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MF Nooksack Channel Monitoring & Adaptive Management Year 5 Monitoring

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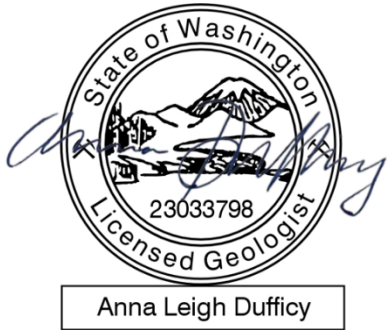
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DISCLAIMER

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- Emmett Rayhill Project Field Support
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NHC partnered with Wilson Engineering on the as-built survey and Kleinschmidt for Fish Passage Assessment:

- Tom Brewster Survey Lead
- Paul DeVries Fish Passage Assessment

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1 INTRODUCTION

The City of Bellingham (City), with partner organization American Rivers, removed the City's water diversion dam on the Middle Fork Nooksack River in summer 2020 and restored the river through the previous dam site to a natural historical channel configuration, as part of the Middle Fork Nooksack Fish Passage Project. This was intended to provide passage and restore fish access to approximately 16 miles of pristine spawning and rearing habitat in the upper Middle Fork Nooksack River for three Endangered Species Act (ESA) listed fish species: spring Chinook salmon (*Oncorhynchus tshawytscha*), Steelhead (*O. mykiss*), and Bull Trout (*Salvelinus confluentus*).

NHC was retained to monitor channel response to the dam removal following the Draft Effectiveness Monitoring and Adaptive Management Plan, or MAMP (City of Bellingham and American Rivers, 2019). The purpose of this Plan is to verify that the project meets the intended project goal of restoring the channel to a natural configuration by monitoring the physical river responses that improve fish passage and habitat connectivity. This report summarizes the results of Year 5 monitoring, based on qualitative observations and photo documentation collected through spring 2026 by NHC in collaboration with Kleinschmidt-R2. Full reports, which report findings related to the four key monitoring metrics that are outlined in Table 1.1, were completed in Year 1, Year 2, and Year 4. The next full monitoring work will be completed in 2027 and reported in 2028.

Table 1.1 Key monitoring metrics

Monitoring Technique	Monitoring Metric	Thresholds	Decision Pathway
Photo/Visual Survey	N/A Provides indication of channel changes to inform field work.	N/A	N/A
Digital Elevation Model Development and Analysis	N/A Provides indication of channel changes to inform field work.	N/A	N/A
Channel Longitudinal Profile derived from Digital Elevation Model	Average Water Surface Elevation slope along low flow centerline.	1. >8% average slope over the entire monitoring site length. 2. >12% slope occurring over a 200 ft length within the monitoring site.	1a. <7% Average (Pass) 1b. >7% Average (Monitor) 2a. >7% in any 200 ft segment (Monitor) 2b. >10% in any 200 ft segment (Evaluate Adaptive Management Action)
Channel Cross Sections derived from Digital Elevation Model	Channel Water Surface Elevation at Minimum Instream Flow.	> 3ft water surface elevation decreases at any channel cross section.	1. <1ft decrease (Pass) 2. >1ft decrease (Monitor/Investigate) 3. >3ft decrease (Evaluate Adaptive Management Action)

The focus of this report is to document channel adjustments observed and measured since monitoring began, with particular focus on recent changes since the last topographic survey in 2024. Figure 1.1 illustrates the timing of various observations relative to flood pulses and their associated stream power that occurred through the entire monitoring period. The primary Year 5 site visit occurred in October of 2025, consisting of photo documentation and observations. In December 2025, a 20,100 cfs flood occurred, which is between a 50-yr and 100-yr event, and also larger than the November 2021 events (Figure 1.1). A brief follow-up site visit was added in the spring of 2026 to confirm that damages from the storm did not compromise the channel design or surrounding infrastructure. Observations in the fall of 2025 and again in spring of 2026 revealed that the channel bed remained mostly stable during this monitoring period, despite the large event. This report summarizes the qualitative site visit findings, highlights the continued success of the restored main channel, and provides discussion on the benefits to fish passage in the channel's current state.

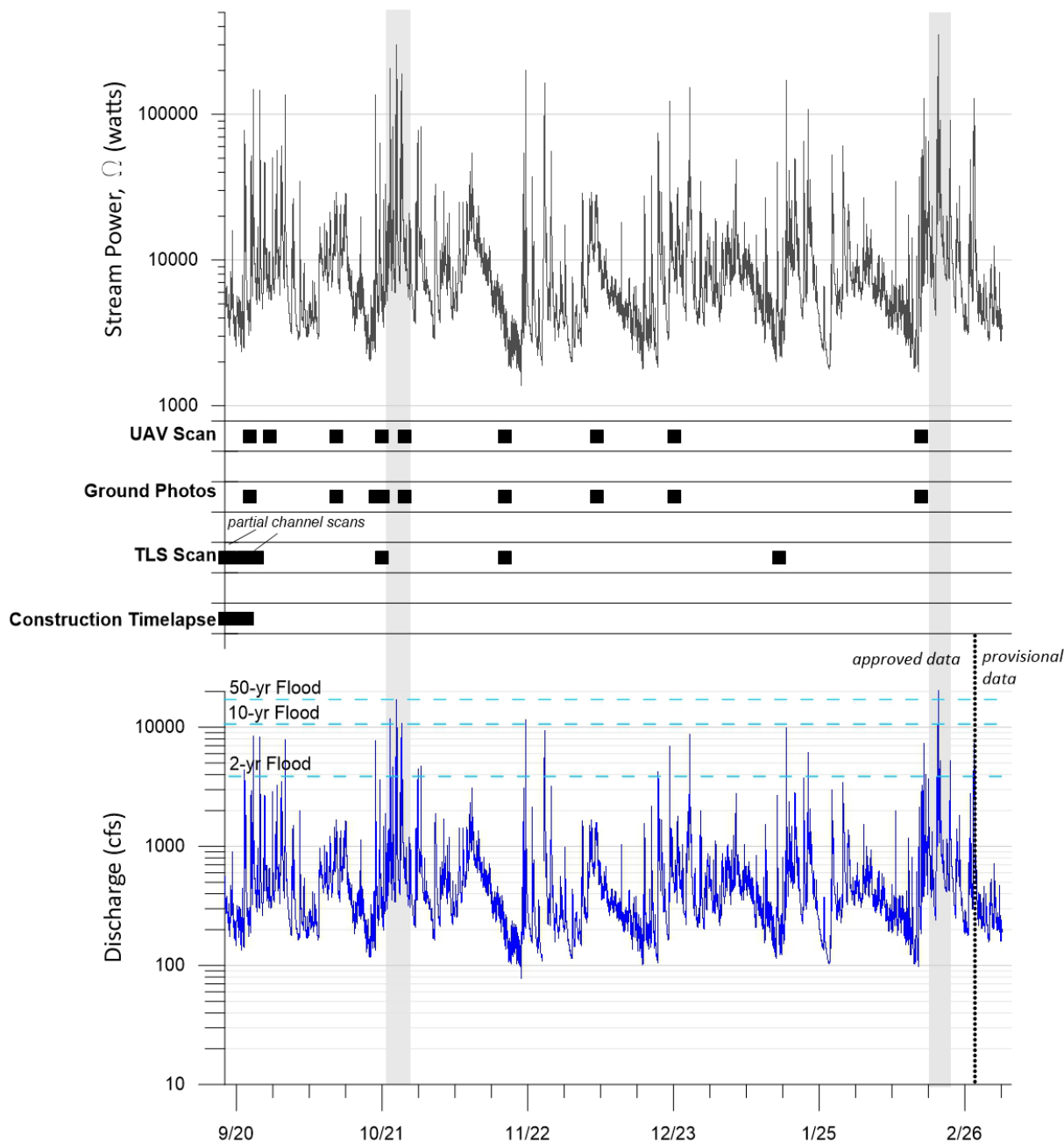


Figure 1.1 Timeline of stream flow, stream power, and observation efforts from August 31, 2020 through April, 2026, with notable large flood events highlighted in gray.

This five-year post-construction monitoring report is structured similarly to the qualitative analysis presented in the previous monitoring reports. This report includes an overall site-scale narrative describing the layout of the monitoring observations, key observations during the fall low flow and spring monitoring site visits, as well as a summary of observed changes since monitoring began. It is

supported by an appendix of detailed exhibits showing conditions and changes in conditions at each monitoring site visit.

2 MONITORING METHODS

2.1 Monitoring Site Layout

Photos were collected at defined photo documentation locations, which were established in the post-construction as-built monitoring report (NHC, 2021) at approximately 20 ft intervals (allowing some flexibility to choose good and accessible vantage points) along the left bank of the channel. These photo transect locations extend from a point defined as station zero, which is located approximately 200 ft downstream of the historic dam crest, to Station 760, which is located approximately 560 ft above the historic dam crest and 55 ft downstream of the new intake, as illustrated in Figure 2.1 (for context, the regraded reach extends from about Station 60 to about Station 400). These are named by the corresponding bank station. In addition, photo documentation points were set at eleven vantage points around the channel; these are given brief descriptive names.

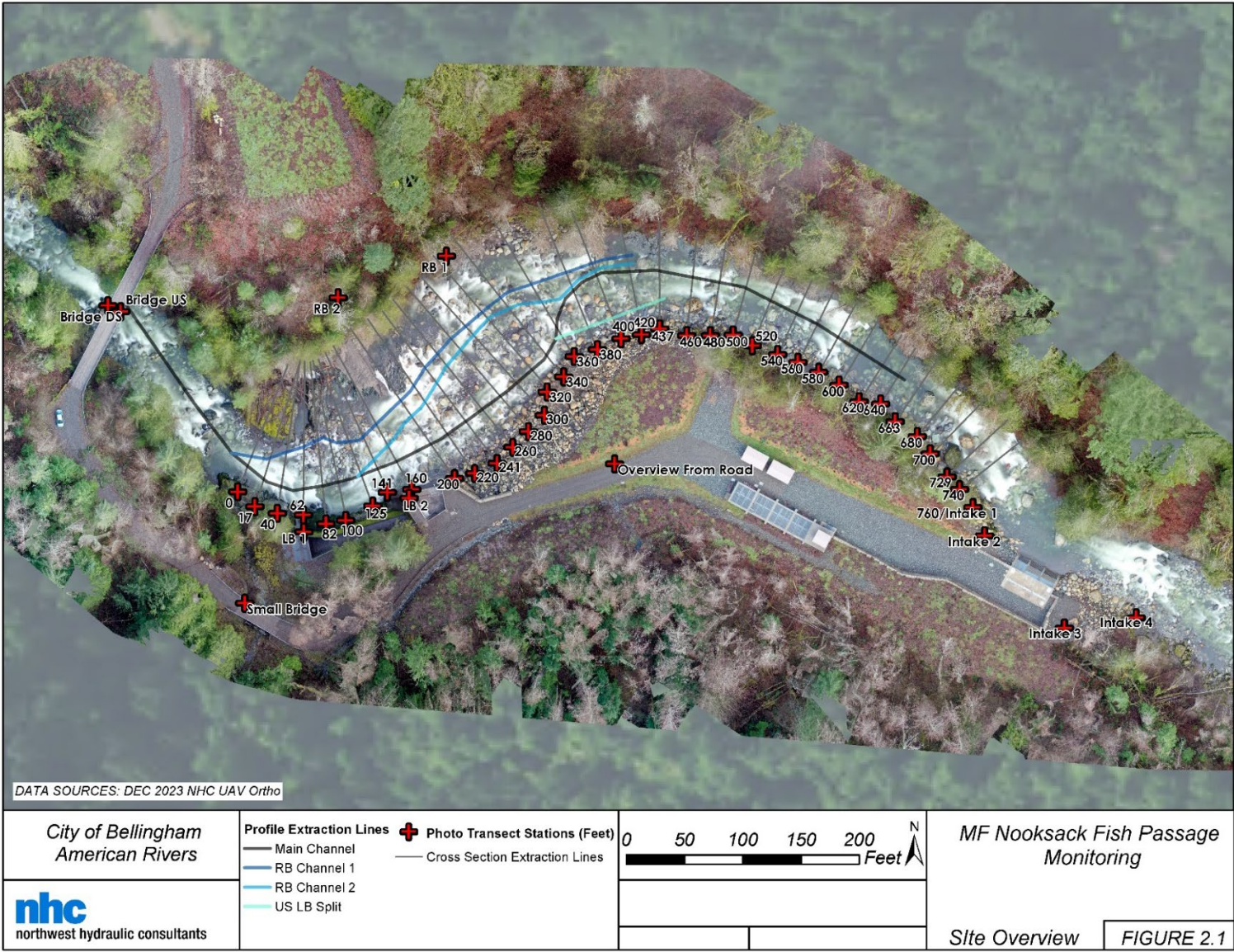


Figure 2.1 Map illustrating monitoring site layout

3 AS-BUILT THROUGH APRIL 2026

3.1 Summary of Year 4 Observations (NHC, 2025)

Quantitative metrics derived from the Year 4 (October 2024) TLS survey data confirmed that only minor channel adjustments occurred between 2022 and 2024, indicating that the reach has entered a period of relative stability following the substantial reorganization that occurred during the November 2021 floods. The channel bed remained largely unchanged, with only localized boulder transport occurring in areas not incorporated into stable channel-spanning jams or boulder clusters. The engineered boulder jams remained in similar positions to those observed during previous monitoring efforts, and most mobilized boulders from the 2021 flood have reorganized into new stable jammed configurations. Continued adjustments within both the main and right bank flow paths have maintained or reduced overall channel slopes, while increasing channel complexity through the development of additional pools and flow pathways. Low-flow observations conducted in 2024 indicated that the main channel continues to receive flow and provide suitable fish passage conditions, with no major changes observed since 2023. Overall, the restored channel has continued to function as intended, with the engineered boulder clusters maintaining stable channel grades and supporting the ongoing evolution of a complex, passable step-pool morphology.

3.2 October 2025 Site Visit Summary

Detailed low flow observations took place in October 2025 after a relatively calm year (no notable runoff events, Figure 1.1) and before the December flood (observations from after that flood are described in the next section). Observations were conducted at 225 cfs. During the visit, it was concluded that the channel bed structure has remained largely stable and unchanged since the December 2024 observations (Figure 3.1). The widespread regrade and channel lowering through the fish bypass outlet pool was still apparent during low flows but does not appear to have downcut any further (Figure 3.2), due to the prolonged stability of the boulder line that formed at the downstream end of the bypass pool in November 2021. As anticipated, the fish bypass slide outlet remains perched above the water surface. However, more abrasion of the concrete slide has occurred since 2024, exposing additional rebar. The exposed rebar is bent against and generally flush with the concrete surface such that it does not protrude from the slide, minimizing the current risk of injury to passing fish. The slide appears to remain structurally sound but should be monitored following future sediment transport events for evidence of additional erosion near the slide outlet. The simultaneous regrade of both main channel and right channels has prevented the main channel from dewatering at low flows. Therefore, the engineered boulder clusters have worked as designed by adjusting with the lowering channel, maintaining passable slopes in the main channel (assumed to be largely unchanged since the 2024 topographic survey), and creating stable roughness from which small step arches can build and form new jamming features and pools (Figure 3.3).

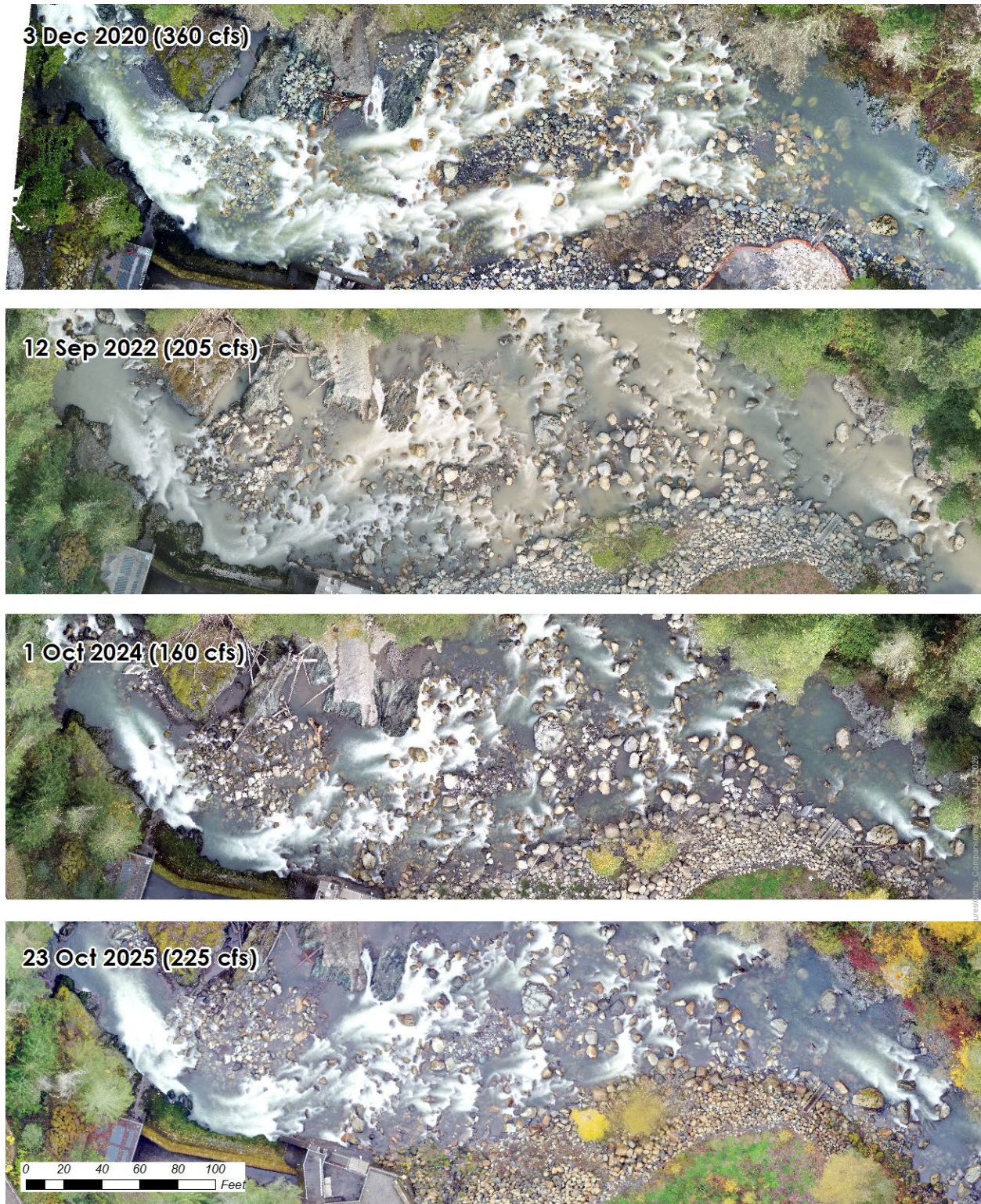


Figure 3.1 Orthomosaic comparisons showing observed channel conditions during monitoring site visits between December 2020 to October 2025.



Figure 3.2 UAV oblique photos showing channel evolution at the pool outlet near Transect 400c between October 2020 (top, 225 cfs), December 2023 (middle, 410 cfs), and October 2025 (bottom, 225 cfs).

View looking upstream

View looking downstream

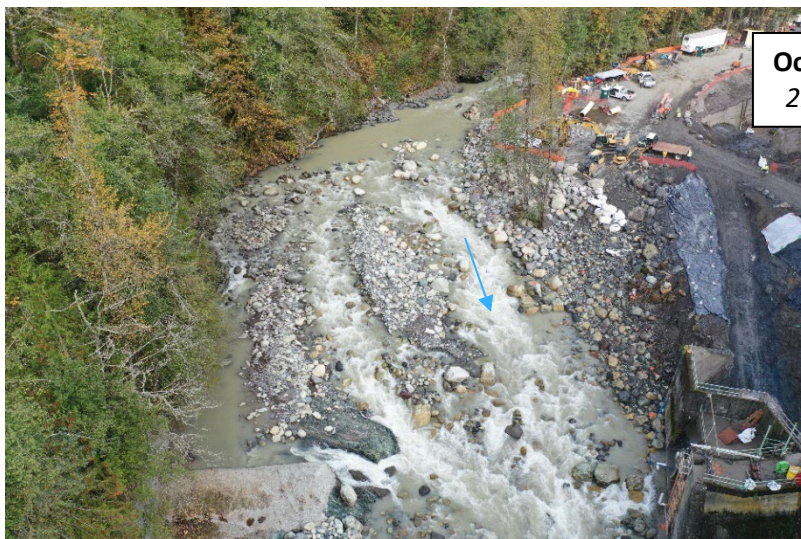


Figure 3.3 Repeat UAV imagery showing low-flow channel comparisons between October 2020 (top) and October 2024 (bottom)

3.3 Post December 2025 Flood Observations

An atmospheric river in December 2025 caused widespread flooding in the region, the flood peak on the MF Nooksack was just slightly higher (20,100 cfs) than the peak of the November 2021 flood (17,200 cfs). The December 2025 event was below the 100-yr trigger that would require additional survey and a full report, but NHC completed reconnaissance observations to evaluate whether substantial changes to the site had occurred that would trigger the mobilization for an additional topographic survey and full monitoring report. This site visit was completed on April 22, 2026. No major changes were observed in the monitoring reach that caused concern for fish passage. All boulder cluster locations were visually observed and found to be stable relative to the October 2025 conditions (as described in Section 3.2; Figure 3.4). The smaller boulders that had formed force chains across the design boulder clusters and channel banks have reorganized into new bed structures, but any lowering that has occurred in the left bank pathways has occurred simultaneously in the main restoration pathway as well, alleviating concerns about dewatering for the existing channel bed conditions.

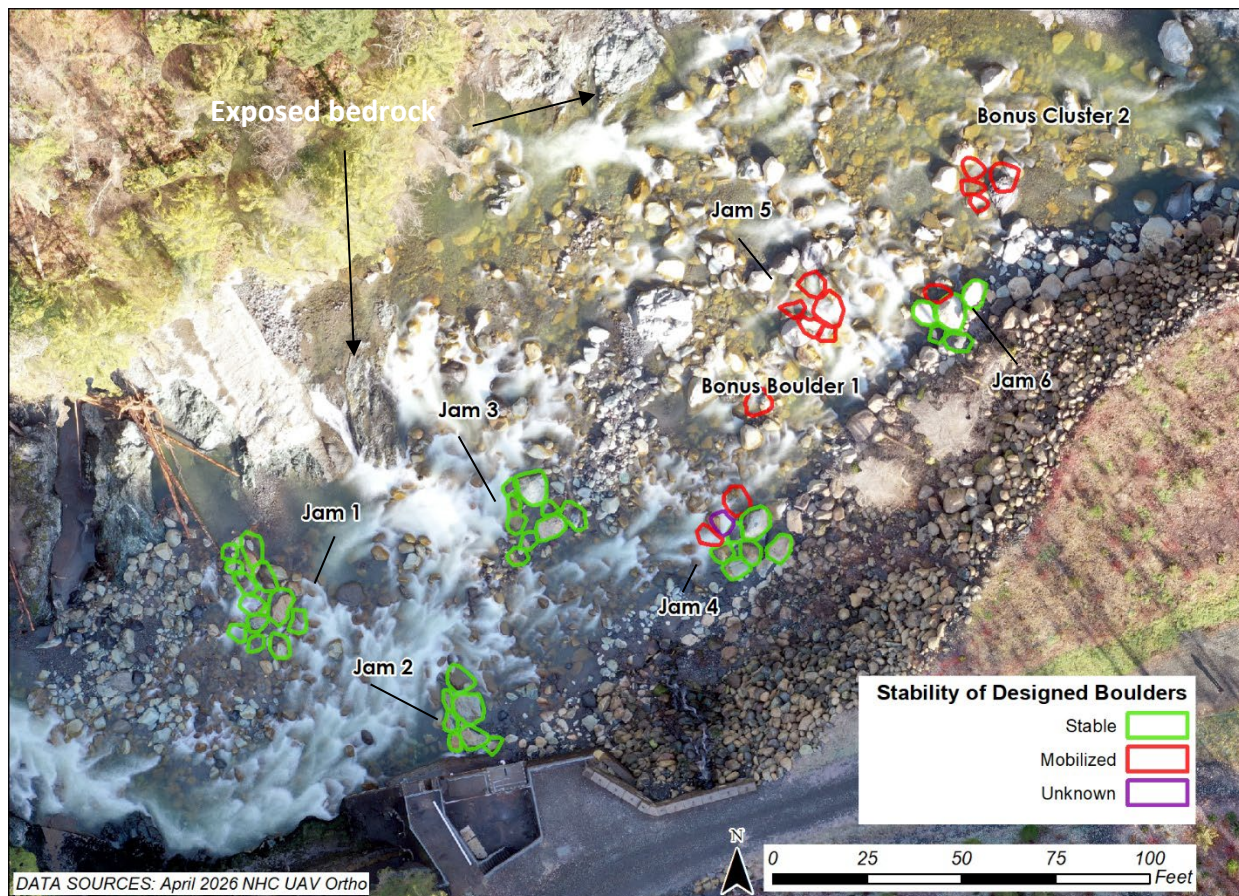


Figure 3.4 April 2026 (300 cfs) orthomosaic documenting relative instability in the restored channel, with engineered boulder cluster jams labeled. Areas of exposed bedrock on the channel bed are also labeled. (Photo: NHC)

Sediment deposition was observed near the inlet of the diversion, associated with growth of a coarse bar immediately upstream (Figure 3.5). While sediment between sand and small boulders were blocking some of the upstream diversion, the downstream gates remained mostly clear and flowing. Sediment will likely continue to deposit here until local hydraulics change. This location will continue to be monitored in the future to confirm whether bar growth continues, or if the location of the bar and existing large boulder create sufficient scouring flows at the downstream gates to prevent flow loss to the diversion. Placement of an additional large boulder upstream of the existing large boulder could mitigate the issue if placed closer to the left bank to facilitate scour around and downstream of it.



Figure 3.5 Comparison of the diversion structure in fall of 2025 (left) and spring of 2026 (right)
(Photos: NHC)

4 QUALITATIVE EVALUATION OF FISH PASSAGE CONDITIONS

As referenced in earlier reporting (NHC, 2021), typical fish passage design criteria are not readily applicable to natural or restored reaches - similar to the project site - where natural volitional passage is provided by complex in situ channel hydraulics that are controlled by natural geomorphic processes. The wide planform, multiple passage opportunities, and potentially variable fish movement behaviours make it difficult to quantitatively characterize passage conditions.

Fish passage conditions evaluated in October 2025 and April 2026 occurred during flows around 225 cfs and 300 cfs, respectively, which is in the lower range of fish passable flows analyzed for the design (R2, 2007). NHC (2025) outlines how there were no hydraulics within the channel that appeared to preclude volitional upstream passage despite widespread regrade approaching thresholds in the MAMP triggering consideration of adaptive management actions. Connectivity for adult passage appeared to be highly likely, and different potential swimmable pathways appeared possible for transit of the regraded reach

at different flow levels. None of the local head drops were more than about 2 ft in height, with sufficiently deep water at base that steelhead, Chinook, & bull trout could partially swim up the nappe as well.

Previously, degradation along the upper portion of both right and left channels had improved fish passage upstream by locally lowering slopes and increasing pool frequency. During optimal fish passage flows (300 to 500 cfs), the right bank pathways (RB 1) become fish passable, creating routes across the channel that have shifted over time, but have not decreased in number (Figure 4.1). As noted as a potential outcome in previous reports, the right bank flow path has degraded further and has exposed more of the underlying bedrock near the bankline but is not widespread.

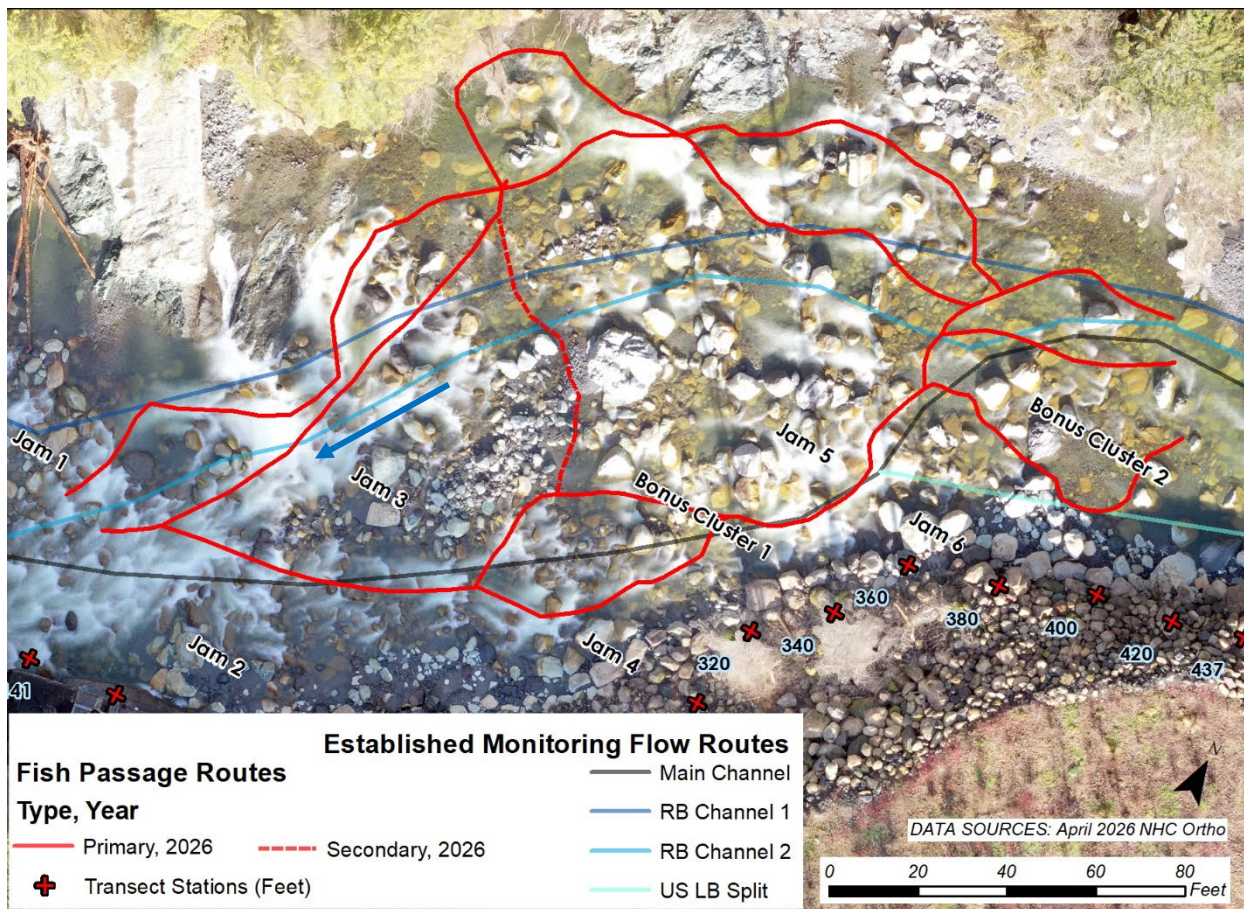


Figure 4.1 Potential upstream passage routes overlaid on October 2026 orthomosaic and relevant monitoring pathways (main channel, RB 1 and RB 2). Solid line = expected primary pathway during lower to mid-flow range; dashed lines = additional routes during mid- and higher flow range. (Photo: NHC)

Closer monitoring of the larger head drops of several steps upstream of the regrade area, specifically stations 480 and 580, has been a focus of each report as downstream lowering of the water surface in

the regrade area has increased the relative heights of these step features upstream (Figure 3.2). Multiple routes appear passable via a combination of swimming and small leaps (Figure 4.2).



Figure 4.2 Likely passage routes at the observed flow at steps upstream of the fish outlet slide (October, 2025). Solid lines = expected primary pathway during lower to mid-flow range; dashed lines = additional routes during mid- and higher flow range.

5 SUMMARY & RECOMMENDATIONS

This report documents the results of the qualitative geomorphic assessment from site photos and videos taken during fall of 2025 to spring of 2026. The primary finding of this assessment is that no meaningful channel bed changes were observed compared to the low flow observations in December 2024. This is despite a large flood event occurring in the middle of the monitoring period (between a 50-yr and 100-yr recurrence interval). Given the lack of visual change from 2024 and the results from the qualitative photo assessment, we believe physical conditions at the site remain conducive for fish passage.

Table 5.1 Current performance of project relative to channel monitoring metrics.

Monitoring Technique	Monitoring Metric	Thresholds	Decision Pathway	Status as of April 2026
Photo/Visual Survey	N/A Provides indication of channel changes to inform field work.	N/A	N/A	No evidence of impassable hydraulic conditions. Channel bed has not changed meaningfully since 2024 despite large flood event.
Digital Elevation Model Development and Analysis	N/A Provides indication of channel changes to inform field work.	N/A	N/A	N/A: Analysis last conducted in Year 4 Report and will be updated next in Year 7 Report (next full survey report)
Channel Longitudinal Profile derived from Digital Elevation Model	Average water surface elevation slope along low flow centerline.	1. >8% average slope over the entire monitoring site length. 2. >12% slope occurring over a 200 ft length within the monitoring site.	1a. <7% Average (Pass) 1b. >7% (Monitor) 2a. >7% in any 200 ft segment (Monitor) 2b. >10% in any 200 ft segment (Evaluate Adaptive Management Action).	N/A: Analysis last conducted in Year 4 Report (with recommendation to monitor natural regrade process) and will be updated next in Year 7 Report (next full survey report)
Channel Cross Sections derived from Digital Elevation Model	Channel water surface elevation at minimum instream flow	> 3 ft water surface elevation decreases at any channel cross section > 5 ft drop downstream boulder	1. <1 ft decrease (Pass) 2. >1 ft decrease (Monitor/Investigate) 3. >3 ft decrease (Evaluate Adaptive Management Action).	N/A: Analysis last conducted in Year 4 Report (with recommendation to monitor natural regrade process) and will be updated next in Year 7 Report (next full survey report)

As stated in the previous monitoring reports, if this or any subsequent field survey effort identified potential concerns of passage, then NHC would recommend the city consider collecting full ground-based topographic and bathymetric survey of the bed of the wetted channel to combine with the TLS-grade surface representing the subaerially exposed part of the channel and water surface and using this data to assemble an updated hydraulic model to evaluate fish passage flows. Given the lack of observed risk, this action is not recommended at this time. Future monitoring will be necessary to confirm whether fish passage is maintained for the duration of the 10-yr monitoring period, with the option to pursue more detailed data collection and updated modelling if adverse conditions arise.

Another photo documentation monitoring report will be completed in Year 6 after the site visit is completed later this year in the fall of 2026. The next full survey report is scheduled in Year 7 in the fall of 2027. Several areas have been identified for continued monitoring in subsequent reports, including the fish bypass return slide (rebar exposure), the water intake structure (sedimentation), the steps between the fish bypass return slide and the water intake structure (changes in step height), flow distribution across the main channel and right flow paths (ensuring the main channel does not dewater), and bedrock exposures (throughout).

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**MF NOOKSACK CHANNEL MONITORING
& ADAPTIVE MANAGEMENT
APPENDIX A
COMPLETE PHOTO DOCUMENTATION**