SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

Your Northwest renewables utility

June 25, 2018

VIA ELECTRONIC FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission (FERC)
888 First Street NE
Washington, DC 20426

Re: Jackson Hydroelectric Project, FERC No. 2157
Fish Habitat Enhancement Plan 2017 Annual Report
License Appendix G A-LA 12

Dear Secretary Bose:

Enclosed is Public Utility District No. 1 of Snohomish County's Fish Habitat Enhancement Plan 2017 Annual Report pursuant to the Jackson Hydroelectric Project's License Appendix G A-LA12. The draft report was provided to the Aquatic Resource Committee for a 30-day review and comment period. Consultation documentation is included in the report's appendices.

If you have any questions on the Fish Habitat Enhancement Plan 2017 Annual Report, please contact Dawn Presler, Sr. Environmental Coordinator, at (425) 783-1709 or DJPresler@snopud.com.

Sincerely,

/s/ Tom DeBoer

Tom DeBoer
Assistant General Manager of Generation, Power, Rates and Transmission Management
TADeBoer@snopud.com
(425) 783-1825

Enclosed: Fish Habitat Enhancement Plan 2017 Annual Report

cc: Aquatic Resource Committee

Henry M. Jackson Hydroelectric Project
(FERC No. 2157)

Fish Habitat Enhancement Plan: 2017 Annual Report (A-LA 12)

Snohomish County PUD
Public Utility District No. 1

Everett, WA

June 2018

Final – This document has been prepared for the District. It has been peer-reviewed by the District for accuracy and formatting based on information known at the time of its preparation and with that understanding is considered complete by the District. The document may be cited as:

Public Utility District No. 1 of Snohomish County (District). 2018. Fish Habitat Enhancement Plan: 2017 Annual Report (A-LA 12) for the Henry M. Jackson Hydroelectric Project, FERC No. 2157. June 2018.

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1.0 INTRODUCTION

Public Utility District No. 1 of Snohomish County (the District) received a license on September 2, 2011 (License), from the Federal Energy Regulatory Commission (FERC) for the Henry M. Jackson Hydroelectric Project (Project). License Ordering Paragraphs D (Washington Department of Ecology 401 Water Quality Certification conditions) and E (U.S. Forest Service section 4(e) conditions) require the District to implement Aquatic License Article 12: Fish Habitat Enhancement Plan (A-LA 12) as detailed in License Appendix G. The District filed the Fish Habitat Enhancement Plan (FHE Plan) with the FERC on November 19, 2010.

As indicated in the FHE Plan, funded projects will be designed to provide additional Project-related enhancements to aquatic resources and hydrologic processes focused in the Sultan River basin; thereby, providing considerable benefits to aquatic habitat and anadromous and resident fish populations throughout the License term. These additional habitat enhancement projects, working in conjunction with other protection, mitigation and enhancement measures, such as improved side channel connectivity, increased instream flows, and implementation of fish passage at the Diversion Dam, will likely substantially increase the quantity and quality of aquatic habitat and performance of anadromous and resident fish populations in the lower Sultan River. Establishment of the ongoing FHE Plan and Habitat Enhancement Account (HEA) will also allow for adaptive management as conditions in the basin change. The mitigation provided through the fund will best be able to address long-term habitat enhancement and restoration needs by allowing flexibility to ensure that projects are developed and implemented during the License term.

Pursuant to Section 6.2 of the FHE Plan, the District is to prepare a report by June 30 of each year detailing activities that occurred the previous year and activities planned for the present year as they relate to implementation of FHE Plan-approved projects. This FHE Plan Annual Report, covering activities conducted in 2017 and planned for 2018, was provided to the Aquatic Resources Committee (ARC) for a 30-day review and comment period. The ARC consists of the City of Everett, City of Sultan, Snohomish County, Washington Department of Ecology, Washington Department of Fish and Wildlife (WDFW), Tulalip Tribes, U.S. Forest Service, National Marine Fisheries Service, U.S. Fish and Wildlife Service, and American Whitewater. Documentation of consultation with the ARC regarding the draft report is included in Appendix 2 with response to the one comment from WDFW in Appendix 3.

2.0 ACTIVITIES FOR YEAR 2017

2.1 Project Selection

No additional projects were proposed at the fourth quarter 2016 ARC Meeting for implementing in 2017.

2.2 Project Implementation

Two projects were previously approved for funding in 2013 and continued through 2017, with 2017 activities described below – these include the lower Skykomish River restoration and the lower Sultan River riparian restoration projects. Activities in 2017 also included the ARIS project approved in 2016.

2.2.1 Lower Skykomish River Restoration

All construction and implementation activities were finalized in 2016. The remaining activity for the FHE-funded project in 2017 included development of the final report. In July 2017, Snohomish County provided the final report for the project; it is included as Appendix 1.

2.2.2 Lower Sultan River Riparian Restoration

In 2017, Adopt-a-Stream continued control of invasive plant species, primarily in Osprey Park and on the Hambelton property. Invasives in Osprey Park have been significantly reduced in number and spread such that control efforts now consist primarily of locating and treating isolated individual weeds. The large knotweed patch on the Hambelton property has also been largely eradicated, with revegetation efforts occurring for the past two years.

2.2.3 Diversion Dam Fish Counting Sonar Device

The ARIS 3000 Sonar instrumentation (ARIS) acquired in 2016 was deployed at the Diversion Dam volitional fish passage location in 2017. The initial deployment was a pilot investigation during fall to test equipment effectiveness. Fish biologists downloaded and reviewed the data that were collected as part of this investigation.

2.3 Project Monitoring

No additional monitoring of FHE Plan habitat projects was conducted since no FHE-funded habitat projects were completed in 2017 beyond that already described above.

3.0 ACTIVITIES FOR YEAR 2018

3.1 Project Selection

No new projects for funding in 2018 were proposed at the October 2017 ARC meeting. However, the ARC approved a timing extension for the Lower Sultan River Riparian Restoration project during its first quarterly meeting in March 2018. As such, the planned activities as of the timing of this report include two projects as discussed below.

3.2 Project Implementation

3.2.1 Lower Sultan River Riparian Restoration

In 2018, Adopt-a-Stream will finalize treatment of invasive plant species within Osprey Park and the Hambelton property, and follow up with re-vegetation efforts in the fall, as needed. A final report will be provided to the District by years end.

3.2.2 Diversion Dam Fish Counting Sonar Device

The ARIS was deployed for a second time in early 2018 but sustained damage during a high flow event. The District had the ARIS was repaired at the District's own expense. Redeployment of the ARIS has been delayed due to the mobilization and transport of a significant volume of sediment through the Diversion Dam area and attendant changes to the stream channel. Deployment is tentatively scheduled for late summer 2018. A lift system is also being installed at the Diversion Dam so the ARIS can be easily removed from the water when high flow events are anticipated to prevent future damage to the system.

4.0 FUND BALANCE

As of December 31, 2017, the fund's account balance was $2,058,892.14. However, this balance does not reflect amounts not yet spent towards approved projects and reserves for potential slides. The balance of unallocated funds for use on future projects is approximately $1.32 million, as follows:

Fund Start	$ 2,500,000.00
Interest to-date (12/31/17)	+$ 61,261.69
Subtotal	$ 2,561,261.69
Confluence property acquisition	- $ 4,861.38 (closed)
Lower Skykomish River restoration	- $ 157,955.98 (closed)
Future slides reserve	- $ 500,000.00 (allocated)
Hochfeld property acquisition	- $ 173,300.00 (allocated)
Riparian restoration Sultan River	- $ 230,000.00 (allocated)
Riparian restoration Sultan River (2-yr extension)	-$ 25,000.00 (allocated)
ARIS system	-$ 150,000.00 (allocated)
Total	**$1,320,144.33**

Starting the tenth anniversary after issuance of the License (Year 11) and annually thereafter for the term of the License, the District will deposit $200,000 (based on 2011 dollars) into the fund account per Section 5.1 of the FHE Plan.

5.0 FHE PLAN RECOMMENDATIONS

No recommendations for changes to the FHE Plan are being made at this time.

Appendix 1

Lower Skykomish Restoration Project Final Report

Lower Skykomish River Fish Habitat Enhancement Project
2016 Final Report

Snohomish County

PUBLIC WORKS
SURFACE WATER MANAGEMENT
(425) 388-3464

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July 2017

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1.0 Introduction

This report is made to document the activities and monitoring findings of the Lower Skykomish River Restoration Project.

1.1 Project Summary

The Lower Skykomish River Restoration is a 2.8 mile phased, multi-site, multi-benefit project. This project included high priority actions identified in the adopted 2005 Snohomish Basin Chinook Recovery Plan (SBSRF, 2006), 2010 Lower Skykomish River Restoration Assessment (R2, 2010), and the County-facilitated Sustainable Lands Strategy Skykomish River Reach Scale Plan (Snohomish County Surface Water Management and the SLS Executive Committee, 2017). This project was also identified as a Tier 1, primary focus reach project in the Snohomish Basin Chinook Recovery 3-Year Work Plan. The Puget Sound Partnership (PSP) Ecosystem Recovery Targets for 2020 specifically call for removal of riprap and the use of soft shore techniques for new and replacement of armoring. Moving this project from plan to implementation depended on multiple partnerships and serves as a model for reach scale, multiple benefit approach. With this project, a combination of strategies were applied that work with natural channel processes to promote habitat and water quality improvement, and to help safeguard the productivity of adjoining floodplain areas.

The Snohomish River basin is one of the primary producers of anadromous salmonids in the Puget Sound region. The Skykomish River supports eleven populations of salmonids, four are ESA-listed as threatened and two are designated as candidate populations (WDFW, 2016). According to the 2005 Snohomish River Basin Salmon Conservation Plan, the Lower Skykomish sub-basin has high use by salmonid fish but degraded watershed conditions. For the Skykomish population of Chinook salmon, spawner abundance (number of fish returning from the ocean to spawn) historically was 51,000 fish (Snohomish Basin Salmon Recovery Forum (SBSRF), 2005). Between 2005 and 2015, the average spawner abundance for natural-origin Skykomish Chinook was merely 2,323 (WDFW, 2016); only 4.5 percent of the historical level. A key reason for the decline of Snohomish River basin Chinook salmon is the loss of rearing habitat quantity and quality along mainstems, within the estuary, and in the nearshore environment (SBSRF, 2005).

Actions that improve habitat complexity in the vicinity of and downstream from Chinook spawning areas are predicted to be the most effective in improving population performance (Snohomish Basin Salmon Recovery Forum, 2005). Most of the Skykomish River Chinook spawn in the mainstem, lower Sultan and Wallace Rivers. The habitat restoration and enhancement value of the project site is its geographic location relative to Chinook spawning. The project slough and side channel reach begins at the confluence of the Sultan River, adjacent the outlet of Tychman Slough, approximately 2 river miles downstream of the Wallace River and the Skykomish Braided Reach.

The Lower Sky project is situated on the Lower Skykomish River, West of Sultan, Washington, between River Mile (RM) 9.7 and the confluence of the Sultan River (RM, 13). Major project

components have been designated by the sub-project general location in river mile (RM); occasionally the primary landowner's names are referenced. Attachment A-1 illustrates the project vicinity, including an overview of project components.

Snohomish County Public Works Surface Water Management Division (SWM) led project design, implementation, and monitoring of the Lower Skykomish River Restoration Project. Project partners include three agricultural landowners, the state Salmon Recovery Funding Board (SRFB), Public Utility District No. 1 of Snohomish County (PUD), Washington Department of Ecology, Snohomish County Public Works, Snohomish Conservation District, and USDA Conservation Reserve Enhancement Program (CREP).

Fish habitat enhancements include wood structures placed in existing major side channels. These immediately create habitat for juvenile Chinook and introduce opportunities for continued habitat formation and maintenance through natural recruitment of large wood. The Lower Skykomish River Restoration Phase 1 project, between RM 10 and RM 13, included multi-benefit techniques consisting of individual wood placement, wood structures, bio-engineering, and riparian planting. The project initiated riparian vegetation restoration over 12 acres. More than 6,000 linear feet of riparian edge were enhanced with cottonwood flood fencing, inter-planted with conifers. A 330-foot previously eroding riprap bank was treated with bio-engineering techniques, slowing erosion rates and allowing for the future maturation of a new riparian buffer more than 100 feet in width. The project identified and coordinated the conservation of 29 acres of forested riparian with more than 3,000 feet of natural edge habitat.

Pre and post-project monitoring was conducted to establish baseline habitat conditions and determine whether desired habitat conditions were created as a result of project actions. Early monitoring result show that pool frequency increased in both monitored side channel segments by more than 50 percent. In the RM 12.5 side channel, the wood debris piece count was increased from 10 pieces per 100 meters of channel length to 60 pieces per 100 meters, elevating the habitat rating for wood to the recommended interim management ‘‘target’’ (Fox and Bolton, 2007). Within the RM 10.5 project side channel, the wood count and jam frequency tripled. The RM 11.5 wood placements nearly doubled the large wood frequency within a backwater pool habitat used by both adult and juvenile Chinook salmon. Wood structures and riparian plantings were installed where there was evidence of cold water inputs, providing increases in quality rearing habitat and future thermal refugia. Fish use monitoring documented that the project habitat was used by juvenile Chinook, steelhead, coho, and bull trout.

2.0 Completed Activities 2013 – 2016

Preliminary work began on the Lower Skykomish River and side channels, RM 10 -13, in 2012 with landowner outreach, project concept and feasibility studies. The project activities during the period of the agreement are detailed by subcategory; Project Management, Construction, Maintenance, and Monitoring.

2.1 Project Management

Project management involved building and maintaining partnerships related to funding, permitting, and implementation of project components. Principal tasks included: administration of funding agreements, coordination of; permit agencies, permit reviewers, the design engineer and county staff. Other activities included materials sourcing and coordination with county contracting, purchasing, and construction departments for the RM 10.5 project construction bid. The project required a significant amount of coordination with permitting agencies given some of the unique components and the scale of the overall project. Several site visits and project presentations were made between landowners, funding and regulatory agencies. Additional project partnerships were developed through project management actions between landowners and other stakeholders; including land conservation and additional buffer planting.

2.2 Project Construction

Project construction was separated into 5 individual site or construction type designations; floodplain flood fencing, RM 12.5 side channel wood placement, RM 11.5 side channel wood placement, RM 10.5 side channel wood placement and bank rehabilitation. Also riparian plantings associated with each site.

The project structural construction began in March 2014 with site preparation and installation of 690 cottonwood boles along 5900 feet of riparian edge. The construction was completed through a small works bid and contract with the RRJ Company from Monroe Washington. Within the edge of the farm fields, the blackberry was removed and cottonwood boles were installed by boring holes to 10 feet below grade and installing 15 foot boles to 5 feet above grade. The floodplain flood fencing was completed in April 2014.

Instream construction began in June 2014 and was completed in October 2014. An as-built report by project engineer, Paul Devries, R2 Consultants Inc. (2014) is provided in Appendix A-2. This report details the structural components of the project. The following text summarizes the structural installations.

The RM 12.5 side channel wood placement consisted of instream vertical arrays and small jams. The in-channel vertical arrays were installed in two array sets at the top end of the side channel consisting of 42 vertical fir boles excavated to 10 feet below grade and 5-7 feet above grade. Eight horizontal logs were secured to the 2 arrays with 1-1/2 inch manila rope. Six small jams consisting of 10 logs with rootwads each were placed in the side channel. Small jams were structured with 6 logs placed vertically, excavated to a depth of 8-10 feet below grade and were cut at 8–10 feet above grade. Fir logs with rootwads, 4 each, were interlaced in the vertical logs so their rootwads extended into the wetted channel. The horizontal logs were secured to the vertical logs using 1-1/2 inch manila rope.

Wood placement in the RM 11.5 side channel, predominantly backwater slough habitat, consisted of 25 individual ballasted logs. The logs were consistently over 24” diameter at breast height (DBH) with

large rootwads. The logs were ballasted, fastened to two 3000lb round boulders with 1-1/4 inch manila rope. Wood placement in the RM 11.5 and Rm 12.5 side channels was completed by the Snohomish County Public Works, Bridge Crew.

Construction at RM 10.5 side channel consisted of vertical arrays on a meander bar, a small jam, in stream wood placement, and bio-engineered bank rehabilitation. The construction, beginning in August 2014, was accomplished by Wetlands Creations Inc. from Monroe Washington. In-stream flood fencing was arranged in 6 arrays totaling 93 fir boles at a meander bar location. The fir boles were excavated to a depth of 10 feet below grade and 5 feet above grade. Rootwad logs (11 ea.), ballasted by three 3000lb round boulders, secured with 1-1/4 inch manila rope were placed in a small jam upstream of a high flow channel backwater and a simplified glide habitat. Rootwad logs (36 ea.), ballasted by three 3000lb round boulders and secured with 1-1/4 inch manila rope were placed in a simplified side channel pool adjacent to an eroding bank. More than 30 pieces of rip rap bank armoring were removed from the channel.

The eroding, vertical, agriculture bank edge, was re-graded by excavating 1400 cubic yards of sand and silt to a final slope grade of 3:1, installing two brush layers (13,000 live stakes), placing 19 edge complexity structures, placing coir fabric over the exposed soils, and planting grass and native plants along the slope. The edge complexity structures consist of 1 cottonwood and 1 fir log (30 foot ea.) excavated 20 feet into the bank perpendicular to the river flow and held in place by vertical fir logs driven through the bank material to the coble layer at a depth of approximately 10 feet. Floodplain flood fencing was installed landward of the bank set-back and a buffer of 100 feet was planted with native trees and shrubs.

Preparation for areas to be planted included invasive vegetation treatment which began in late summer and fall of 2013. The areas planted totaled approximately 12 acres and were comprised of 2 acres of conifer bareroot inter-plantings along the river and side channel edges, 7 acres of coniferous seedling or deciduous live stakes along side-channel riparian bar areas, and 3 acres adjacent the RM 12.5 instream project. CREP provided the incentive and coordination to accomplish 6.5 acres of the total acres planted. The CREP plantings included establishing a 100 foot buffer along the eroding agricultural bank. The CREP planting was managed by the Snohomish Conservation District. Appendix A-3 contains a map of the CREP planting areas. Additional plantings were added in the spring, after the record flood season of 2015-16, including; 2575 willow live stakes along the RM 12.5 sidechannel, 610 willow stakes at the RM 11.5 bank erosion, and 1050 willow stakes were planted at the RM 10.5 bank project. Planting and maintenance (described below) not associated with the CREP, was accomplished by Washington Conservation Corps (WCC) Crews.

2.3 Project Maintenance

Planting activities and invasive vegetation control was accomplished every fall and winter season 2013 through 2016. Anti-browse netting was installed on the floodplain flood fencing inter-planted conifers in 2015. After the 2015-2016 flood year many of the plants required flood damage repair and browse

netting replacement. Due to the drought, summer 2015, the County Road Maintenance was utilized to water the 5900 foot riparian edge plantings. Two watering efforts were made in the late summer 2015. Post planting invasive control, mowing and replacement was accomplished in 2015 and 2016. Additional invasive control and conifer inter-plantings was extended to a ~1000 foot area of floodplain flood fencing installed in 2006 on the Groeneveld Side channel.

One year after project installation, the 2015/16 flood season, the Lower Skykomish River Reach experienced six floods, as shown in the hydrograph in Appendix A-4. Some project components received a boost in river process while others were "stress tested". The RM 10.5 project is in a more direct flow path than the other project sites due to a developing split channel river configuration rather than the more confined side channels. Some of the instream wood was lost and portions of the bio-engineered bank treatment was damaged. Project maintenance considerations were made. Additional assessment was conducted due to the extensive reach scale geomorphic changes specifically within the side channel. Snohomish County staff conducted a geomorphic assessment (Kopp, 2017) of the reach that included landowner engagement. Instream maintenance or future work will be considered as a component of a reach scale plan.

2.4 Project Monitoring

Project monitoring was funded by the Public Utility District No. 1 of Snohomish County as a component of the Jackson Hydroelectric Project (FERC No. 2157). Project monitoring is performed to account for project treatments, assess the treatment effectiveness to date and to determine the influence of the treatment at specified scales. The Lower Skykomish River Restoration Project's overall assumption is that the project treatments will improve limiting habitat conditions for target species within the reach. Habitat conditions could be improved from static habitat creation and/or changes in channel responses. The project as-built is used to determine level of implementation and set a base line for evaluation over time. Effectiveness monitoring measures outcomes over time and determine if the project met its objectives. Comparisons to baseline conditions and established metrics allows us to detect change at a treatment site or larger scale as established in basin or reach restoration plans.

Project monitoring performed includes:

- Water quality monitoring was represented by temperature using continuously recording Hobo® data loggers (Onset Inc.) placed throughout the treatment reach and ambient sites for comparison. Continuous water temperature was recorded using methods from Washington State Department of Ecology (WDOE, 2003). A handheld temperature probe was used to compare sites throughout the project.
- Habitat monitoring was represented by woody material count and wetted habitat features that can be compared to pretreatment conditions and habitat suitability criteria, which represent the levels of desired habitat conditions. Water level loggers were placed to determine treatment area connectivity.

- Construction implementation monitoring was represented by the enumeration of treatments/individual elements and topographic mapping of structure positions (as-built).
- Channel topographic monitoring was represented by cross sections and longitudinal profiles characterizing the as-built baseline and to identify changes in hydraulic processes (scour and/or fill), design function, and project durability/adaptive management monitoring.
- Vegetation monitoring included documenting the area planted in order to evaluate establishment and survival of planted areas.
- Fish presence monitoring was conducted to simply show access and general use by target species.
- Photo points monitoring was implemented to display outcomes primarily as a demonstration tool. Key project components were photo documented after construction to visualize project outcomes and photos can be updated over time.

3.0 Monitoring Results

3.1 Structure Monitoring

Constructed structures are surveyed and monitored for change. The change may be an expected or unexpected change to the existing, installed structure. Detailed in the as-built report (DeVries, 2014) is the final construction count and location of each piece of wood and material placed. An inventory was completed during the 2015 habitat survey. Additional inventories and structural observations were made during and after the flood season 2015-2016.

The RM 10.5 project structures were installed on the right bank inside meander bar and further downstream on the right bank outside meander eroding bank. The inside meander bar structures consisted of 93 vertical boles, arranged in 5 arrays on the forested and open gravel meander. Eleven ballasted logs with rootwads were placed in the channel as a small jam on the downstream end of the meander bar. In the 2015 inventory and again in the summer of 2016, the Vertical arrays and small jam remained in the as-built configurations.

On the outside meander bank there were 36 ballasted logs placed on the channel bottom in an interlaced pattern, at the right bank toe extending out into the pool center. During summer low flow 2015 RM 10.5 habitat inventory, 33 ballasted logs were identified as well as 3 naturally recruited pieces. In 2016 a count was made during the summer low flow and only 10 placed ballasted logs were present. The boulders used for ballast remained in place. Figure 1 shows the aerial view of the RM 10.5 project bank structures in the summer of 2015 and 2016. The vertical eroding bank was back-sloped and 19 habitat structures were embedded in the bank extending out into the channel. The inventory in 2015 identified 18 originally installed structures remained as well as 7 naturally recruited logs. After the flood season of 2015-2016, 13 of the 19 structures remained. Ballasted logs at RM 11.5 were surveyed in the as-built report and have shifted but have not been re-surveyed as the water has

deepened and survey is difficult at that location. The habitat inventory in 2015 accounted for the all of the placed pieces within the backwater habitat.

Figure 1. Google Earth aerial photos, June 2015 and 2016 of the RM 10.5 bank rehabilitation project.

The RM 12.5 project had six small jams remaining intact through both the 2015 and 2016 flood seasons. In-channel vertical arrays (z-arrays) were partially covered by log jam material making confirmation of each piece difficult. A count was accomplished in 2016 detailing that 3 vertical boles and 1 horizontal log were lost off the southern vertical array. One vertical bole was lost on the northern array. In the center of the channel, the center most vertical boles were pushed, tilted downstream of their original position.

Over the 6000 lineal feet of floodplain flood fencing, a section ~100 feet in length was lost due to channel migration. The estimated 12 lost cottonwood boles were at the RM 11.5 project site in a location where installation was narrowed due to landowner constraints. The RM 12.5 site flood fencing accumulated natural wood at a bend in the side channel (Figure 2).

Figure 2. Accumulated natural wood on floodplain flood fencing, RM 12.5.

The effectiveness of wood placed and structures installed as components of the bank rehabilitation, RM 10.5, were less than expected. The side channel is expanding capturing more of the mainstem flow. The flood season of 2015-2016 (graphed in Appendix 4) proved to be challenging to the structures as installed. Early on in the flood season, after the third and highest flow, the installed wood structures remained mostly intact. The successive floods diminished the in-channel and bank rehabilitation structures to about half of the as-built condition. The design considerations as funded and permitted were to provide soft armoring techniques that improve habitat conditions without "locking" the bank in place. The bank erosion rate would be slowed to allow riparian plantings to mature providing a long term more natural erosion process. The RM 10.5 side channel has become a mainstem split channel with increased erosion potential.

The RM 10.5 project components upstream as well as bar arrays and small jam remain intact and functioning as of the recent survey. The RM 11.5 wood was intended to increase the wood loading habitat benefits within the backwater pool and help accumulate natural wood and form jams. Some of the wood is shifting within the channel. The accumulation of wood on placed pieces has yet to be detected. Small jam structures at RM 12.5 remain intact and two have accumulated natural wood as intended. The vertical array structures at RM 12.5 accumulated large amounts of natural wood meeting the design expectations. The structures remain functional with the loss of 4 vertical boles and one horizontal "pre-rack" piece. The floodplain flood fencing arrays remain intact and functioning for most of the installation length. A CREP planting is being installed at the RM 11.5 location and will include some smaller cottonwood vertical boles at the channel migration location.

3.2 Channel Form Monitoring

Cross-Sections

The project structures were placed to stimulate a channel response, either at the point of installation or more broadly to the entire channel. Topographic survey was made with Trimble® RTK equipment at cross-sections associated with installed project structures. Cross-section data was analyzed in GIS and plotted as looking downstream left to right bank, along the width of the cross-section line in Excel. The as-built data was compared to data collected in 2016, after the major flood season 2015-2016. A trend line (2 point moving average) was added to the point data to represent the bed and bank surface. An example graph is shown in figure 3; the remaining compilation of cross-section graphs are in appendix 6. Locations of the RM 12.5 project cross-sections are shown in Figure 4. Figure 5 shows the RM 10.5 project cross-section locations. Bathymetric data was collected in the RM 11.5 side channel and RM 10.5 split channel. This data is not summarized in this report but will be used to update hydrographic modeling of the Reach in 2017. Cross-section findings are summarized below.

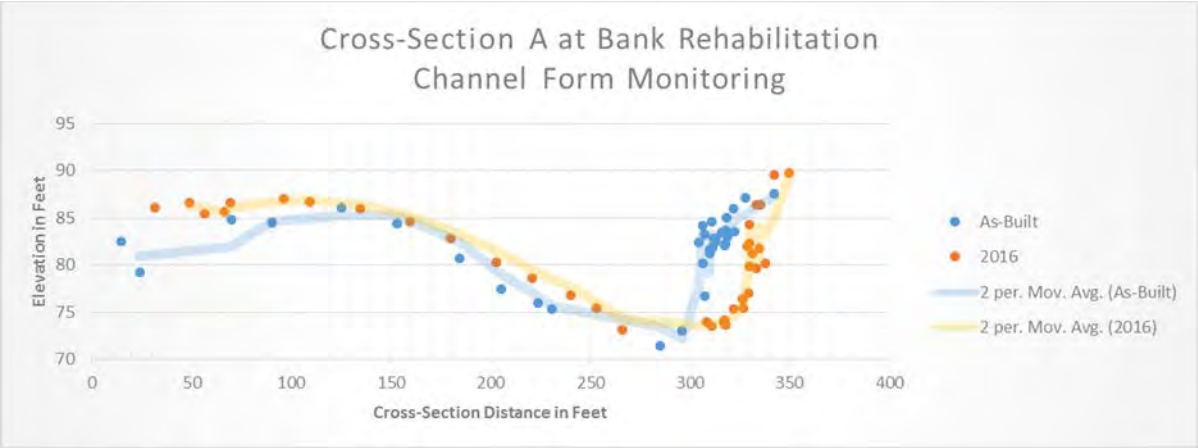

Figure 3. Example channel cross-section graph.

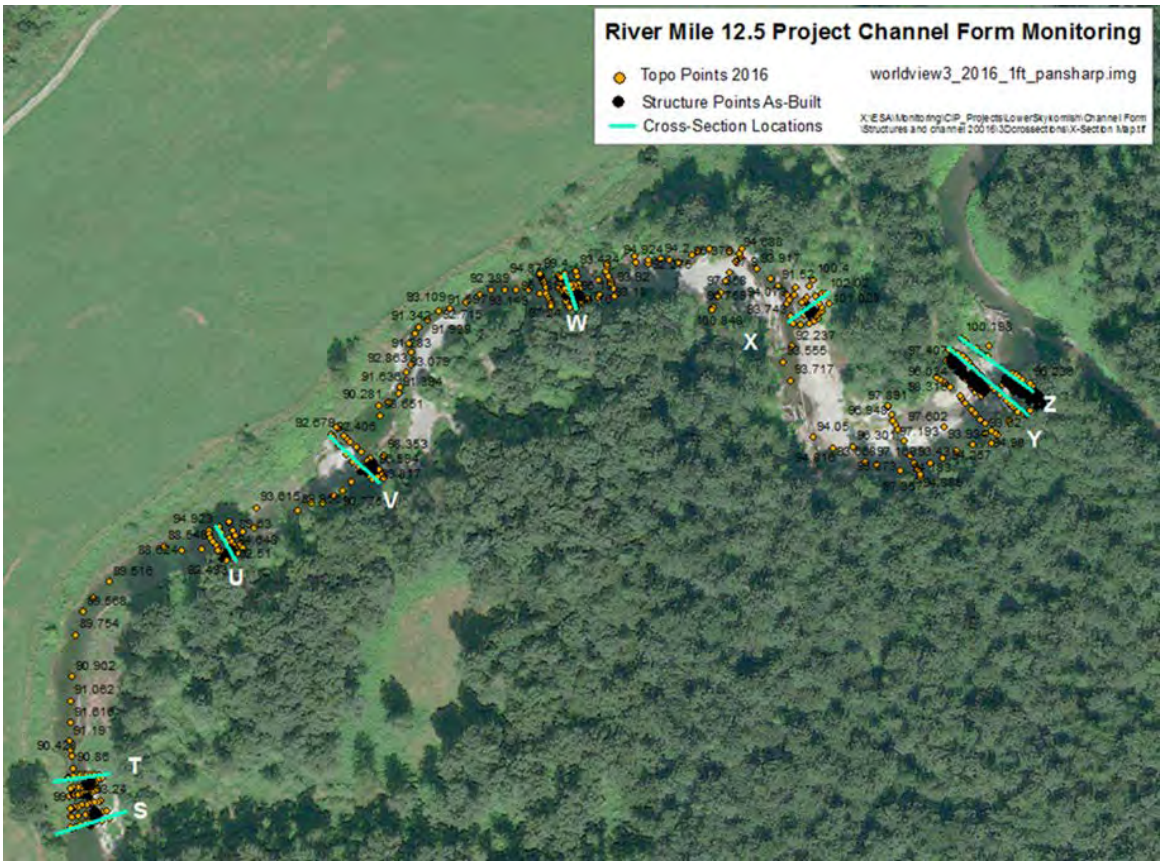

Figure 4. RM 12.5 channel form monitoring cross-section locations.

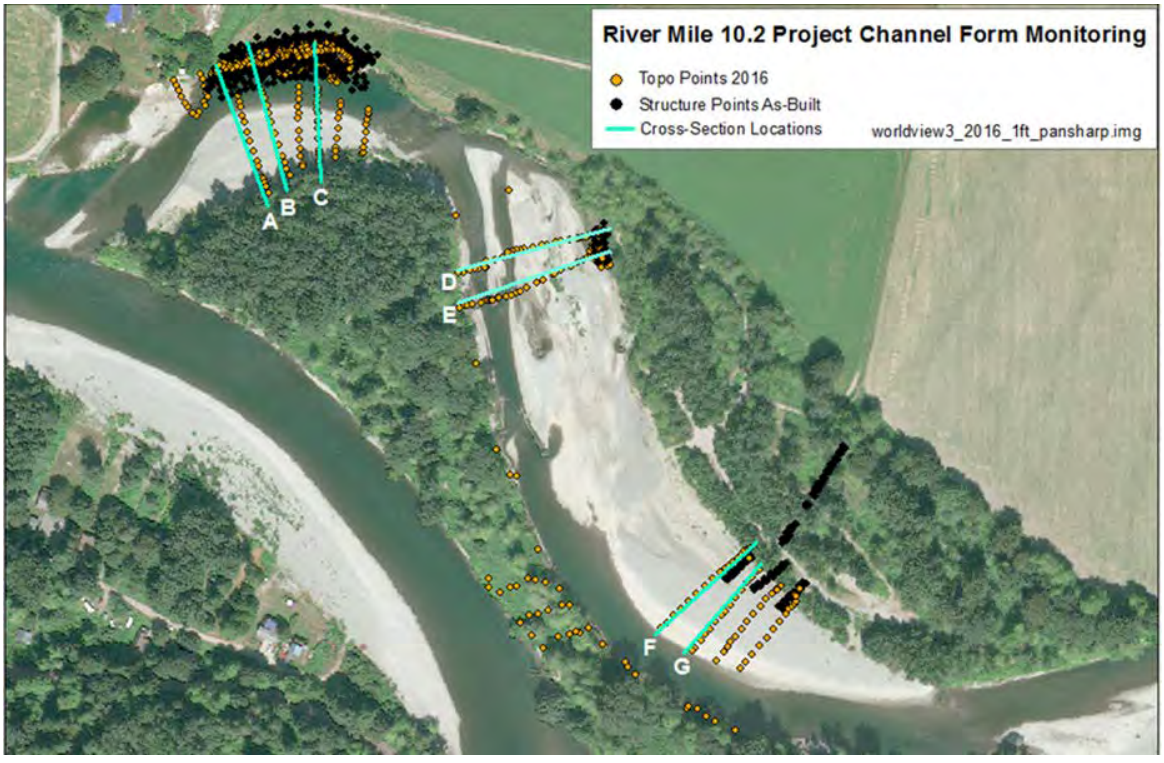

Figure 5. RM 10.5 channel form monitoring cross-section locations.

Cross-sections S, T, U, and V (Figure 4) represent small jams in the RM 12.5 side channel without accumulated natural wood. The cross-sections S, T, and U saw a small amount of deepening of the bed generally in the channel middle or across from the structure. Cross-Section V deepened at the point of the wood, indicating scour. Cross-section W, that accumulated wood upstream, resulted in a buildup of sediment at the placed wood and a widening channel response across the channel as well as erosion to the bank behind (inland) of the placed structure. Cross-section X had a deepening pool associated with a large accumulated rootwad on the jam and erosion to the bank behind (inland) of the placed structure. The in-channel vertical arrays (Z arrays) at RM 12.5 were cross-sections Y and Z (Figure 4); with Y representing between the arrays and Z slightly upstream. The response to the channel bed at these two cross-sections was only slightly varied between scour and fill and there was some indication of the channel widening on the left bank.

At the RM 10.5 project, the cross-sections associated with the bank rehabilitation are, A, B and C. Cross-section A, B and C show the bank migration to the right bank; ~20ft at A, ~15ft at B and C. A and B show the gravel bar on left bank building. There are signs of a slight sediment buildup at the right bank bed and toe at all cross-sections. However, the net result of right bank channel migration and limited left-bank bar accumulation, suggests that the pool habitat area and volume have increased at this location, contributing to the overall increase in percent pool area within RM 10.5 as summarized in sections following. Cross-sections D and E are across the channel at the small placed jam (Figure 5). The increase in channel splits and channel widening on the left bank are evident on the cross-section graphs D and E (Appendix A-6). The channel left bank has migrated 70 -100 feet (~25m) in the two years at this location. There is an accumulation of sediment building at the downstream end of the small jam as seen in cross-section D. The cross-sections at the meander bar arrays are F and G (Figure 5). The cross-section graphs F and G (Appendix A-6) indicate the channel migrating to the left bank, into the island. The bar sediment deposition is up to 5 feet in depth since the installation of the vertical arrays.

Channel Length Profile

A longitudinal profile of the RM 12.5 channel thalweg was collected prior to the project construction and repeated in 2016 after the flood season. Figure 6 shows the longitudinal comparison by year through the structure treatment reach of the side channel. The channel increased in thalweg length by 194 feet, as seen by the resultant shift in the ford along the thalweg (Figure 6). The channel gained the most length between the Z arrays and the first jam, and again just after the first jam as the channel migrated to the left bank (south) and then the right bank (north). The natural bank erosion within the RM 12.5 surveyed reach was 17% in 2016, but not recorded in the 2005 survey. A change of note was the absence of a large beaver dam between jam 4 and 5, and the deepening of the pool upstream as indicated in the 2016 survey (Figure 6).

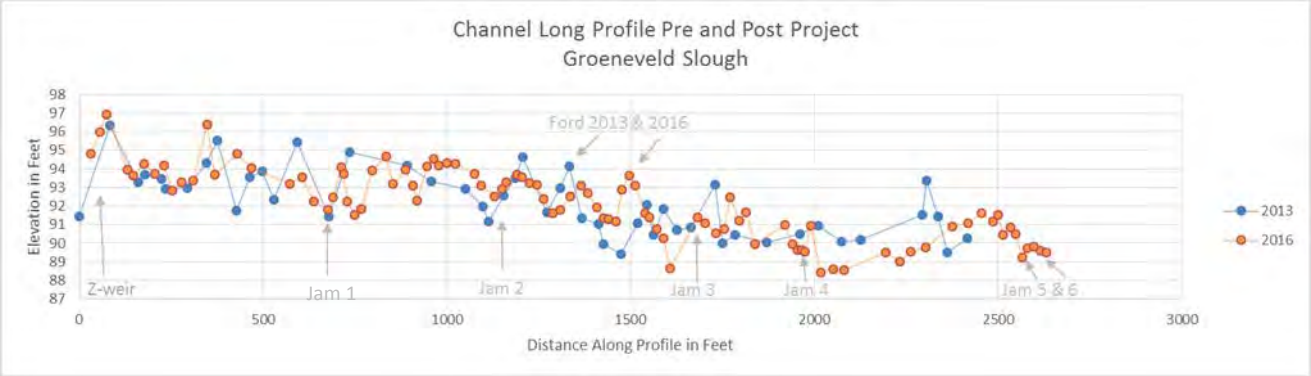

Figure 6. Longitudinal profile of RM 12.5 side channel pre and post project.

The channel length monitoring for the RM 10.5 channel was accomplished by comparing changes to the length of the left (island inner) bank. Bank edge data was collected at areas of erosion using Trimble® RTK equipment and aerial images were used to measure total bank lengths between years. Figure 7 shows the bank adjustment as the channel migrates away from the sediment deposition. Erosion distance measurements are taken at the location of maximum change and only represent the rate at that location for comparison purposes. The left bank length increased in the 2 years post project installation by ~35 meters. The channel length, increase rate pre project was 0.31% per year average. The channel length post-project after the following 2 years was an average increase of 1.14%. The increase in meander length and associated increase in edge habitat adjacent the bar flood fencing is ~25 meters along the meander bend.

Figure 7. Aerial images pre, as-built and post RM 10.5 meander bar vertical array construction.

Channel Response Discussion

The expected channel response based on placement of 6 small jams in the channel along the RM 12.5 side channel was to increase pool quality associated with the structures and accumulated wood. Pool count increased in the reach and the cross-section data identified increased depth at some of the structure locations. The channel also increased in length and wood loading. This resulted in an

estimated increase of habitat area by ~1500 m² at spring flows; when juvenile Chinook are present. The increased channel area resulted in an increase in wood-formed pool habitat. As the channel process matures, as measured by habitat metrics, the flow distance and resistance to flow increases in the side channel and may result in reduced erosion rates on adjacent agriculture fields.

The bank rehabilitation at RM 10.5 was effective at slowing the rate of channel migration; although the extent of damage to the placed structures and bioengineering effort was not predicted. The erosion rates are estimates from aerial images and from project monitoring data. The erosion rates associated with the maximum erosion that occurred at each site was not representative of ranges outside of the observed site measurements. The bank erosion rate at the RM 10.5 bank rehabilitation site prior to the project was estimated to be ~4.3 meters/year. In the 2 years following the project the erosion rate is ~3.0 meters/year. During the same period following the project, the erosion rate upstream in the split channel is ~12.5 meters/year and ~13.3 meter/year downstream.

The channel response across from the RM 10.5 meander bar indicates a response based on the presence of the structures and response to channel changes from sediment accumulation in the mainstem upstream (Kopp, 2017). The channel complexity has increased due to the recruitment of wood as the channel erodes the forested island. Channel length increased as the bank erosion rates increased in response to the bar treatments, floods, and natural channel changes. The left bank erosion rate prior to the installation of the vertical bar arrays was ~5 meters/year. In the two years post treatment, the erosion rate was 19 meters/year. Field observation in 2017 indicate ~10 meters of migration over the 2016-2017 flood season. The channel length increased at more than 3 times the rate post project resulting in ~700m² of low flow pool habitat increase at the meander.

The meander increase has a limit, it is likely to breach the RM 10.5 island. This will result in additional channel complexity as the island split evolves. Predicting the responding channel response is challenging. The mainstem may transition more to the north split channel, as has been the recent trajectory, indicated by an increasing BFW and sediment recruitment (Kopp, 2017). An apex jam may form at the new island split. This may direct the upstream right bank migration toward the small jam placement and maturing meander riparian vegetation. A pre-project concept was that a channel split would reduce water velocities in the remnant right bank channel and that sediment would begin to deposit in this channel. The wood placement is predicted to maintain points of scour and maintain the side channel habitat.

3.3 Water Temperature Monitoring

Temperatures are summarized using the 7 Day Average of the Daily Maximum temperature (7DADMax – in degrees Celsius) and compared to aquatic life temperature criteria from Washington Department of Ecology (WDOE, 2006). Temperature was monitored at several locations to determine if the structures were located in areas that promote acceptable temperature conditions for juvenile salmon in spring and summer. Temperature monitoring also establishes a baseline/benchmark to detect improving conditions as the project riparian plantings mature and natural processes advance.

Prior to project construction, in 2005 and 2013, water temperature was recorded at project sites and on the mainstem Skykomish River upstream of the project and adjacent to the project. In 2005 the temperature logger locations within the project area were located in the RM 12.5 side channel middle and outflow. Mainstem loggers in 2005 were upstream of the Wallace River and downstream of the Sultan River. Key findings in 2005 were that the mainstem temperature upstream of the Wallace River is higher than the mainstem downstream of the Sultan River. Additionally, the 2005 logger in the middle of the RM 12.5 side channel was cooler than the side channel outflow. In 2013 temperature was monitored for a shortened period between mid-August and the latter half of September. The 2013 loggers were located at RM 10.5 side channel (18.8^0C, 18.9^0C), the middle of RM 11.5 side channel, (20.5^0C) and at the RM 12.5 side channel outflow (21.1^0C). An abbreviated monitoring effort in 2013 indicates that the RM 10.5 side channel was cooler than both of the other side channel loggers; more closely tracking the mainstem temperature.

Temperature loggers were placed in 2015 and 2016 during the core summer rearing period. Temperature logger locations, by year, are displayed in Figure 8. Figure 9 graphically displays and compares the 7DADMax temperatures of project and ambient locations between these years. 2005 data is also represented as well as project logger that collected data within the RM 11.5 side channel lower end in 2014. The mainstem logger in the upstream Skykomish River in 2015 was placed after the 7DADMax was likely reached. Therefore; an estimated 7DADMax is included in addition to the 7DADMax as recorded for that location. There were higher 7DADMax observations during the 2015 drought monitoring year at most sites than occurred in 2016.

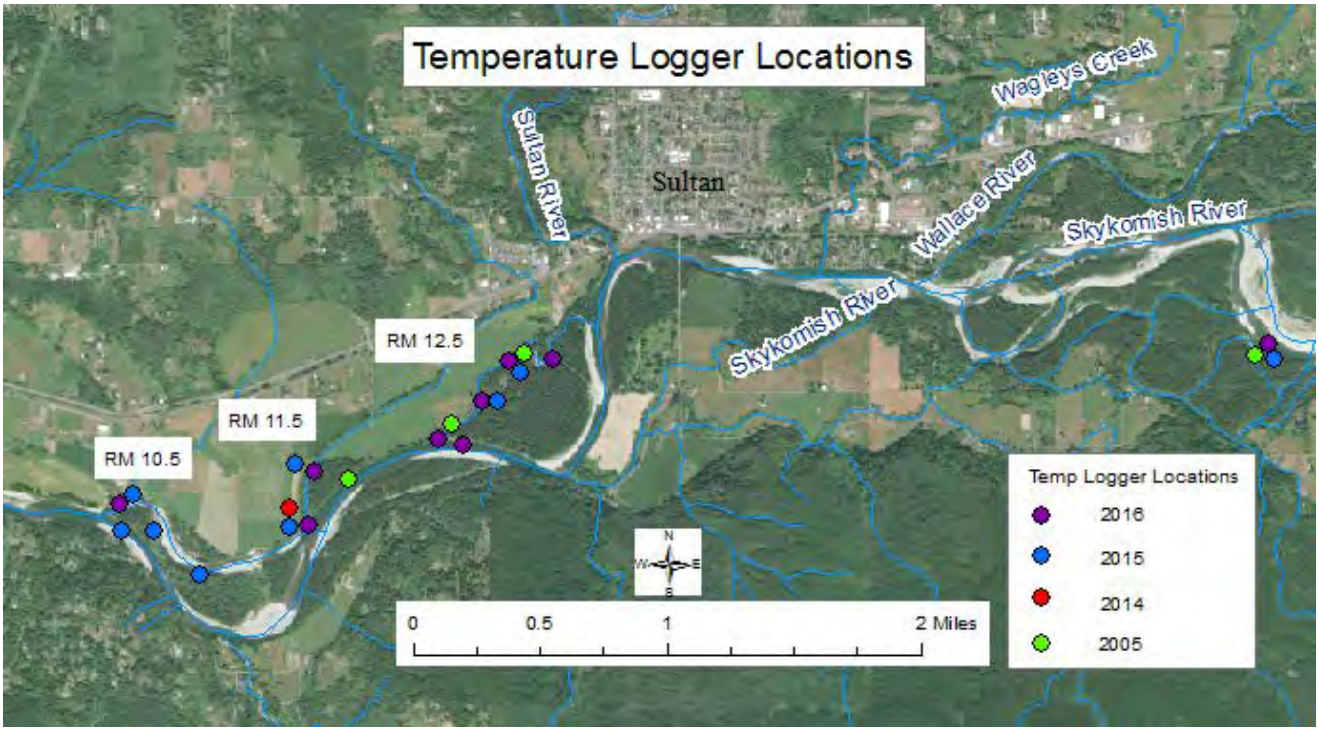

Figure 8. Temperature logger locations by year.

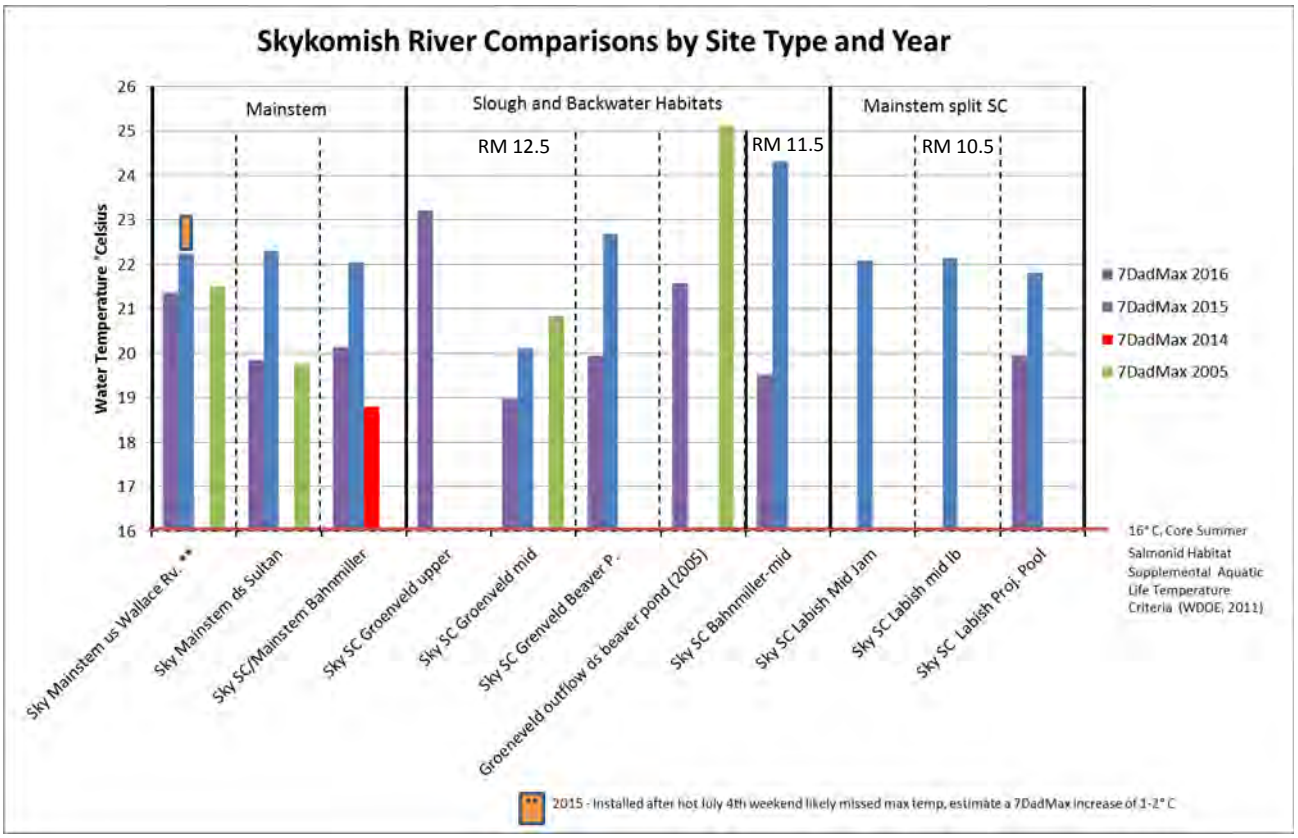

Figure 8. Water temperature monitoring summary by 7DADMax and year monitored.

While fish sampling in August 2016 a handheld temperature probe was used to spot check temperatures throughout the project in sampled habitat locations (table 1). The findings show evidence of hyporheic input to the RM 12.5 side channel during low flow conditions at the pool associated with the upstream most small jam installation. The cool water is detected in the downstream direction to the upstream end of the beaver pool mid-way of the RM 12.5 side channel. The RM 11.5 side channel temperature, as collected on the left bank sample area, was higher than the continuous temperature logger installation (at the same time) deeper on right bank; 19^0C vs 17.4^0C. The temperature in the RM 11.5 backwater pool appears to be stratified and there is evidence of mainstem cooling from groundwater seepage in this side channel.

Table 1. Spot check project water temperature at fish sample locations same date.

Location	Habitat	Temperature	Date/Time
RM 12.5 SC upper	Disconnected pool	18.1^0C	8/22/2016 – 10:00
RM 12.5 SC upper	Wood pool	14.8^0C	8/22/2016 – 11:00
RM 12.5 SC mid	Rock pool	14.9^0C	8/22/2016 – 12:45
RM 12.5 SC mid	Beaver Pool	17.3^0C	8/22/2016 – 1:45
RM 11.5 SC lb	Backwater pool	19^0C	8/22/2016 – 2:30
RM 10.5 SC mid	Meander pool	17.8^0C	8/22/2016 – 3:10
RM 10.5 SC lower	Project pool	17.6^0C	8/22/2016 – 3:50

The Skykomish River mainstem temperature is cooler downstream of the Sultan River as compared to upstream of the Wallace River due to colder inflow from the Sultan River (documented by PUD annual water quality monitoring). Ground water cools the RM 12.5 and RM 11.5 side channels, though this cooling effect on surface water was diminished during the 2015 drought year in the RM 11.5 location as compared to RM 12.5. This cooling is evident downstream through the side channel. The RM 12.5 side channel is also affected by the variation in summer flows regimes and increased connectivity of direct flow and ground water throughout the side channel. The difference between 2005 and the cooler outflow temperature in 2016 may indicate this. The RM 10.5 side channel temperature is consistent with the mainstem temperature downstream of the Sultan River. All of the temperature locations exceeded the state WQ standards 7DADMax of 16^0C WDOE (2006). Based on additional 2005 temperature data, as detailed in the Snohomish Pollutant Diagnosis and Implementation Project Centennial Clean Water Fund Grant # G0400041 (Haas, 2007); the side channel habitat downstream of the Sultan River benefits from the cooling effects as compared to braided mainstem split channels upstream of the Wallace River.

3.4 Habitat Monitoring

Woody Material

Wood placed in the channel was either a vertically-oriented, partially-buried, bole or a large log with or without a rootwad. The vertical boles are meant to anchor placed wood (not buried) and/or accumulate natural wood and/or sediment in the channel. Placed large logs are an enhancement of fish habitat measured by a count of individual pieces or as a jam. The total number of wood pieces placed as part of this project were constructed in various configurations and counted by sub-project location (Table 2). Within the RM 12.5 project area, in-channel wood placed directly accounted for an increase in total large woody material loading of 136 pieces/km (per kilometer) and 7.5 wood jams/km. The RM 11.5 project increased the large wood loading by 50 pieces/km. The placed wood at the RM 10.5 site increased wood loading by 126 pieces/km and 2.5 wood jams/km.

Table 2. Summary of installed wood count by type and location.

Type	RM 12.5 side channel	RM 11.5 side channel	RM 10.5 side channel
Floodplain FF	270 & 140 mainstem	270	66
In-channel vertical boles	42		114 & 55 within forested bar
Log with RW	60	25	47
Log without RW	8		38

Habitat data was collected in 2015 during summer low flow using a modified version of the Snohomish County Surface Water Management Wadeable Stream Survey Protocol, (Rustay et al. 2008). Key habitat metrics were collected and summarized to compare to data collected in 2004 and

2005 at the side channel scale. This summary data is used to evaluate project effectiveness. Summarized habitat metric tables are in Appendix A-5.

The summary metrics detail the difference in accumulated wood between 2005 and 2015. Figure 10, shows the wood loading (pieces/km) pre-project, as-built, and inventoried one year after construction. In the RM 12.5 side channel, the total wood debris piece count was increased from 95 pieces per kilometer (95/km) to 604/km. Within the RM 10.5 project side channel, the large wood frequency increased, from 31/km to 115/km. The RM 11 wood placements increased large wood frequency from 36/km to 115/km.

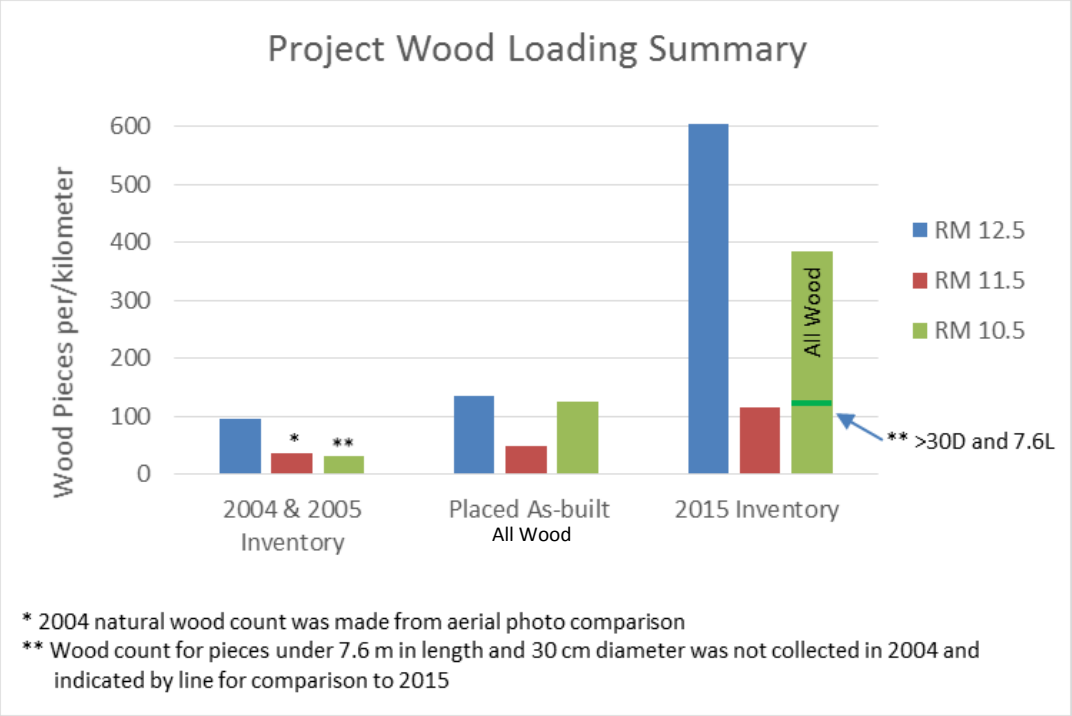

Figure 10. Wood loading within inventoried side channel reach, pre, as-built, and 1-year post construction.

Jam inventory data was collected in 2015 at the RM 12.5 and RM 10.5 sites where wood was installed or expected to accumulate into jam formations. At the RM 12.5 site 6 small jams were constructed as well as two vertical arrays; each expected to accumulate naturally recruited wood over time. The monitoring counted jams and individual wood pieces within the jams. Figure 11 details the wood count as related to jams in the RM 12.5 project reach. The placed wood count included a jam that was constructed in 2006, with 25 remaining pieces. The habitat inventory reach at RM 12.5 included 2 natural jams in 2005. The total jam count in the 2015 inventory was 10 jams; 4 additional placed jams were outside the inventory reach. In 2015, most of the accumulated wood was in new natural jams; while the two upstream vertical arrays accounted for the majority of the accumulated wood on placed structures. Naturally recruited wood on the Z-arrays accounted for 16% of all wood in the project area.

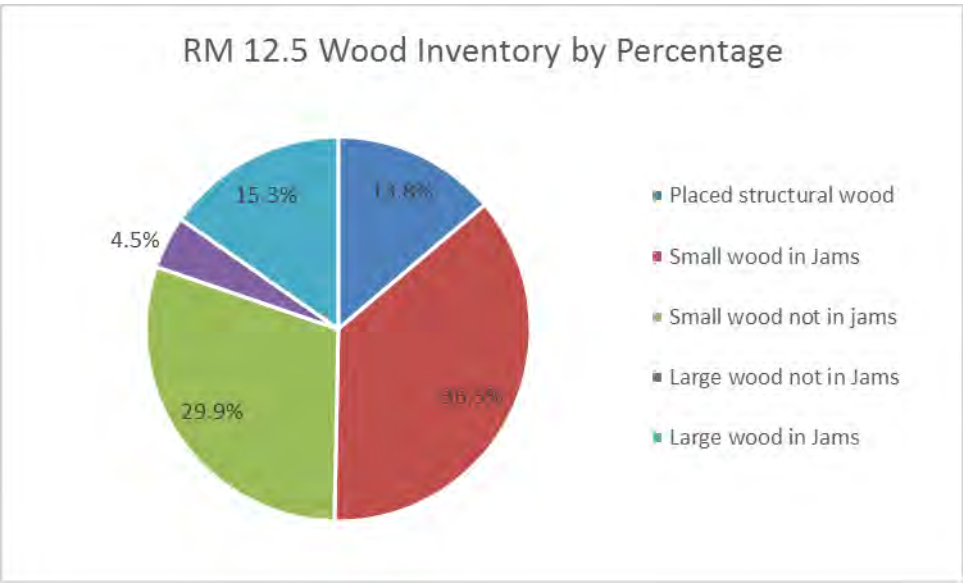

Figure 11. RM 12.5 wood accumulations, by percentage.

The RM 10.5 inventory reach extended upstream of the placed structures to include the entire split channel. Summary data available from 2004 included the entire side channel reach as compared to 2015 data. Table 3 shows the jam count pre-project, treatment, and post-project inventory. Total jam count was 3 in 2004 and 10 in 2014. The jam count in 2004 consisted of 3 jams upstream of the 2014 installed project structures. The 2015 jam count upstream of the project structures was 4. Of the remaining 6 jams within the project structure section of the side channel, 3 were the 2014 placed wood. Figure 12 shows the RM 10.5 bar array and adjacent area pre and post-project changes in bar growth and wood loading. The majority of new accumulated wood within the RM 10.5 side channel was in 2 natural jams, adjacent the bar structures and process channel adjustment.

Table 3. Jam count pre and post treatment.

Jam Location	2004/2005 Jam Inventory	2006 Placed Jam	2014 Placed Jams	2015 Total
RM 12.5	3	1	6 and 2 vertical arrays	14
RM 10.5	3		3	10

Figure 12. RM 10.5 bar array and adjacent area pre and post project changes in wood loading.

Aquatic Habitat

Habitat features - pools, riffles, and other glides or runs - were inventoried and summarized by percent area to compare to pre-project data collected in 2004 and 2005. Pools were further summarized by type, count, and frequency. Within the project area, the percent habitat areas are summarized in Figure 13. For RM 11.5, the percent pool area was 100% within the inventoried reach each sample period. The only notable change in percent aquatic habitat was in the RM 10.5 reach, were the % pool area increased from 45% to 56% (Figure 13).

In the RM 12.5 reach the pool count increased from 12 in 2005 to 18 in 2015. Within the RM 10.5 side channel, pool count increased from 10 in 2004 to 25 in 2015. One pool in the RM 10.5 side channel changed from riprap form to artificial structure (placed wood) formed. Two pools in the RM 12.5 side channel were classified as artificial structure (placed wood) formed. The number of natural wood-form pools within the RM 12.5 side channel, increased by 5, between 2004 and 2015. Natural wood formed pools increased in the RM 10.5 side channel by 8, between 2005 and 2015.

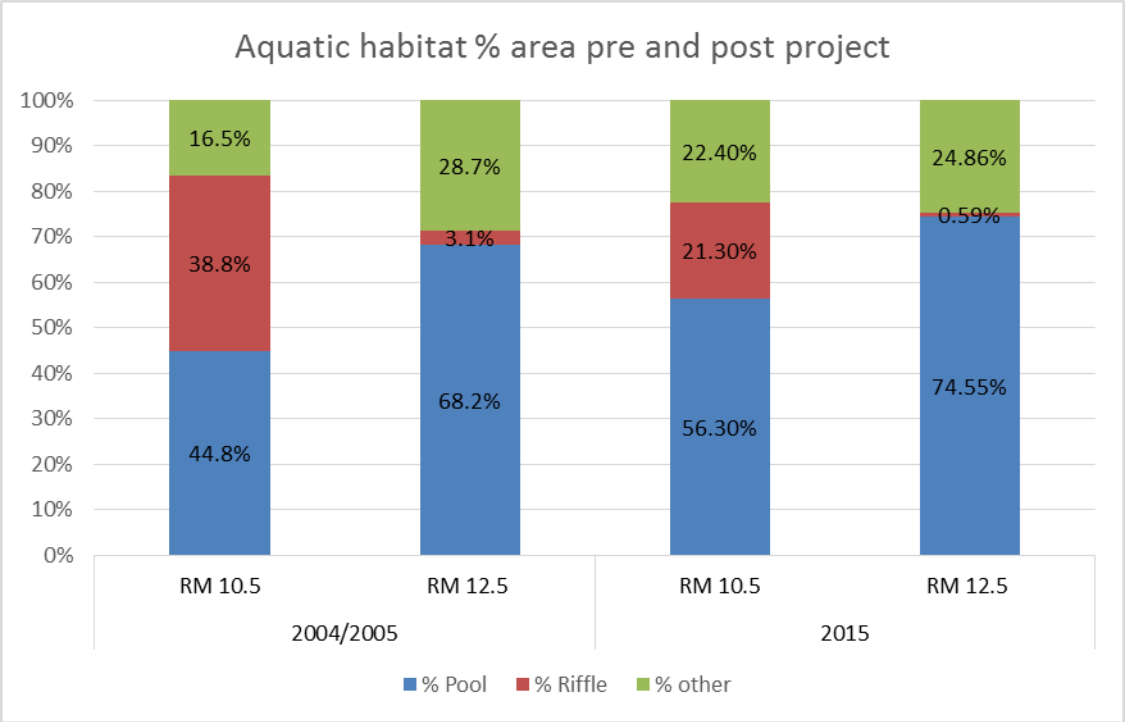

Figure 13. Aquatic habitat area by percentage, pre and post project installation.

Side Channel Connection

The RM 10.5 side channel flow from the mainstem is disconnected during low flow conditions. Pre-project channel flow connection was estimated at 3000 cubic feet per second (cfs) at the USGS Skykomish River, Gold Bar gage. Monitoring this connection is important when considering the access opportunity to the habitat enhancements associated with the timing of juvenile salmonid emergence and rearing. Figure 14 shows the 2015 USGS gage data as graphed for the month of May, 2015 at the Skykomish and Sultan River gages.

Using a water level logger, collecting continuous data, it was determined that the RM 10.5 side channel becomes connected to the mainstem of the Skykomish River above 2000cfs combined between the USGS Skykomish gage at Gold Bar and the USGS Sultan River gage near Sultan. Comparing the water level logger readings and flow graph/tables from the gages in 2015 (Figure 14) this occurred on the 26th of May 2015. Using the USGS displayed median daily statistic data (Figure 15), it was estimated that on an average flow year this occurs around July 25th. For 2016, we estimate this occurred the second week of July. An additional water level logger was placed downstream in the RM 12.5 sidechannel documenting a water level increase in a beaver formed pool during the low flow period.

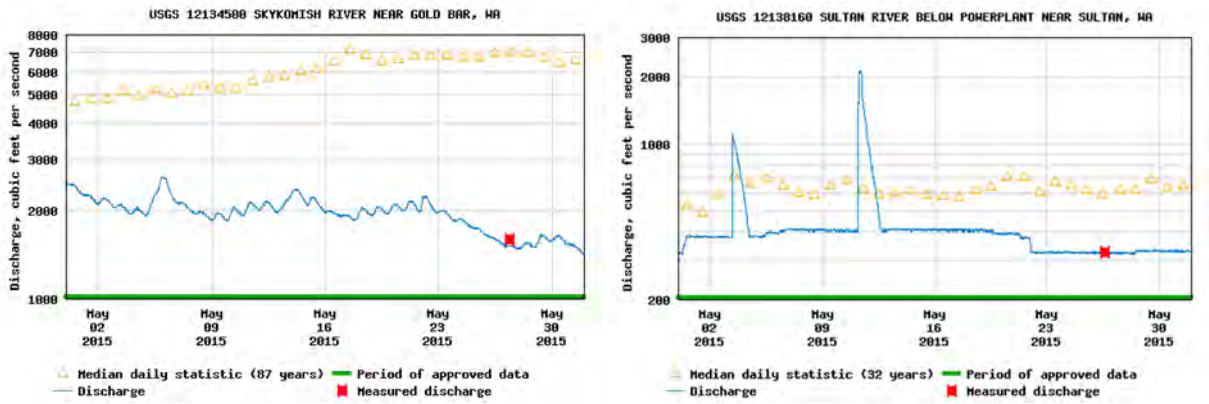

Figure 14. USGS gage data as graphed for the month of May, 2015 at the Skykomish and Sultan River gages.

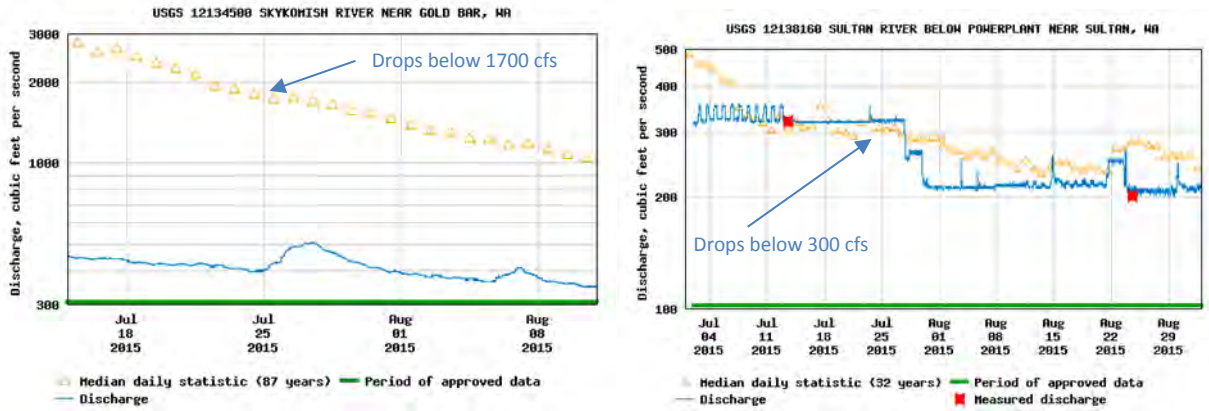

Figure 15. USGS Skykomish and Sultan River gages displaying median daily statistic trend line, for July and August.

Habitat Summary Discussion

Wood accumulations seen post-construction are associated with the wood installations. Naturally recruited wood is predominantly racked on the placed structures and/or a result of river adjustment to the placed structures. Both the RM 12.5 and RM 10.5 side channels are expanding and recruiting wood. The process within the RM 12.5 side channel is that a narrow channel allows for wood to easily rack on the installed structures; and was an objective of the project. Natural jams also form in the narrower forested channel at RM 12.5 from channel process adjustments to placed structures and natural wood accumulations. Within the RM 10.5 side channel, wood accumulations have resulted from process based adjustments to placed wood and structures as well as natural channel processes.

The project was effective in increasing the wood load as compared to pre project counts. Compared to habitat suitability criteria, the project was successful in increasing wood loads in the RM 12.5 side channel close to wood quantities observed in natural forested channels (Fox, 2001). The wood load more than doubled in the RM 11.5 side channel and more tripled in the RM 10.5 side channel. While the wood count and loading remains below desired future habitat conditions, the increase in wood jam counts has made gains toward the watershed 10 year recovery goals. The 2005 Snohomish River

Basin Salmon Conservation Plan (2005) target for increase in wood jams was 41. The overall project increased the total wood jam count in the Lower Skykomish reach by 14. Of those jams, 7 were formed from placed pieces only. As inventoried in 2015, the project had directly influenced 5 new large jams. The RM 12.5 project added 3 jams that had both installed wood and accumulated natural wood. In the RM 10.5 side channel, 2 new natural jams were formed as a result of increased channel response to other placed wood (Figure 12).

Pool count per mile within the RM 10.5 inventory reach increased from 9 in 2004 to 25 in 2015, meeting performance criteria for properly functioning stream habitat condition (NMFS, 1996). The pool frequency within the RM 12.5 reach was just below properly functioning for the BFW in 2005; at 24 pools/mile. In 2015 the pool frequency increased resulting in 36 pool/mile; meeting the criteria for a properly functioning stream (NMFS, 1996). A beaver formed pool identified in the pre-project survey changed as surveyed in 2016 to a deep pool with a large boulder in the center. The pools that were added were predominantly wood formed pools.

3.5 Fish Use

Fish monitoring in the side channels at RM 10.5, 11.5 and 12.5 was completed by using a beach seine. Sample site locations are identified in Figure 16. Fish collection was permitted with conditions determined by the Northwest Indian Fisheries Commission, Puget Sound Tribal Salmon Research Plan coordinated by Tulalip Tribes Department of Natural Resources. We prepared a fish collection sampling proposal outlining purpose, methods, and expected “catch”. Reporting to the Tribe included total catch by species. The permit allowed the collection to be completed in 2016.

A beach seine (1/8th inch knotless mesh) was used to collect fish within pools, backwater and slow moving channel areas with little or no wood structure or other cover. Beach seines were not used directly in areas containing LWD, log jams, or other cover. A large seine net (6-10 feet deep by 60-80 feet long) was used. Nets were set in a “round haul” fashion by fixing one end of the net to the bank while the other end was deployed with the current using a raft, or by foot, then returning to the shoreline in a closed half circle for final retrieval along shore. No attempts of repeat seine sets was made to judge fish “depletion” or catch efficiency; a single seine sample represents a conservative estimate of the sampled area. All fish were enumerated and measured unless a representative sample could be obtained without measuring all fish (see fish handling, below). The individual seine set area was measured with a rangefinder and calculated as a semi-circle.

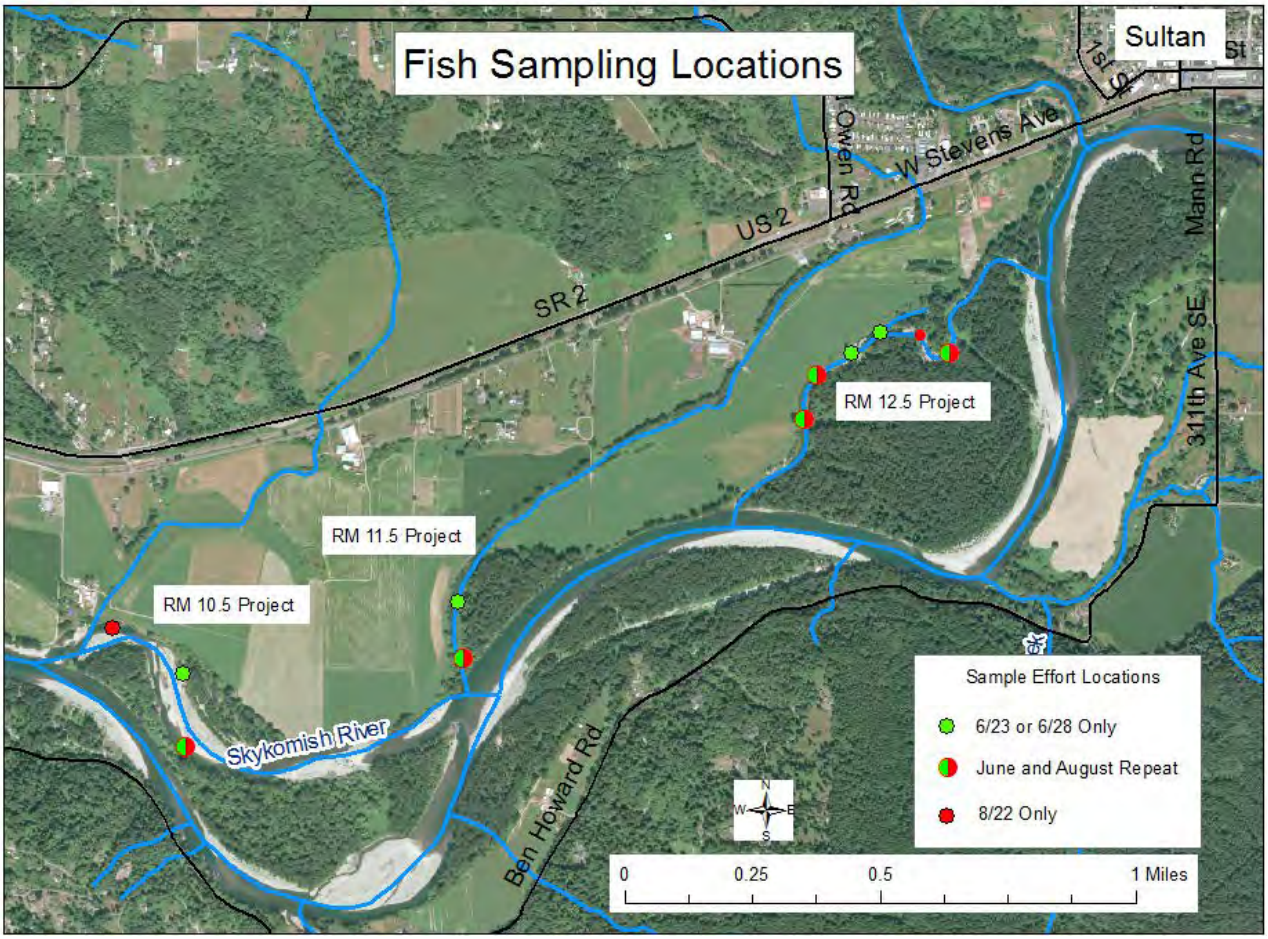

Figure 16. Fish sampling locations by date.

Collected fish were held in 5 gallon buckets filled with water from the collection site. Fish collected in seines were enumerated and identified to species (e.g. salmonids) or genus (e.g. sculpins or sticklebacks). Salmonid fork lengths were recorded. The condition of salmonids were recorded, where injured or abnormal in appearance. In addition site information, time, date, and water temperature were measured and recorded. Fish were released immediately after sample processing at or near their original collection site.

The sampling effort consisted of 3 sampling days, June 23rd, June 28th and August 22nd. Table 4 summarizes the overall sampling effort and fish collection results. The June sample days represent one project wide sample effort that was roughly repeated on August 22nd. Areas sampled included predominantly pool habitat adjacent to installed structures that were favorable for use of the seine net. An earlier effort to snorkel in the spring flows was unsuccessful due to poor visibility in the water column. The August 22nd repeat effort adjusted sample locations based on changes in water levels affecting the ability to fish.

Table 4. Fish sampling effort summary table.

Date	Method / Effort	Mainstem Flow* CFS	Salmonid Collected	Non-Salmonid Collected
6/23/2016	4 small seine set	425 Sultan 2700 Skykomish	61	37
6/28/2016	4 small seine set	320 Sultan 2630 Skykomish	57	66
8/22/2016	7 small seine set	513 Sultan 616 Skykomish	292	574

The RM 12.5 location had a total of 6 sample locations; 3 were repeated between sample efforts, 2 were only sampled in the June effort and 1 was only sampled in the August effort. At RM 11.5, two sample locations were collected in June; only one was accessible in August. Three sample locations were within the RM10.5 project area. One was sampled both in June and repeated in August (although the habitat conditions varied with water levels), one small habitat was sampled in June only, and the large project pool was only sampled in August as the lower flows allowed. Table 5 details the sample location habitat conditions for each sample location; the sites are listed by project site in a downstream orientation.

Six species of salmonid were found within the project side channels. Both wild and hatchery juvenile Chinook salmon were collected. Five species of non-salmonid fish were collected. Table 6 lists the total number of fish collected by species in the project sampling efforts. The fish collection data is available in a table of individual fish counts by site, species and date (Appendix A-7).

Table 5. Fish sample site habitat detail by sample date and sub-project location.

Date	Site	Habitat type and brief description
6/23/2016	RM 12.5 - Z structure pool	Flowing >1.5m pool, downstream of placed structure, large jam
6/23/2016	RM 12.5 - Small jam 2	Flowing other with wood cover, placed jam
6/23/2016	RM 12.5 - Ford Pool *net snagged	Flowing >1.5m pool *many snags
6/23/2016	RM 12.5 - Big Rock pool	Flowing >1.5m pool, freeform, little wood
6/23/2016	RM 12.5 - Twin Jam Pool	Slow flow pool ~1m two small placed jams
6/28/2016	RM 11.5 - PUD Pool Upstream	Backwater pool >1.5m, little wood
6/28/2016	RM 11.5 - PUD Pool Downstream	Backwater pool >1.5m, little wood
6/28/2016	RM 10.5 - Bar Flood Fence	Flowing gravel meander bar, no wood
6/28/2016	RM 10.5 - Labish SC small jam	Shallow wood formed pool and other
8/22/2016	RM 12.5 - Z structure pool	Flow isolated pool ~1m, downstream of placed structure, large jam
8/22/2016	RM 12.5 - Groeneveld small jam 1	Cold water, flow isolated wood jam pool 1.25m, placed small jam
8/22/2016	RM 12.5 - Big rock pool	Stagnant deep pool some cool ground water, little wood
8/22/2016	RM 12.5 - Twin jam Pool	Stagnant deep pool water warm, two placed small jams
8/22/2016	RM 11.5 - PUD Pool DS	back water pool very warm water, little wood
8/22/2016	RM 10.5 - Bar Flood Fence	Flowing side channel 1.25m pool deep natural edge habitat
8/22/2016	RM 10.5 - Labish Pool	Flowing 1.5m pool with placed large wood

Table 6. Fish sampling totals by species.

Species	Skykomish Project
Chinook wild	36
Chinook hatchery	11
Coho	210
Chum	0
Pink	0
Bull Trout	1
Steelhead	150
Cutthroat	2
Whitefish	90
Stickleback	495
Sculpin	23
Peamouth	15
Dace	85
Lamprey	2
Total	1120

Salmonid densities were estimated for each catch at individual sites and area sampled. Repeat or depletion sampling was not conducted to estimate sampling efficiency or to produce an abundance estimate. The sample area was not isolated (closed) and as stated efficiency was not known (but assumed to be less than 1.00). Furthermore, it is possible fish escaped being sampled from the target area because they moved downstream or into areas of cover. Therefore, total catch and density estimates are likely an underestimate of total salmonid abundance. Although, ideally, all habitats representative of the project side channels would have been subsampled; this was infeasible (as were attempted snorkeling efforts). In particular, we excluded habitat units with woody debris from beach seine sampling for obvious reasons. Salmonid densities are listed, as collected by sample site, in table 7. Chinook densities were calculated using combined origin (hatchery & wild) counts; further analysis of the data can reference the table in Appendix A-7.

Table 7. Salmonid density by sample site and date.

Fish density at sample location. Fish /per hectare

Date	Site	Water temp ^{0}	Area m2	Area / hec	Chinook	coho	steelhead	bull trout	cutthroat
6/23/2016	RM 12.5 - Z structure pool	12.9 ^{0}C	200	0.02	1050				
6/23/2016	RM 12.5 - Small jam 2		161	0.0161			435		
6/23/2016	RM 12.5 - Ford Pool *net snagged	12.9 ^{0}C	64	0.0064			313		
6/23/2016	RM 12.5 - Big Rock pool	^{0}	150	0.015	1333				
6/23/2016	RM 12.5 - Twin Jam Pool	13.1 ^{0}C	200	0.02	50	250	250		
6/28/2016	RM 11.5 - PUD Pool Upstream	15.5 ^{0}C	60	0.006	500				
6/28/2016	RM 11.5 - PUD Pool Downstream	15.4 C	80	0.008	250	375			
6/28/2016	RM 10.5 - Bar Flood Fence	15 C	70	0.007			143		
6/28/2016	RM 10.5 - Labish SC small jam	^{0}	90	0.009		2778	2556		
		^{0}							
8/22/2016	RM 12.5 - Z structure pool	18.1 ^{0}C	400	0.04		825	1400		
8/22/2016	RM 12.5 - Groeneveld small jam 1	14.8 ^{0}C	161	0.0161		8075	186		
8/22/2016	RM 12.5 - Big rock pool	14.9 ^{0}C	100	0.01			400		
8/22/2016	RM 12.5 - Twin jam Pool	17.3 ^{0}C	220	0.022		591	1318		45
8/22/2016	RM 11.5 - PUD Pool DS	19 ^{0}C	80	0.008					
8/22/2016	RM 10.5 - Bar Flood Fence	17.8 C	196	0.0196		51	408	51	51
8/22/2016	RM 10.5 - Labish Pool	17.6 C	168	0.0168			714		

Fork length was recorded for each of the salmonid specimens collected. Figure 17 summarizes the average fork length by species, origin, and sample date. Although the June 2016 samples were collected one week apart, the measurements were combined for this summary. Hatchery Chinook were larger than their wild counterparts. The coho and steelhead average fork length increased over the 2 months between sample dates.

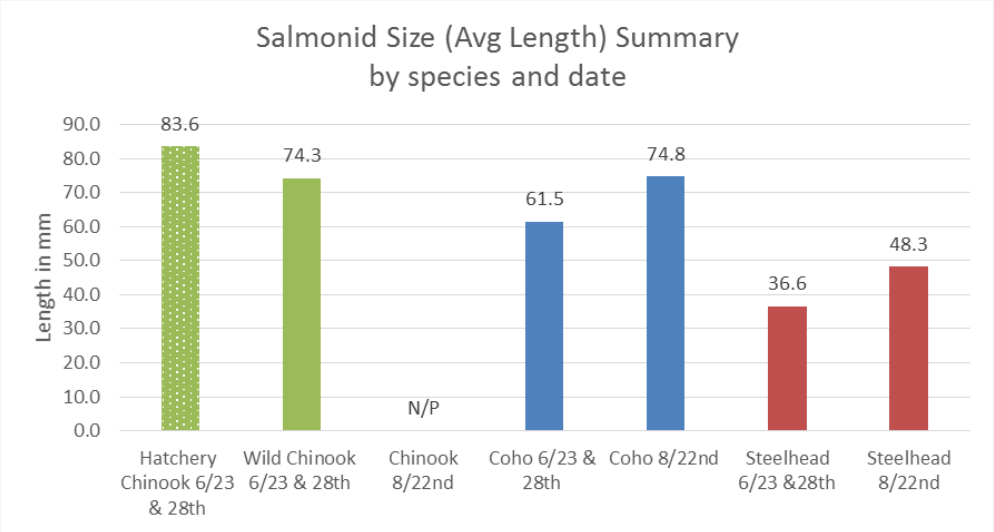

Figure 17. Project target species size summary by date collected.

Fish Sampling Conclusions

The fish sampling effort was minimal and used primarily to identify target fish species in the project areas. Project goals were focused on increasing and enhancing fish habitat in locations used by target species. Effectiveness of each project was further evaluated. The sampling effort was not sufficient to

summarize fish usage; therefore density comparisons to other area studies was not further considered. Sampling earlier in the season and more frequently would be necessary to encounter peak Chinook densities and were likely missed with the current effort. Adult spawning and Redds were observed including chum and pink; which juveniles were not collected. The late sampling efforts likely missed those species juvenile presence. No comparison samples were collected in control reaches to compare densities between treatment to non-treatment sites and mainstem to side channel habitats. Efforts to mark and recapture fish collected originating in the Sultan River were not made.

Juvenile Chinook were present in deeper pool habitat in proximity to placed structures during late June. The presence of hatchery clipped Chinook indicates attraction and entrainment into the side channel and backwater habitat for fish when migrating downstream, seeking off-channel rearing habitat. Growth in coho and steelhead between sample efforts (~ 2 months) may indicate prolonged and preferred habitat use within the project reaches. Juvenile steelhead and coho were present well into the summer and they may overwinter in this habitat as well. No juvenile Chinook were collected in the late August sampling suggesting that potential river type chinook are not generally utilizing the habitat. The positive identification of juvenile salmonid use in the proximity, downstream of the Sultan River confluence indicate the likelihood of benefit to Sultan River fish stocks associated with the project habitat gains.

3.6 Vegetation Monitoring

As installed the floodplain flood fencing is intended to assist establishing a maturing riparian edge. The treatment habitat function along with the inter-planted vegetation is characterized as total area occupied. The footprint of the 5900 lineal feet of flood fencing, other than what was installed within the CREP buffer, is 2 acres. Flood fencing and vertical boles installed within the CREP buffer, at the RM 10.5 bank restoration and forested bar (66 individual boles and 55 boles respectively), serves an important function for protecting the seedling and live stakes from flood damage. The habitat metric of note in that area would be primarily the 7 acres of CREP initiated riparian buffer. The invasive vegetation treatment area varied between 13 and 25 acres over 4 years. That treatment was in preparation for plantings, including 3 acres of side channel bars replanted with willow stakes.

Vegetation monitoring in the two years post-planting included solely plant survival. The floodplain flood fencing, cottonwood vertical boles, have a secondary function of, a chance to establish as a growing tree. The nearby 2006 flood fence installation had a long term (5-10 year) survival rate of ~5%. During the initial summer of 2014, leaf out of the cottonwood boles was near 100%. The second summer, 2015, regeneration of the cottonwood boles was 16%. The regeneration was inconsistent although generally uniform along the greater than 6000 feet of installation. The drought summer of 2015 stunted the growth of the cottonwood boles resulting in a limited five percent survival during the third summer of 2016. The surviving boles were generally located in low elevation historic channels.

Due to the past experienced low survival rate of the cottonwood boles and the likelihood of natural deciduous propagation, the project initiated conifer inter-planting of the floodplain flood fencing area. Total conifers inter-planted in the within the floodplain flood fencing footprint was 372. Due to drought and predation, 26% were severely damaged or died in the first year. Predator netting was installed on vulnerable tree and a watering effort was made. Live stake willow and cottonwood were installed as well as 25 bareroot conifer were replaced.

3.7 Photo Points

Photos were taken at 6 key project locations throughout the project timeline from as-built September 2014 until summer of 2016. Appendix A-8 represents a time series comparison among locations and years to date. The photos are labeled for the date and orientation notes, including landmark orientation arrows. In particular, the time series of photo points depicts the elements of change at each project component. The 5 locations are the RM 10.5 bank rehabilitation, RM 10.5 left bank across from meander bar arrays, RM 10.5 meander bar vertical arrays structures, RM 11.5 floodplain flood fencing, RM 12.5 Z-vertical array structures, and RM 12.5 small jam 1.

4.0 Project Conclusions

The project goal of establishing a long-term riparian restoration foothold was accomplished with the 12 acres of plantings spread over one mile along the riparian zone. Another goal was to enhance fish habitat in the short to medium time frame using direct wood placement and structures that work with natural river processes to encourage an increase in channel complexity and accumulate wood. By building stakeholder partnerships the overall project exceeded the original goals with the conservation purchase of 29 acres of mature forested edge habitat and by utilizing incentive-based restoration, achieved the planting of 7 acres with a 100 foot minimum buffer. The project concentrated restoration efforts on predominantly privately owned side channels enabling treatments to be more aggressive with reduced recreational and overall public use. Monitoring showed increases in useable habitat and enhancement of habitat conditions with the presence of recovery targeted salmonid species.

A multi-benefit approach garnered willing landowners giving access to prioritized restoration areas. The riverside landowners are concerned with increased erosion, avulsion risk and changing hydrology. Often, as was the case with this project, river geomorphic conditions are changing and this promotes partnership programs with landowners. Restoration funded projects have a priority goal of increasing habitat conditions with no negative ecological impacts. Regulatory and funding agencies focus predominantly with guidance that tends toward process-based restoration actions and less with support for enhancement (and less yet for actions that reduce or limit natural process). Increasing habitat conditions and providing stability for a maturing riparian buffer were the priority design considerations for the RM 10.5 bank rehabilitation project. Slowing the bank erosion using ecologically preferred soft armoring techniques that also consider river use and downstream infrastructure was required by

permit agencies. The project was in a challenging outside bend location subjected to a major flood season resulting in a shorter term in which habitat enhancements could materialize. Much of the placed wood was removed by flood forces and the original landowner concerns of erosion are renewed. The bank erosion was slowed at the point of the project despite higher erosion rates observed upstream and downstream in the expanding side channel. The riparian plantings and floodplain flood fencing remain intact.

5.0 Project Management Recommendations

The RCO access agreement with the landowners is 10 years, giving coordinated access to the site until 2024. Long term riparian planting establishment goals may require invasive vegetation control and replacement plantings until the native vegetation exceeds the invasive vegetation maturity height. An additional incentive based planting project has begun in the RM 11.5 project area. Coordination with the project manager is recommended to provide protection for new plantings in the area of lost floodplain flood fencing. Within the RM 10.5 split channel there has been communications with the original project and neighboring landowners. Innovative projects that follow the spirit of multi-benefit actions to garner support for future restoration and enhancement is recommended. An updated assessment and modeling is being accomplished to move projects forward as part of the Lower Skykomish River Reach-Scale Plan (2017).

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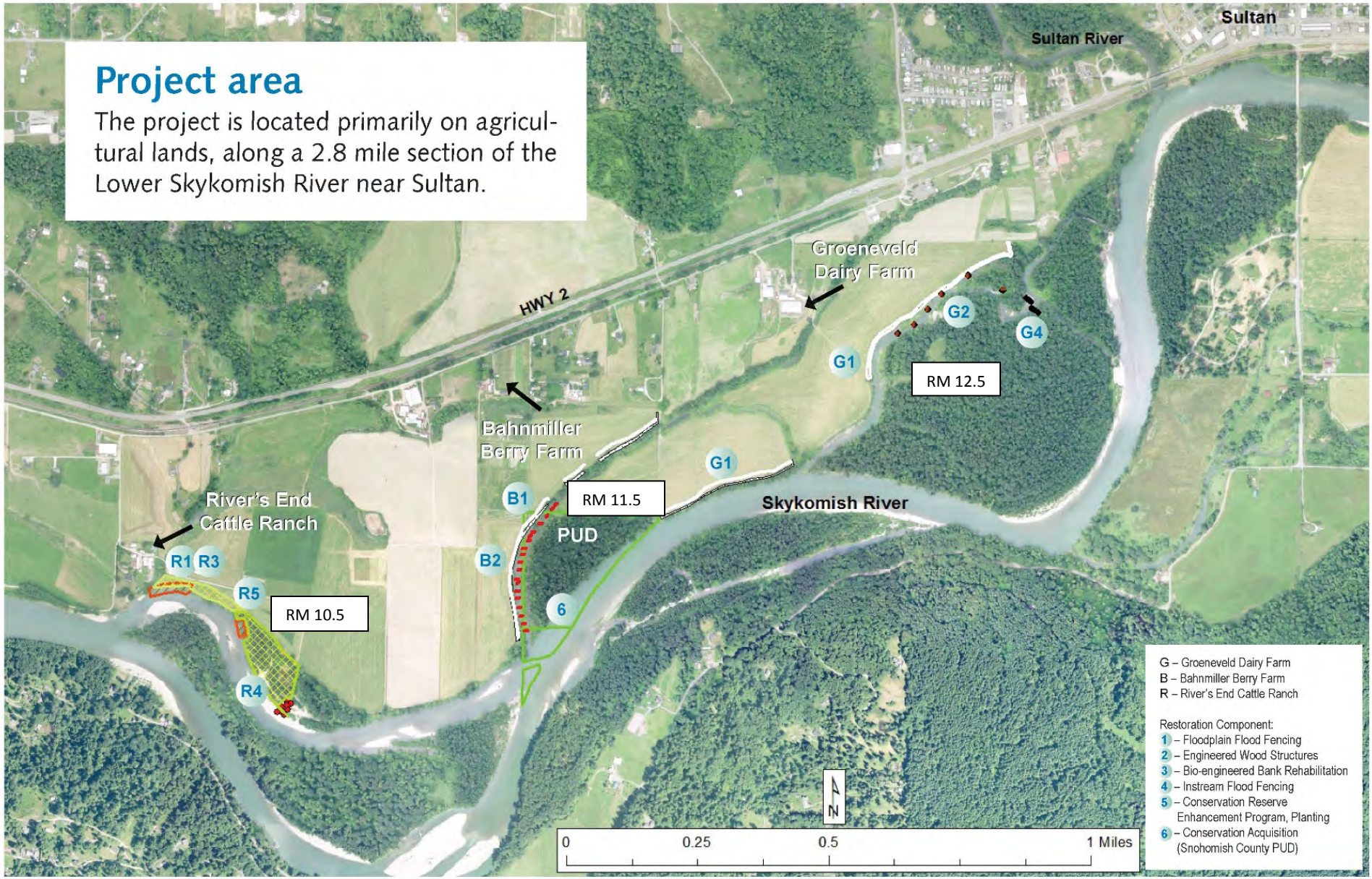

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Technical Memorandum No. 5

Date: December 23, 2014 1958.01

To: Brett Gaddis
Snohomish County Surface Water Management

From: Paul DeVries, Ph.D., P.E.

Subject: As Built Documentation, Lower Skykomish River Riparian and Fish Habitat Restoration Project, Labish, Bahnmiller and Groeneveld Properties

1. BACKGROUND

Snohomish County Surface Water Management (County) contracted with R2 Resource Consultants (R2) to develop engineering designs of off-channel fish habitat and riparian restoration sub-projects at three general side channel locations on the lower Skykomish River that are part of a larger, reach scale river restoration project. The overall project was conceived to address needs identified in the Snohomish Basin Salmon Conservation Plan (SBSRF 2005). The goal is to address key juvenile salmon habitat needs by restoring portions of a denuded riparian zone and increasing side- and off-channel fish habitat complexity through installation of instream wood that will provide habitat cover. The three sub-projects are located between Monroe and Sultan, and the respective actions are distinguished by the name of the affected property owners. The property owners' last names and corresponding sub-projects are, in order from downstream to upstream, Labish, Bahnmiller, and Groeneveld.

Construction activities were initiated and completed in 2014 at all three sites. Snohomish County crews constructed the Groeneveld and Bahnmiller sub-projects, and Wetland Creations, Inc. was contracted by the County to construct the Labish sub-project. The specific elements for each sub-project and their design bases are described in preceding technical memoranda. This memorandum documents the ways in which the final as-built condition of the three projects differs from the design drawings.

2. AS-BUILT DOCUMENTATION BY SUB-PROJECT

As-built documentation consists primarily of accounting for changes in materials and locations of structures relative to the 100% plan sets for each sub-project. County staff surveyed the locations of large wood structures and components after construction was completed, and provided the data to R2. The data were imported into the CAD plan sets, and the as-built

locations and approximate extents of the constructed structures were drawn to show where changes in position and orientation occurred. In addition, documentation was maintained of changes in design and implementation during construction of the Labish project in the form of submittal reviews and the creation of a final construction punch list. As-built plans are presented in Appendix A for each sub-project. Copies of submittal review responses and construction as-built review punch list form are presented in Appendix B. The remainder of this memorandum summarizes the changes and differences.

2.1 Groeneveld Sub-Project

Two in-channel flood fences (Figure 1) and six small modular log jam structures (Figure 2) were completed in Groeneveld Slough, a location where side- channel habitat complexity could potentially be provided for juvenile salmonids consistent with the recovery plan. The locations of the log jam structures and flood fence arrays were determined by myself in consultation with Brett Gaddis and the landowners, and reflect functional changes in bathymetry that occurred since survey data were collected plus access constraints presented by trees and changes in bathymetry. The flood fence arrays were sited where in-water work would be minimized while still providing the proportion of cross-channel coverage intended

The in-channel flood fence design was modified slightly as a result of discussions with the landowners, who wished to incorporate owner-supplied logs. To accommodate them, the logs were laid on the backfilled river bed and lashed with hemp rope to selected flood fence boles. The intent was to ‘re-charge’ the flood fence arrays with large wood. Calculations of buoyancy pullout were performed to determine if the boles needed to be installed deeper than specified. The boles were accordingly installed ~1-2 ft deeper, as overseen by County staff.

A visit to the site in late November 2014 after a relatively large flood indicated that all structures are performing as designed to varying extents, and are persisting. The post-project survey and site visit indicate that structure locations are not exactly at the locations specified in the design, but are nonetheless functioning in their actual locations. The log structures were generally constructed as designed, although there are some variations in their structural configuration that reflect conditions and materials available at the time of construction. Overall, the variations should not adversely affect structure performance.

2.2 Bahnmiller Sub-Project

Twenty-four (24) large boulder-ballasted logs were placed on the bed of an off-channel slough to provide instream habitat cover during summer low flows and refuge habitat during high flows. Placement of the logs reflected bathymetric conditions at the time of construction and

accessibility for crane equipment. The logs were generally placed within the length of channel specified according to the as-built survey data provided by the County.

Figure 1. Composite photograph of the completed in-channel flood fences at the Groeneveld site. Flow direction is toward the photographer.

Figure 2. Photographs of the six completed modular log jam structures at the Groeneveld site. Structures are numbered consecutively moving in downstream direction.

2.3 Labish Sub-Project

There were two sites within this sub-project.

At the upstream site, ten (10) boulder-ballasted logs with rootwads were placed at a location overlapping the downstream portion of the design location, reflecting access constraints posed by trees (the County attempted to minimize cutting of riparian trees). Five (5) flood fence arrays were installed as planned, although their location was upstream of that depicted in the design which reflected a constraint presented by the landowner who wanted to avoid placing the northernmost array in an open grassy area; the array was placed at the upstream side of the area, and the configuration of the accompanying other four arrays was rotated upstream to be consistent with the design goal of forming the flood fences in-line. A visit to the site after the November 2014 flood indicated that all structures and arrays were functioning as intended, where deposition and grain sorting was noted at the flood fences and habitat complexity formation seen at the ballasted logs (Figure 3).

Figure 3. In-channel flood fences and ballasted logs in the upstream site, Labish sub-project.

All project elements specified in the design were constructed at the downstream site where the bank was laid back. However, because of erosion subsequent to surveying for the design, the actual locations of placed edge complexity logs and floodplain flood fence were shorewards of the design location. The boulder ballasted logs were accordingly also placed shoreward of their planned location. Nonetheless, all logs were placed according to the numbers specified. The flood fence boles were installed over the general length of bank required. Figure 4 depicts the constructed site with ballasted logs, edge complexity logs, flood fence, and geotextile fabric in place.

Figure 4. Constructed laid back bank and log elements at the downstream site, Labish Sub-Project.

There was only one aspect of the design that did not appear to be followed rigorously, which was noted in the punchlist (Appendix B), and concerned the spacing of stakes holding down the geotextile fabric. The maximum 4 ft spacing was not strictly adhered to. Some stakes were added in response to the punchlist, but more could have been added to increase stability of the fabric until vegetation becomes established. However, considerable deposition of sand was seen over the fabric during a visit after the November 2014 flood, thus this feature may not be a problem as vegetation takes root.

There were several modifications made to the design based on conditions and constraints encountered during construction. The contractor and County requested changes to the design that made the project more constructible. I reviewed those requests and made approved changes to the design accordingly. In summary, the changes were:

1. The diameter of manila rope was increased from ¾" to 1 ¼" to allow the contractor to suspend the boulders form the logs during installation. This increased the rope strength and life and was approved.

2. The contractor suggested looping the rope through one of the pairs of eyebolts in each boulder to allow both ropes to self-equilibrate. This was also approved and represented an improvement in the design.

3. The contractor requested reducing the portion of the log circumference to be grooved to save time. This was approved.

4. At my direction, the vertical boles associated with the edge complexity logs were installed away from vertical to help pin down the logs, and manila rope was used to tie down the logs at both sets of boles, to increase resistance against buoyancy pullout. These changes reflected a concern I had that the amount of soil above the logs providing ballast weight to counter buoyancy of the logs was less than anticipated in the design.

APPENDIX A

As-Built Drawings

SKYKOMISH RIVER GROENEVELD RM 12.5

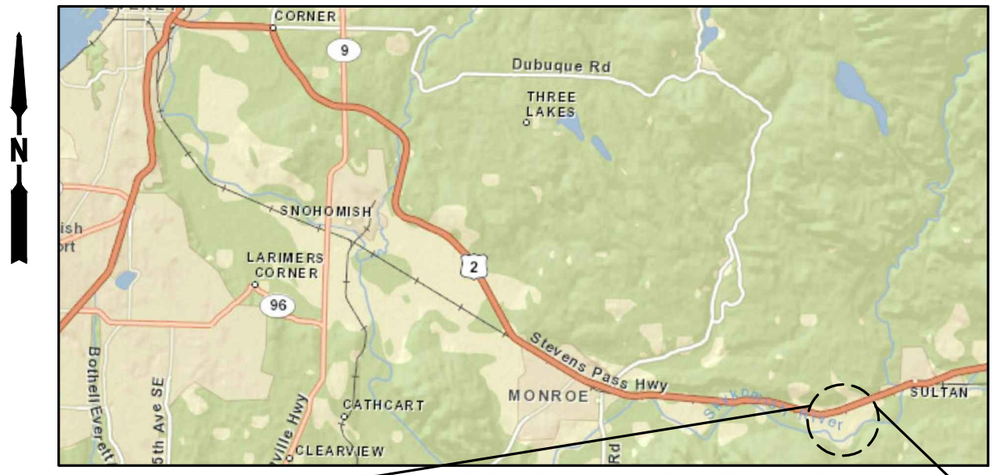
INSTREAM HABITAT RESTORATION PROJECT - AS-BUILT

SNOHOMISH COUNTY DEPT OF PUBLIC WORKS - WATER SURFACE MGMT

UPI # 12-0089-1

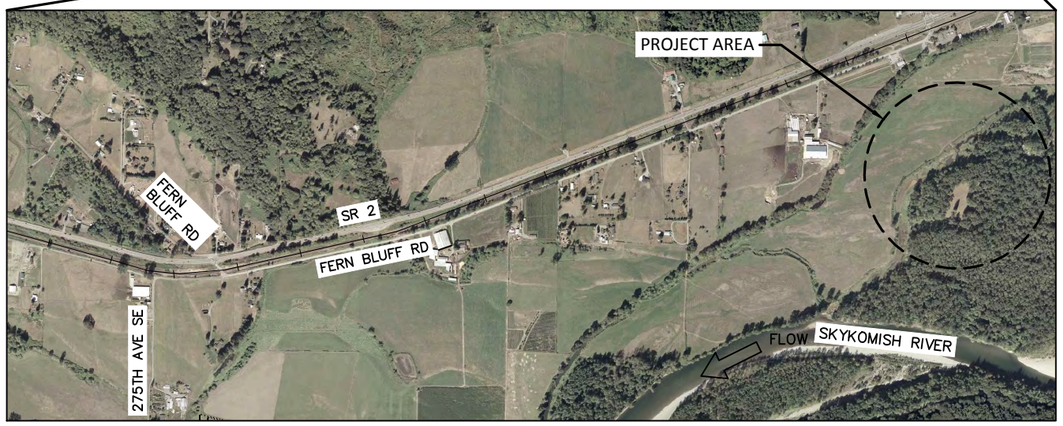
RR# 49244 FUNDING: SRFB 10-1338 RST

AS–BUILT



REGIONAL VICINITY MAP

N.T.S.



VICINITY & SURVEY CONTROL POINT MAP

N.T.S.

AS–BUILT SHEET INDEX

SHEET NAME	SHEET #
COVER SHEET, SHEET INDEX, LOCATION MAP	1
PLAN VIEW LAYOUT – SITE	2
LOG JAM LAYOUTS	3
PLAN VIEW – FLOOD FENCING	4

PAUL EDWARD DEVRIES
STATE OF WASHINGTON
37881
REGISTERED
PROFESSIONAL ENGINEER

Snohomish County Officials

DIRECTOR OF PUBLIC WORKS
STEVEN E. THOMSEN, P.E.

COUNTY ENGINEER
OWEN B. CARTER, P.E.

EXECUTIVE
JOHN LOVICK

COUNCIL MEMBERS
JOHN KOSTER – DIST. 1
BRIAN SULLIVAN – DIST. 2
STEPHANIE WRIGHT – DIST. 3
DAVE GOSSETT – DIST. 4
DAVE SOMERS – DIST. 5

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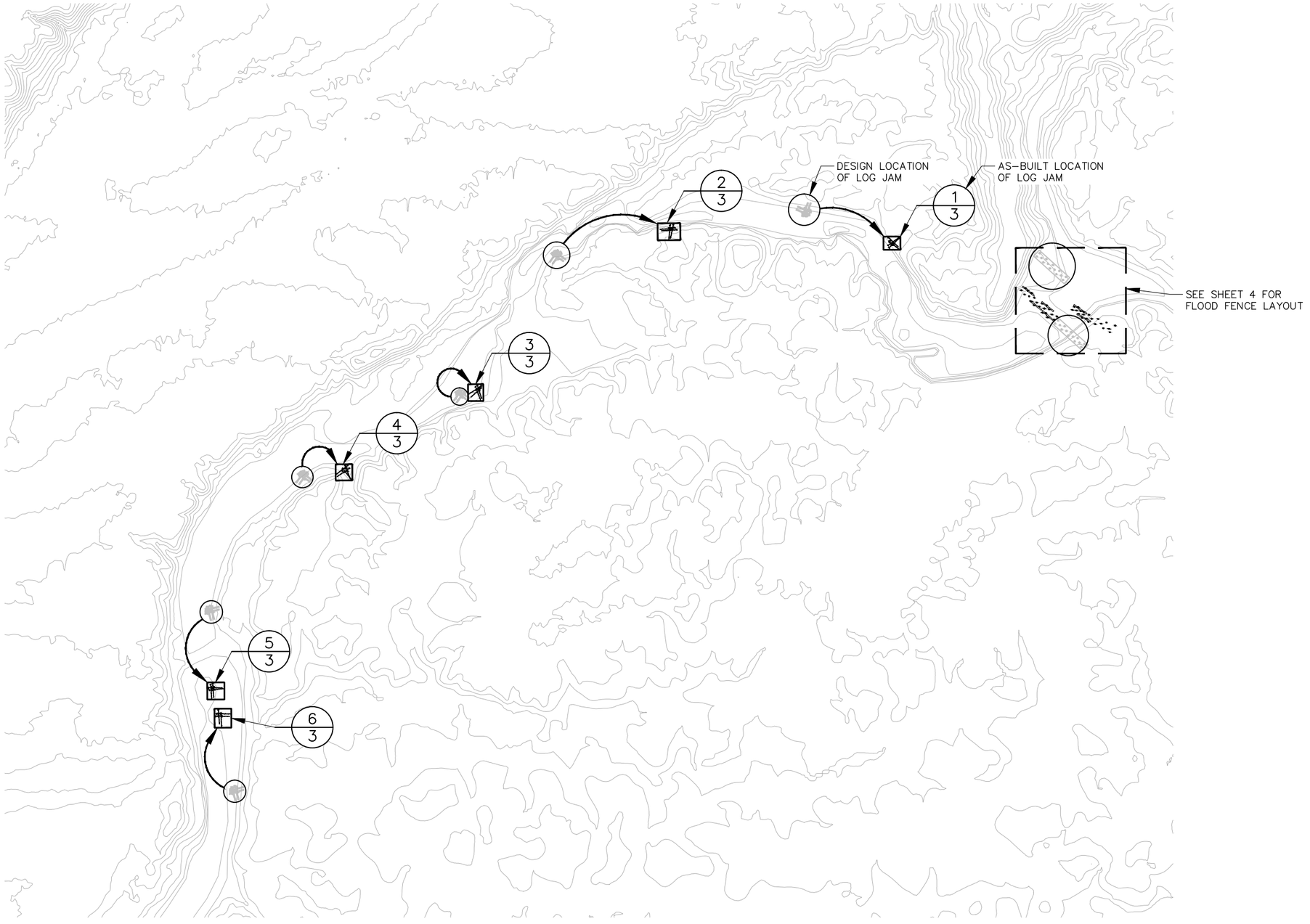

AS-BUILT

PLAN CHECK	BY	DATE					
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REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

DESIGNED BY: PDV | DRAWN BY: PWH

FIELD BOOK(S): | UPI# 12-0089-1

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APPROVED FOR CONSTRUCTION

OWEN B. CARTER, P.E.
SNOHOMISH COUNTY ENGINEER

DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR49244

SKYKOMISH R. GROENEVELD
INSTREAM HABITAT RESTORATION
PLAN VIEW LAYOUT
SITE

REFERENCE SHEET NO.

SHEET 2 OF 4 SHEETS

SECTION 6, T.27N., R.8E, W.M.

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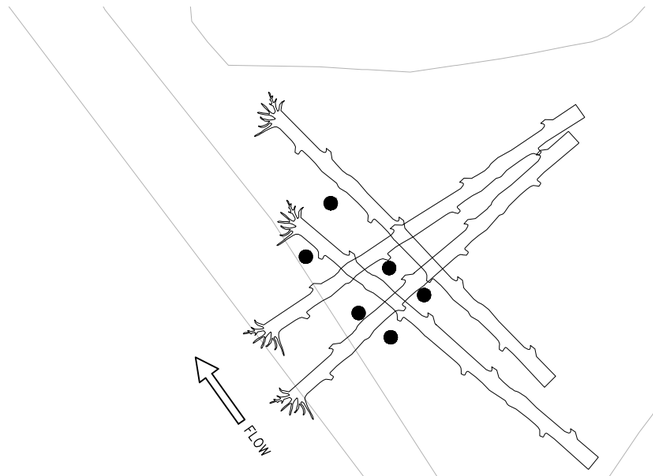

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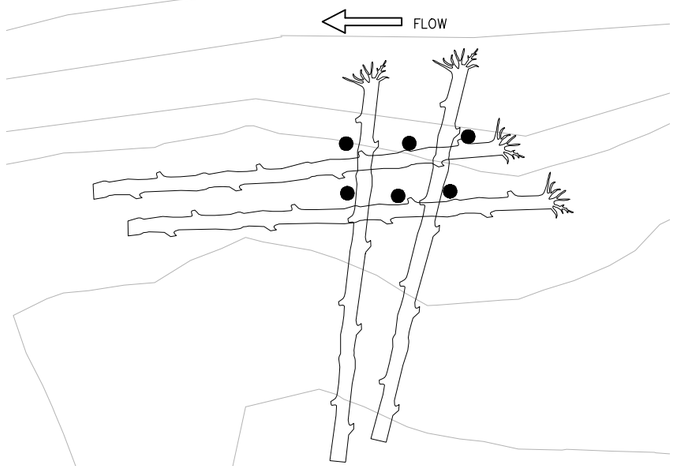

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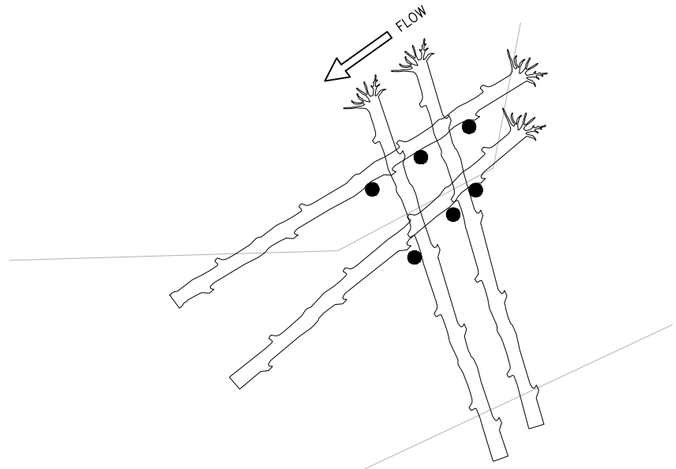

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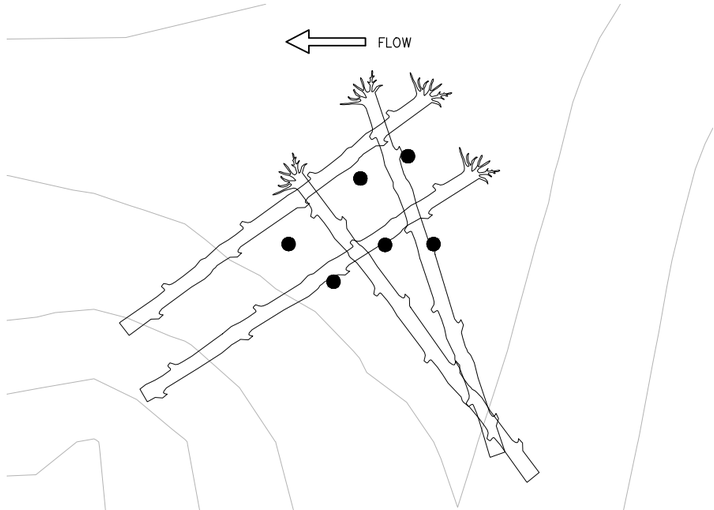

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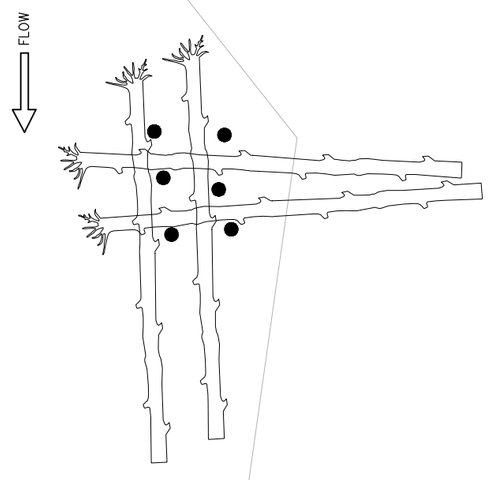

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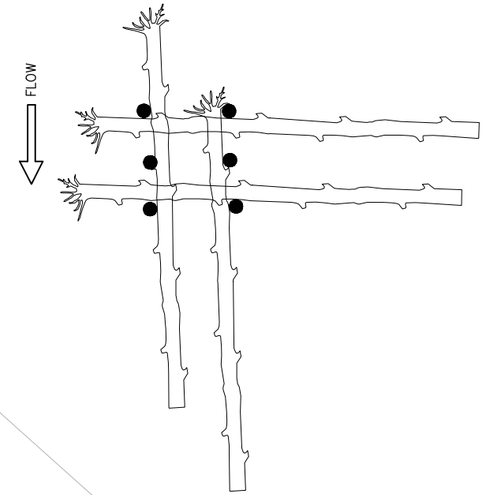

LOG JAM 6/4
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10 0 5 10
SCALE: 1"=10'

AS-BUILT

PLAN CHECK	BY	DATE					
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Last Saved By: phil Dec 29, 2014 – 12:41pm

REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

DESIGNED BY: PDV | DRAWN BY: PWH

FIELD BOOK(S): | UPI# 12-0089-1

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DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR49244

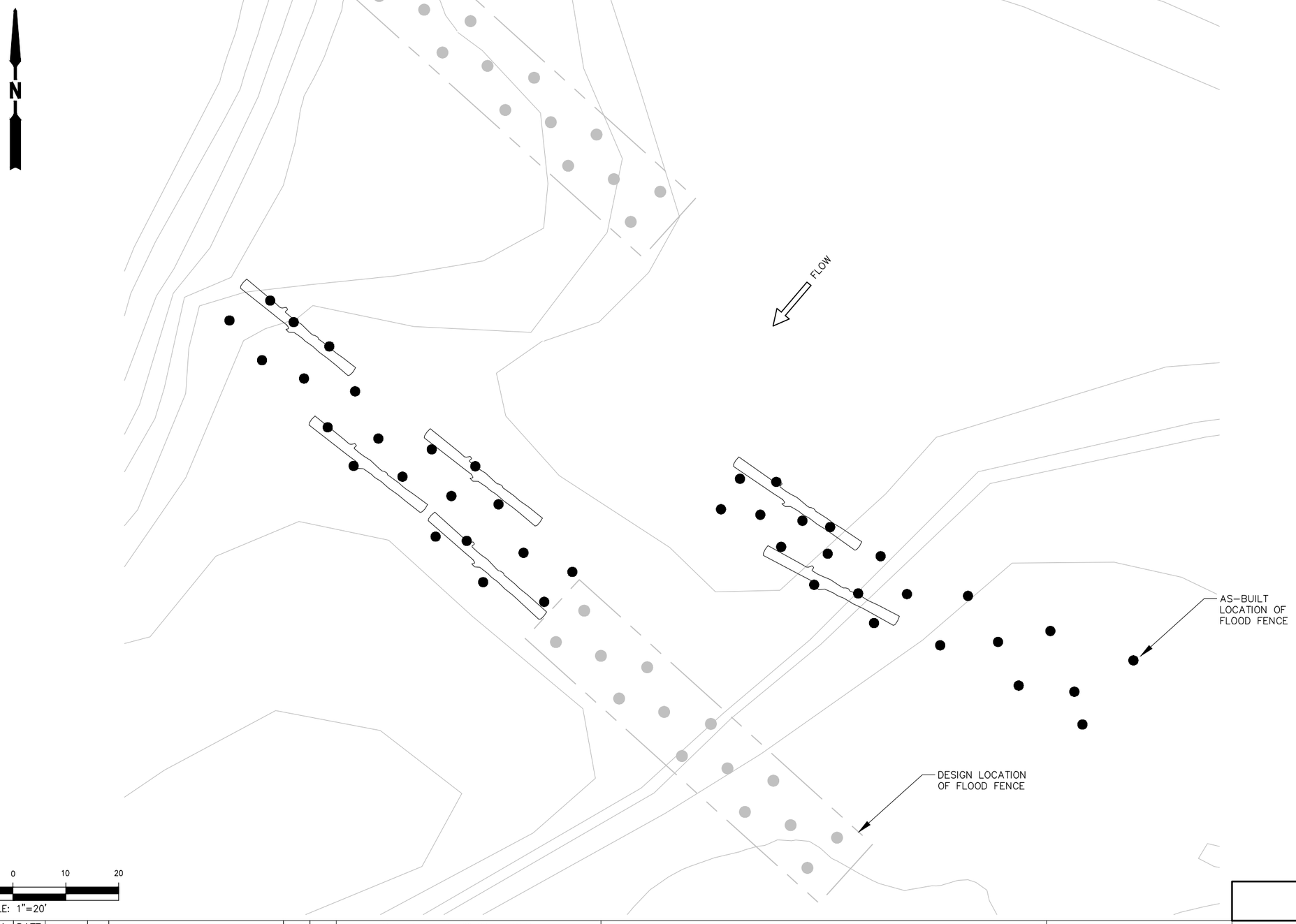
SKYKOMISH R. GROENEVELD
INSTREAM HABITAT RESTORATION

LOG JAM LAYOUTS

REFERENCE SHEET NO.

SHEET 3 OF 4 SHEETS

SECTION 6, T.27N., R.8E, W.M.



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REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

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REDMOND, WA 98052
PHONE: (425) 556–1288

PAUL EDWARD DEVRIES — STATE OF WASHINGTON — 37861 — REGISTERED PROFESSIONAL ENGINEER

APPROVED FOR CONSTRUCTION

OWEN B. CARTER, P.E.
SNOHOMISH COUNTY ENGINEER

DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR49244

AS–BUILT

SKYKOMISH R. GROENEVELD INSTREAM HABITAT RESTORATION

PLAN VIEW LAYOUT FLOOD FENCING

REFERENCE SHEET NO.

SHEET 4 OF 4 SHEETS

SKYKOMISH RIVER BAHNMILLER RM 11.3

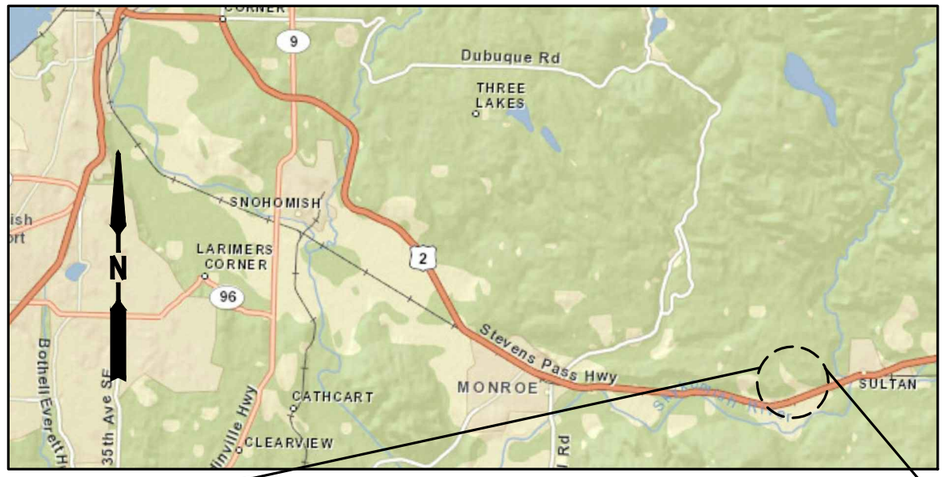
INSTREAM HABITAT RESTORATION PROJECT - AS-BUILT

SNOHOMISH COUNTY DEPT OF PUBLIC WORKS - SURFACE WATER MGMT

UPI # 12-0088-1

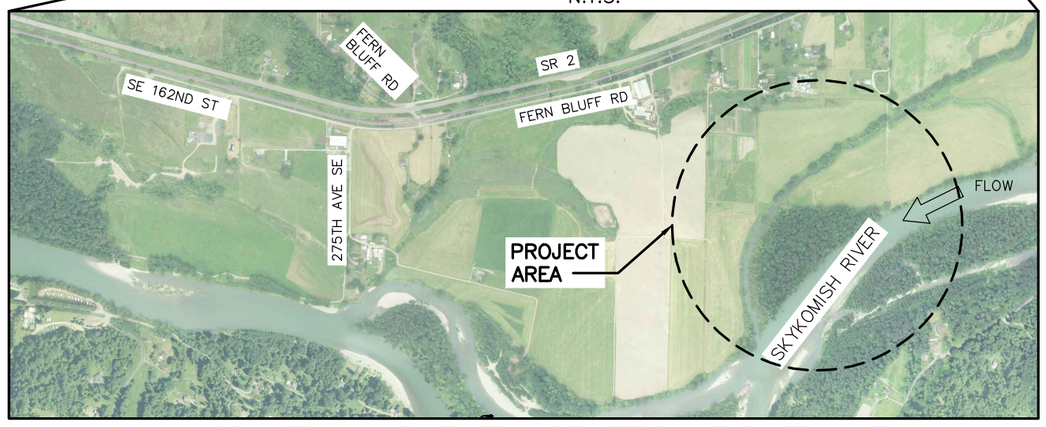
RR# 49243 FUNDING: SRFB 10-1338 RST

AS-BUILT



REGIONAL VICINITY MAP

N.T.S.



VICINITY & SURVEY CONTROL POINT MAP

N.T.S.

AS-BUILT SHEET INDEX

SHEET NAME	SHEET #
COVER SHEET, SHEET INDEX, LOCATION MAP	1
PLAN VIEW LAYOUT	2

PAUL EDWARD DENTRES — STATE OF WASHINGTON — 37861 — REGISTERED PROFESSIONAL ENGINEER

Snohomish County Officials

DIRECTOR OF PUBLIC WORKS
STEVEN E. THOMSEN, P.E.

COUNTY ENGINEER
OWEN B. CARTER, P.E.

EXECUTIVE
JOHN LOVICK

COUNCIL MEMBERS
JOHN KOSTER – DIST. 1
BRIAN SULLIVAN – DIST. 2
STEPHANIE WRIGHT – DIST. 3
DAVE GOSSETT – DIST. 4
DAVE SOMERS – DIST. 5

Last Saved By: phil Dec 29, 2014 – 10:11am

SECTIONS 10/12, T.27N., R.7E, W.M.

AS-BUILT

PLAN CHECK	BY	DATE					
			DATE	NO.	REVISION		BY

Last Saved By: phil Dec 29, 2014 - 10:11am

REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

DESIGNED BY: PDV | DRAWN BY: PWH

FIELD BOOK(S): | UPI# 12-0088-1

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

PAUL EDWARD DEFRIES — STATE OF WASHINGTON — 37861 — REGISTERED PROFESSIONAL ENGINEER

APPROVED FOR CONSTRUCTION

OWEN B. CARTER, P.E.
SNOHOMISH COUNTY ENGINEER

DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR49243

SKYKOMISH R. BAHNMILLER INSTREAM HABITAT RESTORATION

PLAN VIEW LAYOUT

REFERENCE SHEET NO.

SHEET 2 OF 2 SHEETS

SKYKOMISH RIVER RM 10.1

FISH AND RIPARIAN HABITAT RESTORATION - AS-BUILT

SNOHOMISH COUNTY DEPT OF PUBLIC WORKS - SURFACE WATER MGMT

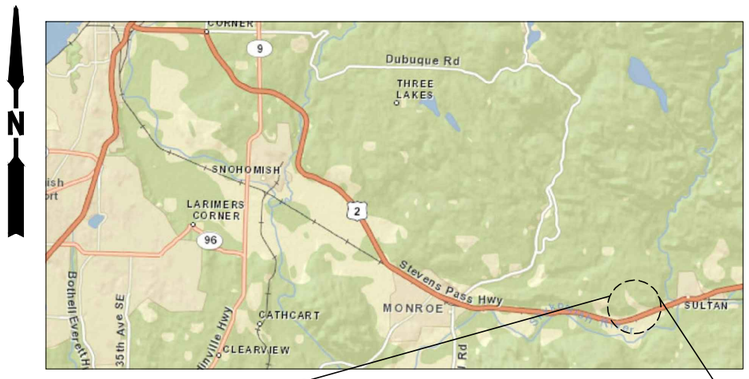
UPI # 12-0087-1

RR# 49245 FUNDING: SRFB 10-1338 RST

AS-BUILT

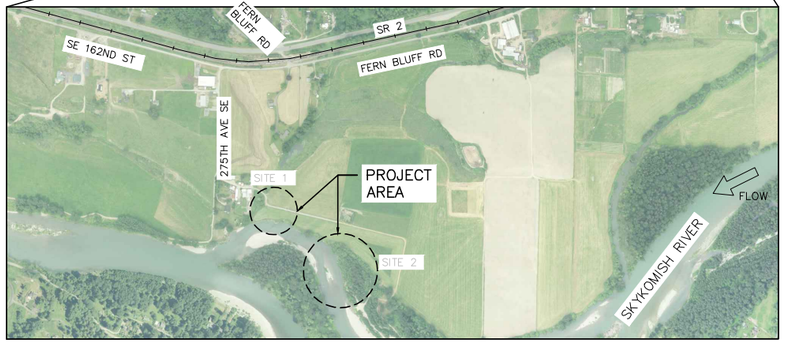
AS-BUILT SHEET INDEX

SHEET NAME	SHEET #
COVER SHEET, SHEET INDEX, LOCATION MAP	1
PLAN VIEW LAYOUT – SITE 1	2
PLAN VIEW LAYOUT – SITE 2	3



REGIONAL VICINITY MAP

N.T.S.



VICINITY & SURVEY CONTROL POINT MAP

N.T.S.

PAUL EDWARD DEVRIES
STATE OF WASHINGTON
37861
REGISTERED
PROFESSIONAL ENGINEER

Snohomish County Officials

DIRECTOR OF PUBLIC WORKS
STEVEN E. THOMSEN, P.E.

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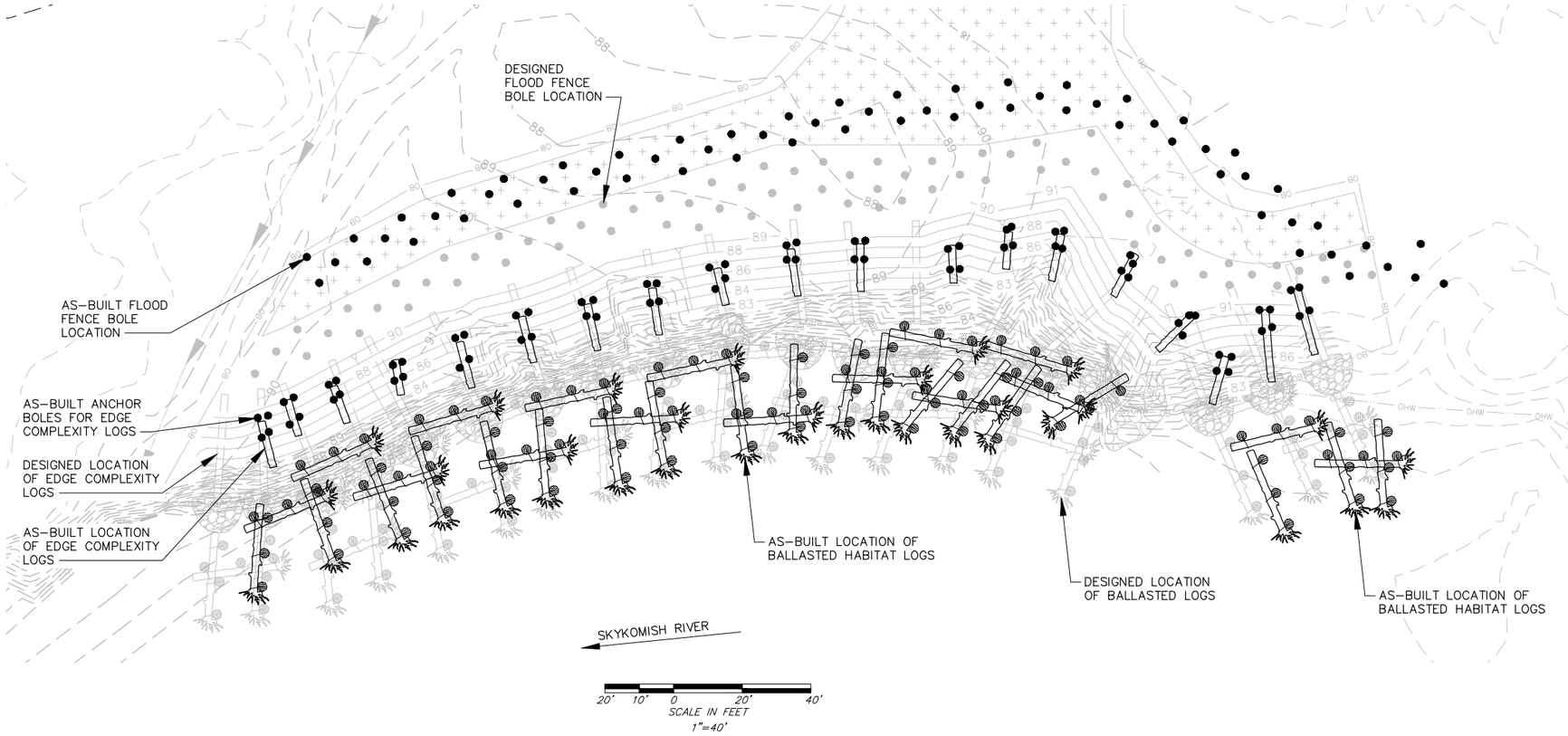
DAVE SOMERS – DIST. 5

Last Saved By: phil Dec 29, 2014 – 1:02pm

SECTION 12, T.27N., R.7E, W.M.

N



AS-BUILT

PLAN CHECK	BY	DATE					
			DATE	NO.	REVISION	BY	

Last Saved By: phil Dec 29, 2014 - 1:02pm

REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

DESIGNED BY: PDV | DRAWN BY: PWH

FIELD BOOK(S): | UPI# 12-0087-1

Resource Consultants, Inc.
REDMOND, WA 98052
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PAUL EDWARD DEVRIES — STATE OF WASHINGTON — 37861 — REGISTERED PROFESSIONAL ENGINEER

APPROVED FOR CONSTRUCTION

OWEN B. CARTER, P.E.
SNOHOMISH COUNTY ENGINEER

DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR 49245

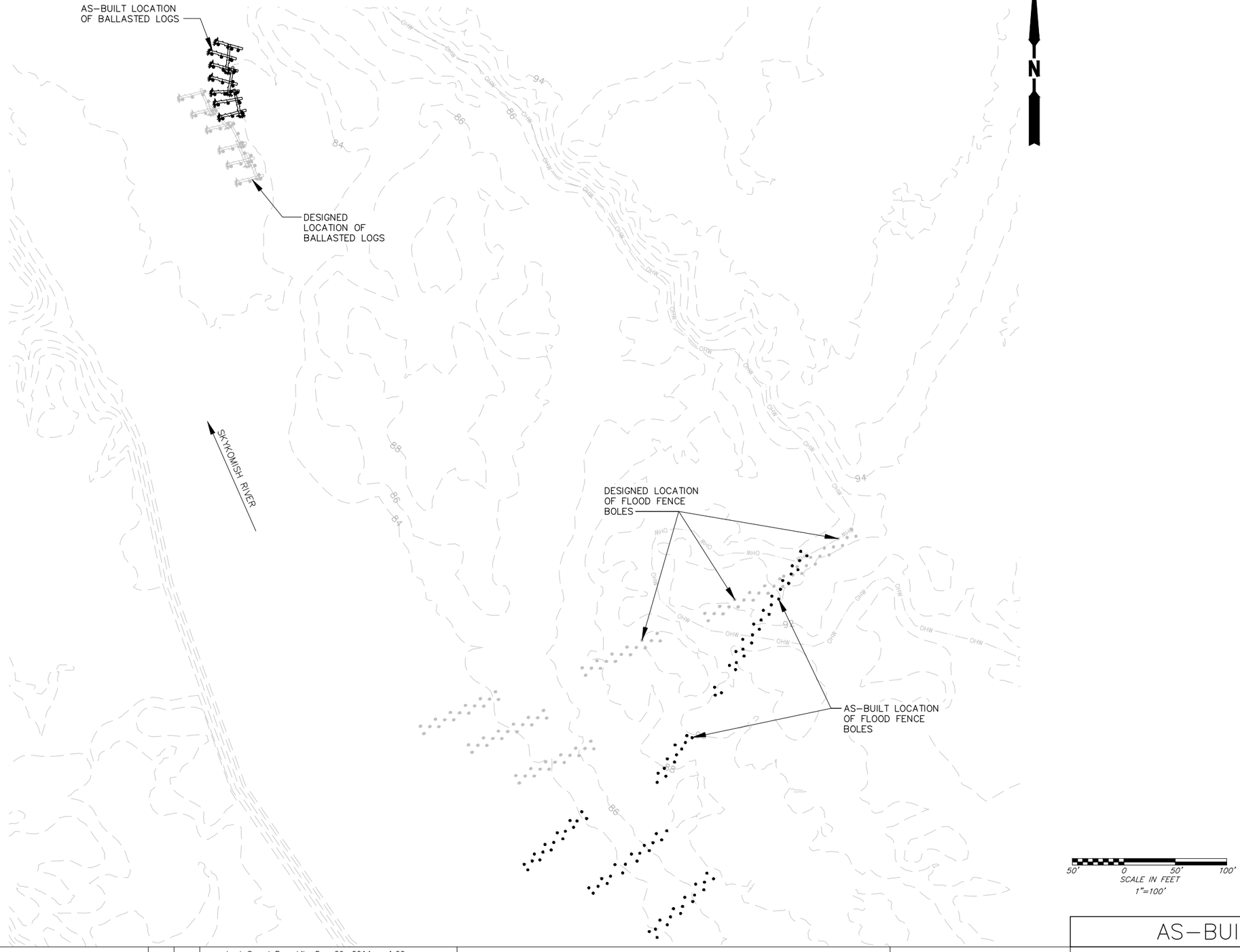
SKYKOMISH R. LABISH HABITAT RESTORATION PROJECT

PLAN VIEW LAYOUT SITE 1

REFERENCE SHEET NO.

SHEET 2 OF 3 SHEETS

SECTION 12, T.27N., R.7E, W.M.



PLAN CHECK	BY	DATE					
			DATE	NO.	REVISION	BY	

Last Saved By: phil Dec 29, 2014 – 1:02pm

REGION NO.	STATE	FED. AID PROJ. NO.	SURVEY NO.
10	WASH.		

DESIGNED BY: PDV | DRAWN BY: PWH

FIELD BOOK(S): | UPI# 12-0087-1

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PAUL EDWARD DEVRIES — STATE OF WASHINGTON — 37861 — REGISTERED PROFESSIONAL ENGINEER

APPROVED FOR CONSTRUCTION

OWEN B. CARTER, P.E.
SNOHOMISH COUNTY ENGINEER

DATE APPROVED:

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR 49245

AS-BUILT

SKYKOMISH R. LABISH HABITAT RESTORATION PROJECT

PLAN VIEW LAYOUT SITE 2

REFERENCE SHEET NO.

SHEET 3 OF 3 SHEETS

APPENDIX B

Copies of Submittal Review Forms and Final Punch List Form Completed by R2 During Course of Construction

Submittal Review

R2 Resource Consultants, Inc.

15250 NE 95th Street (W) 425-556-1288
Redmond WA 98052 (F) 425-556-1290

Date 8/14/2014

To: Snohomish County Public Works Dept.	Project Owner Snohomish County
Attention:	Project Name: Lower Sky RM 10.1 Restoration
Reference: Date Bid Item Number Rev No.	Job No. 1958.02
Item of Equipment or Material	Section

Subject submittal has been reviewed and review action is as shown below:

Submittal No.	Subject	No. of Copies	No Exception Taken	Make Corrections Noted	Amend and Resubmit	Rejected Resubmit
1	Modification of Boulder attachment material & method: 1. Use 1 ¼" manila rope instead of ¾" to allow movement of log+boulders assembly as a unit 2. Thread rope through eyebolts and tie off on log side w/ carrick bend knot to allow for easier manipulation of boulders 3. Replace full circumferential groove for rope with partial groove on ¼ of log.			X		

Remarks:

1) Use of 1 ¼" rope is acceptable and represents an improvement. Note that if ¾" rope is used as primary line, a galvanized ¾" thimble should be used to attach rope to eyebolt, with the rope lashed to the thimble (e.g., w/ baling wire) at a minimum of four points on the thimble, two per side of eyebolt. Some boulders are excessively large, the ¾" rope should be tied on as an additional fastening to the bolts and around the log, in addition to the 1 ¼" rope.
2) One of the two ropes per boulder can be threaded as requested, but the eye bolt opening should be facing the direction of the rope to allow unrestricted sliding through the eye; The other ropes should remain tied as in the plan set. Noted in field that contractor was placing the bolts too close together, informed contractor representative of such and correction action was promised on all subsequent bolts.
3) One quarter groove is acceptable with requirement that rope does not wrap across a cut edge.

Corrections or comments made relative to submittals during this review do not relieve the contractor from compliance with the requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all qualities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades, and performing his work in a safe and satisfactory manner.

Very truly yours,

Paul DeVries, P.E.

Submittal Review

R2 Resource Consultants, Inc.

15250 NE 95th Street (W) 425-556-1288
Redmond WA 98052 (F) 425-556-1290

Date 10/6/2014

To: Snohomish County Public Works Dept.	Project Owner Snohomish County
Attention:	Project Name: Lower Sky RM 10.1 Restoration
Reference: Date Bid Item Number Rev No.	Job No. 1958.02
Item of Equipment or Material	Section

Subject submittal has been reviewed and review action is as shown below:

Submittal No.	Subject	No. of Copies	No Exception Taken	Make Corrections Noted	Amend and Resubmit	Rejected Resubmit
2	Direction by Engineer of Record to modify vertical bole construction approach at edge complexity logs			X		

Remarks:

1) Detail 2, Sheet 7 of the Bid design plan set shows manila rope tied to river-side vertical boles only. The purpose of the boles tie-off is to provide additional resistance against buoyancy pull-out of embedded edge complexity logs during extreme flood levels. Based on visual inspection of field conditions of soil composition and cover thickness over embedded portions of edge complexity logs, plus shallower than anticipated backfill to match graded bank slope, and reported depth to gravel during augering of holes for vertical boles, it was accordingly recommended by me that the contractor should attempt to install the landward side boles in sloped alignment to provide a wedge above the logs to help keep them down should they break loose through the soil cover. Where this is not possible, the landward pair of boles should be tied with manila rope in a manner similar to the river-side boles as shown on Detail 2, Sheet 7 of the plan set.

Corrections or comments made relative to submittals during this review do not relieve the contractor from compliance with the requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all qualities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades, and performing his work in a safe and satisfactory manner.

Very truly yours,

Paul DeVries, P.E.

Construction As-Built Review

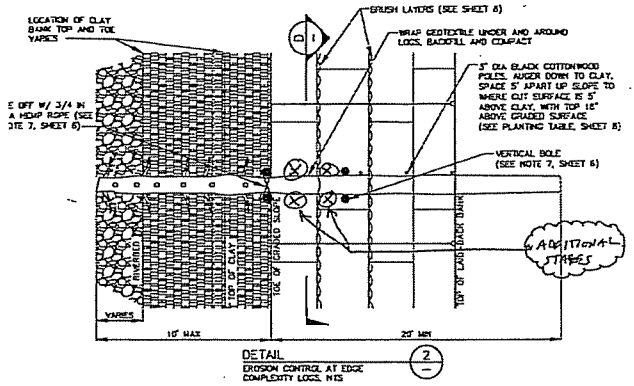
R2 Resource Consultants, Inc.

15250 NE 95th Street (W) 425-556-1288
Redmond WA 98052 (F) 425-556-1290

Date 10/13/2014

To: Snohomish County Public Works Dept.	Project Owner Snohomish County
Attention: Andy Lentz, Brett Gaddis	Project Name: Lower Sky RM 10.1 Restoration
Date of Site Visit: 10/10/2014	R2 Job No: 1958.02

The contractor's construction products have been reviewed and remaining corrections/completion items are noted below:

Item No.	Issue/Action Required
1	The spacing of stakes to hold down the geotextile fabric does not meet specification, and the manner of stake placement allows for billowing of the center of the fabric. Place more stakes to reduce the maximum spacing to 4' or less. In general, stakes should be placed in the center of each square defined by existing stakes, along the approximate centerline of the fabric in the roll-out direction.
2	The geotextile fabric was cut where it crosses the exposed middle portion of the edge complexity logs., and is loose at many locations where scour could occur next to the logs. Place at least four stakes to better tie down loose fabric that was cut at the edge complexity logs, two per side, and at least two per horizontal roll, per following schematic: 
3	There are a few vertical bole holes at the edge complexity logs that need to be back-filled flush with the excavated surface.
4	Live stakes and container plantings will be installed in late October/early November according to contractor.

Remarks:

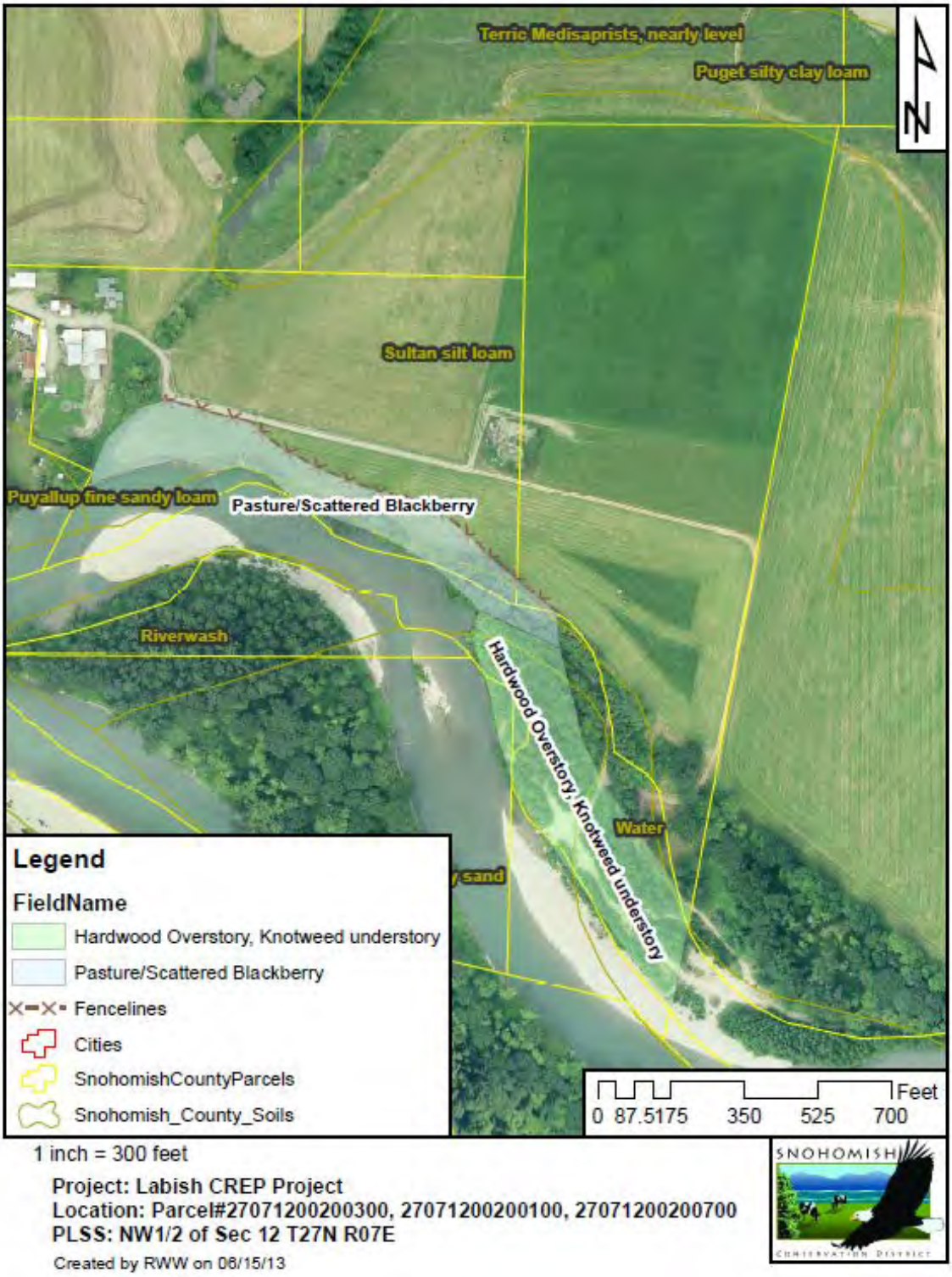
1) No other exceptions taken.

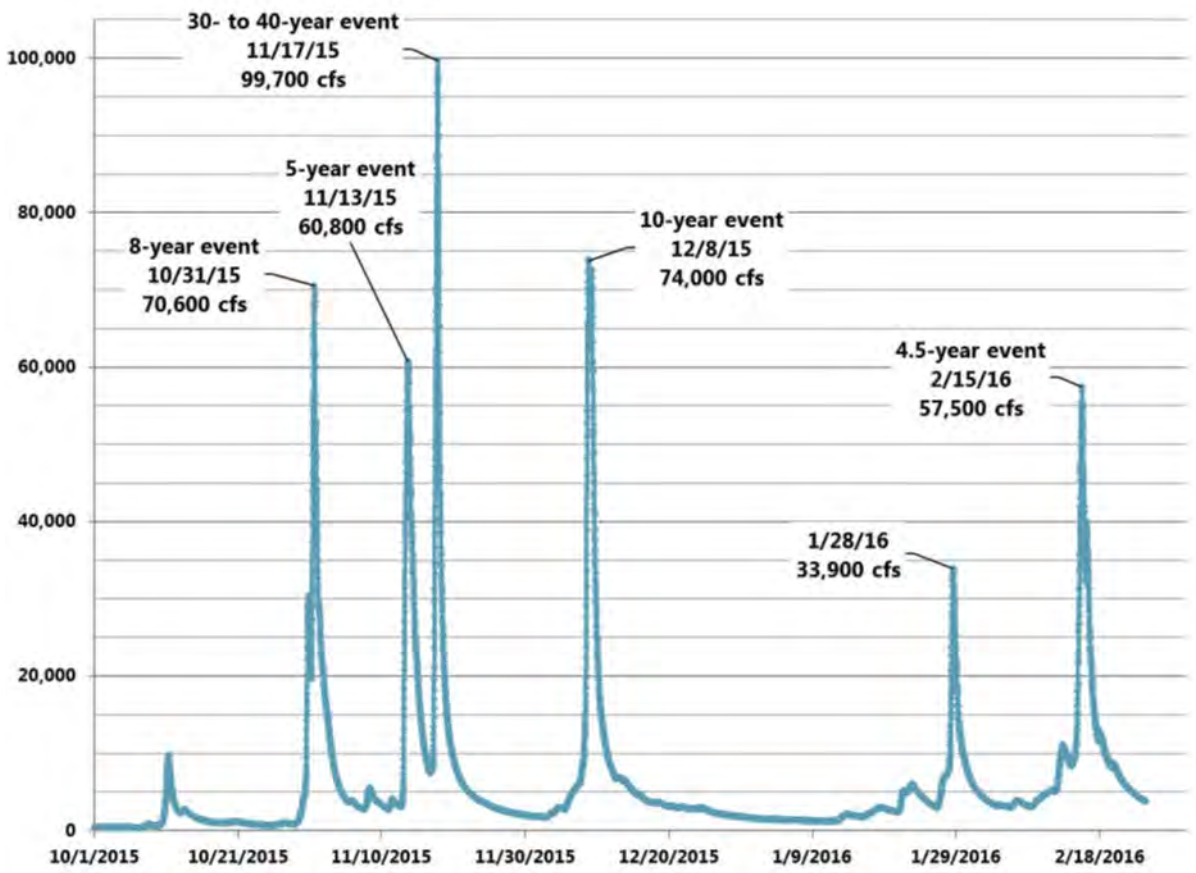
Corrections or comments made during this review are to ensure that the design is adhered to as faithfully as possible, where the contractor is notified of actions required to be in compliance with the requirements of the drawings and specifications. The contractor is responsible for confirming and correlating all qualities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades, and performing his work in a safe and satisfactory manner.

Very truly yours,

Paul DeVries, P.E.

Appendix A-3


Terric Medisaprists, nearly level
Puget silty clay loam
Sultan silt loam
Puyallup fine sandy loam
Pasture/Scattered Blackberry
Riverwash
Hardwood Overstory, Knotweed understory
Water
Legend
FieldName
Hardwood Overstory, Knotweed understory
Pasture/Scattered Blackberry
Fencelines
Cities
SnohomishCountyParcels
Snohomish_County_Soils
0 87.5175 350 525 700
Feet
1 inch = 300 feet
Project: Labish CREP Project
Location: Parcel#27071200200300, 27071200200100, 27071200200700
PLSS: NW1/2 of Sec 12 T27N R07E
Created by RWW on 06/15/13
SNOHOMISH



Hydrograph of Skykomish River at Gold Bar (USGS Gage 12134500). Flood detail for 2015-2016 flood season.

Appendix A-5

Habitat Summary Metric Tables

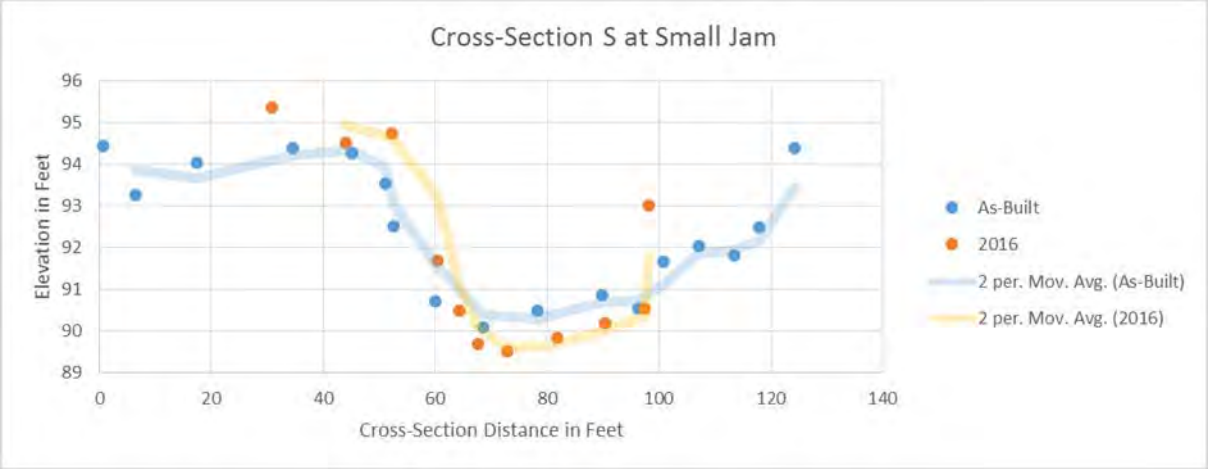
Project Site	BFW	Length, survey	Pool count (>1m)	Pool Freq/km	Pool area %	Riffle area %	Glide area %	Placed LWD (Small)	Placed LWD freq (all) /km	Nat LWD (tally)	All LWD pieces LWD/w tally	WD freq (LWD >30cm-7.5m or RW)	All Jam count Nat (+placed)	Jam Freq all/km (placed)	Bank Instability (outer only)	Bank Mod / Project Bank
RM 10.5 SC **2004**	79	1440	10	7	44.8%	38.8%	16.5%	NA	NA	44	44 (no tally)	30.6	3	2.1	2.8%	32.7%
RM 10.5 SC **2015**	97	1620	25 (19)	15.4 (11.7)	56.3%	21.3%	22.4%	38 (166)	23.5 (126)	148 (276)	623	114.8	6 (10)	6.1 (2.5)	23.3%	19.8% / 6.7%

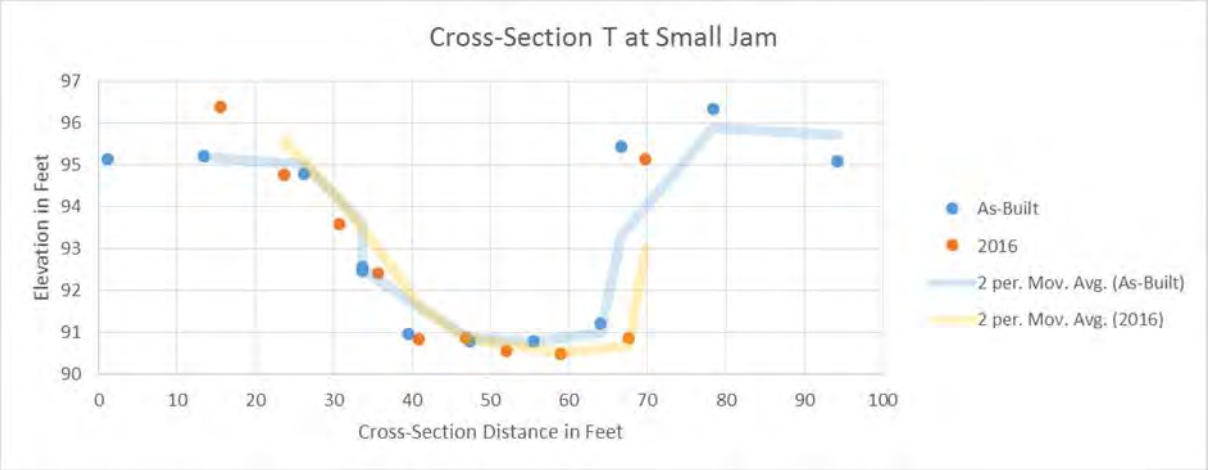
Project Site	BFW	Length, survey	Pool count (>1m)	Pool Freq/km	Pool area %	Riffle area %	Glide area %	Placed LWD	Placed LWD freq /km	Nat LWD (tally)	All LWD pieces LWD/w tally	WD freq /km (LWD >30cm-7.5m or RW)	All Jam count Nat (+placed)	Jam Freq /km (all)	Bank Instability (outter only)	Bank Mod / Project Bank
RM 11.5 SC **2015**	28	500	2	4	100.0%	0.0%	0.0%	25	50	32 (2)	59	114.8	0	0	25.0%	0.0%

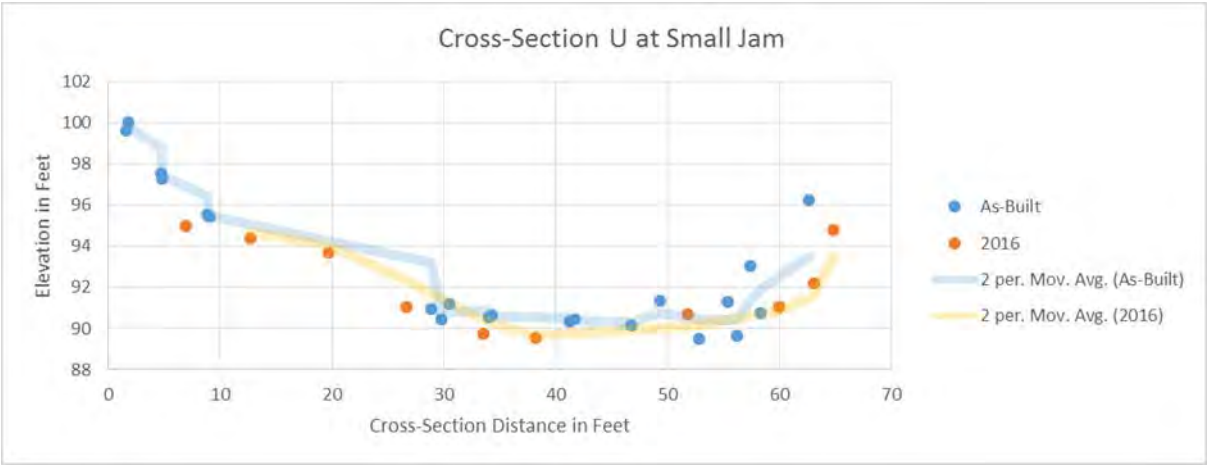
Project Site	BFW	Length, survey	Pool count	Pool Freq/km	Pool area %	Riffle area %	Glide area %	Placed LWD (jam count)	Placed LWD (jam) freq	Nat LWD >30D 7.5L / tally	All LWD pieces LWD&tally	WD freq (LWD >30cm-7.5m or RW)	All Jam count Nat (+placed)	Jam Freq (all)	Bank Instability	Bank Mod
RM 12.5 SC upper **2005**	14.6	799	12	15	68.2%	3.1%	28.7%	(2006 - 25est. (1)	31 (1.25)	21/55 = 76	76	95/km (26.3/km)	2	2.5/km	NA	NA
RM 12.5 SC upper **2015**	25.1	805	18	22	74.5%	0.6%	24.9%	110 (6)	136/km (7.5/km)	93/313 = 406	486	604/km (115.3/km)	7 (10)	8.7/km (12.4/km)	16.6%	6.8%

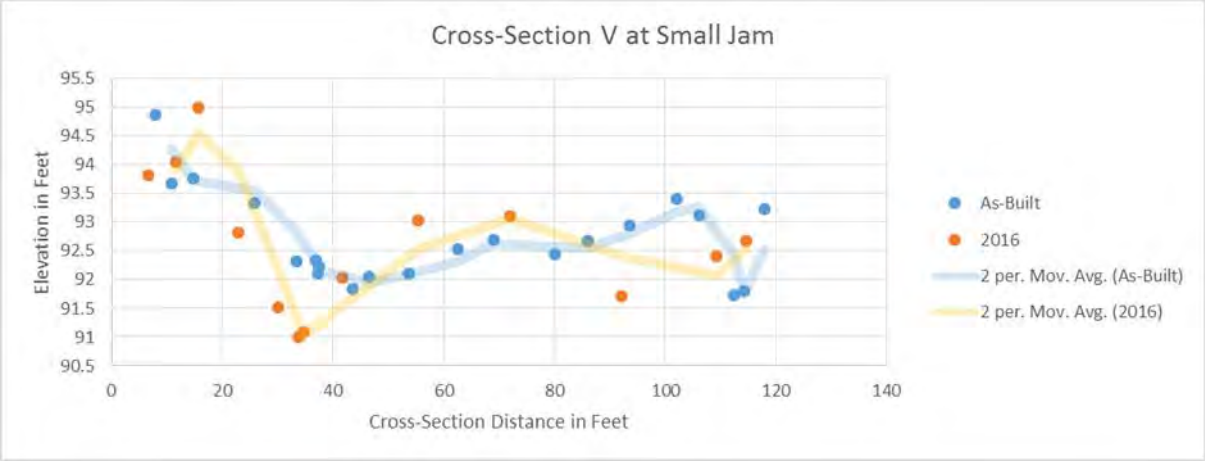
Appendix A-6

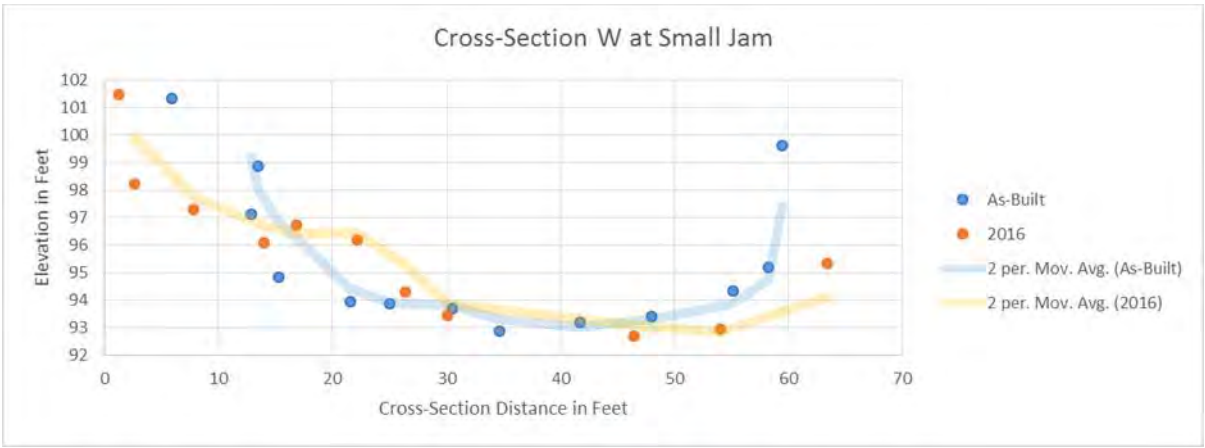
RM 12.5 Cross-Sections

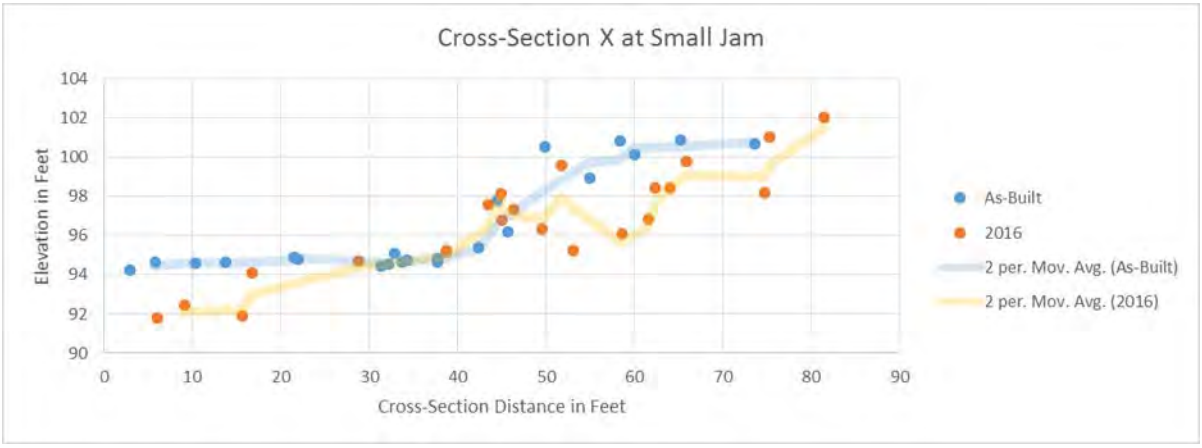


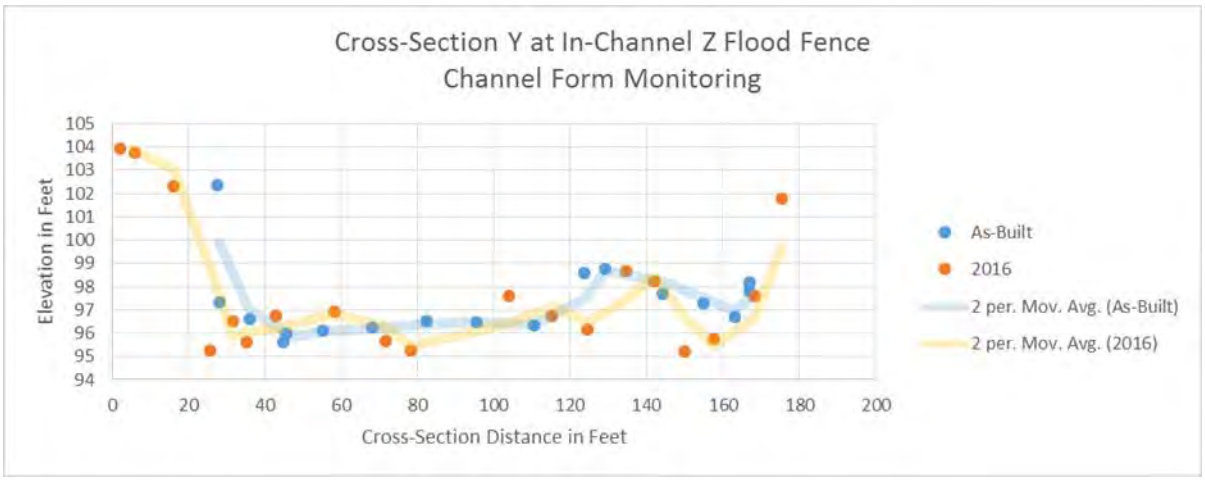


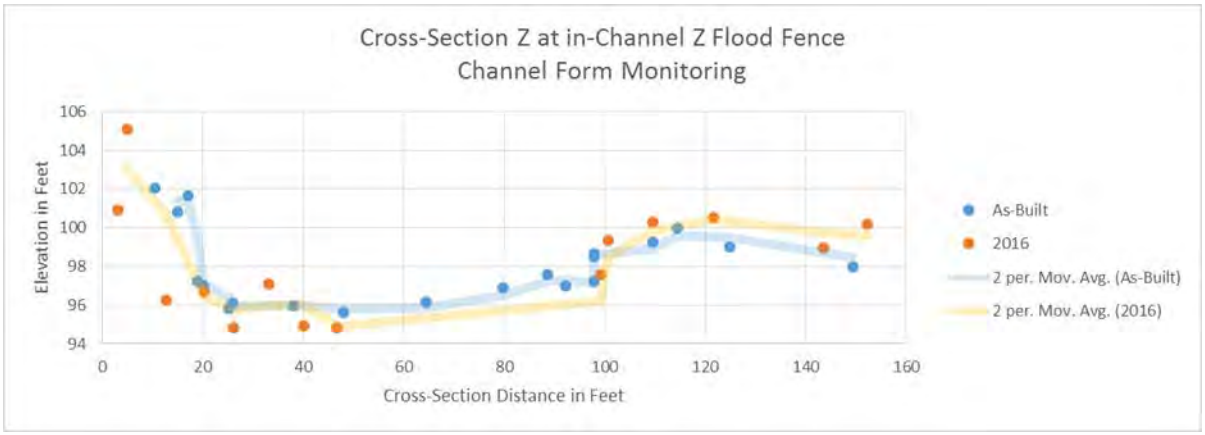



Cross-Section V at Small Jam
Elevation in Feet
95.5
95
94.5
94
93.5
93
92.5
92
91.5
91
90.5
0
20
40
60
80
100
120
140
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)

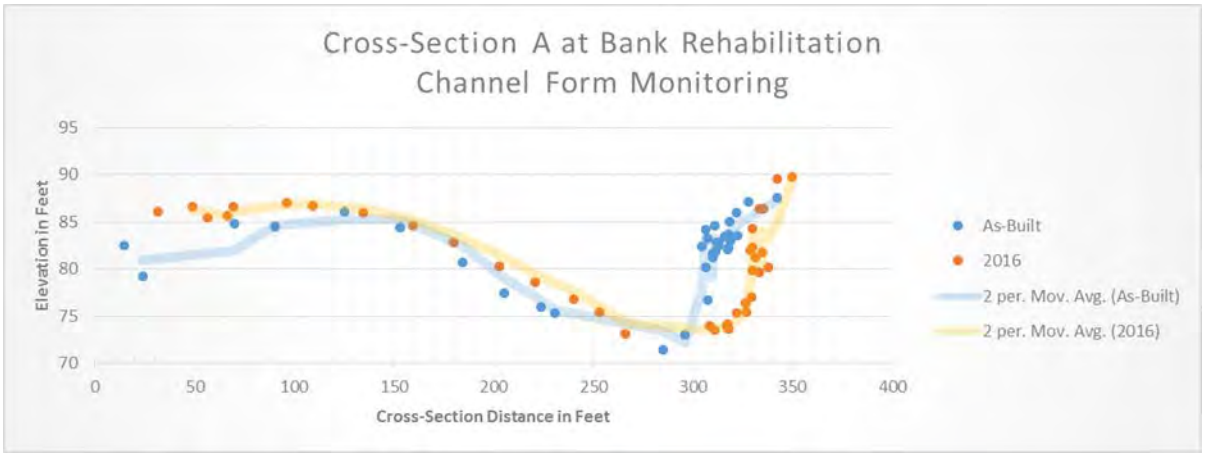

Cross-Section W at Small Jam
Elevation in Feet
102
101
100
99
98
97
96
95
94
93
92
0
10
20
30
40
50
60
70
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)

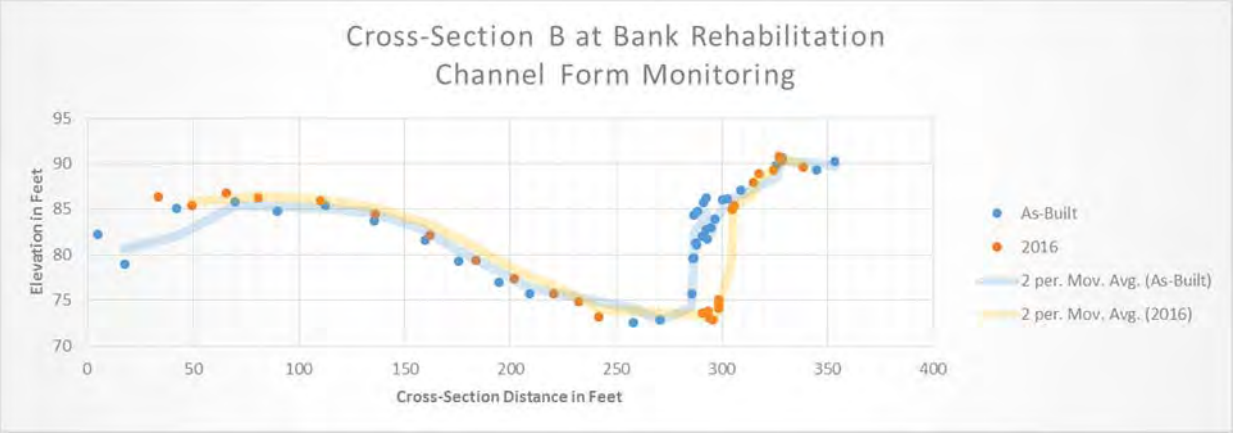

Cross-Section X at Small Jam
Elevation in Feet
104
102
100
98
96
94
92
90
0
10
20
30
40
50
60
70
80
90
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)

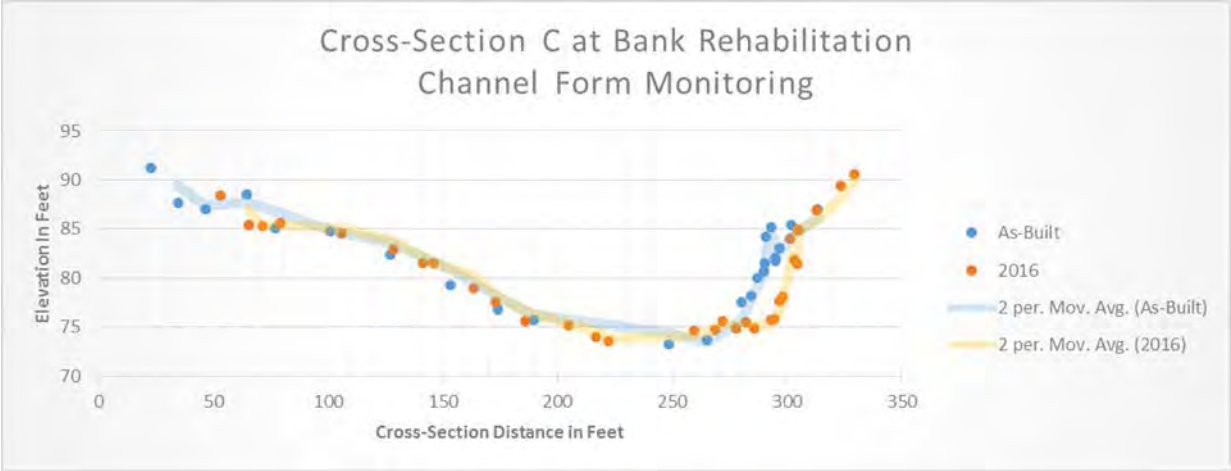


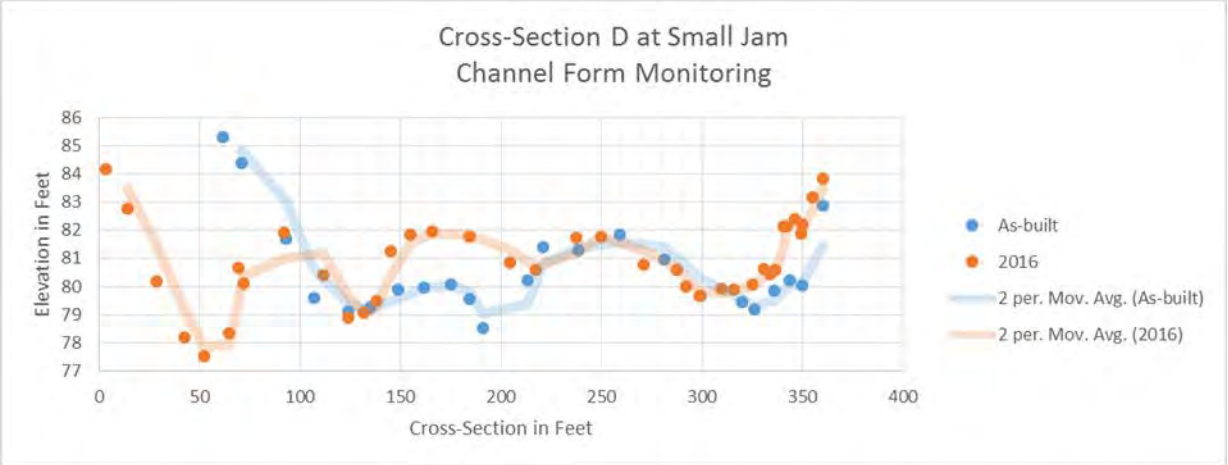


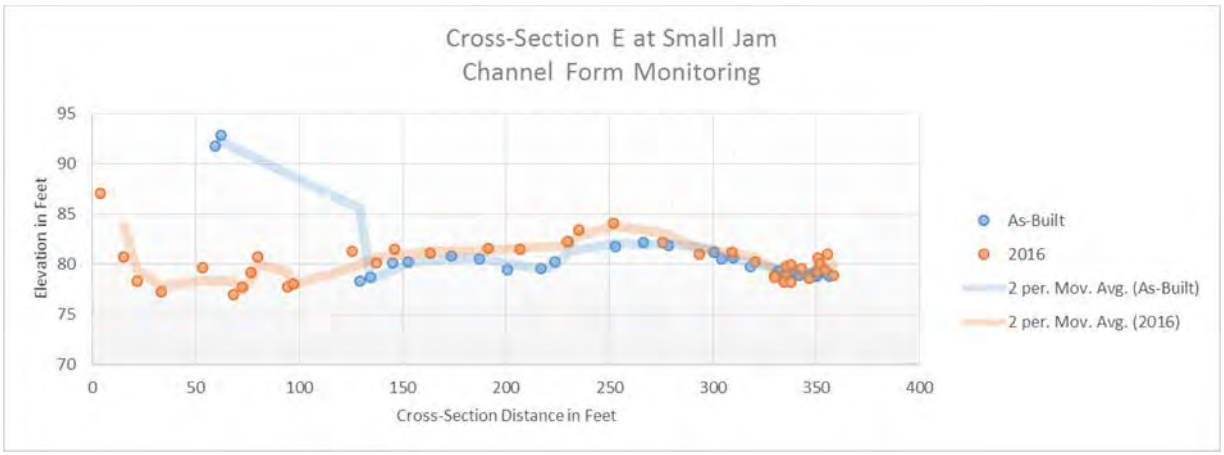
RM 10.5 Cross-Sections

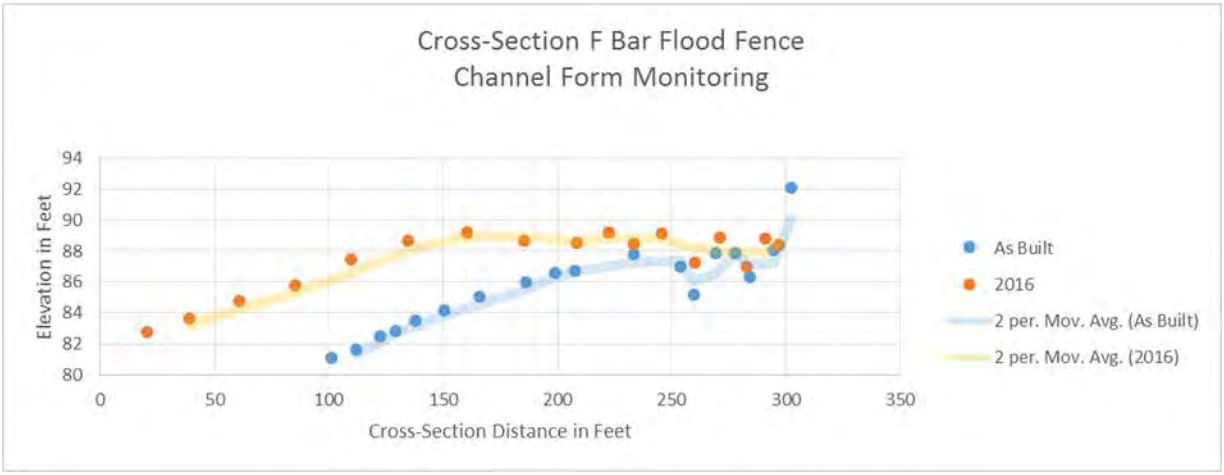


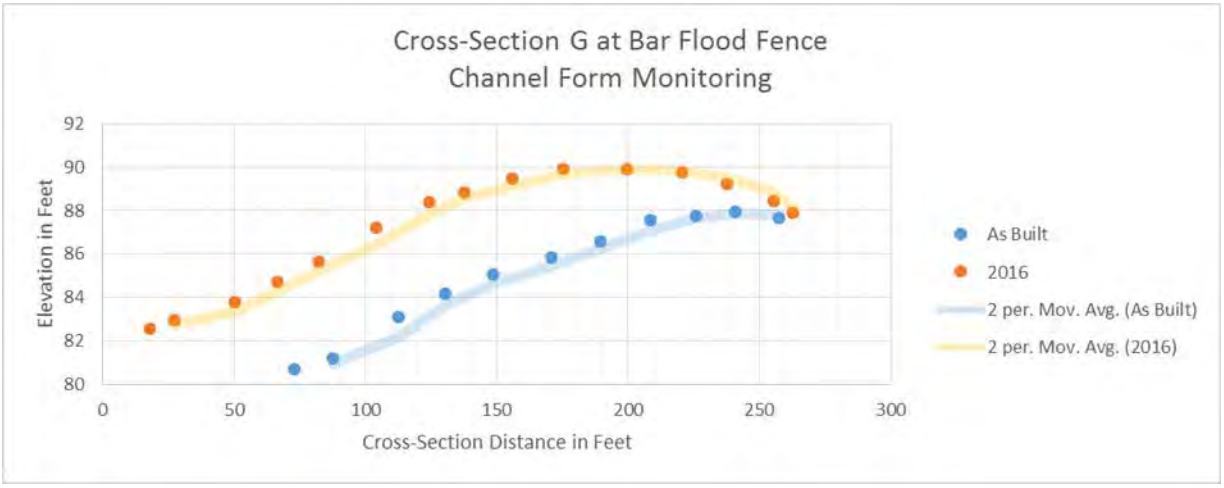

Cross-Section B at Bank Rehabilitation
Channel Form Monitoring
Elevation in Feet
95
90
85
80
75
70
0
50
100
150
200
250
300
350
400
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)


Cross-Section C at Bank Rehabilitation
Channel Form Monitoring
Elevation In Feet
95
90
85
80
75
70
0
50
100
150
200
250
300
350
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)


Cross-Section D at Small Jam
Channel Form Monitoring
Elevation in Feet
86
85
84
83
82
81
80
79
78
77
0
50
100
150
200
250
300
350
400
Cross-Section in Feet
As-built
2016
2 per. Mov. Avg. (As-built)
2 per. Mov. Avg. (2016)


Cross-Section E at Small Jam
Channel Form Monitoring
Elevation in Feet
95
90
85
80
75
70
0
50
100
150
200
250
300
350
400
Cross-Section Distance in Feet
As-Built
2016
2 per. Mov. Avg. (As-Built)
2 per. Mov. Avg. (2016)


Cross-Section F Bar Flood Fence
Channel Form Monitoring
Elevation in Feet
94
92
90
88
86
84
82
80
0
50
100
150
200
250
300
350
Cross-Section Distance in Feet
As Built
2016
2 per. Mov. Avg. (As Built)
2 per. Mov. Avg. (2016)


Cross-Section G at Bar Flood Fence
Channel Form Monitoring
Elevation in Feet
92
90
88
86
84
82
80
0
50
100
150
200
250
300
Cross-Section Distance in Feet
As Built
2016
2 per. Mov. Avg. (As Built)
2 per. Mov. Avg. (2016)

Appendix A-7

Individual fish count by site and date collected.

Date	Site	Chinook W	Chinook H	coho	steelhead	Bull trout	cutthroat	whitefish	stickleback	sculpin	peamouth	dace	Lamprey
6/23/2016	RM 12.5 - Z structure pool	15	6					4		3			
6/23/2016	RM 12.5 - Small jam 2				7			1	1			2	1
6/23/2016	RM 12.5 - Ford Pool *net snagged				2							1	1
6/23/2016	RM 12.5 - Big Rock pool	18	2					14	1	1		1	
6/23/2016	RM 12.5 - Twin Jam Pool		1	5	5			21	18	3		6	
6/28/2016	RM 11.5 - PUD Pool Upstream	3							9				
6/28/2016	RM 11.5 - PUD Pool Downstream		**2**	**3**					46	2			
6/28/2016	RM 10.5 - Bar Flood Fence				**1**							1	
6/28/2016	RM 10.5 - Labish SC small jam			**25**	**23**							7	
8/22/2016	RM 12.5 - Z structure pool			33	56			4	100	2	6	23	
8/22/2016	RM 12.5 - Groeneveld small jam 1			130	3				8	1			
8/22/2016	RM 12.5 - Big rock pool				4			9	55	1	0		
8/22/2016	RM 12.5 - Twin jam Pool			13	29		1	26	214	1	4	18	
8/22/2016	RM 11.5 - PUD Pool DS								42	2	4	2	
8/22/2016	RM 10.5 - Bar Flood Fence			1	8	1	1	7	1	7	1	12	
8/22/2016	RM 10.5 - Labish Pool				12			4				12	

Appendix A-8 - Photo Points

RM 10.5 Bank Rehabilitation

As-built October 2014

First Flood Winter 2014

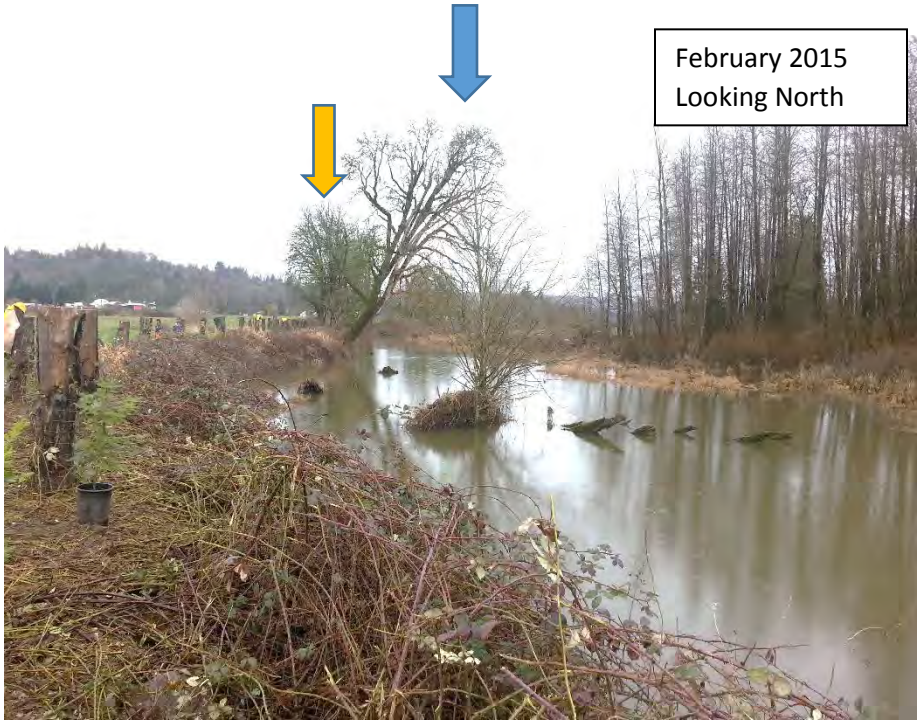
Post 3rd Major Flood 2015 (102,000cfs)

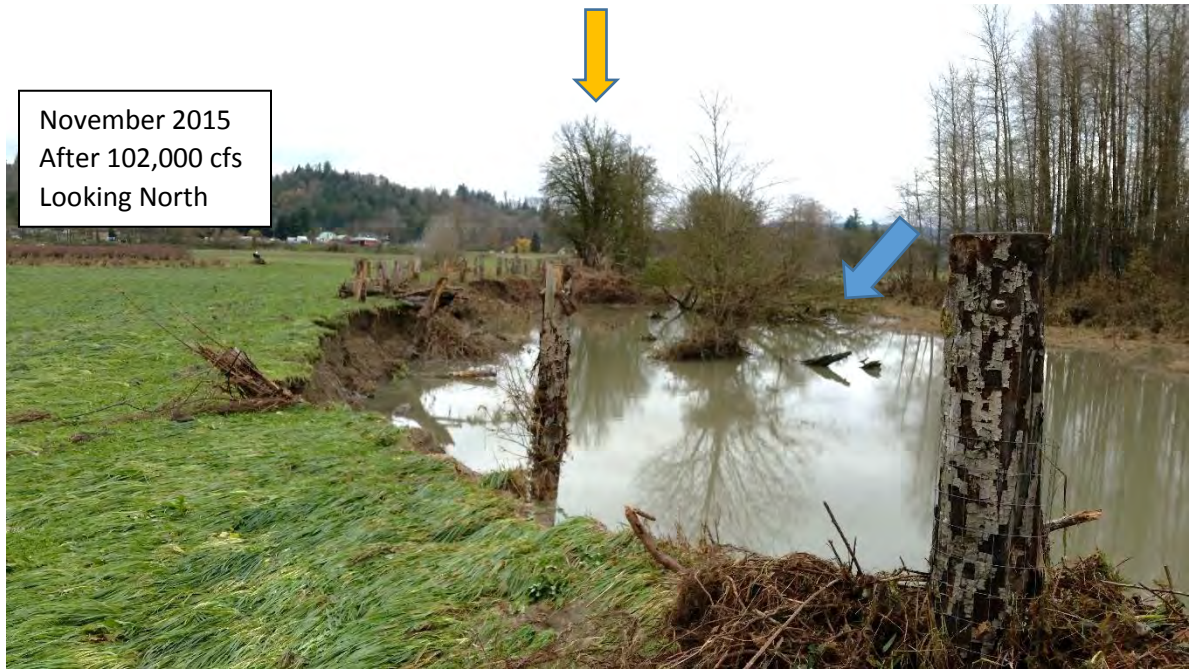
June 2016

RM 10.5 Channel across from bar vertical arrays

RM 10.5 Meander Bar Vertical Arrays

RM 11.5 Floodplain Flood Fence




November 2015
After 102,000 cfs
Looking North

RM 12.5 Z Structures

RM 12.5 Small Jam 1

Appendix 2

Consultation Documentation Regarding Draft Report

Presler, Dawn

From: Applegate, Brock A (DFW) <Brock.Applegate@dfw.wa.gov>
Sent: Monday, June 18, 2018 3:13 PM
To: Presler, Dawn
Subject: FW: WDFW Comments for draft Fish Habitat Enhancement Plan 2017 Annual Report -- Jackson Hydro
Attachments: 2017 FHEP DRAFT Annual Report.pdf; 201707 Lower Sky River Fish Habitat Final Rpt.pdf

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From: Applegate, Brock A (DFW)
Sent: Monday, June 18, 2018 2:51 PM
To: 'Vacirca, Richard -FS' <rvacirca@fs.fed.us>; 'Anne Savery' <asavery@tulaliptribes-nsn.gov>; Pacheco, James (ECY) <JPAC461@ECY.WA.GOV>; 'Rustay, Michael' <mike.rustay@co.snohomish.wa.us>; Jim Miller (JMiller@everettwa.gov) (JMiller@everettwa.gov) <JMiller@everettwa.gov>; 'Thomas O'Keefe' <okeefe@americanwhitewater.org>; 'Janet Curran - NOAA Federal' <janet.curran@noaa.gov>; 'nate.morgan@ci.sultan.wa.us' <nate.morgan@ci.sultan.wa.us>
Cc: 'Binkley, Keith' <KMBinkley@SNOPUD.com>
Subject: WDFW Comments for draft Fish Habitat Enhancement Plan 2017 Annual Report -- Jackson Hydro

Hi Dawn, WDFW repeats the same comment for this annual report. Many hydroelectric projects have a land trust group actively looking for habitat land for acquisition. When the land trust finds a possible piece of land for habitat purchase, the land trust, jointly with the utility's real estate agents work with the land owner to identify a willing seller. The ARC would approve or not on whether a SnoPUD real estate agent would pursue negotiations for purchase of land and completes appraisals and surveys for information necessary to help the ARC make the final decision.

WDFW recommends that the Aquatic Resources Committee have a discussion on land acquisitions, particularly on a discussion of where we would want to search for land. The ARC has quickly discussed the Sultan River, but we should also discuss lands near the confluence of the Skykomish and downstream as well. Where would the ARC have a land trust and SnoPUD search for land?

WDFW appreciate the opportunity to recommend actions related to the implementation of this license article.

Sincerely, Brock

Brock Applegate
Renewable Energy/Major Projects Mitigation Biologist
Washington Department of Fish and Wildlife
P.O. Box 1100
111 Sherman St. (physical address)
La Conner, WA 98257-9612

(360) 466-4345 x244 (office)
(360) 789-0578 (cell)
(360) 466-0515 (fax)

From: Applegate, Brock A (DFW)
Sent: Wednesday, June 13, 2018 3:59 PM
To: Applegate, Brock A (DFW) <Brock.Applegate@dfw.wa.gov>
Subject: FW: JHP (FERC No. 2157) - draft FHE Plan 2017 Annual Report for 30-day review and comment by June 17

From: Presler, Dawn [mailto:DJPresler@SNOPUD.com]
Sent: Friday, May 18, 2018 8:12 AM
To: Applegate, Brock A (DFW) <Brock.Applegate@dfw.wa.gov>; 'Vacirca, Richard -FS' <rvacirca@fs.fed.us>; 'Anne Savery' <asavery@tulaliptribes-nsn.gov>; Pacheco, James (ECY) <JPAC461@ECY.WA.GOV>; 'Rustay, Michael' <mike.rustay@co.snohomish.wa.us>; 'Jim Miller (JMiller@everettwa.gov)' <JMiller@everettwa.gov>; 'Thomas O'Keefe' <okeefe@americanwhitewater.org>; 'Janet Curran - NOAA Federal' <janet.curran@noaa.gov>; 'Asman, Lindsy' <lindsy_asman@fws.gov>; 'nate.morgan@ci.sultan.wa.us' <nate.morgan@ci.sultan.wa.us>
Cc: Binkley, Keith <KMBinkley@SNOPUD.com>
Subject: JHP (FERC No. 2157) - draft FHE Plan 2017 Annual Report for 30-day review and comment by June 17

Dear ARC Members,
Attached is the Jackson Project's Fish Habitat Enhancement Plan 2017 Draft Annual Report for a 30-day review and comment period. Please provide comments, if any, back to me (with cc: to Keith) by June 17. The attached Lower Skykomish Habitat Project Final Report will be included as appendix 1.

Hope you have a great weekend!

Dawn Presler
Sr. Environmental Coordinator
Generation Resources
(425) 783-1709

PUD No. 1 of Snohomish County
PO Box 1107
Everett, WA 98206-1107

Appendix 3

Response to Comments Regarding Draft Report

Comment	Response
B. Applegate, WDFW, via email dated 6/17/2018	
WDFW repeats the same comment for this annual report. Many hydroelectric projects have a land trust group actively looking for habitat land for acquisition. When the land trust finds a possible piece of land for habitat purchase, the land trust, jointly with the utility's real estate agents work with the land owner to identify a willing seller. The ARC would approve or not on whether a SnoPUD real estate agent would pursue negotiations for purchase of land and completes appraisals and surveys for information necessary to help the ARC make the final decision. WDFW recommends that the Aquatic Resources Committee have a discussion on land acquisitions, particularly on a discussion of where we would want to search for land. The ARC has quickly discussed the Sultan River, but we should also discuss lands near the confluence of the Skykomish and downstream as well. Where would the ARC have a land trust and SnoPUD search for land? WDFW appreciate the opportunity to recommend actions related to the implementation of this license article.	The District repeats the same response to this comment that the FHE Plan allows for property acquisition. WDFW should put together an FHE proposal and submit to the ARC for review and consideration (see FHE Plan Section 3) if it deems that its recommendation is consistent with the intent of the FHE Plan (see FHE Plan Section 1.2). A discussion at the ARC meeting in October can take place with the ARC.