QUALITY ASSURANCE PROJECT PLAN
LUMMI NATION AMBIENT SURFACE WATER QUALITY MONITORING PROJECT

Version 1.2

Water Resources Division
Natural Resources Department
Lummi Indian Business Council

Prepared for EPA Region 10

July 2021

Lummi Nation Ambient Surface Water Quality Monitoring Project Quality Assurance Project Plan Approval (A1):

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REVISION RECORD

Approval	Date	Responsible Person	Description of Change	Location of Change
1	October 2018	Kara Kuhlman	Initial Approval and Release of Version 1.0	N/A
1.1	December 2019	Kara Kuhlman	Staffing updates (new staff)	Distribution List, Section 1.2
			Remove completed studies	Section 1.1
			Update water quality concerns in Portage Bay	Sections 2.2, 13.1
			Add two sites to program	Sections 3.1, 6.2, Tables 6.1, 6.2, Figure 3.1
			Reporting frequency increased from annual to every two years	Sections 3.1, 5.2, 11.2
			Replace sign-out board with informing supervisor	Section 7.3
			Update equipment used	Table 7.1, Sections 8.2, 9
1.2	July 2021	Kara Kuhlman	Change EPA Tribal Coordinator to Michael Ortiz	Signature page, Distribution list
			Remove ZAPS Technologies LiquID Station Continuous Water Quality Monitoring Study. The study has been completed.	Section 1.1, 4.5
			Correct frequency of Water Quality Assessment Report from annual to every two years	Section 3.1, 4.0
			Update STORET to WQX	Sections 6.1, 8.2, 13, 14.1
			Change sampling sequence at site SW058 from when flowing to only when flowing downstream.	Section 3.1, 7.4
			Delete incomplete sentence	Section 4.0

SIGNATURE PAGE

Document: Lummi Nation Ambient Surface Water Quality Monitoring Project

Version 1.2

The following technical staff have read this manual. A copy of this page will be distributed to the employee training record file.

Signature	**Date**
Name (printed)	**Title**

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TABLE OF CONTENTS (A2)

LIST OF TABLES

LIST OF FIGURES

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1. DOCUMENT AND PROJECT ORGANIZATION

1.1 Document Organization

This document is organized following *Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans* (EPA 2001, reissued 2006a) with the companion document *Guidance for Quality Assurance Project Plans* (EPA 2002). Where a letter and number follow a section title (*e.g.,* Distribution List [A3]), they indicate the corresponding section in the *EPA Requirements for Quality Assurance Project Plans*.

This Quality Assurance Project Plan (QAPP) Version 1.2 for the Lummi Nation Ambient Surface Water Quality Monitoring Project supersedes the Lummi Nation Water Quality Monitoring Program QAPP Version 4.0 (2010 QAPP; LWRD 2010).

The 2010 QAPP (LWRD 2010) has been reviewed, revised, and reorganized into a new framework. Whereas the 2010 QAPP included quality procedures for all Lummi Nation Water Quality Monitoring Program (WQM Program) projects (*e.g.,* surface and ground water) and equipment under one QAPP, the new framework includes a Quality Management Plan (QMP) as the umbrella document outlining the overall quality system for the WQM Program and several QAPPs for each individual project. The individual projects include the following:

- Ambient Surface Water Quality Monitoring Project (this document)
- Ambient Groundwater Quality and Quantity Monitoring Project
- Continuous Water Temperature Monitoring Project
- First Flush Monitoring Project
- Department of Health Support (National Shellfish Sanitation Program) Project
- Nutrient, Metal, and Hydrocarbon Monitoring Project
- Continuous Water Level Monitoring Project
- Lummi Peninsula Groundwater Settlement Agreement Compliance Monitoring Project

In addition, Standard Operating Procedures (SOPs) have been developed for each instrument used or parameter measured.

1.2 Project Organization (A4)

The Lummi Nation Ambient Surface Water Quality Monitoring Project (Surface Water Project) is administered and implemented through the Lummi Water Resources Division (LWRD), a division within the Lummi Natural Resources Department (LNR), contained under the Lummi Indian Business Council (LIBC). An organizational chart of the individuals participating in the Surface Water Project and laboratories providing analytical services is provided in the QMP. A complete and detailed discussion of the structure of the WQM Program, including organization charts identifying the components of all projects part of the WQM Program and individuals participating in the WQM Program are provided in the QMP (LWRD 2021b).

In summary, the Water Resources Specialist II is the primary staff person responsible for Surface Water Project coordination, including maintaining the official, approved QAPP. The Water Resources Specialist II, Water Resources Technician II, and Natural Resources Technician II are responsible for implementing the Surface Water Project. The Water Resources Specialist II supervises the Water Resources Technician II and Natural Resources Technician II and provides approval and oversight of the Surface Water Project including coordination with the independent contracted laboratory. The Water Resources Manager evaluates compliance with project goals and makes recommendations to the LNR Director and Deputy Director, who make decisions based upon data collected as part of this Project. The Database Manager created and maintains the Water Database and is the primary staff member responsible for database development, training, and documentation.

1.3 Special Training Requirements and Certification (A8)

Details on the roles, contact information, position requirements, and qualifications held by the individuals responsible for managing and implementing the Surface Water Project are listed in detail in the QMP. The QMP also includes details on the required and recommended training and certification for all staff involved in the WQM Program. Supervisors and the Water Resources Manager are responsible for ensuring staff are qualified and trained.

2. PROBLEM DEFINITION AND BACKGROUND (A5)

2.1 Project Summary

The Lummi Nation Surface Water Project has been ongoing since 1993, and is focused on monitoring the quality of freshwater drainages of waters on and flowing onto and through the Lummi Indian Reservation (Reservation), including marine waters, Portage Island, Nooksack River, and Lummi River. The Surface Water Project continues to provide water quality data from 36 surface water sites on the Reservation to determine whether these waters meet the *Water Quality Standards for Surface Waters of the Lummi Indian Reservation* (Lummi Nation Water Quality Standards; Lummi Administrative Regulation [LAR] 17.07). The Surface Water Project is one of the LWRD's ongoing core monitoring projects that are complemented by other, shorter-term or more intensive monitoring projects. Summaries of other WQM Program water quality monitoring projects are provided in the QMP.

Bacteria (fecal coliform, *Escherichia coli*, and enterococcus) samples and *in situ* water quality parameters are measured monthly at 21 sites and 6 times per year at 15 sites. These water quality data are compared with Lummi Nation Water Quality Standards for the designated water quality class for each particular system monitored. The results of this project will advise regulatory actions, restoration efforts, and Total Maximum Daily Load development for the Nooksack River and Lummi River watersheds, as determined by the Water Resources Manager, LNR Director, and LNR Deputy Director.

2.2 Water Quality

As summarized in the QMP, there are numerous threats to Lummi Nation Waters.[1] The QMP provides a detailed description of Lummi Nation Waters and the geographical location of the Lummi Indian Reservation. Threats to Lummi Nation Waters include bacterial contamination of surface waters from both on- and off-Reservation sources which have the potential to damage resource-rich Reservation tidelands and adversely impact fisheries (*e.g.,* closure of shellfish beds harvested for cultural, subsistence, and commercial purposes). Commercial shellfish beds located on the Portage Bay tidelands of the Reservation were downgraded from "approved" to "restricted" status in various areas from 1996 to 2006. The cause of the downgrades was attributed to contaminated Nooksack River water entering Portage Bay (Ecology 2000). The presence of Nooksack River water in Portage Bay occurs frequently and is evidenced by lowered salinities, salinity-based stratification, and/or color. In general, elevated fecal coliform bacteria levels in Portage Bay are associated with lower surface salinities. Since water quality improvements led to the reopening of Portage Bay shellfish beds in 2006, water quality has again declined. In September 2014, a 335-acre portion of the Portage Bay shellfish growing area

[1] Pursuant to 17.09.010 of the Lummi Code of Laws, Lummi Nation Water includes all fresh and marine waters that originate or flow in, into, or through the Reservation, or that are stored on the Reservation, whether found on the surface of the earth or underground, and all Lummi Nation tribal reserved water rights.

was voluntarily closed to harvest by the Lummi Nation. In March 2015, the Washington State Department of Health (DOH) changed the classification of nearly 500 acres of Portage Bay, including the portions already under the voluntary closure, from "approved" to "conditionally approved," which closes harvesting from April through June and October through December (DOH 2015). In April 2016, an additional 325 acres of the Portage Bay growing area were voluntarily closed by the Lummi Nation to protect public health; these areas were reclassified from "approved" to "conditionally approved" with the areas failing to meet NSSP standards closed to harvest from April through June and October through December (DOH 2016).

Following improvements in water quality during the spring season, all of Portage Bay was reopened to commercial, ceremonial, and subsistence shellfish harvest from April 1 through June 30 beginning in 2019 (DOH 2018). Poor water quality persists during the fall season, and commercial, ceremonial, and subsistence shellfish harvest remains closed in 820 acres of Portage Bay from October 1 through December 31 annually.

2.3 Project Context

The Surface Water Project is implemented by the LWRD, which has the overall goal of protecting treaty rights to water of sufficient quantity and quality to (a) support the purposes of the Reservation as a permanent economically viable homeland for the Lummi People, and (b) to support a sustainable harvestable surplus of salmon and shellfish to maintain a moderate living standard.

The Surface Water Project is the primary component of the Lummi Nation Water Quality Monitoring Program (WQM Program). The goals of the WQM Program are threefold:

1. To establish the baseline conditions of surface and ground waters on and flowing onto the Reservation;
2. To use this information to evaluate regulatory compliance of waters flowing onto the Reservation; and
3. To support the development and implementation of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Lummi Nation Water Quality Standards) on the Reservation.

The WQM Program is an important element of the Comprehensive Water Resources Management Program (CWRMP). Additional details on project context and related projects are provided in the QMP. Two important milestones in the CWRMP development were the January 2004 adoption of the Lummi Nation Water Resources Protection Code (Title 17 of the Lummi Code of Laws) and the August 2007 adoption of the *Water Quality Standards for Surface Waters of the Reservation* (Lummi Nation Water Quality Standards; 17 LAR 07), which the EPA approved in September 2008. The Lummi Nation Water Quality Standards detail four surface water classes and their characteristic uses, and provide numeric water quality criteria for, among others, fecal coliform, enterococcus, dissolved oxygen, temperature, and pH. Additional details on the Lummi Nation Water Quality Standards are provided in the QMP. Applicable criteria and action limits are also provided in the QMP.

2.4 Project Justification

Regular measurement of water quality parameters is required to accurately evaluate ambient conditions of the waters on and flowing onto and through the Reservation and to determine whether these conditions comply with the EPA-approved Lummi Nation Water Quality Standards. Because sites are visited six or twelve times annually on a random schedule, ambient conditions of the surface waters on the Reservation can be assessed through all four seasons and a variety of weather conditions. Sites are sampled "randomly" in that the tides, season, and weather are not used to bias sampling efforts.[2]

The data collected as part of this project are used to identify trends (seasonal, annual, and multi-year) and impairment, establish baseline conditions, and evaluate compliance with Lummi Nation Water Quality Standards. Sample runs have been established to monitor water quality conditions in different geographical regions of the Reservation, and can serve to provide representative and targeted information for each watershed. Details on the justification of the experimental design for this project are provided in Section 6.1.

[2] The exception to the general rule is specifically due to practical considerations; for marine sampling to occur, a sufficient tidal elevation is required to access marine sample sites by boat.

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3. PROJECT DESCRIPTION (A6)

The Lummi Nation Surface Water Project has been ongoing since 1993. The overall objective of the Surface Water Project is to achieve the overall LWRD mission and the WQM Program goals (Section 2.3). Specifically, the Surface Water Project objectives are to:

1. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Waters;
2. Evaluate compliance with water quality criteria;
3. Evaluate fecal coliform contributions from on- and off-Reservation sources; and
4. Support the development of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Water Quality Standards) on the Reservation.

3.1 Project Description

The Lummi Nation Surface Water Project is focused on monitoring water quality of surface waters on and flowing onto and through the Reservation, including Reservation marine waters, the freshwater drainages of Portage Island, the Nooksack River, and the Lummi River. Surface water quality on the Reservation is characterized monthly at 23 sites and 6 times per year at 15 sites. Two sites are sampled more frequently; SW051 (mouth of the Lummi River) is sampled one to two times per month, and SW118 (Nooksack River at Marine Drive Bridge) is sampled three to four times per month. A total of 38 sample sites are assessed as part of the Surface Water Project. The majority of the sample sites are accessible from land (28 of 36 sites). The remaining 10 sample sites are boat-accessible marine sites located in Portage Bay, Lummi Bay, the Sandy Point Marina, and on Portage Island. Figure 3.1 provides a map of the sample site locations.

Water quality parameters are only measured when flowing water is present at the sample site; stagnant waters are not sampled.[3] Water quality is generally measured *in situ* for salinity, specific conductivity, water temperature, dissolved oxygen, and pH using a multi-parameter water quality sonde. A bacteria (fecal coliform, *E. coli*, and enterococcus) sample for analysis at an independent contracted laboratory is collected. Secchi depth is measured *in situ* for boat-accessible marine sites. In addition, air temperature, water depth, flow direction, and other site observations are recorded.

Data collected as part of the Surface Water Project are used to determine whether these waters meet Lummi Nation Water Quality Standards (17 LAR 07) and inform regulatory actions, restoration efforts, and Total Maximum Daily Load development in the Nooksack River and Lummi River watersheds, as determined by the Water Resources Manager, Natural Resources Director, and Natural Resources Deputy Director. A summary of water quality data, comparison

[3] All channelized sites are sampled when flowing water of sufficient depth to sample is present, whether flowing upstream or downstream, with the exception of site SW058, which is only sampled during downstream flow.

with Lummi Nation Water Quality Standards, and comparison with results from the period of record are included in the Water Quality Assessment Report provided to the EPA every other year to fulfill Clean Water Act Section 106 grant funding requirements by March 31 of the year following the two-year assessment period (EPA 2006b). Surface water quality data are submitted to EPA via the Water Quality Exchange (WQX) framework.

Field visits and sample collection occurs January-December of each year. Data analysis and report preparation is conducted every-other year in January-March of the year following data collection for the two-year reporting period. The data transfer to EPA via WQX is scheduled annually by March 31 of the year following data collection. It is anticipated that all sites will be sampled as scheduled (once per month or six times per year depending on the site). However, sampling of marine sites is occasionally limited due to sea conditions and safety concerns. As possible, sampling events cancelled due to safety concerns are rescheduled for a later time to ensure that minimum sampling requirements are met. Equipment failure, staffing limitations, and budget restraints may also restrict planned site visit frequency.

Quality Assurance/Quality Control (QA/QC) procedures include equipment calibration, accuracy checks, and maintenance as specified in equipment SOPs. Details of the QA/QC procedures are provided in Section 8 of this QAPP.

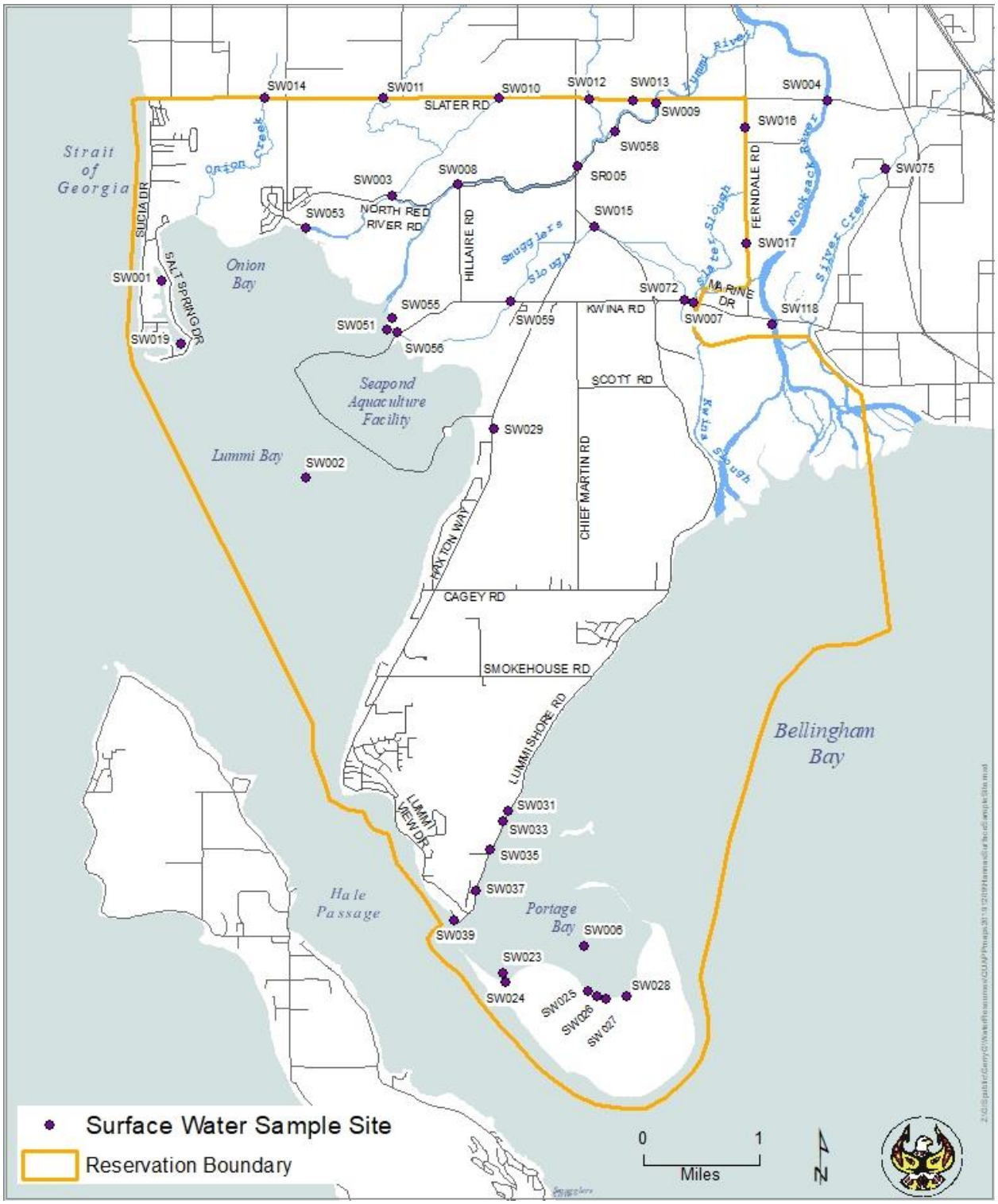

Figure 3.1 Location of Surface Water Quality Monitoring Sites

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4. QUALITY OBJECTIVES AND CRITERIA (A7)

The overall performance standard for the Surface Water Project is the collection of high-quality data sufficient to meet project goals. Data must be of sufficient quality (*i.e.,* known precision, accuracy, bias, traceability, completeness, and representativeness) to support scientifically valid and legally defensible decisions. The Surface Water Project is ongoing and is not designed to prove or disprove a specific hypothesis. The data are used to assist in identifying and addressing actual and potential impairments of water quality and for evaluation of water quality trends against regulatory criteria.

Project quality control activities are designed to indicate data quality in the field and prompt corrective actions at that time, if necessary. In addition, quality control activities provide the necessary information to assess and quantify data quality and comparability for data analysis to ensure and document the reliability and usefulness of the water quality data for evaluation of trends, impairment, and compliance with Lummi Nation Water Quality Standards.

Summary statistics for all parameters are calculated, as needed, and used for comparison with previous results from the period of record and relevant water quality criteria. See QMP for calculation of summary statistics, including field variability and quality control parameters. These summary data are presented in the Water Quality Assessment Report.

4.1 Measurement Performance/Acceptance Criteria

Quality assurance/quality control (QA/QC) procedures include: equipment calibration, accuracy checks, and maintenance activities as required by the equipment SOPs; aseptic bacteria sample collection and handling techniques, field blanks, and chain of custody procedures as required by the bacteria sample collection SOP; and field duplicates (Section 8).

Acceptance criteria and detection limits vary depending on the parameter measured. Refer to equipment SOPs for details (YSI 556 SOP, YSI ProPlus SOP, Air Temperature SOP, Bacteria Sample Collection SOP, Secchi Depth SOP, Current/Flow Direction SOP). Project action limits include measurements that exceed water quality criteria and measurements that are unusual or unexpected for the site. Additional details on project action limits are included in the QMP.

4.2 Precision

Manufacturer-stated resolution for air temperature, water temperature, salinity, specific conductivity, dissolved oxygen, and pH are listed in the instrument SOPs.

At least 10% of all field measurements are duplicated in the field during each sample run, except for samples collected for analysis at a laboratory. Field duplicates provide information on both the precision of the instrument used to measure the parameter and the natural field variability of the parameter. However, duplicate measurements are not routinely used to calculate the precision of the instrument or method; they are primarily used as an indicator of field variability.

If quantification of precision of a particular parameter or instrument is required, standard error can be calculated from repeated accuracy checks with a known standard. However, quantification of precision in addition to manufacturer-stated resolution is not routinely conducted.

If a visual observation (*e.g.,* current or flow direction) changes during a site visit, it is noted in the Water Database.

4.3 Accuracy and Bias

The accuracy of the parameters measured is specified by the manufacturer (see instrument SOPs, Bacteria Sample Collection SOP, and other parameter SOPs for details). Parameters measured using a water quality monitoring sonde (*i.e.,* the YSI 556 or YSI ProPlus) are calibrated and verified against National Institute of Standards and Technology traceable standards. If the instrument cannot be calibrated or the accuracy check is not within acceptance criteria, corrective actions are taken to determine and correct the problem (see instrument SOPs for details).

4.4 Representativeness

Water quality measurements and laboratory samples are collected from a representative portion of the waterbody that is characteristic and removed from possible influences of the sampler. Representative portions are determined by visual means, measured water quality variation, and the location where samples have been collected historically. Shallow margins and uncharacteristic areas are avoided. Although water quality variation does not necessarily suggest non-representativeness due to the variable nature of surface waters on the Reservation, the variability of salinity, specific conductivity, temperature, and dissolved oxygen is evaluated while the sample site is being measured and any variability is recorded in the Water Database. Care is taken to minimize disturbance of the water column when collecting samples and taking measurements to determine if a waterbody is stratified. Details on selection of a representative location and sample procedures to minimize disturbance are provided in Sections 7.5 and 7.6.

4.5 Comparability

Data quality can be assessed and quantified for all data collected over the period of record. Although different brands of water quality meters or model types have been used over time, methods for collecting water quality data have not changed significantly since 1993. Equipment changes are documented in field log books, field datasheets, and Water Database. Units of measurement have remained consistent throughout the period of record. The measures of accuracy, precision, and traceability have not changed and provide for the ability to assess these quality objectives for data collected over the entire period of record.

Information regarding data quality allows for comparison of data collected at different times over the period of record within the Surface Water Project and with other Lummi Nation water

quality projects (*e.g.,* First Flush, Department of Health Support, ZAPS Continuous Monitoring Study), as well as comparison with non-WQM Program sources of data, assuming quality control information is available for non-Program data. The Nooksack River (SW118) is sampled the day prior to sampling in Portage Bay as part of the National Shellfish Sanitation Program (NSSP) in coordination with the Whatcom Clean Water Program. Site SW118 results may be compared with results from other sites within the Nooksack River watershed collected by agencies partnering in the Whatcom Clean Water Program or with data obtained from the ZAPS Continuous Monitoring Study.

The U.S. Geological Survey (USGS) maintains a gaging station on the Nooksack River at Ferndale (USGS 12213100) with turbidity, discharge, and gage height data available as daily minimum, maximum and average. The USGS also maintains a stage station on the Nooksack River at Marine Drive Bridge (USGS 12213145) providing real-time gage height data. Water quality data collected at site SW118 (Nooksack River at Marine Drive Bridge) may be compared to the Nooksack River gages to describe the general water quality and flow conditions in the Nooksack River.

4.6 Completeness

The goal of the Surface Water Project is for the majority of sample sites to be visited 6 or 12 times a year and some more frequently (*e.g.,* Site SW118 is sampled two to four times per month), as described in this QAPP. With the exception of more frequent sample runs, sampling events should be equally distributed throughout the year. Surface water sample sites are grouped into sequential sample runs that provide spatially representative data. If the sequence is incomplete, it would be difficult to determine the source or location of a disturbance.

Data are considered complete when all efforts have been taken to collect the data. It is anticipated that all samples will be collected as outlined in the QAPP. Sea conditions may limit sample collection at some marine sites; however, this is expected to occur only occasionally (one or two months per year) and sample runs will be rescheduled to provide the minimum number of sampling days, as possible. Equipment failure, staffing limitations, budget reductions, or changing department priorities may also result in temporary reduction of sample collection depending on the year. If 80% or fewer of the planned samples are collected in a calendar year, the experimental design of this project will be re-evaluated.

Data gaps may affect future analysis of baseline conditions and comparison to regulatory criteria, but do not immediately compromise the integrity of the monitoring project because monitoring is not attempting to answer a specific hypothesis. Data gaps are addressed on a case-by-case basis. Missing data may be due to staff turnover, resource constraints, equipment failure, corrective actions, or logistical problems. Corrective actions are undertaken to remedy conditions that create missing data to prevent data gaps in the future (see YSI 556 SOP, YSI ProPlus SOP, Air Temperature SOP, Bacteria Sample Collection SOP, Secchi Depth SOP, and Current/Flow Direction SOP for details).

4.7 Range/Sensitivity

The sensitivity and range that can be measured depends on the equipment selected. See YSI 556 SOP, YSI ProPlus SOP, Air Temperature SOP, Bacteria Sample Collection SOP, Secchi Depth SOP, and Current/Flow Direction SOP for details. The goal of the Surface Water Project is to collect data with sufficient resolution (sensitivity) to establish baseline conditions and identify trends, evaluate water quality against appropriate Lummi Nation Water Quality Standards, evaluate fecal coliform contributions from on- and off-Reservation sources, and support the development and implementation of a water quality regulatory program on the Reservation. Deficiencies in sensitivity are evaluated on a case-by-case basis and corrected for future monitoring.

5. DOCUMENTS AND RECORDS (A9)

5.1 Quality Assurance Project Plan Distribution

The Water Resources Specialist II is responsible for ensuring that the people listed on the Distribution List for this QAPP have the most current version of the QAPP. Records are maintained by the Water Resources Specialist II documenting substantial and minor version changes, and the Water Resources Manager is responsible for the distribution of minor change letters and revised QAPPs. Details on documenting QAPP revisions, including version number conventions, are included in the QMP.

5.2 Data Report Package

Results of the Surface Water Project are included in the Water Quality Assessment Report, which summarizes the results of the WQM Program projects implemented by the LWRD. The reports determine whether Lummi Nation Water Quality Standards are met and include analysis of water quality data for the two-year reporting period as well as for the period of record. The report is provided to the EPA Project Officer every-other year by March 31 of the year after the two-year reporting period, following approval by the Water Resources Manager and the LNR Deputy Director.

The Surface Water Project data are transmitted to the EPA via WQX upon approval by the Water Resources Manager and the LNR Deputy Director. Data collected as part of the Surface Water Project are provided to the EPA Project Officer by March 31 of the subsequent calendar year.

5.3 Documentation and Storage

The QMP provides detailed requirements for project document storage, including field datasheets, lab results, and electronic data.

In summary, the Water Resources Specialist II is responsible for maintaining and storing all documents and records associated with the Surface Water Project. Quality control reports, field datasheets, and final lab results are stored in three-ring binders in the LWRD office. All paper records are scanned and saved on LIBC servers that are backed up nightly. All data are entered into the Water Database, which is saved on LIBC servers that are backed up nightly.

In this QAPP, reference to data or comments entered “into Water Database” includes entry directly into the Water Database via the iPad or by recording onto hardcopy field datasheets that are later transcribed into the Water Database. Details are included in the QMP and specific instructions on data entry are provided in the Water Database User Guide. The QMP also details what information should be recorded in the Water Database and the conventions for making changes or correcting errors on hardcopy field datasheets or electronically in the Water Database.

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6. EXPERIMENTAL DESIGN (B1)

The Surface Water Project is based on a sample-run system, and is designed to achieve the following objectives:

1. Provide high quality data sufficient to establish baseline conditions of Lummi Nation Waters;
2. To evaluate compliance with water quality criteria;
3. To evaluate fecal coliform contributions from on- and off-Reservation sources; and
4. To support the development of a water quality regulatory program (*e.g.,* Lummi Code of Laws Title 17, Water Quality Standards) on the Reservation.

The Surface Water Project is ongoing and not intended to prove or disprove a specific hypothesis.

6.1 Sample Runs and Structure

The Surface Water Project is run-based system comprised of five sample runs: Floodplain East (FPE), Floodplain West (FPW), Lummi Shore Road (LSR), Marine Boat Accessible (Sandy Point and Portage Island [SP&PI]), and Nooksack River.

The FPE and FPW sample runs divide the on-Reservation portion of the Lummi Bay watershed into two runs based upon the surface water drainage network. FPE captures the discrete drainage network of the eastern Lummi Bay watershed from the Reservation Boundary and hydrographic divide (Site SW072) to Lummi Bay. FPW captures the drainage network of the western Lummi Bay watershed from the Reservation boundary to Lummi Bay. The FPE and FPW runs are sampled monthly. On months when LSR is not sampled, sampling of two sites on the LSR run is conducted during the FPE run.

The LSR sample run characterizes on-reservation upland sources of freshwater discharge to Portage Bay. The LSR run is sampled six times per year in coordination with sampling of Portage Bay as part of the NSSP by the DOH. The LSR run is sampled when the DOH conducts sampling in Portage Bay. On months when LWRD staff sample Portage Bay in support of the DOH, the LSR run is not conducted, and sampling of two sites on the LSR run is conducted during the FPE run.

The SP&PI sample run characterizes marine waters in the Sandy Point Marina, Lummi Bay, Portage Bay, and the five Portage Island freshwater discharges to Portage Bay. The SP&PI sample sites are targeted for sampling six times per year. Occasionally unsafe weather conditions can reduce the sample frequency; when sample runs are cancelled due to weather, runs are rescheduled for a later time, if possible, to maintain six times per year sampling at these sites. The SP&PI sample run can be conducted in one trip, or can be split into two trips. Sites on Portage Island and in Portage Bay are typically sampled concurrently with sampling in Portage Bay as part of the DOH Support (NSSP) Project. Sites in the Sandy Point Marina and

Lummi Bay are typically sampled concurrently with sampling in Lummi Bay as part of the DOH Support (NSSP) Project due to proximity of sample sites.

The Nooksack River run characterizes freshwater inputs from the Nooksack River into Portage Bay and corresponds with NSSP sampling in Portage Bay. The Nooksack River and Silver Creek, a tributary to the Nooksack River, are sampled the day prior to NSSP sampling in Portage Bay. As part of the Whatcom Clean Water Program, several agencies coordinate to collect samples from the Nooksack River watershed at select sites on the same day. Partnering agencies include the Whatcom County Public Works Department Water Resources Division, Washington State Department of Ecology, the Nooksack Indian Tribe, and the Washington State Department of Agriculture. In addition, the Nooksack River is sampled the day of NSSP sampling in Portage Bay. On months when DOH staff sample Portage Bay, the Nooksack River site (SW118) is included in the LSR run. On months when LWRD staff sample Portage Bay in support of the DOH and the LSR run is not conducted, only the Nooksack River site (SW118) is sampled. Information about NSSP sampling is provided in the DOH Support (NSSP) Project QAPP.[4]

Information from all sample runs is used to establish baseline conditions and to evaluate compliance with Lummi Nation Water Quality Standards. Sample runs are established to monitor water quality conditions in different geographical regions of the Reservation, and can serve to provide targeted information for each watershed.

The data collected during the FPE and FPW sample runs are used to establish baseline conditions for waters on and flowing onto and through the Reservation and into Lummi Bay. The data collected as part of the FPE and FPW sample runs aid in determining fecal coliform sources that may affect the Lummi Bay shellfish beds. The collection of water quality data along the Reservation boundary allows for the evaluation of compliance of waters on and flowing onto and through the Reservation with water quality criteria. Water quality can also be evaluated along the length of the Lummi River floodplain waterbodies and their tributaries. These water quality data are used to help identify pollution sources in the Lummi Bay watershed.

Data collected as part of the SP&PI sample run are used to establish baseline conditions and to evaluate regulatory compliance of waters in the Sandy Point Marina, Lummi Bay, Portage Bay, and the five Portage Island freshwater discharges to Portage Bay. These data can also help identify sources of pollution.

Due to water quality concerns in Portage Bay, particularly as it relates to fecal coliform contamination of shellfish beds, several sample runs provide information of freshwater sources of fecal coliform into Portage Bay. The LSR sample run provides information on sources of fecal coliform bacteria from the Reservation uplands and the Nooksack River. The SP&PI sample run provides information on sources of fecal coliform bacteria from Portage Island. Frequent

[4] "NSSP sampling" refers to sampling conducted as part of the National Shellfish Sanitation Program, a Food and Drug Administration program implemented in Washington State by the Department of Health (DOH). The DOH Support (NSSP) Project is a LWRD project that provides logistical support to the DOH in the collection of samples as part of the National Shellfish Sanitation Program. NSSP sampling can be conducted by either the DOH or LWRD.

sampling of SW118 (the Nooksack River at the Marine Drive Bridge) on multiple sample runs (FPE, FPW, LSR, and Nooksack River) at several times each month provides temporal patterns of water quality conditions and fecal coliform concentrations in the major source of freshwater to Portage Bay. The Nooksack River sample run provides information on water quality in the Nooksack River timed with NSSP sampling in Portage Bay and coordinated with other agencies collecting water quality samples in the Nooksack River watershed. This temporally coordinated sampling provides precise information on the quality of water entering Portage Bay prior to and on the day of NSSP sample collection, and provides a snapshot of water quality in the watershed on a monthly basis. Details on Portage Bay sampling are provided in the DOH Support (NSSP) Project QAPP.

The sample site distribution on the Reservation is dense in order to protect shellfish and freshwater resources and capture the spatial variability associated with estuarine environments. Temporal variability is also significant and is addressed through regular but random sampling at the same location over long periods of time. The dense sampling network provides some insight into the range of temporal variability as individual sample sites respond more or less quickly to environmental conditions.

Sampling on the SP&PI run is scheduled to occur on days with sufficient tidal height to allow for launching the boat and accessing shallow sites during daylight hours. Additionally, the LSR and Nooksack River sample runs are timed to coincide with sampling of Portage Bay, which similarly requires sufficient tidal height. Otherwise, sampling is “random” in that weather and season do not bias sample dates. Occasionally, severe weather can create unsafe marine sampling conditions. If marine sample runs cannot be safely conducted, they are rescheduled for later in the month, if possible.

6.2 Sample Sites

The 38 surface water quality sample sites (Figure 3.1) were selected to achieve the project goals and includes 16 Class AA freshwater, 10 Class AA marine water, 9 Class A freshwater, and 2 Class A marine water sites. One site, SW 075 (Silver Creek) is located off-Reservation and therefore, Lummi Nation Water Quality Standards (17 LAR 07) do not apply. This site is monitored by LWRD to document the quality of water in Silver Creek before it flows into the Nooksack River and onto and through the Reservation. Table 6.1 lists the sample sites, provides a description of their location, water class designation (see QMP for discussion and details on water quality criteria), and sample run during which the site is sampled. Note that numerical gaps in the sequential identification numbers for the surface water sites are for sites no longer sampled (see QMP for project changes). Site SW004 is included in Table 6.1 and Figure 3.1 although it is not regularly sampled; Site SW004 is sampled only when Site SW118 is inaccessible.

Table 6.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Run Name

Sample Site ID	Sample Site Location	Water Class Designation	Run Name
SW001	North end of Sandy Point Marina	AA Marine	SP&PI
SW002	Lummi Bay southwest of Seapond Aquaculture Facility	AA Marine	SP&PI
SW003	Jordan Creek at North Red River Road	AA Fresh	FPW
SW004	Alternate Nooksack River site at Slater Road[5]	Flows to AA Fresh[a]	Alternate to SW118
SR005	Lummi River at Haxton Way pedestrian bridge	AA Fresh	FPW
SW006	Portage Bay, North of Portage Island	A Marine	SP&PI
SW007	Kwina Slough at Marine Drive	AA Fresh	LSR, FPE
SW008	Lummi River at Hillaire Road Bridge	AA Marine	FPW
SW009	Lummi River at Slater Road	AA Fresh	FPW
SW010	Drainage on Slater 200 yards west of Haxton	AA Fresh	FPW
SW011	Jordan Creek at Slater Road	AA Fresh, Eph.	FPW
SW012	Schell Creek at Slater Road	AA Fresh	FPW
SW013	Agricultural drainage between Schell Creek and Lummi River	AA Fresh	FPW
SW014	Drainage from Phillips 66 stormwater treatment facility at Slater Road; flows to Onion Creek	AA Fresh, Eph.	FPW
SW015	Smuggler Slough at Lummi Shore Drive	AA Fresh	FPE
SW016	Drainage on Ferndale Road south of Slater Road	AA Fresh	FPE
SW017	Drainage on Ferndale Road north of Marine Drive	AA Fresh	FPE
SW019	South end of Sandy Point Marina	AA Marine	SP&PI
SW023	Portage Bay near beach on the northwest inner corner of Portage Island	A Marine	LSR
SW024	Drainage along road at beach on the northwest inner corner of Portage Island	A Fresh, Eph.	SP&PI
SW025	Drainage along road at beach on Portage Island	A Fresh, Eph.	SP&PI
SW026	Portage Island drainage	A Fresh, Eph.	SP&PI

[5] Site SW004 is sampled when access to SW118 for sampling is unsafe or impractical. For example, flooding can limit access to SW118.

Table 6.1 Location of Surface Water Quality Monitoring Sites, Water Class Designation, and Run Name

Sample Site ID	Sample Site Location	Water Class Designation	Run Name
SW027	Stream originating from wetland on Portage Island	A Fresh, Eph.	SP&PI
SW028	Portage Island drainage	A Fresh, Eph.	SP&PI
SW029	Drainage from Lummi Peninsula uplands east of Haxton Road near Lummi Shellfish Hatchery	AA Fresh, Eph.	LSR, FPE
SW031	Outflow along Lummi Shore Road	A Fresh	LSR
SW033	Outflow along Lummi Shore Road	A Fresh	LSR
SW035	Outflow along Lummi Shore Road at Adams Road	A Fresh	LSR
SW037	Outflow along Lummi Shore Road at Bay Lane	A Fresh	LSR
SW039	West side of Portage Island Spit at south end of Lummi Peninsula	AA Marine	LSR
SW051	Lummi River Mouth	AA Marine	FPE, FPW
SW053	North Lummi River distributary mouth	AA Marine	FPW
SW055	Drainage channel culvert outlet on east side of Lummi River levee road	AA Marine	FPE
SW056	Smuggler Slough outlet	AA Marine	FPE
SW058	Agricultural ditch that flows to Lummi River through culvert under South Red River Road	AA Fresh	FPW
SW059	Smuggler Slough at Kwina Road	AA Marine	FPE
SW072	Smuggler Slough at Self Regulating Tidegate at Marine Drive	AA Fresh	FPE
SW075	Silver Creek at Marine Drive	Flows to AA Fresh[a]	Nooksack
SW118	Nooksack River at Marine Drive Bridge	AA Fresh	FPE, FPW, LSR, Nooksack

Eph. = Ephemeral

[a] Site SW075 is located off-Reservation, but flow to Lummi Nation Waters classified as Class AA Freshwater (Nooksack River north of line between Fish Point and Treaty Rock) (17 LAR 07).

Detailed maps, descriptions of sample locations, and driving directions to sample sites are provided to field personnel in the *Water Quality Monitoring Program Field Reference Manual* to ensure that sites are sampled in the proper location (LWRD 2019). With the exception of the

SP&PI run, where tides and weather may occasionally preclude sampling, sample site access is usually not a problem. If Site SW118 becomes inaccessible due to flooding, Site SW004 can be sampled. If sites are inaccessible, another representative location is sampled, the sample site is skipped for that sample run, the sample site is returned to at a later time in the sample run, or the sample run is rescheduled. The QMP provides details on site inaccessibility and sampling of sites off-station.

6.3 Water Quality Parameters

Table 6.2 lists the sample runs, sites included in each run, parameters measured, laboratory samples collected, and frequency of site assessment. Water quality is generally measured *in situ* for salinity, specific conductivity, water temperature, dissolved oxygen, and pH. Salinity-based stratification is evaluated at all marine and tidally-influenced sites. If salinity-based stratification is present, *in situ* water quality parameters are measured for both the top and the bottom strata. Samples for laboratory analysis (fecal coliform, *E. coli*, enterococcus) are collected, labeled (site identifier, date, time, analysis, and collecting agency), placed on ice, and delivered to the laboratory using chain of custody procedures and the methods detailed in the Bacteria Sample Collection SOP. Secchi depth is measured *in situ* for marine sites sampled from the boat on the SP&PI run. In addition, air temperature is measured and current/flow direction and water depth are evaluated.

Fecal coliform bacteria and *E. coli* are enumerated from the same plate to provide information about the presence of other bacterial species (*i.e., Klebsiella*) in fecal coliform counts and increase the comparability of the fecal coliform bacteria and *E. coli* results. Enterococcus bacteria are enumerated from the same sample bottle as fecal coliform bacteria and *E. coli* to provide information about enterococcus distributions. The EPA is advocating for the discontinuation of fecal coliform as a regulatory indicator bacteria. However, at this time all three types of bacteria will continue to be sampled because the NSSP criteria are based on fecal coliform counts and there is no indication that this will change in the near future.

Table 6.2 Surface Water Quality Monitoring Sites, *In Situ* Parameters Measured, Laboratory Samples Collected, and Frequency of Sampling

Run Name	Site ID (SW)	*In Situ* Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Frequency	Notes
Floodplain East (FPE)	15, 16, 17, 51, 55, 56, 59, 72, 118 7, 29 (LSR)	Air temperature, salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen, pH, water depth, and general observations	Fecal coliform, *E. coli*, and enterococcus	Monthly	SW118 and SW051 are sampled in both the FPE and FPW runs. LSR Sites SW007 and SW029 are sampled as part of the FPE run during months that LSR is not sampled.
Floodplain West (FPW)	3, 8, 9, 10, 11, 12, 13, 14, 51, 53, 58, 118, SR005				
Lummi Shore Road (LSR)	7, 29, 31, 33, 35, 37, 39, 118			Six times per year in coordination with the DOH sampling of Portage Bay	LSR Sites SW007 and SW029 are sampled as part of the FPE run during months that LSR is not sampled.
Nooksack River	075, 118			12 (SW075) and 18 times (SW118) per year in coordination with sampling of Portage Bay	Both are sampled each month the day prior to sampling in Portage Bay. Only SW118 is sampled the day of Portage Bay sampling, when LSR is not sampled.
Sandy Point and Portage Island (SP&PI)	1, 2, 6, 19, 23, 24, 25, 26, 27, 28	Same as above. Secchi depth measured for marine sites sampled from boat.	Fecal coliform, *E. coli*, and enterococcus	Six time per year	Sites sampled concurrently with DOH Support (NSSP) Project sampling or as a separate trip.

Ten percent of sites sampled are treated as duplicates, with all measurements, except bacteria sample collection, duplicated for each stratum. Sites are randomly selected for duplication, or sites can be selected for duplicate analysis because water quality parameters at the site are variable. Duplication provides information about the natural field variability concurrently with the inherent precision of the instrument or method used to measure the parameter. Duplicate measurements are recorded in Water Database, and values are averaged for reporting the parameter results of a particular site on a given day. If variability is present and is suspected to be caused by instrument malfunction or operator error, the problem is corrected, if possible. Measurements collected using a malfunctioning instrument or using improper technique are re-collected after the problem is corrected or are assigned a data qualifier in the Water Database (see QMP and Water Database User Guide).

Critical information varies with the type of sample run. For example, bacteria, salinity, and water temperature are critical for the LSR and SP&PI sample runs. All other data collection is critical in the sense that representative and complete data are required to meet the goals of the project. Measurements for FPE and FPW do not have to occur at specified times, but they do need to be collected in groupings assigned (*i.e.,* sample runs). The LSR run must also be collected in the grouping assigned, and be sampled the day the DOH is sampling in Portage Bay. Measurements for the SP&PI run do not need to be collected at specified times, but are frequently sampled concurrently with sampling in Lummi Bay and Portage Bay as part of the DOH Support (NSSP) Project to conserve staff time and resources. Only the sites on Portage Island need to be collected in the grouping assigned.

The parameters measured and analyzed provide substantial information about water quality and general environmental conditions. For example, air and water temperature, specific conductivity, salinity, dissolved oxygen, pH, Secchi depth, presence of salinity-based stratification, water depth, and flow or current direction characterize basic water chemistry and site conditions, providing insight into both the variation and the potential causes of variation of these parameters. As previously mentioned, the measurements also provide information for determination of regulatory compliance. Many of the parameters measured are associated with regulatory criteria (*i.e.,* water temperature, dissolved oxygen, pH, bacteria). To date the extent of these evaluations rarely includes citations or legal actions, but they guide follow-up actions to confirm and remedy potential problems (Section 11.2).

7. SAMPLING METHODS (B2, B3, B4)

Sampling methods (B2), sample handling and custody (B3), and analytical methods (B4) for each parameter measured or sampled are described below. This section also describes sample handling and custody, safety during sampling, the water sampling sequence, procedures for selecting a representative location and avoiding contamination, a summary of what samples to collect and which parameters to measure under different site conditions, and a summary of practices specific to each parameter measured. Details on parameter measurement and sample collection are included in the parameter and equipment SOPs.

7.1 Sampling Method Overview

At each sample site, a bacteria sample is collected, placed on ice, and delivered to the LNR independent contracted laboratory using chain of custody procedures for fecal coliform, *E. coli*, and enterococcus enumeration. Water quality is generally measured *in situ* using a multi-parameter water quality sonde for salinity, specific conductivity, water temperature, dissolved oxygen, and pH. Salinity-based stratification is evaluated at all marine and tidally-influenced sites. If salinity-based stratification is present, *in situ* water quality parameters are measured for both the top and the bottom strata. Secchi depth is measured at marine sites sampled from the boat. In addition, air temperature is measured, and current/flow direction and water depth are evaluated. Data are recorded on field datasheets or in Water Database as described in the QMP and the Water Database User Guide.

7.2 Sample Handling and Custody (B3)

Details on sample handling and custody, including how samples are physically handled and transported to the laboratory, requirements for chain of custody procedures, and maximum holding times are provided in the Bacteria Sample Collection SOP. Information on the system for identifying samples and sample tracking is included in the QMP.

7.3 Safety

All field work is conducted by teams of two or more. All procedures listed in the *Lummi Water Resources Division Health and Safety Plan* (LWRD 2015a) are followed while conducting laboratory and field work outlined in this QAPP. Safety is not addressed in detail in this document; however, no water quality measurement is worth risking injury or death. To ensure that hazards are identified and addressed, field personnel must maintain a general awareness of hazards and possess the ability to respond appropriately. Field personnel must be aware of the environment, use common sense and training, and not exceed their abilities or limits. Field personnel always wear life jackets (when performing boat-based sampling), carry a cell phone and car charger, and inform their supervisor of planned field work, including the time of

departure, the time of scheduled return, and the general location of field work. A float plan is required when using the boat for sample collection.

7.4 Water Sampling Sequence

Upon arrival at a sample site, the following sequence is followed to collect surface water quality samples for bacteria analysis and measurement of water quality parameters.

1. Visual observation of sample site conditions and representative area.
    - See Section 7.5 for details on selecting a representative location.
    - Determine whether water at the site is flowing. Record in the Water Database if the site is dry (no water present), has insufficient water to sample, or is stagnant.
        - If site is dry, has insufficient water to sample, or is stagnant, the site cannot be sampled for any parameters.
        - If site has flowing water of sufficient quantity and depth to sample, all water quality parameters are measured and a bacteria sample is collected.
        - All sites are sampled if visible flow is observed (upstream or downstream) except site SW058, which is only sampled during downstream flow.
2. Set up air thermometer, visually observe current and flow direction, water level/depth, and waterbody condition throughout time at sample site.
3. Bacteria samples are collected first in the top six inches of the water column (below the surface) before any other water quality measurements are performed. Sample is collected in a representative portion of waterbody.
    - Bacteria samples are collected with a sampling wand when practicable.
    - Bacteria sample collection details are provided in the Bacteria Sample Collection SOP.
4. *In situ* water quality measurements are collected for water temperature, salinity, specific conductivity, dissolved oxygen, and pH at the previously identified representative portion of the waterbody.
    - Measurements are taken using the YSI 556 (or YSI ProPlus, if used as a backup) in the top six inches of water.
    - Details on using the YSI 556 and YSI ProPlus to collect water quality parameters and stabilization criteria are found in the instrument SOPs.
5. Site is checked for salinity-based stratification. The YSI 556 (or YSI ProPlus, if used as a backup) is lowered to slightly above the bottom of the waterbody, or as low as feasible. If salinity varies by more than 1.0 ppt, the site is considered stratified. Water temperature, salinity, specific conductivity, dissolved oxygen, and pH are measured for the lower stratum.
6. Finally, Secchi depth, water level and/or depth, and air temperature are measured and visual observations (*e.g.,* current/flow direction) are recorded.

- Measure Secchi depth at sites that are sampled from the boat.
    - Secchi depth can be measured concurrently with collection of bacteria sample and measurement of *in situ* water quality parameters as long as site contamination does not occur during Secchi depth measurement.
    - Details on using the Secchi disk for Secchi depth are provided in the Secchi Disk SOP.
- Water level and/or depth can be measured using the Secchi disk (at marine sites), the sampling wand, visual assessment, or boat depth sounder. Details are found in the SOPs for water level and/or depth and Secchi disk.
- Details on measuring air temperature are provided in the Air Temperature SOP.
- Details on recording current/flow direction are provided in the Current/Flow Direction SOP.

7. Visual observations are conducted during the entire period of time the sampler is at the sample site. If conditions change substantially (*e.g.,* current direction reverses, tidal channel fills or empties), the changes are recorded on the iPad or field datasheet.
8. At 10% of sites, collect duplicate measurement of all parameters except bacteria sample collection.
9. Assess water quality variation at sample site to confirm that sampling is taking place at a representative location.
    - Note that water quality variation does not necessarily indicate that the measurements are taken in a non-representative location. Field variability of water quality conditions is common at many sample sites.
    - If prior laboratory samples were collected from non-representative areas, consider discarding the samples.
        - If samples are discarded, record this action and reason in the Water Database.
        - If samples are not discarded, associate data qualifier to result in the Water Database and indicate reason why.
        - Consider re-sampling the site if feasible.

7.5 Representative Location

Surface water sample site locations were selected to provide representative water quality measurements for the waterbody. A water quality measurement that is representative of the specific waterbody and site sampled is obtained by following the methods described below. A representative water quality measurement is taken when both the specific methods of sample collection and measurement, as well as the sequence of collection and measurement (Section 7.4), are followed.

The following are considered when selecting a representative location at the sample site:

- Avoid areas along margins, where debris accumulates, and other areas that are not characteristic of the waterbody at the sample site.
- Select an area that minimizes disturbance to the waterbody (Section 7.6).
- For wading sites, unless safety precludes wading into the water, avoid collecting samples along the shoreline where waves are breaking and washing across the beach.
    - Sample seaward of debris and seaweed generally found in the water close to the shoreline.
    - If samples are collected from within the wave or debris zone, associate data qualifier to the result and the reason in the Water Database.
    - Avoid areas of entrained air in the wave-wash zone.
- If a representative location cannot be found, use professional judgment to determine whether the site should be sampled.
    - If the site is not sampled due to inability to find a representative location, note this in the Water Database.
    - If the site is sampled, associate data qualifier with result due to non-representative sampling location in the Water Database.
- If a site is sampled, and the site is recognized as non-representative after the sample is collected:
    - Consider discarding the previously collected sample and re-collecting the water quality measurements and bacteria sample.
    - If samples collected from non-representative location are retained for analysis, associate data qualifier to result and the reason in the Water Database.

7.6 Site Disturbance

Bacteria samples are collected first followed by measurement of *in situ* water quality parameters. Ensure that the sample site is not disturbed prior to or during sample collection. A site is disturbed if sediments or other materials (*e.g.,* plants, benthic algae) settled at the bed of the waterbody are suspended into the water column, or debris falls into the water at the sample site. Fecal coliform bacteria in bottom sediments can remain viable for many weeks. Disturbing sediments can re-suspend these bacteria and result in temporary uncharacteristically high bacteria test results. Strategies for avoiding site disturbance include:

- Avoid walking in the waterbody or near the edge of the waterbody
- If wading into the waterbody is required, approach the sample site from the downstream/down-gradient side
- Use sampling wand to collect samples

7.7 Field Conditions

Upon arrival at the sample site, field personnel observe the site conditions, record the site conditions in the Water Database, and use their professional judgment to make an informed decision on whether the site should be sampled. Site conditions fall into two general categories:

1. If water is present, flowing, and of sufficient quantity to sample, the site is sampled for bacteria, *in situ* water quality, and associated parameters
2. If the site is dry (no water present), water is present but not in a sufficient quantity to sample, or water is present but is stagnant (*i.e.,* not flowing), the site is not sampled

7.8 Parameters Measured

Table 6.2 lists the parameters measured and the sampling frequency for each sample site. Table 7.1 summarizes the parameters measured, units, sampling equipment, measurement method, sample holding container, method of sample preservation, and the maximum holding time for each of the measured parameters. Parameters are measured and bacteria samples are collected only at sites with flowing water. Secchi depth is measured at marine sites sampled from the boat on the SP&PI sample run. "General Observations" are not listed in Table 7.1 because they are not a specific method. General and noteworthy conditions are observed during the time period the sampler is at a sample site and recorded as comments in the Water Database (see Water Database User Guide for details on recording comments).

Cleaning of sample equipment follows manufacturer's instructions and details listed in the equipment SOPs. Improper cleaning can cause damage to equipment. Sterile bacteria sample bottles are provided by the contracted laboratory and are not cleaned by LWRD staff.

Table 7.1 Lummi Nation Water Quality Sampling Methods

Parameter (units)	Measurement Equipment	Analytical Method (B4)	Sample Holding Container	Sample Preserv-ation[a]	Maximum Holding Time
Air Temperature (°C)	Armored non-toxic liquid-in-glass thermometer	See Air Temperature SOP #007	N/A	N/A	Immediately
Current and Flow Direction	N/A	See Current and Flow Direction SOP #009	N/A	N/A	N/A
Dissolved Oxygen (mg/L and % saturation)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 4500-O G-2001	*In situ*	*In situ*	Immediately
Enterococcus (MPN/100ml)	Laboratory with Enterolert Test Kit	See Bacteria Sample Collection SOP #004 Enterolert Test Procedure	250 ml sterile plastic bottle with screw top (same bottle as for fecal coliform and *E. coli*)	Ice	6 hours[b]
Fecal Coliform and *E. Coli* (per 100ml)	Laboratory with membrane filter enumeration capabilities	See Bacteria Sample Collection SOP #004 Membrane filtration with elimination of rosolic acid SM 9222D-G	250 ml sterile plastic bottle with screw top (same bottle as for enterococcus)	Ice	6 hours[b]
PH (pH units)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 4500-H+ B-2000	*In situ*	*In situ*	Immediately
Salinity (ppt)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002	*In situ*	*In situ*	Immediately

Table 7.1 Lummi Nation Water Quality Sampling Methods

Parameter (units)	Measurement Equipment	Analytical Method (B4)	Sample Holding Container	Sample Preserv-ation[a]	Maximum Holding Time
Secchi Depth (meters)	Eight-inch diameter Secchi disk marked alternately in black and white quadrants and measuring tape	See Secchi Disk SOP #008	None	*In situ*	Immediately
Specific Conductivity (µS/cm)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 2510 B-1997	*In situ*	*In situ*	Immediately
Surface Water Level/Depth (feet)	Sample wand, YSI 556, Secchi disk, or boat depth sounder	See Surface Water Level/Depth SOP #010	N/A	N/A	N/A
Water Temperature (°C)	YSI 556 or YSI ProPlus	See YSI 556 SOP #001, YSI ProPlus SOP #002 SM 2550 B-2000	*In situ*	*In situ*	Immediately

SM refers to Standard Methods (APHA various dates).
MPN = Most Probable Number
[a] Sample preservation methods listed are for the collection and delivery of samples to the laboratory by LWRD staff and do not include sample preservation methods performed at the independent contracted laboratory.
[b] Bacteria samples have a maximum holding time of 8 hours but must be delivered to the contracted laboratory within 6 hours to allow time for laboratory processing within the maximum holding time.

For all individual parameters listed below, see parameter or instrument SOPs for details regarding procedures, performance criteria, and corrective actions. The QMP provides details on method validation.

7.8.1 Bacteria Sample Collection

A bacteria sample is collected at all sites with flowing water using aseptic sampling techniques as outlined in the Bacteria Sample Collection SOP. The bottle is labeled with the site identifier and other information as detailed in the SOP, and transported to the contracted laboratory, currently Edge Analytical, Incorporated in Bellingham, WA. Chain of custody forms are used to document sample information, analyses requested, and release of the samples to the laboratory staff.

7.8.2 In Situ Water Quality

In situ water quality is measured at all sites with flowing water using a multi-parameter water quality sonde with sensors for water temperature, salinity, specific conductivity, dissolved oxygen, and pH. The YSI 556 is the primary instrument used to measure *in situ* water quality parameters. The YSI ProPlus can be used as a back-up if the YSI 556 is unavailable or requires maintenance or repair.

As described in the SOPs for the YSI 556 and YSI ProPlus, the instrument must be calibrated and pass pre-run accuracy checks prior to use in the field. The SOPs for the instruments also detail use of the equipment to collect *in situ* water quality measurements, stabilization criteria, corrective actions, and QA/QC procedures.

As described above in Section 7.4, *in situ* water quality is measured in the top six inches of the waterbody. All parameter measurements are recorded in the Water Database.

Salinity-based stratification is assessed for all marine and tidally-influenced sites by lowering the sensor to slightly above the bottom of the waterbody or as low as feasible. If salinity varies by more than 1.0 ppt, the site is considered stratified. Water temperature, salinity, specific conductivity, dissolved oxygen, and pH are recorded for the lower stratum when the site is stratified.

7.8.3 Secchi Depth

Secchi depth is measured at marine sites sampled from a boat on the SP&PI sample run following instructions provided in the Secchi Disk SOP.

7.8.4 Surface Water Level/Depth

Surface water level/depth is measured at all sites with flowing water. Surface water level/depth can be measured using the Secchi disk, the water sampling wand, YSI 556, or the boat depth sounder. Details on estimating and measuring surface water level/depth are found in the Surface Water Level/Depth SOP and the Secchi Depth SOP.

7.8.5 Current and Flow Direction

Current and flow direction is visually estimated at all sites with flowing water as a cardinal direction (*e.g.,* N, E, NE) for open waters and as upstream/downstream for channels. Details on estimating current and flow direction are provided in the Current and Flow Direction SOP.

7.8.6 Air Temperature

Air temperature is measured using an armored non-toxic liquid-in-glass thermometer at all sites with flowing water. Details on measuring air temperature are provided in the Air Temperature SOP.

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8. QUALITY CONTROL AND EQUIPMENT USE

Quality Assurance/Quality Control (QA/QC) activities (B5), equipment testing, inspections, maintenance (B6), and calibrations (B7) are described below. Detailed information for each parameter and instrument is provided in the parameter and instrument SOPs. This section provides a summary of required activities for each parameter and instrument as well as general QA/QC procedures for the Surface Water Project.

Quality control activities are integral to equipment maintenance and provide information to the sampler and analyst about equipment condition and data reliability. The quality control activities can occur before, during, and after sample runs or regularly throughout the year. Equipment operation is assessed at startup and during operation as outlined in the equipment SOPs. Equipment problems or failure to meet QA/QC activity acceptance criteria initiates corrective actions. A summary of corrective actions are provided in Section 8.4 of this QAPP, with details provided in the individual equipment and method SOPs and the QMP. Determination and documentation of control action effectiveness is described in the QMP.

The goal of QA/QC activities for the Surface Water Project is to ensure that measurements have a known accuracy, precision, and traceability. QA/QC activities for the Surface Water Project are listed in this section and in the method and equipment SOPs. Calculation of statistics is detailed in the QMP and summarized in Section 10.2.

8.1 Quality Control (B5)

Quality control procedures for the Surface Water Project include: instrument calibration; pre-run, mid-run, post-run, and quarterly accuracy checks; sterile sampling techniques; sterile blanks; use of sample tracking forms; and field duplicates. Note that some parameters are estimated (*i.e.,* current/flow direction, surface water level/depth), and do not have acceptance criteria or QA/QC activities other than carefully following all instructions listed in the parameter SOPs.

8.1.1 In Situ Water Quality

The YSI 556 (or YSI ProPlus is used as a backup) is calibrated according to the equipment SOPs. The YSI 556 (or YSI ProPlus) is also accuracy checked according to the equipment SOPs prior to the commencement of a sample run (pre-run), during the mid-way point of the sample run (mid-run), and at the end of the sample run (post-run). Detailed calibration and accuracy check requirements are listed in the instrument SOPs.

8.1.2 Bacteria

Details on the QA/QC procedures for bacteria sample collection and analysis are provided in the Bacteria Sample Collection SOP.

8.1.2.1 Sterile Sampling Techniques

Field staff ensure that all bacteria samples are collected using sterile techniques. This includes inspecting the laboratory-provided bacteria sample bottles for contamination prior to use and proper handling of the sample bottle during bacteria sample collection, storage, and transportation.

8.1.2.2 Sterile Blanks

Once per quarter, a sterile blank QA/QC sample is supplied to the independent contracted laboratory (currently Edge Analytical, Incorporated in Bellingham, WA) for analysis. The sterile blank verifies the ability of field personnel to collect, handle, and transport bacteria samples using sterile techniques (*i.e.,* without contaminating the sample). It also verifies the ability of the independent contracted laboratory to process and analyze the sample without contamination.

8.1.2.3 Sample Tracking

Every surface water sample site has a unique numerical identifier. The site identifier is used to track water quality measurements and bacteria samples collected at the site. Section 10.1 of this QAPP and the QMP provide details of sample tracking and data recording. Chain of custody forms are provided by the independent contracted laboratory and are used to handle and track samples from field collection to delivery to the laboratory. The number on the chain of custody form will follow the samples through analysis to final reporting.

8.1.2.4 Holding Times

Laboratory holding times are observed for all bacteria samples collected (Table 7.1).

8.1.2.5 Laboratory QA/QC

The independent contracted laboratory is responsible for maintaining data quality for laboratory-analyzed results. Quality assurance samples may including blanks, positive growth tests, and negative growth tests. Quality assurance practices will meet or exceed method and accreditation requirements as outlined in the laboratory QAPP or method SOP. A summary of laboratory QA/QC requirements are provided in the Quality Management Plan (QMP Appendix C).

8.1.3 Field Duplicates

Duplicate measurement of all field parameters (with the exception of bacteria) is conducted at 10% of sample sites. Sites are randomly selected for duplication or sites can be selected for duplicate analysis because water quality parameters at the site are variable. Duplication provides information about the natural field variability and the inherent precision of the instrument or method used to measure the parameter. Duplicate measurements are recorded in Water Database and identified as duplicates of either the upper or lower stratum. Duplicates are averaged in Water Database for reporting parameter results of a particular site on a given

day. If variability is present and is suspected to be caused by instrument malfunction or operator error, the problem is corrected, if possible.

8.2 Equipment Maintenance (B6) and Calibration (B7)

Equipment maintenance and calibration activities are the responsibility of the Water Resources Specialist II, assisted by the Water Resources Technician II.

Information regarding calibration and maintenance of water sampling equipment is provided in the instrument SOPs and user manuals. The YSI 556 and YSI ProPlus require periodic calibration. Details on actions to be taken when calibrations are unsuccessful are found in the equipment and parameter SOPs. All equipment is inspected, including checking battery charge, prior to use in the field and repaired as necessary. Instruments and other field sampling equipment are kept clean and in working order.

An equipment module is included as part of the Water Database. The equipment module sends the Water Resources Specialist II and Water Resources Technician II email reminders of needed maintenance activities and deadlines according to manufacturer specifications. Details on the equipment module are provided in the QMP.

8.3 Acceptance Criteria and Control Limits

Acceptance criteria and control limits depend on the parameter measured and equipment used. Details on the standard procedures to follow when acceptance criteria are exceeded, calibrations are unsuccessful, or readings are otherwise suspect are found in the equipment and parameter SOPs. Details on how effectiveness of control activities are determined and documented are included in the QMP.

8.4 Corrective Actions

The goals of corrective actions are to solve the problems at hand and to eliminate or reduce the occurrence of the problems. Problems with equipment detected during equipment use, calibration, or during QA/QC activities result in actions to correct the problem (see individual instrument and parameter SOPs). Corrective actions depend upon the parameter being measured. If the problem cannot be resolved on-site, the measurement is discontinued until the problem is identified, remedied, and reliable results are obtained. For most parameters, backup equipment is available for use while the deficiency with the standard equipment is being remedied. Problems with equipment and measurements, corrective actions, and outcomes are recorded in the Water Database.

Details on documenting problems, corrective actions, and outcomes, including associating data qualifiers with results, in the Water Database are provided in the QMP and Water Database User Guide.

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9. SUPPLIES AND CONSUMABLES (B8)

Equipment required for implementing the Surface Water Project are stored in the LNR lab and storage locker. The Water Resources Specialist II is responsible for ensuring that critical supplies and consumables are unexpired, ready for use, and that a minimum two-month supply is always available. Details on supply ordering, stocking levels, and management are provided in the QMP. Details on equipment and supply inspection are listed in the equipment SOPs.

Supplies and consumables used in the Surface Water Project include:

Data Recording:

- iPad
- Field clipboard with surface water field datasheets
- Waterproof pen and/or pencil

General:

- Sampling wand
- Distilled water in marked spray bottles
- Cooler
- Ice

Water Quality Sampling Equipment:

- Yellow Springs Instruments (YSI) 556 Multi Parameter System (YSI 556) and associated reagents needed for calibration and accuracy checks as specified in the YSI 556 SOP. YSI 556 must meet all pre-run QA/QC requirements prior to use for collection of water quality parameters in the field.
    - The YSI Professional Plus (YSI ProPlus) can be used as a backup water quality sonde in the event that the YSI 556 is unavailable or inoperable. The YSI ProPlus must meet all pre-run QA/QC requirements prior to use for collection of water quality parameters in the field. See YSI ProPlus SOP for details on QA/QC requirements and associated reagents needed.
- 250 ml sterile bacteria bottles, provided by the contracted laboratory
- Air thermometer

For boat-accessible marine sampling:

- Secchi disk
- Spill Response Boat equipped with GPS unit and depth sounder
- Safety equipment for boat, including life vests, fire extinguisher, flares, tools, radios, etc
- Completed float plan

10. DATA MANAGEMENT (B10)

The Water Resources Specialist II is responsible for data management of Surface Water Project data with support and supervision provided by the Water Resources Manager and the Database Manager.

A detailed description of the data management process, including record keeping and QA/QC procedures, is included in the QMP. Components of the Water Database, including data archiving and uploading, hardware and software configurations, and automated data validation and verification tools, are included in the QMP. A summary of the data management process is provided here.

All sampling and related water quality data are entered into the Water Database, either in real time using the iPad or through transcription of data from field datasheets and laboratory reports. Data entry is manually verified, and a QA/QC report is generated for each trip. All paper records (*e.g.,* field datasheets, final lab reports, chain of custody forms, and QA/QC reports) are stored by the Water Resources Specialist II in the LWRD office. All electronic records are saved in the Water Database and in a data archive folder on the LIBC server, which is backed up nightly. Data are verified and validated according to their quality as outlined in the QMP. Verified data are transmitted to the EPA via WQX annually upon approval by the Water Resources Manager and the LNR Deputy Director.

10.1 Sample Tracking and Data Recording

Details on data entry and use of the Water Database are provided in the QMP. A summary of sample tracking and data recording follows.

Every surface water sample site has a unique numerical identifier. The site identifier is used to track water quality measurements and bacteria samples collected at the site. Typically, water quality data and site observations for each site visit are entered directly into the Water Database in real time via an iPad. When field datasheets are used, the site identifier is recorded (a copy of the surface water field datasheet is included in the QMP). The site identifier is also recorded on bacteria sample bottles and chain of custody forms to track the results of laboratory bacteria analysis. Detailed procedures on labeling of bacteria sample bottles, sample handling and transportation, and completion of chain of custody forms are provided in the Bacteria Sample Collection SOP. The Bacteria Sample Collection SOP also includes an example chain of custody form in the appendix.

All run details, QA/QC procedures completed (*i.e.,* instrument calibrations and accuracy checks), site visit observations, water quality parameter measurements, notes on measurements not taken and reasons why, issues, corrective actions, and outcomes are recorded either directly into the Water Database in real time using the iPad or are recorded on field datasheets. Notes and data from field datasheets are entered into the Water Database

within one week of trip date, if feasible, and data entry QA/QC is completed by the Water Resources Specialist II upon receipt of the final laboratory results for that trip.

10.2 Data Analysis

Calculation of precision (as available) and accuracy/bias, identification of outliers, and identification of data gaps provide the basis for quantifying data reliability for the Surface Water Project. Details on data validation and verification, database maintenance, calculation of statistics, and identification of outliers and missing data are provided in the QMP.

Duplicate measurements are automatically averaged by the Water Database. Field variability can be calculated manually.

The Water Database includes an analysis module that allows for rapid and accurate filtering and querying of data for the period of record. The analysis module is in the process of being updated to automate analysis of various summary statistics. The Database Manager is responsible for changes to the Water Database with support from the Water Resources Specialist II. Additional data analysis details are supplied in the QMP.

10.3 Non-Direct Measurements (B9)

Non-direct measurements are used to assist with implementation of the Surface Water Project and to provide context for project data. Non-direct measurements include tidal elevation, U.S. Geological Survey (USGS) gage data for the Nooksack River, and weather and sea conditions. If included in the Water Database, this information is only entered as a trip or site visit comment.

Tidal elevation and sea condition information are used to determine when and whether to collect samples for the SP&PI sample run, which requires use of the LNR Spill Response Boat to access sample sites. USGS gage data (USGS 12213100[6] and USGS 12213145[7]) may be used to determine Nooksack River discharge and flood stage to inform the analysis of water quality conditions at Site SW118 (Nooksack River at Marine Drive Bridge). Weather conditions are routinely recorded for all trips to inform the analysis of water quality results that may be affected by weather.

Additional details on documentation of non-direct measurement and external data, including data quality, are included in the QMP.

10.4 Data Review and Usability (D1, D2, D3)

Data review, verification, and validation requirements (D1), verification and validation methods (D2), and reconciliation with user requirements (D3) are discussed in detail in the QMP.

[6] http://waterdata.usgs.gov/usa/nwis/uv?site_no=12213100. Last accessed November 2015.
[7] http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12213145&PARAmeter_cd=00060,00065. Last accessed January 2016.

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11. OVERSIGHT AND REPORTING

11.1 Assessments and Response Actions (C1)

Section 1 of this QAPP and the QMP list the key personnel and their responsibilities. In summary, the person conducting the monitoring (primarily the Water Resources Specialist II and Water Resources Technician II) is responsible for performing all inspections, QA/QC activities, and data management. The Water Resources Specialist II is responsible for screening the data as necessary, with support from the Database Manager. The Database Manager is responsible for transmitting the data to EPA via WQX. The Water Resources Manager ensures that QA/QC objectives and reporting requirements are achieved.

Operator error and equipment problems detected during accuracy check and other QA/QC activities will initiate actions to correct the problem. Corrective actions and troubleshooting information are supplied in the equipment SOPs. Quality control activities also inform potential data correction factors that may be applied, as appropriate. Project action limits and assessments are described in the QMP.

11.2 Reports to Management (C2)

The Water Resources Specialist II is responsible for evaluating water quality, laboratory, and QA/QC data and reporting to the Water Resources Manager regularly and as needed if problems are detected. When problems are detected and not resolved through standard practices or are of a more complex nature than the staff conducting water quality sampling typically address, the Water Resources Specialist II, Water Resources Technician II, and the Water Resources Manager will jointly develop an action plan to remedy the problem with clear roles, responsibilities, and timelines. The Water Resources Manager is immediately alerted if elevated levels of fecal coliform bacteria are detected. Assessments are described in the QMP.

The Water Resources Specialist II prepares a Water Quality Assessment Report that summarizes the collected water quality and laboratory data for a two-year reporting period, compares the results with Lummi Nation Water Quality Standards and data for the period of record, and documents attainment or non-attainment of designated uses. This report is reviewed and approved by the Water Resources Manager and the LNR Deputy Director, and approved reports are transmitted to the EPA by March 31st every-other year. The Water Resources Manager submits bi-annual (twice per year) progress reports to the EPA Project Officer that describe project status, problems, remedies, and schedules.

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12. ACRONYMS AND ABBREVIATIONS

CWRMP	Comprehensive Water Resources Management Program
DOH	Washington State Department of Health
EPA	Environmental Protection Agency
FPE	Flood Plain East
FPW	Flood Plain West
LIBC	Lummi Indian Business Council
LNR	Lummi Natural Resources Department
LSR	Lummi Shore Road
LWRD	Lummi Water Resources Division
NSSP	National Shellfish Sanitation Program
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
SP&PI	Sandy Point and Portage Island
USGS	U.S. Geological Survey
WQM	Lummi Nation Water Quality Monitoring [Program]
WQX	Water Quality Exchange
YSI 556	Yellow Springs Instruments 556 Multi Parameter System
YSI ProPlus	Yellow Springs Instruments Professional Plus

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13.2 QMP, QAPPs, SOPs

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SAMPLE PLAN ALTERATION FORM
(QAPP Addendum – SPAF #1)

QAPP Title, Author (company), Revision, and Approval Date of standing 'parent' QAPP:

Quality Assurance Project Plan: Ambient Surface Water Quality Monitoring Project, Version 1.2
Water Resources Division, Natural Resources Department, Lummi Indian Business Council
July 2021

Project Name and assigned Region 10 Project Code:

Material to be Sampled:

Water

Measurement Parameters:

No changes in measurement parameters

Standard Procedure for Field Collection and Laboratory Analysis (cite references):

Change site number SR005 to SW135

Reason for Change in Field Procedure or Analytical Variation:

Site SR005 was initially established as a spill response site. This sample site was added to the Ambient Surface Water Quality Monitoring Project in December 2019. Since the site is now a long-term surface water quality monitoring site, it has been renamed SW135 as specified in Quality Management Plan Section 9.4.1.

Variation from Field or Analytical Procedure (reference specific QAPP sections):

Site number changes affect Figure 3.1, Table 6.1, and Table 6.2.

Special Equipment, Materials, or Personnel Required:

No changes

CONTACT	APPROVAL SIGNATURE	DATE
Leroy Deardorff, Lummi Indian Business Council (LIBC) Natural Resources Department Deputy Director	for Leroy	12-20-21
Water Quality Monitoring (WQM) Program Manager: Kara Kuhlman, CFM LIBC Water Resources Manager		12-20-2021

SAMPLE PLAN ALTERATION FORM
(QAPP Addendum – SPAF #1)

WQM Program Quality Assurance Officer: Jamie L. Mattson, LIBC Water Resources Specialist II/Planner	Jamie L. Mattson	12/20/2021
WQM Program Coordinator: Hanna Winter, LIBC Water Resources Specialist II	Hanna Winter	12/20/2021
EPA Project Manager: Michael Ortiz, EPA Tribal Coordinator	Michael Ortiz	12/20/2021
EPA QA Manager: Donald M. Brown, EPA Region 10 Quality Assurance Officer	Meghan Dunn	12/20/2021