since the project area is prone to flooding, non-vented Rugged Trolls have been selected for use on this project which require correction to account for changes in atmospheric pressure. Variations in atmospheric barometric pressure will be measured and recorded by a BaroTrollTM pressure logger. The reference pressure loggers will be installed above the anticipated high water mark at each site or in a protected area selected based on site conditions.

Data will be downloaded from the loggers approximately every 30 days and water level elevation data recovered from temperature/pressure (Rugged Troll) loggers will be corrected using the ambient atmospheric data recovered from the BaroTrollTM instruments. For all monitoring locations with a Rugged Troll, calibration will occur at deployment and checked during monthly site visits. Each Rugged Troll will be installed using a cable that extends from the top of the casing to the base of the screened interval at the stilling wells. The cable allows for real-time calibration of instrument elevation set points.

The following procedure will be used to install and calibrate Rugged Trolls:

1. Each Rugged Troll will be connected to a communication cable of the appropriate length.
2. The instrument will be calibrated to zero in ambient air conditions.
3. The instrument and cable will be slowly fed down into the well to the appropriate depth as described above.

4. The installer will connect to the instrument cable with a portable field computer.
5. The installer will measure the water level elevation using staff gages that have been tied into a reference elevation.
6. The installer will program the instrument to collect one measurement of water level elevation at 30-minute intervals.
7. The above-ground connector on the cable will be protected by a dust cap or similar to protect against moisture based on site conditions.
8. Each data logger will be checked to confirm that data is being logged.

6.3.2 Monitoring

Monthly site visits will be conducted to monitor the instrumentation deployed. Visual inspection of the site conditions will be observed and noticeable changes in site conditions will be noted on the field forms. If any monitoring location is damaged, the damage will be documented on field logs and photos will be taken. The location will be repaired and instruments replaced if budget allows.

A staff gage will be installed and tied in to surveyed reference elevations. Field personnel will measure the water level elevation on this gage, and record the level and the time. The manual measurements will be used as reference points for the data generated by the level logging equipment. Levels will be measured to the nearest 0.01 foot and recorded immediately on a water level data sheet with the date, time (on a 24-hour clock), reference point, and initials of the person who made the measurements. Differentials of more than 0.05 foot between manual and instrument elevation measurements may result in adjustment of the instrument reference elevation when data is compiled and reduced. The acceptable range of drift between manual and instrument elevations is 0.05 foot.

Logged data will be retrieved using Win-Situ® software on a portable computer or appropriate equipment. Each data file will be opened on site to ensure data records are complete. If instrument failure is identified, the instrument will be replaced.

6.3.3 Rugged troll accuracy

The Rugged Troll water level accuracy is plus or minus (±) 0.1 percent of the measurement range of the transducer. Transducer drift will be examined when data are downloaded and compared to manually measured water level elevations. If drift is identified, the data can be reasonably adjusted by assuming a linear correction over the time interval from the previous data download. Large drift (>0.1 foot) would indicate that the transducer should be replaced.

6.3.4 BaroTROLL

Accurate, time-coincident measurements will be used to evaluate the performance of the piezometer and stilling well system. A BaroTROLL transducer will be installed at each site to collect time-coincident barometric pressure and temperature data which will be used to correct the non-vented water level elevation data recorded by the Rugged Troll loggers.

7.0 SAMPLING PROCESS DESIGN

7.1 Study design

The project objectives will be met through characterizing seasonal temperature in the side channels. Continuous temperature data collection will be required for future analysis to assess suitability of habitat for salmon. Monitoring will occur July 2016 to October 2017.

7.1.1 Field measurements

The sampling design will use a fixed network of monitoring sites with continuous temperature loggers. Temperature checks will be conducted every 3-4 weeks. Also, instantaneous temperature readings and discharge measurements will be collected at selected locations within the side channels during some of these visits. Flow measurements may be taken during these visits by direct means or by estimation of hydraulic properties. Direct means include bucket measurements from the end of the culvert or discharge measurements using a velocity meter. Hydraulic property estimates include methods such as measuring depth of flow in pipes and relating the depth to discharge using Manning's equation, a standard civil engineering pipe flow formula.

7.1.2 Sampling location and frequency

Data collection will occur between July 2016 and October 2017. Monitoring locations are provided in Table 6 and Figure 6.

Continuous temperature collection:

- Water temperature loggers will be deployed to log every 30 minutes in locations where representative temperature data may be obtained throughout the entire monitoring period. It is anticipated that 8 temperature loggers will be deployed and temperature will also be recorded at 2 locations with water level transducers.

Continuous stage data collection:

- Water level transducers will be deployed to log every 30 minutes at two locations (Table 6).

Substrate condition:

- Substrate condition in the connected, northern side channel will be assessed during low flow conditions, in the summer or fall of 2016, at the location indicated in Figure 6.

Table 6. Monitoring sites and parameter to be measured.

Site Descriptor	Latitude	Longitude	Parameter
Right bank downstream	46.319184°	-119.486881°	Temperature
Right bank	46.318045°	-119.486842°	Temperature
Right bank upstream	46.317294°	-119.485130°	Temperature
Logger in river	46.317150°	-119.486950°	Temperature
Culvert outlet	46.317117°	-119.486983°	Temperature and stage
Side channel inlet	46.316537°	-119.482935°	Temperature and stage
Mid-side channel	46.316167°	-119.483450°	Substrate
Chase culvert	46.315582°	-119.486932°	Temperature
Spring 2	46.315033°	-119.486900°	Temperature
Oxbow head	46.314656°	-119.484358°	Temperature
Spring 1	46.314533°	-119.486267°	Temperature

Figure 6. Map of monitoring locations.

7.1.3 Parameters to be determined

See Section 3.1.3.

7.2 Maps or diagram

See Figure 1 in Section 3.1 and Figure 6 above for maps of the study area.

7.3 Assumptions underlying design

Not applicable.

7.4 Relation to objectives and site characteristics

By monitoring water temperature and flow in the side channels from groundwater discharge, MCF can determine the best course of action that will increase channel connectivity and water quality. Characterizing the condition of the substrate in the northern side channel will inform the design of restoration actions in that channel.

7.5 Characteristics of existing data

Not applicable.

8.0 SAMPLING PROCEDURES

Water temperature loggers will be deployed in locations where representative temperature data may be obtained throughout the entire monitoring period.

Each deployment location will be photographed and have site-specific survey information documented on a standardized Continuous Temperature Survey Form (Ward 2015).

The HOBOs will be deployed in a polyvinyl chloride (PVC) housing attached atop a 20-pound lead anchor ball with quick links. Alternative means of anchoring the housing may be utilized, however the methods will conform with EAP 080. PVC housings will be drilled with multiple holes to allow water circulation around the HOBOs. Arrays will be anchored to the shore using a cable attached to a shoreline tree or anchored in the bank using a screw anchor. Each array will be deployed at each location such that the PVC housing is off the bottom.

Further, mid-deployment checks of the water temperature logger locations will be conducted every 3-4 weeks. The periodic checks may result in a temperature logger re-location to a greater depth. All check observations and measurements will be recorded on the survey form.

For all monitoring locations with a Rugged Troll, calibration will occur at deployment and retrieval. Each Rugged Troll will be installed using a cable that extends from the top of casing to the base of the screened interval in the stilling wells. The cable allows for real-time calibration of instrument elevation set points. Monthly site visits will be conducted to monitor the instrumentation deployed. Measurement of stage using survey equipment and a known benchmark or through use of an established ceramic gage will be made each site visit and data download. Visual inspection of the site conditions will be observed and noticeable changes in site conditions will be noted on the field forms. If any monitoring location is damaged, the damage will be documented on field logs and photos will be taken. Damaged instruments will be removed and replaced if possible.

Where possible, flow measurements in the oxbow and its northern side channel will be conducted using cross-sectional wading and velocity measurements. Procedures for streamflow measurements will follow the *Standard Operating Procedures for Estimating Streamflow* (Kardouni 2013). Flow results will be recorded in cubic feet per second (cfs).

8.1 Field measurement and field sampling SOPs

To ensure comparability, field measurements will follow approved EAP SOPs (Ecology 2014):

- EAP080 – Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams (Ward 2015).
- EAP011 – Standard Operating Procedure for Instantaneous Measurements of Temperature in Water (Nipp 2006).
- EAP024 – Standard Operating Procedure for Estimating Streamflow (Kardouni 2013).

- EAP063 – Measuring Sediment Size and Channel Dimensions: 11-Count Method (Clinton 2009).
- EAP070 – Standard Operating Procedures to Minimize the Spread of Invasive Species (Mackie 2016).

8.2 Containers, preservation, holding times

Not applicable.

8.3 Invasive species evaluation

SOP EAP070 (Mackie 2016) will be followed to minimize any chance of spreading of invasive species.

8.4 Equipment decontamination

Not applicable.

8.5 Sample ID

Not applicable.

8.6 Chain of custody, if required

Not applicable.

8.7 Field log requirements

A field log will be maintained by the field lead and used during monitoring. Observations and measurements for water and air temperature logger checks will be recorded on a continuous temperature survey form (Appendix A).

All observations and measurements will be recorded on forms printed on waterproof paper. They will contain:

- Name of location and site ID.
- Date and time.
- Field staff.
- Field measurement results.
- Instrument IDs.
- Pertinent observations.
- Any temperature logger information.

- Stage data from staff gages.
- Comments.

8.8 Other activities

Not applicable.

9.0 MEASUREMENT METHODS

9.1 Field procedures table/field analysis table

Only field procedures will be associated with this study. Table 7 shows the field measurement methods required to meet the goals and objectives of this project.

Table 7. Field procedures.

Parameter	Sample Matrix	Field Protocol #	Expected Range of Results	Method
Water Temperature	Water	EAP080 (Ward 2015)	1.0 - 35°C	Field check thermometer: Digi-sense 2-input data logging thermistor thermometer, NIST traceable Cal, Item# EW-20250-94
Water Temperature	Water	EAP080 (Ward 2015)	1.0 - 35°C	Temperature Logger (Water/Air) #UA-001-64 HOBO Pendant Onset Computer Corp.
Water Temperature	Water	EAP080 (Ward 2015)	1.0 - 35°C	Rugged Troll™pressure transducers
Air Temperature	Air			BaroTroll™ pressure transducers
Stage Measurement	Water		0-5 feet	Rugged Troll™pressure transducers
Discharge	Water	EAP024 (Kardouni 2013)	Not known	Field discharge measurements per EAP024
Sediment Size	Sediment	EAP063 (Clinton 2009)	Not known	11-count method per EAP 063

9.2 Laboratory procedures table

Not applicable. See Section 8.1.

9.3 Sample preparation method(s)

Not applicable. See Section 8.1.

9.4 Special method requirements

Not applicable. See Section 8.1.

9.5 Lab(s) accredited for method(s)

Not applicable. See Section 8.1.

10.0 QUALITY CONTROL (QC) PROCEDURES

Prior to deployment, the HOBOs will be calibrated following procedures recommended by Ward (2015). Each HOBO will be pre-set for a delayed start so that each would start recording at the same pre-set time prior to calibration and continue to log temperature every 5 minutes. A separate watch will be synchronized with the computer start time so that calibration readings would be simultaneous with the watch.

HOBOs will be placed into two separate water baths with a high and low temperature of 22.5 and 2.0 degrees Celsius (°C), respectively, and allowed to equilibrate prior to recording temperatures. Calibration will be performed using a National Institute of Standards and Technology- (NIST-) certified HB Instruments thermometer with serial number 1114593. Mean differences calculated from the HOBO calibration procedures are added or subtracted as appropriate from field data prior to use.

The Rugged Troll accuracy and precision specifications are described in Appendix C. The Rugged Troll water level accuracy is plus or minus (±) 0.1 percent of the measurement range of the transducer. Transducer drift will be examined when data are downloaded and compared to manually measured water level elevations. If drift is identified, the data can be reasonably adjusted by assuming a linear correction over the time interval from the previous data download. Large drift would indicate that the transducer should be replaced.

10.1 Table of field and lab QC required

Table 8. Required field and lab quality control.

Parameter	Field
	Mid-deployment Check
Temperature	1 measurement collected per temperature logger per field check[1,2]

[1]Field checks will occur every 3-4 weeks.

[2]Temperature will be collected using the field thermometer.

10.2 Corrective action processes

QC results may indicate problems with data during the course of the project. Options for corrective actions might include:

- Recheck pre- and post-calibration checks.
- If possible, retrieve missing information.
- Qualify or reject results.

11.0 DATA MANAGEMENT PROCEDURES

11.1 Data Recording/reporting requirements

Staff will record all field data in a field notebook or an equivalent electronic collection platform. Before leaving each site, staff will check field notebooks or electronic data forms for missing or improbable measurements. Staff will enter field-generated data into Microsoft Excel® spreadsheets as soon as practical after they return from the field. The field lead will check data entry against the field notebook data for errors and omissions.

Data from temperature loggers that meet the calibration check accuracy requirement will be proofed and QC checked by plotting the data in a spreadsheet and displaying them with a chart. All continuous data will also be entered into Microsoft Excel® spreadsheets. Field-checked air and water temperatures will be compared to recorded values on the dates of field visits.

Results of quality control checks and calibrations will be recorded on electronic forms to allow for quality assurance review. Quality assurance records will be saved on Mid-Columbia FEG computers until Ecology's final approval of the project report so they may be accessed for post-project analysis and audits.

11.2 Lab data package requirements

Not applicable.

11.3 Electronic transfer requirements

Described above in Section 11.1.

11.4 Acceptance criteria for existing data

Not applicable.

11.5 EIM/STORET 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 Ecology.

12.0 AUDITS AND REPORTS

12.1 Number, frequency, type and schedule of audits

Not applicable.

12.2 Responsible personnel

See Table 1 in Section 5.1.

12.3 Frequency and distribution of reports

The data collected under this project will be summarized and published in a formal, peer-reviewed report that includes results, methods, and data quality assessment.

Grant progress reporting for this project will be completed according to the requirements outlined in WQC-2016-MCFEG-00215 between MCF 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

Annual water quality progress reports will be submitted between December and February following the conclusion of the monitoring season. A template will be used if provided by the Ecology Project Manager.

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.

12.4 Responsibility for reports

Rebecca Wassell will be the lead on the final report.

13.0 DATA VERIFICATION

13.1 Field data verification, requirements and responsibilities

The data will be verified by following the procedures described in the *Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams* (Ward 2015). These procedures are summarized below:

- Calibration checks and field procedures will be documented on appropriate forms.
- Data will be checked for entry errors and completeness.
- Pre- and post-calibration check results and field measurements will be reviewed to ensure the data quality objectives were met.
- Results will be verified using data plots, field measurements, and stream height/flow information (if available).
- Detected data errors will be corrected, flagged with data qualifiers, or deleted.

For field measurements, the field lead will verify initial field data before leaving each site. This process involves checking the data sheet for omissions or outliers. If measurement data are missing or a measurement is determined to be an outlier, the measurement will be repeated.

13.2 Laboratory data verification

Not applicable.

13.3 Validation requirements, if necessary

Not applicable.

14.0 DATA QUALITY ASSESSMENT PROCEDURE

14.1 Process for determining whether project objectives have been met

After all field data are verified, the field lead or project manager will thoroughly examine the data to determine if MQOs have been met. The project manager will examine the data to determine if all the criteria for MQOs, completeness, representativeness, and comparability have been met. If the criteria have not been met, the project manager will decide if affected data should be qualified or rejected.

14.2 Data analysis and presentation methods

No data analysis or methods presentations are currently planned.

14.3 Treatment of non-detects

Not applicable.

14.4 Sampling design evaluation

The data collected during this project will be evaluated to determine whether temperatures in the off-channel area at the site are suitable for salmonids. If so, further study of the feasibility of opening the side channel area to the main flow of the Yakima River will be performed. The data will be evaluated by fisheries biologists and habitat restoration professionals.

14.5 Documentation of assessment

The data collected will be documented in accordance with the grant reporting requirements and in accordance with Ecology requirements.

Please refer to section 12.3 for more detail on reporting.

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APPENDIX A. QUALITY ASSURANCE

Parameter Measured: Continuous Temperature

#UA-001-64 HOBO Pendant
Onset Computer Corp.
Measurement range: -20° to 70°C (-4° to 158°F)
Alarms: High and low alarms can be configured for total amount of contiguous or non-contiguous time outside of user-defined limits between -20° and 70°C (-4° to 158°F)
Accuracy: ± 0.53°C from 0° to 50°C (± 0.95°F from 32° to 122°F), see Plot A
Resolution: Temperature: 0.14°C at 25°C (0.25°F at 77°F), see Plot A
Drift: Less than 0.1°C/year (0.2°F/year)

<u>Response Time</u>
Airflow of 2 m/s (4.4 mph): 10 minutes, typical to 90%
Water: 5 minutes, typical to 90%

Time accuracy: ± 1 minute per month at 25°C (77°F), see Plot B

<u>Operating Range</u>
In water/ice: -20° to 50°C (-4° to 122°F)
In air: -20° to 70°C (-4° to 158°F)

Water depth rating: 30 m from -20° to 20°C (100 ft from -4° to 68°F), see Plot C
NIST traceable certification: Available for temperature only at additional charge; temperature range -20° to 70°C (-4° to 158°F)
Battery life: 1 year typical use

<u>Memory</u>
UA-001-64: 64K bytes (approximately 52K sample and event readings)

Calibration Procedure

The logger cannot be calibrated, but should be checked for drift twice annually: before deployment and following removal at the end of monitoring season. This will be done using a well-mixed ice bath 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. If the monitoring site does not appear to be at risk of scour, loggers may remain deployed until the following spring. The monitoring sites are visited bimonthly for data downloading and measurement of other water quality parameters. The placement of the loggers requires that they measure a representative temperature for the spring, side channel, or river (e.g.; Temperature loggers should be placed in the main flow, but not in a backwater or eddy). 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. 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 with also be synchronized when they are re-launched after download.

APPENDIX B. DATA FORMS

Continuous Temperature Survey Form

Station #: ________ **Station Name:** ____________________ **Samplers:** __________________

Interval Frequency 00:30

Water Temperature Logger

I.D. # ______________

Water Depth ______ **ft** **Deployment Depth** ______ **ft**

Height (Abv Bottom) ______ **ft** **Retrieval Depth** ______ **ft**

Air Temperature Logger

I.D. # ______________

Height (Abv Stream) ______ **ft**

Date	Time	Water Temp	Air Temp	Weather/ Comments

Air Temperature Logger Location:

Water Temperature Logger Location:

X:\EA PROGRAM\ECYEAPSOP\Approved SOPs\ECY_EAP_SOP_Cont_Temp_Mon_Ambient_v2_0EAP080.docx_3/25/2015_Page 25

Figure 7. Continuous temperature survey form (Ward 2015).

Site Name:

Date: ____________ Meter/Type: ________

Start time: ____________ End time: __________

Staff Gage: ____________ Staff Gage: __________

Staff: __________________________________

	Distance	Depth	V-0.6	V-0.2	V-0.8	Notes
1		Bank				
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

Comments: IW=In Weeds;BW=Behind Weeds;OR=On a Rock;BR=Behind a Rock

Figure 8. Flow measurement form.

11.1 Appendix A. 11 Count Substrate: Depth, Class, Embeddedness

ERST TYPE N F Westside MM/DD__________ 2009 CREW____________ Site ID #______________

11 Count Substrate: Depth, Class, Embeddedness																		
POS	T-1			T-2			T-3			T-4			T-5			T-6		
	dep	sub	emb	dep	sub	emb	dep	sub	emb	dep	sub	emb	dep	sub	emb	dep	sub	emb
0%																		
10%																		
20%																		
30%																		
40%																		
50%																		
60%																		
70%																		
80%																		
90%																		
100%																		

Notes: ____

dep = depth (cm), sub = substrate size class, emb = embeddedness (%)

ERST TYPE N F Westside MM/DD_________ 2009 CREW_________ Site ID #____________________

Transect Dimensions, Canopy Closure, Riparian Vegetation Cover									
	DIMENSIONS(m)				CANOPY CLOSURE				Notes:
Tr.	WW	BFW	BAR	THD	Up	Left	Down	Right	
1									
2									
3									
4									
5									
6									

RIPARIAN VEGETATION COVER	T - 1 LB	T - 1 RB	T - 2 LB	T - 2 RB	T - 3 LB	T - 3 RB	T - 4 LB	T - 4 RB	T - 5 LB	T - 5 RB	T - 6 LB	T - 6 RB
Vegetation Type (> 5m)												
Big Trees (> 5m)												
Small Trees (> 5m)												
Vegetation Type (5 - 0.5m)												
Woody Plants (0.5 - 5m)												
Non-Woody Plants (0.5 - 5m)												
Woody Plants (< 0.5m)												
Non-Woody (< 0.5m)												
Barren, Bare Dirt or Duff												
Unstable Bank (%)												

Vegetation Type (D = deciduous, C = coniferous, E = broadleaf evergreen, M = mixed, N = none). For big/small trees, woody/non-woody dirt/duff use: 0 = Absent (0%), 1 = Sparse (<10%), 2 = Moderate (10-40%), 3 = Heavy (40-75%), 4 = Very Heavy (>75%)

Figure 9. Count substrate forms.

APPENDIX C. RUGGED TROLL SPECIFICATIONS

Rugged TROLL® 100 and 200 Data Loggers Spec Sheet In-Situ

General	Rugged TROLL 100 & 200	Rugged BaroTROLL
Temperature ranges[1]	Operational: 0-50° C (32-122° F) Storage: -40-80° C (-40-176° F) Calibrated: 0-50° C (32-122° F)	Operational: 0-50° C (32-122° F) Storage: -40-80° C (-40-176° F) Calibrated: 0-50° C (32-122° F)
Diameter	2.62 cm (1.03 in.)	2.62 cm (1.03 in.)
Length	14.43 cm (5.68 in.)	14.43 cm (5.68 in.)
Weight	170 g (0.37 lb)	170 g (0.37 lb)
Materials	Titanium body; Delrin® nose cone, hanger, backend	Titanium body; Delrin nose cone, hanger, backend
Output options	Rugged TROLL 100: USB or RS232 via docking station Rugged TROLL 200: USB or RS232 via docking station; Modbus/RS485 or SDI-12 via Rugged TROLL 200 Cable	USB or RS232 via docking station; Modbus/RS485 or SDI-12 via Rugged TROLL 200 Cable
Battery type & life[2]	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings
External power	Rugged TROLL 100: NA Rugged TROLL 200: 8-36 VDC	8-36 VDC
Memory Data records[3] Data logs	2.0 MB 120,000 Rugged TROLL 100: 1 log Rugged TROLL 200: 2 logs	2.0 MB 120,000 2 logs
Fastest logging rate	1 per second	1 per minute
Fastest output rate	Rugged TROLL 200 only Modbus & SDI-12: 1 per second	Modbus & SDI-12: 1 per second
Log types	Linear, Fast Linear, and Event	Linear
Sensor Type/Material	**Piezoresistive; Ceramic**	**Piezoresistive; Ceramic**
Range	9 m (30 ft) (Burst: 18 m; 60 ft) 30 m (100 ft) (Burst: 40 m; 134 ft) 76 m (250 ft) (Burst: 112 m; 368 ft)	7 to 30 psi; 0.5 to 2 bar
Accuracy[4]	±0.1% full scale (FS) typical ±0.3% FS max.	±0.1% FS typical ±0.3% FS max.
Resolution	±0.01% FS or better	±0.01% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg
Temperature Sensor	**Silicon**	**Silicon**
Accuracy	±0.3° C	±0.3° C
Resolution	0.01° C or better	0.01° C or better
Units of measure	Celsius or Fahrenheit	Celsius or Fahrenheit
Warranty	**2 years**	**2 years**

Notes: [1]Temperature range for non-freezing liquids. [2]Typical battery life when used within the factory-calibrated temperature range. [3]1 data record = date/time plus 2 parameters logged for a total of 360,000 data points, no wrapping. [4]Across factory-calibrated pressure and temperature ranges. Delrin is a registered trademark of E.I. du Pont de Nemours & Co. Specifications are subject to change without notice.

CE FC

Rugged BaroTROLL® Data Logger

Use the titanium Rugged BaroTROLL with either a Rugged TROLL 100 or 200 Data Logger. Win-Situ® Baro Merge® Software simplifies post-correction of water level data for barometric pressure changes.

Rugged TROLL® 200 Cable

Access real-time data by using Rugged TROLL 200 Cable with a Rugged TROLL 200 or a Rugged BaroTROLL. Use a Cable Suspension Kit to anchor the cable in place. Available configurations:

- Modbus/RS485 stripped-and-tinned cable or SDI-12 stripped-and-tinned cable—Use with PLC, telemetry system, or logger.
- Modbus/RS485 top-of-well cable—Use with Rugged TROLL Com Device and a RuggedReader® Handheld PC or a PC.

Jacket options	TPU (thermoplastic polyurethane)
Conductors	4 conductors, 24 AWG, polypropylene insulation
Diameter	Cable: 5.1 mm (0.200 in.) Connector: 26.1 mm (1.03 in.)
Cable lengths	Modbus/RS485: Customizable up to 300 m (1,000 ft) SDI-12: Standard lengths up to 60 m (200 ft)
Minimum bend radius	5X cable diameter
Break strength	68 kg (150 lbs)

Rugged TROLL® Com Communication Device

Use the Rugged TROLL Com Device for communication between a cabled Rugged TROLL 200 or a cabled Rugged BaroTROLL and a RuggedReader Handheld PC or a laptop/PC.

Operating temp. range	0-50° C (32-122° F)
Storage temp. range	-40-80° C (-40-176° F)
Materials	Delrin, rubber, copper pins
Environmental rating	IP67 with battery cover closed
Dimensions (LxWxH)	8.9 x 2.9 x 4.8 cm (3.5 x 1.14 x 1.88 in.)
Input connection	Modbus/RS485
Output connection	Available with either USB or RS232
Power source	9V alkaline battery, user-replaceable
Cable	Black polyurethane, 91 cm (3 ft) long

Rugged TROLL® Docking Station

Use the docking station to program and download data from a Rugged TROLL 100 or 200 or from a Rugged BaroTROLL. The docking station is available with either a USB or RS232 communication interface. USB allows fast data transfer to a PC. Use the RS232 version with a laptop/PC or a RuggedReader Handheld PC.

CALL OR CLICK TO PURCHASE OR RENT
1-800-446-7488 (toll-free in U.S.A. and Canada)
1-970-498-1500 (U.S.A. and international)
WWW.IN-SITU.COM

221 East Lincoln Avenue, Fort Collins, CO 80524 USA

Figure 10. Rugged Troll specifications[3].

[3] https://in-situ.com/wp-content/uploads/2014/11/Rugged_TROLL_100_200_Baro_Specifications.pdf.