Taku River Tlingit Fisheries

# 2018 Summary Report for the Silver Salmon River Sockeye Access Improvement Project

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## Executive Summary:

Silver Salmon River is a migration corridor for sockeye salmon destined for Kuthai Lake. Kuthai sockeye escapement has been low for numerous years and does not seem to be recovering. Since 2007 returns to Kuthai Lake have been markedly lower than the long term average. The Kuthai stock is known to have early run timing, passing the lower Taku River in latter June, arriving at the confluence of the Nakina and Silver Salmon Rivers in early to mid-July. Peak enumeration into Kuthai Lake has historically been latter July to early August**.** The lower 700 meters of Silver Salmon River is a canyon reach with a number of boulder obstructions that pose jump height and velocity/turbulence challenges to upstream migration. Previous work and long term observations by TRT Fisheries has noted that the passage obstructions in the canyon may be the cause of these reduced returns. The TRT and the Pacific Salmon Commission are collaborating on this study to explore the cause of reduced returns to Kuthai Lake and to undertake mitigation if feasible. Those assessments have resulted in the ranking of specific sites for passage difficulty. Project activities for 2018 included two site visits, a July site visit to conduct sockeye telemetric data collection, collect design data for the mitigation plan and to implement a beaver dam management traverse, and a late October site visit to implement the rock notch works for passage mitigation at site SR3-3 in the Silver salmon Canyon.

Acknowledgements:

This project was funded through the Northern Fund (NF) of the Pacific Salmon Commission (PSC) and implemented by Taku River Tlingit (TRT) Fisheries.

The following groups or individuals should be recognized for their help with this project: Patrick Hudson (Project Hydrologist); Richard Erhardt (TRT Fisheries Biologist); Mark Connor (TRT Fisheries Manager); Angus Mackay and Victor Keong (PSC NF); Atlin Air, Alaska department of Fish and Game Telemetry team and Discovery Helicopters (in Atlin, BC).

Taku River Tlingit Fisheries

# Introduction:

The Taku River Tlingit (TRT) and the Department of Fisheries and Oceans (DFO) have been working collaboratively to mitigate the adult fish passage issues in the Silver Salmon canyon since 2015. After several years of assessment a mitigation approach has been developed to remediate fish passage at several locations in the Silver Salmon canyon. In 2018 the project was granted a Change Approval (#6001882) to conduct the work at one of the migration challenges identified in the assessment phase. The mitigation works were implemented in the October low flow period to ensure that they were complete prior to the 2019 migration period.

2018 was a very low flow year in the Silver Salmon watershed which resulted in poor returns to Kuthai Lake and the virtual loss of the 2018 year class (a total of 11 sockeye reached the lake). The poor returns were, in part, a function of the stage dependency of the target obstacle (site SR3-3) whereby extremely low flows are problematic for staging pool and "landing pad" migration hydraulics. The specific issues here were two fold;

1. The staging pool below the upstream plunge was obstructed with a rubble pile of boulders that did not allow for adequate jump heights to be achieved by migrating sockeye;
2. Observations during the migration period indicated that fish were attempting to stage from river left which caused them to approach the "landing pad" at the upper crest at an oblique angle to the flow which resulted in many failed attempts when the migrants hit the crest and were spun around parallel to the flow. Fish were not able to reach the upper crest head-on since the rubble pile caused them to stage from too far away to reach the crest.

In their review of the 2018 project activities the Trans-boundary Technical Committee expressed an interest in expediting the mitigation work in the Silver Salmon in order to be certain that a second, consecutive year class failure, does not occur. The project approach has been to address fish passage challenges in an upstream direction starting at the Nakina confluence and proceeding up to the head of the canyon. There is one remaining migration challenge upstream of SR3-3 (site SR3-5, "the Mushroom") that is proposed to be addressed in the 2019 mitigation works.

# 2018 Project Summary:

## Desktop Scope:

The desktop scope of work for 2018 included the following;

1. Finalization of the design for the 2018 mitigation works;
2. Ministry of Environment "Changes in and about a Stream" Permit application preparation and consultation.
3. Permit extension for 2019 mitigation works, and
4. Final report preparation.

### Field Scope:

Fieldwork for the 2018 project implementation included the following;

1. A May site visit to obtain mitigation design information for site SR3-3, conduct spring time gauging and low water recon of the Silver Salmon canyon.
2. A July site visit to capture sockeye telemetry data between Village falls and the top of the Silver Salmon canyon, capture video jump attempt data, conduct an elder interview to capture traditional use information and conduct beaver dam management between the canyon and Kuthai Lake;
3. A late October site visit to implement the mitigation works at site SR3-3.

## 2018 Results:

### Desktop Scope:

Mitigation design was completed during the summer and early fall of 2018 following the summer site visit. The design process considered, in detail, two options for mitigation. The first option was to fabricate a welded aluminum Alaska Steep Pass structure that would be mounted to the bedrock at SR3-3. This option was rejected due to the overall cost, need for ongoing maintenance, lower durability ranking as compared to the second option (a rock notch), and the uncertainty around whether the design would pass Chinook which are also known to migrate through the canyon. The second option was to modify the SR3-3 step with a rock notch to provide a landing pad that is hydraulically aligned with the deeper staging areas to river left of the staging pool. This option was deemed to be the most likely to successfully pass sockeye (and Chinook) without the need for ongoing maintenance, is unlikely to generate any channel response (keystone boulder movement) and could be implemented at a lower total cost than the Alaska Steep Pass. The implementation plan was to mobilize to the site in October and drill and blast a rock notch at the river left position of the existing SR3-3 spill point. Guidance from the engineer's report suggested that the exact dimensions of the rock notch would have to be "field fit" on site once the rock stability was ascertained and the drilling was under way.

The Change Approval Application to the Ministry of Environment was successful and was in hand by early June. This was later than hoped and did not allow for implementation during the original May window so the work was deferred until the October window. A permit extension was applied for in January 2019 to allow further work at the site in the 2019 project year.

### Field Work Results:

### Spring Site Visit:

A spring site visit was conducted between May 4$^{th}$ and 10$^{th}$. The site visit was conducted to take advantage of low water in order to achieve the following objectives;

1. Reconnaissance of the canyon migration challenges from the Nakina confluence to the top of the canyon;
2. Collect further design information for the mitigation works at SR3-3;
3. Conduct hydrometric survey data (gauging the Nakina above Silver Salmon station and staff gauge data for the Silver Salmon).

The canyon was traversed from top to bottom to assess the previously identified migrations, check for Steelhead, and to conduct a low flow recon of the SR3-3 site in preparation for mitigation works in terms of site access, rock quality assessment and safety plan development. River stage was rising during the site visit. At SR1-1, the lowermost challenge immediately above the confluence pool the high flow alternate passage option through the boulder pile was cleared of small woody debris. This should provide a high flow passage option and reduce high stage flow volume through the main channel. Photo 1, below, indicates the high flow route through the boulder pile.


***Photo 1: Site SR1-1 high stage passage was opened by removing small woody debris.***

The Nakina was gauged on May 6th and a set of stage checks was conducted at both the Nakina and Silver Salmon confluence stations. Hydrology information is included in the Hydrology section below.

## July Site Visit:

During the July site visit (July 28th the August 3rd) a set of digital video jump attempts was captured for analysis of passage. Monitoring was conducted on six days during the main migration period (July 31st to August 25th). The results of the jump attempt monitoring is detailed below. Water levels were low during the period of observation and no successful jumps were observed.

Telemetry observations of tagged sockeye was collected on eight days between July 30th and August 25th. Telemetry was monitored at the Nakina confluence and the top of the canyon to estimate the passage transit time for sockeye bound for Kuthai Lake. Due to the close proximity of the two stations there was some overlap in detections that complicated the analysis and the assessment of the results.

**Table 1: Summary of 2018 Jump Attempt Monitoring**

| Date | Site | Jump Rate (per second) | Observation Time (seconds) | Successful Attempts |
|---|---|---|---|---|
| July 31 | SR3-3 | .13 (80 attempts) | 610 | 0 |
| August 1 | SR3-3 | .18 (101 attempts) | 528 | 0 |
| August 2 | SR3-3 | .24 (212 attempts) | 889 | 0 |
| August 12 | SR3-3 | .15 (88 attempts | 600 | 0 |
| August 16 | SR3-3 | .025 (15 attempts) | 600 | 0 |
| August 25 | SR3-3 | .097 (58 attempts) | 600 | 0 |

An elder interview was conducted at site with James Williams in early August. Mr. Williams has considerable experience at Village falls and the lower Taku and has a wealth of family knowledge from his parents and grandparents who frequented the area to access their trap line on the Inklin River. James also worked on the River as a fishing guide and archaeological field assistant. The interview is summarized below;

| | Table 2: James Williams Elder Interview Summary | |
|---|---|---|
| | Survey Question | **Response** |
| **1** | What was the condition of salmon caught at Village Falls? | Salmon were harvested pre-spawn and generally looked healthy. On one occasion James recalls harvesting a chinook that had a hook and line still attached. Chinook were abundant I those days. |
| **2** | How were bears managed in those days and how many were frequenting the Village Falls site? | James did not see bears during the two years (1973 and 74) he was conducting archaeology surveys although there was bear signs and indication of night-time bear activity. He also didn't see bears during the day while he was working as a fishing guide. There were not any issues with bears in his field experience. |
| **3** | What time of year did the sockeye and Chinook arrive? Did you notice Pink salmon above Village Falls? | Chinook arrived at Village falls in Late July until early August. They arrived at Canoe Landing in early July. Sockeye were caught at Village falls in late July and early August. Fish were stored in ground caches and according to his mother each family had their own style of cutting fish which enabled the families to tell each other's caches apart. James only saw Chinook and sockeye above Village Falls, not Pink salmon. James recalls gaffing a Chinook from out of the rock pile (river right). The fish had been passing through the pile and got stuck. |
| **4** | Did James notice if fish were being held back at Village Falls? | James doesn't recall fish being backed up at Village Falls. |
| **5** | Are there noticeable differences in weather between historic and now? | James doesn't notice changes in weather from historic. The weather always had a lot of variability. |
| **6** | How much fish was harvested? | When he was working on the Nakina they only harvested as much food as they needed, there wasn't enough time to harvest and dry more than that. |
| **7** | Did the run sizes vary from year to year? | James didn't notice any variation in run size, there was always enough to meet their needs. |
| | Comment | James added that, 6 or eight years ago he saw six Chinook in Silver Salmon near Kuthai Lake. |
| | Comment | James also talked about how important it was to respect the many bears in the region and that talking to them when they are encountered is good. |

On July 29th a traverse of Silver Salmon River from Kuthai Lake was conducted open beaver dams along the migration route. Aerial overview during successive access flights indicated that there were several

large beaver dams that would at the low flows observed, be passage obstacles. The largest dam was only a couple of kilometers downstream of Kuthai Lake. During the traverse a number of dams were breached although the traverse ended without breaching the last three or four dams due to time constraints. It was noted that the largest dam near the lake was rebuilt after a couple of days so it may be wise to conduct a more sustained beaver dam program in 2019 if passage is improved through the canyon. It was noted that there was a slight rise in stage at the SR1 staff gauge following the beaver dam breaching. Had the last few dams been breached it may have produced a larger flow response that could have positive influence on passage in the canyon.

## Fall Site Visit:

A fall site visit was conducted between October 10th and 15th.The main objective of the 2018 mitigation implementation works program was to address the hydraulic issues at site SR3-3 by widening the spill crest at the channel step that has been a migration bottle-neck. The original plan was to drill a series of holes and blast a small notch in the river left bedrock outcrop that forms the step. A drill and blast plan was developed, a certified blaster was put on standby in Whitehorse and the crew proceeded to the site to conduct the work. Once the initial drilling was underway it became apparent that the bedrock sidewall was not as stable as was originally thought and a weak layer was detected. This posed risks associated with blasting as it appeared that controlling the blast might be problematic and an "over-achievement" may have been possible. Uncertainty around blast control raised the risk of producing too much blast rock and potentially creating a more problematic hydraulic outcome. Because of this the team decided to forgo blasting and create the rock notch by a combination of rock drilling, rock sawing and sledge hammer removal. This resulted in a much smaller volume of rock removal under much more controlled conditions. The majority of the rock removed was achieved manually by sledge hammer. A basic as-built survey was conducted once the work was complete and an as-built diagram produced from the survey data, overhead photo-mosaic and professional judgement. The SR3-3 as built survey diagram (Appendix 1) enabled the estimation of total material removed and the resulting hydraulics of the step. The figure shows that approximately 1.1 cubic meters of material was removed to create the notch, which is considerably less than 3 to 5 cubic meters projected with the blasting plan. Mitigation of the step is being achieved by creating a rock notch on river left that achieves the following;

1. Migrants are now able to stage from directly below the plunge and are thus approaching the crest head-on to the flow;
2. The new staging area has a surveyed depth of 2.7 meters which should result in much better staging velocities and better jump performance;
3. The crest of the step spill point has been widened by approximately 0.75 of a meter which should create better overall hydraulics. Widening the crest has resulted in a "landing pad" with low aeration (see picture 1) which should improve swimming performance by increasing traction. Excessive aeration can reduce flow density and thus reduce burst swimming performance which is critical for fish passing high jump height obstacles. One of the main recommendations of the design engineer was to assure that the "landing pad" was minimally aerated and hydraulically laminar.
4. The final alignment of the notch includes a narrow low flow notch (LFN) that will assure that the "landing pad" does not dewater under low flow conditions.

Photos 1 and 2, below, show the pre and post-mitigation conditions.

**Photos 2 and 3: View of the site before and after mitigation at SR3-3.**

# Analysis

## Hydrology:

Several sites were gauged during the site visits. Table 3 is a summary of the sites gauged during 2018.

| Table 3: Nakina Silver Salmon Gauging Summary, 2018. | | | |
|---|---|---|---|
| **Date** | Site | Discharge )$m^3/s$ | Notes |
| **May 6th** | Nakina above silver Salmon | 22.455 | Stage rising rapidly due to early season heat. Early freshet discharge. |
| **July 30th** | Nakina above silver Salmon | 9.811 | Compares to 15.22 $m^3/s$ on July 11, 2015, |
| **Aug 3** | Kuthai Creek at the weir | 0.077 | Compares to 0.160 $m^3/s$ on July 11, 2015, and 0.197 $m^3/s$ on July 26, 2016 |
| **Aug 3** | Silver Salmon Above Kuthai Creek | 0.610 | Compares to 2.57 $m^3/s$ on July 15th, 2015, 1.74 $m^3/s$ on July 16th, 2016 and 1.78 $m^3/s$ on August 1st, 2017 |

The staff gauge installed in 2017 in the pool above the Nakina / Silver Salmon confluence seems to be un-interesting to the bears at site and is still standing despite the fact that they have easy access to it. This has allowed the inter-annual comparison of Silver Salmon stage during the migration window. Stage in 2017 during the migration window (Aug 5th through August 12th) was on average at 0.418m (n=4), while in 2018 the stage averaged 0.325 m (n=9) during the migration window (July 28th through August 21). This indicates a significant difference in stage between the two years as the stage was 9.5 cms (23%) lower in 2018 than 2017. Low flows tend to increase jump heights as they reduce the backwater elevation of staging pools and reduce or eliminate the passage options through the boulders that need more flow to be fully watered.

## Jump Attempts and Telemetry:

Jump attempt monitoring was conducted between July 31st and August 21st. There were no successful jumps recorded although we assume that stage was falling throughout the period and noted that some fish were able to pass through SR3-3 to SR3-5 prior to the onset of monitoring. Obviously a small number of sockeye made it out of the canyon since 11 fish were recorded entering Kuthai Lake. Passability may have been better earlier in the migration due to higher stage.

Telemetry results were problematic as there was insufficient distance between the upper and lower stations which resulted in some double detects. The data was edited to eliminate these double detects based on signal strength. There may have been issues with bears pulling out tagged fish and taking them up the sidewalls of the canyon as well. Tags that were indicating fish mortalities seemed less problematic as there were fewer cross detects there. This may be that morts in the bottom of the channel did not transmit well if they were shielded by the canyon walls and boulders. The mortality data was parsed to indicate how many individual fish perished in the upper canyon (Sub-Reach 3) as compared to the lower canyon (Sub-Reach 1).

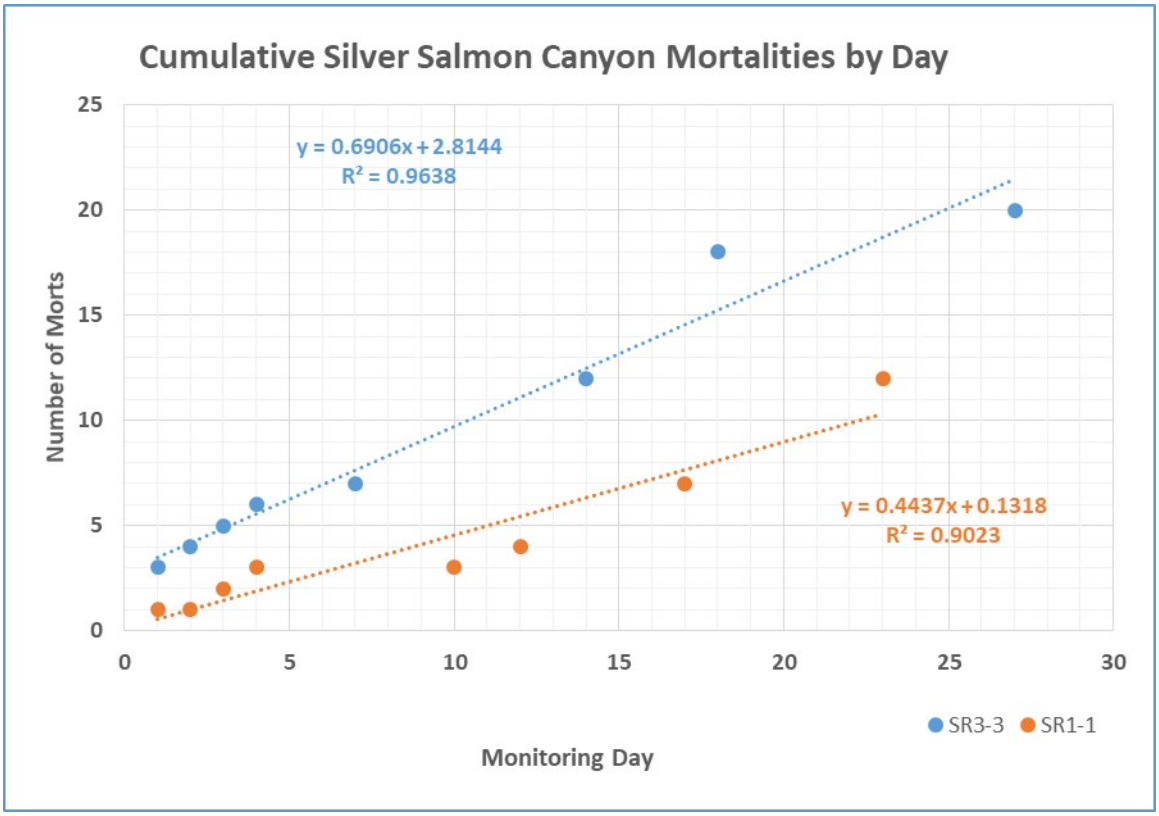



***Figure 1: Cumulative mortalities by site. Both the total number of mortalities and the time average rate of mortality was higher at the top of the canyon than at the confluence pool.***

Figure 1 shows the cumulative number of mortalities over the observation period compared between the lower site near the confluence with the Nakina and the upper site in Sub-reach 3. The plot shows that both the total number of mortalities and the rate of mortality was higher in Sub-reach 3 at the top of the canyon. Mortalities in the lower canyon were not insignificant however which may suggest that at these water levels bear mortality is high and/or that some of the fish arrive in poor condition due to migration challenges in the Nakina (Village Falls). Given the issues with the telemetry data is was difficult to arrive at a canyon transit time due to cross detection but there were two tagged individuals that were detected at the bottom and arrived at the top without cross detection. Tags 843(17) and 803(47) gave reasonable transit estimates of 2 days and 5 days respectively indicating that fish are spending considerable time migrating from the Nakina confluence up to Sub-reach 3.

## Discussion:

2018 was the lowest flow year of the study period which produced the lowest returns to Kuthai Lake indicating that stage dependent passage is worst at low flows. The telemetry monitoring indicates that mortalities are significant throughout the canyon but are most severe in Sub-reach 3. Jump success was very poor at SR3-3 and SR3-5 (the “Mushroom”). Despite the fact that in previous years the passage at the Mushroom was adequate 2018 saw similar passage difficulty there as at SR3-3. This may indicate that the cumulative metabolic cost of the obstacle at SR3-3 has reduced the jumping ability and metabolic fitness of migrants and reduced the jumping performance of fish trying to ascend the Mushroom. The works implemented in October provide a more direct alignment from the staging pool

at SR3-3 to the upper landing pad so it is hoped that less time spent ascending this obstacle will translate to better jump performance at the Mushroom which is the final rated obstacle in the canyon.

The stage monitoring at the confluence pool (SR1-1) indicates that passage is very difficult at around a stage of 0.300 meters and that passage improves at stages above 0.425. This may provide a benchmark stage for the 2019 program such that if early season stage is near 0.300 and passage is not as good as expected at SR3 an airlift to move fish above the canyon may be warranted to preserve the year class. This puts a priority on the collection of stage data at the SR1-1 staff gauge as early as possible.

At low flow the beaver dams in the upper Silver Salmon also become more difficult so a beaver dam breaching program in 2019 is recommended as soon as fish are detected above the canyon.

It was interesting to note that there were Chinook attempting to transit the canyon in both 2017 and 2018. This correlates with observations of Chinook redds immediately above the canyon, upstream of the Silver Salmon / Kuthai Creek confluence and previous telemetry reports of Chinook making it up to Bell Lake. James Williams also noted, in his interview, that he had seen 6 Chinook in Silver Salmon Creek near the confluence with Kuthai Creek some time around 2012. Given the large amount of available habitat above the canyon, improving passage for sockeye may have a commensurate effect on increasing Chinook escapement to the upper Silver Salmon. During the fall site visit during the initial canyon recce a spawning population of sockeye was observed spawning along the entire length of the Silver Salmon canyon. These fish were observed spawning on almost all available patches of gravel up to (but not above SR3-3). A rough count of spawners indicated there were at least 200 individuals in the canyon. Passage mitigation in Sub-reach 3 may also allow access for this late run of sockeye to colonize river sites above the canyon. Given the large amount of groundwater fed river habitat between the canyon and Kuthai Lake this may warrant some further investigation.

## Proposed 2019 Works:

The proposed work for 2019 involves a continuation of the work to the last upstream migration obstacle, SR3-5. This obstacle is formed as flow passes over a rounded boulder that causes flow dispersion resulting in a mushroom shaped cascade (thus the obstacle is called the “Mushroom”). An overview of Sub reach 3 (SR3) is included in Appendix 2. Previous assessments and jump attempt monitoring indicates that this is the preferred migratory path, likely because the river left channel is a velocity barrier at typical summer flow levels (during the migration period) and there is a cluster of small boulders obstructing the staging area.


***Photo 3: Upstream view to obstacle SR3-5. SR3-4 is cluster of boulders in the foreground and SR3-3 is just out of frame on the right side of the picture. This picture was taken at low flow.***

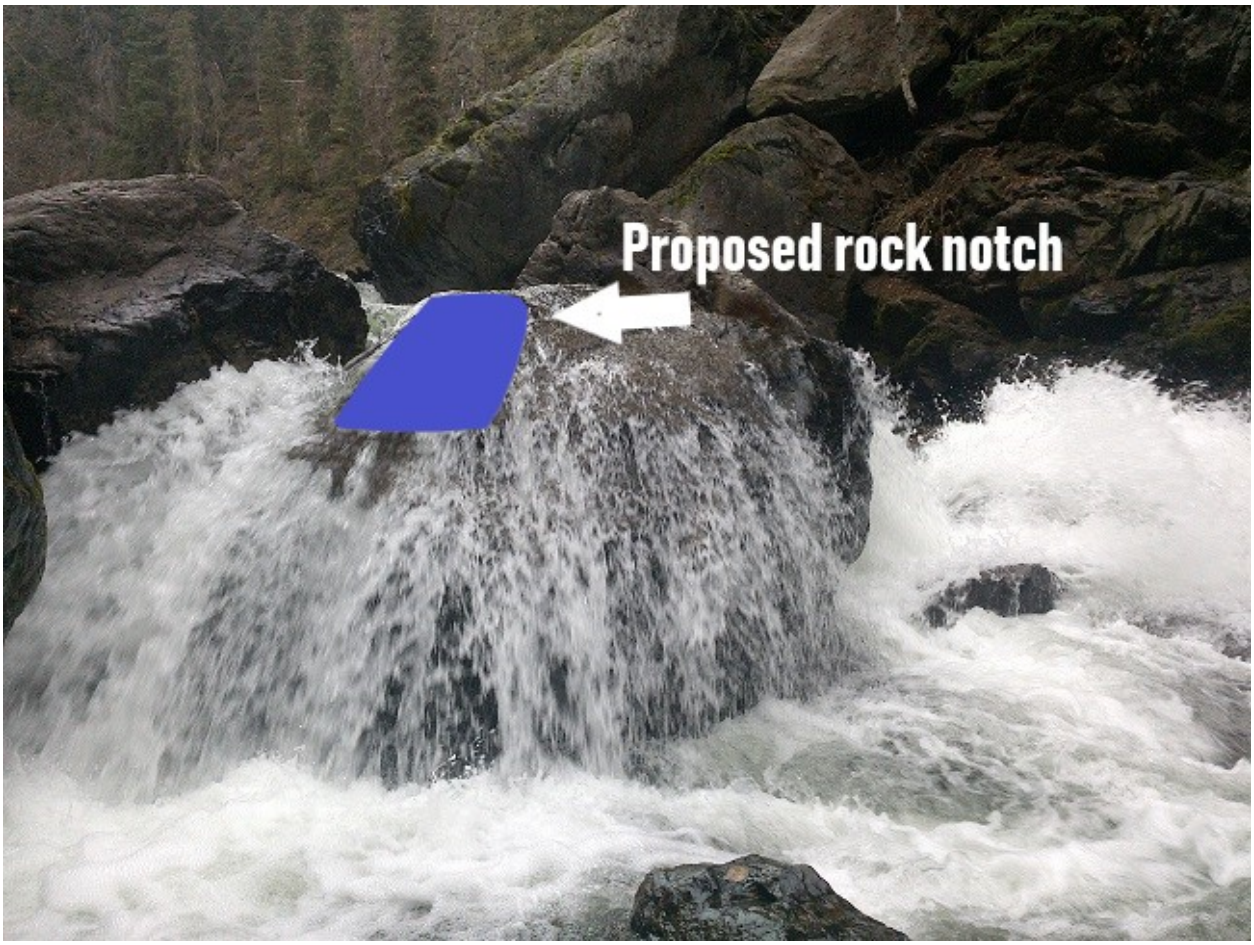


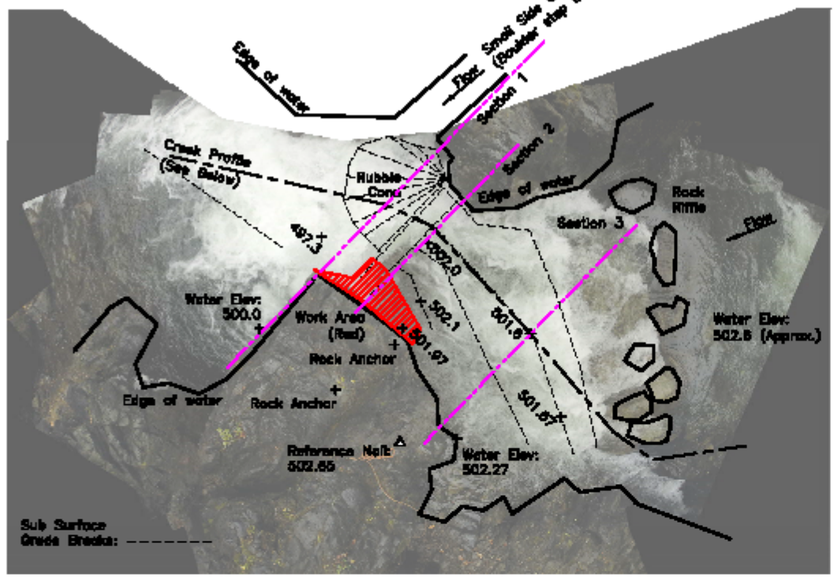

***Photo 4: Upstream, low flow view of the proposed 2019 works. The rock notch will create more concentrated hydraulics at the landing pad at the crest of the Mushroom..***

The proposed scope of work for 2019 includes the following;

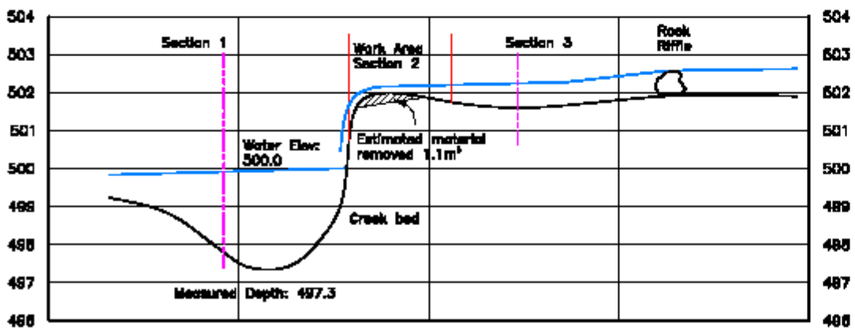
1. Cut a small rock notch with the rock saw and manually remove the material to create improved landing pad hydraulics. Higher flow volume directed to the staging pool area (attraction flow) should scour and create better staging depth. A minimal volume of rock is to be removed (approximately 0.25 of a cubic meter). As with the 2018 works the exact alignment will be field fit depending on the rock quality;
2. Expand the rock notch at SR3-3 slightly to increase the attraction flow, widen the crest and deepen the low flow notch. Expansion will be done by sledge hammer and rock drill as per the 2018 works.

The approach to the work will be similar to 2018 with the exception that we are not considering any blasting. The boulders and bedrock in the channel are partially lithified sandstone (chert) that is relatively easy to drill. Dewatering the work area would be impossible given its location but stop nets can be used to keep resident fishes out of the area. The manual methods to be applied produce little sediment and the total volume of rock to be removed at the Mushroom is minimal. The timing for the work will be from the 7$^{th}$ to the 14$^{th}$ of April to avoid the smolt outmigration period that occurs in mid-May.

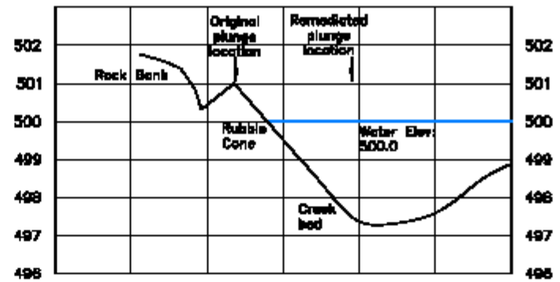
# Appendix 1: As-built drawing of the 2018 works at SR3-3.



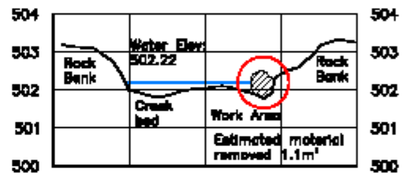

Site SR3-3 Sketch



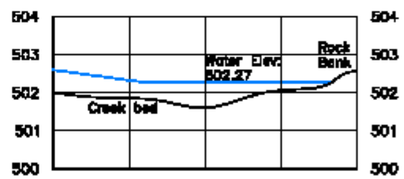

Silver Salmon Creek Profile
Through Centreline of Creek




Section 1
Plunge Pool




Section 2
Crest of Falls




Section 3
Upper Run

UTM COORDINATES:

| NAD 83 (CSRS) (2002.0), Zone 8 | | |
|---|---|---|
| Site | Northing | Easting |
| SR3-3 | 6554712.0 | 614260.0 |

As-built Survey By: Hydrologic Inc.
As-built Survey Date: Oct 13, 2018
Drawn By: HBH Land Surveying Inc.

Plan, Profile and Sections
As-built Survey of Passage Remediation Works
Silver Salmon Creek
Site SR3-3

**Appendix 2: Overview Mosaic of Sub Reach 3, Silver Salmon canyon.**