AVISON MANAGEMENT SERVICES LTD.

Leader in Environmental Services | Vanderhoof, BC

Knight Creek 2024 Stream Restoration Project – Stuart Hall

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EXECUTIVE SUMMARY

The Nechako Environment and Water Stewardship Society (NEWSS) engaged Avison Management Services Ltd. (AMS) to undertake a restoration project at Knight Creek, a tributary of the Nechako River, to improve stream functionality and water retention. Initially, 29 Beaver Dam Analog (BDA) locations were proposed, but a detailed risk assessment refined the scope to eight structures. These BDAs, constructed during the dry season using natural materials, were strategically placed to maximize ecological and hydrological benefits while adhering to site constraints. Additionally, four groundwater monitoring wells equipped with data loggers were installed to track water retention and infiltration. The project leveraged existing vegetation for stabilization, eliminating the need for erosion control measures, and minimized environmental disturbance during construction.

Monitoring plans were implemented to assess the BDAs' structural integrity, water retention capacity, and impact on local hydrology through seasonal and event-driven inspections. Proposed enhancements for 2025 include integrating a real-time telemetry system for one monitoring well, establishing a hydrometric station on Knight creek, and conducting drone-based mapping to document changes in stream conditions. Key lessons learned include the importance of pre-construction surveys, adaptive design based on risk assessments, and the value of collaboration with stakeholders. These insights will guide the continued restoration efforts, ensuring long-term sustainability and resilience for the Knight Creek ecosystem.

PROJECT DESCRIPTION AND LOCATION

Avison Management Services Ltd. (AMS) was retained by the Nechako Environment and Water Stewardship Society (NEWSS) to assess, design, and manage restoration efforts along a segment of Knight Creek, a tributary of the Nechako River. The primary objective of this project is to enhance stream functionality and water retention through the strategic installation and monitoring of Beaver Dam Analogs (BDAs). This summary outlines the activities undertaken at Knight Creek, located on the private property of Stuart Hall.

Prior to the commencement of construction, the placement of BDAs was planned to maximize ecological and hydrological benefits. Site-specific factors—including topography, stream grade, and accessibility—were analyzed to determine the most effective locations for BDA installation. An initial plan was developed to construct 29 BDAs across the site. After an in-depth risk assessment only eight BDAs were selected to be built.

To ensure the feasibility and safety of the project, a comprehensive risk analysis was conducted. This analysis evaluated potential challenges, including water storage capacity and downstream impacts. Due to water storage restrictions and other site-specific considerations, the scope was adjusted, resulting in the construction of eight BDAs. These were strategically placed within the southern portion of the property to provide ecological value while adhering to project constraints and accessibility (Figure 1). The constructed BDAs are expected to support improved water retention, enhanced habitat functionality, and increased resilience of the stream ecosystem.

Figure 1: Map location of BDAs on the property of Stuart Hall

Table 1: UTM locations of BDAs

Knight Creek - Hall			
Site	**Zone**	**Northing**	**Easting**
BDA 1	10U	5987039	438250
BDA 2	10U	5987057	438286
BDA 3	10U	5987121	438270
BDA 4	10U	5987271	438265
BDA 5	10U	5987323	438280
BDA 6	10U	5987362	438278
BDA 7	10U	5987386	438243
BDA 8	10U	5987389	438261

2024 ACTIVITIES

Construction occurred while the creek was dry as this location remains dry for the majority of the year. The BDAs were built according to the designs provided by Golder (Appendix A). Each structure consisted of layered willow branches and spruce boughs, built to a maximum height of one meter, with a combined water storage capacity of less than 300m³ (Table 1). The structures were capped with mud and rocks collected in situ from the local area. To finalize the structures, they were reinforced with stakes to ensure structural integrity and resilience against freshet flows (Figure 3).

Figure 2: Completed BDA

Table 2: Potential water storage of each BDA (m³)

BDA ID	Potential Water Storage (m³)
1	24
2	22
3	59
4	36
5	28
6	34
7	26
8	31
Total	**260**

To monitor groundwater recharge, four shallow groundwater wells were installed (Figure 3), each equipped with HOBO loggers. The wells were constructed using 10-foot sections of 6-inch PVC pipe, perforated to allow groundwater infiltration. The wells were installed to depths of 6–7 feet below ground level, surrounded by pea gravel, and capped with a clay layer to prevent surface water infiltration. The loggers were winterized using a combination of latex covers and an environmentally friendly antifreeze solution to ensure functionality during colder months.

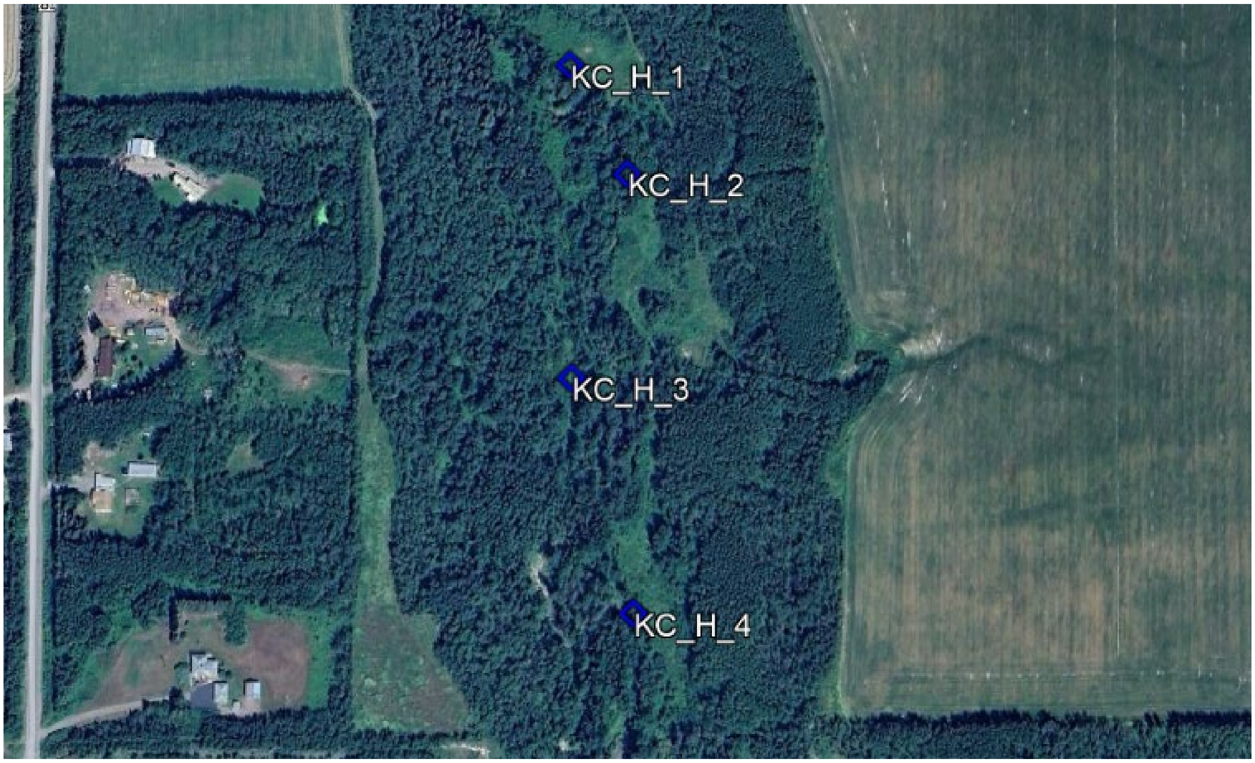

Figure 3: Location of groundwater wells

Given the site's characteristics, including the presence of well-established stands of deciduous and coniferous trees—primarily spruce and aspen—no erosion and sediment control (ESC) measures were deemed necessary to finalize the project. The natural vegetation provided adequate stabilization, mitigating the risk of erosion or sediment displacement.

At the time of demobilization, minor site cleaning was conducted to address residual materials and maintain overall site integrity. The area remained well-preserved and undisturbed during the project, reflecting the minimal environmental impact done by on-site staff.

MONITORING PLAN

1. **In-Person Water Retention Monitoring**
   - **Purpose:** Evaluate the structural integrity of BDAs (Beaver Dam Analogues), their effectiveness in retaining water, and their impact on local hydrology.
   - **Frequency:**
     - Conduct pre- and post-construction inspections (already completed).
     - Perform seasonal inspections: End of spring runoff, mid-summer, and fall during the open water season.
     - Conduct additional inspections after significant weather events (e.g., heavy rainfall or high runoff).
   - **Methodology:**
     - Conduct on-site inspections at designated monitoring points.
     - Assess seepage or signs of water loss through the BDA structure.
     - Evaluate signs of pooling, saturation, or changes in flow patterns around the BDA.
     - Record observations of sediment accumulation that might affect water retention.
     - Document observations regarding erosion, sediment accumulation, and any structural issues.
2. **Groundwater Monitoring**
   - Purpose: Track changes in groundwater levels to evaluate the BDAs' impact on water retention and infiltration.
   - Frequency:
     - Manual data collection: End of freshet, mid-summer, and fall.
     - Continuous data logging via HOBO loggers installed in all wells.
     - Real-time monitoring (one well integrated into a telemetry system).
   - Methodology:
     - Ensure all groundwater wells are maintained and loggers remain functional year-round.
     - Equip one well with a telemetry system to enable remote, real-time data collection.
     - Analyze data for trends in water table fluctuations corresponding to freshet flows and seasonal changes.
   - Output: Determine success based on changes to the groundwater system over time

Proposed Additions to Enhance Monitoring

1. Telemetry System Integration:
   - Potentially equip one groundwater well with telemetry hardware to enable continuous remote data transmission.
2. Performance Metrics for BDAs:
   - Define measurable indicators such as:
     - Structural integrity (e.g., no visible breaches).
     - Water retention (e.g., seasonal or year-round ponding and detectable groundwater storage increase).

NEXT STEPS AND LESSONS LEARNED

Planned Activities for 2025

The BDA installation program will continue in 2025 at other locations. This phase will include the addition of groundwater wells, instrumentation, and potential hydrometric stations for flow measurement. Furthermore, the installation of real-time telemetry unit is planned for the summer of 2025 to enhance monitoring capabilities.

Ongoing Monitoring

Monitoring activities initiated in 2024 for this site will proceed through the open-water season of 2025. These efforts will include drone-based mapping of Knight Creek to compare conditions before and after BDA installations if possible. In person inspections of the BDAs to ensure they are functioning and are maintaining their integrity

Lessons Learned from BDA Construction

The following key lessons were identified during the planning and construction phases of the BDAs:

1. **Understanding Risk:** The concept of process-based restoration has been around for more than 30 years in the United States, but has really just caught on in Canada in the last 3-4 years. As a result, provincial regulators are still trying to understand this process and how to best permit these activities. Understanding risk and liability is a crucial role of government as they weigh the risks and benefits of projects before approving them. As a result, the approval process for 2024 projects using BDA's took substantially longer than anticipated as practitioners had to help educated regulators regarding these processes and regulators had to rethink and decide how to regulate and approve these projects. While this was trying at times, government and practitioners worked together to lay the groundwork, and form a framework for which future projects can be evaluated. Good communication with regulators is key to this process. Now that an initial framework is in place and practitioners have a better understanding of the requirements of this framework, projects should be approved in a timelier manner.
2. **Understanding Process Based Restoration is Key**: Six key principles inform low-tech process-based restoration (Wheaton et al. 2019) . These principles are rooted in the notion that we are not designing and building the solution, but rather we are simply initiating and promoting natural processes with structural additions as efficiently as possible to maximize the miles of riverscape we can improve. Since the basic action we take with low-tech restoration is to add structures that promote and mimic wood accumulation and beaver dam activity, there is a natural tendency to focus on individual structures. While much can be learned at this structure scale, focusing on single structures leads to some major short-comings:
    - Over-designing every structure and losing sight of broader-scale riverscapes goals and objectives
    - Unnecessarily complicating the design process, making it more expensive, and less scalable
    - Following individual recipes too literally and rigidly; while missing opportunities for material substitutions,
    - creative adaptations to local situations, and possibilities to scale up more efficiently (i.e., build more structures),
    - Over-building structures primarily for stability, instead of recognizing that like a meal, it will be eaten, digested,
    - and processed by the system giving it the energy to exercise, build, maintain, create, and rearrange habitat.

3. **Simplicity in Design Encourages Feasibility:** The straightforward construction of BDAs using natural and locally sourced materials ensured ease of implementation and minimized environmental disturbances.
4. **Industrializing Key Project Components Increases Efficiency and Feasibility:** Where project access feasible, the use of heavy equipment can be used to complete projects. Where it may take 3-4 days to gather materials and build an BDA with staff and hand tools, an excavator with the right attachments can expedite this process to less than a day when constructing multiple BDA's and the process is mechanized. This is not always possible, but should be utilized where it makes sense.
5. **Sourcing Local Materials Increases Efficiency and Feasibility:** Using materials at or close to the site when available reduces haul times, and increases efficiency. Using local materials also reduces the risk of establishment of invasive weeds.
6. **Stakeholder Collaboration Promotes Project Success:** Cooperation with property owners and adherence to ecological principles ensured alignment with broader community and environmental goals.

DISCLAIMER

This report has been prepared by Avison Management Services to summarize the work conducted upon the completion of the Beaver Dam Analog (BDA) installations. The information contained herein reflects the scope of activities, findings, and lessons learned during the project. While every effort has been made to ensure accuracy, this report is intended for informational purposes only and should not be considered a comprehensive assessment or a guarantee of project outcomes. Avison Management Services accepts no liability for decisions or actions taken based on the contents of this report. For specific details or technical inquiries, please contact Avison Management Services directly.

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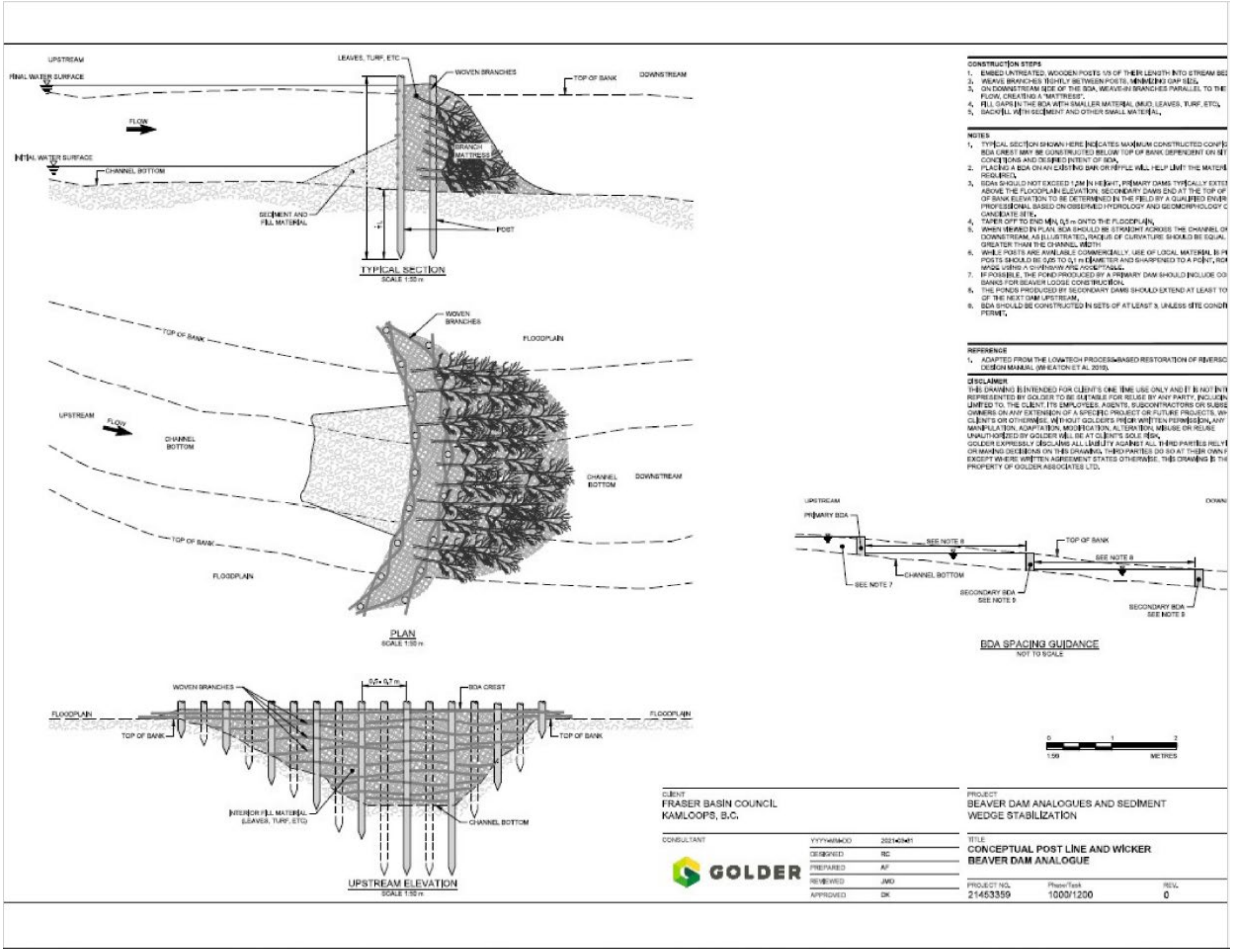
APPENDIX A – BDA CONCEPTUAL DESIGN



CONSTRUCTION STEPS

1. EMBED UNTREATED, WOODEN POSTS 1/3 OF THEIR LENGTH INTO STREAM BE
2. WEAVE BRANCHES TIGHTLY BETWEEN POSTS, MINIMIZING GAP SIZE.
3. ON DOWNSTREAM SIDE OF THE BDA, WEAVE-IN BRANCHES PARALLEL TO THE FLOW, CREATING A "MATTRESS".
4. FILL GAPS IN THE BDA WITH SMALLER MATERIAL (MUD, LEAVES, TURF, ETC).
5. BACKFILL WITH SEDIMENT AND OTHER SMALL MATERIAL.

NOTES

1. TYPICAL SECTION SHOWN HERE INDICATES MAXIMUM CONSTRUCTED CONFI BDA CREST MAY BE CONSTRUCTED BELOW TOP OF BANK DEPENDENT ON SI CONDITIONS AND DESIRED INTENT OF BDA.
2. PLACING A BDA ON AN EXISTING BAR OR RIFFLE WILL HELP LIMIT THE MATER REQUIRED.
3. BDAs SHOULD NOT EXCEED 1,5M IN HEIGHT, PRIMARY DAMS TYPICALLY EXTE ABOVE THE FLOODPLAIN ELEVATION. SECONDARY DAMS END AT THE TOP OF OF BANK ELEVATION TO BE DETERMINED IN THE FIELD BY A QUALIFIED ENVI PROFESSIONAL BASED ON OBSERVED HYDROLOGY AND GEOMORPHOLOGY C CANDIDATE SITE.
4. TAPER OFF TO END MIN. 0,5 m ONTO THE FLOODPLAIN.
5. WHEN VIEWED IN PLAN, BDA SHOULD BE STRAIGHT ACROSS THE CHANNEL O DOWNSTREAM, AS ILLUSTRATED, RADIUS OF CURVATURE SHOULD BE EQUAL GREATER THAN THE CHANNEL WIDTH
6. WHILE POSTS ARE AVAILABLE COMMERCIALLY, USE OF LOCAL MATERIAL IS P POSTS SHOULD BE 0,05 TO 0,1 m DIAMETER AND SHARPENED TO A POINT, RO MADE USING A CHAINSAW ARE ACCEPTABLE.
7. IF POSSIBLE, THE POND PRODUCED BY A PRIMARY DAM SHOULD INCLUDE CO BANKS FOR BEAVER LODGE CONSTRUCTION.
8. THE PONDS PRODUCED BY SECONDARY DAMS SHOULD EXTEND AT LEAST TO OF THE NEXT DAM UPSTREAM.
9. BDA SHOULD BE CONSTRUCTED IN SETS OF AT LEAST 3, UNLESS SITE CONDI PERMIT.

REFERENCE

1. ADAPTED FROM THE LOW-TECH PROCESS-BASED RESTORATION OF RIVERSC DESIGN MANUAL (WHEATON ET AL 2019).

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FRASER BASIN COUNCIL
KAMLOOPS, B.C.

PROJECT
BEAVER DAM ANALOGUES AND SEDIMENT
WEDGE STABILIZATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-01
DESIGNED	RC
PREPARED	AF
REVIEWED	JMD
APPROVED	DK

TITLE
CONCEPTUAL POST LINE AND WICKER
BEAVER DAM ANALOGUE

PROJECT NO.	Phase/Task	REV.
21453359	1000/1200	0

APPENDIX B – PROJECT PICTURES

Figure 4: Knight Creek in July, after freshet, prior to BDA construction

Figure 5: Knight Creek in July, after freshet, prior to BDA construction

Figure 6: Completed BDA

Figure 7: Completed BDA without posts

Figure 8: Completed BDA without posts