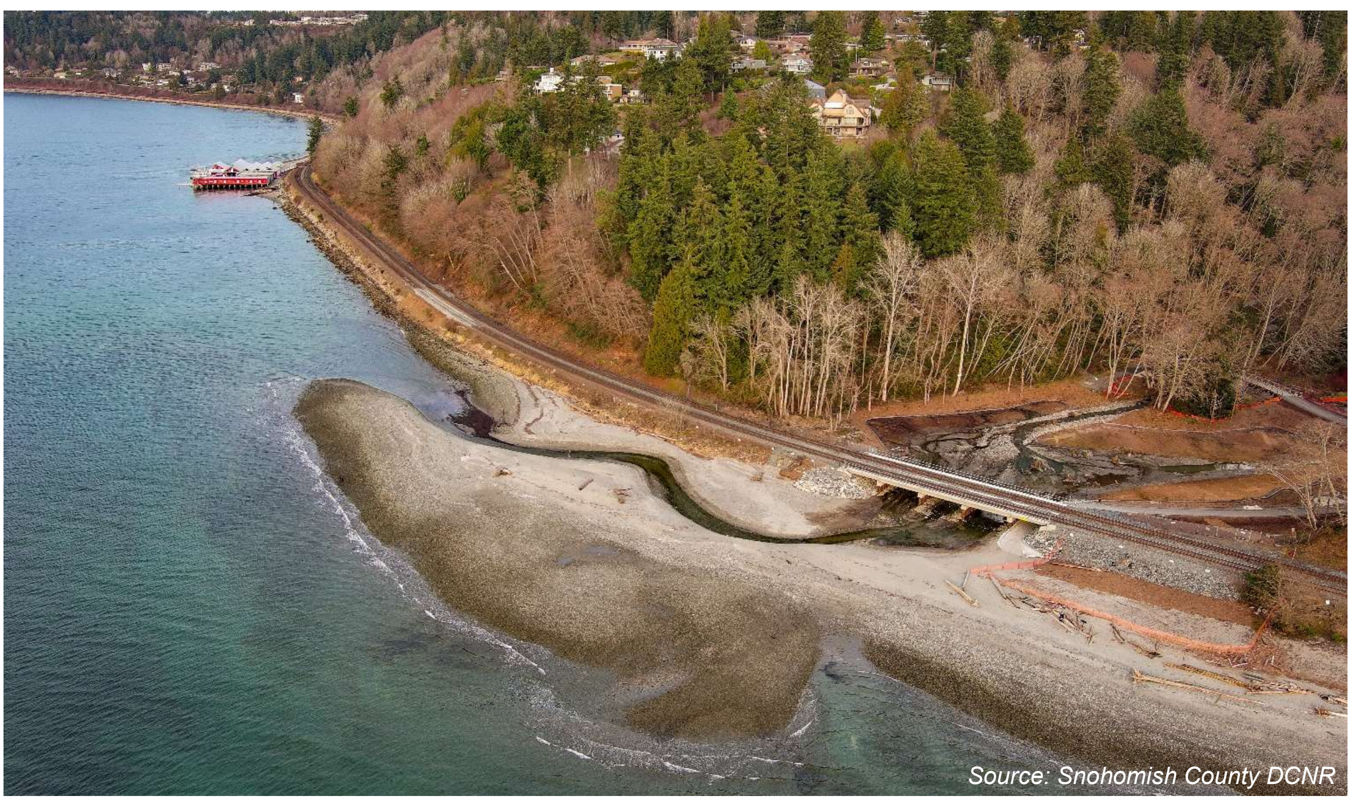
FINAL

MEADOWDALE BEACH PARK AND ESTUARY RESTORATION EFFECTIVENESS MONITORING

Year 1 Report

Prepared for
Snohomish County
Surface Water Management

December 2023
Revised June 2024



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NOTE: This Year 1 monitoring report was revised in June 2024 to include an additional memorandum prepared by Snohomish County in order to meet one of the reporting requirements of the project grant from the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-NMFS-HCPO-2020-2006306). As part of implementation monitoring, the grant requires a comparison of pre- and post-hydrographs for the Meadowdale Beach Park Estuary Restoration project (NOAA 2022). Two approaches were followed for evaluating the before and after effectiveness of the culvert replacement with a railroad bridge on the natural tidal fluctuations: 1) before-after hydrographs, and 2) before-after flow velocity. Approach 1 is described and demonstrated in Appendix E of this document. Approach 2 is reported in the Year 1 Monitoring Report under Fish Passage Conditions (pp. 8 – 11).

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EXECUTIVE SUMMARY

YEAR 1 MONITORING REPORT

Meadowdale Beach Park and Estuary Restoration

The Meadowdale Beach and Estuary Restoration Project, completed by Snohomish County Parks and Recreation Division, restored the estuary of Lund's Gulch Creek by replacing an undersized culvert through the Burlington Northern Santa Fe (BNSF) railroad embankment along the Puget Sound shoreline with a wide bridge. The project provides important habitat for young salmon, especially Chinook salmon. Snohomish County and partners are conducting 10 years of restoration effectiveness monitoring. This report provides the results of Year 1 post-restoration monitoring.

Project Significance

This project is regionally significant for its role in Chinook salmon recovery and Puget Sound shoreline restoration. It is the "first of its kind" in Puget Sound by replacing the railroad crossing and restoring a large estuary. This was a high priority restoration action addressing a key need identified in the watershed's salmon recovery plan. **Effectiveness monitoring of this major restoration will provide information on the ecological value of the investment and help inform the design of future similar projects.**

Previous conditions

MONITORING PARTNERS:

SNOHOMISH COUNTY Conservation & Natural Resources

Snohomish County Marine Resources Committee

TULALIP TRIBES

EDMONDS STREAM TEAM

USGS science for a changing world

Sea Grant

For more information, contact **Elisa Dawson**, Senior Planner, Marine Resources Snohomish County, Department of Conservation and Natural Resources/Surface Water Management, (425) 508-2726.

Monitoring

Monitoring began 2023 and will occur year-round for ten years (until 2032) to fulfill funding and permit requirements, inform decision-making about site maintenance, and inform the design of future similar projects. It includes data collection for several monitoring elements in the estuary and stream:

REQUIRED MONITORING ELEMENTS

- Fish passage conditions
- Channel cross section and profile surveys
- Stream habitat and benthic macroinvertebrate populations
- Large wood retention and recruitment in upper estuary
- Planted vegetation survival and coverage

ADDITIONAL MONITORING ELEMENTS

- Sediment dynamics and habitat area
- Fish use
- Salmon spawning surveys
- Forage fish egg presence

Year 1 Results

Year 1 monitoring will serve as a baseline for future monitoring years. Results as follows:
RED = element needs management; **YELLOW** = on track or not yet known; **GREEN** = met performance standards

RESULT	MONITORING ELEMENT	NOTES
	Fish passage conditions	Velocities below maximum threshold. Restored natural passage conditions for estuary.
	Channel cross section and profile surveys	Baseline measurement.
	Stream habitat and benthic macroinvertebrate populations	Baseline habitat data collected. Two benthic macroinvertebrate samples collected with results pending.
	Large wood retention and recruitment in upper estuary	Much more large wood through restoration. Post-restoration there is 107 pieces of large wood in stream and estuary compared to 2 pieces pre-restoration.
	Planted vegetation survival and coverage	Exceeded 90% survival standard for native planted vegetation and low coverage (<20%) of non-native vegetation.
	Sediment dynamics and habitat area	Baseline measurement.
	Fish use	Ten fish species captured in electrofisher sampling, including chinook, coho, and chum salmon and coastal cutthroat trout.
	Salmon spawning surveys	Mixed results compared to pre-restoration surveys. Coho salmon highest numbers since 2019. Chum salmon lowest numbers since 2019.
	Forage fish egg presence	No forage fish eggs were detected in Year 1. Mid-construction, surf smelt and sand lance eggs were detected. Pre-construction, no forage fish eggs were documented.

Monitoring efforts will help answer critical questions:

- What elements are working well?
- What elements need maintenance or adaptive management?
- What are the measurable benefits of the site's restoration?
- What can we do better in the future?
- Has the project been a good investment?
- How can our results inform planning and design for similar restoration projects throughout the Salish Sea?

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Acronyms and Abbreviations

ADA	Americans with Disabilities Act
BFW	bankfull width
BNSF	Burlington Northern Santa Fe
DCNR	Department of Conservation and Natural Resources
ESRP	Estuary and Salmon Restoration Program
GPS	global positioning system
HAT	highest astronomical tide
LWD	large woody debris
Meadowdale project	Meadowdale Beach Park and Estuary Restoration project
MHHW	mean higher high water
MTL	mean tide level
NOAA	National Oceanic and Atmospheric Administration
RTK-GPS	Real-Time Kinematic Global Positioning System
WDFW	Washington Department of Fish and Wildlife

MEADOWDALE BEACH PARK AND ESTUARY RESTORATION EFFECTIVENESS MONITORING

Year 1 Report

Introduction

In 2023, Snohomish County Department of Conservation and Natural Resources (Snohomish County) completed construction of the Meadowdale Beach Park and Estuary Restoration Project. The project transformed the site to restore fish passage, improve salmon habitats, increase the site's resilience to climate change, and improve the park experience and safe access to the Puget Sound shoreline.

The primary components of the habitat restoration project were the replacement of an undersized 6-foot-wide culvert with a multi-span railroad bridge to create a 90-foot-wide channel opening at the mouth of Lund's Gulch Creek, the excavation of a large estuary immediately upstream from the Burlington Northern Santa Fe (BNSF) railroad crossing, and an expanded tidal channel downstream of the railroad crossing. Native riparian planting and large woody debris installation in the estuary and stream further improve habitat conditions.

The project restored estuary habitat to benefit salmon originating in Lund's Gulch Creek as well as juvenile salmon migrating to the site from other river systems. A primary objective of the restoration was to improve habitat for rearing by juvenile Chinook salmon (*Oncorhynchus tshawytscha*) which are listed under the Endangered Species Act. In addition to salmon, the project aimed to benefit other fish and wildlife who use estuary habitats and restore fluvial, estuarine, and coastal processes in the project area.

Project construction began in 2021 with the excavation of much of the enlarged estuary. In 2022, the new railroad bridge was installed and the rest of the estuary excavation was completed. Important habitat restoration refinements were made in 2023 so that the constructed project more fully matched the engineer's final design.

The Meadowdale project is regionally significant due to the railroad bridge component and the extent of estuary habitat restoration at the site. This is the first restoration in Puget Sound that included replacing a railroad crossing to improve habitat restoration and fish passage in a larger project. Another aspect of regional significance is the repurposing of a substantial portion of the park area near the railroad from a recreational focus to a habitat focus.

Snohomish County and multiple partners are committed to monitoring the site and evaluating the effectiveness of the restoration. A 10-year effectiveness monitoring plan was prepared to guide the monitoring program (ESA 2022). The monitoring plan was developed with input from a monitoring workgroup of experts convened by Snohomish County. 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 that contributed to the restoration, and to BNSF Railway, which controls the right-of-way.

The monitoring plan includes monitoring elements that are required as part of grant funding and 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. The monitoring plan also 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.

This Year 1 post-restoration monitoring report documents the monitoring work completed in 2023 and evaluates the performance for each of the monitoring elements studied. Since construction continued into 2023 in the estuary and the project included comprehensive changes to the lower stream and estuary, the data collection reported here sets the post-restoration baseline against which future years of data collection can be compared. This Year 1 post-restoration monitoring report includes adaptations to the general methods described in the monitoring plan (ESA 2022). These adaptations reflect the methods implemented by project partners collecting the data. The adaptations were necessary to improve consistency with standard protocols, previous methods used to collect baseline data, and based on site conditions requiring adjustment to the methods.

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 2018a).

The overarching ecological goal of the project was 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 (*O. kisutch*) and chum salmon (*O. keta*), coastal cutthroat trout (*O. clarkii clarkii*), 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.

A Collaborative Monitoring Partnership

The planning and implementation of the monitoring program is a highly collaborative effort among many organizations. Snohomish County convened a monitoring work group to guide monitoring activities. The monitoring work group includes partners from Snohomish County, Tulalip Tribes, Snohomish County Marine Resources Committee, Edmonds Stream Team, Blue Coast Engineering, U.S. Geological Survey, and Washington Sea Grant. Snohomish County appreciates the contributions each of these partners has made.

Monitoring Area Definitions and Sampling Reaches

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; the upstream end is the pedestrian bridge near the park ranger's house.
- **Creek Outlet** – Transitional area where the 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 and 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 Tulalip Tribes established sampling reaches throughout the monitoring area (**Table 1** and **Figure 2**). The sampling reaches were used in the aquatic habitat mapping and fish-use sampling efforts. These post-restoration reaches varied from pre-restoration reaches, but pre-restoration sampling results were adjusted here for reporting to coincide with the post-restoration reaches. For example, the pre-restoration stream habitat mapping occurred in two reaches (numbers 2 and 3), but those reaches coincide with three post-restoration reaches so the data are reported as being from three sampling reaches (numbers 1 through 3).

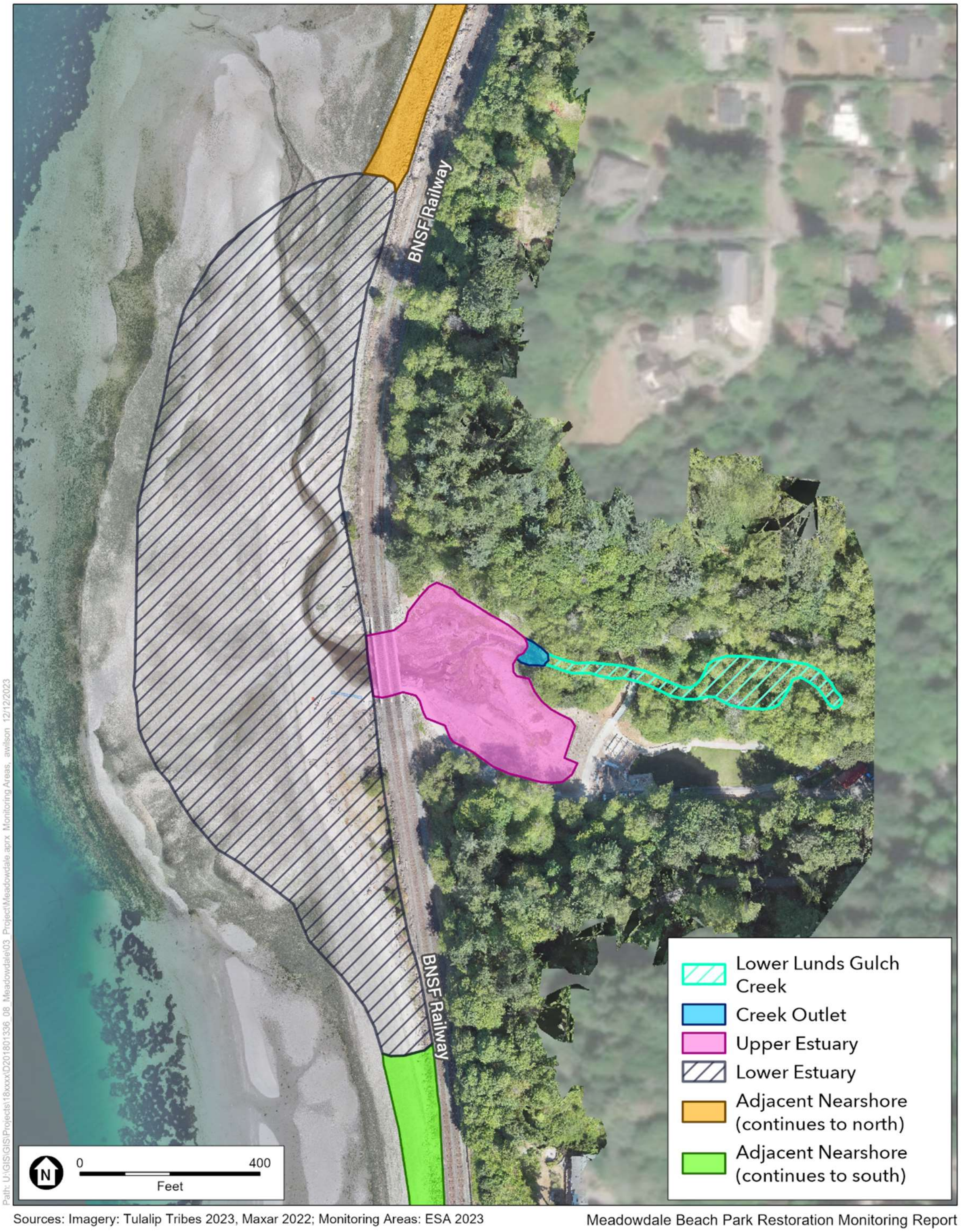


Figure 1. Monitoring Areas

TABLE 1
SAMPLING REACHES

Reach	Post-Restoration Description	Monitoring Area(s) Included
0	Estuary waterward from railroad crossing	Lower Estuary
1	Estuary through railroad embankment up to bottom of creek alluvial fan	Upper Estuary
2	Creek alluvial fan up to stream channel	Upper Estuary and Creek Outlet
3	Lowermost segment of creek channel	Lower Lund's Gulch Creek
4	Middle segment of creek channel	Lower Lund's Gulch Creek
5	Uppermost segment of creek channel	Lower Lund's Gulch Creek

Figure 2. Sampling Reaches

Overview of Monitoring Elements

The monitoring elements identified in the monitoring plan are listed in **Table 2**. The table 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. The table also indicates whether the monitoring is being conducted—and reported on here—or is currently unfunded. The unfunded monitoring elements are further explained in the monitoring plan (ESA 2022) and could be funded in future years if funding is available.

TABLE 2
EFFECTIVENESS MONITORING ELEMENTS

ID	Monitoring Element	Monitoring Conducted in Year 1 Post-Restoration	Monitoring Partner
Required Per Grant Funding Agreement or Permits			
A	Fish passage conditions	Yes	Snohomish County
B	Channel cross-section and profile surveys	Yes	Snohomish County, Tulalip Tribes
C	Stream habitat in lower Lund's Gulch Creek and creek outlet	Yes	Snohomish County
D	Large wood retention and recruitment in upper estuary	Yes	Snohomish County
E	Planted vegetation survival and coverage	Yes	Snohomish County
Additional Effectiveness Monitoring – With Monitoring Leads Identified, Pending Funding			
F	Sediment dynamics and habitat area in upper estuary and creek outlet	Yes	Tulalip Tribes
G	Sediment dynamics in lower estuary and adjacent nearshore	Yes	Tulalip Tribes
H	Fish use	Yes	Tulalip Tribes
I	Salmon spawning ground surveys	Yes	Edmonds Stream Team
J	Forage fish egg presence	Yes	Snohomish County
K	Macroinvertebrate production in the upper and lower estuary	No	
L	Additional vegetation characterization	Yes	Snohomish County
M	Photo points	Yes	Snohomish County, Tulalip Tribes, Blue Coast Engineering
Additional Effectiveness Monitoring – With No Monitoring Leads Identified and No Funding Sought			
N	Extended salmon spawning ground and redd surveys	No	
O	Carbon sequestration in soils	No	
P	Wildlife use	No	
Q	Public use	No	

The monitoring elements not conducted in year 1 would still provide useful information for evaluating the effectiveness of the restoration. If funding becomes available, some or all of the additional monitoring elements may be conducted.

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).

Fish Passage Conditions

A key aspect of the restoration design was to replace the undersized culvert crossing through the railroad embankment with a five-span railroad bridge to restore unrestricted fish passage typical of a coastal estuary. Prior to restoration, the crossing through the railroad embankment was a 6-foot-wide box culvert, of which only 4.5 feet was a low-flow concrete channel for the creek and 1.5 feet was a ledge that pedestrians used to walk to and from the beach. The culvert was approximately 94 feet long from upstream end to outlet on the beach side. The restoration project removed the box culvert and replaced it with a railroad bridge. The restoration also removed a section of the railroad embankment composed of riprap armoring. The new crossing provides a 90-foot-wide area for the estuary.

Many estuaries can provide conditions that are only intermittently accessible to fish moving against the direction of flow—especially small fish such as juvenile salmon. Fish passage conditions at Meadowdale Beach Park were evaluated to ensure fish passage was restored. **Table 3** shows the monitoring element and performance standard, and whether the performance standard was achieved.

TABLE 3
FISH PASSAGE MONITORING SUMMARY

Monitoring Element / Performance Standard	Performance Standard Met?	Year Post-Construction										
		0	1	2	3	4	5	6	7	8	9	10
Develop velocity/frequency curve by installing velocity meter in the low-flow channel. Performance standard is to provide suitable velocity conditions for juvenile and adult salmonid access to the restored estuary.	Yes		X									
Develop depth/frequency curve by installing water-level logger in the low-flow channel. Performance standard is to provide suitable depth conditions for juvenile and adult salmonid access to the restored estuary.	Yes		X									

Notes: X indicates required years of monitoring. Orange shading indicates current reporting year.

The NOAA grant required additional sampling for implementation monitoring (NOAA 2022) that was not included in the monitoring plan (ESA 2022) but added in this revised Year 1 Monitoring Report. NOAA (2022) required a comparison of pre- and post-hydrographs for the Meadowdale Beach Park Estuary Restoration project. The methods and results for this added monitoring element are described in Appendix E.

Methods

Fish passage conditions assessed during Year 1 monitoring included collecting channel cross-sections, water depth, and velocity data. Data were collected at a transect at the upstream margin of the railroad bridge and at a transect running parallel. Data collection occurred in late January based on predicted tide height, with a priority for sampling occurring on a day when tides would be ebbing from a high tide above mean higher high water (MHHW) to a low tide below mean tide level (MTL) which allows the embayment upstream of the railroad crossing to fully drain.

Flow velocity was evaluated based on 20 regularly spaced measurement intervals across the channel as recorded on a fixed reel tape stretched taught across the channel. The total wetted width and flow velocity was measured every fifteen minutes with identical instruments from the time of high tide to the time when flow was solely influenced by stream flow. Velocity was measured at a depth of 60 percent of the total water depth, which was assumed to represent the average flow velocity in the vertical water column (Snohomish County 2019a). As noted above, methods for the added monitoring element to compare pre- and post-hydrographs are described in Appendix E.

Results and Discussion

The monitoring data document the project's success restoring fish passage at the site. Prior to restoration, the box culvert was substantially undersized to convey flows and support fish passage into the lower stream. The stream channel was funneled into the culvert, which increased velocities through the length of the structure. Prior to restoration, the Washington Department of Fish and Wildlife (WDFW) characterized the culvert as a partial fish barrier due to a high slope (WDFW 2017).

The year 1 post-restoration flow velocity was measured January 25, 2023, when tide height was predicted to be highest within one year after construction. Flow velocity was measured across a transect spanning the channel at the upstream margin of the railroad bridge. **Figure 3** shows the transect at high tide and **Figure 4** looks upstream to the transect at low tide. Flow velocities measured at 20 stations never exceeded 2.0 feet per second, as seen in **Figure 5**. The maximum observed velocity was 1.562 feet/sec, substantially less than velocities observed in the original culvert. Velocity across the wetted width of the channel was highly variable as well, as flow also was unequally distributed between the three bridge spans/supports. Velocity increased as the tidal stage dropped, as flow become more localized between the three primary flow pathways (between bridge supports), and as stream flow began to dominate the total flow volume, which was true after the tide receded downstream of the channel cross section (see **Figure 4**).

Figure 3. Post-Restoration Velocity Measurement Location at Upstream Margin of Bridge During High Tide with Inset Photo of Pre-Restoration Location

Figure 4. Looking Upstream at Bridge and Sampling Transect After Tide Receded

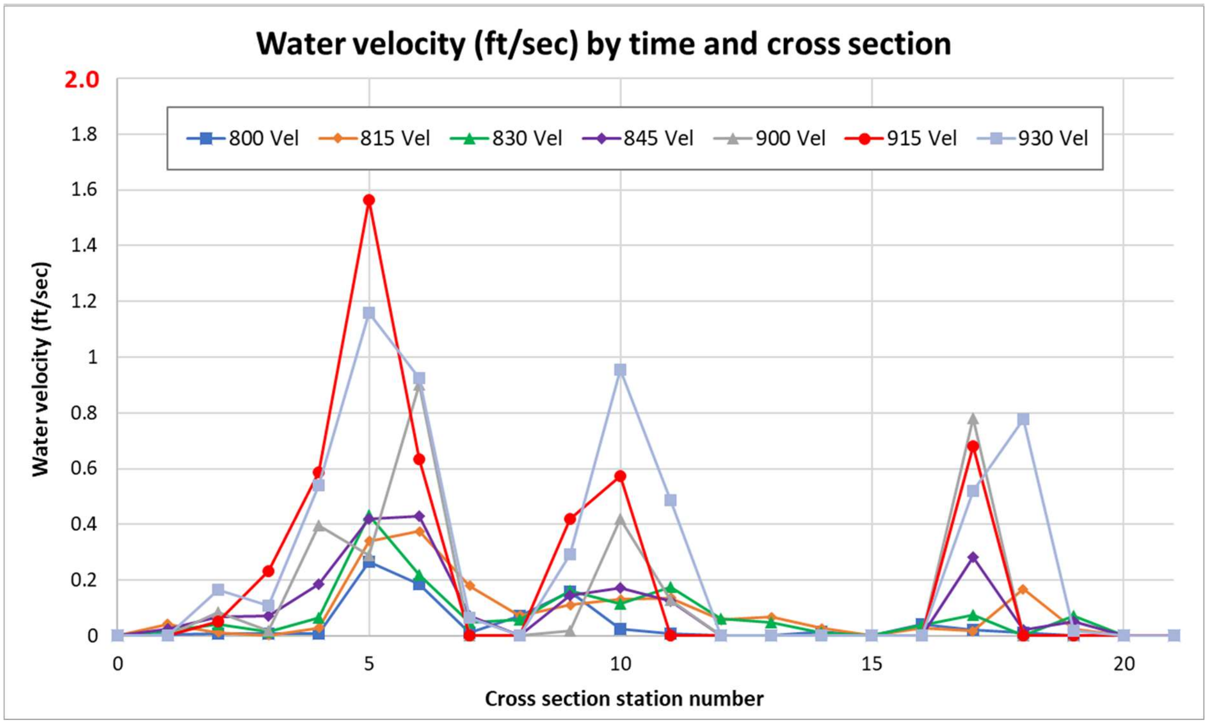


Figure 5. Post-Restoration Flow Velocities Measured in 15-Minute Intervals from High Tide (8:00 am) to Until Only Stream Flow Was Present (9:30 am)

Fish passage conditions to the restored estuary were evaluated based on the velocity criteria in the Washington Administrative Code (WAC) 220-110-070 and WAC 220-660-200. This criterion is referenced in the WDFW draft guidance for evaluating fish passage at tidally influenced culverts (WDFW 2020). The length of the new bridge crossing is approximately 35 feet. Per the WAC and WDFW (2020), for crossings less than 100 feet long, there is no barrier to fish passage until flow velocities exceed 4 feet per second. Post-restoration flow velocities never exceeded 2.0 feet per second; therefore, the velocity performance standard was achieved.

WDFW (2020) does not include depth as a criterion for evaluating fish passage in tidal environments. WDFW (2020) states that more research is needed to determine the appropriate water depth for fish passage through tidally influenced channels. In the absence of a depth criterion to inform the evaluation, the bridge crossing provides approximately 90 feet of crossing width for stream and tidal channels to form and dynamically adapt in response to coastal and fluvial processes. In this way, the restoration provides depth conditions that are supported by the natural processes of the site and therefore will support fish passage to the full amount appropriate for its tidal setting.

As noted above, results for the added monitoring element to compare pre- and post-hydrographs are described in Appendix E.

Channel Cross-sections and Profile Surveys

The channel cross-sections and profile monitoring document the major transformation of stream and estuary habitats through the project. Prior to restoration, the estuary extended only a few feet upstream of the railroad culvert in a narrow stream channel. Downstream of the railroad crossing, the estuary channel at the time of construction was directed nearly straight out into Puget Sound. Following restoration, the lower stream channel was converted into a wide estuary upstream of the railroad to provide expanded aquatic habitat and space for further expansion with projected sea-level rise. Upstream of the estuary, large wood was placed to increase habitat complexity over time as physical processes act on the stream. Downstream of the railroad crossing, the channel was rerouted to a northerly direction that is supported by coastal processes acting on the site. The restoration provided expanded aquatic habitats in all areas compared to pre-restoration.

Monitoring in year 1 establishes the restored baseline to which future monitoring data will be compared. The monitoring will be repeated in years 5 and 10 to document the adjustment of the channel and profile in the creek outlet, upper estuary, and lower estuary monitoring areas. **Table 4** shows the monitoring element and performance standard, the applicable monitoring years post-construction in which performance will be evaluated, and whether the performance standard was achieved.

Methods

Channel cross-sections and transect surveys were completed using a Real-Time Kinematic Global Positioning System (RTK-GPS) along transects throughout the creek outlet, upper estuary, and lower estuary monitoring areas. The creek outlet and upper estuary transects span the entire restoration area. Transects were established and surveyed in the creek outlet and upper estuary by the Tulalip Tribes. As-built post construction survey data were also provided by Anchor QEA.

TABLE 4
CHANNEL CROSS-SECTIONS AND PROFILE MONITORING SUMMARY

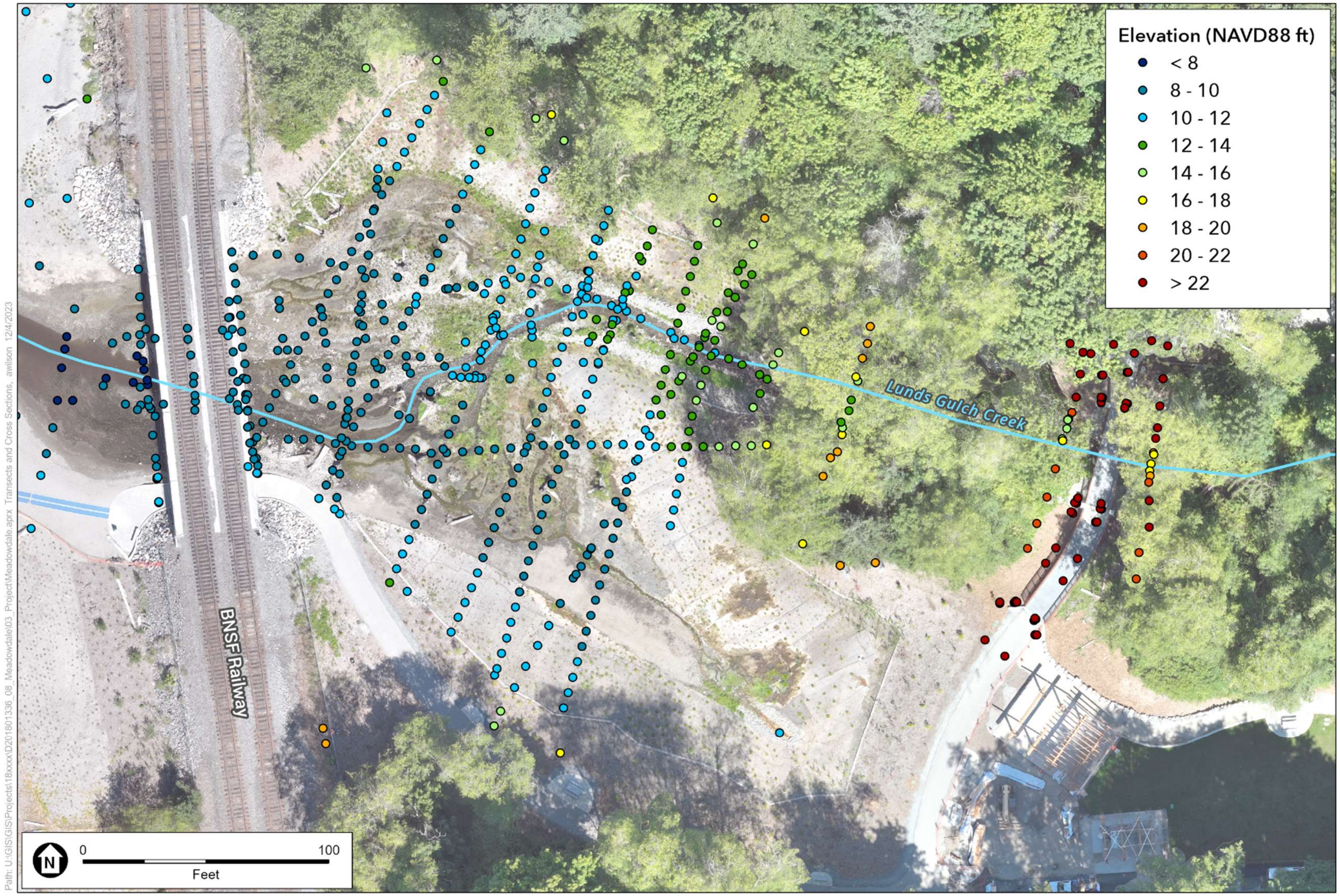
Monitoring Element / Performance Standard	Performance Standard Met?	Year Post-Construction										
		0	1	2	3	4	5	6	7	8	9	10
Channel cross-sections and profile survey in creek outlet, upper estuary, and lower estuary monitoring areas. Performance standard is to provide suitable depth conditions for juvenile and adult salmonid access to the restored estuary.	On track		X				X					X

Notes: X indicates required years of monitoring. Orange shading indicates current reporting year.

Results and Discussion

The Tulalip Tribes collected channel cross-section and transect survey data on August 15, 2023 and on November 5, 2023. during the first year following construction.

Survey data from the Tulalip Tribes for the upper estuary are presented in **Figure 6**. Survey data from Anchor QEA's as-built survey, including cross-sections throughout the lower reach of Lund's Gulch Creek are presented in **Figure 7**. The elevation data from the Tulalip Tribes and Anchor QEA were used to map the mean higher high water (MHHW) line and highest astronomical tide (HAT) line in the restoration area (**Figure 8**). The values for MHHW and HAT at Meadowdale Beach Park were estimated by averaging Everett and Seattle tidal elevations from NOAA Tides and Currents. Cross-sections from lower Lund's Gulch Creek are presented in **Figures 9–11**.



Sources: Imagery: Tulalip Tribes 2023; Survey Points: Tulalip Tribes, Anchor QEA 2023

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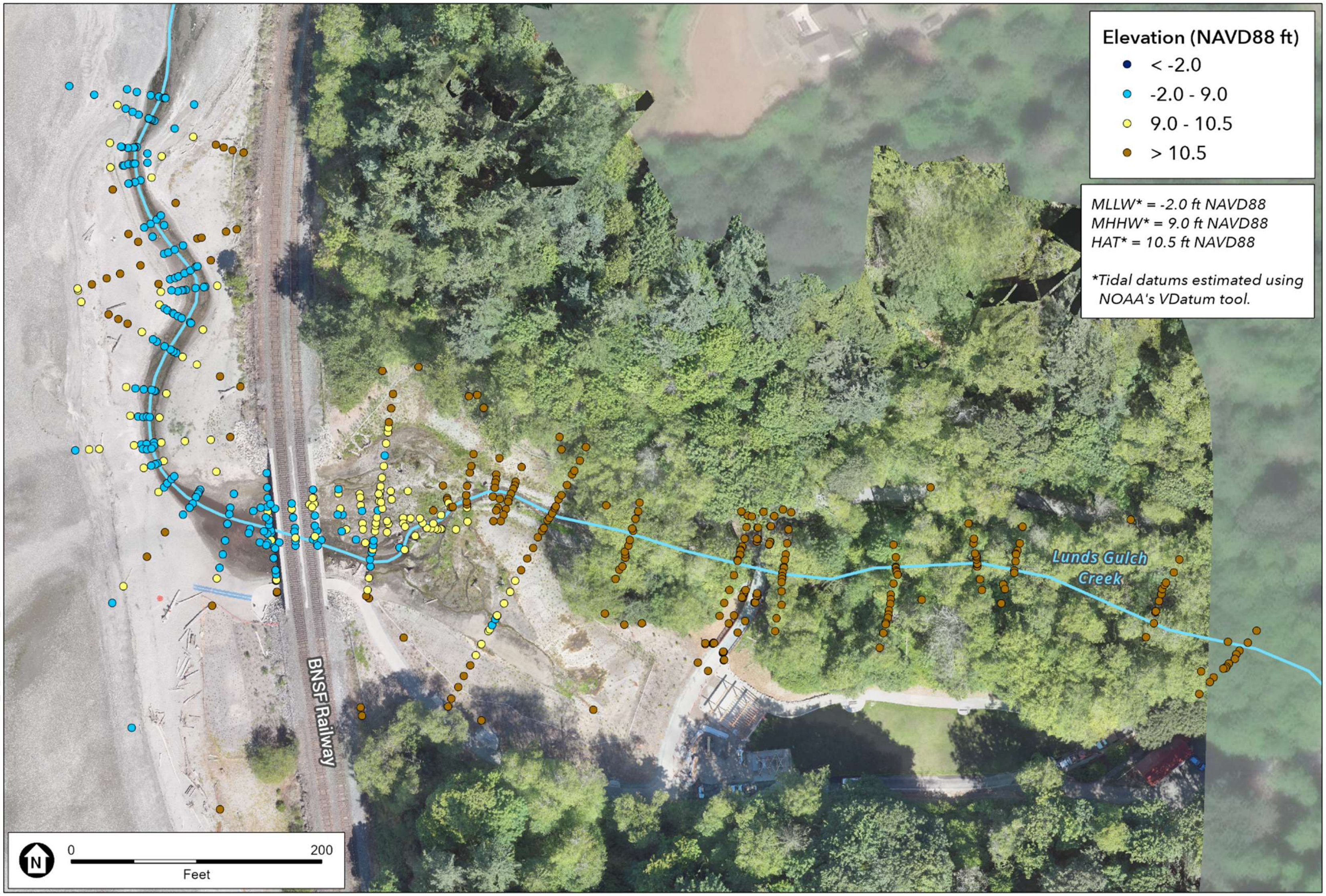
Figure 6. Topographic Survey Data from Upper Estuary and Creek Outlet Transects



Sources: Imagery: Tulalip Tribes 2023, Maxar 2022; Cross Section Points: Anchor QEA 2023

Meadowdale Beach Park Restoration Monitoring Report

Figure 7. Topographic Survey Data from As-Built Survey

Figure 8. MHHW and HAT Locations Based On Topographic Survey Data

Sources: Imagery: Tulalip Tribes 2023, Maxar 2022; Cross Sections: Anchor QEA 2023

Meadowdale Beach Park Restoration Monitoring Report

Figure 9. Cross-section Locations in Lund's Gulch Creek

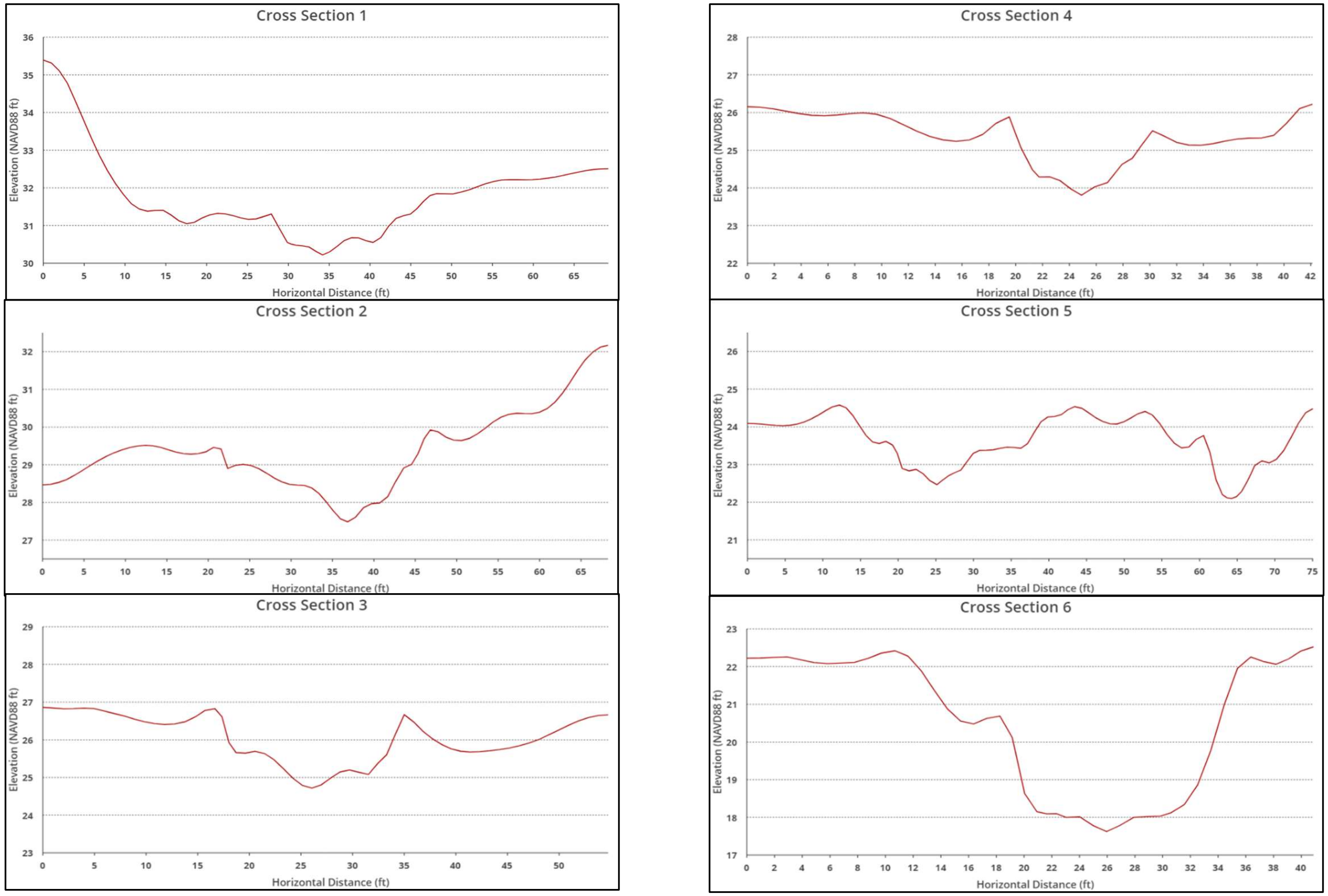


Figure 10. Lund's Gulch Creek Cross-sections 1 through 6

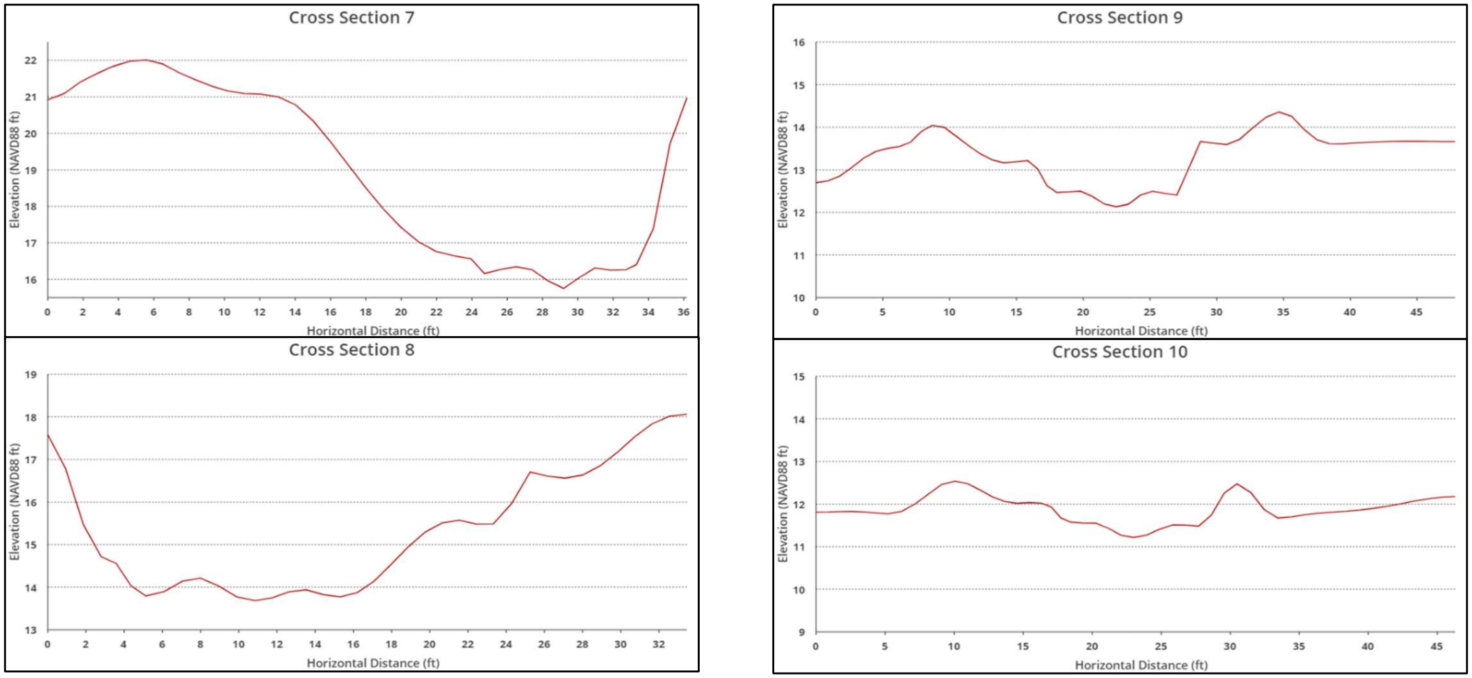


Figure 11. Lund's Gulch Creek Cross-sections 7 through 10

Stream Habitat, Benthic Macroinvertebrates, and Large Woody Material

This section includes data to inform monitoring elements C and D in the monitoring plan. The restoration project converted the lowermost portion of Lund's Gulch Creek to expand the estuary. The restoration also placed large woody material in lower Lund's Gulch Creek and the upper estuary. The restoration added large wood jams that are expected to increase habitat complexity through pool formation, gravel sorting, and providing interstitial spaces for fish to hide in. The large wood is also expected to snag additional wood moving downstream to increase the size and complexity of the structures. These changes are expected to result in stream habitat changes over time, and monitoring was not conducted in year 1.

Monitoring of the aquatic habitat conditions in the restoration area upstream to the bridge near the park ranger's house was conducted to document how effective the stream restoration components were for improving habitat conditions for salmon. **Table 5** shows the monitoring element and performance standard, the applicable monitoring years post-construction in which performance will be evaluated, and whether the performance standard was achieved.

TABLE 5
AQUATIC HABITAT AND LARGE WOODY MATERIAL MONITORING SUMMARY

Monitoring Element / Performance Standard	Performance Standard Met?	Year Post-Construction										
		0	1	2	3	4	5	6	7	8	9	10
Survey of habitat units in Lund's Gulch Creek downstream of park ranger's house. Performance standard is to provide improved habitat compared to pre-project conditions.	Yes		X		X		X					X
Survey of large wood in Lund's Gulch Creek downstream of park ranger's house. Performance standard is to document retention of large wood placed during restoration and additional large wood retention and recruitment following restoration.	Yes		X		X		X					X
Survey of large wood in the upper estuary. Performance standard is to document retention of large wood placed during restoration and additional large wood retention and recruitment following restoration.	Yes		X		X		X					X
Benthic macroinvertebrate sampling in Lund's Gulch Creek downstream of park ranger's house. Performance standard is to provide improved benthic invertebrate community compared to pre-project conditions based on metrics such as taxa density, number of taxa, taxa diversity, and taxa richness	Pending		X		X		X					X

Notes: X indicates required years of monitoring. Orange shading indicates current reporting year.

Methods

Aquatic habitat monitoring in the stream and estuary included habitat mapping, large woody material mapping, stream temperature monitoring, and benthic invertebrate sampling. This sampling was conducted by Snohomish County.

Habitat Mapping

Stream habitat surveys included measurement of habitat units defined as pools, riffles, or other (glides/run) that did not qualify as pools based on residual pool depth. Habitat surveys also included an inventory of large woody material, both natural and placed as art of the restoration. Stream Habitat Surveys were implemented in 2021 prior to project construction using the Snohomish County State of our Waters methodology (State of Our Waters Monitoring Program [Snohomish County 2019b]). Stream habitat data were also collected in 2009 using similar protocols. The 2021 habitat survey repeated the same length and upstream-downstream extent as 2009. However different thresholds were used as criteria for qualifying habitat unit and woody debris measurement. Data will be recalculated as feasible as part of future reporting to interpret longer-term changes or differences. The 2023 habitat survey was implemented post-construction and had greater upstream-downstream extents, reflecting the greater area and length of treatments.

In 2023, habitat surveys were implemented in April and August. The purpose of the survey in April was to quantify habitat types and areas that overlapped the same length of stream where Tulalip Tribes conducted electrofishing for describing fish use. The pre-and post-restoration aquatic habitat mapping reaches are summarized in **Table 6**.

TABLE 6
PRE- AND POST-RESTORATION AQUATIC HABITAT MAPPING BY SAMPLING REACH

		Pre-Restoration		Post-Restoration	
Reach	**Description**	**2009**	**2021**	**2023 (April)**	**2023 (August)**
0	Start at MLLW upstream to end tidal delta			X	
1	Transition from top tidal delta to bottom creek delta			X	
2	Creek alluvial fan/delta – larger substrate	X	X	X	X
3	Creek adjustment zone – incision/expansion	X	X	X	X
4	Creek with narrow floodplain			X	X
5	Creek with wide floodplain, old stormwater pond			X	X

Stream Temperature

In Lund's Gulch Creek, stream temperature was recorded and stored continuously at 30-minute intervals using remote thermistors in summer during the period when the core summer rearing Washington State water quality standard was applicable. For this creek, 16 degrees Celsius is the stream temperature standard, calculated as the seven-day average of the daily maxima, above which water quality would be considered impaired. Stream temperature was monitored near the pedestrian bridge closest to the Meadowdale Park ranger residence in all years. The location was latitude 47.8598, longitude -122.332.

Benthic Macroinvertebrates

Benthic macroinvertebrate collection was completed before project implementation in 2021 and following completion of restoration work in 2023. Two composite benthic macroinvertebrate samples were collected. An upper creek sample was collected from eight locations spanning from upstream of the pedestrian bridge near the park ranger's house downstream to the new pedestrian bridge. A lower creek sample was collected from eight locations spanning from the new pedestrian bridge downstream to the new railroad bridge. Five out of the eight sampling locations forming the lower creek composite sample were in the upper estuary. Composite samples were collected from 8 ft^2 of stream bottom (8 - 1 ft^2 Surber samples combined) and locations of collection were distributed throughout the reach length (bottom to top) in riffle habitat.

Data collection prior to restoration typically was started just upstream from the pre-project railroad culvert. Some earlier years of benthic macroinvertebrate collection (back to 2001) are also available but were sampled using different methods and analyzed using different taxa lists. The past results will be reviewed for potential inclusion in future monitoring reports.

Large Woody Material

Placed large woody material pieces and naturally recruited large woody material were inventoried by counting the number of pieces. This information was compared to bankfull width measurements and the survey length to calculate the number of large woody material pieces per channel width. The 2023 survey extended through sampling reaches 1 through 5 (i.e., upstream of the railroad crossing). A pre-restoration survey in 2021 covered only reaches 2 and 3. At that time, reach 2 started immediately upstream of the railroad crossing.

Results and Discussion

Habitat Mapping

Pre-project monitoring upstream from the railroad culvert extended upstream approximately to the new pedestrian bridge installed as part of the Meadowdale Park enhancements. The pre-project monitoring considered this to be two sampling reaches, but it equates to three sampling reaches (1 through 3) in the post-restoration condition.

The pre- and post-restoration habitat mapping is presented in (**Figure 12**). This part of Lund's Gulch Creek overlapped with the new estuary embayment design, which included excavation to establish tidal inundation. Hence, pre-project monitoring in 2021 was implemented in a stream segment with a pool-riffle planform, whereas in 2023 this same segment was steeper (due to excavation) and geomorphically had intentionally been transformed to an alluvial fan planform that had steeper channel profile and mostly riffle habitat (**Figure 13**). As a result, whereas in 2021, this creek contained 8 pools and approximately 25 percent pool area (**Table 7**), in 2023 this creek segment contains fewer pools and less pool area (**Table 8**). This was by design, and habitat quantities will be evaluated in future years as more channel adjustment occurs.

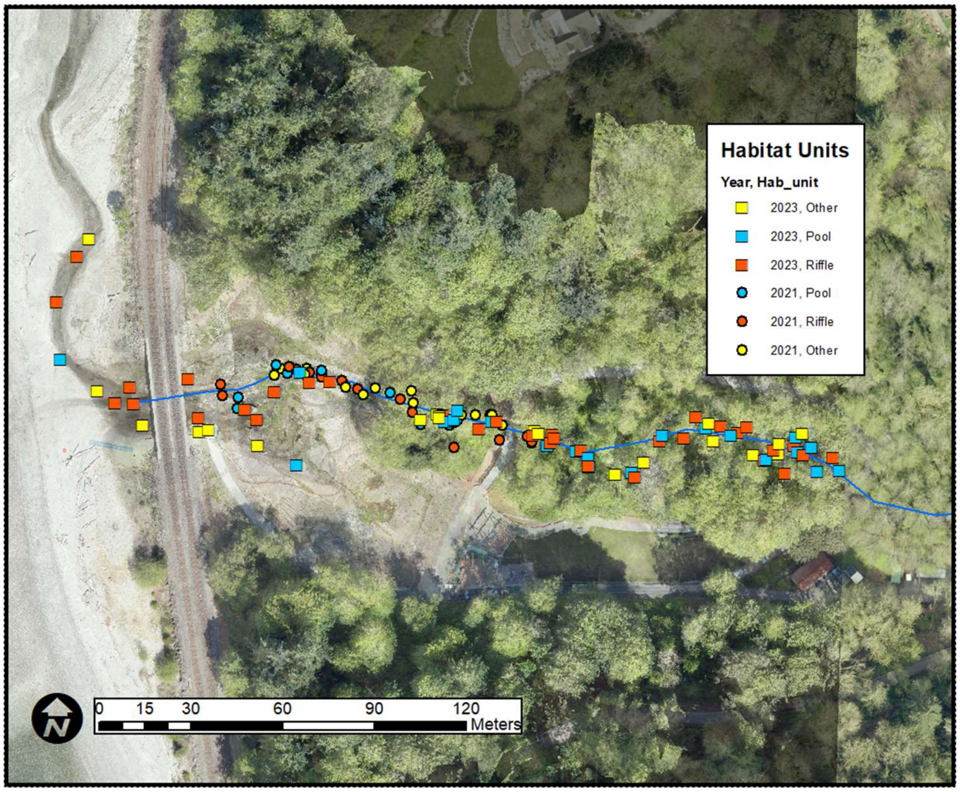


Figure 12. Map of 2021 and 2023 Habitat Unit Survey by Year and Habitat Type

Figure 13. Lund's Gulch Creek Excavated Embayment Area Looking Upstream Toward the Creek Mouth

TABLE 7
2021 PRE-RESTORATION HABITAT INVENTORY IN REACHES 1 THROUGH 3

Parameter	Value
Segment Length (m)	137.95
Pool Count	8
Pool Area (m^2)	60.6
Average Pool Maximum Depth (m)	0.35
Average Residual Pool Depth (m)	0.27
Riffle Count	13
Riffle Area (m^2)	143.12
Other Count	12
Other Area (m^2)	39.29
Pool Percent Area	24.9%
Riffle Percent Area	58.9%
Other Percent Area	16.2%

TABLE 8
SPRING 2023 POST-RESTORATION HABITAT INVENTORY

	Sampling Reach						
Parameter	0	1	2	3	4	5	Total
Segment Length (m)	90.3	135.2	80.8	47.8	52.75	130.1	536.95
Pool Count	1	1	1	4	6	9	22
Pool Area (m^2)	118.95	86.4	5.25	19.43	43.71	71.98	345.72
Average Pool Maximum Depth (m)							40.9
Average Residual Pool Depth (m)							0.36
Riffle Count							0.29
Riffle Area (m^2)	3	4	5	4	6	13	35
Other Count	165.68	365.52	214.37	57.2	31.1	200.23	1034.1
Other Area (m^2)	2	4	0	5	2	7	20
Pool Percent Area	72.28	175.14	0	23.79	10.2	41.6	323.01
Riffle Percent Area	33.3%	13.8%	0.4%	19.4%	51.5%	22.9%	20.3%
Other Percent Area	46.4%	58.3%	99.6%	57.0%	36.6%	63.8%	60.7%

In 2023, one year after project implementation, habitat conditions were surveyed in all project segments (0–5) to quantify habitat unit type and area in support of fish use monitoring. Segments 0–2 spanned the tidal delta, the excavated embayment and the newly forming alluvial fan associated with the creek mouth above tidewater. In these segments, pools were scarce, as expected, and habitat areas were dominated by riffles and other habitat units too shallow to qualify as pools. The majority of pool habitat was in creek segments 3–5 in Lund's Gulch Creek proper and was also where the majority of instream large woody material restoration had been conducted. These stream segments contained more pools and a greater percentage of pool habitat area. These differences may correlate with information on fish use reported elsewhere.

In summer 2023, habitat inventory was conducted again to establish a year 1 condition during summer low-flow conditions when most stream habitat surveys are conducted. This survey was implemented in stream segments 2–5, the creek portion upstream from tidal inundation.

Table 9 shows the summary of habitat conditions surveyed in reaches 2 through 5 during summer 2023. **Table 10** describes the pool characteristics. Compared to the springtime survey, the number of pools had declined, whereas the number of riffles and other habitat units increased. The decrease in the number of pools likely resulted from a combination of shallower water depth in summer due to lower flow and an increase in fine sediment that filled some pools. This observation was unexpected and was likely due to persistent supply of fine sediment from upstream that was transported at relatively lower flows in spring and summer, at discharge levels unable to effectively scour the fine sediment out of the pools. Hence, pools filled with fine sediment. There were at the same time more wood-formed pools observed affiliated with placed wood material. The function of large wood to help scour pool habitat will be evaluated in the future.

TABLE 9
SUMMER 2023 POST-RESTORATION HABITAT INVENTORY IN REACHES 2 TO 5

Parameter	Habitat Type		
	Pool	Riffle	Other
Count #	15	30	27
Average Area (m^2)	13.5	16.2	4.8
Total Area (m^2)	203	486	136
% of Total Habitat	24.6	58.9	16.5
Average Maximum Depth (m)	0.34	0.12	0.19
Average Residual Pool Depth (m)	0.27		
Frequency (per km)	46		

TABLE 10
SUMMER 2023 POST-RESTORATION POOL DATA IN REACHES 2 TO 5

Parameter	Pool Type	
	Backwater	Primary
Average Maximum Depth	0.3	0.35
Pool Count	3	12
Average Residual Pool Depth	0.26	0.27
Total area	114.36	88.64
Average Area	38.12	7.39
% of total Habitat	13.86%	10.74%
Wood Formed Pools	1	10

Habitat is greatly improved through the restoration and the establishment of a large estuary. Post-restoration habitat mapping provides a new baseline for comparing to future monitoring data. There are currently 22 pools in the six sampling reaches, including 19 in the stream channel portions of reaches 3 through 5. Pre-restoration sampling conducted in reaches 1 through 3 had a higher number of pools than the post-restoration survey (8 vs. 6); however, the post-restoration pool area in those reaches was nearly double the pre-restoration conditions (111.1 m^2 vs. 60.6 m^2).

Stream Temperature

Table 11 includes the sample year and maximum stream temperatures observed—the single day summer maximum and the 7-day average (7-DADMax). The standard temperature criterion for evaluation of temperature exceedance of the 7-day average daily maximum (7-DADMax) is 16 degrees Celsius, per Ecology. In all years sampled, the calculated 7-DADMax temperature exceeded the standard and did so for 5–14 days among years. This translates to approximately 6–17 percent of the summer sample period.

For context, the 7-DADMax temperature standard is routinely exceeded in many streams, even those with relatively good, forested stream buffer conditions and shading over the stream surface. In fact, Lund's Gulch creek benefits from sources of cold groundwater that flow into the stream all summer and keep it relatively cool. Additional tree planting and park management over time will likely improve forested buffer conditions and stream shading. Overall stream conditions in terms of temperature are supportive of fish use, growth, and survival in summer.

TABLE 11
STREAM TEMPERATURE DATA IN LUND'S GULCH CREEK

Year	Date Range	Maximum Temperature, Celsius (C)	7-DADMax*	Number of Days Exceeding Temperature Criteria**	Percent Exceedance Time**	Average 7-DADMax***
2009	5/15-10/15	18.3°C	17.4°C	12	14.1%	15.0°C
2015	6/29-10/28	17.4°C	17.1°C	14	16.5%	15.3°C
2016	6/6-10/10	16.9°C	16.3°C	10	11.8%	15.1°C
2017	6/1-10/10	16.8°C	16.2°C	5	5.9%	15.1°C
2022	5/17-9/26	17.2°C	17.0°C	14	16.5%	15.3°C
2023	summer	17.3°C	16.7°C	7	8.2%	15.1°C

Notes:
*7-DADMax is defined as the seven-day average of daily temperature maxima.
** Days and percentage of days based on 85-day summer core temperature period for all years.
***Average 7-DADMax is the 85-day average of the running 7-DADMax calculated for each of the 85 days.

Benthic Macroinvertebrates

In 2023, the 2021 location was also sampled, but is now characterized as an alluvial fan and is contained within the excavated embayment area. A second B-IBI collection was made upstream from the extent sampled in 2021 and 2023 as just described. This collection is fully contained within the creek channel where LWD has been placed but is completely upstream from any floodplain or embayment excavation. Collection effort used the same field procedures as described in the Snohomish County State of Our Waters Monitoring Program. Benthic macroinvertebrate samples were stored in a Nalgene jar as they were collected and preserved in 95% denatured ethanol. The eight sequential Surber sample quadrats (downstream-upstream) collected each year were composited into one sample for analysis. The location of each benthic macroinvertebrate collection from 8 riffles per composited sample in 2021 and 2023 is shown in **Figure 14**.

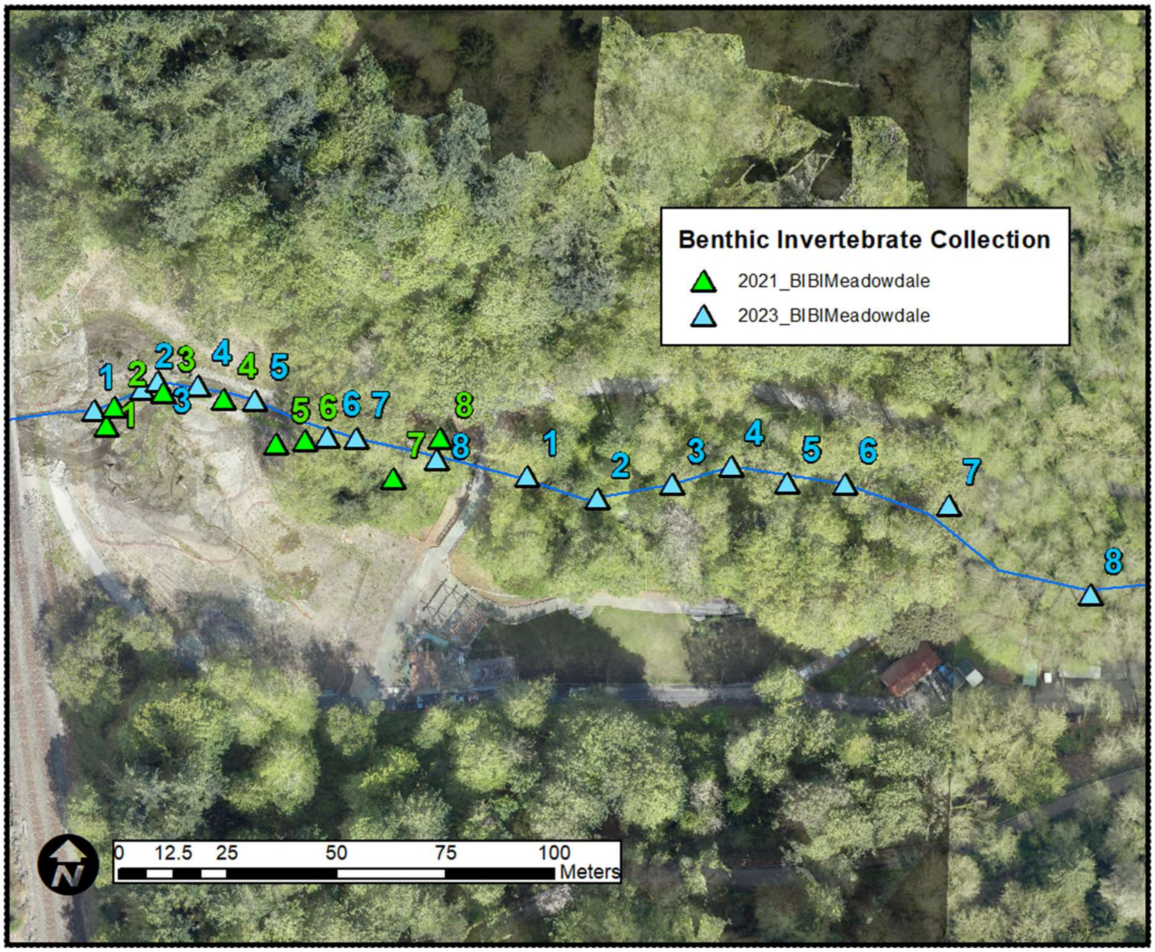


Figure 14. B-IBI Sample Collection Locations in 2021 (green) and 2023 (blue)

B-IBI scores are reported in **Table 12** for recent and past collections. Note that sampling conducted in 2012, 2015, and 2016 overlapped more with the upper 2023 collection. B-IBI scores were similar, though potentially depressed in 2016–2021 compared to earlier years. Variation in B-IBI scores among years could be due to natural variation and/or hydrologic conditions such as flooding that disturbed and scoured the streambed in years prior to sampling. Flow conditions that vary annually also can lead to changes in supply and delivery of fines sediment from upstream areas. Fine sediment was not characterized as part of B-IBI sampling in 2012–2016 but is part of recent data collection. These substrate size results will be summarized and reported in the future when 2023 B-IBI sample results are available.

TABLE 12
BENTHIC MACROINVERTEBRATE DATA COLLECTION YEARS AND RESULTS FOR 10 METRICS THAT CONTRIBUTE TO THE FINAL B-IBI SCORES (0–100)

Site Name	Date Collected	B-IBI Score (1–100)	Taxa Richness	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	Intolerant Richness	Clinger Richness	Long-Lived Richness	Percent Tolerant	Percent Predator	Percent Dominant (Top 3 taxa)
Lund's Gulch Creek	09/12/2012	68.7	42	4	5	5	17	15	5	2.21	17.2	46.9
Lund's Gulch Creek	09/28/2015	78.9	40	6	7	7	20	18	9	4.50	15.6	46.3
Lund's Gulch Creek	08/15/2016	53.5	32	3	4	6	12	12	5	5.06	14.4	66.1
Lund's Gulch Creek	06/23/2021	58.7	36	3	6	4	14	13	5	9.60	12.5	49.9
Lund's Gulch Creek - Lower	07/18/2023	TBD										
Lund's Gulch Creek - Upper	07/18/2023	TBD										

Large Woody Material

Woody material in Lund's Gulch Creek was either placed as part of the restoration project (identified in Figure 5) or occurred naturally. In 2021, only natural woody material or material placed as part of an older restoration effort was present. In creek segments 1 through 3 there were two pieces of wood. Woody debris spacing and frequency was low (**Table 13**), particularly compared to woody material enumerated in 2023 that was part of the restoration project and included stream segments 1 through 5. Woody material placed as part of the restoration nearly doubled the natural wood count and placed pieces were large conifer trees with rootwads (**Figures 15 and 16**).

Overall, there is much more large woody material in the stream and estuary following restoration compared to pre-restoration monitoring of a subset of reaches. The post-restoration large wood survey provides a new baseline for comparing to future monitoring data. The influence of these large, placed pieces on creek habitat formation and abundance of pools will be evaluated as wood quantity is estimated to be near that of a natural condition. The abundance of woody material and changes in quantity and functions will be evaluated over time.

TABLE 13
LARGE WOODY MATERIAL INVENTORY

Year	Survey Length (m)	Average Bankfull Width (m)	Number of Channel Widths	LWD Piece Count	LWD Pieces per Channel Width	LWD Frequency (Pieces per km)
2021 Natural	137.95	4.48	30.77	2	0.06	14.5
2023 Natural	311.45	9.05	34.42	57	1.66	183.01
2023 Placed	311.45	9.05	34.42	50	1.45	160.54
2023 Total	311.45	9.05	34.42	107	3.11	343.55

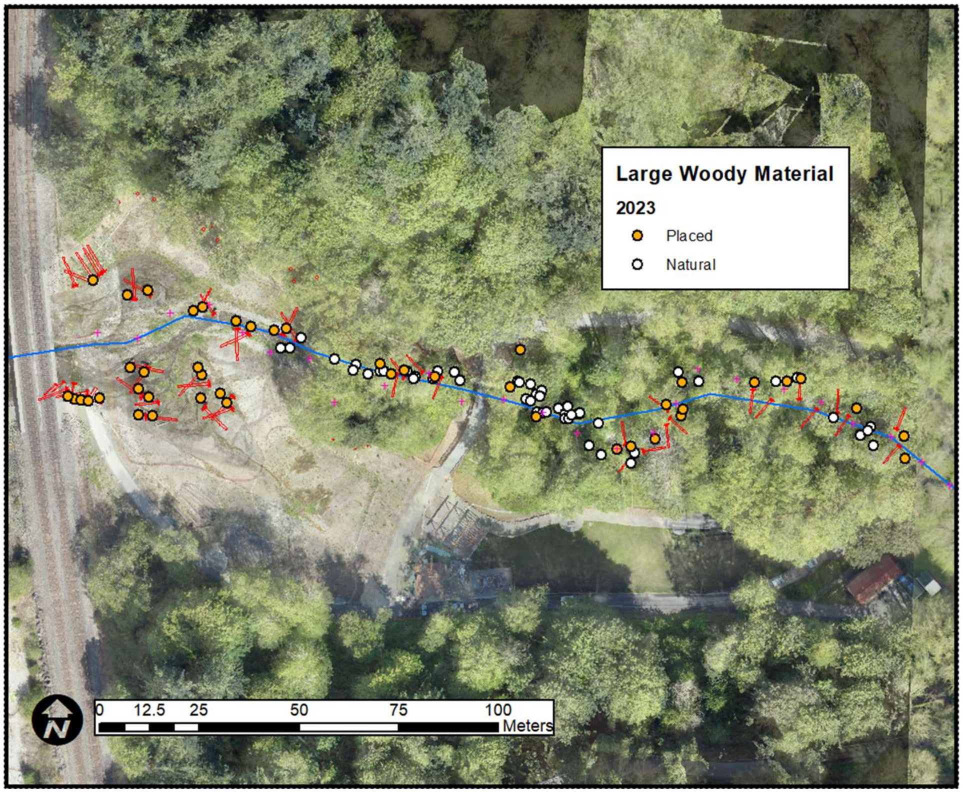


Figure 15. Map view of large woody material surveyed in 2023

Figure 16. Large Woody Material (flagged) with Rootwads Placed in Lund's Gulch Creek Segment 3

Planted Vegetation Survival and Coverage

The restoration included the planting of vegetation to reestablish a native plant community in the restoration area. Several performance standards were established in the grant agreements funding the restoration. Table 14 shows the monitoring elements and performance standards, the applicable monitoring years post-construction in which performance will be evaluated, and whether the performance standard was achieved.

TABLE 14
PLANTED VEGETATION SURVIVAL AND COVERAGE MONITORING SUMMARY

Monitoring Element / Performance Standard	Performance Standard Met?	Year Post-Construction										
		0	1	2	3	4	5	6	7	8	9	10
Improve habitat for fish and wildlife species												
Achieve 50–70% cover of native vegetation species planted per design at monitoring plots within 5 years post-construction and sustain for lifetime of project.	Yes						X*					
Reduce non-native vegetation species to less than 20% cover within 5 years post-construction	Yes		X		X		X					
Document habitat functions via the 2014 Ecology Wetland Rating System (Hruby 2014) and Methods for Assessing Wetland Functions (HGM Model, Hruby et al. 1999) in Year 10. Compare to baseline condition.	n/a											X
Establish Native Plant Communities												
Average survival of planted trees will be at least 90% at end of Year 1.	Yes		X									
Within planted areas, native riparian species cover shall be at least: 25% by Year 3; 50% by Year 5; and 70% cover by Year 10.	n/a				X		X					X
Native herbaceous coverage within designated estuary and beach areas shall be at least: 50% by Year 3; 70% by Year 5; and 95% cover by Year 10.	n/a				X		X					X
Invasive, non-native plant species are maintained at levels below 20% cover within planted riparian areas.	Yes		X		X		X					X

Note: X indicates required years of monitoring. Orange shading indicates current reporting year.

* Although this performance standard is for Year 5, percent native vegetation cover was assessed in Year 1 to establish a baseline for the site for native planted, volunteer, and non-native invasive vegetation.

n/a indicates performance standard does not apply in Year 1.

Methods

Vegetation monitoring parameters assessed during Year 1 included plant survival, vegetation coverage, and vegetation composition in the marsh and riparian planting areas. Surveys were conducted at mean low tide for the estuarine marsh areas and freshwater wetland. Surveys were conducted on September 19, 2023, after most of the growing season had passed, but before vegetation had senesced, to capture the full extent of plant growth for the year. Vegetation monitoring methods were consistent with those outlined in the Meadowdale Beach Park and Estuary Restoration Monitoring Plan (ESA 2022).

In June 2023, prior to Year 1 vegetation monitoring, ESA biologists established vegetative plots, transects, and representative photo points on the site based on those recommended in the Monitoring Plan (ESA 2022) (**Figure 17**). Five permanent, 33-foot diameter sampling plots were established in planting areas, labeled Vegetation Plot (VP) 1 through VP7. The plots were evaluated for percent cover and community composition. In each sampling plot, each species with more than 5 percent cover was recorded, and the percent cover of each vegetation class (herbaceous, shrubs, trees, woody vines) and native volunteer vegetation was calculated.

In addition to vegetation plots, 12 permanent 50-foot-long transects were established in vegetation planting areas, labeled Vegetation Transect (VT) 1 through VT12 (see **Figure 17**). Transect VT9 (saltmarsh habitat) is only 44 feet long so that it does not overlap with VT12 (riparian habitat) and limit each transect to one habitat type. At least one transect was established within each of the vegetation community types shown on the design plans included in the Monitoring Plan: high saltmarsh, low saltmarsh, freshwater wetland, and riparian. Six 1-meter quadrat sampling plots were established along each transect within the saltmarsh planting areas (VT1 through VT6). Quadrat locations were selected using a random number generator to determine the center point of each quadrat along the transects. The Monitoring Plan calls for the same permanent transects to be used during all sampling events, but to vary quadrat locations from one monitoring year to the next. The percent cover of each species rooted within each quadrat was recorded. This percentage was extrapolated as a representative percentage of the overall saltmarsh habitat plant survival, native volunteer vegetation, and invasive areal coverage for the site. Only emergent plant stems within the quadrats were counted; overhanging plants are not counted toward survival.

In the freshwater wetland and riparian planting area (VT11 and VT12, respectively), plant stems of woody species within 5 feet of each side of the transect (i.e., a “10-foot belt” transect) were counted. The Year 1 data will serve as baseline data to determine percent survival and percent cover of native vegetation that voluntarily colonized the site in subsequent years.

However, the data collected along each transect during Year 1 will be used to assess the diversity and success of establishing vegetation in the overall restored system. Recommendations for changes to methods for future monitoring years are included in the Recommendations section.

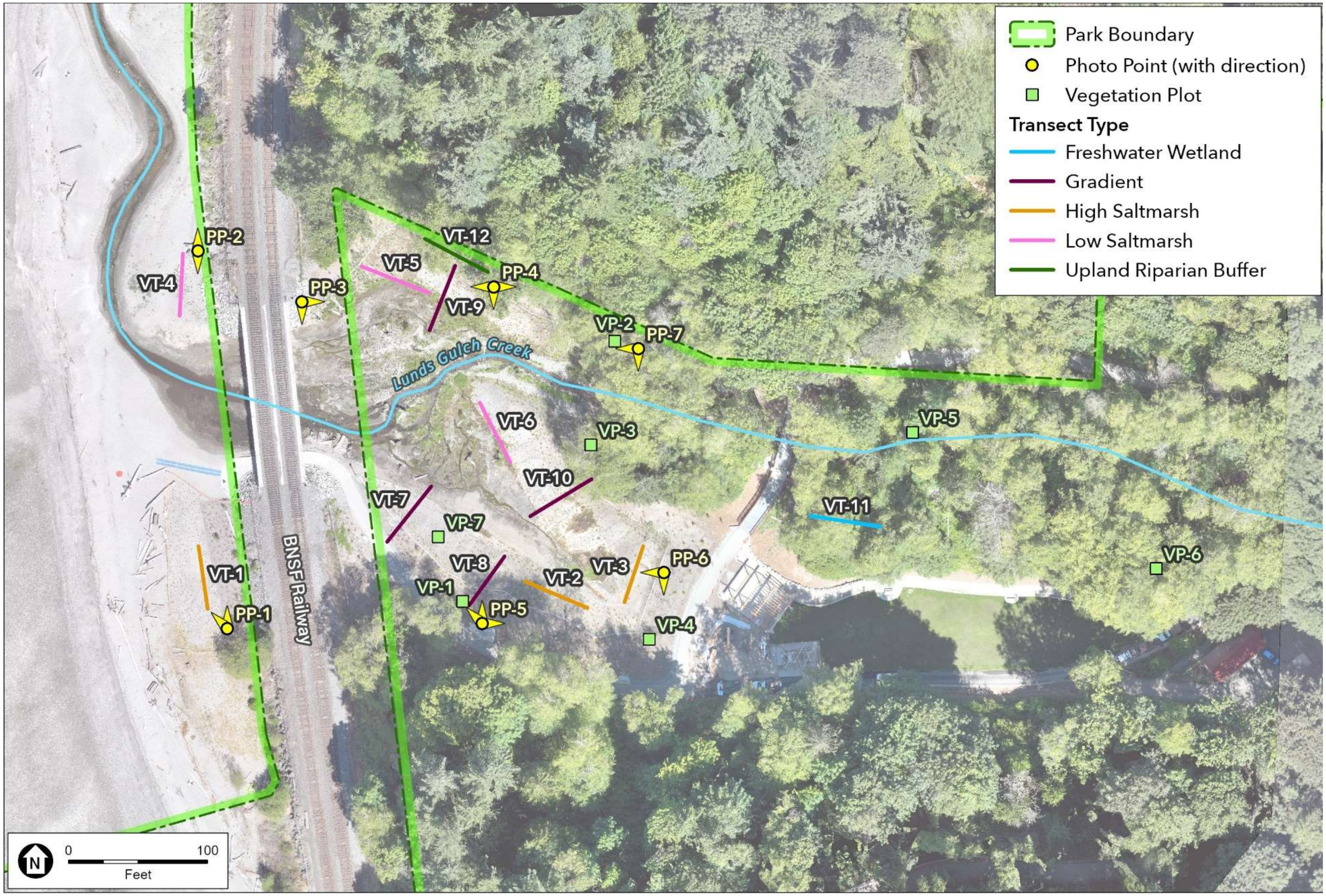


Figure 17. Vegetation Monitoring Transects, Photo Points, and Vegetation Plots

Results and Discussion

The survival and coverage of planted vegetation was surveyed during the first year following construction to document re-establishment of native plant communities in the restoration area. As only a partial vegetation as-built survey was conducted prior to the Year 1 vegetation monitoring, this data will serve as baseline data to compare to subsequent years. Any additional planting completed after Year 1 vegetation monitoring will be included in the Year 2 monitoring report in 2024.

The planting plans changed between the original planting plan, i.e., what was designed (and included in the subsequent Monitoring Plan), and how it was planted on site. The initial vegetation as-built from the contractor is provided in **Appendix A**. The original designed planting plan included bands of vegetation at specific elevations around the estuary perimeter, with one vegetation palette for high marsh located between the riparian/estuary marsh interface and the low marsh, and another palette for low marsh located below the high marsh/low marsh interface. The as-built vegetation plan documents that the contractor installed palettes that encompassed the entire gradient, with one vegetation palette located closer to the railroad crossing and another palette further "upstream," closer to the stream outfall into the estuary and the stormwater outfall. This change was not noticed until after the vegetation monitoring transects were installed in June 2023. However, this change is not anticipated to affect the ability to assess vegetation survival and coverage along topographic gradients in the estuary over time. It is likely that the vegetation will colonize the site in locations most suitable to their biological and morphological needs despite how the site is planted. These changes will be observed over time from Year 2 forward along the transects to observe where volunteer species colonize along each transect and if it can be correlated to an elevation.

The Year 1 vegetation survey conducted stem counts and quantified percent cover of vegetation within quadrats along marsh transects and along riparian and wetland transects. The survey also assessed percent cover of species and strata within vegetative plots to evaluate vegetation survival and coverage. Overall, the site vegetation planted on-site appears healthy, and volunteer vegetation has begun to colonize in many areas throughout the site. Wildlife browse did not appear to be an issue; however, biologists observed several white-tailed deer (*Odocoileus virginianus*) on the north portion of the site, east of the railroad tracks, browsing on vegetation while monitoring occurred. All vegetation monitoring data is included in **Appendix B**. Photos taken from the end of each transect as well as from the established photo points are included in **Appendix C**. See **Figure 17** for the locations of the monitoring plots, transects, and photo points. The survey will be repeated in years 3, 5, and 10. Goals and related performance standards relevant to Year 1 monitoring efforts are discussed below.

Goal: Improve Habitat for Fish and Wildlife Species.

Performance Standard: 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.

This performance standard has been met. The average areal cover for all monitoring plots, including all vegetation strata (trees, shrubs, herbaceous), is approximately 99 percent (**Appendix B**). Broken down by stratum, the average tree cover for all monitoring plots was 20 percent, the average shrub cover was 43 percent, and the average herbaceous cover was 36 percent. The monitoring plot with the highest percent cover was VP5, due in part to having 70 percent tree cover from preexisting trees. Two monitoring plots had a total vegetative cover of less than 50 percent: VP2 had a total cover of 32 percent, and VP4 had a total cover of 40 percent.

Performance Standard: Reduce non-native vegetation species to less than 20% cover within 5 years post construction.

This performance standard has been met. On average, non-native invasive species cover less than 20 percent of the overall project site, averaging only about 1 to 2 percent for the entire site. Only one monitoring plot (VP5) had more than a trace amount of Himalayan blackberry (*Rubus armeniacus*), and only transect (VT8) had more than a trace amount of butterfly bush (*Buddleja davidii*) (**Appendix B**). Other invasive plants present in minimal amounts throughout the site, but not captured in the vegetative plots or transects, include yellow-flag iris (*Iris pseudacorus*) and spotted jewelweed (*Impatiens capensis*).

Goal: Establish Native Plant Communities.

Average survival of planted trees will be at least 90% at end of Year 1.

This performance standard appears to have been met. Year 1 vegetation monitoring occurred before a complete as-built vegetation survey was completed, as additional planting was proposed after the monitoring date. Therefore, there was no baseline data needed to assess tree survival at Year 1. The woody plant data collected in Year 1 will serve as the baseline data for subsequent monitoring years. Biologists observed only two dead planted western redcedars (*Thuja plicata*) near VP4; all other planted trees species appeared healthy.

Within planted areas, 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.

This performance standard is in progress. While there is no specific metric for Year 1, baseline stem count data were collected. The site is on track to meet this performance standard in Year 3.

Native herbaceous coverage within designated estuary (marsh) and beach areas shall be at least 50% by Year 3, 70% by Year 5, and 95% by Year 10.

This performance standard is in progress. While there is no specific metric for Year 1, baseline stem count and percent cover data were collected. The average percent cover for the marsh transects (VT1 through VT6, VT9 and VT10) was 17 percent. The southern beach transect (V1) was particularly low, with only 4 percent cover. This area had a high number of dead plantings, likely due to direct sun exposure and lack of water. Additional plantings are planned to be installed to increase the plant cover across the marsh and will be captured in the Year 2 (2024) monitoring data.

Invasive, non-native plant species are maintained at levels below 20% total cover within planted riparian areas.

This performance standard has been met. As discussed above, non-native species cover less than 20 percent of the overall project site, and less than 20 percent total cover within the planted riparian areas. In the riparian transects (VT7, VT8, VT11, and VT12), only VT8 contained more than trace amounts of butterfly bush.

Additional Monitoring Elements

To further evaluate the effectiveness and sustainability of the restoration, additional monitoring elements are being studied beyond those committed to as part of grants and permits. This section describes the findings of these additional investigations.

Sediment Dynamics and Habitat Area in Upper Estuary and Creek Outlet

Sediment erosion and deposition patterns in the upper estuary and creek outlet will inform how the site is evolving as coastal and fluvial processes act on the area. The wide estuary designed to accommodate increased water levels with sea-level rise provides space for the site to adjust. The monitoring will help inform the size and design of future restoration projects to accommodate creek outlet, estuary, and sediment dynamics.

Methods

The Tulalip Tribes conducted drone flights of the restoration area that provided georectified aerial orthophoto and a digital surface model (DSM). To supplement the drone DSM information, horizontal and vertical positioning data were collected using RTK-GPS to supplement drone data. Data were collected along 6 to 8 transects running in one direction with 1 to 2 additional transects running approximately perpendicular to the railroad embankment.

Results and Discussion

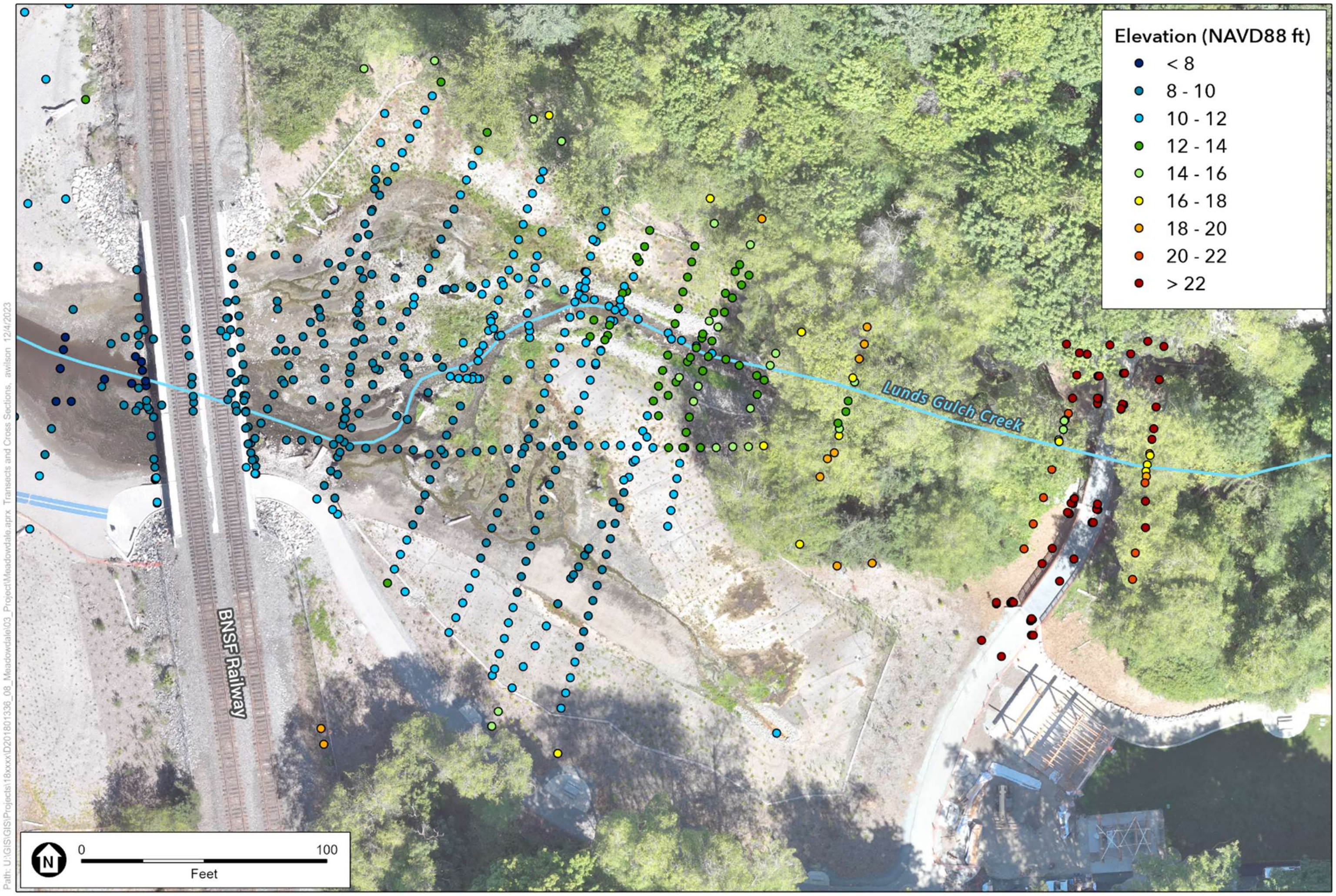
Drone and transect topographic data were collected in May and August 2023. Additional transect topographic data were collected in November 2023. **Figure 18** displays the DSM for the upper estuary, creek outlet, and lower estuary. The supplemental topographic data collected along transects in August is presented in **Figure 19.** The centerlines of channels through the upper estuary were mapped using the topographic data collected in November **(Figure 20**). A high-resolution DSM for the upper estuary is presented in **Figure 21**.

The data establish the new baseline for the restoration area. Similar data collection is planned each year through year 10 post-construction. Each year, the data will be analyzed to evaluate channel alignment changes, inundation area changes, and areas experiencing sediment erosion or deposition.

Sources: DSM: Tulalip Tribes 2023; Thalweg: Digitized using survey point data from Tulalip Tribes 2023

Meadowdale Beach Park Restoration Monitoring Report

Figure 18. Digital Surface Model of Restoration Area



Sources: Imagery: Tulalip Tribes 2023; Survey Points: Tulalip Tribes, Anchor QEA 2023

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Figure 19. Supplemental Topographic Data Collected to Supplement Drone-based Digital Surface Model

Sources: DSM: Tulalip Tribes 2023; Thalweg: Digitized using survey point data from Tulalip Tribes 2023

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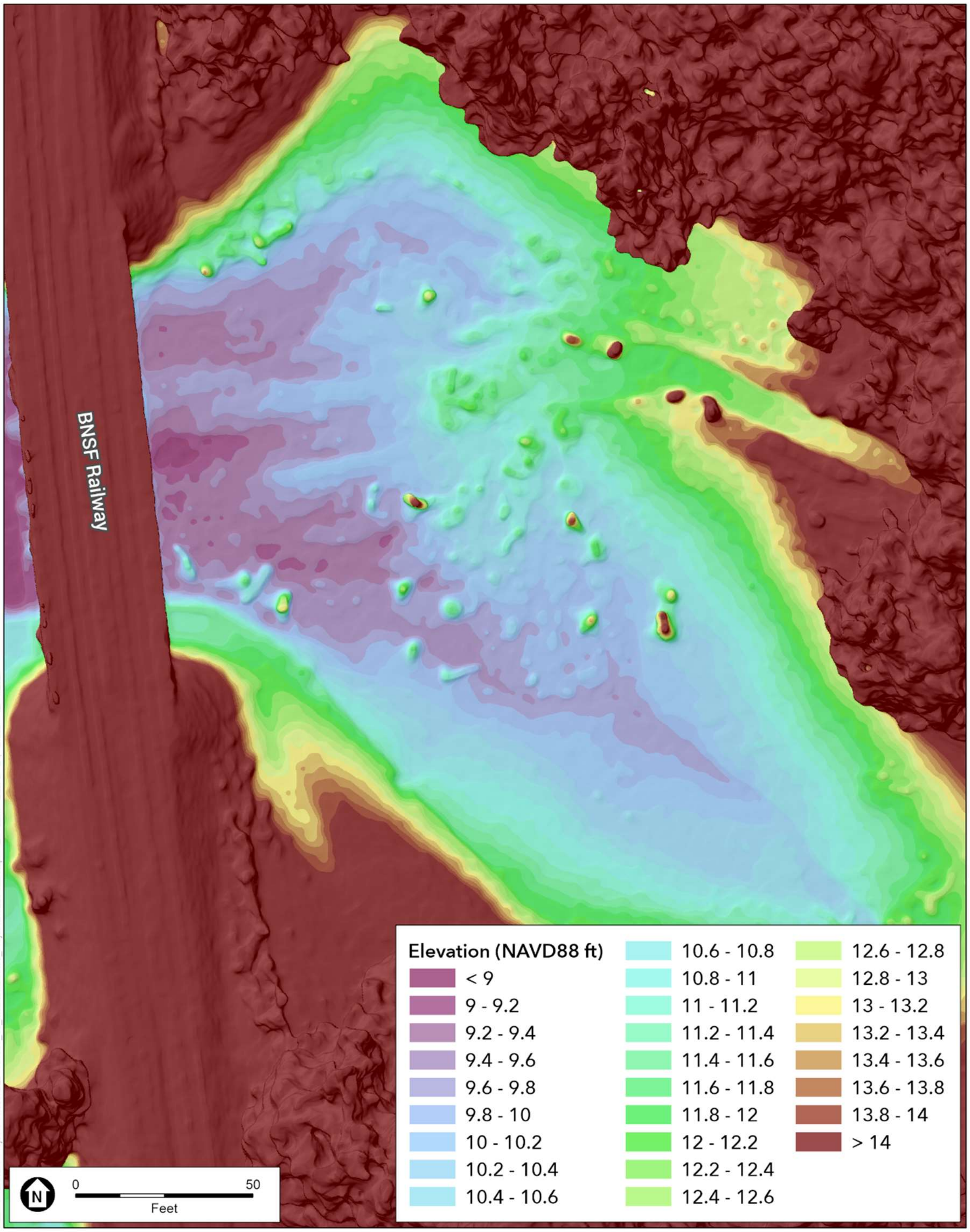
Figure 20. Channel Alignments Through Upper Estuary



Sources: DSM: Tulalip Tribes 2023

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Figure 21. High Resolution Digital Surface Model of Upper Estuary

Sediment Dynamics in Lower Estuary and Adjacent Nearshore

As described above for the upper estuary, sediment erosion and deposition patterns in the lower estuary will inform how the site is evolving as coastal and fluvial processes act on the area. The monitoring will help inform the size and design of future restoration projects to accommodate creek outlet, estuary, and sediment dynamics.

Methods

The Tulalip Tribes conducted drone flights of the restoration area that provided georectified aerial orthophoto and a DSM. To supplement the drone DSM information, horizontal and vertical positioning data were collected using RTK-GPS to supplement drone data. Data were collected along 9 transects running approximately perpendicular to the railroad embankment. **Table 15** presents the start and end point locations for each of the transects.

TABLE 15
LOWER ESTUARY AND ADJACENT NEARSHORE 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

In a separate effort, Blue Coast Engineering collected cross-shore topographic beach profiles along the 9 transects as part of an Estuary and Salmon Restoration Program (ESRP) learning grant focused on developing guidelines and tools for estimating sediment transport and shoreform evolution of shorelines in Puget Sound. This learning grant study is independent from the funding for Meadowdale monitoring and will incorporate data from additional study sites throughout Puget Sound. Monitoring has been completed eight times since August 2021, including spring and fall surveys each year.

Results and Discussion

Drone and transect topographic data were collected in May and August 2023. Additional transect topographic data were collected in October 2023. See Figure 17 for the DSM that includes the lower estuary. A high-resolution DSM of the lower estuary is presented in **Figure 22**. **Figure 23** displays the topographic data collected along beach transects. The data are color coded to depict elevations below mean lower low water (MLLW), between MLLW and MHHW, between MHHW and HAT, and above HAT.

The data establish the new baseline for the project area. Similar data collection is planned annually through year 10. Each year, the data will be analyzed to evaluate channel alignment changes, inundation area changes, and areas experiencing sediment erosion or deposition.

Blue Coast Engineering created a story map to share the beach profile data collected in their ESRP learning grant (available at this link). An example beach profile plot from transect 5 is shown in **Figure 24**. The volumetric change will be calculated between beach profile surveys and used to calibrate and validate sediment transport prediction tools. Blue Coast Engineering anticipates completing the analysis and reporting for their study in Summer 2024.

Fish Use

The estuary restoration was conducted to improve the quality and quantity of habitats for salmon, trout, and other fish. A primary goal for the restoration was to improve habitat accessibility and quality for juvenile Chinook salmon. Monitoring conducted to document 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.

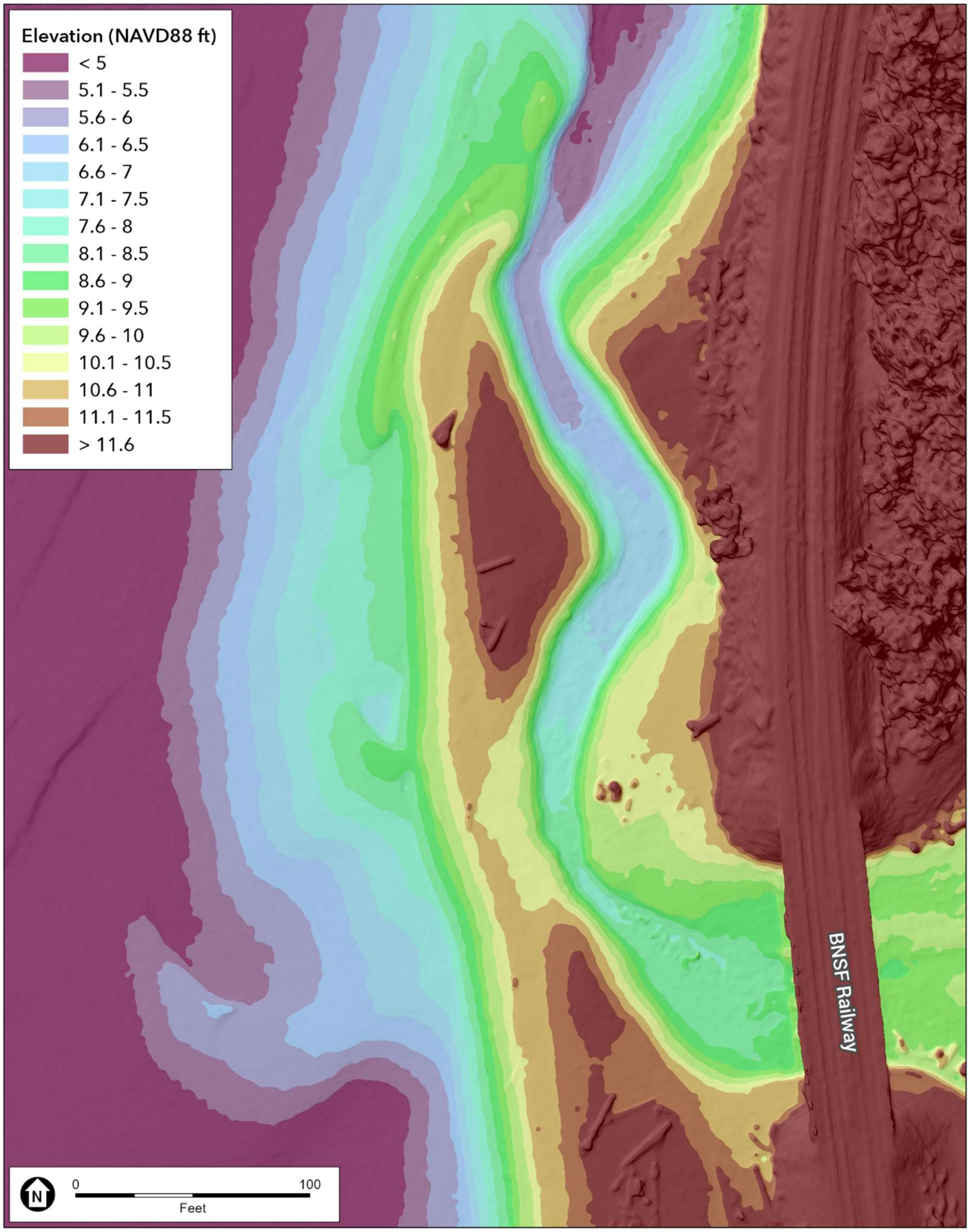
Methods

The Tulalip Tribes have conducted fish sampling in the estuary and lowermost reaches of Lund's Gulch Creek in 2018 and from 2021–2023. The sampling in 2018 and 2021 was prior to restoration. The sampling in 2022 occurred mid-restoration when much of the estuary embayment had been excavated but the culvert crossing was still in place and the tidal channel downstream of the culvert flowed due west. The sampling in 2023 occurred after the habitat restoration was largely complete, including the full excavation of the estuary and installation of the new bridge. Electrofishing was conducted from February through May each year, with additional sampling in June 2022. Fish species are netted, identified as to species, held in an aerated bucket, and released after all sampling is conducted. In future years, beach seining may also be conducted. The survey will be repeated annually through year 10 post-construction.

Results and Discussion

The post-restoration sampling in 2023 caught Chinook, coho, and chum salmon; coastal cutthroat trout; multiple sculpin species; and threespine stickleback (*Gasterosteidae aculeatus*) (**Table 16**). Compared to earlier years, the post-restoration sampling had the fewest sampling events, but the highest number of chum salmon, Pacific staghorn sculpin (*Leptocottus armatus*), prickly sculpin (*Cottus asper*), sharpnose sculpin (*Clinocottus acuticeps*), and unidentified sculpin were captured. Over the four years of sampling, the following salmonid species were captured each year: chinook salmon, coho salmon, and coastal cutthroat trout.

Figure 25 shows salmon and trout catches by year and by reach. See Table 1 for reach definitions. Chinook salmon have only been captured in reach 0, which is the lower estuary. Coho salmon and coastal cutthroat trout have been captured in all sampling reaches both before, during, and after restoration. Chum salmon were captured in all sampling reaches mid-restoration in 2022, but chum were not caught post-restoration in reaches 3 and 4 despite being caught in the furthest upstream reach.



Sources: DSM: Tulalip Tribes 2023

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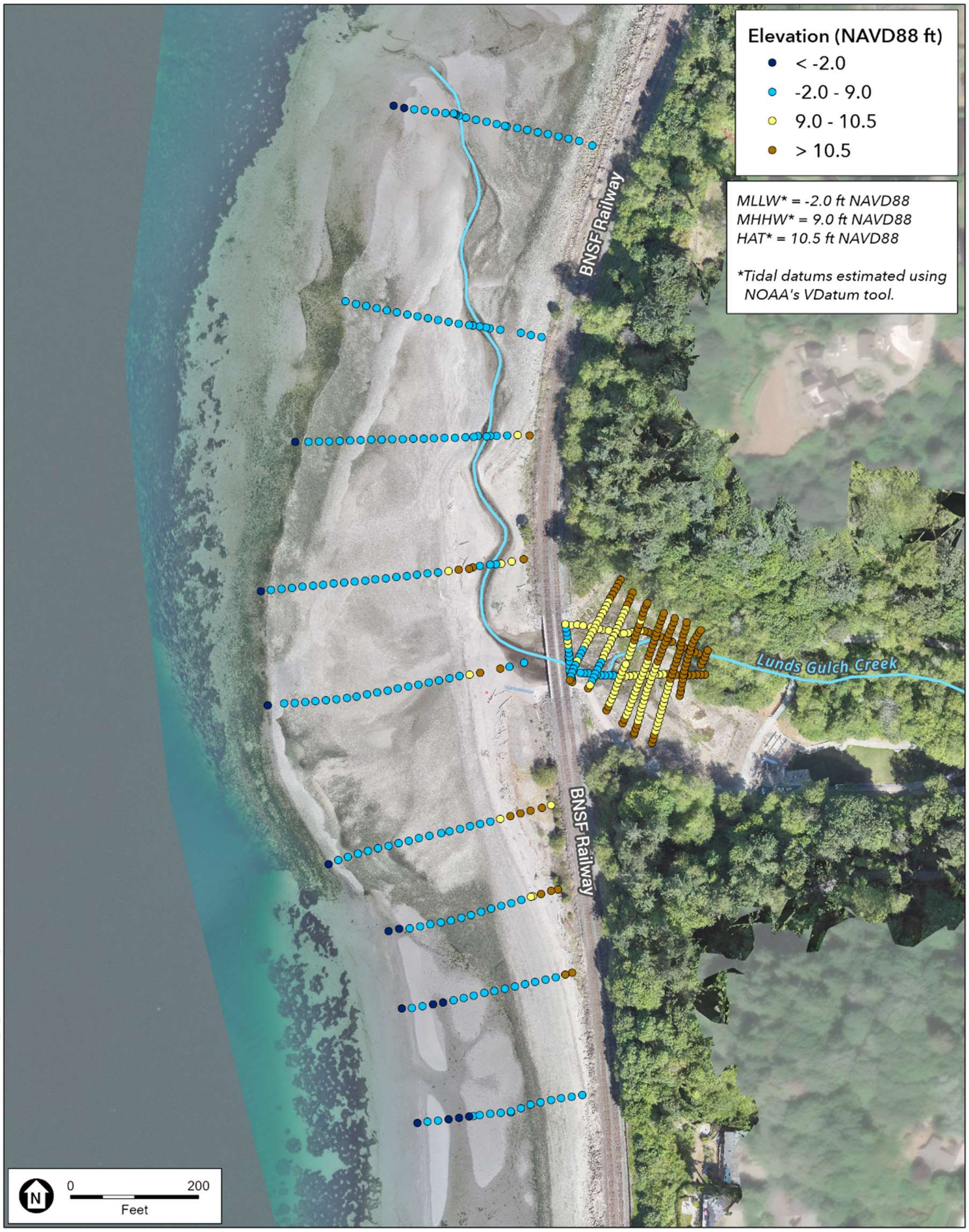
Figure 22. High Resolution Digital Surface Model of Lower Estuary



Sources: Imagery: Tulalip Tribes 2023, Maxar 2022; Transect Points: Tulalip Tribes 2023

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Figure 23. Beach Transects with Elevations Relative to MLLW, MHHW, and HAT

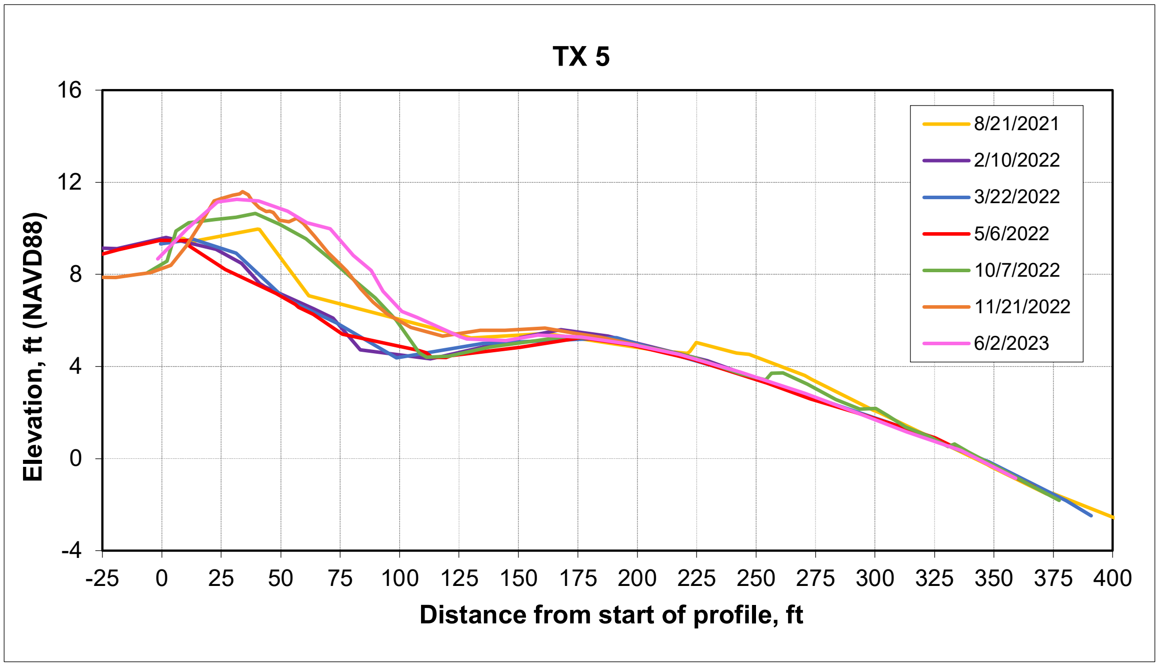

Figure 24. Example Beach Profiles from Blue Coast Engineering

TABLE 16
FISH USE PRE- AND POST-RESTORATION

Species	Pre-Restoration 2018 (n=9)	Pre-Restoration 2021 (n=14)	Mid-Restoration 2022 (n=9)	Post-Restoration 2023 (n=6)[a]	Total
Chinook Salmon	7	1	3	1	12
Coho Salmon	62	6	66	30	164
Chum Salmon	16	0	144	346	506
Pink Salmon	0	0	2	0	2
Coastal Cutthroat Trout	81	61	188	89	419
Pacific Staghorn Sculpin	36	1	8	97	142
Prickly Sculpin	7	17	32	39	95
Coastrange Sculpin	71	133	4	0	208
Tidepool Sculpin	0	1	1	1	3
Sharpnose sculpin	0	0	0	3	3
Unidentified Sculpin	611	252	96	154	1,113
Three-spined Stickleback	0	0	1	1	2
Starry Flounder	0	0	1	0	1

Note:

a = In 2023 sampling was conducted in all reaches in 5 sampling events. Sampling in a 6th event was conducted in one reach and included in the overall count.

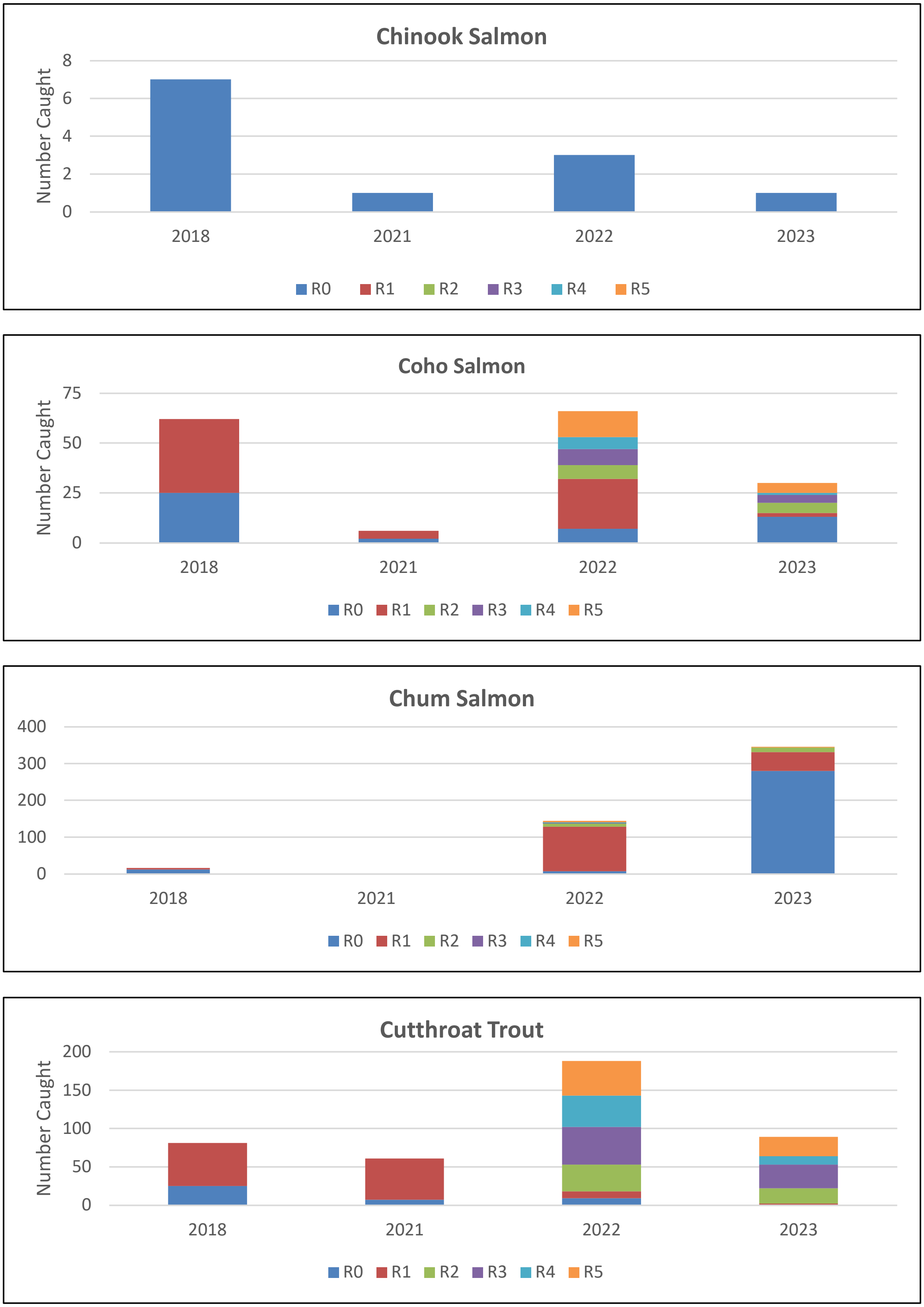

Figure 25. Salmon and Trout Catches by Year and Sampling Reach

Table 17 shows the monitoring element and hypotheses, the applicable monitoring years post-construction in which hypotheses will be evaluated, and whether each hypothesis was supported by the data. Several of the hypotheses cannot be fully answered in Year 1 and will need to be continually monitored in the following years.

TABLE 17
FISH USE MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: 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.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Juvenile Chinook salmon were captured in year 1 sampling.
Hypothesis: Juvenile Chinook salmon will occupy portions of the estuary providing cover habitat, such as large wood, deep pools, or large substrate.	This hypothesis cannot be answered after just one year and will need to be further evaluated.
Question: 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.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Year 1 sampling did not include sampling in adjacent nearshore habitats.
Hypothesis: The seasonality of juvenile Chinook presence in the restored habitats and adjacent nearshore habitats will be the same.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Year 1 sampling did not include sampling in adjacent nearshore habitats.
Question: 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.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Year 1 sampling did not include sampling in adjacent nearshore habitats.
Hypothesis: Juvenile Chinook salmon in the restored habitats will be larger than those in the adjacent nearshore habitats.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Year 1 sampling did not include sampling in adjacent nearshore habitats.
Question: 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.	Yes, other salmon and trout species captured in 2023 included coho salmon, chum salmon, and coastal cutthroat trout.
Question: 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.	This hypothesis cannot be answered after just one year and will need to be further evaluated. Year 1 sampling did not include taking tissue samples for genetic analysis.
Question: 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.	Yes, several nearshore species, including starry flounder and multiple sculpin species, were captured in 2023.
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.	No forage fish were captured in 2023 fish use sampling.

Salmon Spawning Ground Surveys

Methods

The Edmonds Stream Team, a citizen science and student volunteer group based in Edmonds, has conducted fall surveys for adult salmon in Lund's Gulch Creek in Meadowdale Park from 2018–2023. The entire creek is surveyed weekly depending on volunteer availability and stream conditions, and both live and dead salmon are recorded from the end of September through December (Edmonds Stream Team 2023). The Edmonds Stream Team 2023 report provided midway through the 2023 sampling season is provided as **Appendix D**.

The Edmonds Stream Team surveys from the estuary to the estimated upstream extent of chum salmon presence. This is established 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.).

Results and Discussion

Data from 2018 through 2023 are summarized in **Appendix D**. During those years, live adult coho salmon have been observed as early as September 29 and as late as November 26. Live adult chum salmon have been observed as early as October 31 and as late as December 5. Live and dead counts of adult salmon by species by year are presented in **Figure 26**. These counts may overestimate the number of salmon returning to the creek by recording the same fish on different days (Edmonds Stream Team 2023). For example, a live fish may be counted in multiple surveys, then counted again as a dead salmon in later surveys. However, salmon are only counted once as dead because they are marked to avoid being recounted in a later survey (Edmonds Stream Team 2023).

In 2023, seven coho salmon were observed, of which four were alive and three were dead. This is slightly higher than the numbers of coho observed in 2021 and 2022 (four and six, respectively). Chum salmon were more numerous than coho salmon. Eleven chum salmon were observed, of which eight were alive and three were dead. The number of chum salmon in 2023 is much lower than in 2021 and 2022, when 91 and 48 were observed, respectively. The reason for the lower numbers is not readily apparent but will be evaluated further in future years.

Figure 26. Adult Salmon Observations in Spawning Ground Surveys

Table 18 shows the monitoring element and hypotheses, the applicable monitoring years post-construction in which hypotheses will be evaluated, and whether each hypothesis was supported by the data.

TABLE 18
SALMON SPAWNING GROUND SURVEYS MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: 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.	Adult coho and chum salmon spawned upstream of the restored estuary habitat, but no specific observations of fish holding in the estuary habitat were recorded in 2023.
Question: 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.	The number of adult coho salmon increased from 6 fish (3 alive, 3 dead) in 2022 to 7 fish (4 alive, 3 dead) in 2023. The number of adult chum salmon decreased from 48 in 2022 (28 alive, 20 dead) to 11 fish in 2023 (8 alive, 3 dead).
Question: 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.	No predation on adult salmon was observed during the 2023 surveys

Forage Fish Egg Presence

Methods

The Snohomish County Marine Resources Committee collects beach substrate samples to detect forage fish egg presence. Forage fish egg presence samples were collected following the protocols specified by WDFW (2021). Samples are collected from two sites, one at Meadowdale Park and one at Picnic Point. At both sites the same protocols are followed, and samplers complete two samples/stations. At the Meadowdale project site, one sample is collected on the north side of the beach on the berm forming the outer margin of the estuary channel and one sample is collected on the south side of the beach. There are no defined GPS points or landmarks that are used as the starting point for the 100-foot sample zone, but rather surveys move along the beach looking for the best possible substrate for forage fish eggs. The survey is conducted monthly and will be repeated annually through year 10 post-construction.

Results and Discussion

No forage fish were detected in Year 1 at the restoration site in monthly samples collected January through August 2023. Forage fish egg data collected by the Snohomish County Marine Resources Committee since September 2020 is presented in **Table 19**. The sampling did not occur for parts of 2021 and 2022 due to project construction. The only sampling dates when eggs have been identified in the recent monitoring efforts were when sand lance eggs were detected in December 2021 and January 2022 and surf smelt eggs detected in January through March 2022. Previously, sand lance eggs were also documented by WDFW in November 2003 (WDFW 2023).

TABLE 19
FORAGE FISH EGGS DETECTED IN SURVEYS

Month and Year	Surf Smelt		Sand Lance	
	Meadowdale North	Meadowdale South	Meadowdale North	Meadowdale South
September 2020	0	0	0	0
October 2020	0	0	0	0
November 2020	0	0	0	0
January 2021	0	0	0	0
February 2021	0	0	0	0
March 2021	0	0	0	0
April 2021	0	0	0	0
May 2021	0	0	0	0
June 2021	0	0	0	0
November 2021	0	0	0	0
December 2021	0	0	0	1
January 2022	0	1	3	0
February 2022	1	0	0	0
March 2022	2	0	0	0
April 2022	0	0	0	0
January 2023	0	0	0	0
February 2023	0	0	0	0
March 2023	0	0	0	0
April 2023	0	0	0	0
May 2023	0	0	0	0
June 2023	0	0	0	0
July 2023	0	0	0	0
August 2023	0	0	0	0
September 2023	0	0	0	0
October 2023	0	0	0	0
November 2023	0	0	0	0
December 2023	0	0	0	0

Table 20 shows the monitoring element and hypotheses, the applicable monitoring years post-construction in which hypotheses will be evaluated, and whether each hypothesis was supported by the data.

TABLE 20
FORAGE FISH EGG PRESENCE MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: 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.	No forage fish eggs were detected in Year 1 (2023). Mid-construction in late 2021 and early 2022, surf smelt and sand lance eggs were detected. Prior to construction, no forage fish eggs were documented in 2020 or early 2021. Future years of monitoring will be needed to evaluate this monitoring question.

Additional Vegetation Characteristics

Four transects, VT7 through VT10, were established along topographic gradients across multiple plant communities (see **Figure 17**). These four gradient transects are not tied to any required performance standard but were initially established to support additional monitoring elements. Plant stems of woody and herbaceous species along each transect were counted within the 10-foot belt, and the line-intercept method was used to record invasive species along each transect. Elements assessed in Year 1 included vegetative composition, and vegetative density along topographic and tidal gradients. These results are intermingled above under Planted Vegetation Survival and Coverage under Required Monitoring Elements. Additional parameters to be measured in future years include soil salinity and changes in vegetation along topographic gradients. As the site ages, methods and results for these parameters will be presented separately from the required monitoring elements.

Photo Points

Methods

Photo point locations were established throughout the restoration area. The photographs are expected to provide visual documentation of sedimentation, streambank erosion, channel alignments, vegetation establishment, beach changes, etc. Photos were taken when possible by field crews collecting other monitoring data. Photos were taken in multiple directions, often in four directions, to provide 360-degree coverage of the restoration area. Photo points will be collected, as possible, during other monitoring activities through the 10 years of post-construction monitoring.

Results and Discussion

Photo points were established during the first year following construction to provide a library of photos to document change in the restoration area over time. Photo point locations were established in the beach, estuary, and creek areas (**Figures 27** and **28**). Photos collected at photo points were compiled into PowerPoint presentations that are available here.

Table 21 shows the monitoring element and hypotheses, the applicable monitoring years post-construction in which hypotheses will be evaluated, and whether each hypothesis was supported by the data.

TABLE 21
PHOTO POINTS MONITORING SUMMARY

Monitoring Questions and Hypotheses	Summary of Findings
Question: 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.	Yes, a robust set of photo points has been established throughout the site. Photos have already been taken more than once at many of the sites.

Figure 27. Photo Points Established Along the Beach Transects

Sources: Imagery: Tulalip Tribes 2023, Maxar 2022; Photo Points: Snohomish County 2023

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Figure 28. Photo Points Established in the Upper Estuary, Creek Outlet, and Lower Lund's Gulch Creek

Summary of Year 1 Monitoring Findings

The Year 1 post-restoration monitoring program was successfully implemented, although the results of some monitoring elements are still pending. This includes the benthic macroinvertebrate sampling and the salmon spawning surveys. **Table 22** summarizes the results by monitoring element. All of the elements that entail a comparison to pre-restoration conditions, and all data collected and available, were determined to be meeting the performance standards and responding favorably post-restoration.

Due to the continuation of restoration construction into mid-2023, some of the data collected will serve as baseline data against which future years will be compared. As a result, documentation of change following restoration could not be evaluated for monitoring elements such as channel cross-section and profile surveys intended to assess how the site responds after restoration. The effectiveness of these monitoring elements is considered not yet known.

In terms of the required monitoring elements, fish passage conditions, large woody material retention, and planted vegetation survival all met performance standards. The evaluation of channel cross-section and profiles in the estuary will require additional years of data collection to inform post-restoration channel evolution. Stream habitat performance met performance standards for the parameters completed, but is considered not completed evaluated because the benthic macroinvertebrate sample analysis is still underway.

TABLE 22
SUMMARY OF MONITORING RESULTS

Result	Monitoring Element	Notes
	Fish Passage Conditions	Velocities below maximum threshold. Restored natural fish passage conditions for estuary.
	Channel Cross-section and Profile Surveys	Baseline measurement
	Stream Habitat and Benthic Macroinvertebrate Populations	Baseline habitat data collected. Two benthic macroinvertebrate samples were collected with results pending
	Large Wood Retention and Recruitment in Upper Estuary	More large wood through restoration. Post-restoration there is 107 pieces of large wood in stream and estuary compared to 2 pieces pre-restoration
	Planted Vegetation Survival and Coverage	Exceeded 90% survival standard for native planted vegetation and low coverage (<20%) of non-native vegetation
	Sediment Dynamics and Habitat Area	Baseline measurement.
	Fish Use	Ten fish species captured in electrofisher sampling, including chinook, coho, and chum salmon and coastal cutthroat trout
	Salmon Spawning Surveys	Mixed results compared to pre-restoration surveys. Coho salmon highest numbers since 2019. Chum salmon lowest numbers since 2019.
	Forage Fish Egg Presence	No forage fish eggs were detected in Year 1. Mid-construction, surf smelt and sand lance eggs were detected. Pre-construction, no forage fish eggs were documented.

Notes: RED = element needs management YELLOW = on track or not yet known GREEN = met performance standards

Recommendations

Vegetation Monitoring Protocols

Within the data collection, methods, and schedule under Section E, Planted Vegetation Survival and Coverage, the Monitoring Plan includes the following method: "*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*." After establishing transects and monitoring the site for Year 1, it is apparent that up to six quadrats for each transect is sufficient, as all transects but one are only 50 feet long. By establishing six 1-meter quadrats along each transect, the monitoring effort assesses almost 40 percent of the transect's potential area, which is sufficient to extrapolate for overall health and survival, not only along the transects but for the overall site.

Additionally, monitoring efforts will include the following changes/additions:

- Keep quadrats permanent along marsh transects rather than changing every year.
- Include information regarding additional plantings in Year 2 monitoring report;
- Record soil salinity and elevation along each of the four gradient transects to assess whether there is an association between volunteer vegetation and salinity and/or elevation.

Site Maintenance

Based on the vegetation monitoring results, ESA recommends the County replace all dead plants, particularly the western redcedars located near the trail and VP4 and the estuary and those located in the beach planting areas. Although the site may have achieved 90 percent survival of planted tree species as required by the Wetland Delineation Report (Anchor QEA 2018b), a number of herbaceous plantings on the beach and estuary may need to be replanted in order to meet Year 3 performance standards for native vegetation cover. This is particularly true for the beach plantings located along VT1 and VT2. These areas may also need additional watering or irrigation during the summer months, as many plants appeared stressed when the monitoring was conducted in late summer. Invasive and non-native plants should continue to be removed as a part of regular maintenance.

Topographic Surveys, Substrate Size Mapping, and Sediment Particle Tracking

More land-based topographic data collection is recommended to characterize conditions throughout the estuary and support change analysis in future monitoring years. Data gathering focusing on mapping the alignment and extents of the channel network would be informative to track channel evolution over time. Relatedly, channel profile mapping of the thalweg is needed from the bridge near the park ranger's house all the way through the lower estuary.

Additionally,

- At the creek transects, it would be helpful to run a tape across the channel and take a photo of the transect location.

- Substrate size composition mapping is needed along the survey transects in the upper estuary. This is included in monitoring element F in the monitoring plan (ESA 2022).

- Substrate size composition mapping is needed along the survey transects in the lower estuary. This is surface and subsurface size characterization. This is included in monitoring element G in the monitoring plan (ESA 2022).

- Sediment particle tracking is needed throughout the estuary. This is included in monitoring element F in the monitoring plan (ESA 2022).

Conduct Beach Seining of Fish Community

Monitoring element H of the monitoring plan (ESA 2022) includes beach seining through the estuary and adjacent nearshore habitats. The monitoring element also includes collecting a neuston sample during juvenile fish sampling to evaluate the availability and composition of prey communities for juvenile salmonids.

Conduct Additional Monitoring Elements

As summarized in Table 2, six monitoring elements identified in the monitoring plan as a priority for restoration effectiveness monitoring were not sampled in year 1 due to lack of an identified monitoring lead and funding. The monitoring elements for which no data were collected are macroinvertebrate production in upper and lower estuary (K), additional vegetation characterization (L), extended salmon spawning ground and redd surveys (N), carbon sequestration in soils (O), wildlife use (P), and public use (Q). The early years of post-construction monitoring provide important post-restoration baseline data that can be compared to all future years to assess changes over time.

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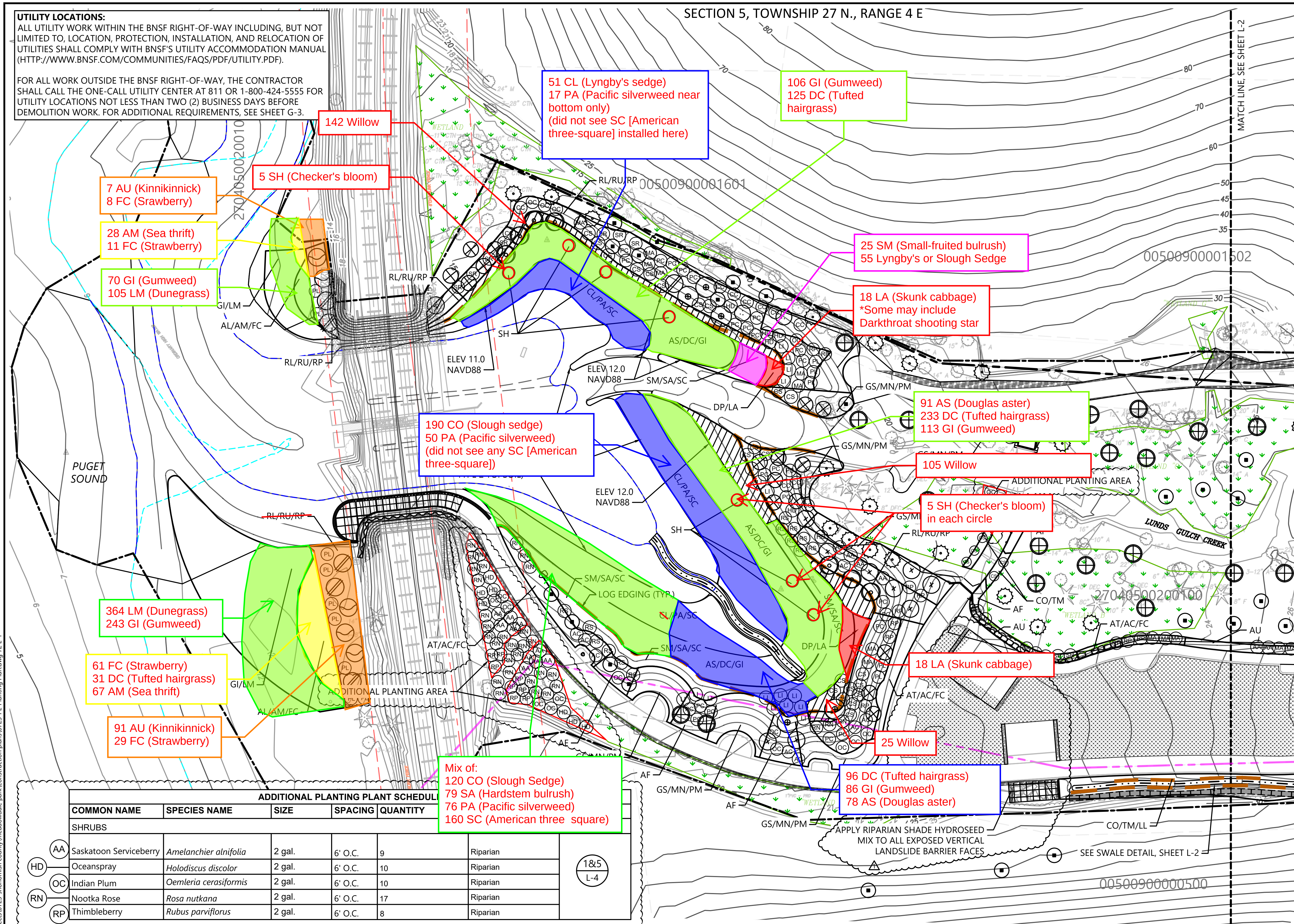
Appendix A

Initial As-Built Survey of Planting Plan

SECTION 5, TOWNSHIP 27 N., RANGE 4 E

UTILITY LOCATIONS:
ALL UTILITY WORK WITHIN THE BNSF RIGHT-OF-WAY INCLUDING, BUT NOT LIMITED TO, LOCATION, PROTECTION, INSTALLATION, AND RELOCATION OF UTILITIES SHALL COMPLY WITH BNSF'S UTILITY ACCOMMODATION MANUAL (HTTP://WWW.BNSF.COM/COMMUNITIES/FAQS/PDF/UTILITY.PDF).

FOR ALL WORK OUTSIDE THE BNSF RIGHT-OF-WAY, THE CONTRACTOR SHALL CALL THE ONE-CALL UTILITY CENTER AT 811 OR 1-800-424-5555 FOR UTILITY LOCATIONS NOT LESS THAN TWO (2) BUSINESS DAYS BEFORE DEMOLITION WORK. FOR ADDITIONAL REQUIREMENTS, SEE SHEET G-3.



ADDITIONAL PLANTING PLANT SCHEDULE

	COMMON NAME	SPECIES NAME	SIZE	SPACING	QUANTITY		
	SHRUBS						
AA	Saskatoon Serviceberry	*Amelanchier alnifolia*	2 gal.	6' O.C.	9	Riparian	1&5 / L-4
HD	Oceanspray	*Holodiscus discolor*	2 gal.	6' O.C.	10	Riparian	
OC	Indian Plum	*Oemleria cerasiformis*	2 gal.	6' O.C.	10	Riparian	
RN	Nootka Rose	*Rosa nutkana*	2 gal.	6' O.C.	17	Riparian	
RP	Thimbleberry	*Rubus parviflorus*	2 gal.	6' O.C.	8	Riparian	

LEGEND:
- PARK BOUNDARY
- PROJECT BOUNDARY
- BNSF RIGHT OF WAY
- EXISTING MEAN HIGHER HIGH WATER
- PROPOSED MEAN HIGHER HIGH WATER
- 10 PROPOSED CONTOUR
- TREE TO REMAIN
- EXISTING WETLAND TO BE PROTECTED
- CLEARING LIMITS
- LOG EDGING
- GABION WALL

NORTH

0 30 60
SCALE IN FEET

NOTES:
1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD 88
3. DRAWINGS ARE INTENDED TO BE VIEWED IN COLOR. SOME INFORMATION WILL BE LOST WITH BLACK AND WHITE VIEWING.
4. SEE SHEET L-3 FOR PLANTING SCHEDULE.
5. 45% OF THE SITE IS LANDSCAPED, WHICH MEETS REQUIREMENTS OF SCC 30.25.015(1).

APPROVED FOR CONSTRUCTION
BY: ____
R/W PERMIT NO. ____
DATE ____
PFN: 19-103913LDA

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

100% CONSTRUCTION DRAWINGS/BID SET

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Jan 31, 2023 2:14pm cwee

ANCHOR QEA
720 Olive Way | Suite 1900 | Seattle, WA 98101

Snohomish County
Parks and Recreation

STATE OF WASHINGTON
PETER C. HUMMEL
LICENSED LANDSCAPE ARCHITECT
NO. 0422 EXP. APRIL 14, 2021

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION
1	06-09-22	CH	JS	REMOVE EXISTING PICNIC SHELTER

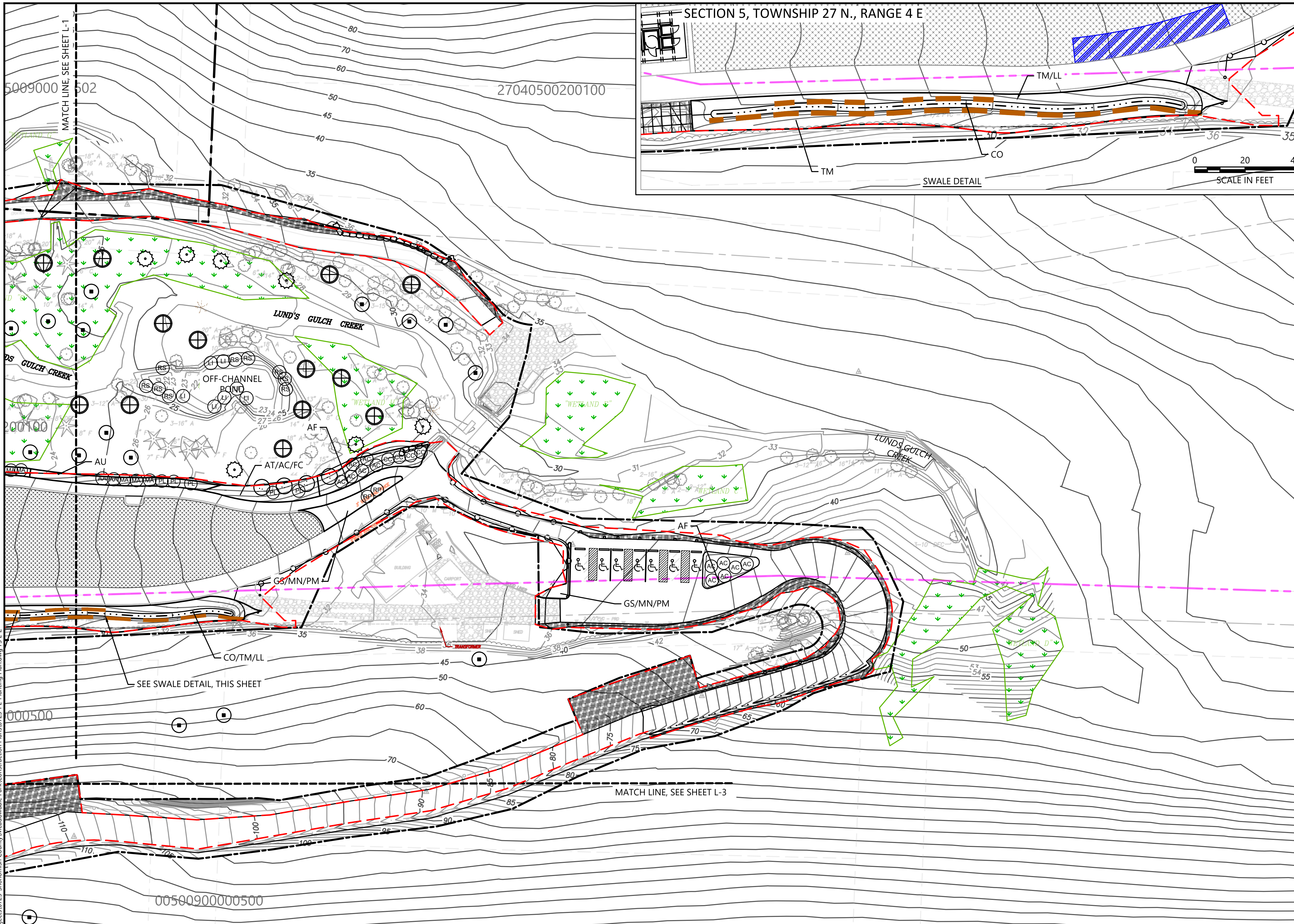
DESIGNED BY: PH
DRAWN BY: CH/TG
CHECKED BY: PH
APPROVED BY: PH
SCALE: 1" = 30'
DATE: SEPTEMBER 2020

MEADOWDALE BEACH PARK AND ESTUARY DESIGN
PFN 19-103913LDA

PLANTING PLAN (1 OF 3)

L-1

SHEET # 75 OF 81



LEGEND:

- PARK BOUNDARY
- PROJECT BOUNDARY
- BNSF RIGHT OF WAY
- EXISTING MEAN HIGHER HIGH WATER
- PROPOSED MEAN HIGHER HIGH WATER
- 10 PROPOSED CONTOUR
- TREE TO REMAIN
- EXISTING WETLAND TO BE PROTECTED
- CLEARING LIMITS
- LOG EDGING

PARKING LOT LANDSCAPING NOTES:

1. AREA OF PROPOSED PARKING LOT LANDSCAPING: 922 SF, EXISTING MATURE VEGETATION INCLUDED.
2. AREA OF PROPOSED PARKING LOT: 3,620 SF.
3. LANDSCAPED PARKING LOT AREA PERCENTAGE: 25%

NORTH

0 30 60
SCALE IN FEET

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE NORTH ZONE, NAD 83, U.S. FEET.
2. VERTICAL DATUM: NAVD 88
3. DRAWINGS ARE INTENDED TO BE VIEWED IN COLOR. SOME INFORMATION WILL BE LOST WITH BLACK AND WHITE VIEWING.
4. SEE SHEET L-3 FOR PLANTING SCHEDULE.
5. CONTRACTOR SHALL PROVIDE CONTINUOUS UTILITY SERVICE AND DRIVEWAY ACCESS TO RANGER RESIDENCE.

APPROVED FOR CONSTRUCTION
BY:__________
R/W PERMIT NO.__________
DATE__________
PFN: 19-103913LDA

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

BID SET

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Aug 11, 2020 7:00pm cwee

ANCHOR QEA
720 Olive Way | Suite 1900 | Seattle, WA 98101

Snohomish County Parks and Recreation

STATE OF WASHINGTON LICENSED LANDSCAPE ARCHITECT
PETER C. HUMMEL
CERTIFICATE NO. 422

REVISIONS

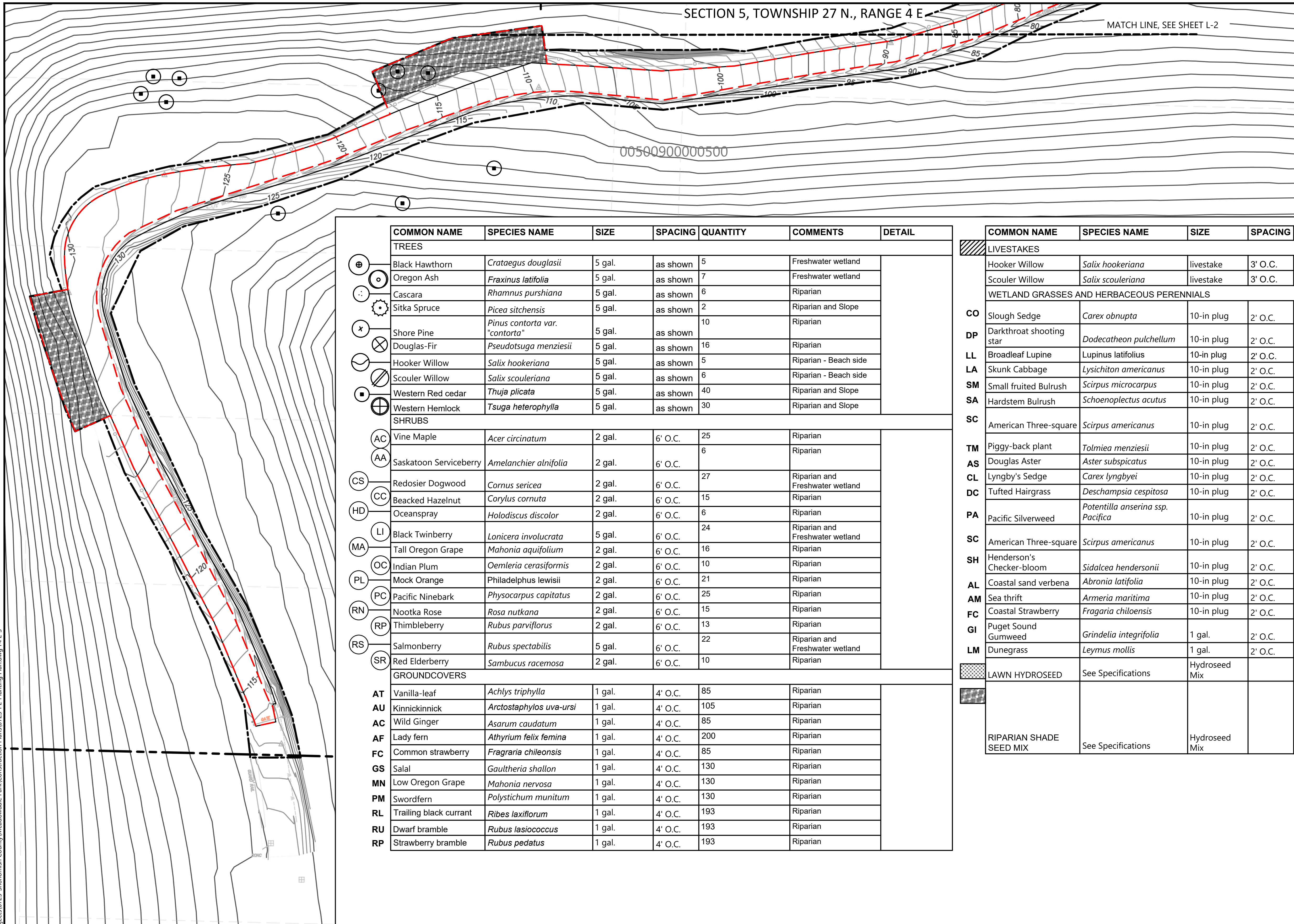
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: PH/BS
DRAWN BY: CH/TG
CHECKED BY: BS
APPROVED BY: PH
SCALE: AS NOTED
DATE: MAY 2019

MEADOWDALE BEACH PARK AND ESTUARY DESIGN
PFN 19-103913LDA

PLANTING PLAN (2 OF 3)

L-2



NORTH

0 30 60

SCALE IN FEET

NOTES:

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2. VERTICAL DATUM: NAVD 88
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4. CONTRACTOR SHALL PROVIDE CONTINUOUS UTILITY SERVICE AND DRIVEWAY ACCESS TO RANGER RESIDENCE.

	COMMON NAME	SPECIES NAME	SIZE	SPACING	QUANTITY	COMMENTS	DETAIL
	TREES						
	Black Hawthorn	*Crataegus douglasii*	5 gal.	as shown	5	Freshwater wetland	
	Oregon Ash	*Fraxinus latifolia*	5 gal.	as shown	7	Freshwater wetland	
	Cascara	*Rhamnus purshiana*	5 gal.	as shown	6	Riparian	
	Sitka Spruce	*Picea sitchensis*	5 gal.	as shown	2	Riparian and Slope	
	Shore Pine	*Pinus contorta var. "contorta"*	5 gal.	as shown	10	Riparian	
	Douglas-Fir	*Pseudotsuga menziesii*	5 gal.	as shown	16	Riparian	
	Hooker Willow	*Salix hookeriana*	5 gal.	as shown	5	Riparian - Beach side	
	Scouler Willow	*Salix scouleriana*	5 gal.	as shown	6	Riparian - Beach side	
	Western Red cedar	*Thuja plicata*	5 gal.	as shown	40	Riparian and Slope	
	Western Hemlock	*Tsuga heterophylla*	5 gal.	as shown	30	Riparian and Slope	
	SHRUBS						
AC	Vine Maple	*Acer circinatum*	2 gal.	6' O.C.	25	Riparian	
AA	Saskatoon Serviceberry	*Amelanchier alnifolia*	2 gal.	6' O.C.	6	Riparian	
CS	Redosier Dogwood	*Cornus sericea*	2 gal.	6' O.C.	27	Riparian and Freshwater wetland	
CC	Beacked Hazelnut	*Corylus cornuta*	2 gal.	6' O.C.	15	Riparian	
HD	Oceanspray	*Holodiscus discolor*	2 gal.	6' O.C.	6	Riparian	
LI	Black Twinberry	*Lonicera involucrata*	5 gal.	6' O.C.	24	Riparian and Freshwater wetland	
MA	Tall Oregon Grape	*Mahonia aquifolium*	2 gal.	6' O.C.	16	Riparian	
OC	Indian Plum	*Oemleria cerasiformis*	2 gal.	6' O.C.	10	Riparian	
PL	Mock Orange	Philadelphus lewisii	2 gal.	6' O.C.	21	Riparian	
PC	Pacific Ninebark	*Physocarpus capitatus*	2 gal.	6' O.C.	25	Riparian	
RN	Nootka Rose	*Rosa nutkana*	2 gal.	6' O.C.	15	Riparian	
RP	Thimbleberry	*Rubus parviflorus*	2 gal.	6' O.C.	13	Riparian	
RS	Salmonberry	*Rubus spectabilis*	5 gal.	6' O.C.	22	Riparian and Freshwater wetland	
SR	Red Elderberry	*Sambucus racemosa*	2 gal.	6' O.C.	10	Riparian	
	GROUNDCOVERS						
AT	Vanilla-leaf	*Achlys triphylla*	1 gal.	4' O.C.	85	Riparian	
AU	Kinnickinnick	*Arctostaphylos uva-ursi*	1 gal.	4' O.C.	105	Riparian	
AC	Wild Ginger	*Asarum caudatum*	1 gal.	4' O.C.	85	Riparian	
AF	Lady fern	*Athyrium felix femina*	1 gal.	4' O.C.	200	Riparian	
FC	Common strawberry	*Fragraria chileonsis*	1 gal.	4' O.C.	85	Riparian	
GS	Salal	*Gaultheria shallon*	1 gal.	4' O.C.	130	Riparian	
MN	Low Oregon Grape	*Mahonia nervosa*	1 gal.	4' O.C.	130	Riparian	
PM	Swordfern	*Polystichum munitum*	1 gal.	4' O.C.	130	Riparian	
RL	Trailing black currant	*Ribes laxiflorum*	1 gal.	4' O.C.	193	Riparian	
RU	Dwarf bramble	*Rubus lasiococcus*	1 gal.	4' O.C.	193	Riparian	
RP	Strawberry bramble	*Rubus pedatus*	1 gal.	4' O.C.	193	Riparian	

	COMMON NAME	SPECIES NAME	SIZE	SPACING	QUANTITY	COMMENTS	DETAIL
	LIVESTAKES						
	Hooker Willow	*Salix hookeriana*	livestake	3' O.C.	1050	Low riparian	
	Scouler Willow	*Salix scouleriana*	livestake	3' O.C.	1050	Low riparian	
	WETLAND GRASSES AND HERBACEOUS PERENNIALS						
CO	Slough Sedge	*Carex obnupta*	10-in plug	2' O.C.	300	Freshwater wetland, swale	
DP	Darkthroat shooting star	*Dodecatheon pulchellum*	10-in plug	2' O.C.	230	Freshwater wetland	
LL	Broadleaf Lupine	Lupinus latifolius	10-in plug	2' O.C.	265	Swale	
LA	Skunk Cabbage	*Lysichiton americanus*	10-in plug	2' O.C.	230	Freshwater wetland	
SM	Small fruited Bulrush	*Scirpus microcarpus*	10-in plug	2' O.C.	300	Freshwater wetland	
SA	Hardstem Bulrush	*Schoenoplectus acutus*	10-in plug	2' O.C.	300	Freshwater wetland	
SC	American Three-square	*Scirpus americanus*	10-in plug	2' O.C.	300	Freshwater wetland	
TM	Piggy-back plant	*Tolmiea menziesii*	10-in plug	2' O.C.	300	Freshwater wetland, swale	
AS	Douglas Aster	*Aster subspicatus*	10-in plug	2' O.C.	913	Tidal marsh	
CL	Lyngby's Sedge	*Carex lyngbyei*	10-in plug	2' O.C.	840	Tidal marsh	
DC	Tufted Hairgrass	*Deschampsia cespitosa*	10-in plug	2' O.C.	913	Tidal marsh	
PA	Pacific Silverweed	*Potentilla anserina ssp. Pacifica*	10-in plug	2' O.C.	840	Tidal marsh	
SC	American Three-square	*Scirpus americanus*	10-in plug	2' O.C.	840	Tidal marsh	
SH	Henderson's Checker-bloom	*Sidalcea hendersonii*	10-in plug	2' O.C.	40	Tidal marsh	
AL	Coastal sand verbena	*Abronia latifolia*	10-in plug	2' O.C.	140	Backshore beach	
AM	Sea thrift	*Armeria maritima*	10-in plug	2' O.C.	140	Backshore beach	
FC	Coastal Strawberry	*Fragaria chiloensis*	10-in plug	2' O.C.	140	Backshore beach	
GI	Puget Sound Gumweed	*Grindelia integrifolia*	1 gal.	2' O.C.	1912	Backshore beach	
LM	Dunegrass	*Leymus mollis*	1 gal.	2' O.C.	1000	Backshore beach	
	LAWN HYDROSEED	See Specifications	Hydroseed Mix				
	RIPARIAN SHADE SEED MIX	See Specifications	Hydroseed Mix			Landslide Barrier and Upland Slopes along paths, roads and parking where adjacent soils are disturbed by construction	

APPROVED FOR CONSTRUCTION
BY: ____________
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BID SET

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ANCHOR QEA

720 Olive Way | Suite 1900 | Seattle, WA 98101

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STATE OF WASHINGTON LICENSED LANDSCAPE ARCHITECT
PETER C. HUMMEL
CERTIFICATE NO. 422

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: PH/BS
DRAWN BY: CH/TG
CHECKED BY: BS
APPROVED BY: PH
SCALE: 1" = 30'
DATE: MAY 2019

MEADOWDALE BEACH PARK AND ESTUARY DESIGN
PFN 19-103913LDA

PLANTING PLAN (3 OF 3)

L-3

Appendix B
Vegetation Monitoring Data Table

ESA

Meadowdale Beach Park and Estuary Monitoring - Vegetative Plot Cover
Year 1 (2023)

Plot	Stratum	Common Name	Scientific Name	% Cover
VP1	S	Vine maple	*Acer circinatum*	5
	S	red alder	*Alnus rubra*	10
	H	Ladyfern	*Athyrium filix-femina*	10
	S	butterfly bush	*Buddleja davidii*	trace
	H	Lyngby's sedge	*Carex lyngbyei*	2
	H	Lyngby's sedge	*Carex lyngbyei*	6
	H	Common strawberry	*Fragaria chileonsis*	2
	S	Salal	*Gaultheria shallon*	7
	H	Toad rush	*Juncus bufonius*	1
	H	daggerleaf rush	*Juncus ensifolius*	trace
	S	Low Oregon grape	*Mahonia nervosa*	3
	H	Swordfern	*Polystichum munitum*	5
	S	Douglas-fir	*Pseudotsuga menziesii*	trace
	S	Salmonberry	*Rubus spectabilis*	5
	H	Hardstem bulrush	*Schoenoplectus acutus*	3
	H	American three-square	*Scirpus americanus*	2
	S	Western redcedar	*Thuja plicata*	8
		VP1 Results	Total	69
			Herbaceous	31
			Shrub	38
			Volunteer Plants	17
VP2	S	bigleaf maple	*Acer macrophyllum*	trace
	S	red alder	*Alnus rubra*	2
	H	Common strawberry	*Fragaria chileonsis*	12
	S	Salal	*Gaultheria shallon*	trace
	S	Black twinberry	*Lonicera involucrata*	3
	S	Mock orange	*Philadelphus lewisii*	2
	S	Pacific ninebark	*Physocarpus capitatus*	5
	H	Swordfern	*Polystichum munitum*	8
	S	Salmonberry	*Rubus spectabilis*	trace
	S	unknown	*unknown*	trace
		VP2 Results	Total	32
			Herbaceous	20
			Shrub	12
			Volunteer Plants	2

Plot	Stratum	Common Name	Scientific Name	% Cover
VP3	T	red alder	*Alnus rubra*	12
	S	red alder	*Alnus rubra*	3
	S	Beaked hazelnut	*Corylus cornuta*	5
	H	field horsetail	*Equisetum arvense*	trace
	H	Common strawberry	*Fragaria chileonsis*	5
	S	Salal	*Gaultheria shallon*	2
	S	Black twinberry	*Lonicera involucrata*	5
	S	Low Oregon grape	*Mahonia nervosa*	1
	S	Pacific ninebark	*Physocarpus capitatus*	2
	S	Shore pine	*Pinus contorta*	5
	H	Swordfern	*Polystichum munitum*	4
	S	Douglas-fir	*Pseudotsuga menziesii*	2
	S	Himalayan blackberry	*Rubus armeniacus*	trace
	S	Thimbleberry	*Rubus parviflorus*	trace
	S	Salmonberry	*Rubus spectabilis*	12
	S	Hooker willow	*Salix hookeriana*	10
	S	Pacific willow	*Salix lucida*	5
		VP3 Results	Total	73
			Herbaceous	9
			Shrub	52
			Tree	12
			Volunteer Plants	3
VP4	S	bigleaf maple	*Acer macrophyllum*	trace
	S	red alder	*Alnus rubra*	5
	H	Ladyfern	*Athyrium filix-femina*	3
	H	Common strawberry	*Fragaria chileonsis*	5
	S	Salal	*Gaultheria shallon*	5
	S	Black twinberry	*Lonicera involucrata*	5
	S	Low Oregon grape	*Mahonia nervosa*	2
	S	Pacific ninebark	*Physocarpus capitatus*	5
	S	Shore pine	*Pinus contorta*	2
	H	Swordfern	*Polystichum munitum*	3
	S	Douglas-fir	*Pseudotsuga menziesii*	1
	S	Nootka rose	*Rosa nutkana*	2
	H	vetch species	*Vicia spp.*	2
		VP4 Results	Total	40
			Herbaceous	13
			Shrub	27
			Volunteer Plants	6

Plot	Stratum	Common Name	Scientific Name	% Cover
VP5	T	bigleaf maple	*Acer macrophyllum*	20
	H	giant horsetail	*Equisetum telmateia*	5
	S	Himalayan blackberry	*Rubus armeniacus*	10
	S	Jewelweed	*Impatiens capensis*	15
	H	Piggyback plant	*Tolmiea menziesii*	80
	T	red alder	*Alnus rubra*	15
	S	Salmonberry	*Rubus spectabilis*	70
	H	stinging nettle	*Urtica dioica*	5
	H	Swordfern	*Polystichum munitum*	5
	S	Western hemlock	*Tsuga heterophylla*	1
	T	Western redcedar	*Thuja plicata*	35
		VP5 Results	Total	261
			Herbaceous	95
			Shrub	96
			Tree	70
VP6	S	Sitka spruce	*Picea sitchensis*	1
	T	Douglas-fir	*Pseudotsuga menziesii*	4
	H	creeping buttercup	*Ranunculus repens*	5
	H	trailing blackberry	*Rubus ursinus*	5
	T	Western redcedar	*Thuja plicata*	15
	H	Piggyback plant	*Tolmiea menziesii*	25
	T	red alder	*Alnus rubra*	40
	S	Salmonberry	*Rubus spectabilis*	70
	H	giant horsetail	*Equisetum telmateia*	trace
	H	stinging nettle	*Urtica dioica*	trace
		VP6 Results	Total	165
			Herbaceous	35
			Shrub	71
			Tree	59

Plot	Stratum	Common Name	Scientific Name	% Cover
VP7	H	velvetgrass	*Holcus lanatus*	trace
	H	Dunegrass	*Leymus mollis*	trace
	H	daggerleaf rush	*Juncus ensifolius*	trace
	H	seashore saltgrass	*Distichlis spicata*	trace
	H	needle spikerush/soft rush/slender rush	*Eleocharis acicularis/Juncus effusus/Juncus tenuis*	trace
	H	Bird's-foot trefoil	*Lotus corniculatus*	2
	H	red clover	*Trifolium pratense*	3
	H	American speedwell	*Veronica americana*	3
	H	American three-square	*Scirpus americanus*	6
	H	Pacific silverweed	*Potentilla anserina ssp. Pacifica*	trace
	H	white clover	*Trifolium repens*	5
	S	Douglas-fir	*Pseudotsuga menziesii*	trace
	H	Hardstem bulrush	*Schoenoplectus acutus*	7
	H	Lyngby's sedge	*Carex lyngbyei*	15
	H	Toad rush	*Juncus bufonius*	10
	S	red alder	*Alnus rubra*	3
		VP7 Results	Total	54
			Herbaceous	51
			Shrub	3
			Volunteer Plants	23

Site Average	Total	99
	Herbaceous	36
	Shrub	43
	Tree	20
	Volunteer Plants	7

Notes: T = tree, S = shrub, H = herbaceous
Green highlighted cell indicates volunteer plants
Red highlighted cell indicaes a non-native species
Blue highlighted cell indicates existing plant (not installed)

Stratum	Common Name	Scientific Name	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover
Transect			**VT1**													
Quadrat			**3**		**8**		**11**		**14**		**30**		**40**		**Total**	**Average**
H	Sea thrift	*Armeria maritima*	1	1			1	1	1	1	1	1	1	1	5	
H	Tufted hairgrass	*Deschampsia cespitosa*			1	1	3	4	2	2			1	0	6	
H	Common strawberry	*Fragaria chileonsis*	1	0	1	2					1	5	1	5	3	
	Totals:		**1**	**1**	**2**	**3**	**4**	**5**	**3**	**3**	**2**	**6**	**2**	**6**	**13**	**4**
Transect			**VT2**													
Quadrat			**2**		**6**		**12**		**14**		**24**		**42**		**Total**	**Average**
S	red alder	*Alnus rubra*	10	1	17	1	10	1	7	1	8	1	10	1	62	1
H	Douglas aster	*Aster subspicatus*	1	1											1	
S	butterfly bush	*Buddleja davidii*	1	3			1	1	1	1	2	3			5	
H	Tufted hairgrass	*Deschampsia cespitosa*							1	3	1	3	2	3	4	
H	Puget Sound gumweed	*Grindelia integrifolia*	1	15	1	4	2	20	2	18	1	5			7	
H	Toad rush	*Juncus bufonius*	1				2	2	2	2					4	
S	Douglas-fir	*Pseudotsuga menziesii*	8	1	4	1									12	
S	Himalayan blackberry	*Rubus armeniacus*			1	3									1	
H	clover	*Trifolium sp.*	2	1	1	1	1	trace	1	trace	2	trace	6	5	13	
	Totals:		23	22	24	10	16	24	14	25	14	12	18	9	**109**	**17**
Transect			**VT3**													
Quadrat			**1**		**4**		**14**		**18**		**21**		**43**		**Total**	**Average**
S	red alder	*Alnus rubra*	51	2	40	5	9	trace	33	2	30	5	29	5	192	4
H	Douglas aster	*Aster subspicatus*									1	trace	1	1	2	
H	Tufted hairgrass	*Deschampsia cespitosa*							1	2	1	2			2	
H	Puget Sound gumweed	*Grindelia integrifolia*					1	15							1	
H	bird's foot trefoil	*Lotus corniculatus*					1	2			1	trace			2	
S	Douglas-fir	*Pseudotsuga menziesii*	2	trace	2	trace	1	trace					1	trace	6	trace
H	Hardstem bulrush	*Schoenoplectus acutus*	2	2	1	2									3	
H	Small-fruited bulrush	*Scirpus microcarpus*	2	5											2	
H	clover	*Trifolium sp.*	3	trace	2	5					4	20	1	1	10	
	Totals:		60	9	45	12	12	17	34	4	37	27	32	7	**220**	**13**
Transect			**VT4**													
Quadrat			**1**		**2**		**10**		**25**		**44**		**47**		**Total**	**Average**
S	Kinnickinnick	*Arctostaphlos uva-ursi*					1	0							1	
H	seashore saltgrass	*Distichlis spicata*									1	5	2	8	3	
H	Puget Sound gumweed	*Grindelia integrifolia*									1	8	1	5	2	
H	Dunegrass	*Leymus mollis*							1	12	2	10	1	8	4	
	Totals:		0	0	0	0	0	0	1	12	4	23	4	21	**9**	**9**

Stratum	Common Name	Scientific Name	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover
	Transect		VT5													
	Quadrat		28		34		37		43		45		--		Total	Average
S	red alder	*Alnus rubra*							3	trace	2	trace			5	trace
H	Lyngby's sedge	*Carex lyngbyei*					1	1	1	2					2	
H	seashore saltgrass	*Distichlis spicata*	7	2	3	trace			3	3	10	7			23	
H	hairy cat's ear	*Hypochaeris radicata*					2	1							2	
H	jointleaf rush	*Juncus articulatus*					2	2							2	
H	Toad rush	*Juncus bufonius*	3	0	2	1	3	0	3	0					11	
H	daggerleaf rush	*Juncus ensifolius*	2	1	2	8	2	2	2	2	1	2			9	
H	needle spikerush/soft rush/slender rush	*Eleocharis acicularis/ Juncus effusus/ Juncus tenuis*	7	5	2	5	4	2	6	15	10	20			29	9
H	Pacific silverweed	*Potentilla anserina ssp. Pacifica*	3	10	12	10	8	20	9	50	11	50			43	
S	Scouler willow	*Salix scouleriana*			2	6									2	
H	Hardstem bulrush	*Schoenoplectus acutus*	12	3											12	
H	Small-fruited bulrush	*Scirpus microcarpus*							1	1					1	
H	American speedwell	*Veronica americana*									1	trace			1	
	Totals:		**34**	**21**	**21**	**30**	**19**	**28**	**28**	**73**	**35**	**79**			**137**	**46**
	Transect		VT6													
	Quadrat		5		6		14		31		35		--		Total	Average
S	red alder	*Alnus rubra*	5	2	8	2									13	
H	Lyngby's sedge	*Carex lyngbyei*	2	2			3	5	1	2	2	2			8	
H	Tufted hairgrass	*Deschampsia cespitosa*	1	2											1	
H	field horsetail	*Equisetum arvense*							35	20	33	5			68	
H	Toad rush	*Juncus bufonius*					1	0	11	5	5	2			17	
H	lady's thumb	*Polygonum sp.*					5	trace	14	trace	18	trace			37	
H	Pacific silverweed	*Potentilla anserina ssp. Pacifica*			2	5	3	2	1	2	5	8			11	
H	Hardstem bulrush	*Schoenoplectus acutus*									7	2			7	
H	clover	*Trifolium sp.*	1	2	2	2					1	trace			4	
	Totals:		**9**	**8**	**12**	**9**	**11**	**7**	**62**	**29**	**71**	**19**			**165**	**14**

Meadowdale Beach Park and Estuary Monitoring - Vegetative Plot Cover
Year 1 (2023)

Stratum	Common Name	Scientific Name	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover	Quantity	% Cover
Transect			VT9													
Quadrat			2		6		10		18		19		29		Total	Average
S	red alder (seedlings)	*Alnus rubra*					2	trace							2	
S	butterfly bush	*Buddleja davidii*							1	trace	1	trace			2	
H	Lyngby's sedge	*Carex lyngbyei*							5	5	5	5	1	2	11	
H	Tufted hairgrass	*Deschampsia cespitosa*					1	dead					1	10	2	
H	willowherb	*Epilobium sp.*					3	trace	2	trace	3	trace			8	
H	Puget Sound gumweed	*Grindelia integrifolia*					1	3	1	10					2	
H	Toad rush	*Juncus bufonius*			4	dead	3	10							7	
H	needle spikerush/soft rush/slender rush	*Eleocharis acicularis/ Juncus effusus/ Juncus tenuis*											1	2	1	trace
H	goose tongue	*Plantago maritima*											1	trace	1	
S	black cottonwood	*Populus balsamifera*			2	trace							4	trace	6	
H	Pacific silverweed	*Potentilla anserina ssp. Pacifica*											2	20	2	
S	Hooker willow	*Salix hookeriana*	1	15											1	
H	clover	*Trifolium sp.*			1	5									1	
	Totals:		**3**	**15**	**13**	**5**	**20**	**13**	**27**	**15**	**28**	**5**	**39**	**34**	**130**	**15**
Transect			VT10													
Quadrat			17		23		34		38		45		48		Total	Average
S	red alder (seedlings)	*Alnus rubra*					27	2							27	
H	Douglas aster	*Aster subspicatus*											1	trace	1	trace
H	Lyngby's sedge	*Carex lyngbyei*					1	5	1	trace			1	10	3	
H	Tufted hairgrass	*Deschampsia cespitosa*	1	trace							1	1			2	
H	seashore saltgrass	*Distichlis spicata*	1	trace	1	2	1	5					8	5	11	
H	willowherb	*Epilobium sp.*							4	1	1	trace	1	trace	6	
H	Toad rush	*Juncus bufonius*			7	2			3	3					10	
H	daggerleaf rush	*Juncus ensifolius*							1	1	2	1	1	trace	4	
H	needle spikerush/soft rush/slender rush	*Eleocharis acicularis/ Juncus effusus/ Juncus tenuis*	1	trace			1	2							2	trace
H	lady's thumb	*Polygonum sp.*	1	trace	1	1	5	trace					1	1	8	
S	black cottonwood (seedlings)	*Populus balsamifera*			10	2			2	trace	12	1	2	trace	26	
H	Pacific silverweed	*Potentilla anserina ssp. Pacifica*							3	5	5	12			8	
H	tall buttercup	*Ranunculus acris*			3	2									3	
H	creeping buttercup	*Ranunculus repens*	3	trace	3	5									6	
H	Hardstem bulrush	*Schoenoplectus acutus*									3	2	2	2	5	
H	Small-fruited bulrush	*Scirpus microcarpus*							8	18					8	
H	clover	*Trifolium sp.*	1	trace			1	trace							2	
	Totals:		**8**	**0**	**25**	**14**	**36**	**14**	**22**	**28**	**24**	**17**	**17**	**18**	**132**	**15**

Notes: T = tree, S = shrub, H = herbaceous
Green highlighted cell indicates volunteer plants
Red highlighted cell indicaes a non-native species
Yellow highlighted cell indicates dead plants (not counted towards total)

Summary:	Total	Average
Volunteer Plants	298	2
All Transects	915	17

Transect	Stratum	Common Name	Scientific Name	Quantity (Stem Count)	% Cover (Invasive Species Only)
VT7	S	red alder (seedlings)	*Alnus rubra*	221	
	H	Ladyfern	*Athyrium filix-femina*	10	
	S	butterfly bush	*Buddleja davidii*	1	trace
	H	Lyngby's sedge	*Carex lyngbyei*	8	
	H	Lyngby's sedge	*Carex lyngbyei*	11	
	H	Tufted hairgrass	*Deschampsia cespitosa*	4	
	H	seashore saltgrass	*Distichlis spicata*	1	
	H	willowherb	*Epilobium sp.*	19	
	H	field horsetail	*Equisetum arvense*	1	
	H	Toad rush	*Juncus bufonius*	54	
	H	daggerleaf rush	*Juncus ensifolius*	3	
	H	Bird's foot trefoil	*Lotus corniculatus*	4	
	H	reed canarygrass	*Phalaris arundinacea*	1	trace
	S	black cottonwood (seedlings)	*Populus balsamifera*	10	
	S	Douglas-fir	*Pseudotsuga menziesii*	7	
	H	creeping buttercup	*Ranunculus repens*	2	
	S	Salmonberry	*Rubus spectabilis*	1	
	H	Hardstem bulrush	*Schoenoplectus acutus*	7	
	H	American three-square	*Scirpus americanus*	4	
	H	American three-square	*Scirpus americanus*	4	
	S	Western redcedar	*Thuja plicata*	1	
	H	white clover	*Trifolium repens*	7	
		VT7 Results	Total	381	0
VT8	S	red alder	*Alnus rubra*	146	
	S	butterfly bush	*Buddleja davidii*	8	3
	H	Lyngby's sedge	*Carex lyngbyei*	7	
	H	Tufted hairgrass	*Deschampsia cespitosa*	1	
	H	needle spikerush/soft rush/slender rush	*Eleocharis acicularis/Juncus effusus/Juncus tenuis*	5	
	S	Salal	*Gaultheria shallon*	3	
	H	toad rush	*Juncus bufonius*	6	
	H	Bird's foot trefoil	*Lotus corniculatus*	6	
	S	Low Oregon grape	*Mahonia nervosa*	3	
	H	Swordfern	*Polystichum munitum*	5	
	S	black cottonwood	*Populus balsamifera*	3	
	H	Pacific silverweed	*Potentilla anserina ssp. Pacif*	17	
	S	Douglas-fir	*Pseudotsuga menziesii*	15	
	H	Hardstem bulrush	*Schoenoplectus acutus*	6	
	H	American three-square	*Scirpus americanus*	1	
		VT8 Results	Total	232	3

Meadowdale Beach Park and Estuary Monitoring - Vegetative Plot Cover
Year 1 (2023)

Transect	Stratum	Common Name	Scientific Name	Quantity (Stem Count)	% Cover (Invasive Species Only)
VT11	S	Redosier dogwood	*Cornus sericea*	7	
	S	Oregon ash	*Fraxinus latifolia*	2	
	S	Sitka spruce	*Picea sitchensis*	1	
	S	Salmonberry	*Rubus spectabilis*	26	
	T	Pacific willow	*Salix lucida*	1	
		VT11 Results	Total	37	0
VT12	S	Saskatoon serviceberry	*Amelanchier alnifolia*	1	
	S	Redosier dogwood	*Cornus sericea*	3	
	S	Tall Oregon grape	*Mahonia aquifolium*	2	
	S	Pacific ninebark	*Physocarpus capitatus*	5	
	S	Pacific willow	*Salix lucida*	1	
	S	Pacific willow	*Salix lucida*	1	
	S	Scouler willow	*Salix scouleriana*	3	
	S	Western redcedar	*Thuja plicata*	1	
		VT12 Results	Total	17	0

Notes: T = tree, S = shrub, H = herbaceous
Green highlighted cell indicates volunteer plants
Red highlighted cell indicaes a non-native species
Blue highlighted cell indicates existing plant (not installed)

Appendix C
Vegetation Monitoring Transect Photographs and Photo Points

Transect Photographs[1,2]

Transect 1 (high saltmarsh)	
VT1A (facing south)	VT1B (facing north)
	
9/19/2023 1:25 PM Tide = +7.51 ft MLLW	9/19/2023 1:24 PM Tide = +7.51 ft MLLW

Transect 2 (high saltmarsh)	
VT2A (facing east)	VT2B (facing west)
	
9/19/2023 1:33 PM Tide = +7.84 ft MLLW	9/19/2023 1:32 PM Tide = +7.84 ft MLLW

[1] Transect termini labeled “A” are either the northern or western termini for a transect, depending on its orientation, while those labeled “B” are the southern or eastern termini.

[2] Tidal elevations were initially based on the mean lower low water (MLLW) elevation recorded at the NOAA NOS Station 9447130 on Elliott Bay, WA. The elevations were then corrected for Meadowdale Beach Park using modeling completed by Environmental Science Associates staff.

<table>
<tr><th colspan="2">Transect 3 (high saltmarsh)</th></tr>
<tr><td>VT3A (facing south)</td><td>VT3B (facing north)</td></tr>
<tr><td>
</td><td></td></tr>
<tr><td>9/19/2023 1:54 PM Tide = +8.29 ft MLLW</td><td>9/19/2023 1:55 PM Tide = +8.29 ft MLLW</td></tr>
</table>

<table>
<tr><th colspan="2">Transect 4 (low saltmarsh)</th></tr>
<tr><td>VT4A (facing south)</td><td>VT4B (facing north)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>9/19/2023 1:25 PM Tide = +7.51 ft MLLW</td><td>9/19/2023 1:25 PM Tide = +7.51 ft MLLW</td></tr>
</table>

<table>
<tr><th colspan="2">Transect 5 (low saltmarsh)</th></tr>
<tr><td>VT5A (facing southeast)</td><td>VT5B (facing northwest)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>9/19/2023 3:45 PM Tide = +9.35 ft MLLW</td><td>9/19/2023 3:44 PM Tide = +9.35 ft MLLW</td></tr>
</table>

Transect 6 (low saltmarsh)	
VT6A (facing southeast)	VT6B (facing northwest)
	
9/19/2023 1:34 PM Tide = +7.84 ft MLLW	9/19/2023 1:33 PM Tide = +7.84 ft MLLW

Transect 7 (gradient)	
VT7A (facing southwest)	VT7B (facing northeast)
	
9/19/2023 3:16 PM Tide = 9.36 ft MLLW	9/19/2023 3:16 PM Tide = 9.36 ft MLLW

Transect 8 (gradient)	
VT8A (facing southwest)	VT8B (facing northeast)
	
9/19/2023 2:31 PM Tide = +8.94 ft MLLW	9/19/2023 2:18 PM Tide = +8.77 ft MLLW

Transect 9 (gradient)	
VT9A (facing southwest)	VT9B (facing northeast)
	
9/19/2023 2:57 PM Tide = +9.26 ft MLLW	9/19/2023 3:10 PM Tide = +9.32 ft MLLW

Transect 10 (gradient)	
VT10A (facing southwest)	VT10B (facing northeast)
	
9/19/2023 2:53 PM Tide = +9.20 ft MLLW	9/19/2023 2:51 PM Tide = +9.20 ft MLLW

Transect 11 (freshwater wetland)	
VT11A (facing east)	VT11B (facing west)
	
9/19/2023 3:56 PM Tide = +9.35 ft MLLW	9/19/2023 4:01 PM Tide = +9.33 ft MLLW

<table>
<tr><th colspan="2">Transect 12 (riparian buffer)</th></tr>
<tr><td>VT12A (facing southeast)</td><td>VT1B (facing northwest)</td></tr>
<tr><td>
9/19/2023 3:45 PM Tide = +9.35 ft MLLW</td><td>
9/19/2023 3:46 PM Tide = +9.35 ft MLLW</td></tr>
</table>

Photo Points[3]

Photo Point 1	
facing north	facing northwest
	
9/19/2023 3:06 PM Tide = 9.29 ft MLLW	9/19/2023 3:06 PM Tide = 9.29 ft MLLW

Photo Point 2	
facing north	facing south
	
9/19/2023 3:02 PM Tide = 9.26 ft MLLW	9/19/2023 3:01 PM Tide = 9.26 ft MLLW

[3] Tidal elevations were initially based on the mean lower low water (MLLW) elevation recorded at the NOAA NOS Station 9447130 on Elliott Bay, WA. The elevations were then corrected for Meadowdale Beach Park using modeling completed by Environmental Science Associates staff.

<table>
<tr><th colspan="2">Photo Point 3</th></tr>
<tr><td>facing east</td><td>facing south</td></tr>
<tr><td>
9/19/2023 3:13 PM Tide = 9.36 ft MLLW</td><td>
9/19/2023 3:14 PM Tide = 9.36 ft MLLW</td></tr>
</table>

<table>
<tr><th colspan="2">Photo Point 4</th></tr>
<tr><td>facing east</td><td>facing south</td></tr>
<tr><td>
9/19/2023 3:30 PM Tide = 9.40 ft MLLW</td><td>
9/19/2023 3:32 PM Tide = 9.40 ft MLLW</td></tr>
</table>

<table>
<tr><td>facing west</td><td></td></tr>
<tr><td>
9/19/2023 3:31 PM Tide = 9.40 ft MLLW</td><td></td></tr>
</table>

Photo Point 5	
facing north	facing east
	
9/19/2023 3:18 PM Tide = 9.36 ft MLLW	9/19/2023 3:18 PM Tide = 9.36 ft MLLW

facing northwest	
	
9/19/2023 3:18 PM Tide = 9.36 ft MLLW	

Photo Point 6	
facing south	facing west
	
9/19/2023 3:38 PM Tide = 9.39 ft MLLW	9/19/2023 3:38 PM Tide = 9.39 ft MLLW

<table>
<tr><th colspan="2">Photo Point 7</th></tr>
<tr><td>facing south</td><td>facing west</td></tr>
<tr><td></td><td></td></tr>
<tr><td>9/19/2023 3:27 PM Tide = 9.39 ft MLLW</td><td>9/19/2023 3:27 PM Tide = 9.39 ft MLLW</td></tr>
</table>

Appendix D

Edmonds Stream Team 2023 Salmon Spawner Survey Preliminary Report

ESA

PRELIMINARY REPORT: 2023 SPAWNER SURVEY IN MEADOWDALE PARK (LUNDS GULCH CREEK)

Joe Scordino
Edmonds Stream Team

Report to Meadowdale Restoration Monitoring Project

December 2023

The Edmonds Stream Team conducted a survey for adult coho and chum salmon in Lunds Gulch Creek in Meadowdale Park from September 25, 2023 to December 2, 2023. The survey consisted of 13 days of walking the edges of the creek, estuary and beach; 14 reports/photos from Park visitors (responding to posted signs to report sightings); and three salmon carcasses retrieved from the beach and estuary edges by Park volunteers for subsequent examination by the Edmonds Stream Team. Remains of dead salmon (many of the dead were remains from a predator foraging) were examined to determine species, sex, and spawning condition and tallied.

Surveys occurred on at least one weekend day every week (except Thanksgiving weekend) with students from Meadowdale and Edmonds-Woodway High School. Survey effort and area increased over past years with additional intermittent weekday surveys with adult volunteers. The surveys ranged from the furthermost east access to the creek (47 ° 51 ' 23.2 " N -122 ° -19 ' -19.9 "W) from the Park trail (less than ½ mile from the upper parking lot) to the beach opening into Puget Sound.

A total of 24 salmon were sighted/examined consisting of 11 chum salmon (8 live, 3 dead); 7 coho salmon (4 live, 3 dead), and 6 unidentified salmon (2 live, 4 dead). Although obvious duplicate sightings are not included in these totals, it is possible that live sightings of the same salmon my have occurred at different locations and different days, and some of the live may have been subsequently found dead. However, there is no duplication within the dead counts because our field process included removing the tail of each dead salmon examined and tallied (to avoid double count). Two of the live coho appeared impaired and lethargic possibly from effects of stormwater pollutants (e.g., 6PPD). A pre-spawn mortality female chum salmon also was found in the estuary.

Further analysis of Lunds Gulch Creek salmon survey data will be conducted to compare 2023 to past years surveys (Table 1). The number of salmon sighted/recovered in 2023 is lower than 2020-2022 in spite of increased upstream survey effort. Considerable streambed siltation noted throughout the lower creek in 2023 may have affected salmon presence and usage for spawning. Year-to-year counts may not be comparable due to physical changes to the lower creek/estuary area that may have affected salmon movement patterns including fallbacks, spawning locations, and observability of live salmon and retrieval of dead salmon.

The lower creek changed from a vegetated stream channel just east of the RR tracks, where both coho and chum salmon spawned, to sediment-laden lagoons in 2021, to a swift moving large-boulder channel in 2022, to the current configuration of a boulder channel into a shallow estuary east of the RR tracks.

The creek channel downstream of the wood bridge near the Ranger House, where chum and coho salmon were observed spawning in prior years, was also modified with large log placements. These physical changes not only affected upstream migration behavior and spawning sites, but also affected the downstream movement and deposition of dead salmon that are a key component of our surveys.

TABLE 1. SURVEY RESULTS	2018	2019	2020	2021	2022	2023
Start Date of Surveys	11/1/2018	10/22/2019	10/15/2020	10/3/2021	11/1/2022	9/25/2023
End Date of Surveys	12/2/2018	12/1/2019	12/5/2020	12/14/2021	12/4/2022	12/2/2023
First live coho sighting	10/15/2018	10/22/2019	NA	9/29/2021	10/27/2022	10/13/2023
Last live coho sighting	11/26/2018	10/23/2019	NA	9/29/2021	11/10/2022	11/18/2023
First dead coho sighting	NA	10/22/2019	NA	10/3/2021	11/1/2022	11/5/2023
Last dead coho sighting	NA	11/6/2019	NA	11/28/2021	11/10/2022	11/18/2023
Total Live Sightings Adult Coho	4	9	0	1	3	4
Total Dead Adult Coho	0	3	0	3	3	3
First live chum sighting	11/1/2018	NA	11/5/2020	10/31/2021	11/1/2022	11/2/2023
Last live chum sighting	12/2/2018	NA	11/20/2020	12/5/2021	11/23/2022	11/12/2023
First dead chum sighitng	11/1/2018	10/31/2019	11/9/2020	10/31/2021	11/1/2022	11/7/2023
Last dead chum sighitng	11/20/2018	11/22/2019	11/24/2020	12/5/2021	11/23/2022	11/11/2023
Total Live Sightings Adult Chum	12	0	26	57	28	8
Total Dead Adult Chum	11	5	8	34	20	3
First live Unid. Salmon sighting	NA	10/31/2019	10/21/2020	10/31/2021	10/21/2022	10/15/2023
Last live Unid. Salmon sighting	NA	10/31/2019	11/4/2020	12/5/2021	11/10/2022	11/12/2023
First dead Unid. Salmon sighitng	11/12/2018	11/1/2019	NA	11/21/2021	NA	11/11/2023
Last dead Unid. Salmon sighitng	11/20/2018	11/1/2019	NA	12/9/2021	NA	12/2/2023
Total Live Sightings Unidenfied Adult	0	2	2	26	17	2
Total Dead Unidentified Adult	2	1	0	11	0	4

Salmon enhancement efforts in Lunds Gulch Creek (i.e., release of chum fry and instream coho and chum salmon egg incubators) ceased after 2020 at the request of the Tulalip Tribe biologists studying before/after affects of the restoration project on juvenile salmon occurrence. We hope to resume enhancement in 2025.

The Edmonds Stream Team also has conducted monthly monitoring at the upper (48th Ave.), middle (52nd Ave.) and lower (Meadowdale Park) portions of Lunds Gulch Creek since 2018 collecting water quality (i.e., dissolved oxygen, water temperature, pH, conductivity, etc.) and habitat condition data. These data will be compiled and presented in separate reports.

ACKNOWLEDGMENTS. Many thanks to the Edmonds Stream Team students and other volunteers who participated in the salmon surveys in Lunds Gulch Creek in 2023. The Meadowdale High School Eco Club students who participated are Abigail Kim, Aspen Spivey, Danika Jinneman, Emie Shepherd, Erika Chagas, Jaqueline Rochel, Katelynne Wyckoff, Leah Stangohr, Lucas Stangohr, Madelyn Harrison, Rowan May, and Zoey Zatloka. The Edmonds-Woodway High School students are Francesca Villanueva, Jacob Volpe, Kendall Asay, and Sophia Woeck. Other volunteers were Nancy Scordino, Tom Kane, Belinda Hughes, Lori Cooper, Jon Scordino, Steve Scordino, Oscar Scordino, Shane Hansen, and Rob Cavness.

Appendix E

Meadowdale Beach Park NOAA Tier 1 Monitoring

ESA

Meadowdale Beach Park Tier 1 Monitoring

The Meadowdale Beach Park 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. The first goal of the project is to**: Restore natural tidal regime to improve salmonid access and refuge opportunities.** For effectiveness, the restored estuary will allow natural tidal fluctuations and appropriate depths and velocities for juvenile and adult passage. Two approaches are followed for evaluating the Before-After effectiveness of the culvert replacement with a railroad bridge on the natural tidal fluctuations; being 1.) Before-After Hydrographs and 2.) Before-After Flow Velocity. Approach 1 is described and demonstrated below. Approach 2 is reported in the Year 1 Monitoring Report.

Before-After Hydrographs

Continuously recording staff gauges were established in Lund's Gulch creek at Meadowdale Beach Park one month prior to project initiation in June 2021. One month of flow gauging was completed (June 1-June 30) before flow diversion. Two locations were established. Location 300 (Figure 1) was upstream from the railroad culvert approximately 60 feet, and the base elevation of the gauge and streambed was 10.6 ft (NAVD88). The gauge at Location 0 was affixed to the downstream side of the railroad culvert (Figures 2 and 3).

Figure 1. Location 300 upstream from the railroad culvert. Base streambed elevation is 10.6 ft (NAVD88). The rail line is immediately below the Blue arrow in the background (for reference).

Location zero was subject to tidal influence, as seen in Figure 2, as higher Puget Sound tides backwatered into the stream culvert. Figure 3 shows the staff plate and gauge affixed to the culvert foundation. The streambed elevation of location zero was 7.2 feet, although the staff plate reading was different.

Figure 2. Outlet of the backwatered Lund's Gulch Creek culvert (under BNSF railroad) at high tide May 17, 2022 (*11.00 ft. MLLW, 5:14 AM*). Puget Sound is in background. Stream flow direction is shown with blue arrow. The red arrow shows the location of the downstream staff gauge, also shown in Figure 3.

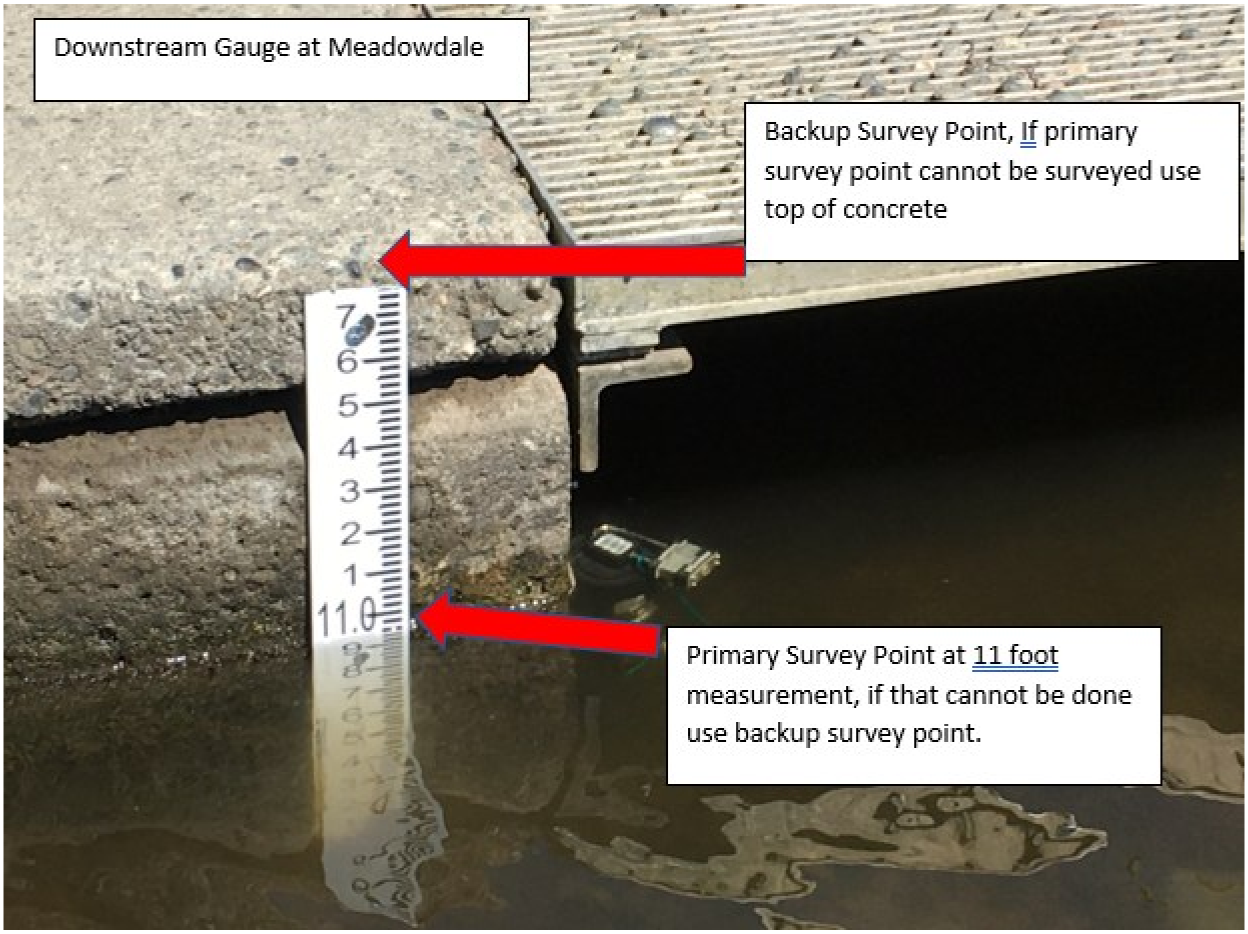

Figure 3. Location 0 staff plate and water level sensor affixed to the railroad culvert in 2021 prior to project initiation.

Figure 4. shows an image of the post-restoration hydrograph location in the restored embayment that is tidally backwatered to a staff gauge elevation of 7.33 ft on the staff plate. This staff plate reading was corrected relative to a known elevation benchmark.

A map-based depiction in Figure 5 shows the staff gauge and water level sensor placement in 2021 and 2023 with respect to both a pre-project image (left, Figure 5) and a post-restoration image (right, Figure 5). Note that in 2023 there is only one sensor that was placed on the upstream side of the new railroad bridge shown in Figure 5. As shown in Figure 2, the pre-project gauge location is fully inundated by tides in Puget Sound. Hence, with restoration, the project monitoring question is with respect to tidal inundation and elevation within the restoration area. The location of the 2023 post-project hydrograph was actually paved and at a higher surface elevation of approximately 12.1 foot elevation (NAVD88). For tidal measurement comparison, we estimate the 12.1 foot elevation is equivalent to the tidal elevation 14.38 ft (MLLW, Mean Lower low Water) – higher than the predicted astronomical high tides for nearby Seattle and Everett. Hence, this location would virtually never be tidally affected.

Figure 4. Post-restoration hydrograph placement in the restored embayment located on the upstream side of the new railroad bridge.

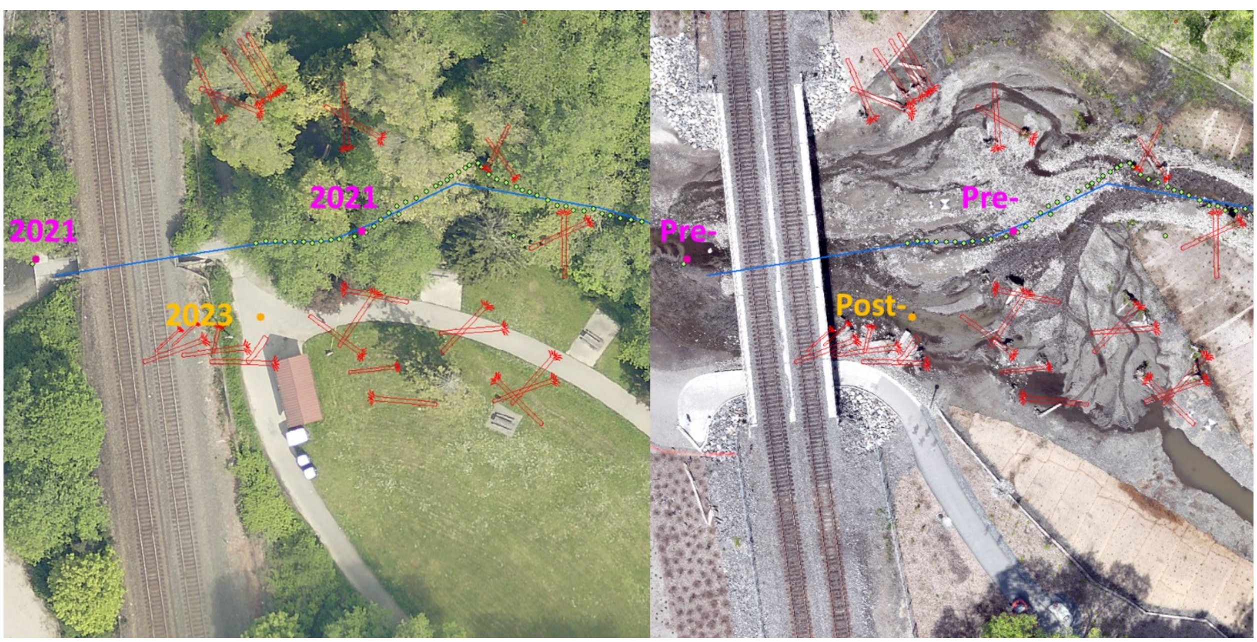

Figure 5. Map view of 2021 and 2023 staff gauge locations relative to pre-project imagery (left) and post-project imagery (right).

At the same time, the upstream location 300 from the pre-project condition was placed at approximately a location where we were not confident that a post-project hydrograph would reveal the extent of tidal restoration, after the embayment and pocket estuary were excavated and restored. Thus, the post-project staff gauge and sensor was placed at a lower elevation, slightly closer to tidewater but where pre-project tidal influence was absent due to the higher ground elevation.

Results are shown in Figure 6 for the pre-project condition spanning one month of time immediately before project initiation. Lund's Gulch Location 0 is at the lower elevation on the Puget Sound side of the railroad culvert and shows a near-daily high tide spike relative to the daily low flow that is controlled by stream flow. The upper Location 300 is at a higher stream elevation and demonstrates that no tidal inundation occurs. Some fluctuation in the gauge height above the streambed elevation is due to variability in upstream run-off.

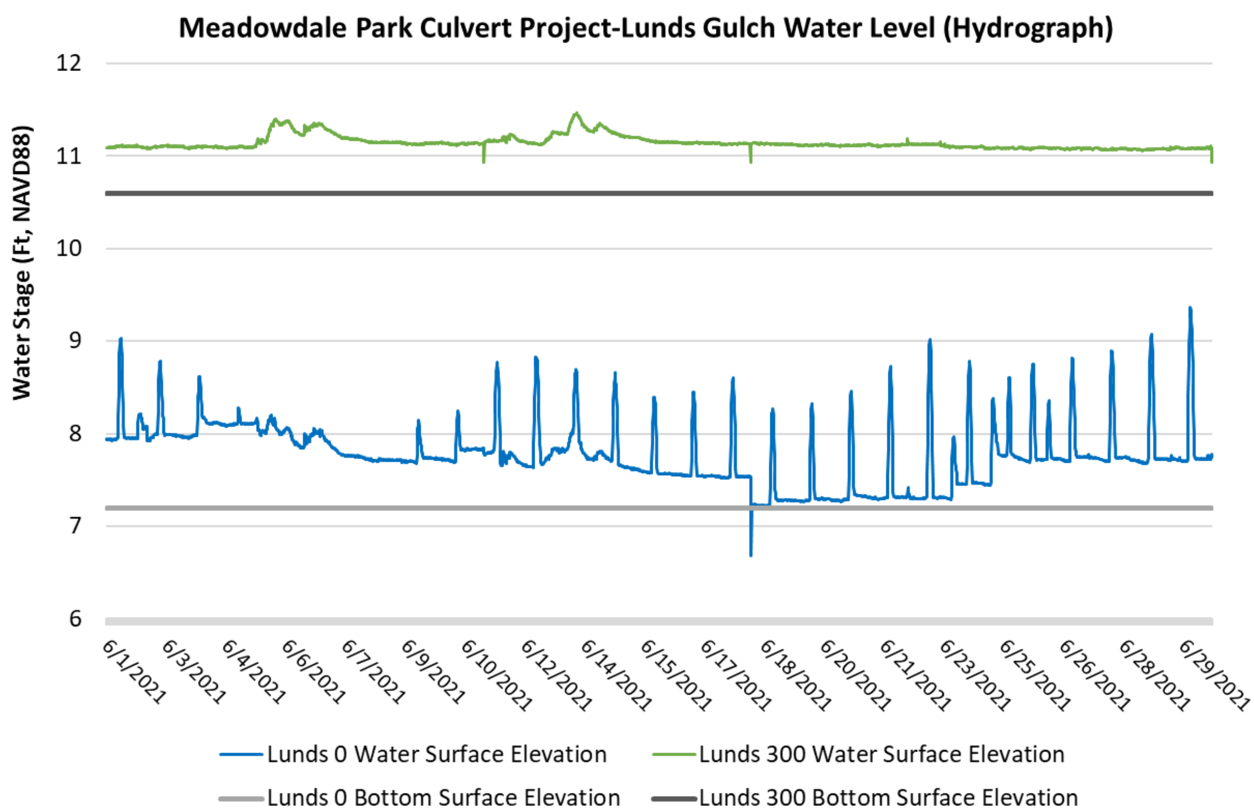

Figure 6. 2021 pre-project hydrograph monitoring upstream and downstream of the railroad culvert.

Next, the post-restoration hydrograph was collected over a period of approximately five months between January and June, 2023 and is shown in Figure 7. Many observations of tidal height exceed 10 feet elevation but are typically less than the original Location 300. Nevertheless, tidal inundation and depth is much greater upstream of the new railroad bridge due to the restored lower elevation of the tidal marsh/embayment. In Figure 7, the yellow star represents the January 25, 2023 date when velocity profiles were measured. Although this date was anticipated to have higher tides, accompanying photos highlight the extent of inundation (also shown in Figure 4).

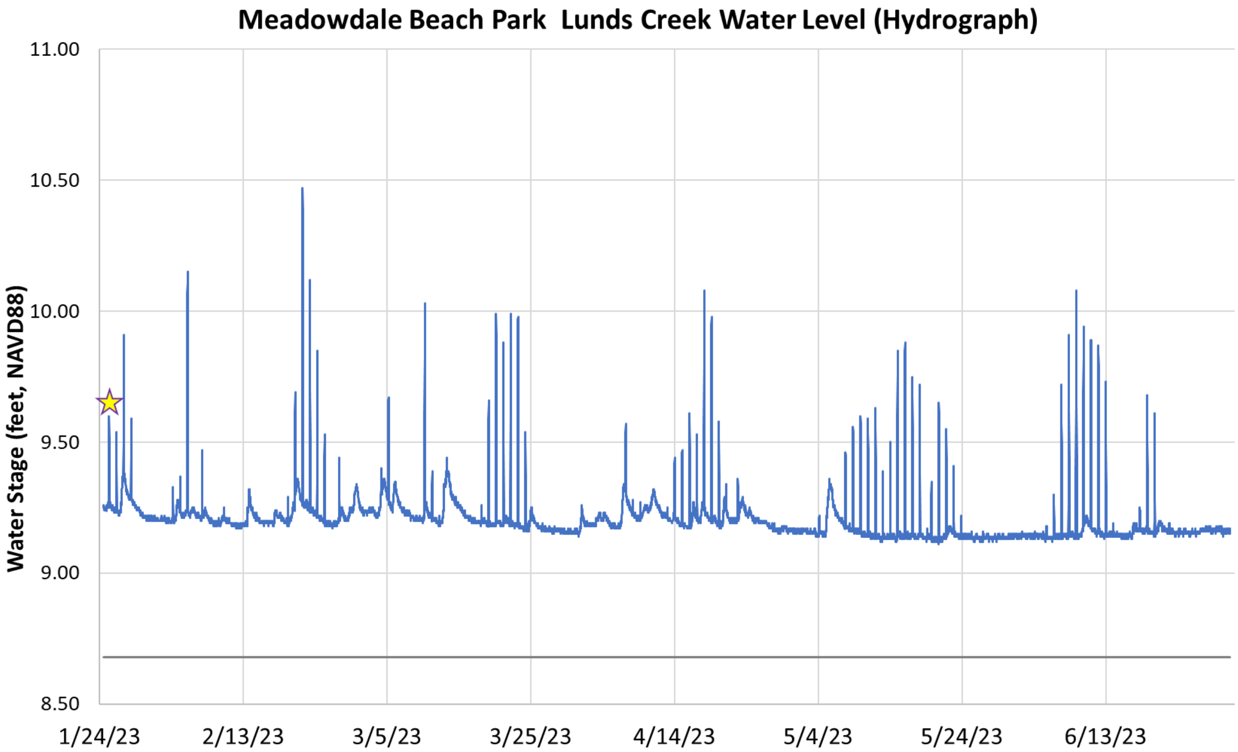

Figure 7. Post-project hydrograph over five months showing tidal inundation with monthly high tide series. Yellow star is the date of the photographic observations in Figures 4 and 8. Elevation of the embayment at the sensor is 8.68 ft NAVD88.

Figure 8 shows the tidal inundation across the profile of the railroad bridge opening. Note that many tidal elevations (in Figure 7) were higher than this photo depicts.

Next, we used the ground elevation from the gauges as well as pre-project and post-project ground surveys to reconstruct a base elevation in the project area according to a longitudinal profile. Figure 9 shows the pre-project and post-project elevation profiles relative to the location of the culvert and two high tidal elevations observed in each sampling period (9.33 ft. and 10.49 ft., respectively). The magenta colored and orange-colored arrows denote the locations of the 2021 (magenta) and 2023 (orange) hydrograph locations along the distance of respective channel centerlines. The magenta line represents the elevation of the streambed in 2021, while orange represents the elevations in 2023. The 2 horizontal lines represent to tidal elevations, and the area under each tidal elevation represents the landward extent (increasing x-axis) and depth of inundation down to the level of each ground profile. Diagonal lines represent the points at which the tidal elevations would meet dry land (for that example tide).

The pre- and post-restoration hydrographs demonstrate that tidal inundation has been effectively restored to locations inland where previously there was no tidal habitat. Additional supporting photos from pre- and post-project years are provided and annotated in Figures 10-16 and demonstrate the extent of tidal in inundation and exchange relative to the pre-project condition upstream of the railroad and former culvert.

Figure 8. Tidal inundation upstream of the former railroad culvert, January 25, 2023. Predicted tidal elevation was 12.54 ft MLLW, though actual tidal elevation was estimated to be 11.63 ft MLLW based on gauge data. The NAVD elevation recorded on the staff gauge was 9.6 feet.

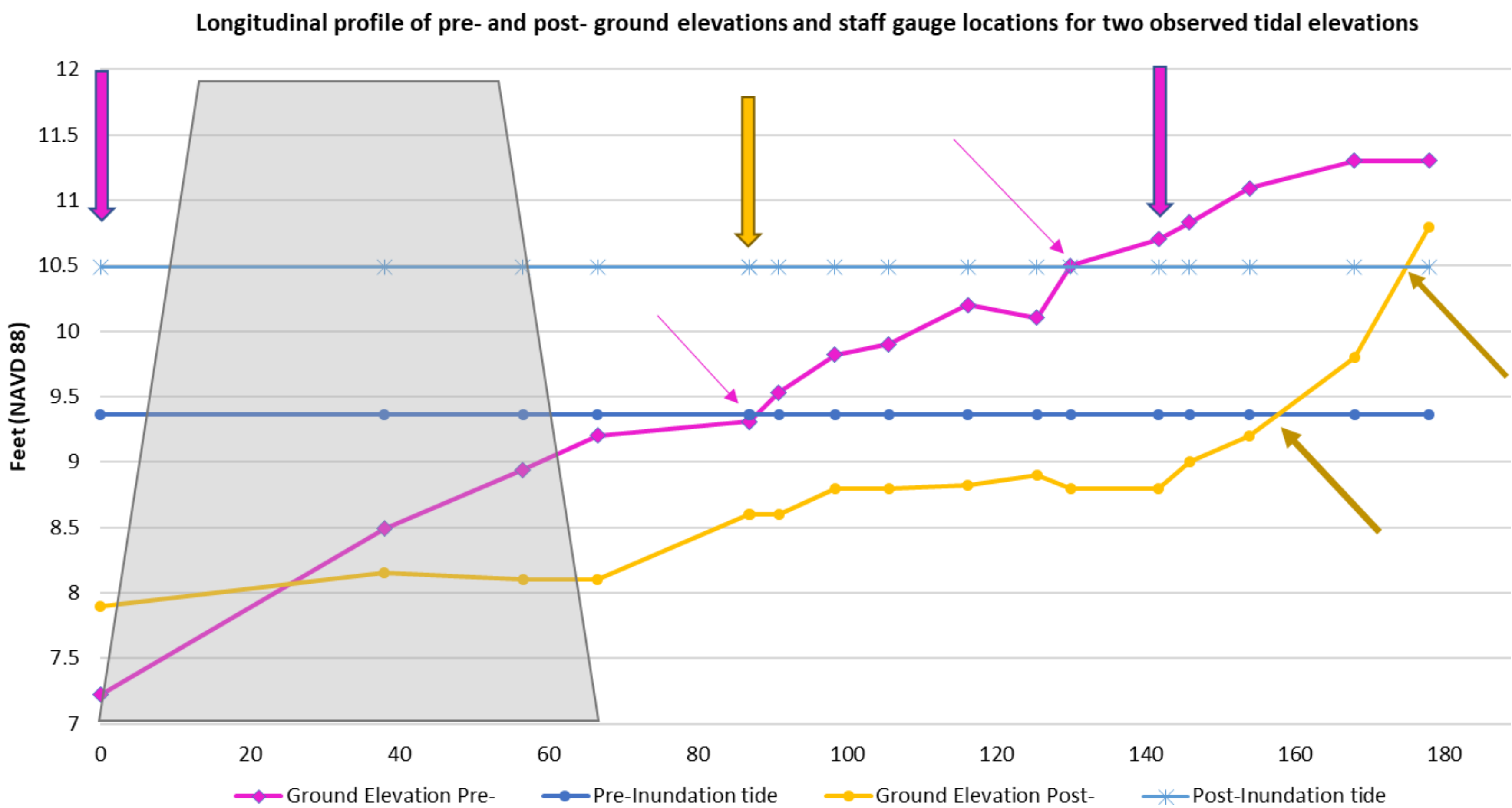

Figure 9. Pre- and post-restoration profile of 2021 (magenta) and 2023 (orange) ground elevations upstream of the railroad culvert (grey trapezoid) with staff gauge locations (block arrows) and elevations of two observed tides and calculated inundation extents (angled arrows).

Figure 10. 2004 (left) and 2023 (right) view inland (east) from walkway. The same building in each photo is highlighted with yellow star.

Figure 11. 2004 and 2023 view inland (east) from walkway. The building with red roof in left image is also in the pre-project image in Figure 5.

Figure 12. 2004 and 2023 view north. The approximate location of the 2023 hydrograph is marked with orange arrow per Figures 5 and 9.

Figure 13. 2004 and 2023 view south. The approximate location of the 2023 hydrograph is marked with orange arrow.

Figure 14. 2004 and 2023 view west. The location of the culvert is marked with a white star.

Figure 15. 2021 and 2023 images of Location 300 (pre-project hydrograph) in left image and estimated location in right image. No longer in stream line.

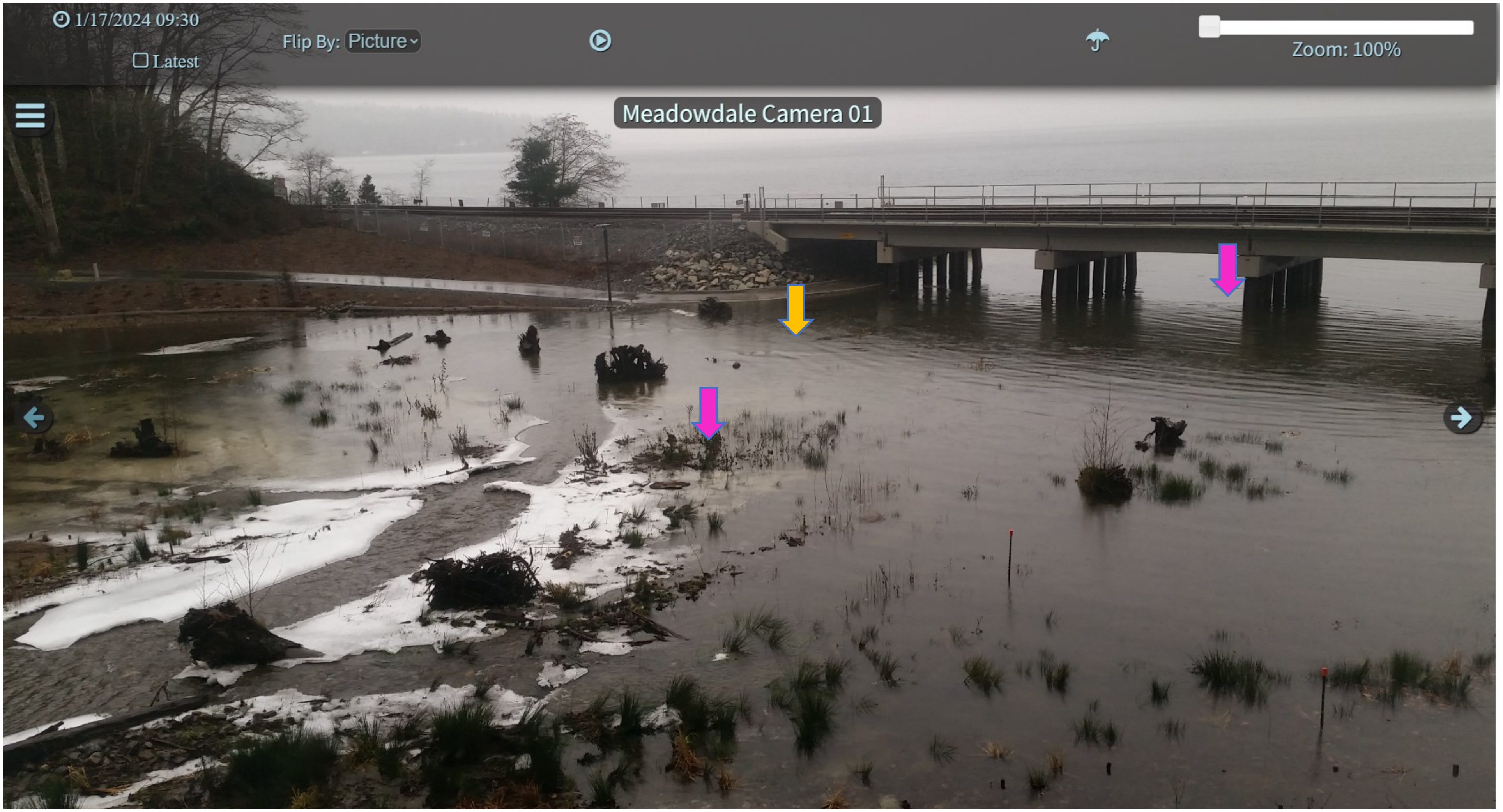

Figure 16. Maximum photographically observed tidal elevation (12.36 ft. MLLW) on January 17, 2024 demonstrating tidal inundation and pocket estuary habitat area. The approximate location s of the 2021 (Magenta) and 2023 (Orange) hydrographs are shown. Daily imagery is available at: Sensera Public View (senserasystems.com)

Supplemental Figure S-1. The verified January 25, 2023 tide height at the Seattle station was more than one foot lower than predicted, while the January 13, 2023 tide was actually more than 1.5 feet higher than predicted. This translates into a potential tidal elevation at Meadowdale that might have been approximately 1.63 feet higher than that shown in the inset photo and substantiates the greater tidal inundation of the embayment.