FINAL

MEADOWDALE BEACH PARK AND ESTUARY RESTORATION MONITORING PLAN

Prepared for

Snohomish County

Department of Conservation and

Natural Resources

July 2022

ESA

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D201801336.08

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Monitoring Plan

Introduction

Snohomish County Department of Conservation and Natural Resources (DCNR) is implementing the Meadowdale Beach Park and Estuary Restoration project (Meadowdale project) in unincorporated Snohomish County and Edmonds, Washington. The Meadowdale project will restore estuary and stream habitat to improve conditions for salmon and enhance overall Puget Sound health, as well as include park amenities to improve beach access and the natural park experience for visitors. The primary components of the habitat restoration project are the replacement of an undersized culvert with a multi-span railroad bridge to create a 90-foot wide channel opening at the mouth of Lund's Gulch Creek, and the excavation of 1.3-acre estuary immediately upstream from the BNSF railroad crossing. The project will restore estuary habitat for rearing by juvenile Chinook salmon (listed under the Endangered Species Act) and restore fluvial, estuarine, and coastal processes in the project area. Project construction began in 2021 and is planned for completion by late 2022.

The Meadowdale project is regionally significant due to the railroad bridge component and the extent of estuary habitat restoration at the site. The restoration design repurposes a large portion of the park area near the railroad from a recreational focus to a habitat focus. Through the habitat restoration, shoreline coastal processes will be reintroduced to a broad excavated estuarine area landward of the new railroad bridge. The restored processes and coastal features landward of the railroad include tidal hydrology, wave and storm influences on the deposition and transport of stream and beach sediments, brackish water quality, estuarine vegetation, detritus accumulation, and the accumulation of large and small wood. The restored conditions in the estuary landward of the railroad will also improve habitat conditions on the portion of the estuary waterward of the railroad.

Given the significance of the Meadowdale project and the interest in evaluating the effectiveness of the habitat restoration, DCNR contracted with Environmental Science Associates to prepare this comprehensive Monitoring Plan. As this is the first stream mouth restoration project along the Puget Sound shoreline impacted by the BNSF railroad, effectiveness monitoring is particularly important to inform the design of future restoration projects at other stream mouths. In addition, the effectiveness monitoring provides essential information to document the benefits and sustainability of investments by Snohomish County, the grant funding programs who contributed to the restoration, and to BNSF Railway who controls the right-of-way.

This Monitoring Plan includes monitoring elements that are required as part of grant funding or permit agreements. Specifically, monitoring and performance standards were established in a monitoring plan included with the National Oceanic and Atmospheric Administration (NOAA) Coastal and Marine Habitat Restoration Grant (NOAA-NMFS-HCPO-2020-2006306) and is provided in Appendix A. This Monitoring Plan identifies several additional monitoring elements focused on other aspects of project effectiveness, some of which are of regional interest and potentially important for future project development and design at other railroad embanked stream deltas at nearshore or estuarine locations. DCNR convened a Meadowdale Monitoring Group to discuss past, ongoing, and future monitoring activities at the park. Input from that group was instrumental to the development of this Monitoring Plan. The group will continue to meet regularly throughout construction and post-construction to coordinate on monitoring and analysis efforts.

Restoration Project Goals and Objectives

The restoration goals and objectives inform what project effectiveness means for the Meadowdale project. The following goals and objectives are from the Restoration Design Report (Anchor QEA 2018).

The overarching ecological goal of the project is to restore the estuary of Lund's Gulch Creek, including natural sediment and hydrologic processes in order to provide high-functioning, sustainable rearing habitat for non-natal juvenile Chinook (listed as threatened by the Endangered Species Act), as well as coho and chum salmon, cutthroat trout, and other fish species, within the park setting. Given the park's setting and the presence of a high-volume railroad line through the project area, a complementary goal of the project is to provide ecological restoration improvements while also maintaining compatible recreational uses, in particular improved access to the beach for park users.

Specific project objectives to achieve the goals included the following:

- Remove approximately 130 linear feet of hard-armored railroad embankment and the undersized (6-foot-wide) culvert.
- Install a multi-span bridge with a 90-foot opening to dissipate flood waters, restore natural sediment transport processes, and allow the creek to meander dynamically over time, creating essential habitat.
- Create approximately 1 acre of tidal estuary habitat.
- Restore approximately 1 acre of nearshore and stream riparian buffers along the shoreline and stream using native trees and shrubs.
- Restore in-stream habitat conditions by placing large woody debris in the lower creek and restored estuary.
- Address public safety (railroad crossing) and beach access issues associated with the undersized culvert, sediment, and flooding.

- Provide Americans with Disabilities Act (ADA)-compliant and year-round access to the beach.
- Enhance the park user experience through provision of diverse natural habitats.
- Enhance environmental education opportunities, including providing interpretive signage.

Pre-Construction Monitoring

Multiple organizations have conducted pre-construction monitoring at Meadowdale Beach Park. These efforts represent both monitoring completed in the past without any affiliation or sample design relevant to the "project," and more recent monitoring conceived in anticipation of this project. The monitoring data provide baseline pre-construction conditions against which post-construction data can be compared. **Table 1** summarizes the pre-construction monitoring that has been completed.

TABLE 1
PRE-CONSTRUCTION MONITORING AND BASELINE DATA

Organization	Parameters	Year(s) of Data Collection
Tulalip Tribes	Juvenile salmonid use of the estuary	2013, 2018, 2021, 2022
Tulalip Tribes and U.S. Geological Survey (USGS)	Aerial imagery acquisition (drone surveys) to inform elevation mapping, sediment size mapping, photo interpretation	2020–2022
Tulalip Tribes	Beach profile transects	2020–2022
Blue Coast Engineering	Beach profile transects and sediment size mapping	2021–2022
University of Washington and Washington Department of Fish and Wildlife (WDFW)	Beach wrack, beach logs, riparian composition, supratidal invertebrate sampling, benthic infauna, and beach profile transects	2016–2019
Snohomish County Surface Water Management (SWM) and Snohomish County Marine Resources Committee (MRC)	Forage fish egg sampling and bulk sample substrate size analysis on shoreline	2016–2018, 2020–2022
Anchor QEA	Meadowdale Beach Park and Estuary Restoration Design Project - Wetland, Stream, and Marine Delineation Report	2017–2018
DCNR	Stream habitat survey, benthic invertebrates, water temperature in Lund's Gulch Creek	2001, 2009, 2021
DCNR	eDNA	2022
DCNR	Streamflow logger and stream channel/floodplain topography in cross-sections and profiles	2021
Edmonds Stream Team	Salmon spawning ground surveys	2019–2021
King County	Juvenile salmonid use of the stream delta (lower estuary)	2000

Monitoring Area Definitions and Drone Survey Extent

The Monitoring Plan includes monitoring activities in five distinct areas. From upstream to downstream, the monitoring areas are defined as follows and shown in **Figure 1**:

- **Lower Lund's Gulch Creek** – Portion of the stream where restoration occurred; upstream end is pedestrian bridge near Park Ranger's house.
- **Creek Outlet** – Transitional area as creek widens as it enters the restored upper estuary.
- **Upper Estuary** – Restored tidal estuary landward of the railroad including the area under the railroad bridge.
- **Lower Estuary** – Estuary waterward of the railroad bridge and including the entire shoreline delta.
- **Adjacent Nearshore** – Adjacent areas north and south of the project area.

These outlined areas on the map outlines are the general boundaries of each monitoring area; these are not strict outlines of the extent of sampling. For example, vegetation monitoring in the upper estuary may extend outside of the outline shown in Figure 1.

The drone surveys to collect aerial imagery extend across the entire project area. Future drone surveys should collect data throughout the survey area established by the Tulalip Tribes in earlier surveys, as shown in **Figure 2.**

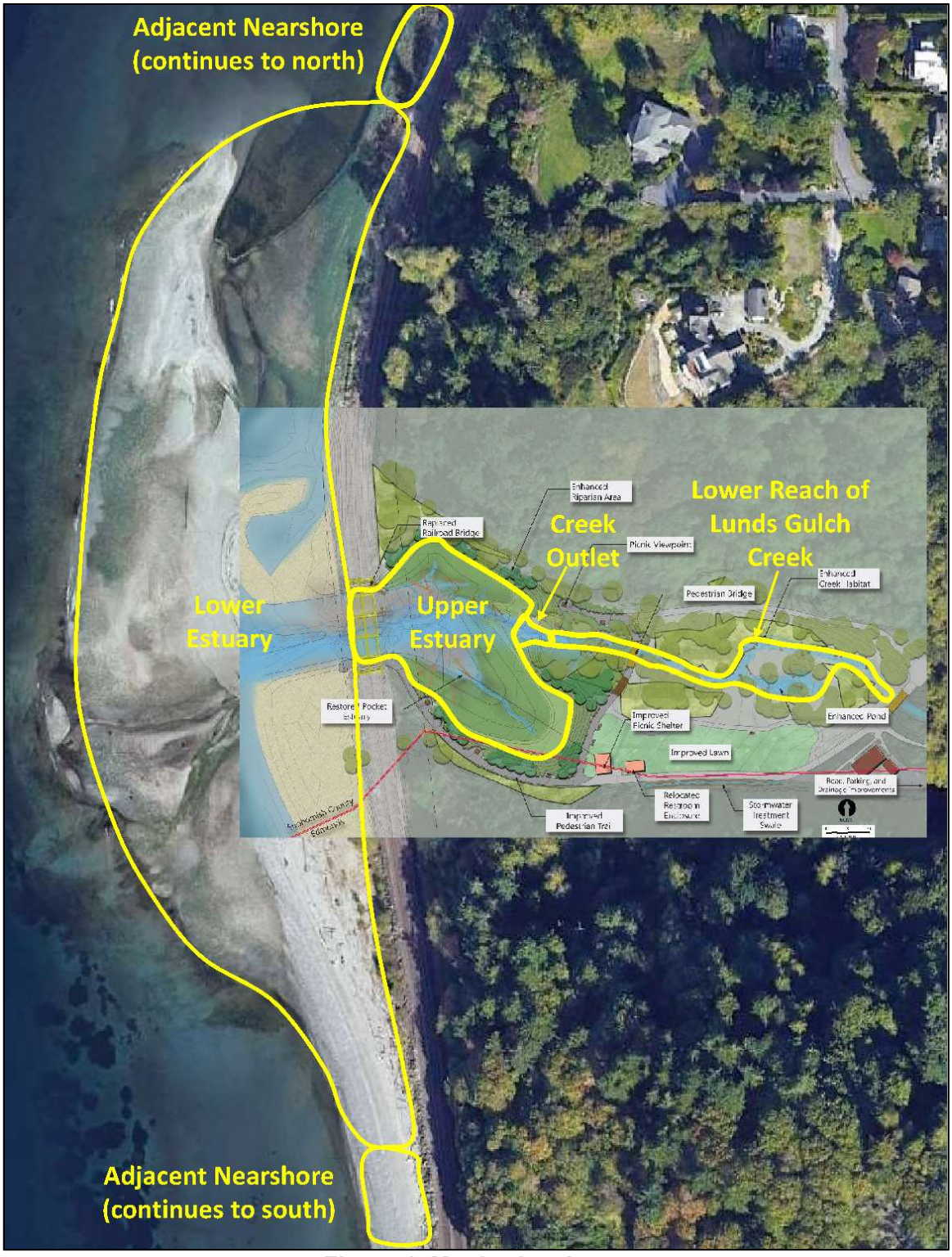


Figure 1. Monitoring Areas

Figure 2. Target Drone Data Collection Area Extent

Summary of Monitoring Elements

Table 2 presents the monitoring elements included in this Monitoring Plan. The table also indicates whether the monitoring is required by a grant funding agreement or permit. Documentation of the implementation and effectiveness of the site restoration is required by permits and approvals issued by federal, state, and local regulatory agencies, in addition to monitoring requirements under the awarded NOAA Coastal and Marine Habitat Restoration Grant (NOAA-NMFS-HCPO-2020-2006306).

Funding for the effectiveness monitoring elements other than those required has not been secured and, therefore, will depend on the availability of funding. The monitoring assigned to other organizations – other than the volunteers in the Edmonds Stream Team – is funded through grants. The Tulalip Tribes are leading a 2022 grant application from the Estuary and Salmon Restoration Program (ESRP) Learning Grant program. If successful, the grant will support a portion of the monitoring in years 2023 to 2025. The Tulalip Tribes also have some funding from other grant funding sources. The timeframe over which that funding is available for monitoring is not assured.

For each monitoring element, the Monitoring Plan presents information on: (1) monitoring purpose and applicability to future restoration projects; (2) monitoring questions and hypotheses; (3) data collection lead organization, methods, and schedule; and (4) analysis and reporting. The information provided in the hypotheses generally describes the desired future conditions and expected beneficial outcomes.

TABLE 2
MONITORING ELEMENTS

ID	Monitoring Element
Required Per Grant Funding Agreement or Permits	
A	Fish passage conditions
B	Channel cross-section and profile surveys
C	Stream habitat in lower Lund's Gulch Creek and creek outlet
D	Large wood retention and recruitment in upper estuary
E	Planted vegetation survival and coverage
Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding	
F	Sediment dynamics and habitat area in upper estuary and creek outlet
G	Sediment dynamics in lower estuary and adjacent nearshore
H	Fish use
I	Salmon spawning ground surveys
J	Forage fish egg presence
K	Macroinvertebrate production in the upper and lower estuary
L	Additional vegetation characterization
M	Photo points
Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought	
N	Extended salmon spawning ground and redd surveys
O	Carbon sequestration in soils
P	Wildlife use
Q	Public use

Coordination of Effort

Given the multiple types of monitoring by multiple entities, continued coordination of monitoring efforts is needed. In Year 1 post-restoration, coordination will be especially important for such considerations as co-located transects, shared information on sampling locations, and monitoring timing to avoid influencing results (e.g., fish sampling could be affected by disturbances from other monitoring elements).

The transect locations included in the figures in this Monitoring Plan are recommendations, but flexibility is warranted depending on as-built conditions and consideration of the transect locations used in other monitoring elements. The co-location of transects is recommended in the following sections. This recommendation is intended to facilitate consistent data collection. The differences in positioning requirements may mean that a single part of a transect (e.g., one end) could be co-located with transects established for other monitoring elements.

The monitoring elements with transects whose location should be coordinated are:

A. Fish passage conditions

B. Channel cross-section and profile surveys

E. Planted vegetation survival and coverage

F. Sediment dynamics and habitat area in upper estuary and creek outlet

G. Sediment dynamics in lower estuary and adjacent nearshore

L. Additional vegetation characterization

Required Monitoring Elements

The monitoring elements included in this section of the Monitoring Plan are required in a grant funding agreement or permit. Documentation of the implementation and effectiveness of the site restoration is required by permits and approvals issued by federal, state, and local regulatory agencies, in addition to monitoring requirements under the awarded Coastal and Marine Habitat Restoration Grant (NOAA-NMFS-HCPO-2020-2006306).

A. Fish Passage Conditions

Monitoring Purpose and Applicability to Future Restoration Projects

To document that the project objective of restoring natural fish passage conditions is achieved.

Questions and Hypotheses

- Do the restored estuary habitats provide fish passage conditions comparable to natural tidal settings (i.e., generally passable, except during peak falling tides and near low tide)?
  - *Hypothesis:* Timing of fish access to the lower estuary and upper estuary relative to the tidal cycle will resemble natural estuaries where adequate depths and velocities are provided for fish passage, except during peak of falling tides (due to high velocities) and throughout low tide (due to shallow depths).

Data Collection Lead Organization, Methods, and Schedule

- Tulalip Tribes
  - Install conductivity, temperature, and depth (CTD) diver gauge to continuously record conductivity, temperature, and depth data in the upper estuary.
- DCNR
  - Collect channel cross-section water depth and velocity data at a transect at the upstream margin of the railroad bridge and running parallel to it. Note: this transect should be co-located with one sampled in Monitoring Element B, which will provide full cross-section geometry data. Collect water depth and velocity data every hour throughout a falling tide from the highest tide stage that can be safely accessed to a low tide stage in which the upper estuary is entirely drained except for streamflow. Water depth and velocity measurements will be taken along the transect using equipment and methods described in the Snohomish County SWM Standard Operating Procedures for collecting stream discharge data (Snohomish County 2019a).
  - Use rod and level to collect water level data at the sampling transect and the CTD diver gauge installed by the Tulalip Tribes to establish the relationship between two locations. This will inform the relationship between water levels at the sampling transect and the gauge, which can be used to analyze the portion of the tidal cycle in which velocities are suitable for juvenile and adult salmon passage.
  - Maintain the Tulalip Tribes' CTD diver gauge by uploading data. The timing of data uploads will be coordinated with the Tulalip Tribes and depend on the timing of when other sampling crews are on-site and able to upload the data.
  - *Schedule:* In Year 1 post-construction. Collect data in late March when juvenile salmon are expected to use the restored estuary and late September, which will be representative of conditions for adult salmon returns later in the fall.

Analysis and Reporting

Fish passage conditions in the estuary will be evaluated based on water depth and velocity using the data collected in the upper estuary. The fish passage evaluation will use criteria established in

the Washington Administrative Code (WAC) 220-110-070 and WAC 220-660-200, and included in the Washington Department of Fish and Wildlife (WDFW) draft guidance for evaluating fish passage at tidally influenced culverts (WDFW 2019). Given the large size of the restored opening under the railroad bridge, the most applicable criteria are water depth and velocity. These criteria were developed for culverts, but provide a reasonable indication of fish passage conditions in the estuary habitats. Since the criteria were established for fish larger than the juvenile Chinook salmon expected to use the estuary (i.e., a 6-inch adult trout instead of a 3-inch juvenile Chinook), it is recommended that a velocity of 2 feet per second be used as the velocity threshold. This conservatively corresponds to the lowest velocity included in the WAC and WDFW (2019). The minimum water depth criterion for fish passage is 0.8 foot.

For this portion of the analysis, the upstream passage conditions for fish the size of juvenile salmon are naturally intermittent in the estuaries of small streams due to the volume of tidal water outflowing during the falling tide. As a result, data showing that a portion of the tide provides conditions unsuitable for upstream fish passage do not necessarily indicate that a man-made barrier remains. Given the wide area of the estuary outlet under the railroad bridge, the site is expected to provide acceptable fish passage conditions, even if such conditions are not continuous throughout the falling tide.

The CTD diver data will be analyzed to provide depths throughout the entire semidiurnal tidal cycle during which the DCNR sampling occurred. The water level at the CTD diver gauge and sampling transect will be compared to establish an elevation conversion factor between the sites. For example, if the CTD diver gauge is 1 foot higher in elevation than the sampling transect, then depths at the sampling transect during the higher tide portion of the tidal cycle can be assumed to be 1 foot more than what was recorded by the CTD diver gauge.

Data from each of the hourly sampling events will be evaluated to determine whether any portion of the transect provides velocities less than 2 feet per second. If so, then the velocities are considered suitable for upstream fish passage during that time. Data can be further analyzed to determine how much of the transect provided passable velocity conditions. In addition, data can be extrapolated across the entire falling tide portion of the tidal cycle to characterize the portion of the tidal cycle in which suitable velocities are provided.

DCNR will include the data and analysis in the Post-Construction Monitoring Report prepared following Year 1 post-construction.

Data Collection	Output
Water depth/velocity measurements	Frequency distribution curve for cross-sectional area that shows the amount of time when depths and velocities are suitable
Conductivity, temperature, depth	Water depths throughout the entire semidiurnal tidal cycle during which the transect was sampled

B. Channel Cross-sections and Profile Surveys

Monitoring Purpose and Applicability to Future Restoration Projects

To document channel conditions in the restored estuary and ensure that fish passage conditions are maintained. This will document the adjustment of the channel and profile in the first 10 years following restoration in the creek outlet, upper estuary, and lower estuary monitoring areas.

Questions and Hypotheses

- Is flow concentrated in a defined channel throughout the estuarine portion of the restoration to maintain conditions conducive to fish passage?
  - *Hypothesis*: The estuary will have one defined channel at low tide and typical spring flow conditions that flows from the creek outlet, through the upper estuary, and out into the lower estuary.

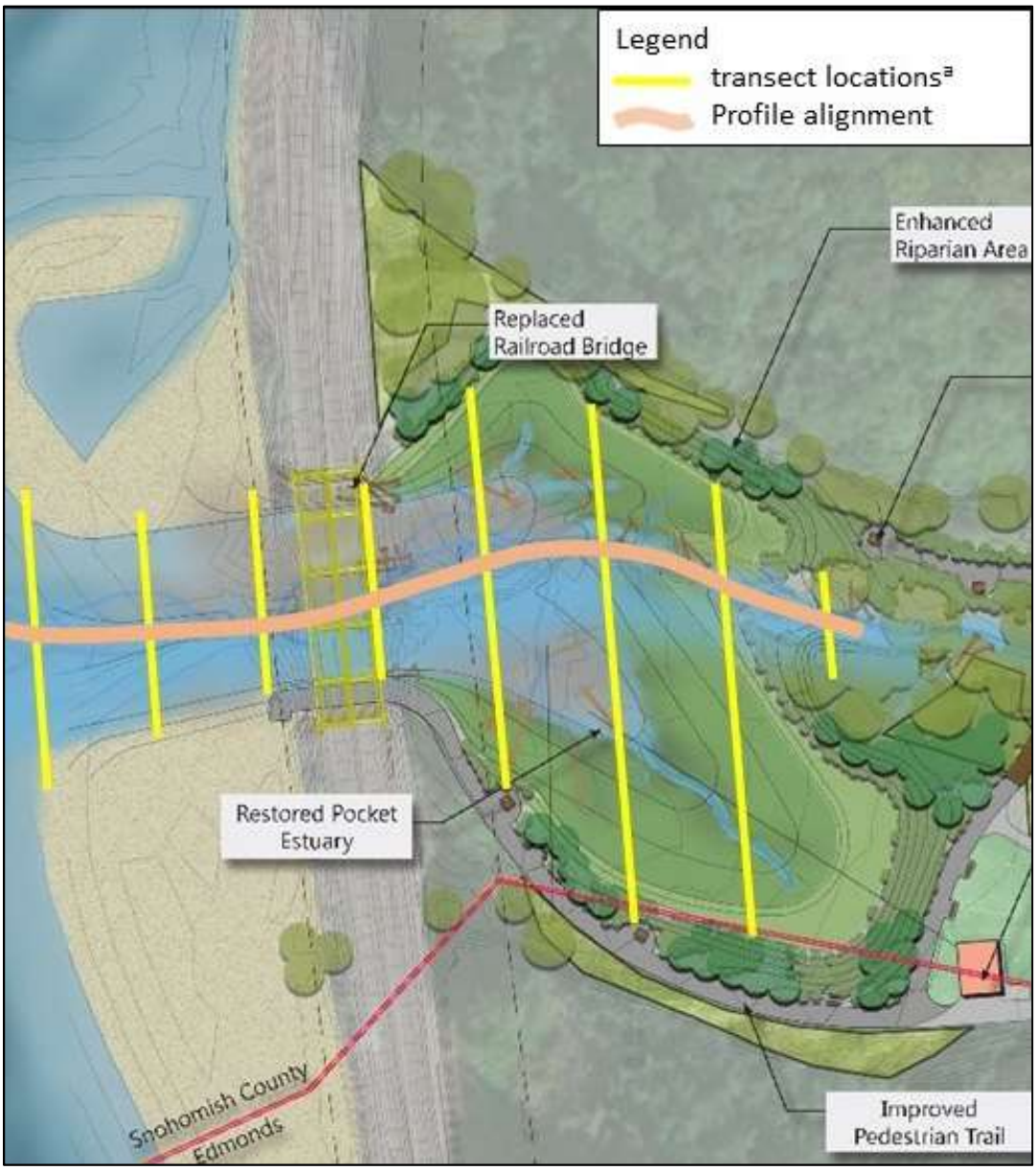
Data Collection Lead Organization, Methods, and Schedule

- DCNR
  - Collect horizontal and vertical positioning data using Real-Time Kinematic Global Positioning System (RTK-GPS) at cross-channel transects located throughout the creek outlet, upper estuary, and lower estuary monitoring areas (**Figure 3**). In the creek outlet and upper estuary, transect locations will be established in the first post-construction sampling event and revisited in subsequent sampling events. The creek outlet and upper estuary transects will run approximately parallel to the railroad embankment and span the entire restoration area. Note: the location of the transect in the upper estuary at the railroad embankment should be co-located with the transect sampled in Monitoring Element A. In the lower estuary, transect locations will be determined based on the route of the outlet channel. Lower estuary transects will be oriented perpendicular to the channel alignment and span the entire channel cross-section. Lower estuary transects will continue downstream to mean lower low water (MLLW) or where the defined channel is no longer apparent. Figure 3 shows the proposed locations of the transects. The figure shows transects spaced every 40 feet. Sampling will occur at or near low tide (i.e., when no impoundment remains in the upper estuary). Observations will be recorded every 3 feet along the transect and at observed grade breaks. Notes will be recorded on whether a location is inundated and, if so, the water depth to the nearest inch. Prior to sampling, data from the previous sampling event will be reviewed to support field recognition of significant changes that may affect fish passage and potential factors contributing to such changes. Data collected by the Tulalip Tribes in Monitoring Element F will occur at the same creek outlet and upper estuary transects, but at a higher frequency. DCNR and the Tulalip Tribes, if funded, should coordinate on collecting the data to avoid redundancy.
  - Collect horizontal and vertical positioning data using RTK-GPS along a profile extending throughout the creek outlet, upper estuary, and lower estuary monitoring areas. Data will also be collected along a profile established along the channel thalweg. The route of the profile during each sampling event will follow the thalweg, thereby likely taking a different route each time.
  - *Schedule:* In Years 1, 5, and 10 post-construction. Collect data in late March when juvenile salmon are expected to use the restored estuary.

Analysis and Reporting

The channel cross-section and profile data will be evaluated for the presence of a channel throughout the creek outlet, upper estuary, and lower estuary monitoring areas. Since fish passage in the estuaries of small streams for fish the size of juvenile salmon is naturally intermittent due to high velocities as the embayment drains during a falling tide and shallow water depths during low tide, the data will not be compared to a minimum depth. Significant changes in channel location and/or geometry from previous sampling events will be noted and potential contributing factors identified.

Data Collection	Output
Cross-section elevations	Time-series analysis of changes in elevations at transects over time; transect data and drone imagery can be used in combination to estimate sediment accumulation or erosion in the project area, as well as dynamics of channel alignments
Profile	Comparison of profiles throughout the project area over time



Note: a) Transect locations in the creek outlet and upper estuary will run parallel to the railroad and span the entire restoration area. Transects in the lower estuary will follow the route of the channel, be oriented perpendicular to the channel alignment, and span the entire channel. Transects will be evenly spaced (as shown, every 40 feet). The as-built channel route in the lower estuary will be turned to the north and not match what is shown in this figure.

Figure 3. Recommended Cross-Section Transect Locations in Creek Outlet, Upper Estuary, and Lower Estuary

C. Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet

Monitoring Purpose and Applicability to Future Restoration Projects

To document instream habitat quality in the portions of the creek included in the restoration. The data will indicate how effective the stream restoration components included in the design are for improving habitat conditions for salmon.

Questions and Hypotheses

- Does stream habitat complexity improve following restoration?
  - *Hypothesis:* The large woody debris installed in the creek will form and increase the number of pools when comparing post-construction data to pre-construction data.
  - *Hypothesis:* The number of pools will vary over time post-construction, but remain higher than pre-construction conditions. Increased channel roughness will lead to increases in channel complexity and habitat area as total number of habitat units, diversity of maximum habitat depths, and increases in inwater or overhanging habitat cover.
- Does the amount of large woody debris change after restoration?
  - *Hypothesis:* The large woody debris installed in the creek will rack other wood moving down the creek and increase the number of small and/or large woody debris pieces.
- Does the benthic macroinvertebrate production indicate improved stream biological health?
  - *Hypothesis:* Stream biological health will improve following restoration when comparing post-construction data to pre-construction data.

Data Collection Lead Organization, Methods, and Schedule

- DCNR
  - Collect data on the wadeable stream habitat parameters using the methods in Snohomish County (2019b) throughout Lower Lund's Gulch Creek and creek outlet reaches, consistent with extents historically sampled. These include habitat units (type, area, depth, cover) and large woody debris inventory required as part of restoration grant funding. Other parameters measured include bankfull width, bankfull depth, stream bank conditions, riparian canopy cover, side channel dimensions and habitats, substrate size, and channel gradient (thalweg survey).
    - *Schedule:* During the summer of Years 1, 3, 5, and 10 post-construction. Sampling should be conducted in the same month each sampling year.
  - Collect benthic macroinvertebrate samples using the methods in Snohomish County (2019c) throughout Lower Lund's Gulch Creek and creek outlet reaches.
    - *Schedule:* During the summer of Years 1, 3, 5, and 10 post-construction. Sampling should be conducted in the same month each sampling year.

Analysis and Reporting

The stream habitat and benthic macroinvertebrate data collected by DCNR will be analyzed to compare post-construction conditions to pre-construction conditions, as well as trends in post-construction conditions over time. DCNR has data for Lund's Gulch Creek stream habitats from 2001, 2009, and 2021 for comparison. The benthic macroinvertebrate samples will be analyzed for identification and enumeration. The benthic macroinvertebrate data will be analyzed to evaluate density, number of taxa, taxa richness, and diversity. The data and analysis will be included in the Post-Construction Monitoring Reports prepared following Years 1, 3, 5, and 10 post-construction.

Data Collection	Output
Stream habitat mapping	Comparison of stream habitat units in the project area over time
Benthic macroinvertebrates	Comparison of taxa density, number of taxa, taxa diversity, and taxa richness

D. Large Wood Retention and Recruitment in Upper Estuary

Monitoring Purpose and Applicability to Future Restoration Projects

To document the recruitment or loss of large wood in the embayment of the upper estuary. The data will indicate how effective the large wood placement was and the overall availability of large wood as habitat structure in the upper estuary.

Questions and Hypotheses

- Will the large wood placed in the upper estuary remain there and be functional?
  - *Hypothesis*: Large wood placed as part of the restoration will remain in place and support the habitat functions of depth and cover. As placed pieces are also anchored, they may become covered with sediment.
- Will additional large wood be recruited into the upper estuary?
  - *Hypothesis*: The number of large wood pieces will increase in the upper estuary post-construction.

Data Collection Lead Organization, Methods, and Schedule

- DCNR
  - Count the number of large wood pieces in the upper estuary. Large wood criteria will match those used in Snohomish County (2019b), which are wood larger than 6.6 feet long and 3.9 inches in diameter. A full count will be conducted during low tide. Placed and anchored pieces will be identified, and the amount of wood covered by sediment will be evaluated.
    - *Schedule:* During the summer of Years 1, 3, 5, and 10 post-construction. Sampling should be conducted in the same month each sampling year.

Analysis and Reporting

DCNR will analyze the large wood counts and include the data in the Post-Construction Monitoring Reports prepared in Years 1, 3, 5, and 10 post-construction.

Data Collection	Output
Large wood counts	Comparison of large wood counts in the upper estuary over time

E. Planted Vegetation Survival and Coverage

Monitoring Purpose and Applicability to Future Restoration Projects

To document the re-establishment of a native plant community in the restoration area.

Questions and Hypotheses

- Will native vegetation planted as part of the restoration design achieve performance goals?
  - *Hypothesis:* Vegetation coverage and composition will achieve the performance goals established in the grant funding agreements and mitigation plan approved by the permitting agencies (see Appendix A).
- Will non-native vegetation in the restoration area be reduced to less than 20 percent cover within 5 years after construction?
  - *Hypothesis:* Non-native vegetation in the restoration area will be reduced to less than 20 percent absolute cover (measured from a baseline of zero) within 5 years after construction.

Data Collection Lead Organization, Methods, and Schedule

- DCNR
  - Establish five 33-foot diameter circular vegetation sampling plots to be evaluated for percent cover and community composition. Use a GPS unit to record the latitude and longitude of the center point of each plot to allow surveyors to reoccupy the same plot in each sampling event. In each sampling plot, record the percent cover of each vegetation class (herbaceous, shrubs, trees, woody vines) and each species with more than 5 percent cover.
  - Document habitat functions for remaining freshwater wetlands delineated by Anchor QEA (2018) using the Washington State Wetlands Rating System for Western Washington (Hruby 2014) and Methods for Assessing Wetland Functions (Hydrogeomorphic [HGM] model; Hruby et al. 1999) in Year 10 post-construction.
  - Establish at least one permanent transect sampling line of the same length and width in each of the following vegetation community types: high saltmarsh, low saltmarsh, and freshwater wetland (Coulloudon et al. 1999). Transects will be established during a post-construction site visit. Note: consideration should be given to co-locating transects with other monitoring elements per the section on Coordination of Effort (page 8). Record the location of each transect terminus with GPS to allow surveyors to reoccupy the same transects in each sampling event. Randomly establish up to 12, 1-meter quadrat sampling plots along each transect. The same transects will be sampled during each sampling event, but the quadrat locations will randomly vary. Record the percent cover of each species in each plot. Use percent cover data by species to determine percent cover of native and non-native vegetation overall. Also use the percent cover data by species to determine the percent cover of native vegetation that voluntarily colonized the site.
  - Establish at least one permanent transect sampling line in the upland riparian buffer (Bonham 1989; Coulloudon et al. 1999). Record the location of each transect terminus with GPS to allow surveyors to reoccupy the same transects in each sampling event. Use

the point-line method (Bonham 1989; Coulloudon et al. 1999) to record vegetation along the transect(s), including quantity (or cover area, if appropriate), species, and condition (dead, stressed, healthy).

– Proposed locations for all vegetation monitoring plots and transects described above and in Section L of the Monitoring Plan are presented in **Figure 4**. See Appendix B for the design drawings that include the planting plan portion of the restoration.

  - *Schedule:* Vegetation will be monitored in established plots and along transects once annually in Years 1, 3, 5, and 10 post-construction. Monitoring should be conducted in mid- to late summer at mean low tide for the estuarine marsh areas and freshwater wetland, and at any time of the day for the riparian areas.

Analysis and Reporting

DCNR will include the data and analysis in the Post-Construction Monitoring Reports prepared following Years 1, 3, 5, and 10 post-construction. The vegetation coverage will be evaluated after each sampling event and compared to the following performance targets in Appendix A:

- Based on the 33-foot diameter plots:

  – Achieve 50–70 percent cover of native vegetation species planted per the as-built design drawings at designated representative monitoring plots within 5 years post-construction and sustain for the lifetime of the project.

  – Reduce non-native vegetation species to less than 20 percent cover within 5 years post-construction.

- Based on the freshwater wetland ratings:

  – The habitat functions in Year 10 post-construction will exceed those in the pre-construction based on the Washington State Wetlands Rating System for Western Washington (Hruby 2014) and Methods for Assessing Wetland Functions (HGM model, Hruby et al. 1999).

- Based on the transect data, the following performance targets from Anchor QEA (2017) will be met:

  – Average survival of planted trees will be at least 90 percent at the end of Year 1.

  – Within planted areas identified in Anchor QEA (2017), native riparian vegetation species cover shall be at least 25 percent by Year 3, at least 50 percent by Year 5, and 70 percent by Year 10.

  – Native herbaceous coverage within designated estuary and beach areas shall be at least 50 percent by Year 3, 70 percent by Year 5, and 95 percent by Year 10.

  – Invasive, non-native plant species are maintained at levels below 20 percent total cover within planted riparian areas. Species such as creeping buttercup may not necessarily be included in invasive cover standards if those species do not interfere with long-term goals.

Data Collection	Output
33-foot diameter plots	Evaluation of achievement of performance standards
Transects	Evaluation of achievement of performance standards
Freshwater wetland rating	Comparison to pre-restoration ratings

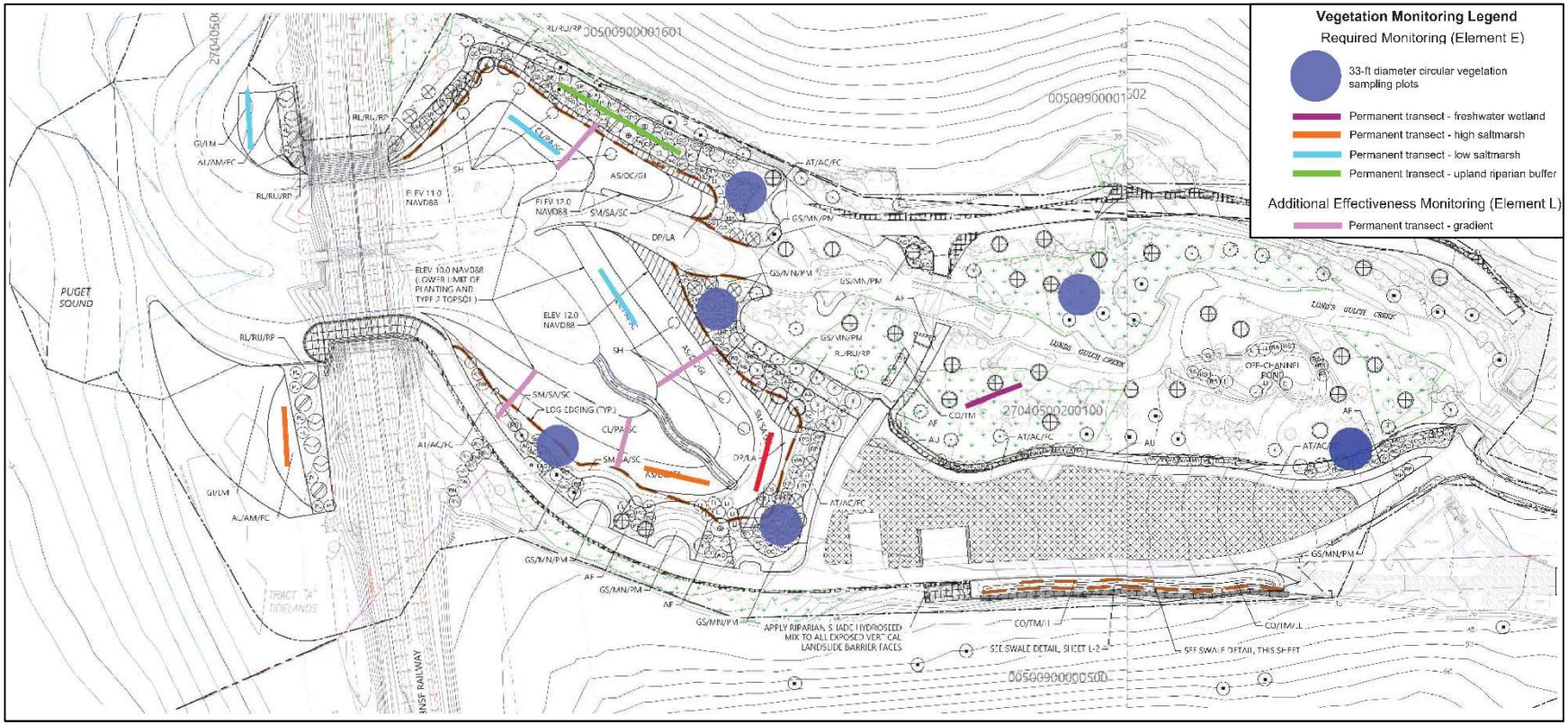


Figure 4. Recommended Vegetation Monitoring Plot and Transect Locations

Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding

The monitoring elements included in this section are those that DCNR or other partners are planning to conduct pending funding. The availability of funding will determine which of these monitoring elements can be conducted by project partners.

F. Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet

Monitoring Purpose and Applicability to Future Restoration Projects

To document how the upper estuary and the creek outlet monitoring areas adjust over time due to the re-established sediment transport and depositional processes associated with the wider estuary and railroad bridge opening.

The upper estuary and railroad bridge were designed to be especially large to accommodate future increases in water levels from sea-level rise and to allow space for the site to adjust naturally once sediment processes are re-established. The monitoring will help inform the size and design of future restoration projects to accommodate creek outlet, estuary, and sediment dynamics.

Questions and Hypotheses

- During low tide and typical spring flows, do streamflows in the creek outlet and upper estuary get transported through one channel or multiple channels, and does the location of channel(s) change over time?
  - *Hypothesis:* The low flow channels will dynamically move around in location to occupy different parts of the upper estuary as sediment from the stream is delivered and redistributed.
- On an annual basis, what changes in elevation occur in the upper estuary related to sediment deposition or erosion?
  - *Hypothesis:* A large portion of the upper estuary will experience sediment deposition, causing higher elevations as the site adjusts to the restored processes following construction.
  - *Hypothesis:* A small portion of the upper estuary will experience sediment erosion, causing lower elevations as the site adjusts to the restored processes following construction.
- On an annual basis, what is the net volume of sediment movement based on changes in elevation in the upper estuary?
  - *Hypothesis:* For an initial period following construction, the upper estuary will encounter a net deposition of sediment.

  - *Hypothesis:* After an initial period of net sediment deposition, the annual net deposition volumes will decrease, presumably as more sediments are transported through the upper estuary and into the lower estuary.

  - *Hypothesis:* While there may be trends in site performance over time, the sediment dynamics in the upper estuary will be highly responsive to episodic events (e.g., large storm events), such that certain sampling events or years do not conform with a previous or subsequent trend.

- How does the inundated area and volume in the upper estuary change over time?

  - *Hypothesis:* For an initial period following construction, there will be marked adjustments in the inundated area and volume in the upper estuary due to the deposition of stream sediments.

  - *Hypothesis:* After an initial period following construction, there will be smaller changes to the inundation area and volume in the upper estuary, presumably as the site equilibrates to the ecological processes post-construction.

  - *Desired Condition:* The creek outlet and upper estuary channels and habitats are dynamic and sustained as ecological processes act on the site post-construction. The inundated area and volume adjust post-construction, but remain expansive over time.

Data Collection Lead Organization, Methods, and Schedule

- Tulalip Tribes

  - Conduct drone flights of the entire area to provide georectified aerial orthophoto and a digital surface model (DSM). Desired drone flight area is shown in Figure 2.

    - *Schedule:* Two times per year, in March and September. Potentially additional times following a storm event. Annually through Year 10 post-construction (pending funding).

  - Collect horizontal and vertical positioning data using RTK-GPS to supplement drone data. Collect data along approximately six transects running perpendicular to the railroad embankment, five transects running parallel to the railroad embankment, and a thalweg transect. Note: consideration should be given to co-locating transects with other monitoring elements per the section on Coordination of Effort (page 8). The thalweg transect will follow the thalweg alignment at the time of sampling and a transect elevation profile will be surveyed from the creek outlet to the downstream margin of the upper estuary. Observations will be recorded every 6.5 feet (2 meters) along the transects and at observed grade breaks. Notes will be recorded on whether a location is inundated and, if so, the water depth to the nearest inch. Transect locations will be established in the first sampling event and revisited in subsequent sampling events. Recommended transect locations are shown in **Figure 5**. The transects running perpendicular to the railroad embankment will be the same as those sampled by DCNR in Monitoring Element B, but sampled with more frequency. DCNR and the Tulalip Tribes, if funded, should coordinate on collecting the data to avoid redundancy.

- *Schedule:* Two times per year, in March and September. Potentially additional times following a storm event. Data collection timing is coordinated with drone flights. Annually through Year 10 post-construction (pending funding).

– Conduct a sediment particle tracking study using passive integrated transponder tags (or PIT tags) across multiple zones of the project area, including the lower reach of Lund's Gulch Creek, the creek outlet, the upper estuary, and the lower estuary.

- *Schedule:* Timing depends on a study plan developed by the Tulalip Tribes.

Figure 5. Recommended Creek Outlet and Upper Estuary Transect Locations

- DCNR
  - Conduct substrate size sampling along the transects established by the Tulalip Tribes' RTK-GPS survey. Dominant and subdominant surface substrate size classes will be visually categorized along transects every 6.5 feet (2 meters) using the size classification system described in Snohomish County (2019b) and presented in **Table 3.**

TABLE 3
SUBSTRATE SIZE CLASSES

Size Class	Size Range (mm)	Size Range (inches)
Fines/Silt	<0.06	<0.002
Sand	0.06 to 2	0.002 to 0.08
Gravel (fine)	>2 to 16	>0.08 to 0.63
Gravel (coarse)	>16 to 64	>0.63 to 2.5
Cobble	>64 to 250	>2.5 to 9.8
Boulder	>250 to 4,000	>9.8 to 157
Hardpan or Bedrock	>4,000	>157

Source: Snohomish County (2019b) adapted from Lazorchak et al. (1998)

    - *Schedule:* Once per year in summer during Years 1, 3, 5, and 10 post-construction.

Analysis and Reporting

The data collected by the Tulalip Tribes will be analyzed following each sampling event. Analysis will include bringing the aerial data into the appropriate grid coordinate system (Washington State Plane) and vertical datum (NAVD 88). The data will be in a geo-rectified TIFF image and DSM. As possible, the geo-rectified image will be analyzed to map features of interest, such as substrate size, vegetation, large woody debris, and landward margin of eelgrass. The DSM will be analyzed to map the extent and magnitude of erosion and deposition by comparing the current elevations to earlier DSMs. The RTK-GPS data along the low flow channel thalweg will be mapped and compared to earlier data. The timing and frequency of reporting will depend on the requirements of the funding source.

The substrate size data collected by DCNR will be analyzed to characterize substrate sizes across transects and compared to earlier substrate size data. The substrate size analysis will be supplemented by information provided by the interpretation of the geo-rectified image, as possible based on funding. The substrate size analysis will be included in the Post-Construction Monitoring Reports prepared following Years 1, 3, 5, and 10 post-construction.

G. Sediment Dynamics in Lower Estuary and Adjacent Nearshore

Monitoring Purpose and Applicability to Future Restoration Projects

To document how the configuration of the lower estuary changes following restoration, specifically the pocket estuary area (i.e., the protected habitat landward of the beach berm). **Figure 6** shows the pocket estuary area of interest based on 2015 aerial imagery of the site. To inform how restoration of the stream mouth benefits both the lower estuary and adjacent nearshore areas (i.e., on-site and off-site locations).

Figure 6. Example of Pocket Estuary Area of Interest (blue line)

Questions and Hypotheses

- Will the lower estuary channel routed to the north of the railroad bridge as part of the construction remain in that alignment or shift around?
  - *Hypothesis:* The lower estuary channel will remain in a northerly direction and provide pocket estuary habitat.
- Will the area of protected pocket estuary habitat and the length of the low flow channel change over time?
  - *Hypothesis:* The pocket estuary habitat between MLLW and mean higher high water (MHHW) in the lower estuary will increase following construction.
  - *Hypothesis:* The length of the lower estuary channel (as demarcated from MLLW) will increase following construction.
- Will changes to the delivery of sediments and water from the stream and upper estuary lead to adjustments in the shape of the delta in the lower estuary?
  - *Hypothesis:* The shape of the stream delta will change following construction, with the expectation that the width of the delta will decrease as sediments are redistributed.
- Will the adjacent nearshore area to the north receive sediment from Lund's Gulch Creek that results in higher intertidal elevations waterward of the railroad embankment?
  - *Hypothesis:* Over time, sediment from Lund's Gulch Creek will increase the elevations across the transects sampled in the adjacent nearshore area to the north.

Data Collection Lead Organization, Methods, and Schedule

- Tulalip Tribes
  - Conduct drone flights of the entire area, as described in Monitoring Element F.
  - Collect horizontal and vertical positioning data using RTK-GPS to supplement the drone data. Collect data along nine transects running approximately perpendicular to the current shoreline and along the thalweg profile from the low flow channel through the lower estuary to approximately MLLW. Transect locations are shown in **Figure 7,** and **Table 4** presents the start and end point locations. These locations were established during pre-construction monitoring and will be revisited in post-construction sampling events.
    - *Schedule:* Two times per year, in March and September. Potentially additional times following a storm event. Data collection timing is coordinated with the drone flights. Annually through Year 10 post-construction (pending funding).

Figure 7. Lower Estuary Transect Locations

TABLE 4
LOWER ESTUARY TRANSECT LOCATIONS

Transect Number	West End		East End	
	Easting	Northing	Easting	Northing
T-1	1271924.10	318075.76	1271553.28	318176.88
T-2	1271846.26	317779.19	1271420.50	317850.22
T-3	1271829.35	317625.27	1271417.00	317626.00
T-4	1271804.66	317432.81	1271380.38	317382.17
T-5	1271798.90	317266.07	1271385.39	317198.50
T-6	1271861.77	317050.83	1271572.63	316985.07
T-7	1271871.29	316918.16	1271544.61	316840.56
T-8	1271893.30	316788.50	1271570.29	316722.59
T-9	1271909.49	316594.71	1271591.39	316553.64

Note: Horizontal Datum: Washington State Plane North, U.S. Survey Feet

- Collect surface and subsurface substrate size data. Collect data every 6.5 feet (2 meters) along the nine transects running approximately perpendicular to the current shoreline. Transect locations will be revisited in successive sampling events. These locations were established during pre-construction monitoring (see Figure 7 and Table 4). Dominant and subdominant surface and subsurface substrate size classes will be visually categorized along the transects using the size classification system described in Snohomish County (2019b) (see Table 3). Subsurface areas will be evaluated by digging 1 foot deep.

  - *Schedule:* Two times per year, in March and September. Potentially additional times following a storm event. Data collection timing is coordinated with the drone flights. Annually through Year 10 post-construction (pending funding).

- Collect camera images of the lower estuary from a nearby overlook location. Photographs will be taken at an interval set by the Tulalip Tribes. Photographs will be stamped with the date and time to allow an evaluation of selected events, such as a king tide or storm event, and compared to other data collected at that time.

  - *Schedule:* Continuous camera deployment with setting to take photographs at timed intervals through Year 10 post-construction (pending funding).

- Blue Coast Engineering

  Blue Coast Engineering will collect beach profile and substrate size data as part of a research grant that is currently funded through 2023. Meadowdale is one of multiple sites to be studied in the grant, and it is less certain how much post-construction data collection will occur at Meadowdale. The data will supplement the data collected by the Tulalip Tribes, which will be the primary data source for effectiveness monitoring.

  - As possible in the course of the data collection for a grant non-specific to Meadowdale, collect horizontal and vertical positioning data using RTK-GPS to supplement the drone data. Collect data along the nine transects running approximately perpendicular to the current shoreline and along the thalweg profile from the low flow channel through the

lower estuary. Transect locations will be revisited in successive sampling events. Transect locations were established during pre-construction monitoring and are the same ones surveyed by the Tulalip Tribes (see Figure 7 and Table 4).

  - *Schedule:* Dependent on data information needs of grant funding. Periodically collected over Years 1 and 2 post-construction. Emphasis on collecting data before and after a storm event.

- Collect surface and subsurface substrate size data. Collect data along the nine transects running approximately perpendicular to the current shoreline. Transect locations will be revisited in successive sampling events. These locations were established during pre-construction monitoring and are the same ones surveyed by the Tulalip Tribes (see Figure 7 and Table 4). Dominant and subdominant surface and subsurface substrate size classes will be visually categorized along the transects using the size classification system described in Snohomish County (2019b) (see Table 3). Subsurface areas will be evaluated by digging 1 foot deep.

  - *Schedule:* Dependent on data information needs of grant funding. Periodically collected over Years 1 and 2 post-construction. Emphasis on collecting data before and after a storm event.

- Collect wave data using gauges deployed in the low intertidal (approximately -2 feet MLLW) and subtidal (approximately -10 feet MLLW) areas to monitor waves during winter storms.

  - *Schedule:* Dependent on data information needs of grant funding. Periodically collected during the winter of Years 1 and 2 post-construction.

Analysis and Reporting

The data collected by the Tulalip Tribes will be analyzed following each sampling event. Analysis will include bringing the aerial data into the appropriate grid coordinate system (Washington State Plane) and vertical datum (NAVD 88). The data will be in a geo-rectified TIFF image and DSM. As possible, the geo-rectified image will be analyzed to map features of interest, such as substrate size, vegetation, and large woody debris. The DSM will be analyzed to map the extent and magnitude of erosion and deposition by comparing the current elevations to earlier DSMs. The RTK-GPS data along the low flow channel thalweg will be mapped and compared to earlier data. The timing and frequency of reporting will depend on the requirements of the funding source.

The substrate size data collected will be analyzed and reported on by the Tulalip Tribes and Blue Coast Engineering to meet their grant requirements. In addition, DCNR may conduct additional analysis to characterize substrate sizes across transects and compare to earlier substrate size data. The substrate size analysis will be supplemented by information provided by the interpretation of the geo-rectified image, as possible based on funding. The substrate size analysis will be included in the Post-Construction Monitoring Reports prepared following Years 1, 3, 5, and 10 post-construction.

H. Fish Use

Monitoring Purpose and Applicability to Future Restoration Projects

To document use of the restored habitats by juvenile Chinook salmon and other fish species. A primary goal for the restoration is to improve habitat accessibility and quality for juvenile Chinook salmon. Documentation of the degree to which juvenile salmon use the site compared to pre-construction will add data on how non-natal habitat restoration and potentially specific elements of the restoration benefit juvenile Chinook salmon.

Questions and Hypotheses

- Are non-natal juvenile Chinook salmon using the restored habitats (lower estuary, upper estuary, creek outlet, and lower Lund's Gulch Creek)? If so, which portions of the project area or specific habitat features are they using more frequently or in greater numbers?
  - *Hypothesis:* Juvenile Chinook salmon will occupy the site in higher numbers compared to pre-construction numbers.
  - *Hypothesis:* Juvenile Chinook salmon will occupy portions of the estuary providing cover habitat, such as large wood, deep pools, or large substrate.
- Are non-natal juvenile Chinook salmon using the restored habitats more than the adjacent nearshore habitats?
  - *Hypothesis:* More juvenile Chinook salmon will be captured in the restored habitats compared to the adjacent nearshore habitats.
  - *Hypothesis:* The seasonality of juvenile Chinook presence in the restored habitats and adjacent nearshore habitats will be the same.
- Is there a seasonal timing and/or size difference between non-natal Chinook salmon in the restored habitats compared to the adjacent nearshore habitats?
  - *Hypothesis:* The seasonality of juvenile Chinook salmon presence in the restored habitats and adjacent nearshore habitats will be the same.
  - *Hypothesis:* Juvenile Chinook salmon in the restored habitats will be larger than those in the adjacent nearshore habitats.
- Are other salmon and trout (i.e., not Chinook salmon) using the restored habitats?
  - *Hypothesis:* Juveniles and adults of other salmon and trout species will be documented using the restored habitats.
- What river system(s) do juvenile Chinook salmon using the restored habitats originate from?
  - *Hypothesis:* Juvenile Chinook salmon from multiple river systems, including north and south of the site, will use the restored habitats.
- Are other nearshore fish, including juvenile and adult forage fish, using the restored habitats?

  - *Hypothesis:* A diverse community of nearshore fish species – other than salmon and trout – will occupy restored habitats in the upper estuary and lower estuary.

  - *Hypothesis:* Juvenile forage fish such as surf smelt, Pacific sand lance, Pacific herring, eulachon, and northern anchovies will occupy restored habitats in the upper estuary and lower estuary.

Data Collection Lead Organization, Methods, and Schedule

- DCNR

  - Collect water samples for eDNA analysis from the creek outlet and lower estuary in March of each year, coinciding with electrofishing at the anticipated peak of juvenile Chinook salmon use.

- Tulalip Tribes

  - Conduct electrofishing in restored habitats (lower estuary, upper estuary, creek outlet, and lower Lund's Gulch Creek). The creek portion of the sampling effort will extend to the pedestrian bridge near the Park Ranger's house. The sampling effort in each area depends on a study plan developed by the Tulalip Tribes.

    - *Schedule:* Every other week between early February and May. Depending on creek flows, sampling may continue in June. Annually through Year 10 post-construction (pending funding).

  - Conduct beach seining in the lower estuary, upper estuary, and adjacent nearshore habitats during high tides. The sampling effort in each area depends on a study plan developed by the Tulalip Tribes. Fin clips will be collected from up to 25 Chinook salmon per site per sampling event.

    - *Schedule:* Every other week between March and June. Annually through Year 10 post-construction (pending funding).

  - Tow a Neuston net in the upper estuary during juvenile fish sampling.

    - *Schedule*: Every other week between March and June. Annually through Year 10 post-construction (pending funding).

Analysis and Reporting

The data collected by the Tulalip Tribes will be analyzed following each year's monitoring. The analysis will address the questions identified. Pre-construction data from the Tulalip Tribes (unpubl.), Beamer et al. (2013), and Brennan et al. (2004) are available for comparison. The timing and frequency of reporting will depend on the requirements of the funding source.

I. Salmon Spawning Ground Surveys

Monitoring Purpose and Applicability to Future Restoration Projects

To document changes in the number adult salmon returning to the spawning grounds in Lund's Gulch Creek.

Questions and Hypotheses

- Are anadromous salmonid adults holding in the restored habitats?
  - *Hypothesis:* Restored estuary habitats will create holding habitats for anadromous coho, chum, and cutthroat trout adults returning to spawn.
- Are there increases in the number of anadromous salmonid adults in Lund's Gulch Creek?
  - *Hypothesis:* Increased numbers of anadromous coho, chum, and cutthroat trout adults will be documented in stream spawning surveys.
- Among the adult salmon returning to the stream, are there fewer observations of injuries from predator attacks?
  - *Hypothesis:* Fewer adult salmon in the creek will have visible injuries from predator attacks.

Data Collection Lead Organization, Methods, and Schedule

- Edmonds Stream Team (volunteers)
  - Spawning ground surveys from the upper estuary to the estimated upstream extent of chum salmon presence. This is judged by the field crew based on the presence of natural barriers, such as fallen trees (Scordino, pers. comm.).
  - When time allows, surveys are also conducted at access points along the trail (approximately up to the chin-up bars located along the side of the trail). This portion of the survey is primarily for coho salmon. The crew tries to have at least two upper stream surveys, in October and November (Scordino, pers. comm.).
  - Data collection includes date, count of living and dead salmon by species and sex, as well as whether dead females spawned their eggs before dying. Notes are also taken on the location within the survey area and visible injuries on fish backs that appear to be caused by predators.
    - *Schedule:* Weekly between mid-September and mid-December. Annually through Year 10 post-construction (pending volunteer availability).

Analysis and Reporting

The Edmonds Stream Team will analyze the data annually and report findings in an annual report. Data will be compared to past years that have already been conducted by the Edmonds Stream Team.

J. Forage Fish Egg Presence

Monitoring Purpose and Applicability to Future Restoration Projects

To document changes in the forage fish spawning. Informs the benefits of restoration beyond salmonid use. Forage fish are important food for salmon (including Chinook), other fish, marine mammals, and birds.

Questions and Hypotheses

- Does the frequency, timing, or species composition of forage fish eggs in the lower estuary, specifically surf smelt and Pacific sand lance, change following restoration?
  - *Hypothesis:* The frequency and duration of forage fish egg presence in the lower estuary will both increase following restoration.

Data Collection Lead Organization, Methods, and Schedule

- Snohomish County SWM and Snohomish County MRC
  - Collect upper intertidal substrate samples and analyze for the presence of forage fish eggs using the methods described in WDFW (2021). One sample will be taken on the north side of Lund's Gulch Creek, one sample will be taken on the south side (North GPS point start: 47.860869, -122.335150. South GPS point start: 47.858940, -122.335076). Sampling effort will match the pre-construction sampling.
    - *Schedule:* Monthly sampling year-round. Annually through Year 10 post-construction (pending funding availability).

Analysis and Reporting

The Snohomish County SWM and Snohomish MRC will perform the initial sample analysis and then send samples to WDFW for further analysis and quality assurance and quality control. Snohomish County SWM and Snohomish MRC will analyze the data annually and report the findings in an annual report. Data will be compared to past years that have already been collected.

K. Macroinvertebrate Production in the Upper and Lower Estuary

Monitoring Purpose and Applicability to Future Restoration Projects

To document macroinvertebrate production in the restored estuary, with an emphasis on common prey of juvenile salmonids.

Questions and Hypotheses

- Do the abundance and diversity of macroinvertebrates in the upper and lower estuary increase over time? Do the trends differ between the portions of the estuary?
  - *Hypothesis:* An increasingly diverse and abundant macroinvertebrate community will occupy restored habitats in the upper and lower estuary post-construction.
  - *Hypothesis:* The trends for the establishment of the macroinvertebrate community will be similar in the upper and lower estuary post-construction.
- Do the abundance and diversity of macroinvertebrates known to be common prey of juvenile salmonids increase over time in the upper and lower estuary? Do the trends differ between the portions of the estuary?
  - *Hypothesis:* An increasingly diverse and abundant community of common juvenile salmonid macroinvertebrate prey items will occupy restored habitats in the upper and lower estuary post-construction.
  - *Hypothesis:* The trends for the community of common juvenile salmonid macroinvertebrate prey items will be similar in the upper and lower estuary post-construction.
- Do the abundance and diversity of insects near the revegetated areas in the upper estuary increase over time?
  - *Hypothesis:* An increasingly diverse and abundant insect community will be produced near the revegetated areas in the upper estuary post-construction.

Data Collection Lead Organization, Methods, and Schedule

- Tulalip Tribes or University of Washington (to be determined pending funding availability and capacity)
  - Sample with five fallout traps in the upper estuary near the revegetated area, per Washington Sea Grant insect sampling protocols in the Shoreline Monitoring Toolbox (shoremonitoring.org). Samples will be collected in upland areas close to shore, and sampling will occur over 1 hour.
  - Sample with five pitfall traps in each area of interest (upper estuary, lower estuary, and adjacent nearshore with riprap [control]) (15 traps total) per Washington Sea Grant wrack invertebrate sampling protocols in the Shoreline Monitoring Toolbox (shoremonitoring.org). Samples will be collected just above MHHW, and sampling will occur over 1 hour.

- Tow a Neuston net in the upper estuary monthly during juvenile fish sampling.
    - *Schedule*: Sample in Years 1, 3, 5, and 10 post-construction.

Analysis and Reporting

The Tulalip Tribes or University of Washington will analyze the data each year and present the findings in a report.

L. Additional Vegetation Characterization

Monitoring Purpose and Applicability to Future Restoration Projects

Changes in geomorphological conditions can affect vegetative success on estuarine restoration sites. Conditions such as elevation, salinity, and tidal inundation can influence the species, strata, location, and quantity/coverage of vegetation that proliferates in a restored estuary and its associated nearshore. As the cost of restoring and maintaining estuarine and nearshore vegetation can be prohibitive, data collected for these parameters may be able to produce a "playbook" for what, where, and how much species diversity needs to be installed at the inception of restoration on similar sites. Additionally, if natural vegetation recruitment can be relied on to revegetate restored tidal systems, it could reduce costs to restore these areas and increase the opportunity for similar sites to be restored.

Questions and Hypotheses

- How do elevation, salinity, and tidal inundation gradients influence the development of native vegetative communities in the upper and lower marshes and adjacent upland?
  - *Hypothesis:* Areas on the site intended for restoration via revegetation will exhibit changes in species density and composition relative to salinity and elevation gradients.
- Will naturally recruited vegetation add to the extent and diversity of the planted vegetation in the estuary?
  - *Hypothesis:* Areas on the site that are subjected to regular tidal inundation and/or graded to allow for shallow standing water will be populated by naturally recruited vegetation in addition to the intended, planted vegetation.
- Did the restoration design properly account for the site elevations able to support various types of estuarine and freshwater wetland species?
  - *Hypothesis:* The restoration design properly estimated the vegetation type based on planned elevations relative to MLLW.

Data Collection Lead Organization, Methods, and Schedule

- DCNR
  - *Gradient Monitoring*: establish a minimum of four permanent transects of the same length and width, starting and ending at the same elevations if possible. Transects will be established during a post-construction site visit and ideally be co-located with other transects surveyed as part of the required monitoring element sampling (i.e., monitoring elements B and E). Note: consideration should be given to co-locating transects with other monitoring elements per the section on Coordination of Effort (page 8). Capped rebar will be installed at each transect terminus and its location collected with GPS. Transects will be divided equally among intended vegetation community types (e.g., two lower marsh, two upper marsh) with similar tidal inundation patterns for each vegetative community type. Use the point-line method (Bonham 1989; Coulloudon et al. 1999) to record vegetation along the transects, and record soil salinity (handheld salinity [EC] probe) and elevation (GPS) at equal distances along the transects.

- *Volunteer Species Monitoring*: Establish up to 12, 1-meter quadrats along the transect line established as part of the required monitoring element sampling, within each of the three vegetation community types: upper marsh, lower marsh, and upland buffer (Bonham 1989; Coulloudon et al. 1999). Geolocate each quadrat such that it can be revisited annually. Conduct a plant/species count within each quadrat and record the quantity, species, and condition (dead, stressed, healthy). Use this count as a baseline to exclude year-over-year to determine volunteers.

- Use the point-line method (Bonham 1989; Coulloudon et al. 1999) to record vegetation along the transects, and record soil salinity (handheld salinity [EC] probe) and elevation (RTK-GPS) at equal distances along the transects.

    - *Schedule:* Gradient and vegetation data will be collected once annually in mid-summer during mean low tide in Years 1, 3, 5, and 10 post-construction.

Analysis and Reporting

DCNR will analyze the data collected during Years 1, 3, 5, and 10 post-construction and report the findings in a monitoring report. Data will be compared to past years that have already been collected by DCNR. Salinity data can be compared to the associated vegetative communities to determine if there is a change in vegetation relative to salinity, as would be expected (Hutchinson 1991; Hruby 2014).

M. Photo Points

Monitoring Purpose and Applicability to Future Restoration Projects

Photo points are identified locations in the restoration area that are revisited over time with multiple photos taken each time. The photographs are not intended for repeatable quantitative analysis, rather are meant as a resource to generally document site conditions and changes over time. The photographs are expected to provide visual documentation of sedimentation, streambank erosion, channel alignments, vegetation establishment, beach changes, etc.

Questions and Hypotheses

- How do different restoration features change over time?
  - *Hypothesis: The photo documentation of conditions at established photo points throughout the restoration area over time will provide pictorial documentation of the evolution of the site*.

Data Collection Lead Organization, Methods, and Schedule

- DCNR, Tulalip Tribes, and potentially others
- Recoding photos at established photo points over time is intended to be a low effort monitoring element that field crews can complete while onsite for other monitoring work.
- The specific details for photo points should be established in the field at the outset of monitoring. These details include the location of each photo points, the number of photos to record at each site, and compass orientation of each photo to be taken.
  - For photo points along the margin of the restoration area, the photos should be focused towards the restoration. For example, Figure 8 shows four photos from a photo point established along the northern shoreline to the excavated estuary. The four photos all face the restoration and are taken at regular intervals showing the restoration.
  - For photo points centrally located among the restoration, the photos should provide 360-degree coverage of the restoration area. This will likely require 4-8 photos.
  - For repeatability of the photo compass orientation, record compass bearings or note target landmarks in photos.
  - Figure 9 displays proposed photo point locations. In addition, it is recommended that photo points are established and the landward margin (east end) of all Lower Estuary transect locations (see Figure 7 and Table 4) and the two forage fish egg survey locations (North GPS point start: 47.860869, -122.335150. South GPS point start: 47.858940, -122.335076). Note: some photo documentation has occurred as part of pre-construction monitoring such that some locations may already be established.
- Create a name for each photo point. Record GPS coordinates of each photo point.
- Create a “master photo points map” that identifies each photo point and indicates which directions photos are to be taken at each point.

- To help with photo organization, it is recommended that the first photo at each photo point shows the name of the photo point.

  – *Schedule:* Photograph at least twice per year (early summer and early winter), with more frequent (quarterly) photo collection encouraged.

Analysis and Reporting

No separate analysis or reporting is required. For photo organization, an example photo page created by Snohomish County is provided in Figure 10.

Figure 8. Example of Four Photos and Their Orientation to Restoration Site Taken at One Proposed Photo Point

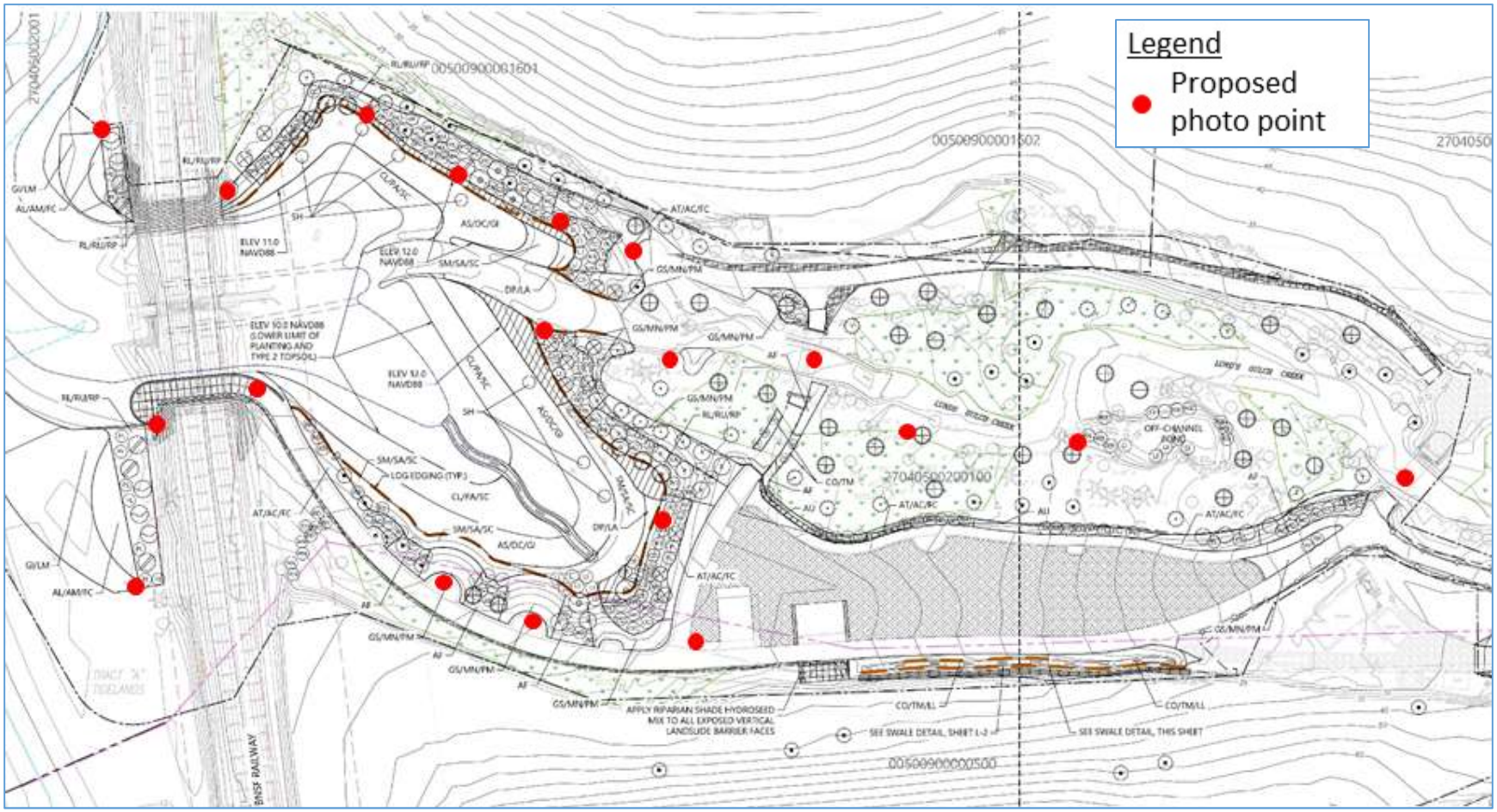


Figure 9. Recommended Photo Point Locations (with additional recommended beach locations described in preceding text)

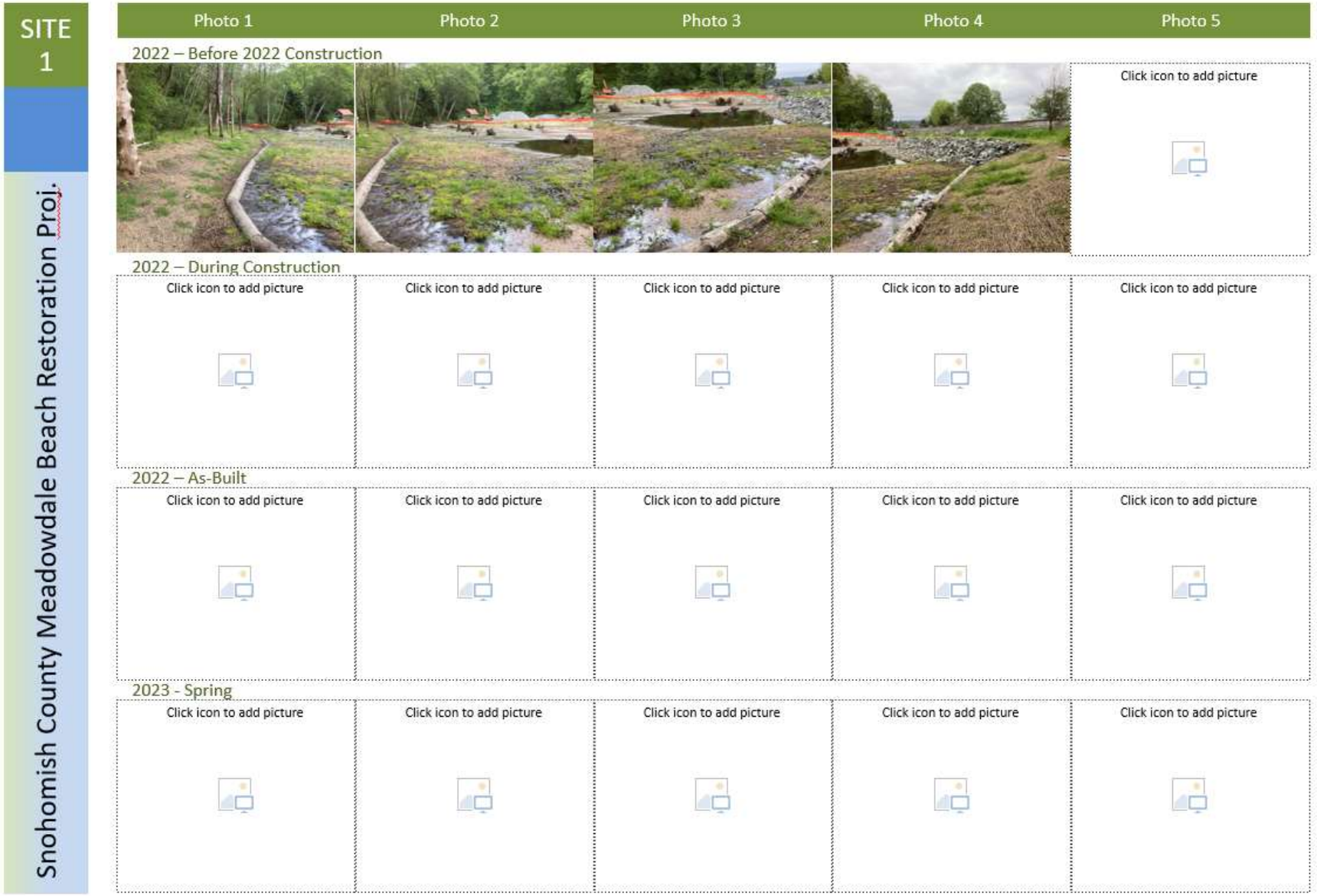


Figure 10. Example Photo Page to Organize Photos Over Time

Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought

The monitoring elements included in this section are those for which there is currently no identified lead organization and no funding for the monitoring. The identification of a lead organization and the availability of funding will determine which of these monitoring elements can be conducted.

N. Extended Salmon Spawning Ground and Redd Surveys

Monitoring Purpose and Applicability to Future Restoration Projects

To supplement the spawning ground surveys conducted by the Edmonds Stream Team (Monitoring Element I), extending the survey farther upstream and including salmon redd (egg nest) counts in Lund's Gulch Creek.

Questions and Hypotheses

- How far up in Lund's Gulch Creek do anadromous salmon adults return to spawn?
  - *Hypothesis:* Coho and chum salmon adults spawn farther upstream than has been regularly surveyed by the Edmonds Stream Team volunteers.
- Do the number of anadromous salmon redds increase year to year after restoration?
  - *Hypothesis:* An increasing number of redds will be recorded in the years following restoration.

Data Collection Lead Organization, Methods, and Schedule

- To be determined
  - Spawning ground surveys continuing upstream from where the chum salmon surveys conducted in Monitoring Element I end. This extends the survey area upstream to provide continuous observations rather than only at access points. The survey area should extend through the potential extent of coho salmon spawning. Data collection includes date, count of living and dead salmon by species and sex, number of redds, and whether dead females spawned their eggs before dying. Notes are also taken on location within the survey area and visible injuries on fish backs that appear to be caused by predators.
  - Redd surveys from the creek mouth to the upstream extent of spawning ground surveys. This includes the area in Monitoring Element I and the additional stream length monitored in this monitoring element.
    - *Schedule*: Weekly or every other week between mid-September and mid-December. Recommended annually through Year 10 post-construction.

Analysis and Reporting

Data would be analyzed annually and reported in an annual report. Data would be compared to results from Monitoring Element I and, over time, earlier years of data.

O. Carbon Sequestration in Soils

Monitoring Purpose and Applicability to Future Restoration Projects

Growing recognition of the ability of wetlands to combat climate change by sequestering and storing atmospheric carbon has led to an increased interest in quantifying the greenhouse gas (GHG) benefits of coastal ecosystems. To date, much of the science and practice of biological carbon sequestration and the development of associated carbon offset projects has focused on forestry, where the science and tools necessary to calculate GHG benefits are fairly well-developed. However, more recently, organizations and agencies from the local to the international scale have begun to quantify the carbon storage and sequestration capacities of wetlands and aquatic habitats, especially salt marshes, mangroves, and seagrass beds. This so-called "blue carbon" is of great significance for both carbon sequestration and storage, as wetlands (both freshwater and saline) store 20–30 percent of global soil carbon while making up just 5–8 percent of global land surface (Nahlik and Fennessy 2016).

Quantifying blue carbon can be used to assess the benefits of restoration for GHG offsets. The addition of climate mitigation benefits is expected to broaden the pool of potential funds for estuarine restoration and conservation, particularly as ecosystems like coastal wetlands are threatened by climate change and sea-level rise. Where carbon financing is not appropriate, recognition of the climate values of salt marsh could help prioritize actions that improve and conserve these habitats in the context of climate adaptation.

Questions and Hypotheses

- What is the baseline carbon stock currently existing in the soils of the restored lower and upper marshes?

- How does the variation in sequestered carbon reflect variation in local environmental conditions (e.g., vegetation, elevation)?

- What is the rate of soil carbon sequestration in the soils of the restored lower and upper marshes and how does it vary based on local environmental conditions?

  – *Hypothesis*: The restored lower and upper marshes already contain carbon in the soils. The amount of carbon stored varies, based on vegetation types. The lower and upper marshes will show a discernible accumulation of soils carbon over a minimum 10-year period. The marshes will sequester soil carbon at a rate within the range recorded in recent scientific literature regarding carbon sequestration in estuarine soils.

Data Collection Lead Organization, Methods, and Schedule

- To be determined

  – Collect six soil core samples at the same elevation annually, two from each of the permanently established geospatially recorded locations. Soil sample should be collected to a depth of a minimum of 1 meter (or until shovel refusal). Cores will then be sampled at different depths, with more detail in the upper 50 cm of the core to capture carbon content variation (i.e., samples every 10 cm and then one sample from 50–100 cm depth).

Collected samples will be sent to a lab to analyze sediment dry bulk density and organic carbon content.

- *Schedule*: Once annually in early summer, after spring storm events are complete. Recommended to sample in Years 1, 3, 5, and 10 post-construction.

Analysis and Reporting

At the lab, the samples will be dried at 70 degrees Celsius (as low as possible to reduce the loss of carbon) to measure the mass of the dry sediment per the Blue Carbon Manual (Howard et al. 2019). This will be used to determine the dry bulk density, defined as the mass of dry sediment divided by the wet sample volume. The samples will then be measured for total organic carbon (TOC) content using an automated elemental analyzer. If subsamples are used, the sample should be homogenized to make sure it is representative of the full sample. The carbon fraction can be multiplied by the bulk density to obtain carbon density. Data would be analyzed for each sampling year (including plots of carbon density by depth and comparisons of carbon density across the site) and reported in an annual report. Over time, data would be compared to document the trends.

P. Wildlife Use

Monitoring Purpose and Applicability to Future Restoration Projects

To document wildlife use of the restored habitats.

Questions and Hypotheses

- Will a broad community of wildlife species use the restored habitats?
  - *Hypothesis:* A diverse community of wildlife, including birds, mammals, and semi-aquatic mammals (e.g., river otters), will occupy the restored habitats.
- Will wildlife move under the railroad bridge to access the lower estuary and upper estuary habitats?
  - *Hypothesis:* Wildlife species will move under the railroad bridge to access estuary habitats on the other side.

Data Collection Lead Organization, Methods, and Schedule

- To be determined
  - Install a camera facing downstream from a location in the creek outlet or lower Lund's Gulch Creek toward the upper estuary. The camera will take photographs at set intervals (e.g., every 15 minutes). Photographs will be stamped with date and time.
    - *Schedule:* Continuous camera deployment with setting to take photographs at timed intervals through Year 10 post-construction (pending funding).

Analysis and Reporting

Photographs would be reviewed from the two cameras deployed – in the upper estuary as described here and in the lower estuary as described in Monitoring Element G. The approach to selecting the subset of photographs for review would be established in the first year, then conducted the same way in subsequent years. The subset of photographs should include all seasons of the year and potentially focus on times of the day or week, such as at dawn on weekdays, when there is less potential disturbance by people visiting the park. The species (or closest taxonomic level) would be recorded, along with the date. A list of wildlife species would be included in annual reports.

Q. Public Use

Monitoring Purpose and Applicability to Future Restoration Projects

To document the public's use of the restored park amenities for educational purposes.

Questions and Hypotheses

- Will the restored portions of the park be used by educational groups?
  - *Hypothesis:* Educational groups will use the restored portions of the park.

Data Collection Lead Organization, Methods, and Schedule

- To be determined
  - Maintain an educator voluntary sign-in sheet on the public notice board near the Park Ranger's house and on the park website. The sign-in sheet could include the date, the number in the group, the areas of the park that were visited, and their organization.
  - Maintain a log of the educational groups who contact the Park Ranger for access or information.

Analysis and Reporting

Each year, the number of educational groups who were logged as using the park would be summarized in an annual report.

Schedule and Responsible Parties

A summary of the monitoring schedule for each monitoring element and the organization in charge of collecting the data is provided in **Table 5.**

TABLE 5
SUMMARY OF SCHEDULE AND RESPONSIBLE ORGANIZATIONS FOR EACH MONITORING ELEMENT

ID	Monitoring Element	Organization	Included in Required Monitoring Reports in Years 1, 3, 5, and 10 Post-Construction?	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9				Year 10			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A	Fish Passage Conditions																																								
	Channel cross-section water depth and velocity, including rod and level data to compare to CTD diver gauge location	DCNR	yes, year 1	x																																					
	CTD diver gauge	Tulalip Tribes	yes, year 1	x																																					
B	Channel Cross-sections and Profile Surveys																																								
	RTK-GPS transects	DCNR	yes	x																x																				x			
C	Stream Habitat in Lower Lund's Gulch Creek and Creek Outlet																																								
	Wadeable stream habitat survey	DCNR	yes			x								x								x																				x
	Benthic macro-invertebrate sampling	DCNR	yes			x								x								x																				x
D	Large Wood Retention and Recruitment in Upper Estuary																																								
	Large wood count	DCNR	yes			x								x								x																				x
E	Planted Vegetation Survival and Coverage																																								
	33-ft diameter circular plot survey	DCNR	yes			x								x								x																				x
	Wetland ratings (freshwater wetlands only)	DCNR	yes																																						x		
	Quadrat sampling in high saltmarsh, low saltmarsh, and freshwater wetland	DCNR	yes			x								x								x																				x
	Point-line sampling in riparian	DCNR	yes			x								x								x																				x
F	Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet																																								
	Drone flights and RTK-GPS transects	Tulalip Tribes		x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*
	Sediment particle tracking	Tulalip Tribes		x			x	x																																		
	Substrate size sampling	DCNR				x								x								x																				x
G	Sediment Dynamics in Lower Estuary and Adjacent Nearshore																																								
	Drone flights and RTK-GPS transects	Tulalip Tribes		x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*	x*		x	*
	Surface and subsurface substrate size sampling	Tulalip Tribes		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x		x	
	Overlook camera images at regular intervals	Tulalip Tribes		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	RTK-GPS transects, surface and sub-surface substrate size sampling, wave gauge monitoring	Blue Coast Engineering		+	+	+	+	+	+	+	+																																
H	Fish Use																																								
	Electrofishing	Tulalip Tribes			x				x				x				x				x				x				x				x				x				x		
	Beach seining	Tulalip Tribes			x				x				x				x				x				x				x				x				x				x		
I	Salmon Spawning Ground Surveys																																								
	Spawner surveys	Edmonds Stream Team				x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x
J	Forage Fish Egg Presence																																								
	Forage fish egg sampling	Snohomish MRC		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
K	Macroinvertebrate Production in Upper and Lower Estuary																																								

ID	Monitoring Element	Organization	Included in Required Monitoring Reports in Years 1, 3, 5, and 10 Post-Construction?	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9				Year 10			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Insect fallout traps	Tulalip Tribes or UW			x								x								x																	x			
	Pitfall traps	Tulalip Tribes or UW			x								x								x																	x			
	Neuston tow	Tulalip Tribes			x								x								x																	x			
L	Additional Vegetation Characterization																																										
	Gradient monitoring	DCNR				x								x								x																	x			
	Volunteer species monitoring	DCNR				x								x								x																	x			
	Soil salinity	DCNR				x								x								x																	x			
M	Photo Points																																										
	Photo Points	ALL		o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x	o	x
N	Extended Salmon Spawning Ground and Redd Surveys																																										
	Extended spawning ground and redd surveys	TBD				x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x		
O	Carbon Sequestration in Soils																																										
	Soil cores	TBD			x								x								x																	x			
P	Wildlife Use																																										
	Overlook camera images at regular intervals	TBD		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q	Public Use																																										
	Educator visits to park	TBD			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x	

Note: x indicates sampling planned

* indicates added sampling following a storm event. Such sampling is not required, but of interest due to information it would provide.

o indicates added sampling that is desired but not a core part of the schedule identified

+ indicates data to be collected periodically as part of a separate project.

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Appendix A
Monitoring Plan from NOAA Community Restoration Grant Agreement

MONITORING PLAN – MEADOWDALE BEACH PARK ESTUARY RESTORATION

This Monitoring plan describes the monitoring to be conducted to evaluate the implementation and effectiveness of the Meadowdale Beach Park Estuary Restoration (NOAA-NMFS-HCPO-2020-2006306), implemented by Snohomish County. Snohomish County is willing to work with NOAA to adjust this Monitoring Plan. Monitoring will be conducted by the Snohomish County Surface Water Management Group or a qualified consultant retained for that purpose.

Implementation Monitoring

The following data sets will be collected in pre- and post-restoration assessments (Year 0) to document the implementation of the restoration as designed:

a) length of armor removed
b) acres of pocket estuary restored
c) acres of freshwater wetland restored
d) acres of nearshore and riparian planting
e) volume of floodplain fill and debris removal
f) count of large wood in the project area
g) miles of stream habitat unblocked (fish access restored)

Effectiveness Monitoring

The following restoration goals will guide the effectiveness monitoring:

1. Restore natural tidal regime to improve salmonid access and refuge opportunities
2. Improve habitat for fish and wildlife species
3. Establish native plant communities

A 10-year monitoring program will be implemented to evaluate the project's performance in meeting these goals. Prior to the first monitoring visit, as-built (or Year 0) plans will be prepared to document the constructed estuary and restoration site conditions. Any changes to the approved estuary restoration designs would be documented on the as-built plans. Based on as-built plans or record drawings, monitoring will take place during the growing season, (preferably late summer or early fall) prior to leaf drop, during the first 10 years after construction, in accordance with the monitoring reporting years.

Snohomish County will prepare a report for those years of monitoring (Years 1, 3, 5, and 10). The reports will be submitted by December 31 of the applicable year. As described in the Data

Management Plan, data will be available through the County's website. Data may also be available through the National Centers for Environmental Information.

The restoration targets and monitoring protocols for each goal are provided below.

Goal No. 1: Restore natural tidal regime to improve salmonid access and refuge opportunities

Target:

- Restored estuary will allow natural tidal fluctuations and appropriate depths and velocities for juvenile and adult passage

Monitoring Protocol:

- Install velocity meter in the low-flow channel to record velocities for one year following construction. Develop velocity/frequency curve.
- Install water-level logger in estuary upstream of the railroad for 1 year following construction. Develop depth/frequency curve.
- Conduct channel cross-section and profile surveys in Years 1, 5, and 10 following construction to evaluate if fish access conditions are maintained. Document changes and identify causal factors for changes observed.

Goal No. 2: Improve habitat for fish and wildlife species

Targets:

- Achieve 50–70% cover of native vegetation species planted per design at designated representative monitoring plots within 5 years post-construction and sustain for lifetime of the Project.
- Reduce non-native vegetation species to less than 20% cover within 5 years post-construction.
- Document habitat functions via the Washington State Wetlands Rating System (Hruby 2014) and Methods for Assessing Wetland Functions (HGM model, Hruby et al. 2001) in Year 10 following construction. Compare scores to the baseline condition.

Monitoring Protocol:

- Establish five permanent vegetation plots to be representative of the plant communities and restored areas. Permanent plots shall be 33-foot-diameter circular plots (center point of each plot will be documented via GPS coordinates to reoccupy in each sampling). Percent cover will be visually assessed and documented for each stratum (herbs, shrubs, trees, woody vines) and each species with more than 5% cover. Sampling will occur in Years 1, 3, 5, and 10 following construction. Meet mitigation performance standards for plant communities.
- Conduct stream/estuary survey of habitat units and large wood in Years 1, 3, 5, and 10 following construction, using appropriate protocol such as recommended in the Status and Trends Monitoring of Watershed Health and Salmon Recovery (Ecology 2006).
- Conduct habitat functions via the Washington State Wetlands Rating System (Hruby 2014) and Methods for Assessing Wetland Functions (HGM model; Hruby et al. 1999) in Year 10 following construction. Compare scores to the baseline condition.

Goal No. 3: Establish Native Plant Communities

Targets:

- Plant communities will be restored by installing native trees, shrubs, and emergent
- In Year 1, average survival of planted trees will be at least 90%
- Within planted areas identified in Table 10, native riparian vegetation species cover shall be at least 25% by Year 3, at least 50% by Year 5, and 70% cover by Year 10.
- Native herbaceous coverage within designated estuary and beach areas shall be at least 50% by Year 3, 70% by Year 5, and 95% by Year 10.
- Invasive, non-native plant species are maintained at levels below 20% total cover within planted riparian areas. Species such as creeping buttercup may not necessarily be included in invasive cover standards as long as those species do not interfere with long-term goals.

Monitoring Protocol:

- Planted and naturally colonizing vegetation will be monitored to measure both the success of the planting efforts and interspersion of wetland classes, as defined by Cowardin and others (1979).
- All monitoring would use standard ecological techniques to sample, measure, or describe vegetation and wildlife habitat conditions. The following information on shrub and tree vegetation will be collected:
    - All plant species, in the order of dominance, based on relative percentage cover of each species within each of the vegetative strata
    - The species composition (i.e., percentage of each species, exotic or native
    - Average height and general health of each planted species
    - Permanent photograph stations will be established; photographs will be taken in the same direction at these stations every monitoring year.

Appendix B

Meadowdale Beach Park and Estuary Design 100% Construction Drawings