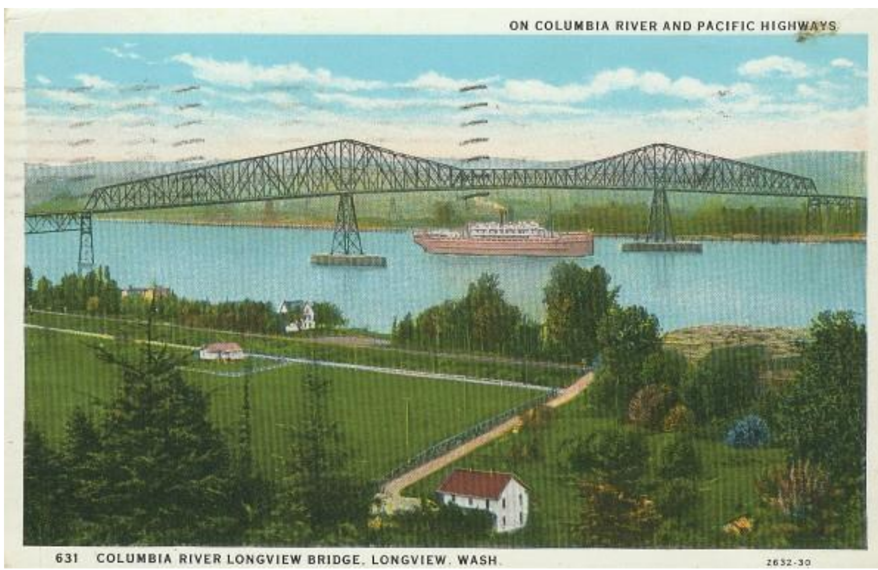
# Quality Assurance Project Plan for Status and Trends Monitoring of Urban Streams in Clark and Cowlitz Counties in the Lower Columbia River Region

## Clark County, Lead Implementing Entity




September 2020

## Publication Information

Each study conducted for the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan (QAPP). This QAPP describes the objectives of the Status and Trends Monitoring of Urban Streams in Clark and Cowlitz Counties in the Lower Columbia River Region (LCUS) study. This QAPP describes the procedures to be followed to achieve the objectives for water quality, sediment chemistry, benthic macroinvertebrate, physical habitat, and continuous parameter monitoring that will be conducted by Clark County. The LCUS study will be funded and using pooled contributions from all of the National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater (MS4) Permittees located in Clark and Cowlitz Counties, in the Lower Columbia River Region.

The final completed QAPP is available at: https://www.clark.wa.gov/public-works/stream-health-and-monitoring

Data for this project will be available on Ecology's Environmental Information Management (EIM) website: https://fortress.wa.gov/ecy/eimreporting/default.aspx and from Clark County's LCUS Project Manager, Chad Hoxeng at Chad.Hoxeng@clark.wa.gov; 1-564-397-4018. In EIM, search on Study ID: SAM_LCU

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***Cover photo:*** Longview, WA - Penny Postcard, Lewis and Clark Bridge, ca. 1930

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# Quality Assurance Project Plan (QAPP) for Status and Trends Monitoring of Urban Streams in Clark and Cowlitz Counties in the Lower Columbia River Region

September 2020

**Approved by:**

| | |
|---|---|
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*Signatures are not available on the Internet version.*

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## 2. Abstract

This Quality Assurance Project Plan (QAPP) details Status and Trends Monitoring of Urban Streams in Clark and Cowlitz Counties in the Lower Columbia Region (Lower Columbia Urban Streams, LCUS, hereafter) as part of Stormwater Action Monitoring (SAM) program. SAM is the regional stormwater monitoring program option in the Phase I and the Western Washington Phase II Municipal Stormwater permits (herein, permits).

This LCUS study is funded by the Permittees in Clark and Cowlitz Counties who chose to the permit options to collaborate and contribute funding via SAM pooled funds managed by Ecology as a Private-Local Account for regional this receiving water status and trends monitoring.
The Permittees participating in this project are Clark and Cowlitz Counties; the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal; and the Washington State Department of Transportation (WSDOT). Clark County is performing the study under an Interagency Agreement (IAA) with Ecology.

This status and trends study is designed to answer the question, "Are regional conditions in receiving water quality and biota improving in concert with broad implementation of required stormwater management practices?"

The LCUS study will follow the protocols developed for the on-going statewide stream health monitoring program-Status and Trends Monitoring for Watershed Health and Salmon Recovery (WHSR) for physical habitat and biological measurements. To better capture the stormwater related hydrologic and water chemistry changes, this study will monitor water level, temperature and conductivity continuously for one full water year from each sampling site.

This QAPP ensures quality data collection, analysis, reporting, and management of the monitoring program to answer this question.

# 3. Introduction

The 2013 National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater (MS4) Permits included a new regional stormwater monitoring program (Stormwater Action Monitoring, or SAM) that includes effectiveness studies, source identification projects, and status and trends monitoring in stormwater receiving waters. The purpose of the status and trends monitoring is to answer the policy question: "Are regional conditions in receiving water quality and biota improving in concert with broad implementation of required stormwater management practices?" Ecology worked with stakeholders in the Lower Columbia Region during the 2013 permit cycle to develop a receiving water monitoring study that would be implemented in the 2019 permit cycle. The permittees in the Lower Columbia Region are: Clark and Cowlitz Counties; the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal, and; WSDOT.

The LCUS is a separate, stand-alone status and trends regional monitoring study, as part of the SAM program.

The study boundaries (Figure 1) are the permit areas in the Lower Columbia River region, including the urban and urbanizing areas of the jurisdictions of Clark and Cowlitz Counties, and the cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal.

In 2012, the City of Longview received a grant from Ecology to assist in the development of the broad LC HSTM effort. Background information and the foundational monitoring design for this Quality Assurance Project Plan (QAPP) was agreed upon in a collaborative effort by the Lower Columbia Fish Recovery Board (LCFRB), the City of Longview, the other permittees, Ecology, and other Lower Columbia River Basin (Program) partners including but not limited to:

- U.S. Bureau of Land Management
- Cowlitz Tribe
- Columbia Habitat Monitoring Program
- National Marine Fisheries Service
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- Pacific Northwest Aquatic Monitoring Partnership (PNAMP)
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Washington Department of Fish and Wildlife
- Washington Department of Natural Resources

Most of the LC HSTM is focused on areas outside of urban areas, and on salmon habitat and recovery efforts. The Program partners' main goal was to develop a stakeholder integrated approach to monitor status and trends throughout the Lower Columbia River Region. The initial work focused on the Washington State partners, however these partners have interest in coordinating with efforts in Oregon State.

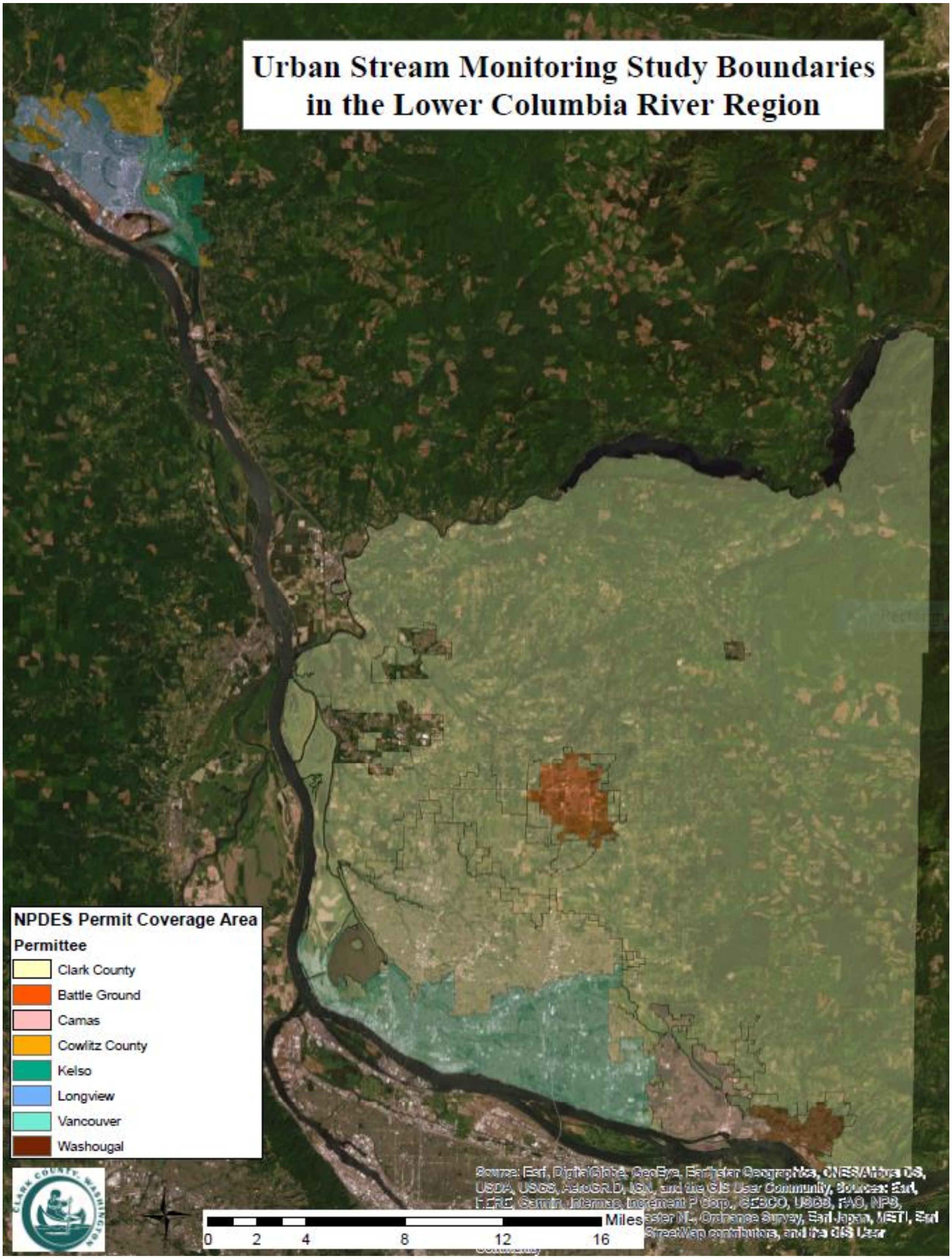


**Figure 1. Map of urban stream monitoring study boundaries in the Lower Columbia River Basin.**

## Scope of this Quality Assurance Project Plan

This study focuses on streams in the urban and urbanizing areas and is intended to answer the stormwater management question: Are regional conditions in receiving water quality and biota improving in concert with broad implementation of required stormwater management practices?

This QAPP provides the basis for the LCUS regional receiving water monitoring study. This QAPP outlines the required guidance and protocols to be followed in measuring indicators with sufficient precision and statistical rigor to adequately characterize the status and trends of small urban streams. The QAPP includes roles and responsibilities for the initial study lead (Clark County) and study partners. This QAPP includes:

- Study design, goals and objectives
- Sampling and measurement procedures
- Type of data and information needed
- Quality of data needed
- Quality control (QC) and assessment procedures
- Data management and interpretation procedures

This QAPP is modified from subsections of: the draft LC HSTM QAPP (Stillwater, 2016a), and; *Status and Trends Monitoring of Small Streams in the Puget Lowlands Ecoregion QAPP* (Lubliner, 2014). In addition to the reports, data, and other deliverables articulated in this QAPP, the LCUS monitoring results can also be integrated into larger regional monitoring efforts including the broader LC HSTM effort to assess the status and trends of stream habitat conditions across the Lower Columbia River Basin. That work to integrate LCUS into the LC HSTM may be conducted separately by regional partners and is outside the scope of this QAPP.

# 4. Project Overview

## Project Goal

The goal of this study is to characterize chemical, biological, hydrological and habitat attributes of urban and urbanizing streams in Clark and Cowlitz Counties in the Lower Columbia River region, and to assess trends over time.

This QAPP includes a set of "base" and "extended" status and trend indicators. All "base" indicators will be collected to provide an understanding of urban stream health conditions across the project area and to answer questions about status and changes in regional stream conditions over time. Extended parameters, if collected, will add information to the base monitoring to inform local stormwater management decisions and the public as to broader urban stream health and water quality conditions.

The monitoring objectives and questions for this study were developed as part of the LC HSTM monitoring implementation plan (Stillwater Sciences, 2016a), for the Urban-Area Water Quality and Quantity component.

## Objectives

**Objective 1**- What are the status and trends of water quality and hydrology in surface waters draining subwatersheds that are primarily within urban and urbanizing areas under the jurisdiction of municipal stormwater NPDES permittees?

**1. a** In streams within these areas, evaluate the status of water-quality conditions and determine if conditions are supportive of watershed-specific beneficial uses identified in WAC 173-201A-602.

**1. b** In streams within these areas, evaluate whether measured water-quality metrics show statistically significant trends over time.

**Objective 2-** What are the status and trends of water quality, hydrology and in-stream biological health that are subject to stormwater discharges from urban areas first developed under requirements of the 2013 municipal stormwater permits which were implemented January 8$^{th}$, 2016 (recognizing that such areas are limited and will likely require opportunistic selection from the larger population of sites identified for Objective 1)?

**2. a** Evaluate status of measured water-quality, hydrology metrics, and in-stream biological health in those subwatersheds that have experienced measurable land-use changes while under provisions of the 2013 (and later) municipal stormwater permit.

**2. b** In the sample population of Objective 2.a, evaluate whether measured water-quality, hydrology metrics and in-stream biological health show statistically significant trends over a 10-year period in those subwatersheds that have experienced measurable land-use changes while under provisions of the 2013 (and later) municipal stormwater permit.

**Objective 3-** What are the status and trends of in-stream biological health, sediment quality and in-stream/riparian habitat conditions that are primarily within urban and urbanizing areas under the jurisdiction of NPDES permittees?

**3. a** In streams within these areas, evaluate the status of biological and habitat conditions according to applicable habitat metrics.

**3. b** In streams within these areas, evaluate the status of sediment quality in comparison to sediment chemistry standards (*e.g.*, sediment cleanup objective, cleanup screening level) or to appropriate reference conditions.

**3. c** In streams within these areas, analyze for statistically significant spatial and temporal trends in biological, habitat metrics and sediment quality.

# 5. Organization and Schedule

## Roles and Responsibilities

Clark County will lead the LCUS monitoring study under an IAA with Ecology. The other permittees will contribute to the SAM pooled funding account and provide ancillary data for analyses and additional assistance as needed to support the monitoring conducted at streams in watersheds areas within their jurisdictions. Table 1 lists the titles and responsibilities of project staff.

**Table 1. Titles and responsibilities of project staff.**

| Staff | Title | Responsibilities |
|---|---|---|
| Jeff Schnabel<br>Clark County<br>Jeff.Schnabel@clark.wa.gov | LC Urban Streams Principal Investigator | Oversees all LC Urban Streams project staff and serves as the program liaison to the SAM Scientist. |
| Chad Hoxeng<br>Clark County<br>Chad.Hoxeng@clark.wa.gov | LC Urban Streams Project Manager | Finalizes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data. Analyzes and interprets data. Oversees entry of data into EIM. Writes the draft report and final report. *May also serve as Field Lead.* |
| Marlee Milosevich<br>Clark County<br>Marlena.Milosevich@claark.wa.gov | Monitoring Coordinator and LC Urban Streams Field Lead | Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP. Oversees all field work and ensures crew safety. |
| Bob Hutton<br>Clark County<br>Bob.Hutton@clark.wa.gov | LC Urban Streams Data Coordinator | Coordinates upload of data to required databases with the Environmental Information Management database (EIM) Data Coordinator. |
| Ben Joner<br>Clark County<br>Benjamin.Joner@clark.wa.gov | LC Urban Streams Field Assistant | Helps make field measurements, collect samples and prepare them for shipping, manage continuous data, maintain instruments, and record field information. |
| Keunyea Song<br>Ecology Water Quality Program<br>kson461@ecy.wa.gov | SAM Scientist | Manages the contract between Ecology and Clark County. Coordinates Ecology review of the QAPP and reports. Approves the final QAPP and all required deliverables. |
| Brandi Lubliner<br>Ecology Water Quality Program<br>brwa461@ecy.wa.gov | Ecology QA Coordinator | Reviews the draft QAPP and approves the final QAPP. |
| Jack Janisch<br>Ecology EAP Section<br>Jack.Janish@ecy.wa.gov | Watershed Health Data Coordinator | Coordinates with LC Urban Streams Project Manager to upload of WSH data to required databases. |
| Howard Holwes<br>ALS, Kelso<br>Howard.Holmes@alsglobal.com | Contract Laboratory Project Manager | Reviews draft QAPP and coordinates with ALS Quality Assurance Coordinator as needed. |
| Robert Wisseman<br>Aquatic Biology Associates, Inc.<br>bob@aquaticbio.com | Contract Laboratory Project Manager | Reviews draft QAPP and coordinates with ABA Quality Assurance Coordinator as needed. |

## Training and Certifications

The monitoring team members and staff will assist with coordination and procurement of equipment and supplies. Monitoring team members must complete all required and necessary training for field work and safety.

LCUS Field lead, crew members, and other key staff will participate in a field-based training for watershed health sampling provided by Ecology's Environmental Assessment Program. These trainings are held each year prior to the first summer stream benthos, sediment chemistry, and watershed health sampling event. This activity involves hands-on training at a field monitoring site to ensure comparability of results for monitoring efforts.

Any necessary training for software uses and programs related to field monitoring, data analysis and data submittal will be completed before monitoring and throughout the monitoring period as needed. Training should be ongoing as needed as staff changes. As technology advances, new data collection/QA/analysis tools may improve the study implementation.

## Reports and Deliverables

Clark County will prepare and submit reports as outlined in the IAA with Ecology. Table 2 below lists expected reports and data submittals for the LCUS over the life of the project.

**Table 2. List of required reports and data entry, due dates, and descriptions.**

| Report Type/Title | Target date | Description |
|---|---|---|
| Monitoring preparation reports | | |
| Site verification report and final Table 6 and Figure 2 | 31-Jan-20 | Memo summarizing activity related to updating Table 6. Final site list and detailed information including exact coordinates and landscape information. Detailed reasons given for any locations changed or sites disqualified from the study. Assignment of sites as either status or trend, and planned dates of active monitoring. |
| Extended monitoring report and final Tables 7 and 11 | 31-Mar-20 | Memo summarizing MS4 Permittee discussions about project budget and prioritizing extended parameter sampling plans and other activity related to updating Tables 7 and 11. Final list of extended monitoring parameters that will be collected during the five-year study. |
| Final QAPP | 30-Jun-20 | Revised completed QAPP, responsive to all comments from Ecology's MS4 NPDES Permit Manager and inclusive of approved site verification report and extended monitoring report tables. |
| Annual monitoring reports | | |
| Watershed Health Training | Spring 2020 and as needed thereafter for new staff | Statement of field staff trained to prepare for upcoming year of monitoring. |
| LC Urban Streams Annual Reports | May 31 each year beginning in 2022 | Annual data summary report with tables and figures summarizing results for the prior water year. The results include status assessments; identifying spatial and other patterns; and analyzing natural and anthropogenic indicators that explain variability (see Section 12.4). |
| Status and trends reports | | |
| LC Urban Streams Status and Trends Reports | May 31 each year beginning in 2025 | Beginning after 4 water years of data collection, in addition to the annual monitoring reports, a report summarizing: all prior status assessments; trend assessment for trend sites; identification of spatial and other patterns; and analysis of natural and anthropogenic indicators that explain variability. |
| Data Entry or Upload to Indicated Database | | |
| Entry of Study ID and monitoring locations into EIM | 31-Dec-20 | Sampling location coordinates and descriptions entered. |
| Entry of bilogical data into PSSB | Annually | All quality assured and quality controlled lab data and modified version for data analysis if necessary. |
| Entry of laboratory results into EIM | Annually | All quality assured and quality controlled lab data and modified version for data analysis if necessary. |
| Upload of continuous data and flow indicators to EIM | Annually | Quality assured and quality controlled finalized data; pressure or temperature corrected data; and all calculated flow indicators. After the first year, this may be done less frequently if approved by Ecology. |
| Adaptive Management Reports | | |
| Memo summarizing need and justification for change to any aspect of this monitoring program | As need is determined by the LC Urban Streams Principal Investigator and Program Manager | Submit for Ecology approval. Stakeholder discussion and agreement may be needed to proceed with recommended changes determined to be substantive, *i.e.*, to the study design approach or parameter list. |

# 6. Experimental Design

## Study Area Description

The study includes the urban and urbanizing areas of the Phase I and Phase II municipal permittees in Lower Columbia Region (Figure 1). All of these areas are in the Willamette lowlands ultimately draining to the Lower Columbia River.

For nearly two decades, the MS4 Permits issued to cities, counties and WSDOT have required permittees to reduce stormwater runoff and pollutants through the development and implementation of stormwater management plans (SWMPs) using new approaches to improve the permittees' management of discharges to and from MS4 to reduce flows and contaminants. Under permit requirements, Clark and Cowlitz Counties, the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal, and WSDOT are implementing measures to promote stormwater stewardship through public awareness, new local ordinances and development standards, and operate the MS4.

## Sampling Site Selection

LCUS sites and their associated Clark County site codes are listed in Table 3.

Sampling sites are needed for both status assessment and trend assessment. For this study, 22 sites have been selected; five sites that will be visited for annual monitoring throughout the study period (called trend sites hereafter) and 17 sites that will be monitored for a single year within a five-year sampling cycle under a rotating panel design (called status sites hereafter). Approximately 20% of the status sites will be monitored each year during the five years of the permit cycle. Note that sampling sites including trend sites and status sites will be used for annual status assessment.

Site selection criteria included:

- Each candidate stream reach/segment should have a predominant urban land cover (based on 2016 National Land Cover Dataset) greater than 25% urbanized in the contributing watershed.
    - Growth Management Act (GMA) designated urban areas, which could include non-urban areas, were also considered as counting toward the urban percentage.
- Each candidate stream reach/segment should have a watershed drainage area between 0.5 and 70 square kilometers ($km^2$).

A total of 24 candidate stream segments that generally meet the selection criteria were identified. Two sites are designated as alternate sites and will only be monitored if any site becomes unsuitable for monitoring in the future.

Several preexisting local sampling sites (the "legacy sites" of Clark County and the City of Vancouver) meeting these criteria were included given their preexisting data and known accessibility.

Six legacy sites are incorporated in this study:

- Trend sites: Cougar Creek (CGR020) and Mill Creek (MIL010)
- Status sites: Curtin Creek (CUR020), Gee Creek (GEE050), Whipple Creek (WPL065), and Brezee Creek (BRZ010)

**Table 3. Location for all sites selected for status and trend monitoring of urban streams in Clark and Cowlitz Counties in the Lower Columbia River Region.**

| | Stream | Clark County Site Code | LAT | LONG |
|---|---|---|---|---|
| Trend Sites | Burnt Bridge Creek | BBC050 | 45.63469 | -122.62404 |
| | Campen Creek | CMP010 | 45.57714 | -122.31537 |
| | Cougar Creek | CGR020 | 45.70744 | -122.68277 |
| | Mill Creek | MIL010 | 45.73306 | -122.62757 |
| | Westover Creek | WST020 | 46.16571 | -122.92018 |
| Status Sites | Allen Caynon Creek | ALN040 | 45.8499 | -122.72033 |
| | Cold Creek | CLD010 | 45.66208 | -122.66797 |
| | Currie Creek | CRE010 | 45.62874 | -122.43926 |
| | Curtin Creek | CUR020 | 45.72227 | -122.59089 |
| | Dwyer Creek | DWY020 | 45.63247 | -122.46157 |
| | Fisher Creek | FSH020 | 45.59223 | -122.48811 |
| | Gee Creek | GEE050 | 45.79967 | -122.77063 |
| | Indian Creek | IND010 | 46.16535 | -122.96877 |
| | LaLonde Creek | LAL040 | 45.7072 | -122.6378 |
| | McCormick Creek | MAC050 | 45.85124 | -122.69182 |
| | Packard Creek | PCK010 | 45.75019 | -122.71132 |
| | Rockwell Creek | RCW010 | 45.71838 | -122.63949 |
| | Suds Creek | SUD010 | 45.70957 | -122.66999 |
| | Tenny Creek | TEN055 | 45.69352 | -122.6513 |
| | Whipple Creek | WPL065 | 45.73754 | -122.69249 |
| | Woodburn Creek | WBN030 | 45.60404 | -122.38679 |
| | Woodin Creek | WDN010 | 45.7427 | -122.54663 |
| Alternate Sites | Brezee Creek | BRZ010 | 45.8606 | -122.66966 |
| | Morgan Creek | MOR005 | 45.75739 | -122.50696 |

National Land Cover Data (NLCD) Imperviousness data (2016) for LCUS sites are listed in Table 4.

**Table 4. 2016 National Land Cover Data (NLCD) imperviousness data and drainage area for all sites selected for status and trend monitoring of urban streams in Clark and Cowlitz counties in the Lower Columbia River Region.**

| | Stream | Clark County Site Code | % Impervious Watershed | Drainage Area (km2) |
|---|---|---|---|---|
| Trend Sites | Burnt Bridge Creek | BBC050 | 86.0 | 22.0 |
| | Campen Creek | CMP010 | 47.4 | 5.3 |
| | Cougar Creek | CGR020 | 97.1 | 7.5 |
| | Mill Creek | MIL010 | 50.0 | 30.1 |
| | Westover Creek | WST020 | 51.9 | 3.3 |
| Status Sites | Allen Caynon Creek | ALN040 | 31.1 | 9.6 |
| | Cold Creek | CLD010 | 99.4 | 6.1 |
| | Currie Creek | CRE010 | 42.8 | 6.6 |
| | Curtin Creek | CUR020 | 78.8 | 21.0 |
| | Dwyer Creek | DWY020 | 58.8 | 12.8 |
| | Fisher Creek | FSH020 | 66.0 | 2.9 |
| | Gee Creek | GEE050 | 34.8 | 24.0 |
| | Indian Creek | IND010 | 29.1 | 1.0 |
| | LaLonde Creek | LAL040 | 98.6 | 3.8 |
| | McCormick Creek | MAC050 | 21.7 | 10.6 |
| | Packard Creek | PCK010 | 33.2 | 6.0 |
| | Rockwell Creek | RCW010 | 99.6 | 1.7 |
| | Suds Creek | SUD010 | 99.6 | 2.0 |
| | Tenny Creek | TEN055 | 98.9 | 2.4 |
| | Whipple Creek | WPL065 | 69.6 | 12.1 |
| | Woodburn Creek | WBN030 | 31.9 | 2.9 |
| | Woodin Creek | WDN010 | 54.2 | 17.7 |
| Alternate Sites | Brezee Creek | BRZ010 | 14.6 | 8.5 |
| | Morgan Creek | MOR005 | 44.6 | 19.5 |

Trend sites and sampling year of status sites are selected based on the size of drainage area and impervious surface cover of the drainage area of sites to ensure each year sampling event to cover broad range of urban development and represent the study area well (Table 5).

**Table 5. Trend and status sampling locations and date of active monitoring.**

| | Stream | Clark County Site Code | 10/1/20-9/30/21 | 10/1/21-9/30/22 | 10/1/22-9/30/23 | 10/1/23-9/30/24 | 10/1/24-9/30/25 |
|---|---|---|---|---|---|---|---|
| Trend Sites | Burnt Bridge Creek | BBC050 | x | x | x | x | x |
| | Campen Creek | CMP010 | x | x | x | x | x |
| | Cougar Creek | CGR020 | x | x | x | x | x |
| | Mill Creek | MIL010 | x | x | x | x | x |
| | Westover Creek | WST020 | x | x | x | x | x |
| Status Sites | Allen Canyon Creek | ALN040 | x | | | | |
| | Curtin Creek | CUR020 | x | | | | |
| | Packard Creek | PCK010 | x | | | | |
| | Dwyer Creek | DWY020 | | x | | | |
| | Woodburn Creek | WBN030 | | x | | | |
| | Suds Creek | SUD010 | | x | | | |
| | Fisher Creek | FSH020 | | | x | | |
| | Woodin Creek | WDN010 | | | x | | |
| | Cold Creek | CLD010 | | | x | | |
| | Whipple Creek | WPL065 | | | | x | |
| | Indian Creek | IND010 | | | | x | |
| | McCormick Creek | MAC050 | | | | x | |
| | Lalonde | LAL030 | | | | x | |
| | Rockwell Creek | RCW010 | | | | | x |
| | Tenny Creek | TEN055 | | | | | x |
| | Gee Creek | GEE050 | | | | | x |
| | Currie Creek | CRE010 | | | | | x |
| Alternate Sites | Brezee Creek | BRZ010 | Alternative sites will be monitored only if any future status site become unsuitable for monitoring | | | | |
| | Morgan Creek | MOR010 | | | | | |

Sample site locations for the Lower Columbia region and their permit coverage area are shown in Figure 2.

Drainage areas for the LCUS sites are delineated in Figures 3 and 4. Drainage areas were delineated based on GIS topography contours and mapped stormwater conveyances, as well as site reconnaissance. Impervious areas within the watershed draining and infiltrating to ground water and not discharging to the stream are not included in drainage areas.

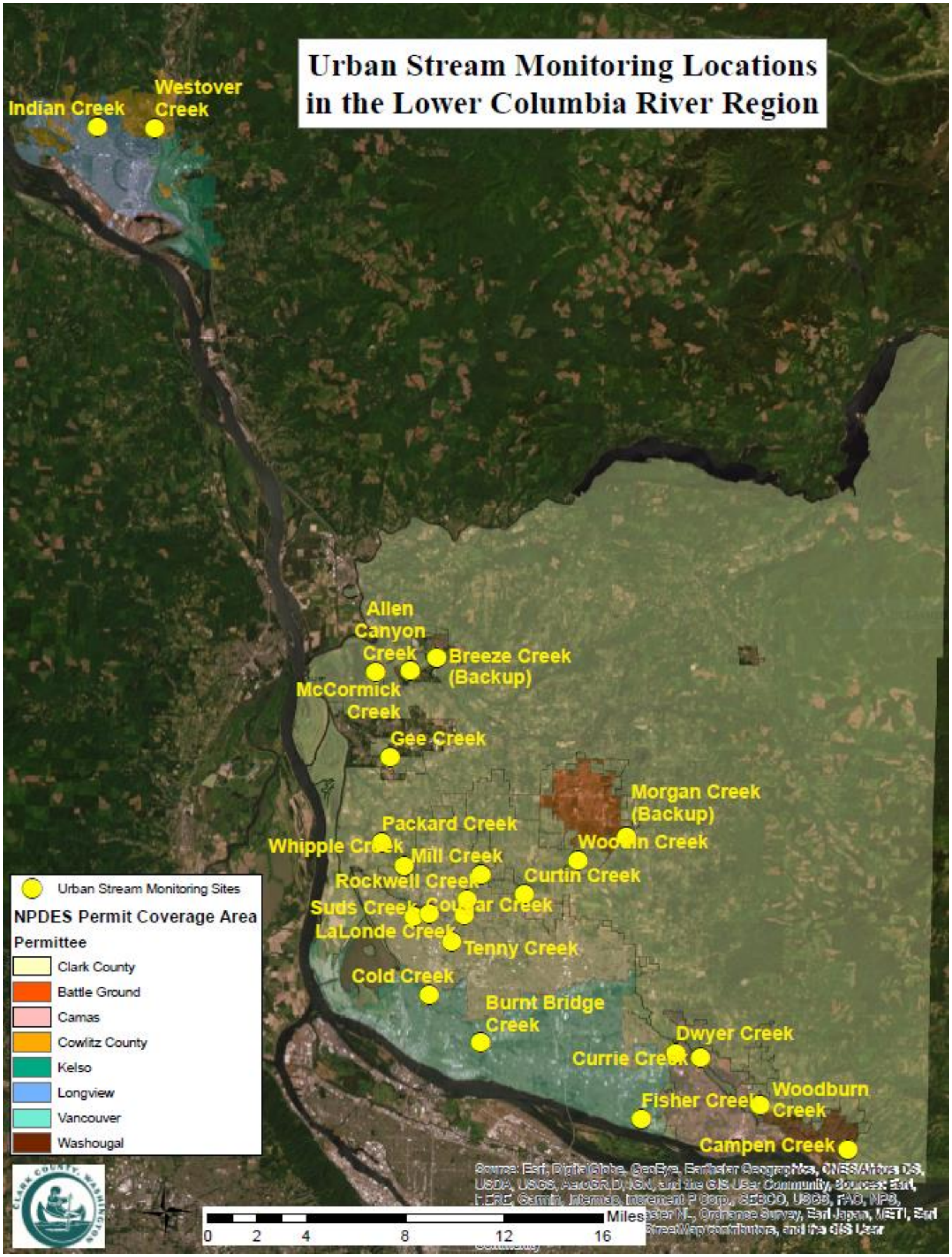


**Figure 2. Map of urban stream monitoring locations and study boundaries in the Lower Columbia River Basin.**

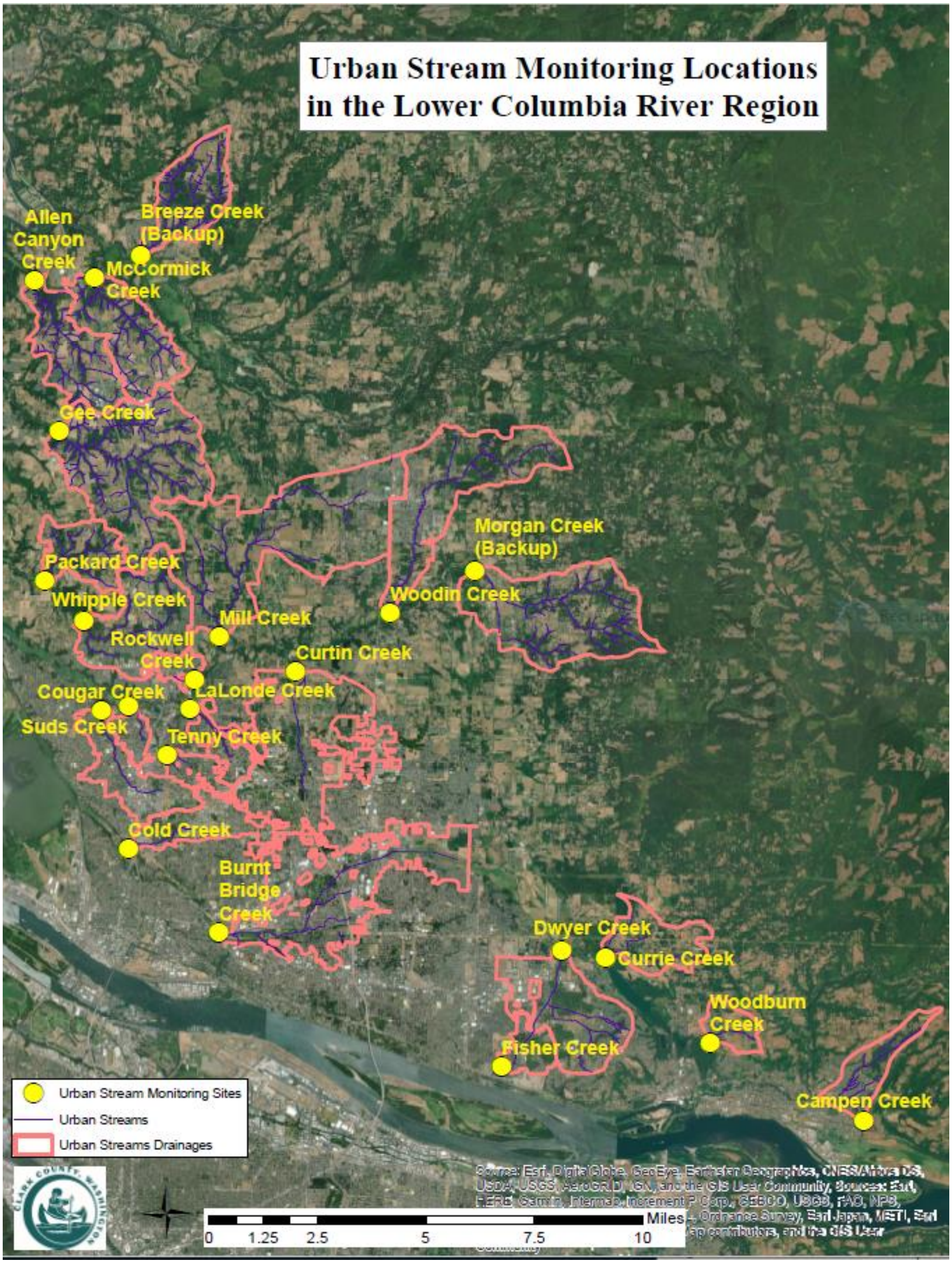


**Figure 3. Map of urban stream monitoring locations and associated drainage catchments in Clark County.**

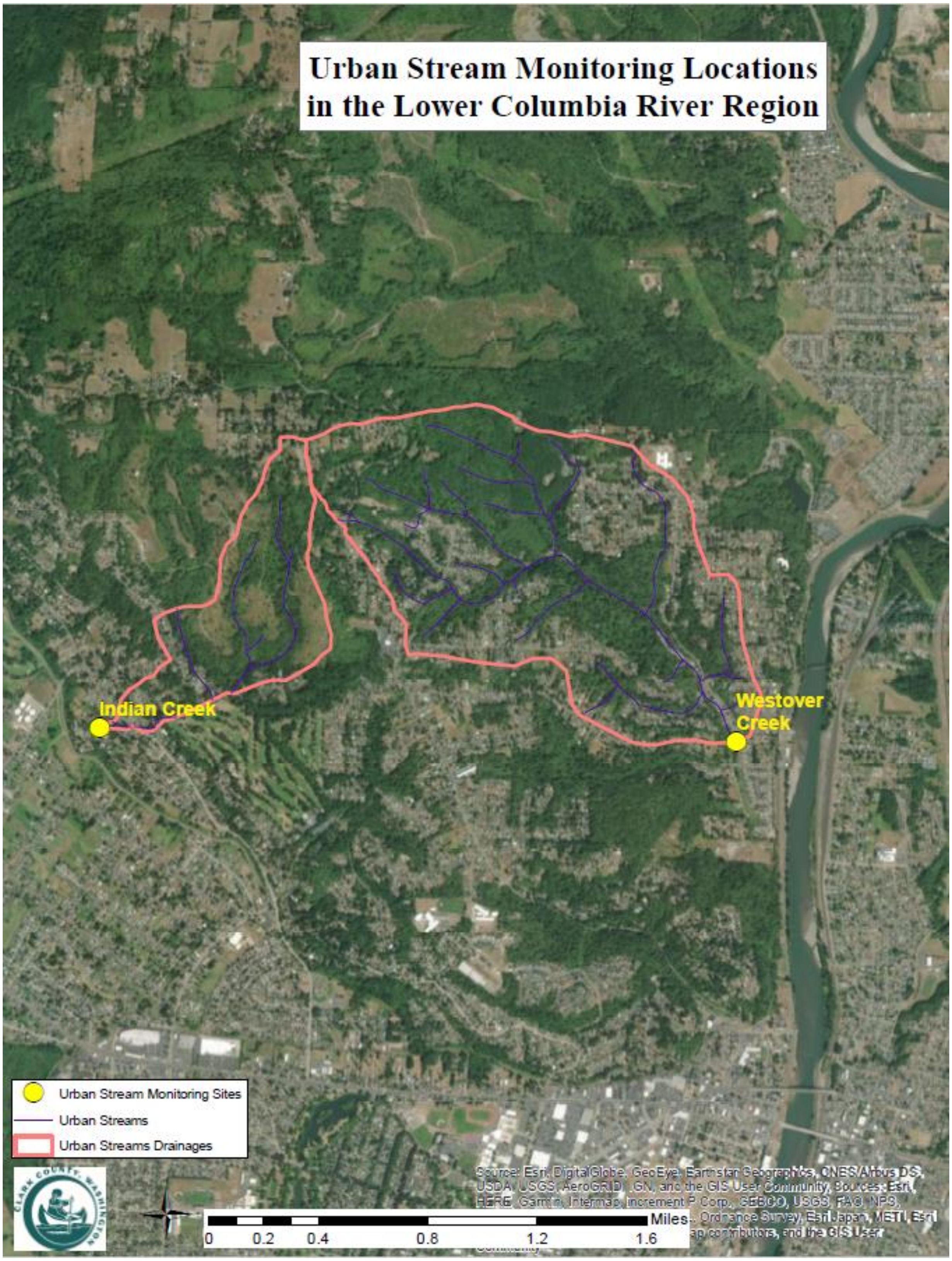


**Figure 4. Map of urban stream monitoring locations and associated drainage catchments in Cowlitz County.**

## Sampling Site Identification and Confirmation

Each stream segment/reach was visited by Clark County and Ecology staff and evaluated for suitability before finalizing (Table 5). Each segment/reach was evaluated and will continue to be based on these sampling suitability criteria:

- **Accessibility**: Address concerns of whether landowners permit access to a site, whether the site can be accessed safely and relatively quickly for sampling throughout the year.
  - If a candidate site is not obviously accessible through public property, contact and obtain access permission from the private property owners and/or tenants whose property will need to be accessed.
  - A site may be deemed unsuitable or impractical for sampling if more than one hour is required to safely access the site from the nearest parking location.
- **Safety conditions**: Assess safety conditions for access and sampling based on state and federal law and organizational policy. It is ultimately the responsibility of the field crew during the site evaluation and at each subsequent time of arrival to decide whether it is safe to access the site and conduct the sampling. Appropriate reasons for disqualifying a site from sampling may include: flow that is too swift or too deep; unstable route of entry; presence of hostile people or animals.
- **Water flow**: Determine that the waterbody has a net flow of water that is unidirectional and perennial. Streams subject to backwater from the Columbia River are not considered suitable sampling sites for this program. Confirm uninterrupted surface-water flow for more than half the length of approximately 20 bankfull widths or a minimum of 150 meters surrounding the candidate site coordinates.
- **Substrate**: Verify presence of predominantly natural substrate in the reach.
- **Streambank**: Confirm that both the left and right banks of the water body are readily discernible from mid-stream.
- **Human influence**: Observe whether flow is in a natural channel or, if highly modified, confirm the modification was not constructed (such as canals, ditches, or pipelines). Monitoring sites will not be located immediately downstream of MS4 outfalls or other point sources.
- **Location confirmation**: Identify sampling reaches and site locations with GPS coordinates and with a narrative description of their location (*e.g.*, East Fork Lewis River, extending 1,500 meters upstream from the NE 82nd Avenue/Daybreak Road bridge). Having both GPS coordinates and a narrative description will provide redundancy and insure that the sampling reaches can be re-located. Clark County will enter all of the sites in its field location site data base and GIS layers.

## Sampling Parameters and Frequency

Monitoring program indicators and metrics were determined as part of the LC HSTM monitoring development process led by the City of Longview, Lower Columbia Fish Recovery Board, and Pacific Northwest Aquatic Monitoring Partnership (Stillwater Sciences, 2016a and 2016b). This LCUS study includes two different groups of indicators and metrics, referred to as the base and extended programs. A "base" program (Table 6) focuses on continuous temperature, conductivity and stage monitoring, as well as yearly measurements of benthic macroinvertebrate populations, physical habitat, and sediment quality. The "base" program will be fully implemented at all sites. An "extended" program may be implemented if there is available funding. The "extended" program adds water quality monitoring of nutrients, metals, and bacteria to the base program. Potential water quality parameters that may be collected as part of the extended program are listed in Table 6.

Continuous monitoring for temperature, conductivity and water level (stage) will be performed using applicable sensors and data loggers for both trend sites and status sites. Equipment will be deployed permanently at trend sites, and for one water year (October through September) during each five-year cycle at status sites. Sufficient equipment will be procured to allow deployment prior to the upcoming water year at the next set of status sites in the rotating panel.

Measurements for continuous parameters will be logged at 15-minute intervals between October 1st and September 30th. All sites will initially be visited monthly for continuous data retrieval and equipment maintenance. Visit frequency may be adjusted as the project proceeds but will occur at least every other month.

Benthic macroinvertebrates and sediment chemistry samples will be collected for scheduled monitoring sites once during the summer between July 1 and September 30, beginning in 2021. Water quality samples selected for sampling under the extended program may be collected monthly or quarterly.

Watershed Health monitoring will follow standard operation procedures for field measurement and sampling using WHM eforms. Standard Operating Procedures Table 7.

**Table 6. Parameters and sampling frequency at active status and trend sites for the base and extended monitoring programs.**

| Indicator/Parameter | Indicator Type | Sampling Frequency at Active Status and Trend Sites |
|---|---|---|
| **Base Program** | | |
| Temperature | Water Quality | Continuous (15 - Minute) |
| Conductivity | | |
| Stage | Hydrology | |
| Benthic macroinvertebrates | Watershed Health | Once every year of sampling (July-Sep) |
| Sediment Metals | Sediment Quality | Once every year of sampling (July-Sep) |
| (As, Cd, Cr, Cu, Pb, Zn) | | |
| Sediment Polynuclear aromatic hydrocabons (PAHs)[1] | | |
| Watershed Health Indicators | Physical Habitat | Every year of sampling (July-Sep) using Washington State Department of Ecology WMH eforms |
| **Extended Program** | | |
| pH | Water Quality | Monthly or quarterly every year of sampling |
| Turbidity | | |
| Dissolved Oxygen | | |
| Total Solids (TS) | | |
| Nitrate+Nitrite (NO3+NO2) | | |
| Total Phosphorous (TP) | | |
| Ammonia (NH3) as (N) | | |
| *E.coli* | | |
| Dissolved Copper (Cu) | | |
| Dissolved Zinc (Zn) | | |
| Hardness | | |
| Dissolved Organic Carbon | | |
| Chloride | | |
| Total Kjeldahl Nitrogen | | |

[1] PAH compounds include: 2-methylnaphthalene, acenaphthylene, acenaphthene anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b,k) fluoranthene, benzo(ghi)perylene, dibenzo(a,h)anthracene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, and retene.

**Table 7. Standard Operating Procedures.**

| Standard Operation Procedures | Ecology Publication No. |
|---|---|
| Standard Operating Procedure EAP109, Version 1.1: Watershed Health Monitoring: Estimating Stream Discharge (Narrow Protocol) | 19-03-226 |
| Standard Operating Procedure EAP122, Version 1.1: Measuring Stream Slope (Narrow Protocol) | 19-03-218 |
| Standard Operating Procedure EAP123, Version 1.1: Measuring Compass Bearings (Narrow Protocol) | 19-03-217 |
| Standard Operating Procedure EAP112, Version 1.1: Assessing Bank Erosion Vulnerability | 19-03-215 |
| Standard Operating Procedure EAP121, Version 1.1: Watershed Health Monitoring: Standard Operating Procedures for Counting Large Woody Debris. | 19-03-214 |
| Standard Operating Procedure EAP095, Version 1.2: Collecting Water Samples for Watershed Health Monitoring | 19-03-216 |
| Standard Operating Procedure EAP073, Version 2.3: Minimum Requirements for the Collection of Freshwater Benthic Macroinvertebrates in Streams and Rivers | 19-03-211 |
| Standard Operating Procedure EAP108, Version 1.10: Collecting In Situ Water Quality Data | 19-03-206 |
| Standard Operating Procedure EAP107, Version 1.0: Measuring Transect Coordinates with a Global Positioning System (GPS) | 18-03-230 |
| Standard Operating Procedure EAP114, Version 1.3: Standard Operating Procedure for Estimating Substrate Sizes and Embeddedness at Major Transects | 18-03-229 |
| Standard Operating Procedure EAP106, Version 1.8: Standard Operating Procedures for Verification and Layout of Sites (Narrow Protocol) | 18-03-226 |
| Standard Operating Procedure EAP120, Version 1.3: Standard Operating Procedure for Quantifying Habitat Units | 18-03-225 |
| Standard Operating Procedure EAP118, Version 1.3: Standard Operating Procedure for Visual Assessment of Human Influence | 18-03-224 |
| Standard Operating Procedure EAP119, Version 1.3: Standard Operating Procedure for Thalweg Profiling | 18-03-223 |
| Standard Operating Procedure EAP117, Version 1.2: Standard Operating Procedure for Assessing Riparian Vegetation Structure | 18-03-222 |
| Standard Operating Procedure EAP115, Version 2.1: Standard Operating Procedure for Measuring Riparian Cover Using a Convex Densiometer | 18-03-220 |
| Standard Operating Procedure EAP113, Version 1.7: Watershed Health Monitoring: Measuring Channel Dimensions | 18-03-219 |
| Standard Operating Procedure EAP070, Version 2.2: Minimize the Spread of Invasive Species | 18-03-201 |

## Landscape Information

Geospatial data will be collected to assess landscape characteristics of sampling sites and surrounding areas. Data includes metrics describing land use/land cover, human stressors, and physical characteristics. The 2016 National Land cover Data Set (NLCD) (www.mrlc.gov), digital elevation models (DEM), and national Watershed Boundary Dataset are basic sources for many of these metrics. Landscape metrics will be calculated at both watershed and riparian scales.

Watershed boundaries of each sampling site were delineated using ArcGIS topography contours and mapped stormwater conveyances, as well as site reconnaissance. Mapped stream data was clipped to watershed boundaries and included stream data from USGS, Clark County and Department of Natural Resources. Riparian buffer zone boundaries were determined using a 50m buffer from mapped center of the streamlines for each site.

Landscape information will be collected once every five years for all status and trend sites starting with the 2016 NLCD. This information will be used to evaluate the effects of land use patterns on stream health and whether any land-cover changes are occurring at measurable rates across the region over time.

Environmental characteristics describing physical and anthropogenic characteristics of the study region will be identified in the watershed and riparian zone around each sampling site. These variables include basin geology, watershed size, slope, land cover, elevation, urbanization (e.g., population density, impervious surface, road density, etc.), and other applicable or available landscape information.

NLCD (2016) data for LCUS sites are shown in Table 8.

NLCD (2016) data for all riparian areas within a 50-foot buffer from stream centerline for LCUS sites are shown in Table 9.

**Table 8. 2016 National Land Cover Data (NLCD) for all drainage areas for sites selected for status and trend monitoring of urban streams in Clark and Cowlitz counties in the Lower Columbia River Region.**

| | | | Percent Land Cover data for drainage areas for stream monitoring locations from National Land Cover Database (2016) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stream | Clark County Site Code | Barren Land | Cultivated Crops | Deciduous Forest | Developed, High Intensity | Developed, Low Intensity | Developed, Medium Intensity | Developed, Open Space | Emergent Herbaceuous Wetlands | Evergreen Forest | Hay/ Pasture | Herbaceuous | Mixed Forest | Open Water | Perennial Snow/Ice | Shrub/ Scrub | Woody Wetlands | Total Area (km2) |
| Trend Sites | Burnt Bridge | BBC050 | 0.0 | 1.2 | 0.1 | 10.7 | 29.3 | 34.7 | 11.3 | 1.1 | 1.5 | 7.8 | 0.4 | 0.3 | 0.0 | 0.0 | 0.4 | 1.1 | 21.97 |
| | Campen Creek | CMP010 | 0.0 | 0.0 | 6.8 | 0.6 | 16.1 | 11.2 | 19.6 | 0.0 | 9.5 | 25.4 | 1.1 | 6.6 | 0.0 | 0.0 | 2.9 | 0.1 | 5.35 |
| | Cougar Creek | CGR020 | 0.0 | 0.1 | 1.8 | 12.4 | 39.1 | 32.2 | 13.3 | 0.3 | 0.2 | 0.3 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 7.47 |
| | Mill Creek | MIL010 | 0.0 | 0.1 | 1.3 | 1.3 | 17.4 | 7.7 | 23.6 | 0.9 | 2.4 | 39.2 | 0.1 | 1.4 | 0.1 | 0.0 | 2.4 | 2.2 | 30.10 |
| | Westover Creek | WST020 | 0.2 | 0.0 | 31.2 | 0.0 | 26.7 | 6.1 | 18.8 | 0.0 | 5.3 | 0.5 | 0.2 | 6.6 | 0.0 | 0.0 | 3.4 | 0.9 | 3.32 |
| Status Sites | Allen Caynon Creek | ALN040 | 0.0 | 0.1 | 3.5 | 1.8 | 13.2 | 4.9 | 11.1 | 0.6 | 5.0 | 51.9 | 0.7 | 3.4 | 0.1 | 0.0 | 0.9 | 2.7 | 9.58 |
| | Cold Creek | CLD010 | 0.0 | 0.0 | 0.0 | 13.9 | 41.2 | 24.4 | 19.8 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.08 |
| | Currie Creek | CRE010 | 0.0 | 0.0 | 2.7 | 0.3 | 16.1 | 1.4 | 25.1 | 0.7 | 9.8 | 39.4 | 0.1 | 1.2 | 0.0 | 0.0 | 2.1 | 1.1 | 6.56 |
| | Cutin Creek | CUR020 | 0.0 | 0.9 | 0.0 | 3.3 | 36.1 | 14.8 | 24.6 | 1.4 | 0.6 | 16.4 | 0.3 | 0.0 | 0.0 | 0.0 | 0.9 | 0.7 | 21.04 |
| | Dwyer Creek | DWY020 | 1.8 | 0.2 | 5.2 | 4.7 | 22.2 | 19.4 | 12.4 | 3.1 | 1.7 | 21.0 | 0.8 | 1.4 | 0.2 | 0.0 | 1.5 | 4.5 | 12.76 |
| | Fisher Creek | FSH020 | 0.6 | 0.0 | 7.7 | 7.9 | 21.2 | 28.3 | 8.9 | 3.5 | 2.3 | 9.1 | 1.1 | 4.1 | 0.0 | 0.0 | 1.3 | 3.9 | 2.94 |
| | Gee Creek | GEE050 | 0.1 | 0.5 | 3.6 | 1.0 | 14.0 | 3.3 | 16.6 | 0.5 | 3.6 | 49.7 | 0.2 | 2.4 | 0.0 | 0.0 | 1.5 | 3.0 | 24.05 |
| | Indian Creek | IND010 | 0.0 | 0.0 | 57.0 | 0.0 | 16.1 | 1.5 | 11.7 | 0.0 | 2.6 | 0.5 | 0.0 | 7.8 | 0.0 | 0.0 | 2.9 | 0.0 | 0.96 |
| | LaLonde Creek | LAL040 | 0.0 | 0.0 | 0.0 | 2.9 | 47.3 | 23.5 | 24.9 | 0.8 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 3.82 |
| | McCormick Creek | MAC050 | 0.0 | 2.5 | 9.5 | 0.7 | 8.6 | 1.9 | 10.4 | 0.2 | 3.9 | 56.5 | 0.7 | 2.2 | 0.0 | 0.0 | 0.8 | 2.1 | 10.57 |
| | Packard Creek | PCK010 | 0.0 | 0.0 | 10.1 | 0.1 | 16.4 | 0.8 | 15.9 | 0.0 | 4.9 | 41.2 | 0.9 | 8.4 | 0.0 | 0.0 | 0.4 | 1.0 | 6.02 |
| | Rockwell Creek | RCW010 | 0.1 | 0.0 | 0.0 | 14.8 | 34.3 | 33.2 | 17.4 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.68 |
| | Suds Creek | SUD010 | 0.0 | 0.1 | 0.0 | 8.6 | 42.8 | 40.3 | 7.9 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.96 |
| | Tenny Creek | TEN055 | 0.0 | 0.0 | 0.0 | 2.9 | 45.5 | 32.6 | 17.9 | 1.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.40 |
| | Whipple Creek | WPL065 | 0.0 | 0.0 | 7.6 | 3.6 | 26.4 | 19.7 | 19.9 | 0.7 | 1.4 | 12.6 | 0.6 | 2.7 | 0.0 | 0.0 | 1.4 | 3.4 | 12.10 |
| | Woodburn Creek | WBN030 | 0.0 | 0.0 | 0.8 | 0.3 | 11.1 | 1.3 | 19.3 | 0.6 | 5.4 | 57.0 | 0.6 | 0.7 | 0.2 | 0.0 | 0.6 | 2.2 | 2.91 |
| | Woodin Creek | WDN010 | 0.0 | 0.1 | 3.6 | 1.9 | 21.4 | 10.0 | 21.0 | 0.6 | 10.6 | 18.4 | 0.7 | 3.9 | 0.1 | 0.0 | 3.8 | 3.9 | 17.67 |
| Alternate Sites | Brezee Creek | BRZ010 | 0.0 | 0.0 | 18.9 | 0.1 | 5.2 | 2.6 | 6.7 | 0.1 | 12.7 | 36.1 | 0.9 | 7.4 | 0.0 | 0.0 | 9.2 | 0.2 | 8.51 |
| | Morgan Creek | MOR005 | 0.0 | 0.1 | 2.4 | 0.1 | 16.1 | 1.1 | 27.2 | 0.5 | 18.4 | 21.9 | 1.1 | 4.1 | 0.1 | 0.0 | 3.9 | 3.0 | 19.52 |

**Table 9. 2016 National Land Cover Data (NLCD) for 50-foot riparian buffer areas for sites selected for status and trend monitoring of urban streams in Clark and Cowlitz counties in the Lower Columbia River Region.**

| | | | Percent Riparian 50ft Buffer Land Cover data from National Land Cover Database 2016 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stream | Clark County Site Code | Barren Land | Cultivated Crops | Deciduous Forest | Developed, High Intensity | Developed, Low Intensity | Developed, Medium Intensity | Developed, Open Space | Emergent Herbaceuous Wetlands | Evergreen Forest | Hay/ Pasture | Herbaceuous | Mixed Forest | Open Water | Perennial Snow/Ice | Shrub/ Scrub | Woody Wetlands | Total Area (km2) |
| Trend Sites | Burnt Bridge | BBC050 | 0.0 | 2.2 | 0.4 | 0.4 | 28.9 | 9.0 | 27.6 | 5.8 | 4.2 | 16.1 | 1.6 | 0.0 | 0.0 | 0.0 | 0.1 | 3.6 | 0.51 |
| | Campen Creek | CMP010 | 0.0 | 0.0 | 17.1 | 0.1 | 11.3 | 0.8 | 34.7 | 0.0 | 10.1 | 7.5 | 0.0 | 15.0 | 0.0 | 0.0 | 2.3 | 1.2 | 0.33 |
| | Cougar Creek | CGR020 | 0.0 | 0.7 | 22.4 | 5.4 | 22.9 | 9.3 | 35.5 | 1.8 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.14 |
| | Mill Creek | MIL010 | 0.0 | 0.0 | 1.9 | 0.2 | 8.9 | 1.7 | 34.3 | 4.8 | 3.4 | 30.1 | 0.1 | 1.8 | 0.0 | 0.0 | 0.6 | 12.1 | 0.79 |
| | Westover Creek | WST020 | 0.0 | 0.0 | 42.1 | 0.0 | 15.8 | 2.6 | 18.0 | 0.0 | 6.9 | 1.1 | 0.0 | 9.7 | 0.0 | 0.0 | 1.1 | 2.8 | 0.39 |
| Status Sites | Allen Caynon Creek | ALN040 | 0.0 | 0.0 | 5.4 | 0.1 | 9.0 | 0.9 | 12.2 | 2.0 | 6.7 | 44.4 | 1.2 | 7.5 | 0.5 | 0.0 | 1.1 | 8.8 | 0.88 |
| | Cold Creek | CLD010 | 0.0 | 0.0 | 0.0 | 4.8 | 51.0 | 14.6 | 29.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.09 |
| | Currie Creek | CRE010 | 0.0 | 0.0 | 9.6 | 0.0 | 8.2 | 0.0 | 18.8 | 2.9 | 15.4 | 35.7 | 0.0 | 2.2 | 0.0 | 0.0 | 3.8 | 3.4 | 0.23 |
| | Cutin Creek | CUR020 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 0.2 | 17.8 | 10.1 | 0.0 | 58.1 | 1.0 | 0.0 | 1.2 | 0.0 | 0.4 | 5.2 | 0.18 |
| | Dwyer Creek | DWY020 | 0.0 | 0.0 | 6.7 | 0.3 | 17.0 | 5.9 | 18.7 | 9.6 | 5.0 | 24.8 | 2.0 | 3.4 | 0.0 | 0.0 | 1.9 | 4.5 | 0.46 |
| | Fisher Creek | FSH020 | 0.0 | 0.0 | 0.0 | 0.0 | 61.6 | 1.9 | 12.6 | 12.5 | 0.0 | 6.8 | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 3.2 | 0.06 |
| | Gee Creek | GEE050 | 0.0 | 0.3 | 8.1 | 0.1 | 7.6 | 1.3 | 13.3 | 2.1 | 5.7 | 39.7 | 0.1 | 5.6 | 0.1 | 0.0 | 1.5 | 14.6 | 1.92 |
| | Indian Creek | IND010 | 0.0 | 0.0 | 53.7 | 0.0 | 17.4 | 1.9 | 10.5 | 0.0 | 4.8 | 0.0 | 0.0 | 11.6 | 0.0 | 0.0 | 0.1 | 0.0 | 0.11 |
| | LaLonde Creek | LAL030 | 0.0 | 0.0 | 0.0 | 0.0 | 26.6 | 0.9 | 72.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.11 |
| | McCormick Creek | MAC050 | 0.0 | 1.3 | 18.3 | 0.0 | 4.4 | 0.7 | 7.6 | 1.0 | 5.3 | 44.8 | 0.3 | 4.2 | 0.1 | 0.0 | 1.7 | 10.3 | 0.95 |
| | Packard Creek | PCK010 | 0.0 | 0.0 | 18.1 | 0.0 | 7.6 | 0.1 | 15.2 | 0.0 | 7.6 | 25.4 | 0.2 | 16.7 | 0.0 | 0.0 | 0.5 | 8.6 | 0.38 |
| | Rockwell Creek | RCW010 | 0.0 | 0.0 | 0.0 | 0.0 | 15.5 | 0.1 | 84.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.03 |
| | Suds Creek | SUD010 | 0.0 | 0.0 | 0.0 | 0.0 | 37.4 | 3.8 | 47.4 | 0.0 | 0.0 | 11.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.05 |
| | Tenny Creek | TEN055 | 0.0 | 0.0 | 0.0 | 0.3 | 50.4 | 12.6 | 36.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.05 |
| | Whipple Creek | WPL065 | 0.0 | 0.0 | 12.2 | 0.0 | 10.3 | 2.8 | 23.7 | 6.0 | 2.2 | 3.5 | 0.0 | 4.5 | 0.0 | 0.0 | 0.8 | 34.0 | 0.46 |
| | Woodburn Creek | WBN030 | 0.0 | 0.0 | 10.0 | 0.0 | 5.2 | 0.3 | 32.4 | 1.1 | 8.4 | 38.7 | 0.0 | 0.0 | 3.0 | 0.0 | 1.0 | 0.0 | 0.06 |
| | Woodin Creek | WDN010 | 0.0 | 0.0 | 6.6 | 0.2 | 14.4 | 2.0 | 30.5 | 1.8 | 11.3 | 12.6 | 0.0 | 5.7 | 0.8 | 0.0 | 4.3 | 9.8 | 0.58 |
| Alternate Sites | Brezee Creek | BRZ010 | 0.0 | 0.0 | 34.8 | 0.1 | 2.6 | 0.9 | 6.3 | 0.4 | 8.9 | 24.5 | 1.0 | 11.1 | 0.3 | 0.0 | 8.5 | 0.8 | 0.91 |
| | Morgan Creek | MOR005 | 0.0 | 0.0 | 3.1 | 0.1 | 7.7 | 0.2 | 26.5 | 0.8 | 27.0 | 11.9 | 0.3 | 6.5 | 0.0 | 0.0 | 2.4 | 13.5 | 1.01 |

# 7. Measurement Quality Objectives

Measurement quality objectives are to obtain sufficient high quality data based on site specific measurements and samples to meet the study objectives. Data quality indicators include precision, bias, sensitivity, representativeness, comparability and completeness.

## Field Work

Field staff will follow standard documented protocols, reporting requirements and quality control (QC) procedures to meet the study measurement quality objectives. Field staff will make a good faith effort to collect field data at the described frequency in this QAPP.

**Completeness** of data collection for this study has a goal of 100%. If an extended or base parameter sample or measurement (excluding continuous measurement parameters) is initially missed, a second good faith effort will be made to collect these data within the same month. If a second attempt is also unsuccessful for the same parameters, a third attempt is optional. The impact of missing continuous data will be evaluated and could be addressed with estimated data (qualified) based on relationships with continuous data for the same parameter from nearby sites. Reasons for missed sampling events or missed parameters will be recorded. Any missed sampling events will be reported to the Ecology SAM Scientist.

Sample loss will be minimized using sturdy sample storage containers and adequate labeling procedures. Complete data acquisition and storage will be supported using established meters and data logging systems.

**Comparability** of measurements between field crews will be supported by following standard protocols and methods. Before the first sampling of each year, the project manager will organize a training session to help ensure all field crews follow the standard protocols.

**Representativeness** of results for sites and the region can also be expressed by following consistent field and laboratory procedures. Measurements and samples taken in the field need to be representative of the condition and should be consistent over time. To ensure the representativeness of samples, field collection and measurements should be uniform in terms of timing, locations, and hydrologic conditions. Sample holding time requirements are also important to maintain the representativeness of samples. Any changes or differences of sampling conditions from protocols will be recorded in the field log.

**Precision** of samples and field measurements will be evaluated using QC sample duplicates and repeat measurements.

## Laboratory Selection

Multiple laboratories will be needed to ensure sample completeness and final selected laboratories are listed in Table 10. Laboratories for the water and sediment parameters must have current accreditation status with Ecology (https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation) and must have the ability to achieve acceptable limits of detection for the parameters monitored as part of this project. The laboratory selected for the stream benthos samples must provide data to the species level.

**Table 10. Laboratories selected for sample processing.**

| Laboratory Name | Analytical Purpose | Address | Phone |
| --- | --- | --- | --- |
| ALS Environmental | Water samples<br>Sediment samples | 1317 South 13th Avenue<br>Kelso, WA 98626 | (360) 501-3364 |
| Aquatic Biology Associates [1] | Stream benthos | 3490 NW Deer Run Street<br>Corvallis, OR 97330-3111 | (641) 762-1668 |

[1] Ecology does not currently have an accreditation process for laboratories that analyze benthic invertebrate samples.

## Data Quality Indicators for Each Parameter

Selected laboratories and in-situ field probes will follow Ecology approved methods and data quality control (QC) (see section 9). Acceptable methods, bias, precision and accuracy are detailed in Tables 11 and 12. Methods follow Standard Methods for the Examination of Water and Wastewater (www.standardmethods.org) and U.S. Environmental Protection Agency (USEPA, or EPA) methods (http://water.epa.gov/scitech/methods/cwa/methods_index.cfm).

For continuous parameters (stage, temperature, and conductivity), the accuracy and instrument bias measurement quality objectives (MQOs) of each electrode meter and/or sensor will be verified through post-deployment calibration checks following the manufacturer's procedures. The sensor's accuracy and precision will be evaluated by in-situ measurements using hand-held probes at the deployment, during each sampling event and data retrieval (Table 11). Field meter measurements will be used to first correct continuous data for linear drift, cleaning or a constant offset. The amount and frequency of continuous instruments excessive drift or non-random drift (predominantly higher or lower than handheld meter readings) will be used to evaluate replacement of continuous meter probes.

MQOs for water and sediment chemistry data are listed in Table 12 and Table 13.

**Table 11. Measurement quality objectives for continuous parameters.**

| Continuous Parameters | Meter Type | Accuracy (deviation between measurements) | Precision (% relative standard deviation) |
|---|---|---|---|
| **Temperature** | Campbell CS547A | ± 0.4 degree C | ± 0.4 degree C |
| | Hobo U24 | ± 0.4 degree C | ± 0.4 degree C |
| **Conductivity** | Campbell CS547A | ± 10 % | ± 10 % |
| | Hobo U24 | ± 3 % | ± 3 % |
| **Stage** | Campbell CS451 | ± 0.02 feet | ± 0.02 feet |
| | Hobo MX2001-01 | ± 0.02 feet | ± 0.02 feet |

**Table 12. Measurement quality objectives for extended water quality parameters.**

| Water Quality Parameters | Analysis methods in Water[3] | Reporting limit target | Field Replicate (RSD) | Lab replicate (RPD)[1] | Matrix spike[2] (% recovery) | Control standard/ surrogate (% recovery) | Matrix spike[2] (% RPD) | Control standard/ surrogate (% RPD) |
|---|---|---|---|---|---|---|---|---|
| | | Sensitivity | Precision | Bias and Precision | Bias and Accuracy | | Relative Percent Difference | |
| Temperature | | ±0.2 ˚C | ≤10% | N/A | N/A | N/A | N/A | N/A |
| Conductivity | | ±3 umhos/cm | ≤10% | N/A | N/A | 90-110 | N/A | N/A |
| Dissolved Oxygen | Electrode Meter* | .1 mg/L | N/A | N/A | N/A | N/A | N/A | N/A |
| pH | | ±0.2 std. unit | ≤10% | N/A | N/A | N/A | N/A | N/A |
| Turbidity | | .3 NTU | ≤25% | ≤25% | N/A | 90-110 | N/A | N/A |
| Total Solids | SM 2540B | 5 mg/L | ≤25% | ≤25% | N/A | 80-120 | N/A | 5 |
| *E. coli* | SM 9223 B | 1 cfu/100 mL | ≤50% | ≤20% | N/A | N/A | N/A | N/A |
| Nitrate+Nitrite | EPA 353.2 | 0.01-0.04 mg/L | ≤25% | ≤20% | 75-125 | 80-120 | ≤20% | ≤20% |
| Ammonia (NH3) as Nitrogen (N) | SM4500 NH3 G | 0.02-0.05 mg/L | ≤20% | ≤20% | 75-125 | 80-120 | ≤20% | ≤20% |
| Total Phosphorous | EPA 365.3 | 0.005 – 0.01 mg/L | ≤25% | ≤20% | 75-125 | 80-120 | ≤20% | ≤20% |
| Dissolved Cu, Zn | EPA 200.8 | 0.1 ug/L Cu, 2 ug/L Zn | ≤20% | ≤20% | 75–125 | 85–115 | ≤20% | ≤20% |
| Hardness, Total as CaCO3 | SM2340 C | 2 mg/L | ≤20% | ≤20% | 90-110 | 80-120 | ≤20% | ≤20% |
| Dissolved Organic Carbon | SM5310 C | 0.5 mg/L | ≤20% | ≤20% | 83-117 | 83-117 | ≤20% | ≤20% |
| Total Kjeldahl Nitrogen | ASTM D1426-08B | 0.2 mg/L | ≤20% | ≤20% | 72-129 | 72-129 | ≤20% | ≤20% |

*In-situ measured parameters follow manufacturer's guidelines for meter calibrations and operations

[1] The relative percent difference (RPD) must be less than or equal to the indicated percentage for values that are greater than 5 times the reporting limit.

[2] For inorganics, the Laboratory Program Functional Guidelines state that the spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of 4 or more (EPA, 2010)

[3] MQOs are based on Hallock (2012) and SOP EAP033 (Swanson, 2007).

**Table 13. Measurement quality objectives for sediment parameters.**

| Sediment parameters | Analysis methods in sediment MQO | Reporting limit target | Lab replicate (RPD)[1] | Matrix spike[2] (% recovery) | Matrix spike duplicate (RPD)3 | Control standard/ surrogate (% recovery) |
|---|---|---|---|---|---|---|
| | | Sensitivity | Bias and precision | Bias and accuracy | Bias and precision | Bias and accuracy |
| Conventional Parameters | | | | | | |
| Grain Size on <2 mm sieved sediment | PSEP PS | Sensitivity = 1.0% | ≤20% | N/A | N/A | N/A |
| Total Organic Carbon | PSEP PS | Sensitivity=0.1% | ≤20% | N/A | N/A | 80-120 |
| Metals | | | | | | |
| Total and dissolved As, Cd, Cr, Cu, Pb, Zn | EPA 200.8 | (0.2, 0.1, 0.2, 0.5, 0.5, 0.5) mg/kg dw | ≤20% | 75–125 | ≤20% | 85–115 (spiked blank) ERA Soil[3] |
| | | | | | | 80–120 (As, Cd, Cu, Pb, Zn) |
| | | | | | | 79–120 (Cr) |
| Semi volatile organics | | | | | | |
| Polycyclic aromatic hydrocarbon (PAH) compounds | EPA 8270D SIM (GC-MS) | 1-5 µg/kg dw | Compound specific ≤40% | Compound Specific | ≤40% | Spiked blank compound-specific |
| | | | | 50–150 | | 50–150[4] |

[1] The Relative percent difference (RPD) is calculated when at least one of the result values is above the practical quantitation limit; if both values are below then the RPD is not calculated.
[2] For inorganics, the *Laboratory Program Functional Guidelines* state that the spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of 4 or more (EPA 2010)
[3] ERA solid LCS, "metals in Soil" the catalogue number is 540 may be needed if using a contract lab
[4] Semivolatile surrogate recoveries are compound-specific. MQOs are based on Lubliner (2014).

# 8. Sampling Procedures

## Field Equipment Handling

**Data loggers** will be deployed permanently at Trend sites and temporarily for the scheduled water year of sampling at status sites. Stage, water temperature, and conductivity are continuous monitoring parameters logged concurrently every 15 minutes for this study. A combination of level loggers and conductivity/temperature loggers will be used at status sites where telemetry is not feasible. All other sites will utilize telemetry with data loggers, pressure transducers and conductivity/temperature probes. It is best not to disturb pressure transducers/level loggers after deployment. Monitoring conductivity calibration and fouling, which requires retrieval of instrumentation, is pertinent to quality control. Therefore, separate pressure transducers or level loggers and conductivity/temperature probes will be utilized.

- **Stage:** Stage data will be collected by installation of a Campbell Scientific CS451 vented pressure transducer at sites where telemetry is feasible following the manufacturer's instructions and approved Clark County SOP (Appendix A). HOBO MX Water Level Loggers (MX2001-0x) will be deployed to collect stage data where telemetry is not feasible following the manufacturer's instructions and approved Clark County SOP. (Campbell Scientific CS451 are available at https://s.campbellsci.com/documents/ca/manuals/cs451-cs456_man.pdf; HOBO MX Water Level Logger are available at https://www.onsetcomp.com/files/manual_pdfs/19389-L%20MX2001%20Manual.pdf ). Stage measurements will be logged at intervals of 15 minutes. A manual stage measurement will be collected at each monthly or every other month field visit (Appendix A). Data will be retrieved during each field visit.
- **Conductivity and Water Temperature:** Conductivity and temperature data will be collected by the installation of a CS547 conductivity/temperature probe where telemetry is feasible and a HOBO U24 conductivity/temperature probe where telemetry is not feasible. Both of these types of instruments will be installed and maintained following the manufacturer's instructions and approved Clark County SOP (Appendix A; https://s.campbellsci.com/documents/us/manuals/cs547a.pdf; those for the HOBO U24 are available at https://www.onsetcomp.com/files/manual_pdfs/15070-J%20U24-001%20Manual.pdf) Conductivity and temperature measurements will be logged at intervals of 15 minutes. Data will be retrieved monthly or every other month depending on site conditions.

All loggers will be deployed inside a 2-inch camouflage-painted PVC pipe to shade them from sunlight and to prevent them from being found and vandalized.

Continuous in-situ data loggers will be calibrated and cleaned prior to deployment and checked for functionality and biofouling during site visits using the manufacturer's recommended protocols and approved Clark County SOP (Appendix A). Each deployment location will be photographed and have site-specific survey information documented on a standardized form (Appendix B). For continuous measurements with on-site sensors (water temperature, conductivity, stage), the accuracy and instrument bias of each sensor will be verified through post-deployment calibration checks along with deployment, retrieval, and grab sample checks collected as described in Appendix A.

The field crew will conduct any necessary cleaning by rinsing the loggers, outside casing, the circulation holes and the optical eyes with fresh running water, distilled water or instrument specific cleanser. Instrument specific brushes can be used as well as Q-tips or other non-abrasive scrubbers. Calcium precipitation can be deposited on the pressure transducer or any portion of the loggers. These deposits can be dissolved and released without damaging the probes using a diluted solution of acetic or phosphoric acid (<10%).

## Field Safety

All crew members are responsible to ensure health and safety during the field sampling events. A written health and safety plan will be prepared prior to the commencement of field activities. The health and safety plan must include at a minimum: phone numbers and a communication tree for notification should an emergency occur; maps to the nearest hospital, fire station, and/or emergency response facility for each sampling location; and enumeration of anticipated potential hazards (Appendix C).

All crew members must review and sign the health and safety plan during a field work kick-off meeting. During the meeting, the Field Lead summarizes the potential hazards and ensures that all crew members are aware of safety procedures and appropriate lines of communication. Crew members must be instructed in proper handling of sample preservatives to avoid hazardous situations that may occur if these chemicals are handled inappropriately.

At least two crew members must be present during all field sampling activities, however three people improves efficiency and can be safer for wadeable stream habitat surveys.

Crews may encounter hazardous materials at site locations. Crews should not disturb or retrieve improperly disposed hazardous materials. Instead, crews will record the finding in detail in the field notebook, take photographs if possible and report to the LCUS Project manager who will report the crew's findings to appropriate authorities as soon as possible.

Field members must be familiar with the signs of heat exhaustion, heat stroke, and hypothermia, and there should always be at least one person trained in first aid and CPR on every field crew. First aid kits must be available at all times. Any field crew member with known allergies to bees, other insects, poison oak, etc. will notify the crew lead. These members must take proper precautions and instruct fellow members as to the location and use of any needed emergency medications that they carry with them at all times.

Motor vehicles must be operated with care and in observance of all applicable laws and regulations.

## Field Safety in Wadeable Streams

Common hazards in wadeable streams include slip, trip and fall hazards; submerged objects; venomous snakes, insects and plants; and adverse weather conditions. Sampling will be discontinued during thunderstorms.

Field crews must wear appropriate personal protective equipment (PPE), including waders (or at a minimum neoprene booties), hats, sunglasses (or safety goggles as needed), and should use sunscreen on exposed skin. When waders are worn, they must be equipped with a belt and follow Clark County PFD requirements. Appropriate gloves must be worn when agitating substrate for the collection of benthic macroinvertebrates.

Extreme care should be used when walking on rip rap as rocks can easily shift. Large woody debris (LWD) must be navigated carefully to avoid falls or getting pinned between pieces of debris.

Crew members must ensure all equipment is in safe working order.

## Field Work Procedures

The procedures are based on existing standard protocols (Table 7).

Before leaving for the sampling site, the field crew will conduct all appropriate preparation including instrument calibration, data log form preparation, and field safety plan completion.

Field procedures (Table 14) should be conducted in the following order to avoid any damage or disturbance to benthic invertebrates and other samples:

1) Site verification and layout,
2) Instantaneous stream flow measurement,
3) In-situ water measurements,
4) Water sample collection for the extended program,
5) Benthic macroinvertebrate,
6) Sediment chemistry sample collection,
7) Physical habitat condition.

**Field handheld probes** will be calibrated and checked for problems prior to each sample event following the manufacturer's recommended protocols and recorded in the field log (Appendix A).

For **sediment sampling,** sediment samples will be collected and processed in a metals free room at the lab for listed analytes in Table 6. Stainless-steel scoops and bowls utilized for sediment sample collection will be cleaned using the following procedure. Stainless-steel sampling implements, including spoons, bowls, and stirrers will be cleaned sequentially as follows:

1. Wash in non-phosphate detergent and hot-tap water,
2. Rinse with hot tap water,
3. Rinse with deionized water three times,
4. Air dry in clean area free of contaminants,
5. Rinse with pesticide-grade acetone or methanol if sampling for PAHs,
6. Air dry in clean area free of contaminants.

After drying, clean equipment will be wrapped in aluminum foil and stored in polyethylene bags until used in the field. Sampling equipment will be dedicated to a single site. Reuse will require cleaning as outlined in the procedure above.

**Table 14. Typical timing of on-site field activities for wadeable streams.**

| Activity | Person | Hours since arrival | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Site verification and layout | A | A | | | | | |
| In-situ flow measurement | B | B | | | | | |
| Water chemistry sampling | C | C | | | | | |
| Macroinvertebrate | A,B | | A,B | A,B | A,B | | |
| Sediment chemistry | C | C | C | | | | |
| Physical habitat | A,B,C | | | | | A,B,C | A,B,C |
| Data retrieval and maintenance of data logger | C | | | C | C | | |

Detailed procedures for site verification and field sampling are listed in Table 7.

At the end of the monitoring period, the field crew will retrieve data from the deployed loggers for all three continuous parameters. The field crew will conduct any necessary cleaning, calibration or re-installation of loggers at the next round of status sites. The storage capacity, battery, electrical connections and tubing will be checked and, if necessary, replaced.

## Field Log

A field log with appropriately detailed notes will be used to record irreplaceable information for each site visit. The field logs will be either:

1. Bound, waterproof notebooks with pre-numbered pages. Use permanent, waterproof ink or pencil for all entries.

   or

2. Electronic field logs that demonstrate equivalent security and durability to a waterproof, bound notebook.

Example field forms are provided in Appendices B and D. Field form entries will include but are not limited to:

- Name and location of activity
- All field personnel, and specifying the recorder's name
- Sequence of events
- Any changes or deviations from the QAPP

- Environmental conditions at time of monitoring activity
- Date, time, location, ID, and description of each sample
- Field instrument calibration procedures and documentation
- Field measurements
- Type and number of QC samples collected
- Unusual circumstances that might affect interpretation of results

Forms will include the station visit/maintenance sheet, meter calibration, and chain-of-custody forms. All errors or typos will be crossed out and rewritten by the technician who recorded the data. All corrections will be initialed and dated when made. Do not use correction fluid or tape. Paper documents will be stored in an organized central filing location.

# 9. Quality Control

## Field Equipment Decontamination

Equipment used in the field for collection or processing of sediment and surface water samples will be decontaminated using Ecology's SOP, *Decontamination of Sampling Equipment for Use in Collecting Toxic Chemical Samples* (Friese, 2014). Field equipment will be maintained at the recommended frequency specified by each manufacturer.

After conducting field work, field staff will:

- Inspect and clean all equipment by removing any visible soil, vegetation, vertebrates, invertebrates, plants, algae or sediment. If necessary, a scrub brush could be used then rinsed with clean water either from the site or brought for that purpose. The process will be continued until all equipment is clean.
- Drain all water in samplers or other equipment that may harbor water from the site. This step will take place before leaving the sampling site or at an interim site. If cleaning after leaving the sampling site, no debris will leave the equipment and potentially spread invasive species during transit or cleaning.
- Assess the possibility of invasive species contamination of both protective gear and sampling equipment, including boats, rafts, and other water-borne devices. Ecology's SOP EAP070 (Parsons et al., 2018) addresses invasive species transport and contamination.

## Field Replicate Samples

Grab and composited field replicate samples will be collected at a rate of 10% of the total samples collected for monitoring each year; composite split for sediment samples, simultaneous grab samples for water quality parameters and an additional composite sample collected for macroinvertebrates. In-situ parameters measured in the field sample also will be measured in the replicate sample for that particular site. Field replicates will be labeled similar to other samples, and each replicate sample will have its own unique identification number. These replicate samples will be submitted blind to the laboratory with all other field samples. Table 15 shows the schedule, control limits, and corrective actions for field replicate samples.

**Table 15. Field quality control schedule for water quality, sediment, and benthic macroinvertebrate samples.**

| Field Sample Collected | Number and frequency | Control Limit | Corrective Action |
|---|---|---|---|
| Composited benthic macroinvertebrate field replicate | One replicate sample each year | Qualitative control – Assess representativeness, comparability, and field variability | Review procedures; alter if needed |
| Composited sediment field replicates | 10% of the total number of samples each year | Qualitative control – Assess representativeness, comparability, and field variability | Review procedures; alter if needed |
| Grab water quality field replicates | 10% of the total number of samples each year | Qualitative control – Assess representativeness, comparability, and field variability | Review procedures; alter if needed |
| Field water quality transfer blank | At least one sample a year | Blank analyte concentration should be below the reporting limit | Compare blanks for analyte to determine whether the sampling process is the source of contamination; re-evaluate decontamination procedures; evaluate results greater than 5x blank concentrations |
| Other blank samples for determining a contamination source | As needed | Blank analyte concentration should be below the reporting limit | Compare results from separated blanks to isolate the source of contamination; evaluate results greater than 5x blank concentrations |

## Sample Storage and Preservation

Holding times are the maximum allowable length of time between sample collection and laboratory manipulation. Holding times are different for each analyte and are in place to maximize analytical accuracy and representativeness. Each sample collected will be packaged in a container and labeled accordingly. If necessary, staff will coordinate with the analytical laboratory to ensure samples can be transported, received, and processed during non-business hours. Sample containers will be transported or sent by the field team to the analytical laboratory, following established sample handling and chain-of-custody procedures. At the laboratory, samples may be further divided for analysis or storage.

Table 16 details sizes and types of sample containers recommended for transporting sample media, sample preservation requirements, and maximum sample holding times prior to laboratory analysis.

**Table 16. Sample containers, preservation, and holding times.**

| Group | Analysis | Matrix | Recommended Quantity | Container | Holding Time | Preservative |
|---|---|---|---|---|---|---|
| Base | Grain Size | Sediment | 100 g | 8 oz plastic jar | 6 months | Cool to ≤6°C<br>Do NOT freeze or dry |
| | Sediment Metals | Sediment | 50 g | 4 oz glass or HDPE jar with Teflon-lined lids | 6 months | Cool to ≤6°C |
| | Sediment PAHs | Sediment | 100 g | 8 oz glass or HDPE jar with Teflon-lined lids | 14 days; 1 year if frozen | Cool to ≤6°C; or freeze at ≤-18°C |
| | Macro-invertebrates | Benthic | 1.0 L | 1.0 L Wide mouth polyethylene jar | N/A | Field preserved with 95% ethanol. Stored in quiescent location |
| Extended | Total Solids | Water | 250 mL | 250 mL w/m poly bottle | 7 days | Cool to ≤6°C |
| | Hardness | Water | 100 mL | 250 mL w/m poly bottle | 6 months | $H_2SO_4$ to pH <2, cool to ≤6°C. preservation in field or lab |
| | Ammonia ($NH_3$) as (N) | Water | 125 mL | 125 mL w/m poly bottle | 28 days | $H_2SO_4$ or HCl to pH <2, preservation in field |
| | Dissolved Organic Carbon | | | | | Cool to ≤4°C |
| | Total Kjeldahl Nitrogen | | | | | |
| | Nitrate ($NO_3^-$) + Nitrite ($NO_2^-$) | Water | 125 mL | (1) 125 mL clear w/m poly bottle | 48 hours | $H_2SO_4$ or HCl to pH <2, preservation in field<br>Cool to ≤4°C |
| | Total Phosphorous (TP) | Water | 60 mL | (1) 125 mL clear w/m poly bottle | 28 days | $H_2SO_4$ or HCl to pH <2, preservation in field<br>Cool to ≤4°C |
| | Dissolved Metals | Water | 250 mL | 250 mL poly bottle with Teflon or polypropylene lid | 6 months | collection; then add $HNO_3$ to pH <2 , |
| | E. coli | Water | 125 mL | 125 mL plastic bottle | 24 hours | Fill bottle to shoulder, Cool to ≤4°C |

## Quality Control for Macroinvertebrates

Detailed quality control procedure for macroinvertebrates (stream benthos) is described in Standard Operating Procedure EAP073 (Table 7). QC procedures require macroinvertebrate sorting efficiency and taxonomic accuracy and precision checks.

## Laboratory Quality Control Procedures

Contract laboratories will make every effort to meet sample holding times and target reporting limits for all parameters. Laboratory QC procedures and results will be closely monitored throughout the duration of the sampling. Measurement quality objectives for laboratory samples are listed in Table 17.

QC procedures for biological samples are currently limited to field replicates precision and laboratory duplicates for accuracy for benthic macroinvertebrates. Contract laboratories will make every effort to ensure accurate identification of specimens.

The schedule for laboratory QC samples is listed in Table 17. These samples will include, at a minimum, the types of QC samples listed and described below:

**Laboratory duplicates**: Laboratory duplicate samples will be analyzed regularly to verify that the laboratory's analytical methods are maintaining their precision. The laboratory should perform "random" duplicate selection on submitted samples that meet volume requirements. After a sample is randomly selected, the laboratory should homogenize the sample and divide it into two identical "split" samples. To verify method precision, identical analyses of these lab splits should be performed and reported. Some parameters may require a double volume for the parameter to be analyzed as the laboratory duplicate. Matrix spike duplicates may be used to satisfy frequencies for laboratory duplicates.

**Matrix spikes and matrix spike duplicates (ms/msd)**: Matrix spike samples are triple-volume field samples to which method-specific target analytes are added or spiked into two of the field samples, and then analyzed under the same conditions as the field sample. A matrix spike provides a measure of the recovery efficiency and accuracy for the analytical methods being used. Matrix spikes can be analyzed in duplicate to determine method accuracy and precision. Matrix spikes will be prepared and analyzed at a rate of 1/20 (5% of total) samples collected or one for each analytical batch, whichever is most frequent.

**Blanks**: Laboratory blanks are useful for instrument calibrations and method verifications, as well as for determining whether any contamination is present in laboratory handling and processing of samples.

**Laboratory standards**: Laboratory standards (reference standards) are objects or substances that can be used as a measurement base for similar objects or substances. In many instances, laboratories using digital or optical equipment will purchase from an outside accredited source a solid, powdered, or liquid standard to determine high-level or low-level quantities of a specific analyte. These standards are accompanied by acceptance criteria and are used to test the accuracy of the laboratory's methods. Laboratory standards are typically used after calibration of an instrument and prior to sample analysis.

**Surrogate and internal standards**: Surrogate standards are used to process and analyze extractable organic compounds (PAHs). A surrogate standard is added before extraction, and it monitors the efficiency of the extraction method. Internal standards are added to organic compounds and metal digests to verify instrument operation when using inductively coupled plasma mass spectrometry (ICP-MS) analysis and gas chromatography-mass spectrometry (GC-MS) analyses.

**Method blanks**: Method blanks are designed to determine whether contamination sources may be associated with laboratory processing and analysis. Method blanks are prepared in the laboratory using the same reagents, solvents, glassware, and equipment as the field samples. These method blanks will accompany the field samples through analysis.

**Instrument blank**: An instrument blank is used to calibrate analytical equipment used in the laboratory's procedures. Instrument blanks usually consist of laboratory-pure water and any other method-appropriate reagents.

**Table 17. Schedule for laboratory Quality Control samples.**

| Quality control sample[1] | Analysis type | Frequency[2] | Corrective action |
|---|---|---|---|
| Laboratory Duplicates | Metals | 5% of total samples, minimum 1 per batch (method-specific) | Evaluate procedure; reanalyze or qualify affected data |
| | Organics | | |
| Matrix Spikes (full constituent list) | Metals | 5% of total samples, minimum 1 per batch | Evaluate procedure and assess potential matrix effects; reanalyze or qualify data |
| | Organics | 5% of total samples, minimum 1 per batch | Evaluate duplicates and surrogate recoveries and assess matrix effects; evaluate or qualify affected data |
| Matrix Spike Duplicates[3] | Metals and Organics | At least 1 sample per year; Metals can be run either by MSD or lab duplicates at otherwise; 5% of total samples, minimum 1 per batch | Evaluate procedure and assess potential matrix effects; reanalyze or qualify data |
| Method Blanks | Metals | 5% of total samples, minimum 1 per batch (method-specific) | Blank concentration may be used to define a new reporting limit. Evaluate procedure; ID contaminant source; reanalyze samples if blanks are within 10x concentration. No action necessary if samples are >10x blank concentrations |
| | Organics | | |
| Spiked (or Fortified) Blanks | Metals and Organics | 5% of total samples, minimum 1 per batch (primarily water) | Evaluate matrix spike recoveries; assess efficiency of extraction method; flag affected data |
| References (lab control standard, lab control sample, or standard reference materials) | Metals | 5% of total samples, minimum 1 per batch (spiked blank). | Evaluate lab duplicates/matrix spike recoveries; assess efficiency of extraction method; evaluate or qualify affected data |
| | Organics | | |
| Surrogates | Organics | Surrogates frequency is 100% | Evaluate results; qualify or reanalyze or re-prep/reanalyze samples. |
| Internal Standards | Metals and Organics | Internal Standard frequency is 100% for GC/MS and ICPMS methods | Evaluate results; dilute samples, reassign internal standards or flag data. |

1 Quality control samples may be from different projects for frequencies on a per-batch basis.
2 Frequencies may be determined from the study number of samples collected by the permittee.
3 The lab may use either a matrix spike duplicate or laboratory duplicate to evaluate precision based on the method.

# 10. Data Management

The LCUS Data Coordinator will be responsible for data QA, data entry, and data export and will ensure effective data management to support the routine data analysis and ultimately ensure a successful monitoring program. The Data Coordinator will also respond to data requests.

## EIM and WHM Database Preparation

Before sampling begins, the LCUS Project Manager or Data Coordinator will coordinate with SAM Scientist and Ecology's WHM Data Coordinator to assign the study identification number and site IDs.

## Field Data Collection and Transfer

Template data sheets and field log are included in Appendix D. These forms will be reviewed by the LCUS Project Manager to ensure that all field crews are collecting the same data in the same way. The forms identify the LCUS Project Manager as the recipient of the final forms.

Field notebooks and 3-ring binders will contain all field activity data, as follows—

- completed data field/maintenance sheets
- chain of custody forms

Field staff is responsible for updating this information and storing it in appropriate binders securely located and available to the Project Manager.

Continuous 15-minute stream stage, temperature and conductivity measurements are recorded on data loggers and either downloaded on field computers or telemetered from the field monitoring sites onto a central computer for data storage and processing. The files are then appended and converted for storage, analyses, and editing utilizing commercially available Aquatic informatics Aquarius software. The Project Manager, or designee, is responsible for acquiring the data in a timely manner and for maintaining the project database, which will be backed up regularly. Continuous 15-minute will be uploaded to Ecology's EIM database under study identification code SAM_LCUC.

All field data sheets will be kept in an organized manner. The project manager will keep the original field data and a copy will be sent to the data manager. Post-processed watershed health data will be finalized and incorporated into electronic forms and uploaded to the Watershed Health Monitoring (WHM) database under study identification code SAM_LCU.

## Laboratory Data

Laboratory data will be sent to the LCUS Project Manager and Data Coordinator directly from each laboratory following completion of each set of analyses for a sampling event. Reporting times may vary depending on holding time and analytical methods but should not exceed six months from the documented sampling date.

Laboratory reports will be reviewed by the Data Coordinator for errors or missing data. The Data Manager and Project Manager will implement corrective actions if needed.

Finalized electronic laboratory data will be loaded to Ecology's EIM database under study identification code SAM_LCU by the Data Coordinator with the assistance of Ecology's EIM Data Coordinator and saved in the Clean Water Division (CWD) water quality database.

## Watershed Health Data

If the permittees choose to collect the entire set of physical habitat watershed health parameters, Ecology will provide electronic field data collection software. The electronic field form (e-form), if used, will assist Clark Co to (1) assure completeness in the field for benthos and habitat monitoring and (2) more easily and efficiently load this data to Ecology's WHM database in EIM under study identification code SAM_LCU. Use of the electronic form greatly reduces the time for review and quality assurance/quality control in transferring the data. If using the e-form, Clark County will work with Ecology's WHM data coordinator to ensure all data required to successfully utilize the e-form are collected. An electronic tablet or laptop is needed for field use of the e-form.

If the permittees decide to collect fewer habitat parameters than required to successfully utilize the e-form. Data in e-form will be submitted after each sampling to WHM database for WHM data coordinators review and approval.

## Data Storage

All field forms, photographs, electronic data, and laboratory data will be stored by the LCUS Project Manager in an organized filing system for electronic or paper files. Location, measurement, and sample result data will be evaluated through the data finalization process. Results judged to be acceptable after all such steps are required to be entered and be available in Ecology's EIM database.

Continuous data will be stored in Aquarius time series software and uploaded into the EIM database yearly following data finalization procedures.

Macroinvertebrate data will be stored in the Puget Sound Stream Benthos database (PSSB) yearly following data finalization procedures by Aquatic Biology Associates, Inc. under study identification code SAM_LCU.

All laboratory data will be provided in an electronic data deliverable (EDD) format. After receipt of data, internal processing and data finalization, the data will be uploaded into the EIM database annually by Clark County's Data Coordinator with assistance from Ecology's EIM Coordinator.

# 11. Data Verification and Validation

Clark County will verify all data to evaluate the completeness, correctness, and conformance/compliance of the data set against the method and other requirements.

## LCUS Field Lead

Field staff will verify field results after measuring and before leaving the site. They will keep field notes to meet the requirements for documentation of field measurements. The field lead will ensure:

- Field-collected data are consistent, reasonable, and complete, with no errors or omissions.
- Instrument measurement and converted values are within the acceptable instrumentation error limits and expected range of values.
- Methods and protocols specified in this QAPP were followed.
- Field QC processes specified in this QAPP were followed.

## LCUS Project Manager

The LCUS Project Manager will verify:

- Field-collected data are consistent, correct, and complete, with no errors or omissions.
- Results of applicable QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in the Sampling Process Design were obtained.
- Methods and protocols specified in this QAPP were followed.
- Field forms are complete and correct.

If a laboratory suspects field blank contamination, the laboratory's project manager will notify the Field Lead and the LCUS Project Manager. The sample results will be reviewed by the LCUS Project Manager and Field Lead to determine if samples associated with the field blanks should be qualified based on the contamination. Sample results will be flagged with a J if they are less than, or equal to, 5 times the field blank concentration.

For macroinvertebrates, the laboratory will verify all taxonomic results prior to reporting and submittal to PSSB. Ecology EAP staff and SAM Scientist will verify all taxonomic data uploaded in PSSB and then submit them into EIM.

For continuous measurements with on-site sensors (water temperature, conductivity, stage), the accuracy and instrument bias of each sensor will be evaluated through post-deployment calibration checks along with deployment, field verification and retrieval. Once continuous stage, conductivity and temperature have been uploaded to Aquarius, corrections will be applied to the dataset using Aquarius software. Corrections needed may consist of cleaning, calibration, or instrumental drift corrections.

At least 10% of field and laboratory data entry will be verified against field forms and laboratory reports prior to final validation in the electronic database to verify consistency. All electronic versions of data will be re-verified using computer programs (*e.g.*, R or DataAccess) by the Data Manager before submitting to EIM.

## Laboratory Data Verification

For the laboratory measurement of sediment PAH's and metals, bias and precision values should be less than 20-40% depending on the indicator and will be checked through replicate samples based on the MQOs in section 7. All accredited laboratories used for the analyses will have their own approved internal quality-control procedures, which will be confirmed and documented by the LCUS Project Manager prior to sample submission.

**If substantial discrepancies in the data are found,** there are two options for correction, depending on when the problem is identified:

1. ***If the problem is identified before the end of the sampling period*** (June 1 to September 30 for sediment chemistry and benthic indicators; the end of the month for extended parameters), a repeat site visit will be made to re-collect the sample. This may occur if the data set is incomplete or incorrectly collected. Due to the inter-related nature of chemical and biological conditions, problems identified in the chemical or biological data should be addressed by again collecting the entire suite of chemical or biological indicators. Before the second sampling, the LCUS Project Manager, Principal Investigator, and Field Lead must review in detail the applicable methods and procedures in this document (including references to *Status and Trends Monitoring of Small Streams in the Puget Lowlands Ecoregion QAPP* (Lubliner, 2014)) to ensure understanding of the protocols. Equipment should be cleaned and recalibrated and checked for proper function.
2. ***If the problem is identified after the sampling period***, the data should be flagged and the problem explained in a comment in the database. This will allow both internal and external users of these data to know the limitations of how these data may be used in projects. If the data are incomplete, or if some data standard was not met, the data may not be used to meet the objectives of the study design.

In either case, the Project Manager will notify the SAM Scientist and the other permittees as soon as possible after learning of such a problem and which of the above corrective actions will be taken.

For continuous parameters, if identified discrepancies are found that indicate sensor or data-logger malfunction, a site visit to correct the problem must occur as soon as possible. Suspect data prior to that time should be clearly flagged in the database and not used in subsequent analyses.

If any errors are found they will be corrected, and the LCUS Project Manager will check all of the remaining associated field and laboratory data spreadsheet files. This process will be repeated until all errors are eliminated.

Permanent records of all environmental data will be made available through online archives (*i.e.*, EIM).

## 12. Data Usability and Data Analyses

### Data Quality (Usability) Assessment

The data usability assessment follows data verification and validation. This involves an overall assessment of the data package to determine whether the quality objectives have been met for the intended use of the data as well as how to treat non-detects and other issues. The LCUS Project Manager and Principal Investigator examine the complete data set to determine completeness and compliance with standard procedures outlined in SOPs using professional judgement.

### Determining if Project Objectives were met

Following data verification and validation, the data assessment will compare the data package with project objectives established at the beginning of the project. If the results do not meet those criteria, this will be explicitly stated in the annual reporting. Based upon data accuracy criteria, some data may be discarded. If this is found to be necessary, then the problems associated with data collection, reasons data were discarded, and potential ways to correct sampling problems will be reported to the SAM Scientist.

In some cases, project objectives may be modified. If that is judged to be necessary, the justification for modification, problems associated with collecting and analyzing data, as well as potential solutions will be reported to the SAM Scientist and discussed with the permittees. Such adaptive management of this QAPP must be approved by Ecology and the LC stakeholders.

### Treatment of Non-Detects in Data Analysis

In the event that non-detect values from the laboratory become an issue and impede the ability to perform the study (data censorship), statistical methods will be used to assign values to non-detects. Methods for performing statistical analyses on non-detect data are found in Table 5 of *Western Washington NPDES Phase I Stormwater Permit, Final S8.D Data Characterization 2009-2013* (Hobbs et al., 2015). Some individual parameters may be detected less frequently than others and may therefore be considered a low priority. Any non-detect issues and statistical analysis performed during the study period will be detailed in the final status and trends report.

### Data Analysis

The LCUS Project Manager is responsible for analyzing the data and providing reports listed in the Table 2. Staff writing the report must know the caveats and limitations of the data and corresponding analyses and be informed by field crew members as to special conditions encountered during sampling. This will increase the chances that the data are properly interpreted.

***Expected data analyses for the LCUS include:***

**Calculation of flow metrics:** Using the continuous stage data for each active site, calculate flow metrics to determine flow alteration indicators known to correlate to biological conditions in small streams, including but not limited to flow reversals, $T_{Qmean}$, and Richards-Baker Index (RBI). These indicators will be calculated and reported as described in DeGasperi et al. (2009) and Booth and Konrad (2017).

**Descriptive statistics summary**: Describe basic features of the data, distribution and frequency of values, detection frequency of each parameter including water quality, watershed health, physical habitat, sediment and hydrology derived indicators. Measured values can be split by meaningful group variables (or subgroups) and displayed by groups. When comparing values between groups, statistical analysis such as T-test, ANOVA or linear-model or nonparametric analyses will be conducted to confirm the significance of differences or any patterns. For an example, see section 2.0 in the final report on the 2015 SAM Puget lowland streams status assessment (DeGasperi *et al.*, 2018).

**Multivariate statistical analyses**: Multivariate statistical analyses may identify key status and trends drivers. Other analyses including multivariate ordination and other learning processes (*e,g.*, tree-based method) can also be done. Basic exploratory data analyses may also be utilized given limitations of the dataset.

**Status assessment**: The assessment of stream conditions will be conducted either by developing thresholds or by comparing to known criteria such as state water or sediment quality standards, and sediment screening level. Data from Lower Columbia regional sites gathered by Department of Ecology or Oregon Department of Environmental Quality can also serve as reference (least-disturbed) condition to assess the status of target streams and the region. When standards or reference conditions are not available, threshold values can be set using peer-reviewed ecological literature. For literature-derived values that provide a meaningful comparison, see section 2.6 in the final report on the 2015 SAM Puget lowland streams status assessment (DeGasperi *et al.*, 2018).

**Trend assessment**: Trend assessment will be done following the fourth year of data monitoring and every five years thereafter.

## Adaptive Management of this QAPP

If a need is identified for adaptive changes to the monitoring protocols or data analysis approaches specified in this QAPP, the proposed revision(s) to this QAPP must be detailed in a separate memo. The memo will provide justification for the change(s) and the expected results and impacts to data usability for the monitoring that has been conducted to date and that will be conducted in the future. Any proposed changes must be approved by the SAM Scientist prior to implementation. At the discretion of the SAM Scientist, the approval process for substantive changes to this QAPP may include discussion(s) with Permittees and other interested parties.

For changes to the study design (selected indicators, or frequency of their measurement), the memo needs to be submitted to the SAM Scientist before the field season in which the changes are expected to be implemented, and with sufficient time for review, discussion, and approval by stakeholders.

# 13. Reporting

The LCUS Project Manager will prepare and submit annual reports and trend reports as described in the IAA between Ecology and Clark County.

LCUS annual reports will typically include summary of complete results of the prior water year. Reports will provide discussion regarding flow indicators, benthic macroinvertebrate indicators, habitat conditions, sediment chemistry and water chemistry (if measured). Reports will include status of streams by comparing of LCUS findings to appropriate benchmarks for each indicator. Each annual monitoring report will include summary statistics, descriptive maps and explanatory variables assessment.

Trend reports will be completed every five years, beginning after four water years of monitoring. Trend reports will describe overall regional trends from inception of monitoring to the current year and identify drivers of stream health status and trends. Trend reports will include a section on each of the types of data analysis listed in section 12 and the Principal Investigator’s findings and conclusions from having conducted these analyses.

### Review of Reports

Draft reports will be shared for review by a technical review committee consisting of permittees, SAM scientist and other interested parties. After addressing the technical review committee’s comments, Clark County will complete the final report.

### Distribution of Reports

The LCUS Project Manager will send electronic (both MS Word and pdf) and paper copies of all reports to the SAM Scientist. Links to online copies of the final reports and other deliverables will be posted on the SAM webpage.

Electronic copies of reports will be posted on the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) website to reach a broad regional audience. The LCUS Project Manager will provide PNAMP with pdf copies of all final reports to be posted on PNAMP webpages. Clark County will send email notifications, with links to the online reports, to the full list of LC HSTM interested parties and to other interested parties identified during the implementation phase of program development; PNAMP staff will assist with this distribution.

# 14. Audits

Field, laboratory, and other audits ensure that QAPP elements are implemented correctly. The quality of the data must be determined to be acceptable, and corrective actions must be implemented in a timely manner. There are two components of the auditing process:

- The Technical Systems Audit is conducted during the study. Staff and the Field Lead evaluate qualitative conformance to the procedures discussed in this QAPP. These evaluations include field collection activities, sample transport, laboratory processing, and data management components of the program.
- Proficiency Testing is the quantitative determination of an analyte in a blind standard to evaluate the proficiency of the analyst or laboratory. This audit is included for analysis of water quality samples as a routine procedure in the accredited laboratory.

These audits are conducted during the study so that any necessary corrective actions can be implemented early in the project. Corrective actions will be led by the LCUS Project Manager and reviewed and approved by the SAM Scientist as soon as possible. Audits at the end of the study by the project lead or partners are necessary as part of data usability assessment and uploading to the EIM database. At any point, an independent party (*e.g.*, state agency staff) could be identified by the Project Manager to conduct a study audit.

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Parsons J., Hallock D., Seiders K., Ward B., Coffin C., Newell E., Deligeannis C., Welch K. 2018. Standard Operating Procedure EPA070 Version 2.2. Minimize the spread of invasive species. Washington State Department of Ecology.

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Ward, W., 2007. Standard Operating Procedures for the Collection, Processing, and Analysis of Stream Samples, Version 1.3. Washington State Department of Ecology, Olympia, WA. SOP Number EAP034. Approved October 26, 2007.

## Appendix A: Procedure for Conductivity Maintenance, Calibration, and Fouling Drift

Trend site calibration and fouling drift correction for Campbell Scientific CS547A-L Conductivity and Temperature Probe:
The CS547A-L has been factory calibrated and does not need to be recalibrated under normal use unless the diameter of the measurement cavity changes because of corrosion or abrasion (Campbell Scientific). However, a field calibration may be performed in accordance to manufacture instructions 8.1.4.
To check for drift and/or fouling the following procedure will occur during deployment (Steps 1-2, and 7) and a site visit (Steps 1-7) approximately every 2 months:

1. A calibrated, NIST temperature checked, ProDSS water quality meter will be placed into the stream alongside the conduit containing the CS547A-L and allowed to equilibrate (See Below for ProDSS calibration SOP).
2. Measurements will be recorded at the same time from both the CS547A-L and ProDSS conductivity and temperature. Remember that data is collected every 15 minutes. Make sure that you are recording on a 15 minute interval.
3. The CS547A-L will then be removed from the conduit and cleaned per manufacturer's instructions.
4. Flush the conduit with stream water to remove built up silt and debris impeding the flow of water through the conduit.
5. The CS547A-L will then be placed back into the conduit and allowed to equilibrate.
6. A measurement will then be recorded for both the CS547A-L and ProDSS conductivity and temperature. Remember that data is collected every 15 minutes. Make sure that you are recording on a 15 minute interval.
7. These measurements will be analyzed back in the office using Aquarius software to correct calibration if greater than 10 % and fouling drift.

Status site calibration and fouling drift correction for HOBO U24 Conductivity and Temperature Logger:
The HOBO U24 conductivity logger measures actual conductivity and temperature. Post data processing will yield Specific conductance data. Calibration of the HOBO U24 is performed in accordance with the manufacture's manual.
To check for drift and/or fouling the following procedure will occur during deployment (Steps 1-2, 8) and a site visit (Steps 1-8) approximately every 2 months:

1. A calibrated, NIST temperature checked, ProDSS water quality meter will be placed into the stream alongside the conduit containing the HOBO U24 and allowed to equilibrate (See Below for ProDSS calibration SOP).
2. Measurements will be recorded for the ProDSS conductivity and temperature. Remember that data is collected every 15 minutes. Make sure that you are recording on a 15 minute interval. (These measurements will be compared to the HOBO U24 measurement readings back in the office using HOBOware PRO Conductivity Assistant software for calibration drift.)

3. The HOBO U24 will then be removed from the conduit and cleaned per manufacturer's instructions.
4. A data download will be performed.
5. Flush the conduit with stream water to remove built up silt and debris impeding the flow of water through the conduit.
6. The HOBO U24 will then be redeployed into the same position within the conduit and allowed to equilibrate.
7. A measurement will then be recorded ProDSS conductivity and temperature. Remember that data is collected every 15 minutes. Make sure that you are recording on a 15 minute interval. (This measurement will be compared to the HOBO U24 measurement reading back in the office using HOBO PRO Conductivity Assistant software for fouling drift)
8. These measurements will be analyzed back in the office using Aquarius software to correct calibration if greater than 3 % and fouling drift.

**Procedure for Stage Maintenance and Drift**

Trend site stage for Campbell Scientific CS451 Pressure Transducer:
The CS451 has been factory calibrated and drift will be corrected using on offset calculation factoring in sensor zero offset, installation, related datum, and manual staff plate measurements. To check for drift and/or fouling the following procedure will occur during a site visit approximately every 2 months:

1. Take a manual stage measurement.
2. Drift will be compensated by taking manual readings of stage plates for the calculation of offset when greater than 0.03 ft. This offset calculation will be entered into LoggerNet or PC400 software

Status site stage for HOBO MX Water level logger (MX2001-0x):
The HOBO MX2001-01 has been factory calibrated. This logger records temperature data, absolute pressure, and barometric pressure. Absolute pressure will be converted to water level using barometric pressure compensation. The water level at each site will then be tied to a datum to calculate stage.
To check for drift and/or fouling the following procedure will occur during a site visit approximately every 2 months:

1. Take a manual measurement of the stage. Drift will be compensated by taking manual readings of stage when greater than 0.02 ft.
2. A data download will be performed.
3. Manual stage measurements will be compared to logger data for offset calculation.

**Calibration SOP for ProDSS**

**Temperature**: Recalibration by laboratory is necessary if off by 0.2°C.

- Fill bucket with tap water.
- Place sonde in bucket and let acclimate for 5 to 10 minutes.
- Use NIST thermometer to verify temperature reading.
- Record temperature readings.

**Conductivity:** One point calibration. Recalibration is necessary if off by ±3 µS/cm.

- Rinse sonde with tap and then two more rinses with conductivity standards
- Fill calibration cup to the second line (top line) (this is because the conductivity probe has two vent holes further up the probe where the sensors are located)
- Press calibration button, conductivity, and then Sp Conductivity
- Highlight calibration value and input µS/cm form the standard that will be used. Usually 146.9 µS/cm
- Accept calibration once reading has stabilized.
- Record reading and post calibration reading.

# Appendix B: Monitoring Site Set-Up Field Form

| CLARK COUNTY PUBLIC WORKS, CLEAN WATER DIVISION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site Information Form** | | | | | | | | | |
| **Station Name** | | | | **Site Type** Trend or Status | | | | | |
| **Station #** | | | | | | | | | |
| **Date of Site Set Up** | | | | | | | | | |
| **Equipment at Gage** | | | | **Serial Number** | | | | | |
| **Stage probe** | | | | | | | | | |
| **Conductivity probe** | | | | | | | | | |
| **Temperature probe** | | | | | | | | | |
| **Data Logger** | | | | | | | | | |
| **Batteries** | | | | | | | | | |
| **Modem** | | | | | | | | | |
| **Antenna** | | | | | | | | | |
| **Solar Panel** | | | | | | | | | |
| **Solar Panel Controler** | | | | | | | | | |
| **Site Conditon** | | | | | | | | | |
| Date | Stream Reach Type where gage is located | | | | | | | | |
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| **STATION NOTES AND OBSERVATIONS** | | | | | | | | | |
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## Appendix C: Health and Safety Plan

# Health and Safety Plan

### Phone Numbers

Jeff Schnabel, Clark County Clean Water Interim Division Manager

564-397-4583

Scott Gage, Clark County Safety & Health Coordinator (Risk Management)

564-397-1606

Chad Hoxeng, Natural Resource Specialist III

564-397-4018

Bob Hutton, Natural Resource Specialist III

564-397-4868

Marlena Milosevich Natural Resource Specialist III

564-397-4282

Ben Joner, Natural Resource Specialist III

564-397-5874

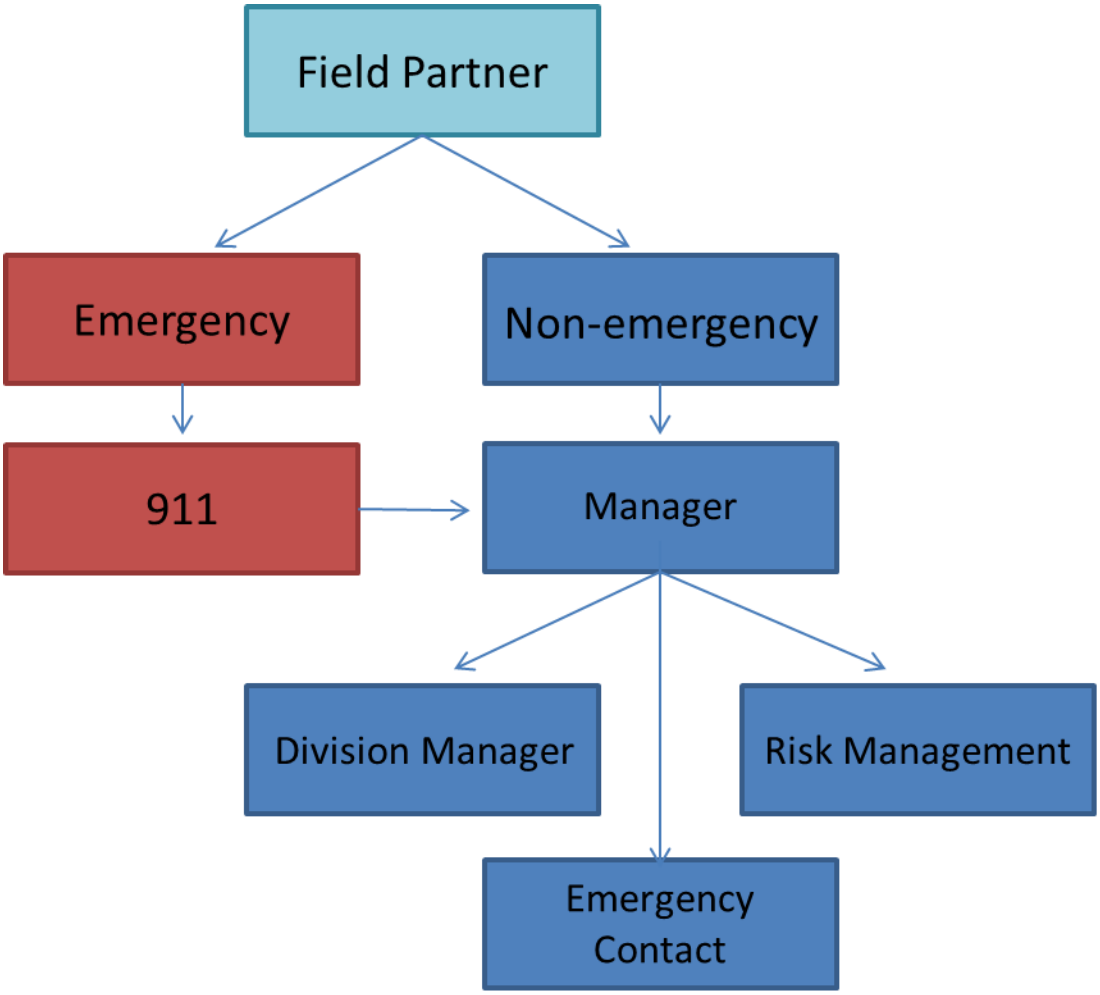
Problems locating someone within Clark County? Call:

564-397-2446 (or just 2446 from a county extension)

Equipment Services Direct Line

564-397-2301

## Communication Tree for Emergency



## Anticipated potential hazards

See appendix: Natural Resource Specialist job Hazard Analysis

Job Hazard Analysis

**Job: Natural Resource Specialist**

**Department: Clean Water Division**

| Task or Step | Hazards | Controls | Personal Protective Equipment (PPE) | Frequency of Task Performed (daily/weekly/monthly) |
|---|---|---|---|---|
| Driving County Vehicle | Road conditions, ice, mud, snow, rain, visibility, fog, etc. | Be cautious, drive defensibly, and according to road conditions. Don't' take unnecessary risks. Emergency lights. Ergonomic assessment. | N/A | Daily |
| | Other motorist | Drive defensibly. Always be alert. Yield right-of-way to other motorists. | N/A | Daily |
| | Obstacles on road | Look way out in front of you and scan the road. Maintain a safe following distance. | N/A | Daily |
| | Vehicle or mechanical failures | Routine PM inspections with follow up repairs, if necessary. | N/A | As needed |
| | Brakes locking up or not working, bad tires, 4x4 not working, lights not working, etc. | Annual inspections – professional mechanics. Conduct pre-trip safety inspection of trailer/truck. | N/A | As needed |
| | Tire blowing out or swerving to miss objects on road. | Don't whip steering wheel, hold steady on wheel. Sometimes it is better to hit obstacle but only if it won't cause damage or injury. | N/A | As needed |
| | | **Hydrology Field Work** | | |
| Water flow measurement | Slips, falls and associated injuries | During low water levels typically one person completes the work.<br>During high level 2 people work together.<br>If the measured water velocity is too high, employees do not enter the water under any circumstance. | Safety lines, life vests, waders, hi-vis vest | Monthly |

| | | | | |
|---|---|---|---|---|
| Steep stream banks | Slips, falls and associated injuries | Some work requires traversing steep stream banks that don't require water entry. It is important to always wear sturdy footwear and have a hand free to steady one's self. | Waders w/ good tread, walking stick as needed, hi-vis vest | Monthly |
| Ladder use | Slips, falls and associated injuries | Some sites require ladder use to access rain gauges. | | Monthly |
| Vehicle traffic as a pedestrian | Struck by vehicle | Walking along the road side with narrow shoulders presents struck by hazards. Employees need to wear a hi-vis vest when walking among traffic and should where possible, walk facing oncoming traffic. | Hi-Vis vest | Daily |
| **Inspections Under High Traffic Conditions** | | | | |
| Toyota site | Struck by vehicle | This site requires measurements taken at the entrance and in the parking lot between cars. The higher risk function is at the entrance. Cones should be placed to increase worker visibility. The employee should plan and take the entrance measurement quickly and during low traffic times.<br>The measurement taken in the parking lot often between parked cars. Employees should use caution as parked cars may leave without warning or that parking space may be pulled into. If the space is empty, use cones at the front of the parking space to prevent parking until the job has been completed and increase worker safety. | Traffic cone, hi-vis vest | Monthly |
| Private facility inspection | Heavy lids, people, pets, insects | Some facilities require two people to safely complete the work.<br>If you are alone on a job, are approached and don't feel safe. Leave the area and return at a different time to complete.<br>Use the magnetic lid pullers on the heavy lids to facilitate lifting and reduce your risk of injury. | Magnetic lid pullers, steel-toed boots, hi-vis vest, traffic cones. | May - August |
| **Bug Sampling** | | | | |
| Walking in creek | Slips, trips, falls and associated injuries, insects, snakes | Samples are collected in riffles and pools and are typically conducted in teams of 2. | Waders, walking stick, bug spray/repellant as needed. | August - September |

| | | | | |
|---|---|---|---|---|
| Temperature logging | Slips, trips, falls and associated injuries, insects, snakes | Employees walk up and down the creek and this typically takes an hour. It is important to always wear sturdy footwear and have a hand free to steady one's self. | Waders or boots, hi-vis vest, walking stick as needed. | June - September |
| **Stream Monitoring** | | | | |
| In-stream sampling | Slips, trips, falls and associated injuries, insects, snakes | Samples are taking by wading through streams using long handled dippers and often short in duration (10-15 minutes). | Waders, knee boots, hi-vis vest | Monthly |
| Vehicle parking and sample testing | Struck by | Samples are tested while standing at the bed of the work truck. The vehicle is often parked along a roadside. | Hi-vis vest, safety glasses | Monthly |
| **Illicit Discharge, Detection and Elimination (IDDE)** | | | | |
| Looking for outfalls and discharge | Pathogen exposure, needle sticks, ergonomic issues, slips, trips, falls and associated injuries, insects, snakes | Looking at various drainage areas, streams and creeks for inappropriate discharge.<br><br>Sampling procedures include aseptic techniques, water jugs, hand sanitizer and soap. | Gloves of varying lengths including nitrile and forearm length kitchen gloves, hi-vis vest, safety glasses, sturdy footwear | Daily: July - August |
| Laboratory | Chemical exposure, cuts from broken glass, chemical splashes to the face and eyes | Employees should understand the buffers and chemicals they use in the lab. An SDS book is kept in the lab and MSDSOnline is available through ClarkNet to learn about what is used. | Gloves, goggles, face shield. | Daily: July - August |
| **General Tasks/Hazards** | | | | |
| Manually moving glass carboys | Back, neck, shoulder sprains and strains, broken glass | 18 liter very fragile carboys are lifted out of vaults. Due to how fragile these are and the lack of handles these are lifted with two hands around the jug neck. It is important to try and lift using the lower body and not the back. Each vault holds 4 of these and must be carried one at a time. | Safety glasses, hi-vis vest | Weekly |
| Office work | Strains & sprains | Take frequent breaks from sitting and from computer to reduce eye strain and muscle fatigue. | Workstation ergo assessment | Daily |
| Needle Sticks, Biohazards, Bodily Fluids | Bloodborne pathogens exposure | Never directly touch a syringe. Always use tongs to place a needle into a sharps container. | Tongs, needle/sharps containers, gloves, safety glasses | Daily |
| Public citizen contact | Confrontation, personal harm | Verbal Judo training. If in danger, disengage with citizen, return to county vehicle and drive away or call 911 if necessary. | Footwear, gloves, reflective gear, hi-vis vest | Daily |

| | | | | |
|---|---|---|---|---|
| Domestic Animals (Dogs) | Bite, scratch, rabies | Dog Bite Prevention Training (Clark County Animal Control) | N/A | Daily |
| Lifting manholes/grates/vault doors, moving heavy objects | Strains and sprains, confined space hazards | Safe lifting techniques, warm up stretch prior to lifting. Training on best methods to lift/lower manual vault doors. Confined Space Awareness training. | Magnetic lifting tool, training on how to lift and lower hydraulic vault doors (OJT), steel toed boots, hi-vis vest. | Daily |
| Insects, snakes | Stings, bites | Training on bee & wasp identification and behaviors as well as exposure symptom identification. | Bug spray/repellant as needed. | Daily |
| Machete use | Lacerations, amputations | Machete use must be trained first. The wrist strap must always be attached. | Safety glasses, sturdy boots | Monthly |

**Required Training**

| | |
|---|---|
| Hazard Communication – OHS-O-161 | Construction Site Safety – OHS-O-53 |
| Office Ergonomics – OHS-O-105 | Eye Wash Stations – Emergency Use – OHS-O-69 |
| Slips, Trips and Falls – OHS-O-66 | Working in Cold Environments – OHS-O-150 |
| Vehicle Use Policy - OHS-O-137 | Working in Hot Outdoor Environments – OHS-O-93 |
| Workplace Violence Prevention Program – OHS-O-68 | Working On, Over, or Adjacent to Water – OHS-O-129 |
| Step Ladder Safety – Ladder Institute – OHS-O-103 | Driving Safety Awareness – OHS-O-139 |
| Personal Protective Equipment – OHS-O-64 | Dog Bite Prevention – OHS-C-33 |
| On Track Safety Roadway Worker Initial – OHS-C-139 | Bloodborne Pathogens – OHS-O-51 |
| On Track Safety Roadway Worker Annual Refresher – OHS-O-148 | Machete Safety – OHS-O-123 |
| Confined Space Awareness – OHS-O-52 | |

# Appendix D: Monitoring Site Field Form

| CLARK COUNTY PUBLIC WORKS, CLEAN WATER DIVISION | | | | |
|---|---|---|---|---|
| **Station Name** | | | | |
| **Station #** | | **Staff** | | **Crest Gage (ft)** |
| **Date** | | **Site Type** Trend or Status | | **CSG** |
| **Gage operating** Yes No | | **Stage recorder Type** | | **Stick** |
| **Data download** Yes No | | **Conductivity Type** | | **G.H.** |
| **Battery Voltage** | | | | |
| **Watch time** | **EDL time** | **Stage** | **Conductivity/Temp** | |
| | | | | |
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**GAGE READINGS**

| | **Stage (ft)** | | | | **Water Temp (°C)** | **Air Temp (°C)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Time | Offset (pre) | Offset (post) | Staff | EDL/U20 | EDL | EDL | | | |
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**CONDUCTIVITY AND TEMPERATURE READINGS**

| **Initial Readings** | | | | | **After Cleaning Readings** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Conductivity** | | **Temperature °C** | | | **Conductivity** | | **Temperature (°C)** | |
| Time | METER | EDL/U24 | METER | EDL/U24 | Time | METER | EDL/U24 | METER | EDL/U24 |
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**STATION NOTES AND OBSERVATIONS**

Entered by: