# Quality Assurance Project Plan

Shoreline Restoration Monitoring in Puget Sound

Grant Number PC-00J907-01

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## Publication Information

This project has been funded wholly or in part by the United States Environmental Protection Agency (EPA) National Estuary Program (NEP) under an assistance agreement to the Washington State Department of Fish and Wildlife (WDFW).

EPA requires a Quality Assurance Project Plan (QAPP) for studies, such as this one, that generate environmental data. This QAPP describes monitoring of conditions associated with shoreline restoration located in Puget Sound. However, the contents of the QAPP do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Copies of this QAPP and final project publications will be available from Phillip Dionne: (phillip.dionne@dfw.wa.gov).

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# 1.0 Title Page, Table of Contents, and Distribution List

# Quality Assurance Project Plan

## Shoreline Restoration Monitoring in Puget Sound
## Grant Number PC-00J907-01

May 2015

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## 2.0 Abstract

The goal of this project is to develop and implement the first phase of what ideally will become a two phase study to monitor and assess the effects of shoreline restoration projects. The first phase, which is the focus of this project, will entail identifying potential monitoring areas, building research partnerships with collaborators, developing survey protocols and plans, implementing survey plans, assessing the near-term response of shoreline habitat to restoration efforts, and setting the stage for long-term monitoring. As funds continue, restoration sites can be resurveyed, perhaps several times over 2 to 10 years post-restoration, to describe the long-term effects of restoration as the second phase of the study.

We will capitalize on opportunities to monitor restoration projects that have already procured funding and are likely to be implemented soon. The Washington Department of Fish and Wildlife (WDFW) will act as the project lead, and will coordinate with restoration project sponsors, researchers from NGOs, universities, and state, local, and tribal governments to develop and implement monitoring plans and complete analysis. When practical, we will use existing methods and techniques for monitoring and analysis, and common metrics will be measured among monitoring sites. Coordinating survey methods and data analyses will facilitate meaningful comparisons among sites and through time.

The data collected by this project will lead to a better understanding of the effects of shoreline restoration and build a foundation for further investigation. This information will provide managers and planners with evidence on which to base restoration planning and funding decisions, and will help regulatory agencies assess the impacts of armoring and armor removal.

# 3.0 Background

## 3.1 Study area and surroundings

This project will monitor shoreline restoration projects in the coastal areas of Puget Sound in Washington State. Puget Sound is situated in a tectonically active region between the Cascade Mountains to the east and the Olympic Mountains to the west. Puget Sound itself is a series of fjords, or deep ice carved channels, that were carved out during the glaciation of the region. The beaches of Puget Sound are generally narrow, backed by coastal bluffs on the landward side, and terminating at the steep wall of the trough on the seaward side. Landslides and coastal streams are important sources of sediment to Puget Sound beaches. The rates of erosion associated with streams and landslides can be influenced by both natural and anthropogenic factors, and in most cases the beaches of Puget Sound are affected by a complex mix of factors resulting in variety of beach conditions.

### 3.1.1 Logistical problems

Logistical challenges that we will need to address over the course of this project include scheduling field work during appropriate tides and weather conditions, identifying and obtaining access to suitable monitoring sites, scheduling field work around restoration work schedules, and transporting staff and equipment to and from monitoring sites.

### 3.1.2 History of study area

This project will monitor shoreline restoration projects in the coastal areas of Puget Sound in Washington State. The restoration activity that we will focus on is the removal of man-made shoreline armoring from the nearshore. Shoreline armoring is generally employed as a means to stop and prevent wave induced erosion of the backshore, but in some cases is also a means to protect fill that has been introduced into the nearshore to extend the backshore further seaward. Shoreline armoring is known to have both direct and indirect long term impacts on nearshore processes and the nearshore environment and habitat. Such impacts include, but are not limited to exclusion of forage fish from spawning habitat, changes to wave energy, sediment supply and transport, and disruption of links between the terrestrial and marine environment. Often times the effects of armoring are coupled with other nearshore activities commonly associated with armoring such as removal of nearshore riparian vegetation, and the addition of impervious surfaces. The restoration projects that we will monitor will remove shoreline armoring along with a variety of other restoration actions in an attempt to reverse some of these impacts.

### 3.1.3 Contaminants of concern

Not applicable. This project will not be sampling or monitoring contaminants.

### 3.1.4 Results of previous studies

A study by Heerhartz et al. (2013) documented the impacts, in Puget Sound, shoreline armoring can have on the connectivity between marine and terrestrial environments. In this study, Heerhartz documented a reduction in wrack material and logs on beaches with armoring when compared to unarmored beaches. A most recent broader scale study by Dethier et al. (2016) confirmed these findings concluding that parameters reduced by armoring included width, beach shade, and log and wrack accumulation. A case study of shoreline restoration by Toft et al. (2013) showed an increase of feeding juvenile salmonids at restored/enhanced urban shorelines relative to un-restored urban shorelines. A case study by Rice (2006) showed higher mortality of surf smelt embryos deposited on an armored beach verses an unarmored beach. A study by Romanuk and Levings (2006) found that some nearshore fish species may be impacted by the loss of nearshore riparian vegetation. There have been a variety of studies of the impacts of armoring on sandy beaches; a statement by Fletcher et al. (1997) from their study of beach loss in Hawai'i succinctly expresses one of the potential effects of armoring: "*We conclude from this study that using a wall or revetment to fix the position of a shoreline undergoing retreat will cause the narrowing and eventual loss of the adjoining beach.*"

### 3.1.5 Regulatory criteria or standards

Not applicable. This study will not to determine compliance with regulatory standards or criteria.

# 4.0 Project Description

## 4.1 Project goals

The goal of this project is to develop and implement the first phase of what ideally will become a two phase study to monitor and assess the effects of shoreline restoration projects. The first phase, which is the focus of this project, will entail:

- Identifying potential monitoring areas
- Building research partnerships with collaborators
- Developing survey protocols and plans
- Implementing survey plans
- Assessing the near-term response of shoreline habitat to restoration efforts
- Setting the stage for long-term monitoring

## 4.2 Project objectives

The objectives of this project are:

- Coordinate with restoration practitioners and monitoring partners to identify standard metrics and methods of data collection and storage.
- Collect or acquire pre-restoration data on 10 armored beach sites around Puget Sound and/or the Strait of Juan de Fuca.
- Collect or acquire post-restoration data on 10 armored beach sites around Puget Sound and/or the Strait of Juan de Fuca.
- Complete descriptive data analyses of the near term effects of shoreline restoration on armored beaches.

## 4.3 Information needed and sources

Landscape scale attributes, such as location of a site on the shoreline and within a drift cell will be obtained from existing GIS datasets available through WDFW and Washington Department of Ecology (Ecology).

Some projects under consideration have already collected restoration monitoring data. If this data is of interest to this project, we will work with the associated project managers to access and utilize this data.

## 4.4 Target population

Shoreline restoration projects in Puget Sound that include removal of shoreline armoring as a restoration activity.

## 4.5 Study boundaries

The sites selected for monitoring will be on the marine shorelines of Puget Sound and the Strait of Juan de Fuca in Washington State.

## 4.6 Tasks required

Project Tasks:

- Identify restoration projects that are suitable for this study
- Contact and coordinate with restoration project managers
- Develop and implement a monitoring plan
- Develop and maintain contracts with research partners if necessary
- Collect data, and provide training for data collection
- Analyze samples, and provide training for sample analysis
- Record, store and analyze data

## 4.7 Practical constraints

Practical constraints include:

- Restoration project schedules and monitoring timeline
- Weather and tide conditions
- Equipment availability and functionality
- Staff availability

## 4.8 Systematic planning process

This QAPP serves as the primary planning process.

# 5.0 Organization and Schedule

## 5.1 Key individuals and their responsibilities

Primary Investigator: Dr. Timothy Quinn

Author/Project Manager: Phillip Dionne will act as the primary contact for coordinating monitoring activities. He will coordinate contract activities between WDFW and restoration monitoring partners and coordinate the exchange of information between WDFW and partners. Mr. Dionne will provide support during the planning and analysis of field investigation.

NEP Quality Coordinator: Tom Gries will review the draft QAPP and recommend it be approved when it satisfies EPA quality requirements and guidance. He may audit the project while in progress. He will also review and provide comments on the draft project report.

Ecology Quality Assurance Officer: William Kammin will approve the QAPP.

Field/Lab Staff: Field/Lab sampling and analysis will be completed by WDFW technicians and/or restoration project staff. Staff will utilize established SOP's and be trained by experienced personnel to prepare for field activities and to ensure that required QC procedures are followed for sampling and analysis.

## 5.2 Special training and certifications

All staff will be experienced or trained to be competent using the following equipment to enable sampling and analysis:

- Rotary laser and stadia rod
- Measuring tape
- GPS
- Quadrat
- Dissecting microscope
- Ro-Tap sieve shaker
- Scale
- Tide chart
- Densitometer

Staff will be experienced or trained to be competent conducting the following assessments:

- Beach profiles
- Sediment composition
- Log line assessment
- Wrack line assessment
- Riparian cover
- Forage fish spawn

## 5.3 Organization chart

The project manager will report to the principle investigator. Project staff will report to the project manager. The project manager and project staff will coordinate with project partners.

## 5.4 Project schedule

The project schedule will depend on the schedules of the restoration projects to be monitored. The first round of pre-restoration surveys for scheduled sites will be completed during the summer of 2015. As new projects come to light, additional pre-restoration surveys will be completed during the summer of 2016. In both regards, restoration project schedules may dictate that pre-restoration surveys are completed earlier than the summer. Similarly, post-restoration surveys would ideally be completed during the summer after at least one winter season has passed since the completion of restoration activities, but due to project timelines, these surveys will need to be completed by summer of 2017.

## 5.5 Limitations on schedule

Most monitoring activities will occur during the summer when low tides are lowest during the day, the time between sun rise and sun set is greater, and the weather is generally less of a concern. However, restoration project schedules may dictate that some work be conducted outside the summer months.

## 5.6 Budget and funding

This project is funded entirely through the Puget Sound Marine and Nearshore Grant Program. In addition to the costs below, equipment and staff time will be provided by WDFW.

Table 1: Project Budget

| **Budget Item** | **Estimates Costs** |
|---|---|
| Personnel | $72,805 |
| Fringe Benefits | $25,482 |
| Travel | $10,000 |
| Equipment (anything over $5,000) | $5,000 |
| Supplies | $3,500 |
| Contractual | $17,500 |
| Other | $2,000 |
| Indirect/Overhead | $35,108 |
| *Total* | *$171,395* |

# 6.0 Quality Objectives

## 6.1 Decision Quality Objectives (DQOs)

Not applicable. It is not the objective of this project to select between conditions or determine compliance with standards.

## 6.2 Measurement Quality Objectives

Table 2: Measurement Quality Objectives

| Parameter | Verification Standards (LCS,CRM,CCV) | Duplicate Samples | Matrix Spikes | Matrix Spike-Duplicates | Surrogate Standards | Lowest Measurements of Interest |
|---|---|---|---|---|---|---|
| | % Recovery Limits | Difference | % Recovery Limits | Relative Percent Difference (RPD) | % Recovery Limits | Units of Measurement |
| Beach profile (elevation) | NA | ±0.25m | NA | NA | NA | 0.1m |
| Location (horizontal) | NA | ±0.25m | NA | NA | NA | 0.1m |
| Log line (width) | NA | ±0.25m | NA | NA | NA | 0.25m |
| Wrack line (% cover) | NA | ±10% | NA | NA | NA | 4% |
| Riparian cover (waterward extent) | NA | ±1m | NA | NA | NA | 1m |
| Forage fish (relative abundance) | NA | ±10% | NA | NA | NA | 2eggs |
| Sediment (grain size) | NA | ±10% | NA | NA | NA | 0.1g |

### 6.2.2 Targets for Comparability, Representativeness, and Completeness

#### 6.2.2.1 Comparability

This study will use measurements collected at various times to assess changes at project sites over time and in response to restoration activities. All methods of data collection will need to be

comparable in terms of data accuracy and also show less potential error than the range of natural variability at sites. Change will be assessed by comparing conditions before and after construction at each project site, so the precision of data collection is of greater value than accuracy. Data collection criteria grew from established methods employed by other studies and recommended for use in nearshore areas.

#### 6.2.2.2 Representativeness

Natural variability in beach characteristics is high and subject to frequent changes. To ensure that samples are representative of existing conditions, multiple samples will be collected along a transect during each survey. Pre and post restoration surveys will be completed during the summer to reduce natural variability associated with storm cycles.

#### 6.2.2.3 Completeness

This study will establish baseline and near-term post restoration conditions at beach restoration sites so that changes or trends in conditions can be monitored over time. This will involve at least one pre and one post restoration survey and collection of various samples and measurements from at least 10 project sites. Incomplete samples may diminish our ability to detect and document changes and trends.

# 7.0 Sampling Process Design (Experimental Design)

## 7.1 Study Design

### 7.1.1 Field measurements

The following field measurements will be collected at each monitoring site:

- Beach profiles (change in elevation relative to fixed elevation)
- Log line (width and numbers of logs at transect points)
- Wrack cover (composition and percent cover of wrack line at transect points)
- Riparian cover (waterward extent of overhanging vegetation at profiles)

The following samples will be collected at each monitoring site and processed in the lab:

- Sediment composition (percent grain size class by weight)
- Forage fish spawn (relative abundance of Surf Smelt and Sand Lance eggs)

### 7.1.2 Sampling location and frequency

Field surveys will be conducted at each restoration monitoring beach once before and once after the restoration is completed (Figure 1). Potential survey sites include the following restoration projects: Brown Island, Family Tides Farm, Shannon Point, Bowman Bay, Fort Townsend, Howarth Park, Seahorse Siesta, Burfoot Park, Waterman, Dawley, Maylor's Point, Titlow Park and Edgewater.

### 7.1.3 Parameters to be determined

This study will establish baseline and near-term post restoration conditions at beach restoration site so that changes or trends in conditions can be monitored over time. Estimates will be based on field surveys and lab analysis. Change or trends will be assessed in future studies by comparing baseline and near-term post restoration conditions with measurements collected in subsequent years. Parameter estimates derived from beach surveys and lab processing will include:

- Beach width
- Beach slope
- Relative encroachment of armor
- Sediment grain size distribution
- Average percent cover of wrack
- Average percent cover of log line
- Average waterward extent of overhanging vegetation
- Average forage fish egg density

## 7.2 Map of study area

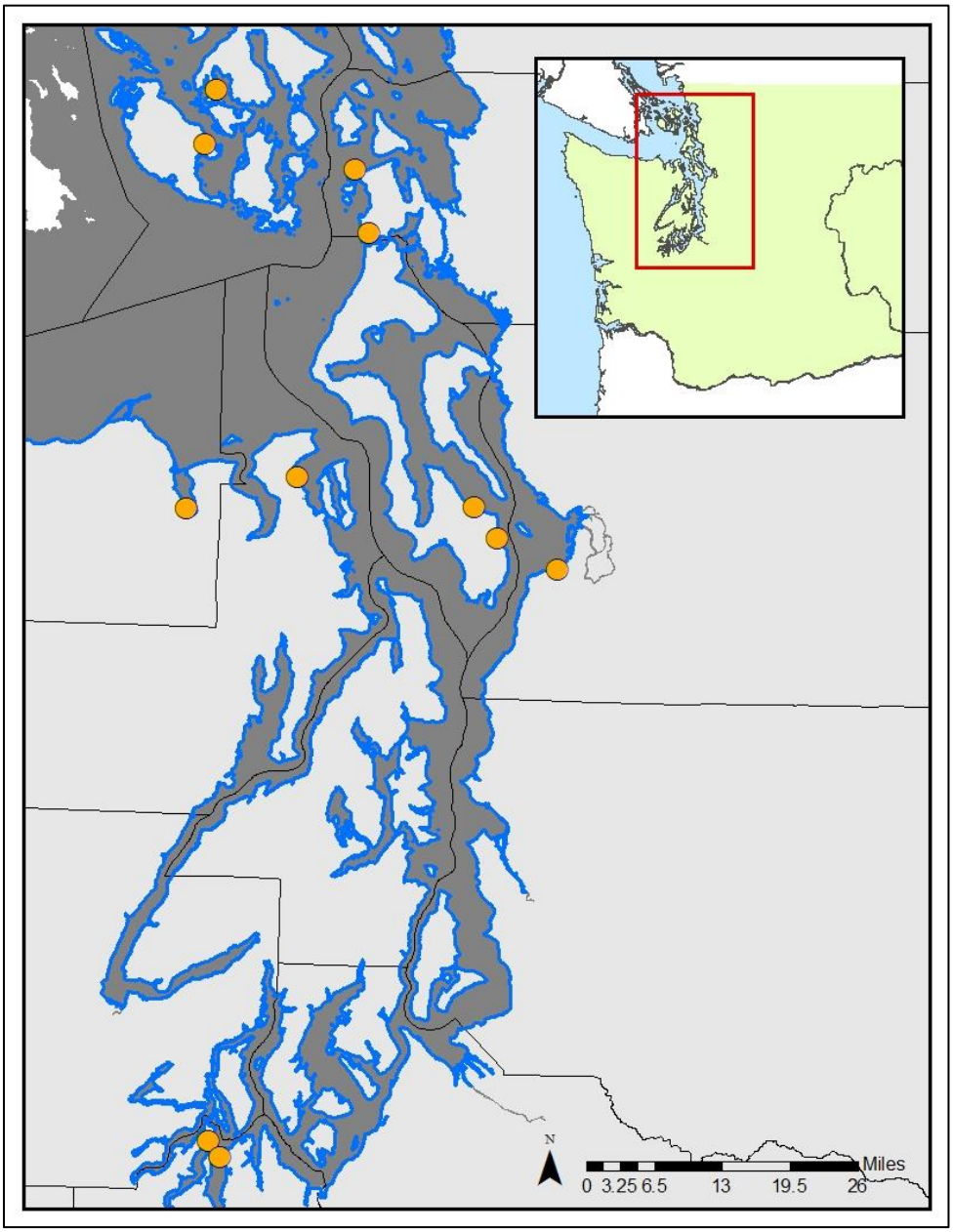


Figure 1: Map of Puget Sound shoreline highlighted in blue with potential project sites marked in orange.

## 7.3 Assumptions underlying design

Beaches are naturally dynamic systems that vary in time and space. This natural variability poses a challenge when attempting to detect differences between beaches related to a modification such

as the removal of shoreline armoring. Our study design is influenced by the assumption that hard armoring structures built within the intertidal zone of Puget Sound beaches are likely to impact the habitat characteristics of the adjoining beach, and that the removal of such a structure will also impact habitat characteristics. We assume we will detect the immediate physical changes that result from restoration activities and that over time (two to ten years) there will be detectable changes in site conditions.

## 7.4 Relation to objectives and site characteristics

Our objectives are related to monitoring beaches where restoration efforts include addressing potential impacts of shoreline armoring; sites have been selected based on these criteria.

## 7.5 Characteristics of existing data

Existing data relative to the monitoring of shoreline restoration is generally restricted to surveys completed shortly before the restoration, and immediately after the restoration at a single beach. Our study will compile similar data, but across multiple projects during a similar timeframe using standardized methods across sites. This approach will provide the foundation for future research and allow for simpler comparison of observations across multiple project sites.

# 8.0 Sampling Procedures

## 8.1 Field measurement and field sampling SOPs

We have adapted SOPs for assessing beach profiles, log lines, wrack lines, riparian cover, forage fish spawn, and sediment composition from SOPs that have been developed and used for similar studies in the region and are designed to be simple to follow so that they can be consistently used at different times and locations by different groups. The sampling SOPs for beach profiles, log line, and wrack cover are based on the Shoreline Monitoring Toolbox that is coordinated with the Puget Sound Ecosystem Monitoring Program's (PSEMP) Nearshore Work Group. Links to these SOPs are available at https://sites.google.com/a/uw.edu/toolbox/protocols. The SOP for forage fish surveys are based on the approved WDFW sampling methods available at http://wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/. The SOP for sediment collection was developed based on work by Church et al. (1987) and sediment sample analysis was adapted from U.S. Geological Survey Open-File Report 00-358, Chapter 1: Grain-Size Analysis Of Marine Sediments: Methodology And Data Processing (http://pubs.usgs.gov/of/2000/of00-358/text/chapter1.htm). The riparian cover SOP is adapted from Strickler (1959). An outline of the SOPs is provided in appendix A.

## 8.2 Containers, preservation methods, holding times

Table 3: Sample container and preservation requirements

| Parameter | Matrix | Minimum Quantity Required | Container | Preservative | Holding Time |
|---|---|---|---|---|---|
| Forage fish (relative abundance) | Sediment | 355 ml | Plastic jar | Stockard's solution | 12+ months |
| Sediment (grain size) | Sediment | 355 ml | Plastic bag or bucket | NA | 12+ months |

## 8.3 Invasive species evaluation

Our survey sites will not be located at any of the areas described by Ecology as regions of extreme concern (http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html).

## 8.4 Equipment decontamination

Not applicable. This project does not intend to collect toxic samples.

## 8.5 Sample ID

Samples will be identified by the sample type, collection location, collection date, and the number of the sample collected in series. The sample ID information will be recorded on the appropriate data sheet as well as a corresponding tag that will be attached to the sample.

## 8.6 Chain-of-custody, if required

Not applicable. It is not the objective of this project to collect environmental samples for regulatory purposes.

## 8.7 Field log requirements

We will utilize data sheets designed specifically for the data being collected in the field. In addition to recording field measurement results, data sheets will include the date, time, location, and ID of each sample; the field personnel completing and recording the measurements; and will provide room for comments or notes about the sample. Data sheets will be printed on waterproof paper, and data will be recorded in pencil to avoid smearing or bleeding of notes (see Appendix A).

## 8.8 Other activities

Field staff that are not familiar with sampling SOP's will be briefed and given the opportunity to practice and demonstrate competence with the various methods.

All measurement tools and monitoring equipment will be maintained in good working order. Forage fish sampling gear will be rinsed between sites to minimize the possibility of cross site contamination.

# 9.0 Measurement Methods

## 9.1 Field procedures table

Table 4: Field procedures

| Parameter | Sample Matrix | Samples [Number/ Arrival Date] | Expected Range of Results | Reporting Limit | Sample Prep Method | Analytical (Instrumental) Method |
|---|---|---|---|---|---|---|
| Beach profile (elevation) | NA | 3 | NA | 0.01m | NA | RTK-GPS, Rotary laser, stadia rod, and measure tape |
| Location (horizontal) | NA | 3 | NA | 0.01m | | RTK-GPS, measure tape |
| Log line (width) | NA | 5 | 0m-20m | 0.1m | NA | Measure tape |
| Wrack line (% cover) | NA | 5 | 0%-100% | 1% | NA | $0.1m^2$ quadrat |
| Riparian cover (waterward extent) | NA | 3 | 0m-20m | 0.1m | NA | Measure tape and vertical densitometer |

## 9.2 Lab procedures table

Table 5: Lab procedures

| Parameter | Sample Matrix | Samples [Number/ Arrival Date] | Expected Range of Results | Reporting Limit | Sample Prep Method | Analytical (Instrumental) Method |
|---|---|---|---|---|---|---|
| Forage fish (relative abundance) | Sediment | 1 | 0-100 eggs/gram | NA | Sieve and winnow | Scale and microscope |
| Sediment (grain size) | Sediment | 1 | 0%-100% | NA | Sieve | Sieves and scale |

## 9.3 Sample preparation method(s)

Sediment: Sediment will be air dried for several days or oven dried overnight (70°C to 95°C) prior to sieving. Sieved samples will be weighed by half phi size class ($4^{\phi}$ to $-4^{\phi}$) to the nearest 0.1 gram.

Forage fish: Sediment will be wet sieved to reduce the sample to only material between 0.5mm and 2.0mm. The 0.5mm to 2.0mm sized material will be mechanically winnowed to extract the lightest material (material most likely to contain eggs). This light fraction will be preserved in Stockard's solution until analyzed.

## 9.4 Special method requirements

Not applicable. Lab processing and analysis will be completed in house.

## 9.5 Lab(s) accredited for method(s)

Not applicable. It is not the objective of this project to collect environmental samples that require analysis by accredited labs.

# 10.0 Quality Control (QC) Procedures

## 10.1 Table of field and lab QC required

Table 6: Quality control procedures

| Parameter | Field | | Laboratory | | | |
|---|---|---|---|---|---|---|
| | Blanks | Replicates | Check Standards | Method Blanks | Analytical Duplicates | Matrix Spikes |
| Beach profile (elevation) | NA | 3 per season | NA | NA | NA | NA |
| Log line (width) | NA | 3 per season | NA | NA | NA | NA |
| Wrack line (% cover) | NA | 3 per season | NA | NA | NA | NA |
| Riparian cover waterward extent) | NA | 3 per season | NA | NA | NA | NA |
| Forage fish (relative abundance) | NA | NA | NA | NA | 3 per season | NA |
| Sediment (grain size) | NA | NA | NA | NA | 3 per season | NA |

## 10.2 Corrective action processes

Before leaving each study site, field sheets and samples will be reviewed in ensure all relevant data is collected and/or accounted for. This project will be managed to allow for adjustment to sampling protocols as needed to achieve the project objectives.

# 11.0 Data Management Procedures

## 11.1 Data recording/reporting requirements

Data will be recorded in the field on Rite in the Rain data sheets and entered into digital records using Microsoft Access and Excel. Data will be visually inspected and compared with data sheets after entry to identify data entry errors.

## 11.2 Lab data package requirements

Not applicable. It is not the objective of this project to collect environmental samples that require analysis by accredited labs.

## 11.3 Electronic transfer requirements

To limit issues with data reentry, data transferred electronically will be requested or provided in Microsoft Excel, Access, or text formats.

## 11.4 Acceptance criteria for existing data

Existing data that are comparable to data collected for this study may be considered for use. If such data exist for a chosen restoration site, they will be reviewed for representativeness, comparability, and other indicators of data quality before used for analysis.

# 12.0 Audits and Reports

## 12.1 Number, frequency, type, and schedule of audits

Not applicable. Beyond biannual check-ins with the lead organization grant coordinator and project partners, there are no audits planned for this project.

## 12.2 Responsible personnel

Not applicable.

## 12.3 Frequency and distribution of report

WDFW and its project partners will prepare a final report by July of 2017. A draft of the final report will be provided for comment to the NEP Quality Coordinator in May of 2017.
The final report will include the following elements:

- Abstract/ executive summary
- Introduction
- Methods
- Results
- Discussion

## 12.4 Responsibility for reports

WDFW and its project partners will prepare a final report by July of 2017.

# 13.0 Data Verification

## 13.1 Field data verification, requirements, and responsibilities

Results of quality control samples will be compared with their respective samples to assess whether quality assurance criteria have been met.

## 13.2 Lab data verification

Lab data will be reviewed for missing and unusual (outlier) values. Results of quality control samples will be compared with their respective samples to assess whether measurement quality objectives have been met.

## 13.3 Validation requirements, if necessary

Not applicable. Independent data validation will not be completed for this project.

# 14.0 Data Quality (Usability) Assessment

## 14.1 Process for determining whether project objectives have been met

If some or all of the data have not met measurement quality objectives, we will decide if the data are usable or if we should reject the data.

## 14.2 Data analysis and presentation methods

While the data generated by this study is intended to be used in analysis to detect trends and relationships in the data, the expected time frame for observable changes is greater than the duration of the project, so this analysis will not likely occur until further investigations are completed. Summary of surveyed conditions before and after the restoration activities will be compiled for each survey site.

## 14.3 Treatment of non-detects

The forage fish spawn samples in this project will assess the detection and relative abundance of eggs in a sample. A non-detect result can have two explanations; either eggs were not present and therefore were not detected, or eggs were present but failed to be detected. It is likely that non-detect results is related to low density of eggs at the site and analysis of forage fish spawn will treat non-detect results as absence for that sample.

## 14.4 Sampling design evaluation

This project will be managed to allow for adjustment to sampling protocols as needed to achieve the project objectives. We will assess whether project objects were met to assess the effectiveness of the sample design.

## 14.5 Documentation of assessment

Documentation of assessment will occur in the final report.

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# 16.0 Figures



# 17.0 Tables

# 18.0 Appendices

## Appendix A. Shoreline Restoration Monitoring SOPs

1. Shoreline Restoration Monitoring SOPs
    A. Field Surveys
        i. Establish site sampling outline. Run a 50m transect tape parallel to shoreline along upper extent of beach. Run a measure tape perpendicular to shoreline for each beach profile, and record where the profile crosses the 50m transect.
        ii. Locate or create and document a local bench mark or control point such as a large boulder, corner of a foundation, rebar stake, etc. that is not likely to move or be affected by the construction activity. Mark, photograph, and record the GPS location and elevation of the bench mark using a Trimble Geo XH 6000 Centimeter Edition GPS.
        iii. Set up the rotary laser level in a location with a clear line of sight to your benchmark as well as your survey area. Determine your instrument height relative to your bench mark using the rotary laser level and stadia rod.
    B. Beach Profile:
        i. Using the tape measures as a guide, use the Trimble RTK GPS and/or laser level and stadia rod to record the elevation and tape distance every two meters or at every change in topography or feature such as OHW, the toe of bluff or toe of armor, upper and lower extent of wrack line(s), upper and lower extent of log line, center of potential forage fish spawning substrate, and obvious changes in beach profile (slope) or grain sizes (e.g., cobble-sand transition that often occurs near MLW).
    C. Sediment Grain Sizes:
        i. At MHW collect a bulk sample of sediment to the depth of the largest mobile grain size observed (generally less than 64 mm). The sample size should be equal to about 100x the weight of the largest grain as measured along the y-axis (Church et al. 1987). Bulk samples will be collected in one to three 2 gallon buckets depending on the grain size and wave dominant wave energy on the beach. Quantitative grain size analysis in the laboratory involves sieving dry sediments through a stack of progressively finer sieves ranging from 4 phi to -4 phi in half phi increments, and weighing the amount retained in each sieve (See Dry Sieve SOP below).
    D. Riparian Cover
        i. At each profile, characterize canopy cover using densitometer. Beginning at toe of bank, follow profile tape and record coverage (yes/no) and vegetation type at every tape meter until riparian coverage is no longer present.
    E. Wood and Wrack:
        i. Generate 10 random points along the 50m transect.
        ii. Wrack surveys: At each of the random points along the transect line, measure to the upper and lower extent of the wrack line from toe of bluff/armor. At each location, taking measurements from the center of the wrack whenever possible,

use a 0.1 $m^2$ quadrat to record the percent cover occupied by wrack at each location.

iii. Log surveys: At every other random point along the transect line (5 points total), measure to upper and lower extent of the log line from toe of bluff/armor. Count the number of marine-derived logs intersecting the extent measurement line. Record the number of large (> 2 m length) and small (< 2 m length) logs, and count that are: in contact with the sediment, show human use, and/or support plant growth.

iv. Count the number of terrestrial-derived logs fallen from the bluff along the entire 50m transect and record the general orientation of logs relative to shore as parallel or perpendicular.

F. Forage Fish spawn: (*reference Moulton and Penttila (2001) for details*)

i. At the each site identify the band of substrate near the likely center of spawning activity (Moulton and Penttila (2001)). Following the methods described in Moulton and Moulton and Penttila (2001), collect several scoops of the top several cm of sediment at four points along this band at intervals of about 10 m. The volume of sediment collected at each point should be similar, and the final volume of the sample should fill an 8" x 24" plastic bag ½ to 2/3 of the way full. Label each sample with its location and date. Store samples in a cool place for up to 48 hours until they are either processed or preserved in Stockard's solution.

ii. Upon returning to the lab, weigh, then sieve and winnow the samples as described by Moulton and Penttila (2001).

iii. Identify, count, and record numbers of live and dead eggs observed using Moulton and Penttila (2001) methods.

**Dry Sieve SOP:** (Adapted from: Coarse Fraction Analysis (Gravel Plus Sand); http://pubs.usgs.gov/of/2000/of00-358/text/chapter1.htm)

First ensure that the sediment to be sieved is dry so that particles do not stick together. Drying can be done in a low temperature oven ($70^0$C-$95^0$C, overnight is usually sufficient) or by spreading the sediment over a tray in a low humidity environment for several days (do not use a fan or place the sediment in an area where fine sediments could be blown away).

1.) Record the weight of the dried sediment to be sieved (large samples may need to be sieved in batches).
2.) Stack the 12" diameter bank of pebble sieves (-1$\phi$ to -4$\phi$) in order with the smallest mesh at the bottom and place the sieve bank on the catch pan (bucket).
3.) Add the sediment to the top sieve, cover and secure the bank of sieves with the cover and catch pan.
4.) Manually shake the bank of sieves for a minimum of 10 minutes.
5.) Remove, measure and weigh sediment retained in the -4$\phi$ sieve.
6.) Record the total weight of the sediment retained in each sieve.
7.) Remove the sediment from the bottom pan and retain for sieving with sand sieves.
8.) Prepare the 8" diameter bank of sand sieves (4$\phi$ to -1$\phi$) by stacking them in order with the smallest mesh at the bottom and place the sieve bank on the catch pan.
9.) Add the sediment retained in the bottom pan of the pebble sieves to the top sand sieve, cover and secure the bank of sieves with the cover and bottom pan in the sieve shaker(large samples, >40grams, should be sieved in batches).

10.) Shake the bank of sieves for a minimum of 10 minutes.
11.) Record the total weight of the sediment retained in each sieve and the catch pan.
12.) Calculate the relative percentages of the fraction in each of the 0.5 phi classes.

Notes for sieve maintenance:
Sieves should be kept clean and dry at all times. To clean, brush the mesh using a nylon bristle brush such as a toothbrush for fine mesh sieves or a fine wire brush for coarse sieves (> 2mm). The sieve openings should be brushed from the underside only with a gentle circular motion.
Do not attempt to remove particles lodged in the sieve with a sharp object or by striking the mesh. You may attempt to dislodge particles by inverting the sieve and tapping it against a table top.

Figure A-1: Example of beach profile data sheet.

County_____ Location_____ **Transect Elevation Survey** Date/Time_____

LAT/LONG_____ Samplers_____

| Profile ID | TD | FS | BS | Comment/Feature | Profile ID | TD | FS | BS | Comment/Feature |
|---|---|---|---|---|---|---|---|---|---|
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*note in comment/feature: toe of bank (TOB) or toe of armor (TOA), HAT, OHWM, MHHW, MHW, landward (LW) and waterward (WW) wrack edge, LW and WW edge of log line, substrate changes (coarse to fine, etc.), last high tide, forage fish (FF) sample #, MLW, water line elevation @ time,*

Figure A-2: Example of forage fish sample collction data sheet.

**Forage Fish Spawning Beach Survey** (see back for codes)

| Month | Day | Year |
|---|---|---|
| | | |
| Camera ID: | | |

| Last High Tide |
|---|
| Time (24-hr): |
| Elevation: |

| 2nd Effective High Tide |
|---|
| Time (24-hr): |
| Elevation: |

| Location: |
|---|
| |

| County: |
|---|
| |

Page ___ of ___

| | Beach Station # | Time (24-hr) | Latitude (decimal degrees) | Longitude (decimal degrees) | Beach | Uplands | Width | Length | Sample # | Landmark | Sample Zone | Tidal Elevation | Shading | Sample Type | Smelt | Sand lance | Rock sole | Photo # | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
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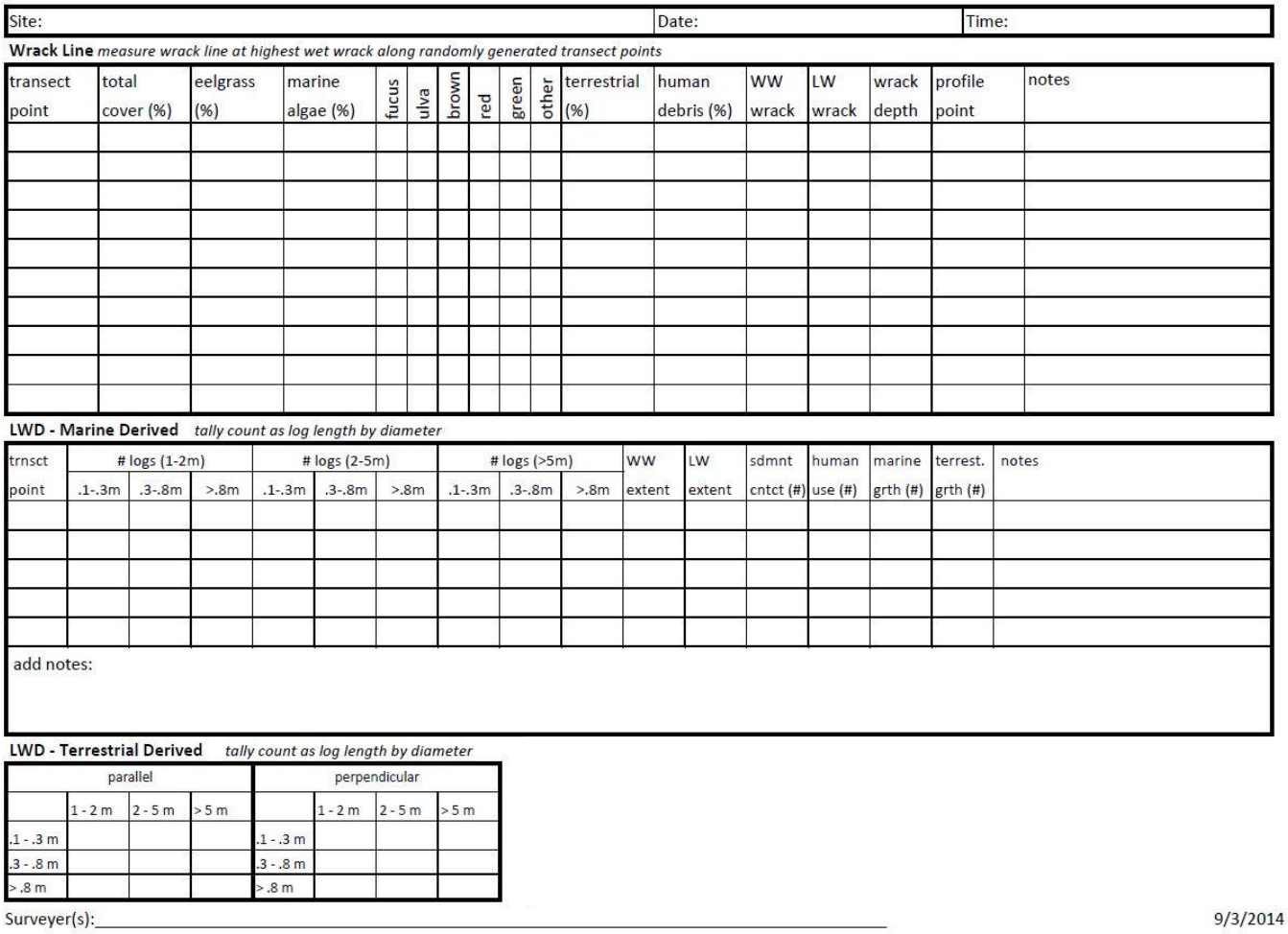
| 14 | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | |

**Samplers:** **Organization:**_____

(*print names here, sign back*)_____ Reviewer:_____

Figure A-3: Example of wrack and log line survey data sheet.



| Site: | Date: | Time: |
|---|---|---|

**Wrack Line** *measure wrack line at highest wet wrack along randomly generated transect points*

| transect point | total cover (%) | eelgrass (%) | marine algae (%) | fucus | ulva | brown | red | green | other | terrestrial (%) | human debris (%) | WW wrack | LW wrack | wrack depth | profile point | notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**LWD - Marine Derived** *tally count as log length by diameter*

| trnsct | # logs (1-2m) | | | # logs (2-5m) | | | # logs (>5m) | | | WW | LW | sdmnt | human | marine | terrest. | notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| point | .1-.3m | .3-.8m | >.8m | .1-.3m | .3-.8m | >.8m | .1-.3m | .3-.8m | >.8m | extent | extent | cntct (#) | use (#) | grth (#) | grth (#) | |
| | | | | | | | | | | | | | | | | |
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add notes:

**LWD - Terrestrial Derived** *tally count as log length by diameter*

| | parallel | | | | perpendicular | | |
|---|---|---|---|---|---|---|---|
| | 1 - 2 m | 2 - 5 m | > 5 m | | 1 - 2 m | 2 - 5 m | > 5 m |
| .1 - .3 m | | | | .1 - .3 m | | | |
| .3 - .8 m | | | | .3 - .8 m | | | |
| > .8 m | | | | > .8 m | | | |

Surveyer(s):_____ 9/3/2014

# Appendix B -- Glossary, Acronyms, and Abbreviations

## Quality Assurance Glossary

**Accuracy** - the degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy. (USGS, 1998)

**Bias** - The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

**Comparability** - The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

**Completeness** - The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

**Data Integrity**- A qualitative DQI that evaluates the extent to which a dataset contains data that is misrepresented, falsified, or deliberately misleading. (Kammin, 2010)

**Data Quality Objectives (DQO)** - Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.
(USEPA, 2006)

**Dataset** - A grouping of samples organized by date, time, analyte, etc (Kammin, 2010)

**Data verification** - Examination of a dataset for errors or omissions, and assessment of the Data Quality Indicators related to that dataset for compliance with acceptance criteria (MQO's). Verification is a detailed quality review of a dataset. (Ecology, 2004)

**Duplicate samples** - two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis. (USEPA, 1997)

**Measurement Quality Objectives** (MQOs) - Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness. (USEPA, 2006)

**Measurement result** - A value obtained by performing the procedure described in a method. (Ecology, 2004)

**Method** - A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed. (EPA, 1997)

**Parameter** - A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all "parameters" (Kammin, 2010; Ecology, 2004)

**Population** - The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

**Precision** - The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

**Quality Assurance (QA)** - A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

**Quality Assurance Project Plan (QAPP)** - A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

**Quality Control (QC)** - The routine application of measurement and statistical procedures to assess the accuracy of measurement data. (Ecology, 2004)

**Relative Percent Difference (RPD)** - RPD is commonly used to evaluate precision. The following formula is used:

**[Abs(a-b)/((a + b)/2)] * 100**

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

**Replicate samples** - two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled. (USGS, 1998)

**Representativeness** - The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

**Sample (field) –** A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

**Sample (statistical) –** A finite part or subset of a statistical population. (USEPA, 1997)

**Standard Operating Procedure (SOP)** – A document which describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

**Systematic planning** - A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning. (USEPA, 2006)

**References**

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USGS, 1998. Principles and Practices for Quality Assurance and Quality Control. Open-File Report 98-636. http://ma.water.usgs.gov/fhwa/products/ofr98-636.pdf

## Glossary – General Terms

**Geometric mean:** A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

**Nutrient:** Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

**Parameter:** A physical chemical or biological property whose values determine environmental characteristics or behavior.

**Riparian:** Relating to the banks along a natural course of water.

**Salmonid:** Any fish that belong to the family *Salmonidae*. Any species of salmon, trout, or char is considered a salmonid. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

**Stormwater:** The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

**Surface waters of the state:** Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

**Synoptic survey:** Data collected simultaneously or over a short period of time.

**Watershed:** A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

**90th percentile:** A statistical number obtained from a distribution of a data set, above which 10% of the data exists and below which 90% of the data exists.

## Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

| | |
|---|---|
| BMP | Best management practices |
| e.g. | For example |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| et al. | And others |
| etc. | Et cetera |
| GIS | Geographic Information System software |
| GPS | Global Positioning System |
| i.e. | In other words |
| MHHW | Mean Higher High Water |
| MHW | Mean High Water |
| MLLW | Mean Lower Low Water |
| MLW | Mean Low Water |
| MQO | Measurement quality objective |
| NPDES | (See Glossary above) |
| OHW | Ordinary High Water |
| QA | Quality assurance |
| RPD | Relative percent difference |
| Spp | Species |
| SOP | Standard operating procedures |
| USGS | U.S. Geological Survey |
| WAC | Washington Administrative Code |
| WDFW | Washington Department of Fish and Wildlife |
| WRIA | Water Resources Inventory Area |

## Units of Measurement

| | |
|---|---|
| cm | centimeter |
| ft | feet |
| g | gram, a unit of mass |
| hr | hour |
| kg | kilograms, a unit of mass equal to 1,000 grams. |
| km | kilometer, a unit of length equal to 1,000 meters. |
| m | meter |
| mg | milligram |
| mL | milliliters |
| mm | millimeter |
| um | micrometer |