AVISON MANAGEMENT SERVICES LTD.

Leader in Environmental Services | Vanderhoof, BC

Knight Creek 2024 Stream Restoration Project – Jack Thomson

Date: January 6, 2025
Revised: January 20, 2025
Project No.: 24-41

Prepared for:
Nechako Environment and Water Stewardship Society
NEWSS
PO Box 2576
Vanderhoof, BC
V0J 3A0
Telephone: 250.567.0844

Prepared by:
Avison Management Services
220 Stewart St E
Vanderhoof BC
V0J 3A0
Telephone: 250.567.2111

www.avison.ca

CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

Avison Management Services Ltd. (AMS) has been engaged by the Nechako Environment and Water Stewardship Society (NEWSS) to oversee the restoration of Knight Creek, a tributary of the Nechako River, through the installation of Beaver Dam Analogs (BDAs) aimed at enhancing stream functionality and water retention. The project, located on Jack Thomson's private property, involves the careful placement of eight BDAs based on site-specific factors and constructed using willow branches, spruce boughs, mud, and rocks, reinforced to withstand freshet flows. Groundwater monitoring was implemented with three shallow wells equipped with HOBO loggers to track recharge and assess the BDAs' impact. Erosion and sediment control measures, including willow planting and site restoration, were applied to stabilize the streambanks and minimize sediment displacement. The project also includes comprehensive monitoring through drone imaging, groundwater data collection, and regular ESC assessments to evaluate structural integrity, water retention, and streambank stabilization. Proposed enhancements for 2025 include the integration of telemetry for real-time groundwater monitoring and the establishment of performance metrics for BDAs. Ongoing monitoring efforts will continue throughout the open-water season, with plans for further BDA installations at other locations, groundwater well expansions, and telemetry integration in 2025 to further improve data collection and analysis.

PROJECT DESCRIPTION AND LOCATION

Avison Management Services Ltd. (AMS) has been engaged by the Nechako Environment and Water Stewardship Society (NEWSS) to assess, design, and oversee restoration activities along a section of Knight Creek, a tributary of the Nechako River. The project specifically involves the installation and monitoring of Beaver Dam Analogs (BDAs) to enhance stream functionality and water retention. This document summarizes the work conducted within Knight Creek, located on the private property of Jack Thomson.

The placement of BDAs was carefully determined prior to the start of construction, with locations selected based on site-specific factors such as topography, grade, and accessibility to ensure the greatest ecological and hydrological benefits (Figure 1).

Figure 1: Map location of BDAs on the property of Jack Thomson

Table 1: UTM locations of BDAs

Knight Creek - Thomson			
Site	**Zone**	**Northing**	**Easting**
BDA 1	10U	5986312	438121
BDA 2	10U	5986350	438142
BDA 3	10U	5986366	438183
BDA 4	10U	5986352	438226
BDA 5	10U	5986486	438277
BDA 6	10U	5986526	438281
BDA 7	10U	5986546	438294
BDA 8	10U	5986591	438293

2024 ACTIVITIES

A total of eight BDAs were constructed along the specified portion of Knight Creek, as shown on the accompanying map. Construction occurred during the creek's dry season, as portions of Knight Creek are seasonally dry. 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 2). The structures were filled with mud collected in situ from the streambed, supplemented by material sourced externally and then further covered with willow and spruce boughs. They were reinforced with stakes to ensure structural integrity and resilience against freshet flows (Figure 2). In areas where water was present during construction, turbidity measurements were taken to ensure compliance with environmental regulations.

Figure 2: Completed BDA

Table 2: Potential water storage of each BDA (m^3)

BDA ID	Potential Water Storage (m^3)
1	16
2	17
3	21
4	30
5	23
6	19
7	31
8	26
Total	**183**

To monitor groundwater recharge, three 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 and to protect from damage during colder months.

Figure 3: Locations of shallow groundwater monitoring wells

Erosion and sediment control (ESC) measures were implemented to finalize the project. Willow planting was carried out to stabilize streambanks, while ruts created by equipment were smoothed and restored using a combination of seeding and hay application. These measures aimed to return the site to its pre-construction conditions and minimize sediment displacement.

MONITORING PLAN

1. Drone Imaging

- **Purpose:** Assess the structural integrity of BDAs, their ability to hold water, and the impact on the surrounding landscape.
- **Frequency:**
  - Pre- and post-construction imagery (completed).
  - Seasonal monitoring: End of freshet, mid-summer, and fall during the open water season.
  - Additional imagery after major weather events (e.g. freshet flows).
- **Methodology:**
  - Use a drone (e.g., Maverick Mini 2) to capture high-resolution images from the same flight paths and angles to ensure consistent comparisons.
  - Analyze imagery for signs of erosion, sediment deposition, structural failure and water storage.
- **Output:** Create comparative before-and-after imagery and reports for review.

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

3. Erosion and Sediment Control Monitoring

- **Purpose:** Assess the effectiveness of ESC measures in stabilizing streambanks and preventing sediment displacement.
- **Frequency:**
  - Visual inspections at the start and end of the open water season.
- **Methodology:**
  - Document streambank conditions, vegetation growth, and the presence of erosion or sediment displacement.
  - Use drone imagery to identify areas requiring maintenance.
  - Reassess ESC measures if failures are observed, and implement corrective actions as necessary.
- **Output:** Ensure that controls are affective and have not failed

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 ponding or all year ponding).
        - Vegetation regrowth (e.g., willow establishment on streambanks).

NEXT STEPS AND LESSONS LEARNED

Planned Activities for 2025

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

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.

This updated approach aims to enhance the efficiency and success of BDA installations in 2025.

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.

BIBLIOGRAPHY AND REFERENCES

Albertson, O. (2024). Knight Creek - Jack Thompson Property: Stream restoration project. [Unpublished document].

British Columbia Water Sustainability Act [SBC 2014] CHAPTER 15. Available at: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/14015

British Columbia Water Sustainability Act - WATER SUSTAINABILITY REGULATION B.C. Reg. 36/2016. Available at: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/36_2016

"Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table, . Canadian Council of Ministers of the Environment. 2007. Available at: https://www.ccme.ca/files/ceqg/en/backup/222-080516095450.pdf

Castro, J, M. Pollock, C. Jordan, G. Lewallen, and K. Woodruff. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. Version 2.0, June 30, 2017. https://www.fws.gov/oregonfwo/promo.cfm?id=177175812

Department of Fisheries and Oceans. 2014. A Modernized Fisheries Act for Canada. Available at: https://www.dfo-mpo.gc.ca/campaign-campagne/fisheries-act-loi-sur-les-peches/index-eng.html

Department of Fisheries and Oceans. 2019. Measures to Avoid Causing Harm to Fish and Fish Habitat. Available at: https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html

Department of Fisheries and Oceans. 2020. Projects Near Water. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html

Field Guide to Noxious and Other Selected Weeds of British Columbia, Fourth Edition, 2002. (Available at: http://www.agf.gov.bc.calcropproVweedguid/weedguid.htm)

Goldfarb, 2018. Beavers, rebooted. Science: Vol 360, Issue 6393 pp. 1058-1061 https://www.science.org/doi/10.1126/science.360.6393.1058

Matechuk, L. (2024). Nechako Environment Watershed Stewardship Society: Beaver Dam Analog Risk Assessment. [Unpublished document].

Ministry of Forests, Lands and Natural Resource Operations. 2012, revised, Fish–stream Crossing Guidebook. Available at: http://www.for.gov.bc.ca/HFP/Fish/Fish-Stream%20Crossing%20Print.pdf

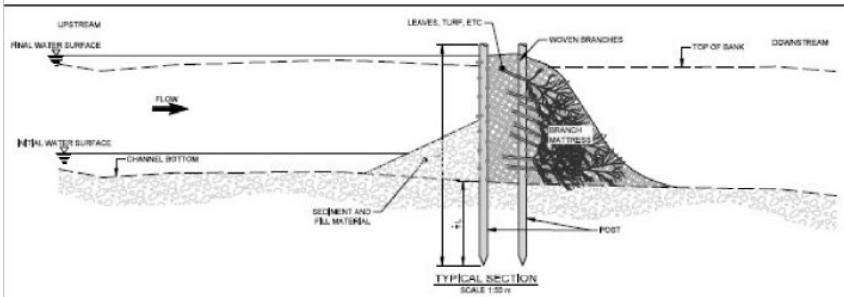
Ministry of Environment & Climate Change Strategy. 2019. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

Ministry of Environment. 2005. A USERS' GUIDE TO WORKING IN AND AROUND WATER. Available at: http://www.env.gov.bc.ca/wsd/water_rights/cabinet/working_around_water.pdf

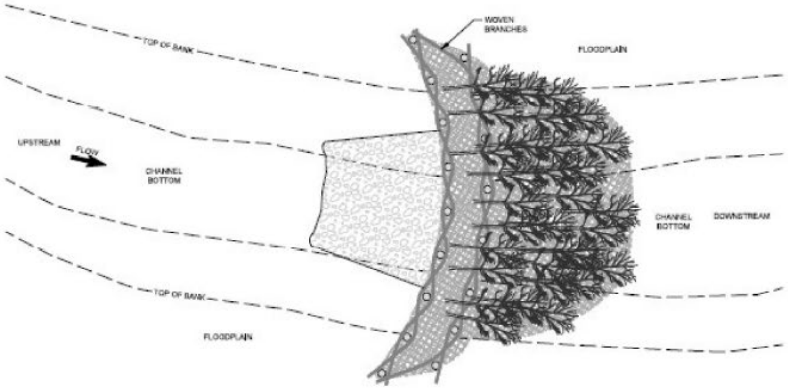
Polster, D.F. 2003. Soil Bioengineering for Slope Stabilization and Site Restoration.

Wheaton J.M., Bennett S.N., Bouwes, N., Maestas J.D. and Shahverdian S.M. (Editors). 2019. Low-Tech Process-Based Restoration of Riverscapes: Design Manual. Version 1.0. Utah State University Restoration Consortium. Logan, UT. 286 pp. DOI: 10.13140/RG.2.2.19590.63049/2.

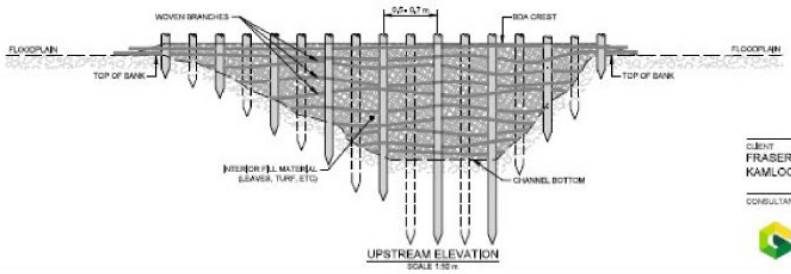
APPENDIX A – BDA CONCEPTUAL DESIGN



TYPICAL SECTION
SCALE 1:50 m



PLAN
SCALE 1:50 m



UPSTREAM ELEVATION
SCALE 1:50 m

CONSTRUCTION STEPS

1. EMBED UNTREATED, WOODEN POSTS 1/3 OF THEIR LENGTH INTO STREAM BED
3. WEAVE BRANCHES TIGHTLY BETWEEN POSTS, ALTERNATING CAP SIDES.
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

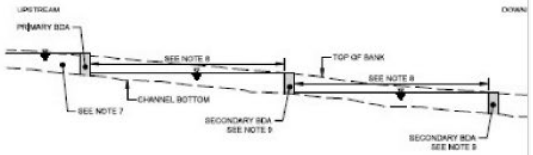
1. TYPICAL SECTION SHOWN HERE INDICATES MAXIMUM CONSTRUCTED CONFIG BDA CREST MAY BE CONSTRUCTED BELOW TOP OF BANK DEPENDENT ON SI CONDITIONS AND DESIRED INTENT OF BDA.
2. PLACING A BDA ON AN EXISTING BAR OR RIFFLE WILL HELP LIMIT THE MATERI REQUIRED.
3. BDAs SHOULD NOT EXCEED 1.2M IN HEIGHT. PRIMARY 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 ENVIR 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 OR 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 WHERE USING A CHAINSAW IS 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 LOWATECH PROCESS-BASED RESTORATION OF RIVERSC DESIGN MANUAL (WHEATON ET AL 2019).

DISCLAIMER

THIS DRAWING IS INTENDED FOR CLIENT'S ONE TIME USE ONLY AND IT IS NOT INT REPRESENTED BY GOLDER TO BE SUITABLE FOR REUSE BY ANY PARTY, INCLUDIN LIMITED TO, THE CLIENT, ITS EMPLOYEES, AGENTS, SUBCONTRACTORS OR SUBSE OWNERS ON ANY EXTENSION OF A SPECIFIC PROJECT OR FUTURE PROJECTS, WH CLIENT'S OR OTHERWISE. WITHOUT GOLDER'S PRIOR WRITTEN PERMISSION, ANY MANIPULATION, ADAPTATION, MODIFICATION, ALTERATION, MISUSE OR REUSE UNAUTHORIZED BY GOLDER WILL BE AT CLIENT'S SOLE RISK. GOLDER EXPRESSLY DISCLAIMS ALL LIABILITY AGAINST ALL THIRD PARTIES RELYI OR MAKING DECISIONS ON THIS DRAWING. THIRD PARTIES DO SO AT THEIR OWN R EXCEPT WHERE WRITTEN AGREEMENT STATES OTHERWISE, THIS DRAWING IS TH PROPERTY OF GOLDER ASSOCIATES LTD.



BDA SPACING GUIDANCE
NOT TO SCALE

0 1 2
1:50 METRES

CLIENT
FRASER BASIN COUNCIL
KAMLOOPS, B.C.

CONSULTANT
GOLDER

YYYY/MM/DD	2021/09/01	
DESIGNED	RC	
PREPARED	AF	
REVIEWED	JWD	
APPROVED	DK	

PROJECT
BEAVER DAM ANALOGUES AND SEDIMENT WEDGE STABILIZATION

TITLE
CONCEPTUAL POST LINE AND WICKER BEAVER DAM ANALOGUE

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

APPENDIX B - PROJECT PICTURES

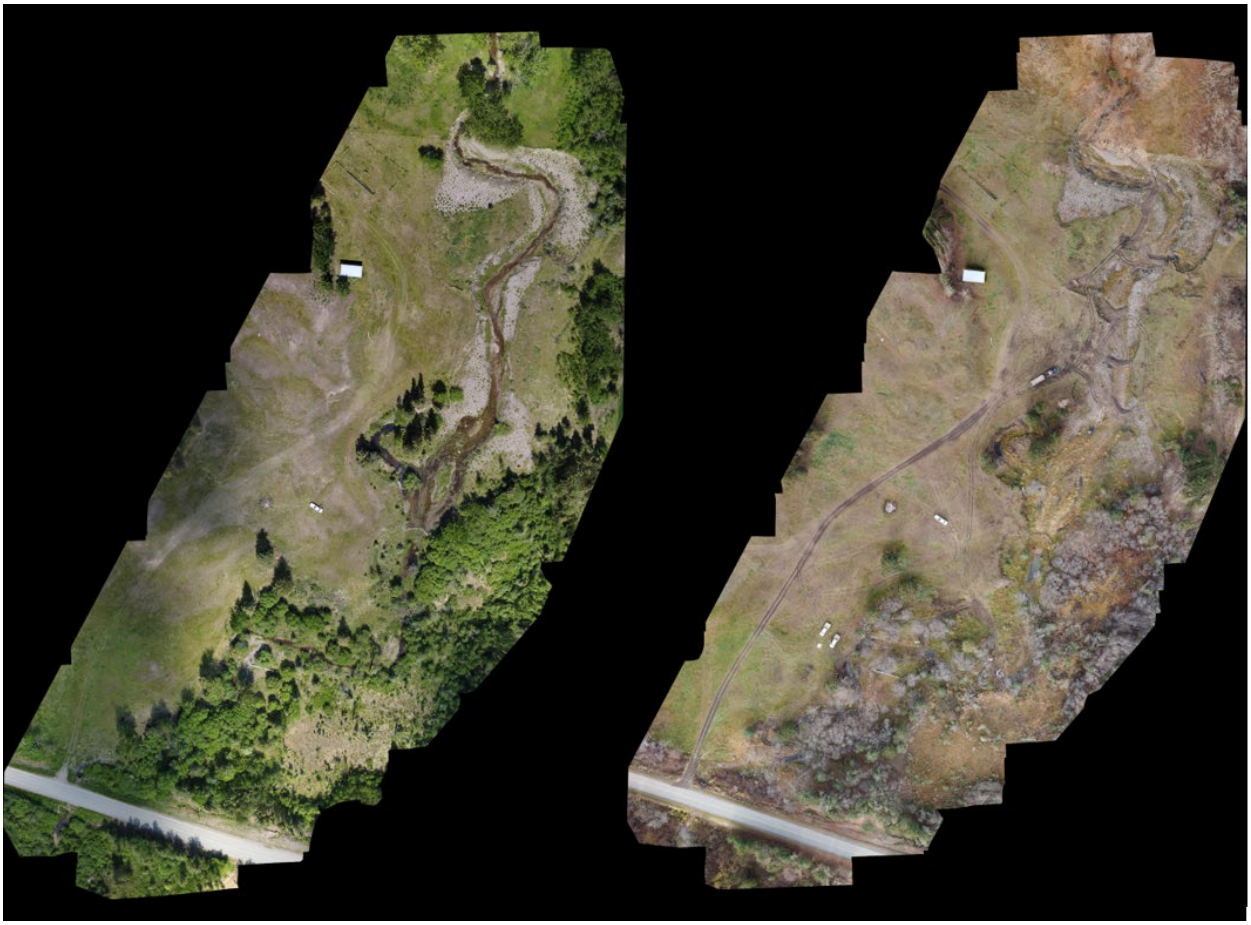


Figure 4: Before (June) and After (November) BDA construction – Aerial Imaging via drone

Figure 5: Knight Creek (June) Pre-construction of BDA

Figure 6: Knight Creek (June) Pre-construction of BDA

Figure 7: Knight Creek Post BDA Construction (October)

Figure 8: Knight Creek Post BDA Construction (October)

Figure 9: Knight Creek Post BDA Construction (November)