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Coats Marsh Dam Preliminary Decommissioning Plan

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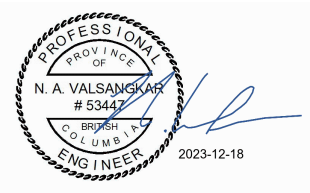

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- Nathan Valsangkar Project Manager, NHC
- Graham Hill Principal in Charge, NHC
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NHC partnered with EDI, who provided subconsultant environmental services:

- Randy Morris Environmental Planner/Biologist, EDI

EXECUTIVE SUMMARY

The Regional District of Nanaimo (RDN) engaged Northwest Hydraulic Consultants Ltd. (NHC) and subconsultant Environmental Dynamics (EDI) to prepare a decommissioning plan for the dam situated in Coats Marsh Regional Park on Gabriola Island, BC. Coats Marsh is a naturally occurring wetland, providing a rare example of this habitat in the Gulf Islands. The marsh has been modified substantially by human activities at the site, including historical blasting of the marsh outlet and eventual construction of the present-day dam. In 2010, RDN and The Nature Trust of BC acquired the property and established Coats Marsh Regional Park.

The existing dam is in poor condition and would need extensive reconstruction to meet safety standards. Adding to the complexity is a beaver dam, situated higher than the existing structure, which now holds most of the water in Coats Marsh. In April 2023, NHC submitted a dam replacement study exploring options to bring the structure into compliance with safety regulations. Subsequent to this study, the RDN Board and The Nature Trust of BC opted to decommission the dam while preserving the upstream beaver dam. This option aims to maintain current ecosystem conditions and biodiversity while adhering to provincial safety regulations.

This preliminary decommissioning plan marks the initial phase of design and planning and will be the subject of public engagement. Its primary goal is to align with provincial Dam Decommissioning Guidelines, ensuring the scope and standards are aptly defined to mitigate adverse consequences for various stakeholders.

The preliminary dam decommissioning design comprises several key elements:

- Removal of the berm adjacent to the concrete weir structure
- Removal of accumulated sediment near the weir
- Reduction of two-thirds of the weir's concrete height
- Retention of a 1.2 m high portion of the weir and filling the centre notch with new concrete. The concrete will function as a grade control structure, blocking the drainage channel that was historically used to drain the marsh.
- Placement of riprap and boulders upstream and downstream of the grade control structure
- Widening a portion of the outlet channel to mitigate beaver activity and improve flood conveyance capacity in the event of an upstream beaver dam failure.

Considerations such as sediment management, geologic conditions, site access, construction sequencing, and permitting are integral to the plan. Technical aspects involving geotechnical conditions, hydrology, fluvial geomorphology, First Nations interests, and infrastructure are detailed in Section 3 of the report. Further refinement of the design will occur post-public engagement to prepare it for the tender stage.

Construction will occur in late summer to minimize environmental impacts and provide drier working conditions. Heavy equipment will access the site via South Road and the existing RDN trail network. Vegetation clearing will be limited to the work area, or where danger trees may impact worker safety. During construction, water will be diverted around the work site to maintain downstream aquatic

habitat and keep the work area dry. All areas impacted by construction will be restored to appropriate habitats according to a detailed restoration and planting plan. The site restoration plan, overseen by registered professional biologists, focuses on converting disturbed areas into appropriate habitat types. Approximately 1,188 m^2 of existing marsh area will be restored as a mixture of seasonal wetland and upland habitats. Treatment area units include low-elevation marsh, mid-elevation swamp, riparian, and riparian transition zones. Monitoring programs, spanning up to 5 years, will ensure habitat restoration and control of invasive species.

The presence of the beaver dam in Coats Marsh will continue to remain a risk because, in the event of a beaver dam failure, a sudden release of water may flood downstream properties and infrastructure. RDN is currently undertaking a risk assessment to identify likely outcomes in the event of a beaver dam failure. While this risk assessment is not yet complete, early indications are that if a beaver dam failure occurred rapidly, the downstream culvert at South Road would be overwhelmed by the amount of flow. In this scenario, water would flow over South Road and likely lead to moderate or severe road damage.

When complete, the Coats Marsh Dam Decommissioning will bring the site to a state that can be accepted by provincial regulators while retaining the wetland habitat that the site is valued for. Ongoing monitoring and maintenance will be required to ensure successful site restoration. The project will not remove all risk associated with the existing beaver dam, but insights from the risk assessment will be beneficial for planning and managing residual risks. This preliminary plan provides details for public engagement, which will be completed before issuing the final dam decommissioning plan and designs.

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ABBREVIATIONS

Acronym / Abbreviation	Definition
CDA	Canadian Dam Association
Dia.	Diameter
DSO	Dam Safety Office of BC
DSR	BC Dam Safety Regulation
EDI	Environmental Dynamics Inc.
EGBC	Engineers and Geoscientists BC
MoTI	BC Ministry of Transportation and Infrastructure
NHC	Northwest Hydraulic Consultants Ltd.
RDN	Regional District of Nanaimo
TNT	The Nature Trust of BC
WSA	BC *Water Sustainability Act*

SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
m^3/s	Cubic metres per second
mm	Millimetres
ha	Hectares
<	Less than

1 INTRODUCTION

The Regional District of Nanaimo (RDN) and The Nature Trust of BC (TNT) co-own the Coats Marsh Dam, located on Gabriola Island. The dam consists of a 3.2 m tall concrete weir with a central notch filled with wooden flashboards, earthen berm, pond leveler, and associated structures. The dam is currently unlicensed but is regulated as a dam under the BC Dam Safety Regulation (DSR)[1] because of its reservoir storage volume. Previous engineering studies identified several deficiencies with the weir and its appurtenant structures relative to current dam safety standards (NHC, 2023; SRM Projects, 2020). Following an evaluation of dam replacement options, RDN and TNT propose to decommission the dam and return the marsh to a naturally regulated condition. Dam decommissioning was selected over replacement due to its lower capital cost and long-term asset management requirements. Under the DSR, dam decommissioning is a restricted activity; provincial authorization is required before decommissioning can proceed.

In September 2023, RDN retained Northwest Hydraulic Consultants Ltd. (NHC) and subconsultant Environmental Dynamics Inc. (EDI) to prepare a dam decommissioning plan meeting provincial requirements. The decommissioning plan follows three development phases:

1. Preliminary dam decommissioning plan. The role of this plan is to provide information to stakeholders, First Nations, and regulators with the goal of facilitating dialogue around the decommissioning design and project effects.
2. Stakeholder engagement, First Nations engagement, and regulatory referrals. The goal is to seek feedback on the preliminary plan and any concerns.
3. Final decommissioning plan, which is submitted to the province for approval prior to construction. The final plan refines the preliminary design information with amendments, where required, resulting from the engagement process.

This report is a preliminary dam decommissioning plan, reflecting phase 1 above.

Currently, the proposed scope of dam decommissioning includes the following elements:

- Leaving the existing upstream beaver dam in place to maintain habitat value
- Removing the existing weir and appurtenant structures, including the existing earthen berm
- Constructing a grade control structure at the marsh outlet to mitigate complete drainage of the marsh, which would otherwise occur due to historical lowering of the marsh outlet channel
- Constructing an overflow channel adjacent to the main outlet channel to better manage water levels near private property boundaries
- Revegetating disturbed areas with native plant species

[1] *Water Sustainability Act*, Dam Safety Regulation (B.C. Reg. 40/2016). Available at: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/40_2016#section17

The remainder of this report summarizes relevant background information, preliminary engineering design, and effects assessments required to support the decommissioning plan review and engagement process.

1.1 Description of Dam

Coats Marsh Dam is located in Coats Marsh Regional Park on Gabriola Island, BC. The dam is currently unlicensed, as it was only recently regulated under the *Water Sustainability Act* (WSA) and DSR. Table 1.1 summarizes key features of the dam, consisting of a concrete weir, earthen berm, and appurtenant structures.

Our knowledge of the dam's history relies on accounts and anecdotes from local residents; to date, no original design plans or documentation have been obtained for the structure. The following provides a brief summary of the dam's history (NHC, 2023):

- Early survey records from 1874/75 indicate that, at that time, Coats Marsh existed as an unforested swamp (Doe, 2021b). At some time in the early 1940s, the marsh was drained for agriculture by blasting and excavating a channel through the sandstone ridge at the west end of the marsh.
- At some time in the late 1960s to 1980s, the former landowner constructed the present-day concrete weir at the marsh outlet. The weir consists of two concrete walls formed against the sandstone bedrock; vertical grooves along the walls allow the installation of flashboards to manually adjust the marsh level. There was no water license issued to store or divert water at Coats Marsh.
- When RDN acquired the property in 2008, beavers had constructed a dam against the weir and obstructed the flashboard opening. A 0.2 m dia. Clemson Pond Leveler was installed in an attempt to manage beaver activity and upstream water levels.
- In 2013, an earthen berm was constructed at the west end of the marsh. The berm functions as a saddle dam to alleviate private property flooding beyond the RDN park boundary.
- After 2013, beavers became more active and established a dam approximately 60 m upstream of the weir structure. As of 2023, the beaver dam has a crest elevation approximately 0.7 m above the concrete weir elevation and 1.3 m above the flashboards. In 2021, RDN installed four 0.1 m diameter siphons over the beaver dam to reduce water levels upstream.
- In 2022, the provincial Dam Safety Office (DSO) determined that the DSR should apply to Coats Marsh Dam on the basis that Coats Marsh is a "stream" under the WSA. Based on findings by NHC, the dam's preliminary consequence classification is "High".

Table 1.1 Summary of key dam features.

Dam Feature	Value
General	
DSO file no.	D720188
Location	UTM 10N 440530 E 5444730 N
Proposed consequence classification	High
Original construction	Unknown (est. 1960s to 1980s)
Water license no.	Currently unlicensed
Reservoir[1]	
Surface area	4.6 ha at the concrete weir crest elevation
Volume at the flashboard elevation (96.4 m)	16,080 m^3
Volume at the concrete weir crest elevation (97.0 m)	38,950 m^3
Concrete Weir and Spillway	
Weir crest elevation	97.0 m
Max. weir height above downstream channel	3.3 m
Weir width	0.6 m
Weir length	6.2 m
Flashboard elevation	96.4 m
Width of flashboard opening (i.e., spillway width)	0.6 m
Width of downstream channel	1.5 to 1.7 m at base with steep side slopes
Foundation conditions	Fractured sandstone bedrock
Concrete design parameters	Unknown concrete mix design. The presence or absence of reinforcement, dowelling, and keyways is unknown.
Earthen Berm	
Embankment type	Homogeneous earthfill with a geotextile wrap
Embankment crest elevation	97.3 m
Normal freeboard above flashboard	0.9 m
Normal freeboard above weir crest	0.3 m
Crest width	2 m
Embankment height	1.5 m
Side slopes	Approximately 2H:1V
Foundation conditions	Marsh bottom sediments. No key excavation or stripping.

Dam Feature	Value
Other Features	
Outlet pipe	0.2 m diameter PVC Clemson Pond Leveler
Instrumentation	Staff gauge at the weir and the beaver dam
Access features	Footbridge constructed directly over the weir
Signage	None
Debris boom	None

1.2 Description of Reservoir

The reservoir upstream of Coats Marsh Dam has a history of being drained and filled by operating the flashboards. The reservoir is located along the main drainage creeks in the watershed and there are no diversions or spillways around the weir. The contributing watershed area above the weir is 1.454 km^2. The marsh was fully drained and in use for agriculture as recently as 2003. There are relic agricultural features known to be present within the marsh, such as a drainage ditch and concrete cisterns. Since the early 2000s, the flashboards have been in place and the marsh has remained wetted.

Since 2013, beaver activity increased upstream of the weir. The beaver dam impounds up to 1.3 m of water above the "normal" marsh level that would be set by the flashboards. The combined storage volume behind the weir and beaver dam is, as of 2023, the highest it has been since historical records have been available. The operating range of the reservoir has fluctuated significantly in the last 20 years, with water levels increasing along with beaver dam height, occasionally overtopping the weir, and experiencing lower water conditions caused by summer evaporation and RDN operations of the siphon system. In 2023, NHC conducted a limited bathymetric survey in the region between the weir and beaver dam; bathymetric data in the reservoir upstream of the beaver dam is from 2010 RDN data with limited coverage of the weir site.

A description of the marsh's environmental features in relation to the decommissioning plan is provided in Appendix C.

1.3 Description of Land Status

Coats Marsh Dam is located in Coats Marsh Regional Park, which was acquired by RDN and The Nature Trust of BC (TNT) as equal partners in 2008. The park was acquired partially using funding from the Environment and Climate Change Canada Ecological Gifts program, which places some restrictions on land-use changes for the site. Environment and Climate Change Canada has indicated their support for decommissioning the dam while leaving the beaver dam in place (see Section 2).

The "regional park" status distinguishes Coats Marsh as being valuable on a regional level for its ecological services and unique habitat, as opposed to community parks, which are intended primarily for use by locals. Regional status means that decisions regarding the park are made by the entire RDN Board, which includes input from directors throughout the Regional District of Nanaimo. Coats Marsh provides a relatively rare example of a wetland within BC's Gulf Islands. A Management Plan for Coats Marsh Regional Park was published in 2011. Since then, the adjacent 707 Community Park has been

expanded south and west to border Coats Marsh Regional Park along its northern and eastern borders, forming a larger continuous park area (Figure 1.1). To the south and west of Coats Marsh Regional Park are large rural residential lots.

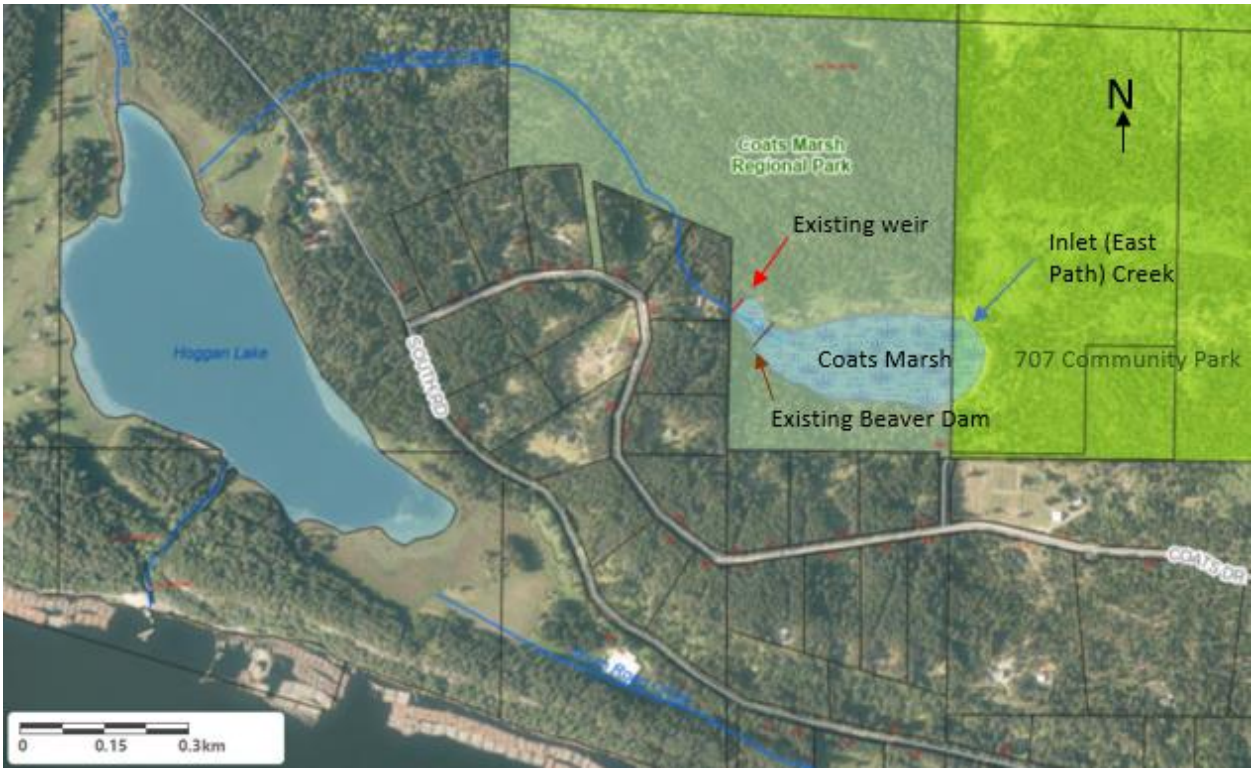

Figure 1.1 Project overview map, modified from RDN (2022).

1.4 Identification of Water Rights Holders

Figure 1.2 illustrates the locations of groundwater wells and surface water licenses in the area around Coats Marsh. In the figure, the blue markers indicate groundwater wells located within the rural properties along Coats Drive, which are used for domestic purposes. Lithography records indicate that most of these wells draw from fractured bedrock aquifers at depths about 50 to 70 m below the ground surface. Coats Marsh Dam itself is currently unlicensed, and there are no surface water licenses along Coats Marsh Creek between Coats Marsh and Hoggan Lake. At Hoggan Lake, there are nine active water licenses held by a single landowner. Hoggan Lake Dam is licensed to store and divert up to 148,000 m^3/year for power production, and 76,476 m^3/year for other purposes, including domestic use, irrigation, and commercial water delivery. West of Coats Marsh, there are two surface water licences at 1035 Coats Drive that are associated with springs.

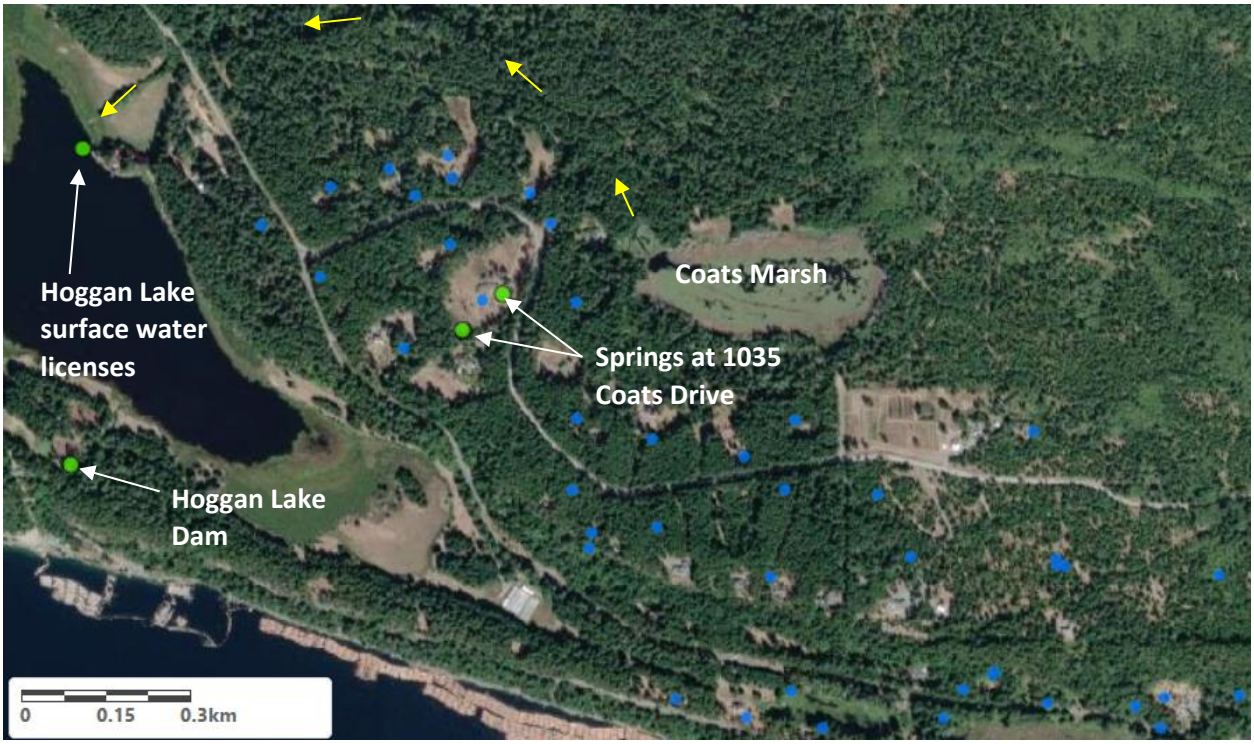

Figure 1.2 Water licenses and groundwater wells in the area around Coats Marsh. Light green points show locations of surface water licenses; blue points show groundwater wells; yellow arrows shows the general direction of flow in Coats Marsh Creek. Map created from iMap BC with ESRI imagery.

1.5 Identification of Stakeholders

NHC and RDN have prepared a list of stakeholders and parties who may be affected by the proposed decommissioning work. All will be notified as part of the engagement process.

- Snuneymuxw First Nation
- Regional District of Nanaimo
- The Nature Trust of BC
- Islands Trust
- Gabriola Lands and Trails Trust
- Gabriola Streamkeepers
- Gabriola Fire Department
- BC Ministry of Transportation and Infrastructure
- BC Ministry of Water, Land, and Resource Stewardship
- Environment and Climate Change Canada, Ecological Gifts Program

- Downstream surface water license holders at 1035 Coats Drive, 825 South Road (Gabriola Golf Club), and for the hydroelectric dam on the outlet of Hoggan Lake
- Downstream property owners through which the outlet creek travels at 1034 and 1040 Coats Drive, and 825 South Road (Gabriola Golf Club)

1.6 Previous Studies

The following studies are available and have been reviewed in preparing the decommissioning plan.

- *Coats Marsh Weir Replacement Elevation Study – Final Report* (NHC, 2023)
- *A Proposed Strategy for Water Level Management – Coats Marsh, Gabriola Island, BC* (Madrone Environmental Services Ltd., 2021)
- *Coats Marsh Weir Assessment* (SRM Projects, 2020)
- *Post-Construction Report – Coats Marsh Flood Protection Berm* (Madrone Environmental Services Ltd., 2013)
- *Coats Marsh Regional Park – 2011-2021 Management Plan* (RDN, 2011)
- Citizen-science studies from local Gabriola Island resident N. Doe (2020, 2021b, 2021a, 2022)

The *Coats Marsh Weir Replacement Elevation Study* (NHC, 2023) is the most recent engineering study carried out for the dam. The study evaluated several dam replacement options, as well as a decommissioning option.

2 PRELIMINARY DECOMMISSIONING DESIGN

The Coats Marsh Weir replacement study (NHC, 2023) included a conceptual decommissioning plan in the event that RDN elected to decommission, rather than replace, the dam. The plan identified a series of design components to remove the dam structures and restore the site to a safe and stable condition.

The preliminary decommissioning design refines the conceptual plan and includes the following elements:

- Decommissioning of the existing dam, including the earthen berm and appurtenant structures
- Construction of a grade control structure at the marsh outlet to mitigate complete drainage of the marsh, which would otherwise occur due to historical lowering of the marsh outlet channel
- Construction of an overflow channel adjacent to the main outlet channel to better manage water levels near private property boundaries
- Revegetation of disturbed areas with native plant species

The remainder of this section summarizes the preliminary decommissioning design, assuming the beaver dam that is 50 m upstream will be left in place. Appendix A includes the preliminary decommissioning design drawings.

2.1 Beaver Dam Management

An important consideration for the plan is whether the existing beaver dam upstream of the weir should be removed or left in place. Normally, dam decommissioning requires post-construction monitoring to ensure that beavers do not re-dam the reservoir and create a public safety hazard. The Coats Marsh Weir replacement study (NHC, 2023) recommended beaver dam removal, as this approach is most acceptable to the DSO and reduces long-term liability for RDN. However, NHC recognizes that Coats Marsh is unique in that a beaver dam is already present in a location separate from the weir and enables natural storage that would have existed prior to historical bedrock excavation at the site.

In fall 2023, DSO indicated that they are prepared to accept a decommissioning plan that leaves the beaver dam in place (D. Johnson, pers. comm.). The advantage of keeping the beaver dam is that the environmental values of the marsh and present species diversity would be largely retained. Following internal discussions, RDN and TNT have decided to proceed with this approach and received RDN Board approval to do so. However, we note that RDN and TNT, as landowners, will retain long-term liability for any beaver dam-related flooding. NHC is not prepared to certify, warranty, or otherwise "sign off" on the beaver dam's stability or future conditions.

NHC has prepared the preliminary decommissioning design with the beaver dam that is 50 m upstream left in place.

A study of potential beaver dam breach effects is presently being conducted and will be considered in the final design to balance risk mitigation with habitat protection. Results from this assessment will be available as an addendum to this preliminary decommissioning plan to support.

2.2 Design Guidelines and Standards

This preliminary decommissioning design reference the following design standards and guidelines.

- Regulations and EGBC professional practice guidelines:
  - British Columbia Dam Safety Regulation (B.C. Reg. 40/2016)
  - *Sustainability – APEGBC Professional Practice Guidelines V1.1* (APEGBC, 2016b)
  - *Site Characterization for Dam Foundations in BC – APEGBC Professional Practice Guidelines V1.2* (APEGBC, 2016a)
  - *Practice Advisory – Determining Dam Hydrologic Loading V1.0* (EGBC, 2022)
- Provincial guidelines:
  - *Dam Decommissioning Guidelines – BC Dam Safety Program* (BC FLNRORD, 2019)
  - *Downstream Consequence of Failure Classification Interpretation Guideline* (BC FLNRORD, 2017)
  - *Estimating Dam Break Downstream Inundation* (BC MFLNRO, 2016)
  - *Manual of Operational Hydrology in British Columbia* (BC MOE, Water Management Division, 1991)

- *Project Cost Estimating Guidelines* (MOTI, 2020)

- Federal guidelines:
  - Canadian Dam Association *Dam Safety Guidelines* (CDA, 2013)
- Other guidelines:
  - *Design of Small Dams* (USBR, 1987)

2.3 Datums and Coordinate Systems

The following survey datums and coordinate systems are used throughout this report and in associated design drawings.

- Elevations are geodetic and referenced to CGVD2013.
- Horizontal coordinates are referenced to UTM Zone 10N.
- References to left and right banks or left and right dam abutments assume a downstream view.

2.4 Dam Decommissioning

The objective of decommissioning is to remove the weir, earthen berm, and appurtenant structures such that there is no man-made reservoir impoundment above the existing marsh grade. The DSR requires that decommissioning be carried out in a way that mitigates adverse impacts to public safety, the environment, and infrastructure and property.

2.4.1 Removals

As part of decommissioning, the existing footbridge, Clemson Pond Leveler, and wood flashboards will be removed. The footbridge may be dismantled and disposed or repurposed for use at another site. The majority of the concrete weir will be removed; some concrete will be retained along the base of the outlet channel to form part of a permanent grade control structure (see Section 2.4.2). It is anticipated that concrete debris will be disposed of off site.

An important consideration for the decommissioning plan is whether to remove the existing berm or leave it in place. If the berm is left in place, it will be considered residual works and RDN will have long-term responsibility for monitoring and maintenance. Future beaver activity could result in re-filling of the marsh and weir pool, to the point that the berm functions as a permanent water retention structure (i.e., a dam). The berm was not designed to current dam standards and has several deficiencies of concern for its long-term integrity (see Section 3.1). However, the incremental consequences of berm failure appear to be low; downstream inundation would likely be limited to low-lying yard and garden areas at 1040 Coats Drive, though this has not been assessed in detail. At RDN's direction, the preliminary decommissioning plan assumes that the berm will be removed (J. Vander Klok, pers. comm.). Removal will involve stripping the berm fill and geotextile materials down to native subgrade, with subsequent revegetation planting during site restoration (see Section 2.5).

2.4.2 Outlet Channel Work

Dam decommissioning normally involves restoration of the outlet channel to its pre-dam elevation, while ensuring the channel is adequately sized to convey flood flows. However, Coats Marsh is unique in that the outlet has been artificially lowered by historical blasting and drainage ditch excavation (see Section 1.1). Restoring the outlet to its pre-dam elevation would require infilling the channel by 2.5 m to 3.0 m, effectively creating a new dam and triggering water license requirements.

As an alternative to full-height channel infilling, the outlet channel design includes a reduced-height grade control structure with a crest elevation of 95.0 m. The structure footprint will be limited to infilling the existing drainage ditch, which is a 1.2 m to 1.5 m deep rectangular channel that was historically excavated. The structure will not impound any water above the marsh's natural base elevation, but will retain some wetted area and convey flood flows during high water events. The grade control structure will also provide some sediment storage capacity in the event of upstream erosion or a beaver dam failure.

To construct the grade control structure, the centre of the remnant weir concrete will be filled with new concrete and doweled into the bedrock and existing concrete with rebar. The concrete core will form a water-resistant barrier. Riprap will be positioned upstream and downstream of the concrete to provide buttressing and ensure channel stability in high-flow events. Boulders will be positioned in the outlet channel to further dissipate energy. Some bedrock will be excavated on the left bank above the outlet channel to act as a secondary overflow channel. The overflow would have an opening of 4 m at an elevation of 96.0 m and would taper to merge with the outlet channel near the property line. The secondary overflow channel will provide additional discharge capacity in the event of an upstream beaver dam breach or other large flood events. The wider opening will also be more difficult for beavers to block than the narrow outlet channel.

2.5 Sediment Management and Reservoir Restoration

The majority of the existing reservoir area will not be impacted by decommissioning of the dam due to the presence of the beaver dam 50 m upstream. Most excavated soil will be used as fill on higher portions of the existing weir pool area to limit off-site disposal, as shown in the design drawings. The weir pool area will be locally recontoured to promote seasonal wetland habitat despite a lower outlet elevation, planted with a mix of native species appropriate for riparian and upland conditions, and monitored to control spread of invasive plant species. For construction, the marsh above the beaver dam should not be drawn down below normal operating levels for late summer, which will ensure that ecological health is maintained during construction. Appendix C includes a preliminary planting prescription and site restoration plan prepared by EDI.

In the event of a beaver dam failure, sediment from the dam and upstream of the dam may be mobilized. The grade control structure will mitigate some mobilization of sediment to the downstream channel, but will likely not control all sediment.

2.6 Permitting Considerations

The following permits and authorizations will be required prior to construction. Additional detail on environmental permitting requirements is provided in Appendix C.

- DSO construction authorization under Division 3 of the DSR
- Provincial Water Sustainability Act (WSA) Section 11 authorization for work in and about a stream
- Fisheries and Oceans Canada Request for Review
- Provincial wildlife permit for amphibian salvage during construction

2.7 Construction Sequence and Schedule

The following is a potential construction sequence to decommission the dam and restore the site. Note that the construction sequence is conceptual and is intended for planning purposes only; the means and methods of construction are the contractor's responsibility.

1. Mobilization and site preparation: the contractor will mobilize all required equipment and materials to site. Site access is available through the RDN trail network, with public road access points at Stanley Place and Coats Drive. Localized brushing and tree limbing will be required to facilitate access, staging, and safe work. Site fencing and project signage will be required for public safety.
2. Water management: site dewatering will be required to carry out work in the dry. If there is flow in the outlet creek, it will be necessary to provide a diversion around the worksite to maintain base flow rates for downstream aquatic habitat. Post-construction flow releases may also be necessary until natural flow has been re-established over the grade control structure. The following approaches, or a combination thereof, could be considered for site isolation. Regardless of the approach, it will be important to design the dewatering system to handle additional inflow in the event of precipitation.
    a. Using a man-made cofferdam (i.e., bulk bags or similar products) to provide site isolation, with continuous pumping or regular releases of flow to the downstream area to maintain flows to downstream.
    b. If flows were present at the start of construction, natural flows should be re-established through the area before complete demobilization to ensure continuous flow to downstream aquatic habitats. The existing siphons or an alternative pumping system may draw a relatively small amount of water from the marsh above the beaver dam to achieve this.
    c. If there is no surface flow to the outlet creek at project commencement, site water management may not be required as an ongoing operation, but capacity for site isolation should be made available in advance of any rainfall event to ensure site safety and prevent uncontrolled sediment release.
3. Berm removal and drainage channel construction: the berm fill will be removed and disposed of, and the drainage channel will be excavated. It will be necessary to carry out localized rock excavation along the drainage channel due to the presence of sandstone bedrock. If the

sandstone is not rippable, it will be necessary to use a hydraulic breaker or similar equipment. Blasting may not be appropriate due to the proximity of existing homes and the relatively small rock excavation volumes.

4. Dam decommissioning: the footbridge, concrete, and pipeworks will be removed and disposed of off site. Sediment and beaver dam debris will be removed from the upstream face of the weir to facilitate concrete demolition and construction of the grade control structure. Machine access into the marsh may require the use of swamp mats or other techniques due to soft bottom conditions. Concrete removal may involve saw cutting to the final design elevation, as well as hammer breaking or ripping with an excavator.
5. Grade control structure construction: the remaining weir concrete will be reinforced with new concrete to form a low sill, with rockfill installed upstream and downstream. Localized foundation preparation will involve the removal of loose rock and debris from the concrete pour area. Reinforcement and waterstops will be placed at the interface between new and old concrete prior to pouring. Rockfill will be placed by machine, and toe boulders will be placed at the limits of rockfill to mitigate sliding.
6. Site restoration: the dewatered marsh sediments and areas disturbed during construction will be revegetated. Temporary dewatering and erosion control materials will be removed from site, and the contractor will demobilize its crew and equipment.

Construction is anticipated to be conducted during the least risk timing window for downstream cutthroat and rainbow trout. In-stream construction is planned to be completed between August 15 and September 15. This time of year also bears the least risk for significant rain events and avoids the breeding season for native amphibians. Table 2.1 provides an approximate schedule for the sequencing of construction activities. Demobilization of heavy equipment can likely occur simultaneously with restoration, as some equipment may still be needed on site for final works.

Table 2.1 Proposed construction schedule.

Task	Duration (Days)	Period
Mobilization	1 to 3	Week 1
Water Management and Site Preparation	2 to 4	Week 1 to Week 2
Removals	5 to 8	Week 3 to Week 4
Outlet Channel Work	5 to 8	Week 5
Demobilization and Restoration	5 to 8	Week 6

2.8 Performance Monitoring and Adaptive Management Plan

Once decommissioning is complete, it will be important to monitor the site to ensure that project objectives have been met. A detailed performance monitoring and adaptive management plan will be included with the final decommissioning design; we anticipate that the plan will include the following elements, which are normally implemented for a period of one to five years:

- Monitoring the stability of the grade control structure and beaver dam

- Monitoring water levels in the marsh and at downstream culverts to identify any capacity issues
- Monitoring the success of revegetation planting
- Monitoring for invasive plant and wildlife species
- Adaptive responses to the monitoring activities, which could include increased revegetation efforts, beaver dam management, enhancement of wetland features, and replacement of undersized infrastructure
- Long term monitoring and maintenance will be required to ensure that the site is in generally adequate condition and that beavers do not dam the lake outlet.

The site owners, RDN and TNT, have responsibility for ongoing monitoring and maintenance of the decommissioned dam site, although environmental monitoring services and warranty conditions may be included as part of the construction contract.

3 SITE CHARACTERIZATION AND EFFECTS ASSESSMENTS

A site characterization and technical assessments were completed for the Coats Marsh Dam replacement study (NHC, 2023). The following subsections summarize the information and assessments of relevance to dam decommissioning, supplemented with additional research where required.

3.1 Geotechnical and Structural Stability

The existing weir structure is located in the blasted marsh outlet channel, with the channel bed and side walls consisting of fractured sandstone bedrock. The weir itself is constructed of concrete; however, it is not known whether the concrete is reinforced, and whether there are keyways or dowels present at the bedrock interface. Previous studies by NHC and SRM (2023; 2020) identified concerns with the long-term integrity of the structure, including concrete surface deterioration, cracking, and abutment seepage. The upstream face of the weir has not been viewed due to accumulated sediment and therefore its condition is not known.

The decommissioning plan proposes to leave a 1.2 m height of concrete in place and to install additional concrete and rock buttressing to form a grade control structure. The following summarizes key safety considerations related to this work:

- The new concrete will be joined to the existing concrete with doweled construction joints to improve internal stability. On its own, the concrete is not expected to provide a water-resistant seal given the relatively poor condition of the existing concrete and the presence of fractured bedrock at the abutments Bentonite and poly sheeting will be applied to the bed, concrete face, and channel side walls to reduce seepage rates.
- NHC has not carried out a static or seismic stability analysis of the grade control structure due to its low height and the presence of buttressing rockfill upstream and downstream. Based on professional judgement, we anticipate that the structure's static stability will be adequate under normal loading conditions. Concrete cracking may occur during a seismic event and result in leakage. However, the grade control structure will not impound water above the existing marsh

grade and leakage volumes would be limited to water present within the upstream drainage ditch.

- It is possible that future beaver activity will result in debris accumulation over top of the grade control structure and additional upstream impoundment. The downstream rockfill has been over-sized to account for increased hydraulic loading; however, it is possible that beaver dam failure could result in downstream infrastructure damage for which RDN could be found responsible for. NHC is currently completing a beaver dam risk assessment to evaluate the potential consequences of beaver dam failure and whether mitigation is warranted.
- The pedestrian bridge will be removed as part of this project, resulting in a vertical drop of approximately 2 m that can be fenced or signed if desired. If RDN wishes to pursue trail extensions along the west and south sides of Coats Marsh, the pedestrian footbridge could be relocated to a different location along the outlet channel, or replaced with a longer structure.

The decommissioning plan currently assumes that the existing berm will be fully removed down to natural subgrade. However, it is possible that stakeholder engagement, regulatory referrals, or First Nations engagement could be favorable to leaving the berm in place. We note that previous studies by NHC (2023) and SRM (2023; 2020) identified concerns with the berm's long-term stability, including non-standard crest width and slope geometry, a lack of foundation preparation during initial construction, inadequate freeboard, exposed geotextile, and trees growing directly into the embankment fill. These issues merit further discussion with the regulator if there is a change in project direction regarding removal or retention of the berm.

With the beaver dam being left in place, marsh storage will rely on natural features whose stability and geometry will change over time. NHC is not qualified to quantify the beaver dam's stability or likelihood of failure; however, the following information is provided for discussion based on our professional experience.

- When the weir is removed, downstream water levels will decrease and there will be a greater water surface differential across the beaver dam. This will decrease the dam's static stability compared to existing conditions.
- With the decrease in downstream water levels, the face of the beaver dam will have regular air exposure, which may accelerate the deterioration of its constituent wood debris.
- The beaver dam has been in place for over a decade and has inundated much of the surrounding marsh. Over time, the availability of suitable forage vegetation will decrease, and the beavers may abandon the site or reduce their activity at the existing dam location. If this occurs, the dam will likely deteriorate, and it may be necessary to pre-emptively breach the dam or draw down the upstream marsh to mitigate the effects of a dam failure.

3.2 Hydrogeological Assessment

Groundwater studies for Gabriola Island were conducted by Burgess and Allen (2016) and further documented in Burgess (2017). Fractured bedrock represents the main aquifer material, with fractures generally having moderate permeability and low storage capacity. Precipitation is the dominant source of aquifer recharge, and is thought to occur relatively quickly in areas of thin, well-drained soils (SRK Consulting, 2013). Drill logs from residential wells along Coats Drive indicate static groundwater depths

around 12 m to 27 m below ground surface at the time of well installation[2]. A nearby residential property at 1035 Coats Drive has a water licence for surface water diversion at two springs (see Figure 1.2), which indicates the presence of localized artesian flow or shallow groundwater seepage.

Surficial materials around Coats Marsh consist of a sparse and thin layer of glaciomarine sediments above fractured sandstone bedrock. Existing soil maps indicate that most or all of the wetland is underlain by very poorly drained soils (Agriculture Canada, 1990). Test pits around Coats Marsh have identified the presence of a poorly-drained fine-grained soil, which appears to validate the available soil mapping (Doe, 2021a; NHC, 2023; RDN, 2011).

The potential effects of dam decommissioning on local hydrogeology are uncertain. Any potential effects would likely relate to groundwater-surface water interactions, which have not been studied in detail at this site. A detailed hydrogeology study would require field investigations and, likely, numerical modeling analysis that is outside the scope of a preliminary decommissioning plan. Instead, NHC has prepared the following qualitative discussion based on available information:

- If poorly drained soils are present below the marsh, the magnitude of groundwater-surface water interaction is likely low compared to other sites on Gabriola.
- It is possible that there are localized areas in the marsh with a greater degree of groundwater interaction. For example, there is a historical drainage ditch along the marsh centreline that terminates at the weir. It is possible that the ditch was excavated down to bedrock over its entire length, representing a zone of increased groundwater interaction compared to other areas of the marsh. It is also possible that the bedrock fractures have plugged with fine sediment over time, reduced their permeability compared to when the ditch was originally excavated.
- Most of the marsh's storage volume is governed by the beaver dam, which is proposed to remain in place after decommissioning. The dewatered weir pool downstream of the beaver dam has a small volume and surface area compared to the upstream marsh. It appears unlikely that dewatering the weir pool would have an appreciable effect on groundwater conditions, compared to the magnitude of groundwater-surface water interaction that exists upstream.
- NHC acknowledges that the beaver dam could fail or deteriorate in the future, resulting in partial or total drainage of the marsh. However, most groundwater wells in the area were established before Coats Marsh Dam regularly operated with higher water conditions. The marsh was entirely drained for agriculture as recently as 2003.

3.3 Sediment Management

There is accumulated sediment along the face of the existing weir to a height of approximately 2.0 m above the underlying drainage channel. Photos 3.1 and 3.2 illustrate the sediment accumulation, which appears to be mainly composed of fines, organics, and wood material from beaver activity. Where visible, exposed sediments in the upstream weir pool also appear to consist of fine-grained soils and

[2] BC Groundwater Well and Aquifer Registry. Available at: https://apps.nrs.gov.bc.ca/gwells/

organics. NHC has not carried out laboratory or field testing to characterize the upstream sediment storage volume, size distribution, or chemical composition.

When the dam is decommissioned, much of the upstream weir pool will be dewatered and there will be exposed bottom sediments. The following summarizes sediment management considerations for the decommissioning design:

- The design includes localized sediment removal near the weir structure to facilitate construction access; however, the remaining upstream sediment will be left in place.
- Upstream sediment in the weir pool area could be mobilized downstream in the absence of mitigation. Loose surficial material including organic soils and small wood debris would be likely to mobilize during higher flow events.
- The decommissioning design includes the following features to mitigate sediment mobilization and transport:
    - The exposed bottom sediments will be planted with native vegetation, which will improve the soil stability over time. Mulch or erosion control matting may be considered.
    - If erosion occurs, the grade control structure will backwater the upstream drainage ditch and function as a sump to encourage sedimentation.
- The sediment load at this location is expected to be low as long as the beaver dam remains in place; however, if the beaver dam fails, there may be a sudden release of additional sediment. During a beaver dam failure, the grade control structure will encourage some sedimentation within the weir pool area, though it is unlikely that it would capture all mobilized sediments. A post-failure site assessment and restoration work could be warranted depending on the severity and effects of the breach.

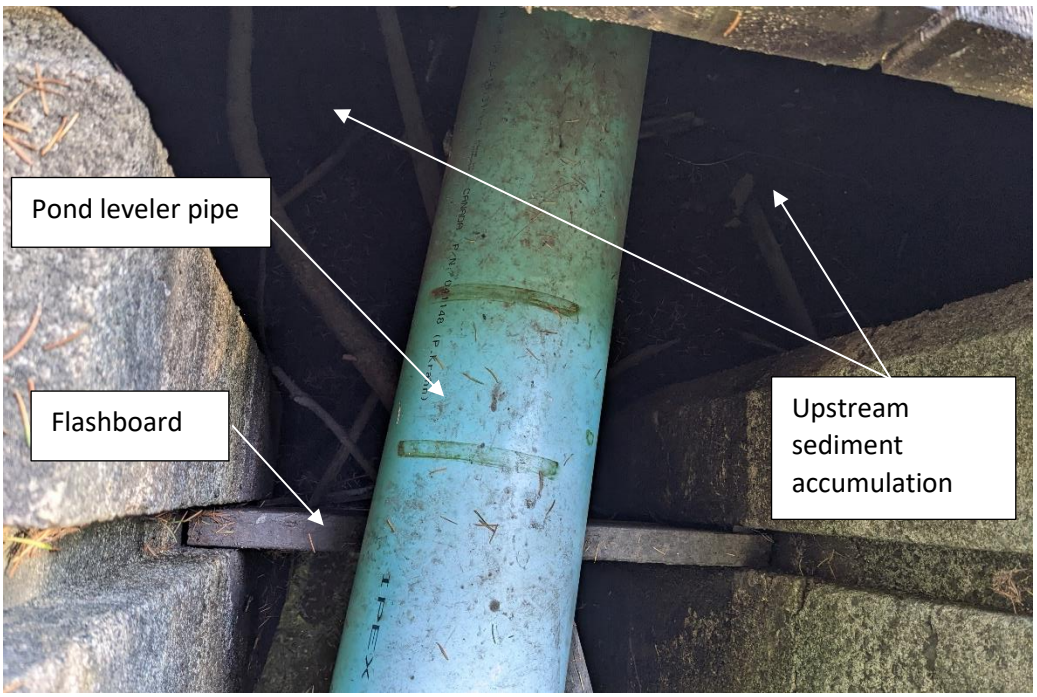

Photo 3.1 Downward view of accumulated sediment upstream of the weir.

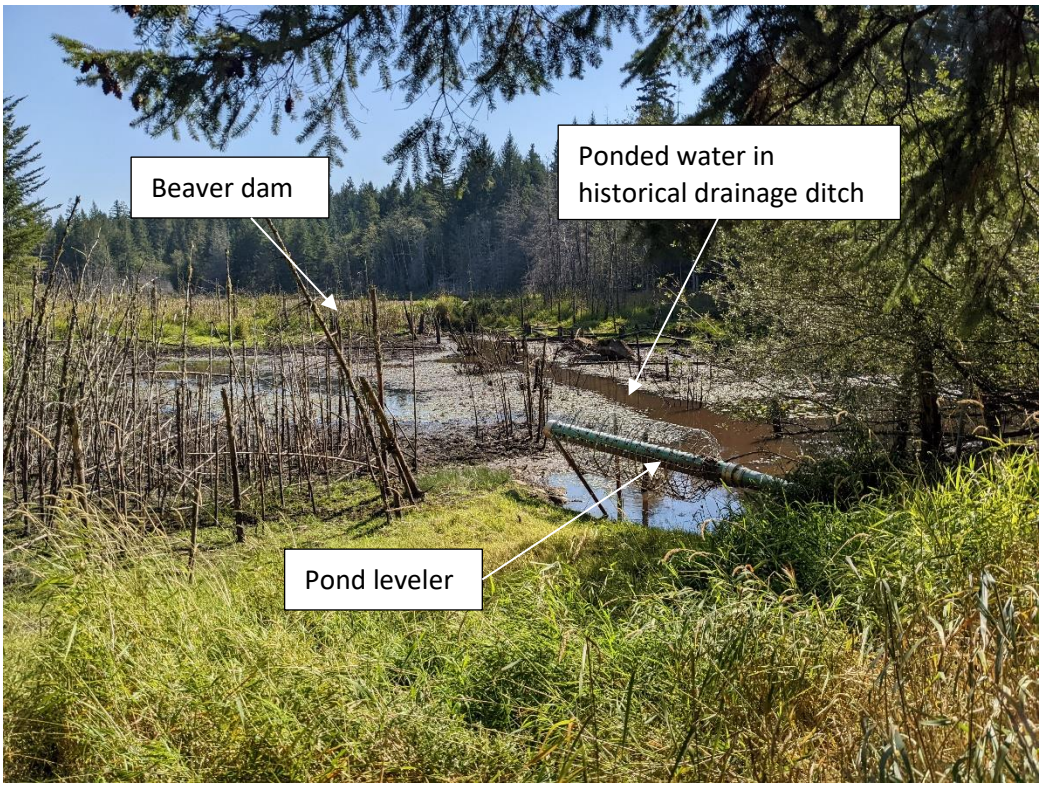

Photo 3.2 Upstream view of the weir pool during low water conditions (September 22, 2023).

3.4 Hydrology and Hydraulics

The watershed draining into Coats Marsh has an area of 1.45 km^2, with land cover consisting of forest, agricultural areas, and rural residential properties. The most significant seasonal inlet creek, known unofficially as East Path Creek, flows into Coats Marsh from the northeast. Poorly maintained beaver dams are present on East Path Creek near its mouth at Coats Marsh. Some smaller wetlands, including one known as McGuffie's Swamp, are located upstream of Coats Marsh.

Provincial decommissioning guidelines require that the restored outlet channel be designed to pass a 1/100-year flood event without causing substantial bank erosion or failure (BC FLNRORD, 2019). A conservative approach is to design the channel to pass the peak inflow, assuming no attenuation of the inflow hydrograph. NHC previously estimated peak inflows at various return periods as part of the replacement study (2023). Table 3.1 summarizes the peak inflow values, including future climate change effects.

Table 3.1 Summary of return period flow estimates

Return Period	Peak Inflow, Historical Conditions (m^3/s)	Peak Inflow, Climate Change Conditions[1] (m^3/s)
2-Year	1.7	2.2
10-Year	2.7	3.5
100-Year	4.1	5.3
200-Year	4.5	5.9

1. Climate change estimates assume a 30% increase on peak inflows, as recommended in NHC (2023).

Outlet channel hydraulics were assessed using the broad-crested weir equation, assuming critical flow will occur over the grade control structure. During annual-scale flood events (< 1.5 m^3/s), upstream water levels were calculated as 0.5 m to 0.6 m above the grade control structure crest. During the 100-year peak inflow, water levels were calculated as 1.1 m above the grade control structure crest, resulting in some water being conveyed through the overflow section. In all cases, the outlet has sufficient capacity to convey flood flows without inundating adjacent private property. Outlet erosion is not a concern at this site due to the presence of bedrock in the channel bed and banks.

When the dam is decommissioned, there will be likely be changes to local hydraulics, seasonal water level ranges, and flow attenuation compared to existing conditions. NHC has prepared a qualitative review of these effects based on available information and previous project experience, with key findings summarized as follows. Note that a quantitative hydraulic analysis is outside the scope of the current study.

With the beaver dam remaining in place, seasonal high-water levels are expected to remain similar for most of the marsh, except for the smaller area between the beaver dam and the existing concrete weir structure. The loss of storage volume between the beaver dam and the weir will modify peak flow attenuation through the marsh. However, we expect these changes to be minor because most of the marsh storage volume is located upstream of the beaver dam. After the dam is decommissioned, there may be additional leakage through the beaver dam due to the increased water surface differential. Additionally, drying of the downstream face of the beaver dam may have some effect on the dam material's hydraulic conductivity. Continued beaver activity may further influence water retention in the marsh. Given that the seasonality and amount of precipitation can vary substantially from year to year, it will be difficult to assess how dam removal affects water retention and seasonal water levels upstream of the beaver dam for several years after implementation of dam decommissioning.

The decommissioning design includes some features to mitigate risk of habitat loss and flooding in the event of a beaver dam failure. By lowering water levels in the weir pool area, there will be some capacity for flood waters to be attenuated through this area before being released downstream. Additionally, the placement of riprap and boulders along the outlet channel will help to dissipate energy. After the breach, conditions in the marsh would degrade similar to Scenario 1 in the NHC (2023) elevation study. Seasonal wetting would still occur in a narrowed region near the drainage channel, with a range of about 0.4 m of vertical fluctuation between dry summer conditions and wetter winter conditions. The loss of storage would also reduce peak flow attenuation compared to existing conditions, increasing outflows and the likelihood of flooding at downstream culverts. We note that the

downstream culverts are likely undersized at baseline and were installed at a time when the marsh was presumably drained.

3.5 Fluvial Geomorphology

The Coats Marsh Weir replacement study (NHC, 2023) provides a detailed description of channel morphology downstream of the weir, summarized as follows:

- The stream length is approximately 1.4 km with an average gradient of 2 to 2.5%. The blasted channel downstream of the weir is typically 1.5 m wide with nearly vertical bedrock sides over a stream length of 20 m.
- Farther downstream, the creek widens and runs through two private properties at 1040 and 1034 Coats Drive. Overbank areas are generally low-gradient and vegetated. Within the properties, the creek is traversed by at least 4 small bridges. A small, unlicensed rock weir at 1040 Coats Drive forms a pond.
- Downstream of 1034 Coats Drive, the creek flows back into Coats Marsh Regional Park, crosses under an access road (easement and walking trail) via a masonry culvert, then flows west into private property (Resource land use classification), before flowing through a culvert underneath South Road and into Hoggan Lake. Channel conditions are variable, with localized areas of bedrock control.

Removing the existing dam while maintaining the beaver dam is not expected to have substantial effects on downstream fluvial geomorphology. Sediment transport will be largely unchanged because the beaver dam will continue to act as a sediment barrier, and the weir pool area is relatively small. There are no streams that feed into the weir pool that would be affected by removal of the dam. Other streams that feed into Coats Marsh, the largest of which is East Path Creek, likely have low sediment loads. Downstream bank erosion or degradation is highly unlikely due to the presence of bedrock.

It is possible that the beaver dam could deteriorate or fail in the future, resulting in full or partial drainage of the marsh. Beaver dam failure could lead to downstream geomorphological effects, including deposition of sediments in the existing channel bed and localized bank and bed erosion in areas lacking bedrock control. If the beaver dam failure is rapid, peak outflows will be relatively high and the geomorphological effects will be more pronounced than during a gradual failure. . Upstream of the beaver dam, the marsh may not retain substantial storage volumes depending on the severity of the breach. If the marsh is entirely drained, the upstream channel will likely erode into the existing bottom sediments and re-establish a flow path through the existing drainage channel, mobilising sediment downstream. Long-term, it is likely that the site would re-establish similar geomorphic conditions as existed before 2003 when the marsh was fully drained.

3.6 Environmental Effects

The marsh is a complex of wetland classes currently dominated by shallow water (aquatic), where permanent inundation occurs. The shallow water area transitions into a marsh, where emergent vegetation and seasonal drying occurs. Beyond the marsh area, a forested swamp is presented. The forested swamp has been classified as a Western Red Cedar – Indian Plum ecological community.

The wildlife community within the marsh is predominantly birds and amphibians. Bird occurrence includes several species of wading birds, swans, geese, and waterfowl. Confirmed amphibian populations include northern red-legged frogs and pacific chorus frogs. Other native amphibian species such as northwestern salamanders and rough-skinned newts may also inhabit the wetland. It is notable that the northern red-legged frog is a federally listed species of concern and a provincially blue-listed species. To date, no fish have been detected within Coats Marsh, though this does not confirm their absence. Both cutthroat trout and rainbow trout were observed at Hoggan Lake in 1972. Mammal presence around the marsh includes beavers and blacktail deer.

EDI's environmental components report (Appendix C) provides a detailed accounting of environmental conditions relevant to the preparation of a dam decommissioning plan. The reports documents site biodiversity and ecosystem services. EDI states that outcomes for biodiversity are likely to be similar to Scenario 4 of NHC's elevation study (2023), which provided the most favourable conditions for retaining current species biodiversity; however, notes that a relatively small area of wetland habitat would be negatively impacted by lowering of the weir in the area between the beaver dam and the existing concrete weir. In addition to how the site is operated by RDN, ecological conditions are subject to potential changes based on local beaver activity.

As part of the dam decommissioning plan, EDI has prepared a planting plant which outlines treatment unit areas appropriate for re-establishing vegetation in areas that will be directly disturbed by construction activities or impacted by changing water levels. The total dewatered area will be approximately 1,188 m^2, much of which will be retained as a slightly drier wetland feature, with more seasonal variation. The restoration plan will ensure a similar habitat area of emergent vegetation is available after decommissioning to ensure similar availability of habitat for northern red-legged frogs. The restoration plan also prioritizes establishing native species appropriate for the area and controlling nearby invasive species, such as reed canary grass, which without management would be likely to dominant much of the disturbed and newly dried areas. More details about restoration and monitoring plans can be found in Appendix A, the preliminary design drawing set, and EDI's environmental report in Appendix C. Ongoing monitoring plans will need to be implemented to ensure successful development of intended habitat types and control of invasive plants.

3.7 Economic and Social Impacts

NHC has prepared a qualitative economic and social impact assessment based on available information and experience with previous decommissioning projects. The following summarizes the potential effects of decommissioning on economic and social values:

- There are no businesses that directly rely on the marsh for water supply, recreational value, or other use. There is no expected loss of business activity associated with dam decommissioning.
- Existing vegetation on the surface of Coats Marsh precludes recreational navigation by paddle-powered watercraft. Other navigational hazards include abandoned agricultural cisterns and woody debris.
- Retaining the beaver dam in place will largely retain existing species biodiversity, and the site can continue to be used for birdwatching, wildlife-viewing, and enjoyment of nature. Several viewpoints near the trail on the north side of the marsh provide opportunities for viewing the

wetland and birdwatching. The site sees a relatively low number of visitors compared to beaches and coastal sites on Gabriola Island, but provides and protects a unique Gulf Islands wetland habitat that is valued by nearby residents.

- There are private properties fronting the marsh at 1040 and 1050 Coats Drive. There are no dock facilities or other infrastructure that directly interact with the marsh, thus the decommissioning should have limited effect on the properties.
- Decommissioning is substantially less expensive than the alternative of constructing a new dam. Maintenance costs for decommissioning are also lower than for other alternatives. This reduces the tax burden that would otherwise be passed to RDN residents. If decommissioning works are awarded to a local area contractor, economic benefits will largely be distributed into the local community and businesses.

3.8 First Nations Considerations

Gabriola Island is in the traditional territory of the Snuneymuxw First Nation (RDN, 2011). There is a Snuneymuxw reserve in the southeast of Gabriola Island; Crown lands to the north and east of Coats Marsh Regional Park may potentially be transferred to Snuneymuxw title in the future through treaty negotiations (Government of British Columbia, 2013). There are no archeological sites currently recorded within the park, or between Coats Marsh and Hoggan Lake (J. Vander Klok, pers. comm.).

First Nations engagement is a requirement of dam decommissioning and will be led by the Province. The goals of engagement are to identify First Nations interests that may be affected by the work, identify and develop mitigation strategies if warranted, and incorporate community and traditional knowledge if such is shared with the project team.

3.9 Infrastructure Impacts

There are several infrastructure assets located downstream of the dam, summarized as follows:

- Small culverts, an unlicensed rock weir, and footbridges along the creek (see Section 3.5)
- A cabin located next to the creek within the 1040 Coats Drive property
- A 1.2 m diameter corrugated metal pipe culvert at South Road
- A small private hydroelectric dam at the outlet of Hoggan Lake, as well as surface water intakes (see Section 1.4)

Decommissioning of the Coats Marsh Dam is not expected to have substantial impacts on downstream infrastructure. Removal of the dam while retaining the beaver dam in place may have some effect on the seasonality of flow exiting Coats Marsh, which could have a very minor impact on flow timing at the hydroelectric dam, with significant attenuation through Hoggan Lake. This impact would be small given that Coats Marsh is not the only stream feeding Hoggan Lake and the change in storage at Coats Marsh is relatively small. More storage fluctuations have occurred in Coats Marsh as a result of beaver activity than would occur from removal of the dam with beaver dam retention. Reduction in storage of Coats Marsh could translate to slightly higher outflows from the marsh during high flow winter periods, and slightly less evaporation during the summer. On balance, it is not expected that these changes would have any substantial effect on power generation at the downstream hydroelectric dam.

In the event of a dam breach, existing culverts and footbridges within downstream private properties and Coats Marsh Regional Park could be affected. The most serious assets at risk during a potential beaver dam breach are the cabin located near Coats Marsh Creek at 1040 Coats Drive and the South Road culvert crossing. Potential impacts to infrastructure will be explored in more detail in the beaver dam breach risk assessment.

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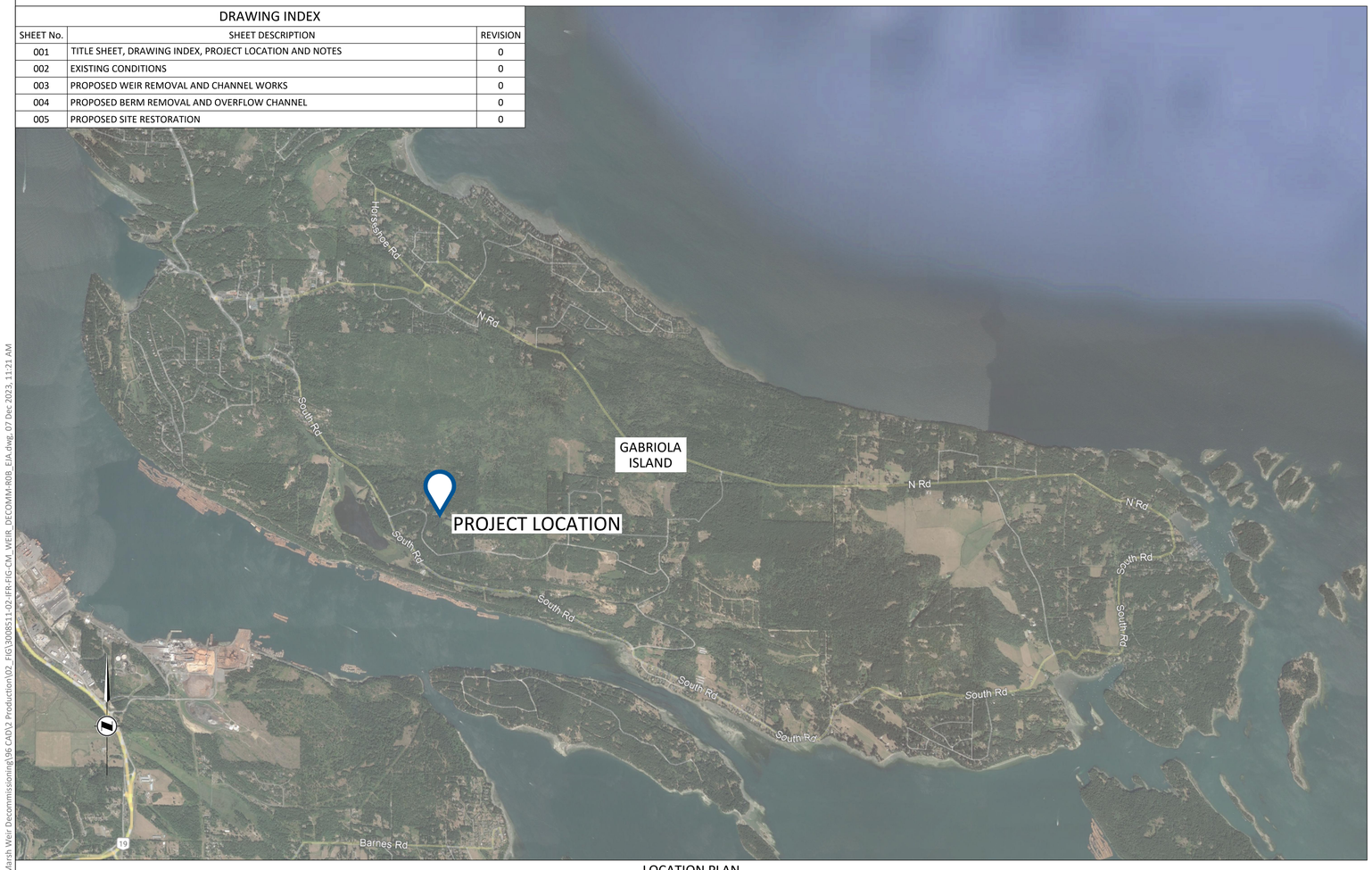
APPENDIX A

PRELIMINARY DESIGN DRAWINGS

COATS MARSH WEIR
PRELIMINARY DECOMMISSIONING DESIGN
ISSUED FOR CLIENT REVIEW, DECEMBER, 2023

DRAWING INDEX		
SHEET No.	SHEET DESCRIPTION	REVISION
001	TITLE SHEET, DRAWING INDEX, PROJECT LOCATION AND NOTES	0
002	EXISTING CONDITIONS	0
003	PROPOSED WEIR REMOVAL AND CHANNEL WORKS	0
004	PROPOSED BERM REMOVAL AND OVERFLOW CHANNEL	0
005	PROPOSED SITE RESTORATION	0



1. IMAGE SOURCE: GOOGLE EARTH; 19th AUGUST, 2016

LOCATION PLAN
SCALE = 1:30,000

NOTES

1. GENERAL
   - 1.1. THE PRELIMINARY DESIGN DRAWINGS REPRESENT THE NATURE AND GENERAL LAYOUT OF THE PROPOSED WORKS AND NOT NECESSARILY THE WORKS EXACTLY AS THEY WILL BE CARRIED OUT.
   - 1.2. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE *COATS MARSH WEIR PRELIMINARY DECOMMISSIONING PLAN REPORT*, PREPARED BY NORTHWEST HYDRAULIC CONSULTANTS LTD. (2023).

2. SURVEY AND DIMENSIONS
   - 2.1. TOPOGRAPHIC DATA IS DERIVED FROM THE FOLLOWING SOURCES:
     - 2022 TOTAL STATION AND RTK-GPS SURVEY BY NHC
     - 2019 TOPOGRAPHIC LiDAR DATA FROM GEO-BC
     - 2010 LIMITED BATHYMETRIC SURVEY FROM RDN
   - 2.2. ELEVATIONS AND HORIZONTAL LOCATIONS ARE EXPRESSED IN METRES AND ARE BASED ON GEODETIC DATA:
     - HORIZONTAL DATUM: NAD83(CSRS)
     - VERTICAL DATUM: CGVD2013, GEOID: CGG2013a
     - PROJECTION: UTM ZONE 10N
   - 2.3. PROPERTY BOUNDARIES ARE DERIVED FROM PROVINCIAL CADASTRE MAPS AND HAVE NOT BEEN VERIFIED BY LEGAL SURVEY.
   - 2.4. THE FOOTPRINT OF THE EXISTING BERM IS APPROXIMATE AND WAS DERIVED FROM "AS-BUILT" PLANS PREPARED BY MADRONE ENVIRONMENTAL SERVICES INC. (2013.)
   - 2.5. QUANTITIES SHOWN ARE NEAT-LINE VOLUME AND AREA ESTIMATES.

3. DESIGN
   - 3.1. PRELIMINARY CIVIL AND HYDROTECHNICAL ENGINEERING DESIGN COMPLETED BY NORTHWEST HYDRAULIC CONSULTANTS LTD.
   - 3.2. PRELIMINARY PLANTING PLAN PREPARED BY ENVIRONMENTAL DYNAMICS INC.

4. MATERIALS
   - 4.1. CONCRETE MIX SHALL CONFORM TO CAN/CSA A23.1, EXPOSURE CLASS F-1. REINFORCEMENT AND CONSTRUCTION JOINT DETAILS WILL BE SPECIFIED DURING DETAILED DESIGN.
   - 4.2. GEOTEXTILE SHALL BE NON-WOVEN, CLASS II.
   - 4.3. POLY SHEETING SHALL HAVE A MINIMUM THICKNESS OF 8 MIL (0.2 mm)
   - 4.4. BENTONITE SHALL BE IN PELLET OR CHIP FORM.
   - 4.5. REVEGETATION SHALL USE NATIVE PLANTS AND A NATIVE COASTAL SEED MIX.
   - 4.6. TABLE 1 INCLUDES A SCHEDULE OF QUANTITIES AND MATERIALS.

MATERIAL QUANTITIES	
MATERIAL	QUANTITY (m^3)
COMMON EXCAVATION	450
ROCK EXCAVATION	10
RIPRAP AND BOULDERS	15
REINFORCED CONCRETE	1

   - 4.7. RIPRAP
     - 4.7.1. MATERIAL SHALL BE HARD, DURABLE, AND ANGULAR QUARRY ROCK OF A QUALITY THAT WILL NOT DISINTEGRATE ON EXPOSURE TO WATER OR THE ATMOSPHERE.
     - 4.7.2. MATERIAL PROPERTIES SHALL MEET THE 2020 BC MOTI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, INCLUDING LOW ACID ROCK DRAINAGE AND METAL LEACHING POTENTIAL.
     - 4.7.3. MATERIAL GRADATIONS WILL BE SPECIFIED DURING DETAILED DESIGN TO SUIT ANTICIPATED FLOOD DEPTHS AND VELOCITIES.

5. EXECUTION
   - 5.1. SITE ACCESS IS AVAILABLE VIA THE RDN TRAIL NETWORK, WITH TRAILHEADS LOCATED AT STANLEY PLACE AND COATS DRIVE. CLEAR THE TRAIL OF ENCROACHING VEGETATION AS REQUIRED TO FACILITATE MOBILIZATION AND DEMOBILIZATION.
   - 5.2. CLEAR THE WORK AREA OF ALL STANDING AND FALLEN TREES, STUMPS, LOGS, AND DEBRIS. DANGER TREES, SNAGS, AND OVERHANGING LIMBS THAT IMPACT SITE SAFETY SHALL BE REMOVED.
   - 5.3. IMPLEMENT WATER MANAGEMENT PLAN.
   - 5.4. EXCAVATE THE EXISTING BERM FILL AND GEOTEXTILE DOWN TO NATIVE SUBGRADE.
   - 5.5. EXCAVATE THE OVERFLOW CHANNEL TO THE DIMENSIONS AND GRADES SHOWN ON THE DRAWINGS. ACCEPTABLE METHODS OF ROCK EXCAVATION ARE RIPPING AND HAMMER BREAKING; BLASTING SHALL NOT BE USED FOR ROCK EXCAVATION.
   - 5.6. REMOVE THE PEDESTRIAN FOOTBRIDGE AND EXCAVATE ACCUMULATED SEDIMENT FROM THE UPSTREAM FACE OF THE CONCRETE WEIR.
   - 5.7. REMOVE THE EXISTING WOODEN FLASHBOARDS AND WEIR CONCRETE TO THE EXTENTS AND ELEVATIONS SHOWN IN THE DRAWINGS. PREPARE THE SUBGRADE FOR CONCRETE INSTALLATION BY REMOVING LOOSE ROCK AND DEBRIS.
   - 5.8. INSTALL CAST-IN-PLACE REINFORCED CONCRETE AS SHOWN IN THE DRAWINGS. THE MINIMUM CURING TIME IS 3 DAYS.
   - 5.9. INSTALL POLY SHEETING, BENTONITE, RIPRAP, AND BOULDERS AROUND THE FINISHED CONCRETE STRUCTURE AS SHOWN IN THE DRAWINGS.
   - 5.10. CARRY OUT SITE RESTORATION IN ACCORDANCE WITH THE REVEGETATION PLAN AND AS INDICATED ON THE DRAWINGS.

6. ENVIRONMENT
   - 6.1. CARRY OUT ALL WORK IN ACCORDANCE WITH THE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN (CEMP), ENVIRONMENTAL PERMIT CONDITIONS, AND APPLICABLE LAWS, REGULATIONS, AND BY-LAWS.
   - 6.2. DISPOSE OF EXCAVATED SOIL ON SITE AS INDICATED ON THE DRAWINGS. WOOD DEBRIS SUITABLE FOR USE IN SITE RESTORATION SHALL BE STOCKPILED AND REUSED WITH APPROVAL OF THE ENGINEER. DISPOSE OF CONCRETE, METALS, AND OTHER DEBRIS OFF-SITE AT A LICENSED DISPOSAL FACILITY, IN ACCORDANCE WITH THE CEMP.
   - 6.3. ALL CONSTRUCTION ACTIVITIES WITHIN THE HIGH-WATER MARK SHALL BE CONDUCTED IN ISOLATION OF FLOWING WATER, ACCOMPLISHED BY TEMORARILY DIVERTING, ENCLOSING, OR PUMPING WATER AROUND THE WORK SITE.
   - 6.4. NO TURBID WATER SHALL ENTER THE CHANNEL DOWNSTREAM OF THE DAM.

7. ARCHEOLOGY
   - 7.1. CARRY OUT ALL WORK IN ACCORDANCE WITH THE RDN'S CHANCE FIND ARCHEOLOGICAL PROCEDURES.

CLIENT:

REGIONAL DISTRICT OF NANAIMO
6300 HAMMOND BAY ROAD
NANAIMO, BC
V9T 6N2

REGIONAL DISTRICT OF NANAIMO

REV.	DATE	DESCRIPTION
0	5 DEC 2023	ISSUED FOR CLIENT REVIEW
1	18 DEC 2023	ISSUED FOR SUBMISSION

nhc northwest hydraulic consultants

SEAL:

COATS MARSH WEIR
PRELIMINARY DECOMMISSIONING DESIGN

TITLE SHEET, DRAWING INDEX, PROJECT LOCATION AND NOTES

DESIGNED: E. ARBUCKLE	SHEET ID: 3008511-02-IFR-FIG-CM_WEIR_DECOMM-R0B_EJA-001 R0	SHEET No:	001
DRAFTED: R.CLARK	STATUS: ISSUED FOR CLIENT REVIEW		
CHECKED: N. VALSANGKAR	SCALE: AS SHOWN WHEN PLOTTED D SIZE		
APPROVED: G. HILL	DATE: 18 DEC 2023	REV No: R1	

SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING

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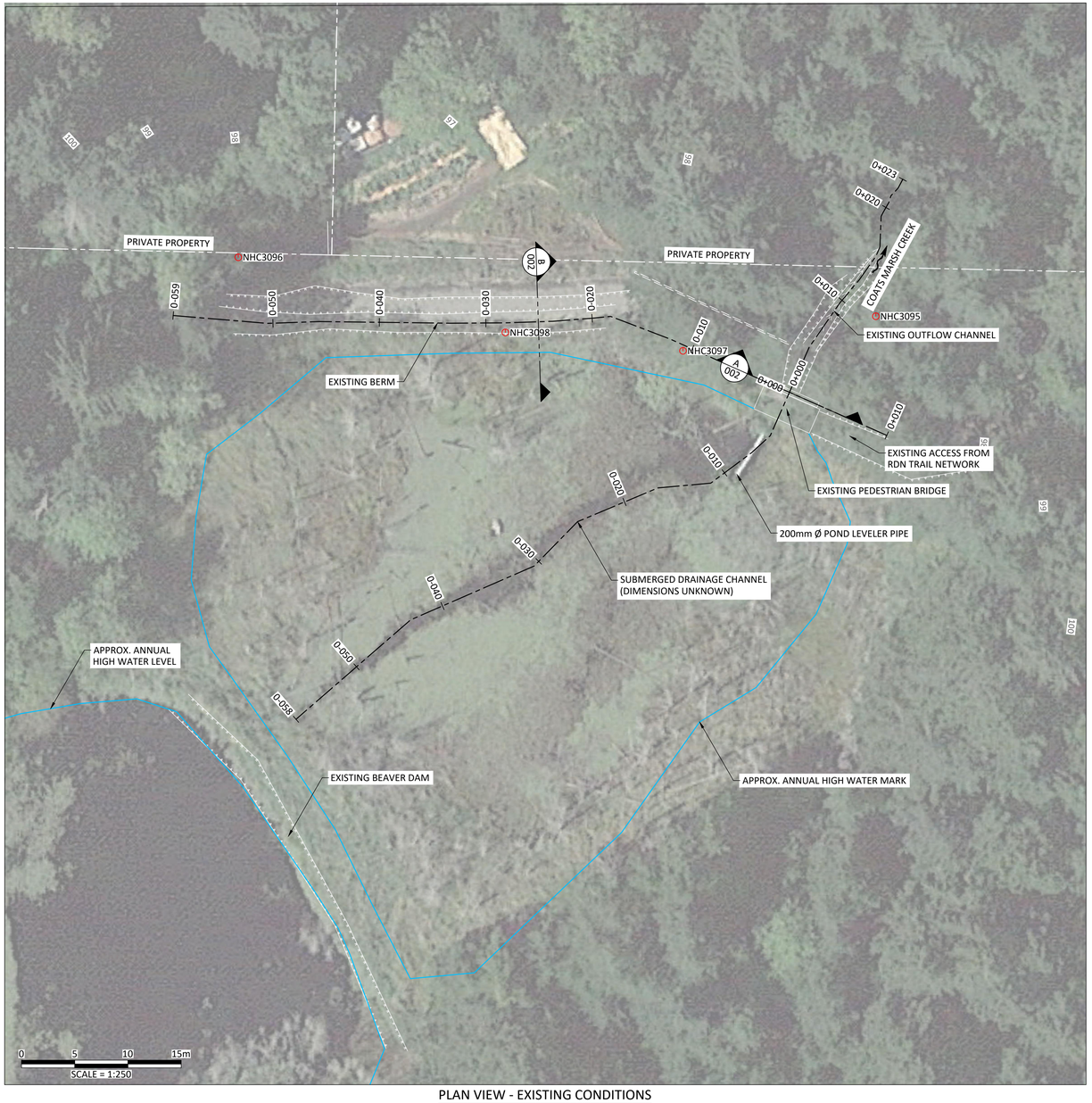

PLAN VIEW - EXISTING CONDITIONS
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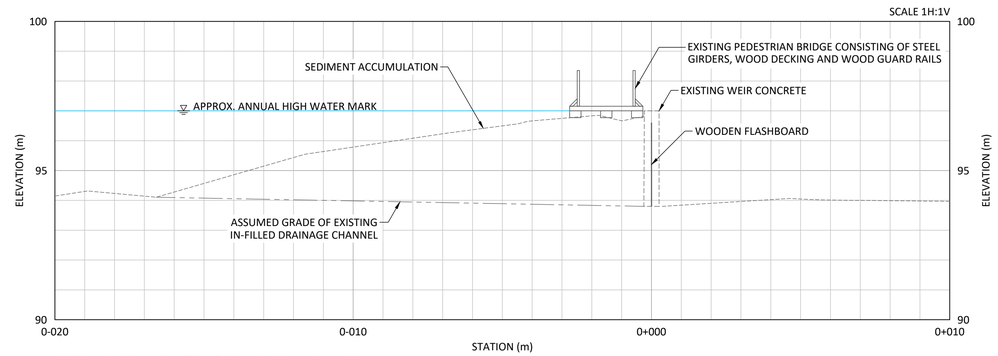

PROFILE VIEW - EXISTING CHANNEL AND WEIR
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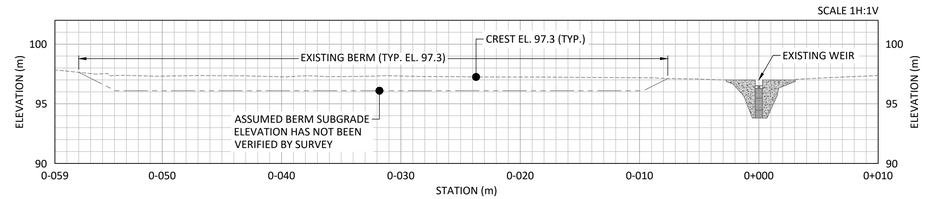

PROFILE VIEW - EXISTING BERM AND WEIR
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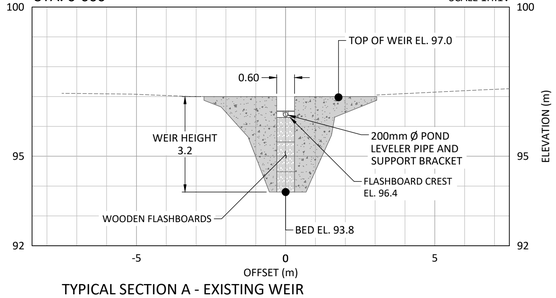

TYPICAL SECTION A - EXISTING WEIR
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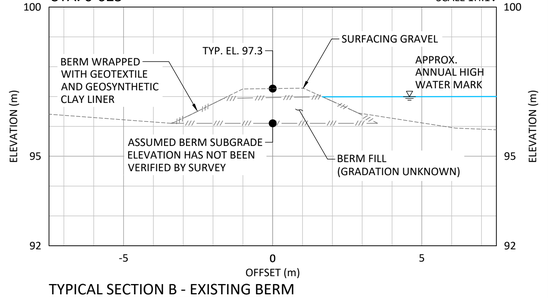

TYPICAL SECTION B - EXISTING BERM
SCALE = 1:100

LEGEND:

- EXISTING CONCRETE
- FLASHBOARD
- EXISTING GROUND
- EXISTING TOP OF SLOPE
- EXISTING BOTTOM OF SLOPE
- EXISTING PIPE
- EXISTING GEOTEXTILE
- ASSUMED EXISTING WATER LEVEL
- ASSUMED SUBGRADE

CLIENT:
REGIONAL DISTRICT OF NANAIMO
6300 HAMMOND BAY ROAD
NANAIMO, BC
V9T 6N2

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PRELIMINARY DECOMMISSIONING DESIGN

EXISTING CONDITIONS

DESIGNED:	E. ARBUCKLE	SHEET ID:	3008511-02-IFR-FIG-CM_WEIR_DECOMM-R0B_EJA-002 R0	SHEET No:	002
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APPROVED:	G. HILL	DATE:	18 DEC 2023	REV No:	R1

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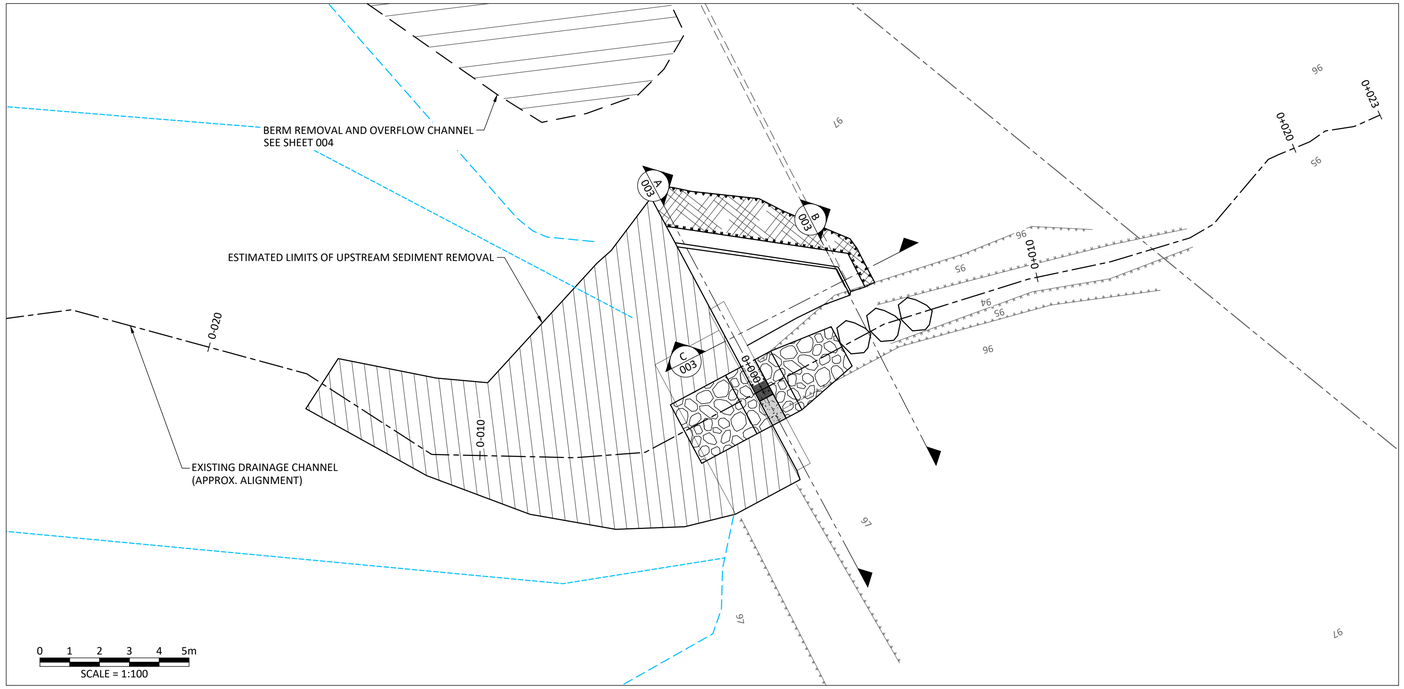

PLAN VIEW - WEIR DECOMMISSIONING AND GRADE CONTROL STRUCTURE

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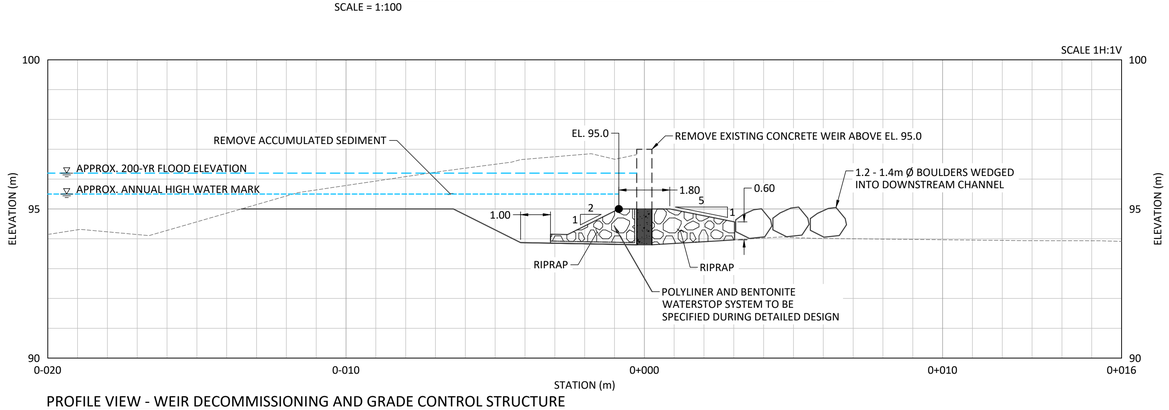

PROFILE VIEW - WEIR DECOMMISSIONING AND GRADE CONTROL STRUCTURE

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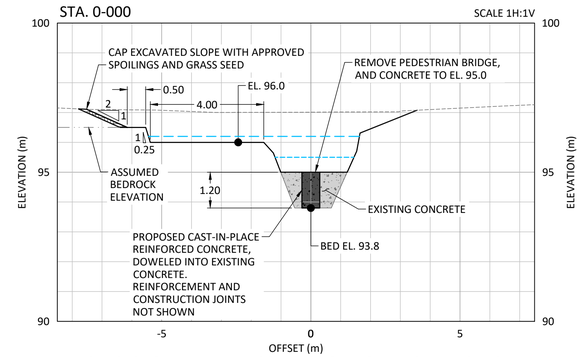

TYPICAL SECTION A - WEIR DECOMMISSIONING AND OVERFLOW CHANNEL

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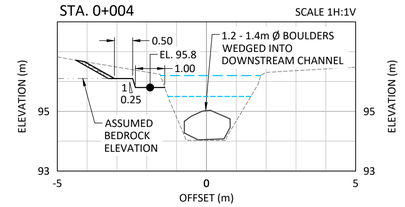

TYPICAL SECTION B - OVERFLOW CHANNEL (DOWNSTREAM) AND CHANNEL WORKS

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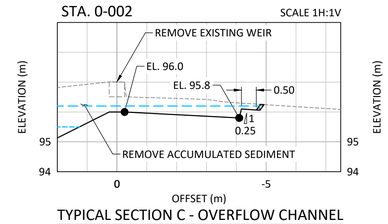

TYPICAL SECTION C - OVERFLOW CHANNEL

SCALE = 1:100

LEGEND:

- EXISTING CONCRETE
- EXISTING GROUND
- EXISTING TOP OF SLOPE
- EXISTING BOTTOM OF SLOPE
- PROPOSED GRADE
- PROPOSED TOP OF SLOPE
- PROPOSED BOTTOM OF SLOPE
- PROPOSED CONCRETE
- PROPOSED SEDIMENT REMOVAL
- PROPOSED RIPRAP
- PROPOSED SPOILING AND GRASS SEED
- PROPOSED BOULDERS
- APPROX. 200-YR FLOOD EL.
- APPROX. HWM AFTER CONSTRUCTION

CLIENT:

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PROPOSED WEIR DECOMMISSIONING AND CHANNEL WORKS

DESIGNED: E. ARBUCKLE	SHEET ID: 3008511-02-IFR-FIG-CM_WEIR_DECOMM-R0B_EJA-003 R0	SHEET No:	003
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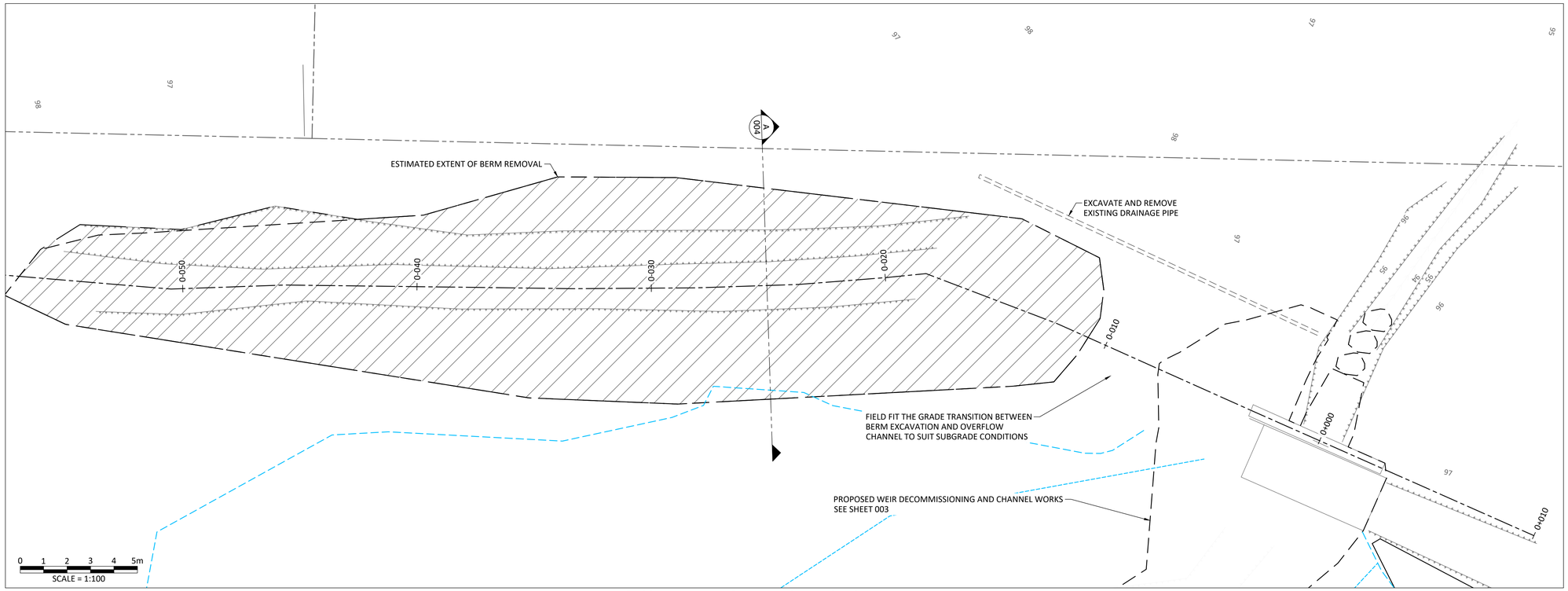

PLAN VIEW - PROPOSED BERM REMOVAL AND OVERFLOW CHANNEL
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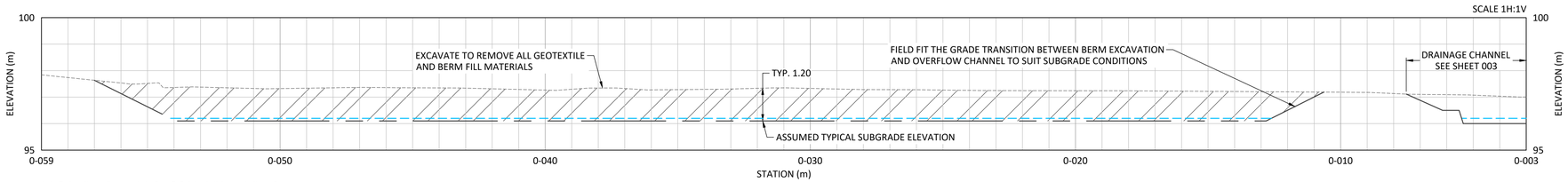

PROFILE VIEW - PROPOSED BERM REMOVAL
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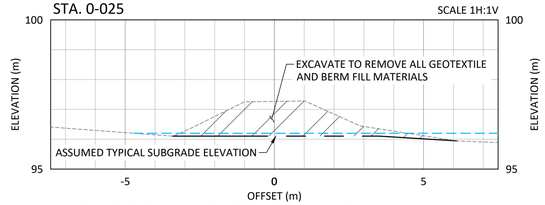

TYPICAL SECTION A - PROPOSED BERM REMOVAL
SCALE = 1:100

LEGEND:

- EXISTING GROUND
- EXISTING TOP OF SLOPE
- EXISTING BOTTOM OF SLOPE
- ASSUMED SUBGRADE
- EXISTING PIPE
- PROPOSED GRADE
- PROPOSED SEDIMENT REMOVAL
- APPROX. 200-YR FLOOD EL.
- APPROX. HWM AFTER CONSTRUCTION

CLIENT:

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REGIONAL DISTRICT OF NANAIMO

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PROPOSED BERM REMOVAL AND OVERFLOW CHANNEL

DESIGNED:	E. ARBUCKLE	SHEET ID:	3008511-02-IFR-FIG-CM_WEIR_DECOMM-R0B_EJA-004 R0
DRAFTED:	R.CLARK	STATUS:	ISSUED FOR CLIENT REVIEW
CHECKED:	N. VALSANGKAR	SCALE:	AS SHOWN WHEN PLOTTED D SIZE
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SHEET No: 004
REV No: R1

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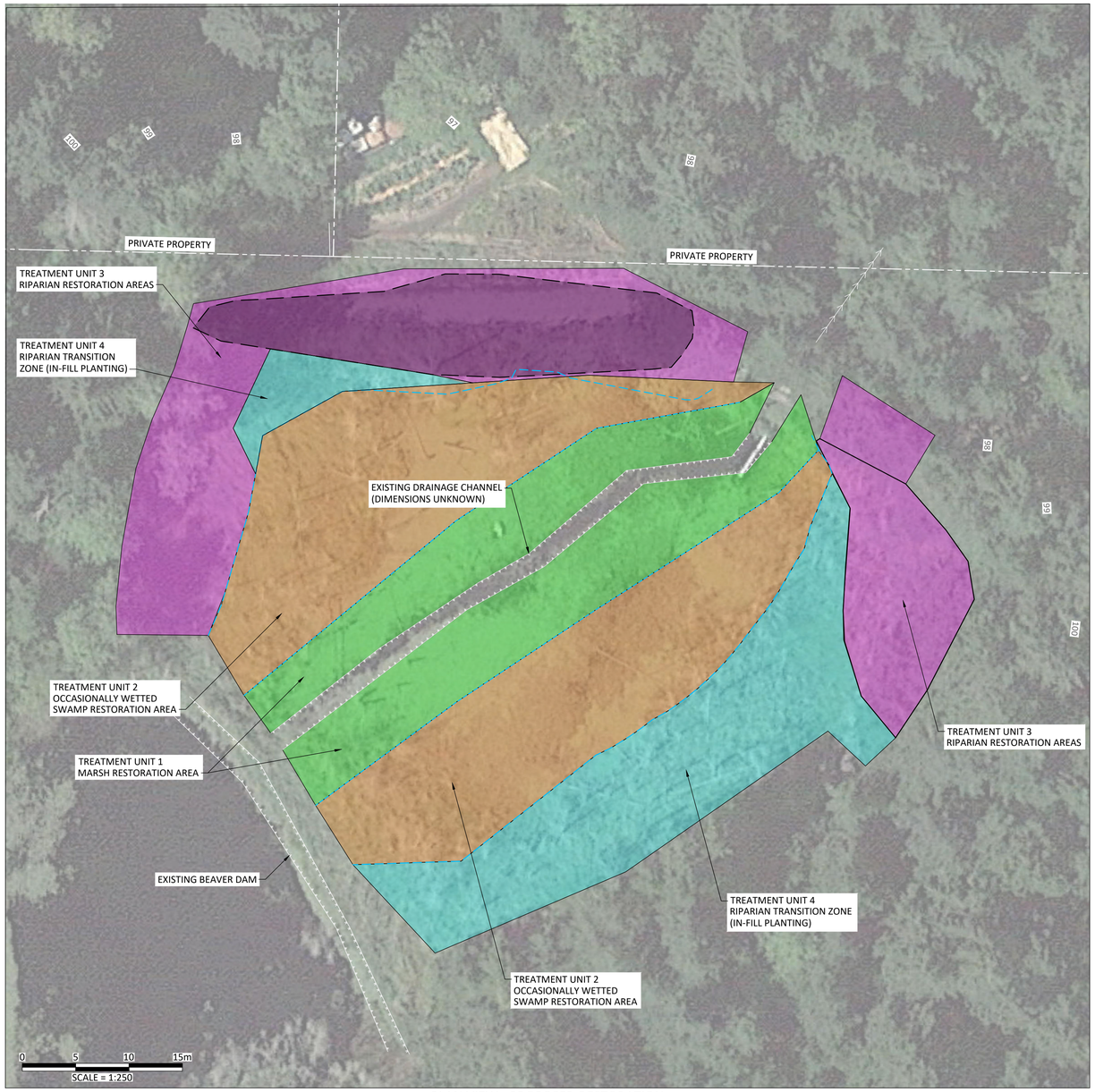

PLAN VIEW - PROPOSED RESTORATION
SCALE = 1:250

Planting List		
Botanical Name	Common Name	
Treatment Unit 1		
Ground cover (aquatic)	Typha	latifolia Common cattail
Ground cover (aquatic)	Juncus effuses	Common rush
Ground cover (aquatic)	Carex spp.	Beaked sedge (or Sitka sedge)
Treatment Unit 2		
Tree	Salix lucida	Pacific willow
Shrub	Spirea douglasii	Pink spirea (hardhack)
Ground cover	Carex spp.	Sitka sedge (or beaked sedge)
Ground cover	Calamagrostis canadensis	Bluejoint
Treatment Units 3		
Tree	Alnus rubra	Red alder
Tree	Thuja plicata	Western red cedar
Shrub	Gaultheria shallon	Salal
Shrub	Sambucus racemose	Red elderberry
Shrub	Oemleria cerasiformis	Osoberry (Indian-plum)
Treatment Units 4		
Tree	Alnus rubra	Red alder
Shrub	Spirea douglasii	Pink spirea (hardhack)
Shrub	Gaultheria shallon	Salal
Shrub	Oemleria cerasiformis	Osoberry (Indian-plum)
Ground cover	Calamagrostis canadensis	Bluejoint

Plant Quantities						
Trees		TU1	TU2	TU3	TU4*	TOTAL
Red alder	Alnus rubra	0	0	143	22	165
Western redcedar	Thuja plicata	0	0	48	0	48
Pacific willow	Salix lucida	0	114	0	0	114
Total		0	114	191	22	327
Shrubs						
Hardhack	Spiraea douglasii	0	454	0	88	542
Osoberry	Oemleria cerasiformis	0	0	191	22	213
Salal	Gaultheria shallon	0	0	239	22	261
Red elderberry	Sambucus racemosa	0	0	143	0	143
Total		0	454	574	131	1,159
Groundcover						
Bluejoint	Calamagrostis canadensis	0	454	0	88	542
Cattail	Typha latifolia	627	0	0	0	627
Sitka sedge	Carex sitchensis	0	454	0	0	454
Beaked sedge	Carex rostrata	314	0	0	0	314
Common rush	Juncus effusus	314	0	0	0	314
Total		1,254	908	0	88	2,250
Total Plants		1,254	1,476	765	241	3,735

LEGEND:

- PREVIOUS PROPOSED WORKS
- PROPOSED ON-SITE SOIL DISPOSAL
- APPROX. 200-YR FLOOD EL.
- APPROX. ANNUAL HWM

CLIENT:
REGIONAL DISTRICT OF NANAIMO
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NANAIMO, BC
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SEAL:

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PRELIMINARY DECOMMISSIONING DESIGN

PROPOSED RESTORATION

DESIGNED: E. ARBUCKLE	SHEET ID: 3008511-02-IFR-FIG-CM_WEIR_DECOMM-R0B_EJA-005 R0	SHEET No:	005
DRAFTED: R.CLARK	STATUS: ISSUED FOR CLIENT REVIEW		
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SUPERSEDES ALL REVISIONS WITH NUMBER PRECEDING 1

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APPENDIX B

PHOTOS

Site Photos

This appendix provides photos of the site and relevant surrounding features. Photos were taken during the site visit from the previous project on 14 September 2022 and updated with photos from a new site visit on 22 September 2023 and are therefore typical of dry early fall conditions. Water surface elevations were lower in September 2023 because more water had been siphoned from above the beaver dam earlier in the season. Photos are roughly ordered hydrologically from the inlet creek at the east end of the marsh, through the marsh, the dam site, and then downstream locations.

B.1 East Path Creek Inlet

Photo B1 East Path Creek inlet at northeast of Coats Marsh, looking upstream. This is an ephemeral stream (14 Sept 2022).

Photo B2 East Path Creek inlet at northeast of Coats Marsh, looking downstream (14 Sept 2022).

B.2 Upper Marsh

Photo B3 View of Coats Marsh from beaver dam (22 Sept 2023).

Photo B4 Coats Marsh above the beaver dam, note waterlogged trees, swampy conditions (14 Sept 2022).

Photo B5 Coats Marsh above the beaver dam, open-water area with less vegetation. Elevation marker in water.

B.3 Beaver Dam

Photo B6 View of beaver dam from north, thickly vegetated conditions (22 Sept 2023).

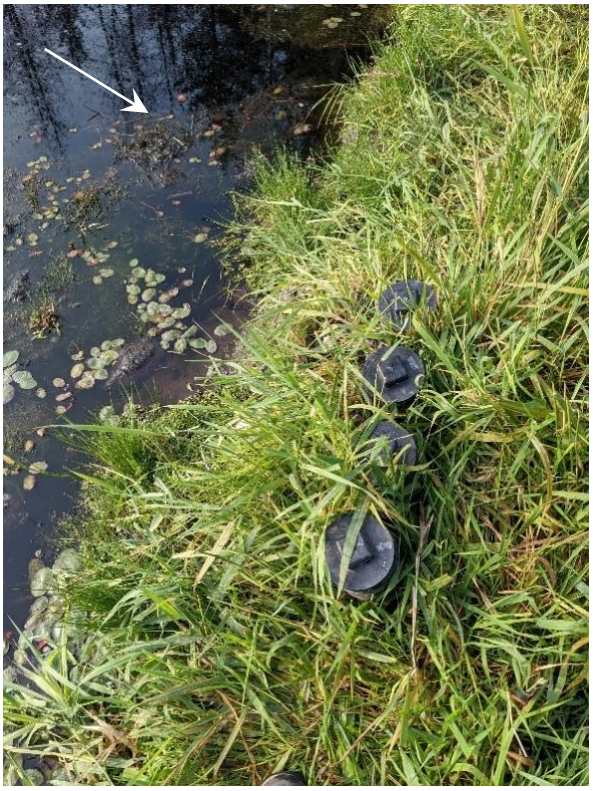

Photo B7 Part of RDN installed siphon system in beaver dam, partially obscured by vegetation.

B.4 Weir Pool

Photo B8 View from weir toward beaver dam, with the Clemson Pond Leveler caged inlet pipe (22 Sept 2023).

B.5 Dam Structure

Photo B9 Pedestrian footbridge and weir, looking toward berm (14 Sept 2023).

Photo B10 Top view of weir (14 Sept 2023).

Photo B11 Leaks visible in the weir structure from downstream (14 Sept 2023).

Photo B12 Concrete cracks in weir (14 Sept 2023).

Photo B13 Concrete cracks in weir (14 Sept 2023).

B.6 Berm

Photo B14 Vegetated berm (14 Sept 2023).

Photo B15 Berm, willows are wrapped in wire to prevent beavers from eating them (22 Sept 2023).

Photo B16 View of berm looking north. Weir pool is on the right and private property to the left. Leakage occurs through the berm, as evidenced by wetland vegetation (22 Sept 2023).

B.7 Test Pit

Photo B17 View of test pit excavated by hand shovel immediately west of berm (14 Sept 2023).

Photo B18 Excavated materials from test pit, representative of conditions for the foundation of the berm (14 Sept 2023).

B.8 Coats Marsh Creek Outlet Channel

Photo B19 View in the narrow channel immediately downstream of the weir (14 Sept 2023).

Photo B20 View of Coats Marsh Creek looking downstream, narrow channel with bedrock walls (14 Sept 2023).

Photo B21 **View toward private property where Coats Marsh Creek enters 1040 Coats Drive. Private wooden footbridge. Marker indicates property line (14 Sept 2023).**

B.9 Coats Marsh Regional Park Downstream of Private Properties

Photo B22 **Culvert crossing below easement accessing Coats Marsh Regional Park from the west (22 Sept 2023).**

Photo B23 Culvert for Coats Marsh Creek below easement access (14 Sept 2023).

Photo B24 Typical conditions of Coats Marsh Creek in western Regional Park area, uneven with exposed bedrock.

B.10 South Road Crossing

Photo B25 Fire hydrant and pump house located at South Road near Coats Marsh Creek (14 Sept 2022).

Photo B26 Inlet of Coats Marsh Creek to culvert crossing below South Road (22 Sept 2023).

Photo B27 **Outlet of South Road culvert crossing. Coats Marsh Creek flows another 200 m through private property before entering Hoggan Lake. A bedrock step feature acts as barrier to most fish passage is downstream of this location within private property (14 Sept 2022).**

APPENDIX C

EDI ENVIRONMENTAL ASSESSMENT REPORT

Coats Marsh Dam Decommissioning: Environmental Components of Preliminary Decommissioning Plan Report

Prepared For
Northwest Hydraulic Consultants Ltd.
495 Dunsmuir Street, #405
Nanaimo, BC V9R 6B9

Prepared By
EDI Environmental Dynamics Inc.
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Randy Morris
Project Manager | Senior Biologist

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23N0345
Version: 1
December 2023

EDI
ENVIRONMENTAL DYNAMICS INC.
Down to Earth Biology

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- Nathan Valsangkar - Project Manager, NHC
- Graham Hill - Principal in Charge, NHC
- Evan Arbuckle - Hydrotechnical Engineer, NHC
- Jacob Kooy - Hydrotechnical Engineer, NHC

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Rachelle Robitaille, R.P.Bio. ..... Senior Review

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LIST OF PHOTOGRAPHS

1 INTRODUCTION

The Regional District of Nanaimo (RDN) and The Nature Trust of BC (TNT) co-own the Coats Marsh Weir, located on Gabriola Island. The weir is currently unlicensed but is classified as a dam under the BC Dam Safety Regulation (DSR)[1] because of its reservoir storage volume. Previous engineering studies identified several deficiencies with the weir and its appurtenant structures relative to current dam safety standards (NHC 2023; SRM Projects 2020). Following an evaluation of weir replacement options, RDN and TNT propose to decommission the weir and return the marsh to a naturally regulated condition. Dam decommissioning was selected over weir replacement due to its lower capital cost and long-term asset management requirements.

Under the DSR, dam decommissioning is a restricted activity; provincial authorization is required before decommissioning can proceed.

In September 2023, RDN retained Northwest Hydraulic Consultants Ltd. (NHC) and subconsultant EDI Environmental Dynamics Inc. (EDI) to prepare a dam decommissioning plan, meeting provincial requirements. The decommissioning plan follows three development phases:

1. Preliminary dam decommissioning plan. The role of this plan is to provide information to stakeholders, First Nations, and regulators with the goal of facilitating meaningful dialogue around the decommissioning design and project effects. The plans presented at this stage are preliminary and intended to be refined in the final design phase.

2. Stakeholder and First Nations engagement and regulatory referrals. The goal of engagement is to seek feedback on the preliminary plan and any concerns.

3. Final decommissioning plan, which is submitted to the province for approval prior to construction. The final plan refines the preliminary design information with amendments, where required, resulting from the engagement process.

This report is intended to support the preliminary dam decommissioning plan, reflecting phase 1 above.

Currently, the proposed scope of dam decommissioning includes the following elements:

- leaving the existing upstream beaver dam in place to maintain habitat value
- removal of the existing weir and appurtenant structures, including the existing berm
- construction of a grade control structure at the marsh outlet to mitigate complete drainage of the marsh, which would otherwise occur due to historical lowering of the marsh outlet channel

[1] *Water Sustainability Act*, Dam Safety Regulation (B.C. Reg. 40/2016). Available at: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/40_2016#section17

- construction of an overflow channel adjacent to the main outlet channel to better manage water levels near private property boundaries
- revegetation planting with native species

The remainder of this report summarizes the components related to environmental assessment and planning, focusing on the collation of background environmental information, the assessment of potential environmental effects and a preliminary revegetation plan to support the decommissioning plan review and engagement process.

1.1 SITE DESCRIPTION

1.1.1 WEIR STRUCTURE

The dam is described in detail in NHC's decommissioning plan report (NHC 2023). At a high-level, the Coats Marsh Weir is located in Coats Marsh Regional Park on Gabriola Island, BC. The weir is currently unlicensed, as it was only recently regulated under the *Water Sustainability Act* (WSA) and Dam Safety Regulation. The history of weir structure has been determined based on accounts and anecdotes from local residents; to date, no original design plans or documentation have been obtained for the structure. Reports indicate that a pre-existing wetland was drained some time in the early 1940's to allow for agricultural use. Sometime later, in between the late 1960s and 1980s, the weir structure was constructed creating the current marsh. The RDN acquired the Coats Marsh property in 2008. In addition to past beaver activity, a large channel-spanning dam was constructed about 60 m upstream of the weir structure around 2013. In 2022, the provincial Dam Safety Office (DSO) determined that the DSR should apply to Coats Marsh Weir on the basis that Coats Marsh is a "stream" under the WSA. Based on findings by NHC, the dam's preliminary consequence classification is "High".

1.1.2 COATS MARSH WEIR RESERVOIR

Dating back to the early 2000s, the weir has maintained a wetted marsh, with elevations being controlled with removable flashboards. Since 2013, increased beaver activity has elevated water levels by approximately 1.3 m, impacting the reservoir's storage volume. The operating range of the reservoir has fluctuated significantly in the last 20 years, with water levels increasing along with beaver dam height, occasionally overtopping the weir, and experiencing lower water conditions caused by summer evaporation and RDN operations of the siphon system. Bathymetric data from 2010 was provided by RDN but was only available for the pond area upstream of the beaver dam. In 2023, NHC conducted a limited bathymetric survey between the weir and beaver dam to address the missing bathymetric data. Further project details can be found in NHC's preliminary dam decommissioning plan report (NHC 2023).

1.2 PREVIOUS STUDIES

The following studies have been reviewed in preparing the decommissioning plan.

- *Coats Marsh Weir Replacement Elevation Study – Final Report* (NHC 2023)
- *A Proposed Strategy for Water Level Management – Coats Marsh, Gabriola Island, BC* (Madrone Environmental Services Ltd. 2021)
- *Coats Marsh Weir Assessment* (SRM Projects 2020)
- *Post-Construction Report – Coats Marsh Flood Protection Berm* (Madrone Environmental Services Ltd. 2013)
- *Coats Marsh Regional Park – 2011-2021 Management Plan* (RDN 2011)
- Citizen-science studies from local Gabriola Island resident N. Doe (2019, 2020, 2021, 2023)

The *Coats Marsh Weir Replacement Elevation Study* (NHC 2023) is the most recent engineering study carried out for the weir. The study evaluated several weir replacement options, as well as a decommissioning option.

2 PRELIMINARY DECOMMISSIONING DESIGN

As defined in preliminary dam decommissioning plan report (NHC 2023), the objective of decommissioning is to remove the weir and its appurtenant structures such that there is no man-made reservoir impoundment above the existing marsh grade. The DSR requires that decommissioning be carried out in a way that mitigates adverse impacts to public safety, the environment, and infrastructure and property.

2.1.1 REMOVALS

In the decommissioning process, the footbridge, Clemson pond leveller, and wood flashboards will be removed. The concrete weir will undergo significant removal, retaining some concrete along the outlet channel for a permanent grade control structure. Concrete debris will be disposed of off-site. The existing berm's removal is recommended due to long-term integrity concerns, with potential re-filling issues and limited downstream consequences. The preliminary plan assumes berm removal involves stripping fill and geotextile down to the native subgrade, followed by revegetation.

2.1.2 OUTLET CHANNEL WORK

Coats Marsh's unique situation, with an artificially lowered outlet, requires a distinctive approach. Full-height channel infilling would trigger water license requirements, so an alternative involves a reduced-height grade control structure with a crest elevation of 95.0 m. The structure's footprint will infill the existing drainage ditch, maintaining some wetted area and allowing seasonal flooding. To construct the structure, the remnant weir concrete's center will be filled, and riprap positioned upstream and downstream for stability. Boulders

and excavation on the left bank will create a secondary overflow channel at an elevation of 96.0 m, providing additional discharge capacity and resilience against beaver dam breaches.

2.2 SEDIMENT MANAGEMENT AND RESERVOIR RESTORATION

As paraphrased from NHC (2023), the majority of the existing reservoir will not be impacted by removal of the weir due to the presence of the beaver dam 60 m upstream. To minimize off-site disposal, most spoil materials will be utilized as fill on higher sections of the current weir pool area, as illustrated in the design drawings in the Coats Marsh weir preliminary dam decommissioning plan (NHC 2023). Despite the lower outlet elevation, the weir pool area will be locally reshaped to encourage seasonal wetland habitat and planted with a mix of native species suitable for riparian and upland conditions. EDI has developed a preliminary planting prescription and site restoration plan (refer to Section 3.10). In the event of a beaver dam failure, sediment mobilization may occur from the dam and its upstream area. While the grade control structure will help reduce sediment movement to the downstream channel, it may not entirely prevent all sediment transport.

2.3 PERMITTING CONSIDERATIONS

Permitting considerations are described in the Coats Marsh weir preliminary decommissioning plan (NHC 2023). The following permits and authorizations will be required prior to construction:

- DSO construction authorization under Division 3 of the DSR
- Provincial WSA Section 11 authorization for work in and about a stream
- Fisheries and Oceans Canada Request for Review
- Provincial wildlife permit for fish and amphibian salvage during construction

2.4 CONSTRUCTION SEQUENCE AND SCHEDULE

The Coats Marsh weir preliminary decommissioning plan (NHC 2023) outlines a recommended construction sequence and schedule. Construction activities must carefully consider the least risk timing for environmental values, especially for fish, birds, and amphibians. In order to minimize impact on downstream cutthroat and the potential presence of rainbow trout, instream works should be completed between August 15 and September 15, 2024. This timeframe also reduces the risk of significant rain events and avoids the breeding season for native amphibians. To safeguard breeding birds, construction activities should steer clear of the breeding bird period (typically March 1 – August 31). However, if works proceed in mid-August, pre-clearing breeding bird surveys must be conducted, and mitigations implemented if active nests are identified. For an approximate schedule of construction activities, refer to Table 2.1. Demobilization of heavy equipment can likely coincide with restoration, considering that some equipment may still be required on-site for final works.

Table 2-1. Proposed construction schedule.

Task	Duration (Days)	Period
Mobilization	1 to 3	Week 1
Water Management and Site Preparation	2 to 4	Week 1 to Week 2
Removals	5 to 8	Week 3 to Week 4
Outlet Channel Work	5 to 8	Week 5
Demobilization and Restoration	5 to 8	Week 6

2.5 SITE ISOLATION AND WATER MANAGEMENT

As noted in the Construction Sequence and Schedule section (Section 2.4), the dam decommissioning will require the isolation of the construction area (i.e., weir structure) from flows so that the work can be completed in dry conditions. If there is flow in the outlet creek prior to construction, it will be necessary to isolate the work site and divert the water around the weir structure to maintain base flow rates for habitat.

There are several constraints that will need to be addressed during the site isolation:

- The pond area above the reservoir should be kept within its normal elevation range. Drawing the beaver pond down below the normal low elevation, particularly during the late summer, could have impacts to shoreline vegetation and habitat for amphibians, including the northern red-legged frog, and should be avoided.
- Downstream flow conditions in Coats Marsh stream (i.e., the outlet creek) must always be maintained during construction. This means that water must be diverted around the worksite and directed back into the channel immediately downstream of the project area such that there is no reduction in water flow and no measurable change in the downstream natural flow regime. Given the potential presence of cutthroat trout and rainbow trout in the downstream reach (i.e., just upstream from Hoggan Lake), flows in the creek must be maintained to avoid potential fish stranding.
- The Contractor will need to consider the risk of operating downstream of the beaver dam and the associated pond in determining their preferred approach to dewatering the site.
- Passive approaches (e.g. gravity-fed culvert or flume) to diverting water around the construction site are generally preferred to pumping, as they maintain natural downstream flows without relying on power. However, conditions on site appear to prevent the use of these passive approaches. The bedrock substrate at the weir location is anticipated to impede the installation of a gravity-fed diversion channel or culvert, leaving a pumping system as the only alternative.
- If pumps are used to divert water around the work site for more than one day, the pump operation should be monitored during periods when no work is occurring at the worksite. Back-up pumps should be readily available on-site in case of pump failure or high flow events.

The following approaches, or a combination thereof, will be considered for site isolation. Regardless of the approach, it will be important to design the dewatering system to keep the beaver pond within its normal range of operation while also being able to handle additional inflow in the event of precipitation.

a) Using the existing beaver dam to provide site isolation. This could be accomplished by lowering the water level behind the beaver dam using the existing siphons and pumping out the work area downstream of the beaver dam. Note that the beaver pond should not be drawn down lower than its normal range of elevation.

b) Using a man-made cofferdam (i.e., bulk bags or similar products) downstream of the beaver dam in the weir pond area to provide site isolation.

As a general approach, the Contractor will use cofferdams (e.g., bulk bags) or sheet piles to isolate and dewater the instream work area, pumping clear water around the site into the downstream channel. All water pumps will be equipped with an appropriately sized fish screen to prevent fish entrainment or impingement as per DFO's Interim Code of Practice[2]. The effective screen area will be determined based on the capacity of the pumps and mesh size of 2.54 mm.

Turbid water that is pumped from the isolated work areas should be directed towards a low-lying vegetated area where it can infiltrate the ground. The EM must monitor any dewatering to ensure that turbid water does not re-enter the stream unless it meets water quality standards.

A more comprehensive site-specific work plan will be developed by the Contractor in advance of the proposed works. The final site isolation and water management plan will need to be reviewed and approved by a QEP.

[2] Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater. https://www.dfo-mpo.gc.ca/pnw-ppe/codes/screen-ecran-eng.html

3 ASSESSMENT OF ENVIRONMENTAL CONCERNS

3.1 DESCRIPTION OF NATURAL ENVIRONMENT FEATURES

3.1.1 VEGETATION AND ECOSYSTEMS

Coats Marsh occupies an elongated somewhat oval depression of approximately maximum width of 200 m in the north-south direction and approximately 425 m long in the east-west direction (Photo 3-1). The marsh is a complex of wetland classes currently dominated by shallow water (aquatic), where permanent inundation occurs. The shallow water area transitions into a marsh, where emergent vegetation and seasonal drying occurs. Beyond the marsh area, the ecosystem transitions into the forested swamp. Field verification estimates that Coats Marsh is comprised of approximately 65% shallow water, 25% marsh and 10% shrubby swamp. The forested swamp has been classified as a Western Red Cedar – Indian Plum ecological community.

Photo 3-1. Looking east towards Coats Marsh from the beaver dam.

Increases in wetland area have been evident for at least 10 years, related to previous beaver activity around the vicinity of the outlet weir and current beaver dam. This is evident by the occurrence of dead or dying coniferous trees, mainly Douglas fir (*Pseudotsuga menziesii*), around the wetland margin that have become inundated (Madrone Environmental Services Ltd. 2021).

The shallow water ecological community is dominated by water smartweed (*Persicaria amphibia*). The shallow water area between the beaver dam and the existing weir also contains yellow pond lily (*Nuphar variegate*) and a bladder wort species (*Utricularis* sp.) (Photo 3-2).

Photo 3-2. Area between cement weir and beaver dam (looking north).

On the periphery of the shallow water is a transitional wetland area. The transitional area is composed of mixture of emergent and hydrophytic vegetation such as water smartweed, bladder wort, pondweed (*Potamogeton* sp.), sedges (*Carex* sp.), common rush (*Juncus effusus*), and marsh horsetail (*Equisetum palustre*). Some of the sections currently classed as marsh contain dead/dying trees which signifies inundation of these areas have occurred for a period long enough to modify the wetland class from swamp to marsh.

The marsh area is described as being vegetated with a dense coverage of sedges (*Carex* sp.) and interspersed with cattails (*Typha latifolia*). The marsh component of this complex is currently dominated by reed canarygrass (*Phalaris arundinacea*) (Photo 3-3). There are patches of cattails (*Typha latifolia*) along the edges of the beaver dam and the weir berm. Like many marshes, plant diversity is low except in the transitional area between the shallow water and marsh. In areas that were not inundated during the September site visit, the presence of shrub cover, such as pink spirea (*Spirea douglasii*), was observed. These areas were considered more of a pink spirea swamp than marsh.

Photo 3-3. Marsh area that is currently dominated by invasive reed canarygrass.

A forested ecosystem surrounds much of the wetland and this mature forested ecosystem consists mainly of Douglas fir and western red cedar (*Thuja plicata*). Red alder (*Alnus rubra*) also occurs along the wetland edge (Madrone Environmental Services Ltd. 2021).

3.1.2 FISH AND WILDLIFE

The marsh provides habitat for a variety of wildlife species, including birds, amphibians, reptiles and mammals. Bird occurrence includes several species of wading birds, swans, geese, and waterfowl. Reports from local naturalists provide records of local wildlife observations at the site (Doe 2020). As noted, the marsh provides year-round habitat for Common Ravens (*Corvus corax*) and Northwestern Crows (*Corvus caurinus*), and also sees occasional visits from Steller's Jays (*Cyanocitta stelleri*) and Bald Eagles (*Haliaeetus leucocephalus*). Forested areas harbor Spotted Towhees (*Pipilo maculatus*) and Pacific Wrens (*Troglodytes pacificus*), while clearings attract American Robins (*Turdus migratorius*) and Violet-green Swallows (*Tachycineta thalassina*).

The shallow open water pond hosts a variety of waterfowl, including year-round residents like Mallards (*Anas platyrhynchos*) and occasional visitors like Yellowleg Waders (*Tringa sp.*). Annual migrations bring Trumpeter Swans (*Cygnus buccinator*) and Canada Geese (*Branta canadensis*) to the area.

The Coats Marsh area hosts a thriving amphibian community, including Pacific tree frogs (*Pseudacris regilla*) and the blue-listed northern red-legged frogs (*Rana aurora*). Additionally, the presence of the western long-

toed salamander (*Ambystoma macrodactylum*) and rough-skinned newt (*Taricha granulosa*) adds to the region's amphibian diversity. Coats Marsh is not identified as critical habitat under SARA or an Approved Wildlife Habitat Area (WHA) provincially for northern red-legged frogs. Reptiles, with garter snakes (*Thamnophis ordinoides*) as the primary representative, are relatively rare.

Coats Marsh area hosts a varied population of mammals. While reports of black bears and cougars remain unconfirmed, black-tailed deer (*Odocoileus hemionus ssp. columbianus*) are noted as commonplace, even in winter. Other documented mammals include raccoons (*Procyon lotor*), red squirrels (*Tamiasciurus hudsonicus*), and beavers (*Castor canadensis*). Additionally, the presence of rodents such as deer mice (*Peromyscus maniculatus*) and Townsend's voles (*Microtus townsendii*) is highlighted, alongside the seasonal activity of bats (*Myotis sp.*).

Fish presence in the Coats Marsh area have been investigated to some extent in the past, and the observations suggest that the marsh does not sustain a salmonid fish population (Doe 2019, EDI 2023). Records describe that fish sampling occurred in 2010 but that no fish were caught (Foul Bay Ecological Research 2010). The historical use of Coats Marsh for agriculture, along with documented barriers like a concrete weir structure and constructed rock dams downstream, makes it unlikely to support a natural population of salmonid fish. Additionally, a barrier to fish passage has been documented approximately 50 m upstream from Hoggan Lake, preventing fish passage to Coats Marsh. This does not definitively rule out the possibility of fish in the area but supports the conclusion that the marsh does not sustain a salmonid population. Although unconfirmed, the pond could provide suitable habitat for three-spined stickleback (Madrone Environmental Services Ltd. 2012) but there have not been any detections reported.

In contrast, Hoggan Lake has a history of fish presence, with Cutthroat Trout stocked in 1924 and 1927. Observations in 1972 indicated both Cutthroat Trout and Rainbow Trout in the lake. Ongoing research, primarily focused on threespine stickleback, has been conducted in Hoggan Lake, yet no captures of salmonid species were documented during various sampling periods from 2007 to 2017. Interviews with the Coats family in 1972 suggested possible spawning by Cutthroat or Rainbow Trout in the lower reach of the Coats Marsh stream, below the barrier, leaving open the possibility of utilization by these spring-spawning salmonid species in the lower stream reaches. There is some doubt whether the documented barrier does in fact prevent fish passage, as Doe (2023) states that mature fish and fry were reported by Gabriola Island Streamkeepers up to 100-200 metres upstream of the South Road culvert (Doe 2023). Results presented by Madrone Environmental Services Ltd. (2012) indicate that fish habitat attributes are extremely limited in this area, likely a result of historical straightening and ditching of the channel through the surrounding pasture lands. The sidewalls of the ditch are steep, with evidence of erosion from high, concentrated flows. The substrate is comprised mainly of organic material, although short sections of alluvial deposits also occur.

3.2 ALTERATION OR DESTRUCTION OF FISH HABITAT

EDI's wetland assessment report (EDI 2023) provides a detailed description of environmental conditions at Coats Marsh and downstream areas in the context of how theses characteristics would be affected by a dam set at various elevations, including a case with removal of the weir and beaver dam. In that report, a full decommissioning of the weir was found to have the most adverse effects on preserving existing species

diversity. However, this scenario also assumed the removal of the beaver dam, which currently provides natural retention of water and subsequently maintains flood conditions in the marsh.

The present decommissioning plan includes retention of the beaver dam, which is intended to allow for the maximum water retention while still decommissioning the weir. The assumption is that this outcome will result in a scenario closest to full water retention, which had the greatest benefit for preservation of present ecological conditions, including for amphibians and waterfowl. Assuming the beaver dam retains the similar pond conditions, environmental outcomes are not expected to deviate significantly from Scenario 4 in the wetland assessment (EDI 2023), which assumed a small reduction in the weir height to the current beaver dam elevation (weir crest of 97.7m). The present design plans for the removal of the weir, resulting in a smaller weir pool area, but retaining approximately the same wetland area upstream of the beaver dam.

In this situation, where the weir is decommissioned but the beaver dam is retained, it is assumed that water will continue to be impounded by the beaver dam and that most of the marsh area will have similar values to present conditions. However, these values will likely change if the beaver dam fails to effectively retain water and water levels drop. There is a risk that the level of local beaver activity could change in time. If local beavers abandon the marsh, this could lead to a future deterioration of the beaver dam. This deterioration could cause fluctuations in water levels within the marsh area and could lead to uncontrolled releases of water downstream of the beaver dam. This could result in a scenario with significant water drawdown in the Coats Marsh. While we acknowledge this risk, EDI is not qualified to speak to the beaver dam's stability, functionality or likelihood of failure, and defers to information provided by NHC (2023) for consideration and discussion.

Only the area between the existing weir and the beaver dam located 60 m further upstream will be dewatered as a result of the weir removal. Most of the marsh's storage volume is governed by the beaver dam, which is proposed to remain in place after decommissioning. The dewatered weir pool downstream of the beaver dam has a small volume and surface area compared to the upstream marsh. Based on preliminary drawings from NHC (2023), the current area within the annual high-water mark between the weir and beaver dam is 2,303 m^2 (Figure 3-1). With the decommissioning of the weir structure, the area within the estimated future annual high water is approximately 739 m^2 (Figure 3-2). In total, this represents a loss of 1,654 m^2 that will be dewatered at the weir pool, to be revegetated and restored to a shrubby swamp habitat planted with appropriate plant species. The existing stream channel in the weir pool area will be retained to convey water through the marsh area to the decommissioned weir outlet.

Removal of the weir but retention of the beaver dam is anticipated as having little effect to downstream flow conditions, and subsequently little effect on downstream fish habitat. No significant impacts to fish are anticipated as the flow regime should remain similar to current conditions. Salmonid fish species are considered absent from Coats Marsh, given barriers to fish access from Hoggan Lake and a history of complete drawdowns for agricultural purposes. Downstream flows and dry periods are anticipated to be similar to current operations with seasonally dry conditions encountered in the late summer and early fall. Based on existing flow patterns, the beaver dam should provide passive water retention and release naturally, maintaining seasonal flows throughout the spring without having any significant negative impacts on spawning or egg development if Cutthroat Trout are indeed present.

Figure 3-1. Existing weir pool/marsh area (to estimated annual high-water mark) prior to dam decommissioning

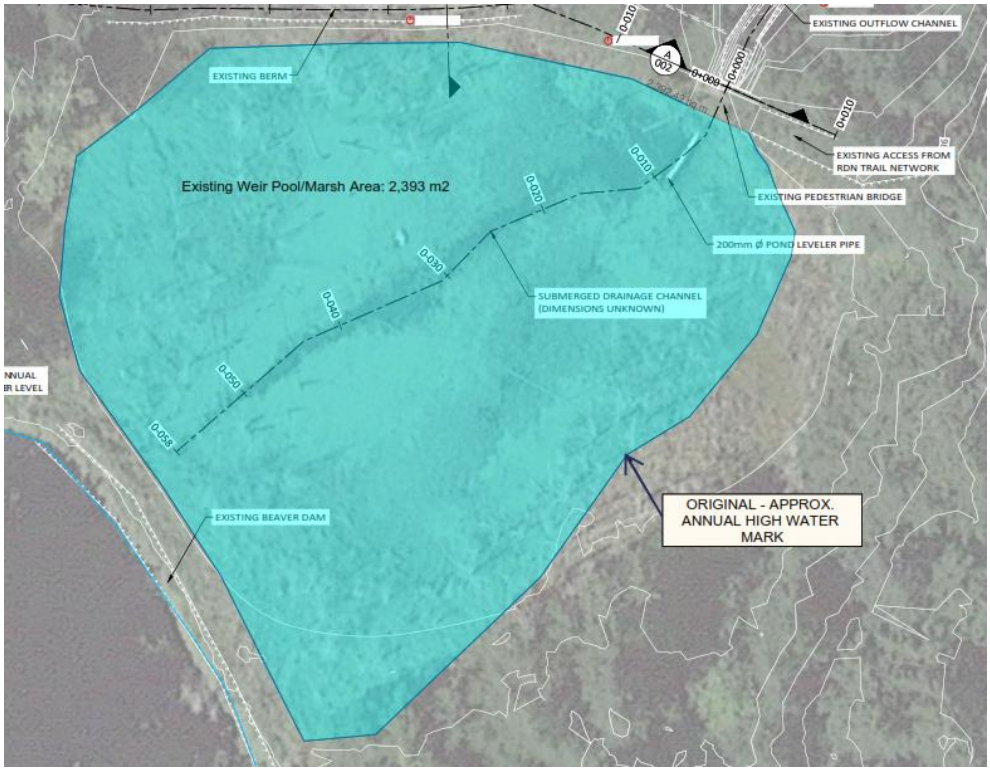
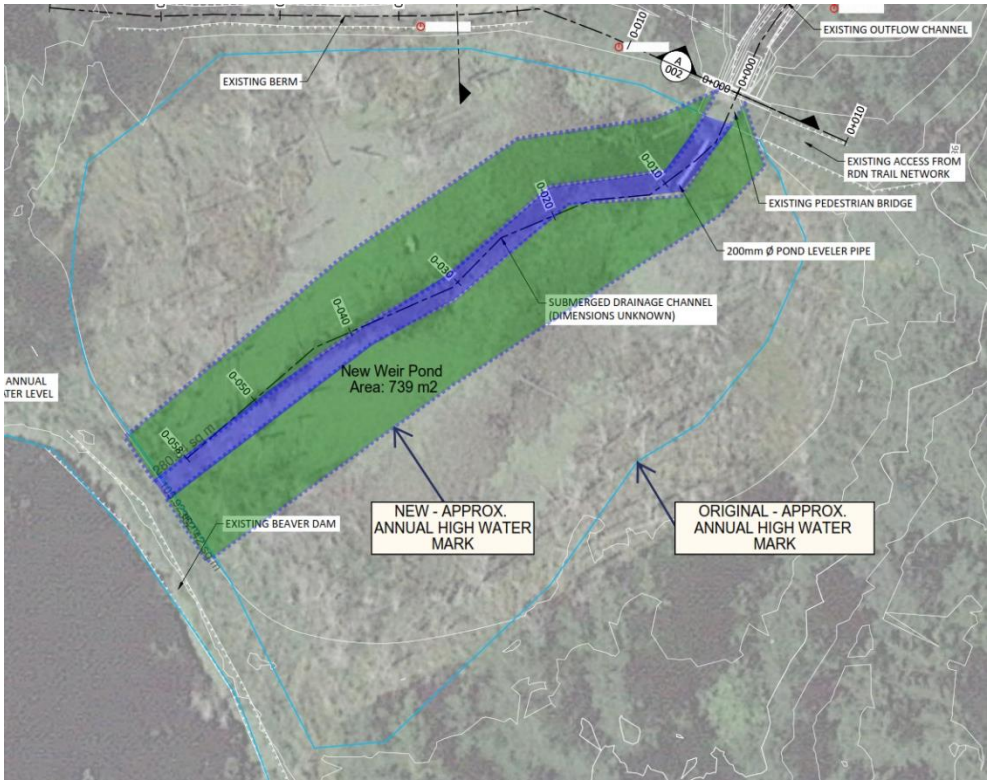


Figure 3-2. Proposed weir pool/marsh area (to new estimated annual high-water mark) after dam decommissioning



EDI noted that there are risks associated with preservation of the beaver dam, given that beaver populations may be subject to change, and the site could be abandoned. EDI also noted that a potential for dam failure presents some ecological risks. A dam failure could result in an outlet stream wash-out that could affect resident cutthroat trout spawning or amphibian reproduction. The greatest risk of dam failure for adverse fish habitat impacts would be between February to May, and for northern red-legged frogs would be between February to July.

3.3 WETTING AND DRYING OF LITTORAL EDGE HABITAT

With the retention of the existing beaver dam, the amount of littoral edge habitat is not anticipated to change substantially with the removal of the weir structure, assuming the beaver dam continues to effectively retain water. The main pond area of Coats Marsh is assumed to have an equivalent coverage as the current wetland complex proportions, with a large area of shallow water wetland and a fringe of marsh/shrubby swamp wetland. The edges should largely remain unchanged upstream of the beaver dam.

The primary change will be the loss of some of the surface water between the removed weir and the beaver dam being retained. Removal of the weir and berm structures will result in the dewatering of the weir pool and marsh. With a reduced surface water level between the weir and beaver dam, we estimate that site conditions will shift to drier wetland ecosystems. Assuming wetland areas between the weir structure and beaver dam are dewatered somewhat by the removal of the weir (minus the construction footprint and soil deposit areas), the total dewatered area (i.e., within annual high-water mark) is estimated to be approximately 2,393 m^2. The weir pond is comprised of shallow open water habitat in the centre with a gradient of marsh and swamp components extending outwards. The new shallow open water area will have an estimated area of 739 m^2. Following removal of the weir, the existing main channel through this area will be retained and provide continued drainage. The weir structure will be restructured such that outlet is a suitable elevation to retain some pooling water upstream. The adjacent areas will be restored into a gradient of wetland types, with drier soil conditions being anticipated further from the channel.

3.4 AT RISK SPECIES

At present, no species at risk are considered to be at risk due to the environmental changes induced by the decommissioning of the dam. Rather, the plan to remove the weir purposely includes the retention of the existing beaver dam as this represents the least amount of change to the overall marsh area when compared to other plans for upgrading or reconfiguring the weir structure.

According to Madrone (Madrone Environmental Services Ltd. 2021), Coats Marsh has confirmed occurrences of northern red-legged frogs (*Rana aurora*) which is a federally listed species of concern and a provincially blue-listed species. Although unconfirmed, the wetland may provide breeding habitat for this species as it contains extensive woody debris and emergent vegetation that can act as egg-mass attachment media. The adjacent forest also provides security and forage habitat for dispersing native amphibians. Madrone

noted at least 20 northern red-legged frogs during their site assessment and also noted the presence of Pacific chorus frogs (*Pseuadacris regilla*) within the wetland (Madrone Environmental Services Ltd. 2021).

Although northern red-legged frog is unlikely to be at risk as a result of the proposed works, there will be a change in the available habitat between the weir structure and the beaver dam. The amount of open water will be reduced in the lower weir pond area, which will in return reduce the amount of emergent vegetation available on the peripheries. This loss of emergent vegetation will be addressed with site restoration, with a focus on planting emergent vegetation like cattails and sedges within the new wetted area between the weir and beaver dam, targeting conditions that are comparable to a sedge marsh.

3.5 FLORA AND FAUNA LIST

A list of flora and fauna has been developed incorporating unconfirmed species lists from local naturalists (Doe 2019, Doe 2020), past site investigations (Madrone Environmental Services Ltd. 2021) and observations during the site visit (EDI 2023). The compiled species lists are:

Table 3-1. Plants observed at site compiled from various sources (EDI 2023, Madrone 2021, Doe 2020)

Common Name	Scientific Name
Arbutus	*Arbutus menziesii*
Bigleaf maple	*Acer macrophyllum*
Bitter cherry	*Prunus emarginata*
Bladderwort species	*Utricularia sp.*
Bur-weed species	*Sparganium sp.*
Common rush	*Juncus effusus*
Douglas-fir	*Pseudotsuga menziesii*
Duckweed	*Lemna minor*
Dull Oregon-grape	*Berberis nervosa*
Evergreen huckleberry	*Vaccinium ovatum*
Grand fir	*Abies grandis*
Gummy gooseberry	*Ribes lobbii*
Horsetails	*Equisetum spp. including marsh horsetail (E. palustre)*
Juniper haircap moss	*Polytrichum juniperium*
Marsh horsetail	*Equisetum palustre*
Marsh skullcap	*Scutellaria galericulata*
Narrow-leaved bur-weed	*Sparganium angustifolium*
Ocean spray	*Holodiscus discolor*
Oregon beaked moss	*Kindbergia oregana*
Osoberry	*Oemleria cerasiformis*
Pacific ninebark	*Physocarpus capitatus*
Pink honeysuckle	*Lonicera hispidula*
Pink spirea/hardhack	*Spirea douglasii*

Pondweed species	*Potamogeton sp.*
Red alder	*Alnus rubra*
Red elderberry	*Sambucus racemosa*
Red huckleberry	*Vaccinium parvifolium*
Redcedar	*Thuja plicata*
Red-flowering currant	*Ribes sanguineum*
Reed canarygrass	*Phalaris arundinacea*
Rose	*Rosa acicularis*
Salal	*Gaultheria shallon*
Salmonberry	*Rubus spectabilis*
Scouler's willow	*Salix scouleriana*
Sedge species	*Carex sp.*
Snowberry	*Symphoricarpos albus*
Sword fern	*Polystichum munitum*
Thimbleberry	*Rubus parviflorus*
Trailing blackberry	*Rubus ursinus*
Water smartweed	*Persicaria amphibia*
Watershield	*Brasenia schreberi*
Western redcedar	*Thuja plicata*
Yellow pond lily	*Nuphar polysepala*

Table 3-2. Birds observed at site compiled from various sources (EDI 2023, Madrone 2021, Doe 2019)

Common Name	Scientific Name
American Coots	*Fulica americana*
American Robins	*Turdus migratorius*
American Widgeons	*Anas americana*
Bald Eagles	*Haliaeetus leucocephalus*
Barred Owls	*Strix varia*
Belted Kingfishers	*Ceryle alcyon*
Blue-winged Teals	*Anas discors*
Brown Creepers	*Certhia americana*
Bushtits	*Psaltriparus minimus*
Canada Geese	*Branta canadensis*
Cedar Waxwings	*Bombycilla cedrorum*
Chestnut-backed Chickadees	*Poecile rufescens*
Common Ravens	*Corvus corax*
Common Yellowthroats	*Geothlypis trichas*
Coopers' Hawks	*Accipiter cooperii*
Dark-eyed Juncos	*Junco hyemalis*
Downy Woodpeckers	*Picoides pubescens*

Fox Sparrows	*Passerella iliaca*
Gadwalls	*Anas strepera*
Golden-crowned Kinglets	*Regulus satrapa*
Great Horned Owls	*Bubo virginianus*
Green-winged Teals	*Anas crecca*
Hairy Woodpeckers	*Picoides villosus*
House Finches	*Carpodacus mexicanus*
Mallards	*Anas platyrhynchos*
Northern Flickers	*Colaptes auratus*
Northern Shovelers	*Anas clypeata*
Northwestern Crows	*Corvus caurinus*
Orange-crowned Warblers	*Vermivora celata*
Pacific Wrens	*Troglodytes pacificus*
Pacific-slope Flycatchers	*Empidonax difficilis*
Pied-billed Grebes	*Podilymbus podiceps*
Pileated Woodpeckers	*Dryocopus pileatus*
Pine Siskins	*Carduelis pinus*
Red-breasted Nuthatches	*Sitta canadensis*
Red-tailed Hawks	*Buteo jamaicensis*
Red-winged Blackbirds	*Agelaius phoeniceus*
Ring-necked Ducks	*Aythya collaris*
Ruby-crowned Kinglets	*Regulus calendula*
Ruddy Ducks	*Oxyura jamaicensis*
Sharp-shinned Hawks	*Accipiter striatus*
Snowy Owls	*Bubo scandiacus*
Song Sparrows	*Melospiza melodia*
Spotted Towhees	*Pipilo maculatus*
Steller's Jays	*Cyanocitta stelleri*
Townsend's Warblers	*Dendroica townsendi*
Trumpeter Swans	*Cygnus buccinator*
Turkey Vultures	*Cathartes aura*
Violet-green Swallows	*Tachycineta thalassina*
White-crowned Sparrows	*Zonotrichia leucophrys*
Yellowleg Waders	*Tringa sp.*
Yellow-rumped Warblers	*Setophaga coronata var.Auduboni*

Table 3-3. Amphibians and reptiles observed at site compiled from various sources (EDI 2023, Madrone 2021, Doe 2019)

Common Name	Scientific Name
Northwestern Garter Snake	*Thamnophis ordinoides*
Northern Red-legged Frogs	*Rana aurora*
Pacific Tree Frogs	*Pseudacris regilla*
Rough-skinned Newts	*Taricha granulosa*
Western Long-toed Salamanders	*Ambystoma macrodactylum*

Table 3-4. Mammals observed at site compiled from various sources (EDI 2023, Madrone 2021, Doe 2019)

Common Name	Scientific Name
Bats	*Myotis spp.*
Beaver	*Castor canadensis*
Black bear (unconfirmed reports)	*Ursus americanus*
Black-tailed Deer	*Odocoileus hemionus ssp. columbianus*
Cougar (unconfirmed reports)	*Puma concolor*
Deer Mice	*Peromyscus maniculatus*
Raccoon	*Procyon lotor*
Red Squirrel	*Tamiasciurus hudsonicus*
Townsend's Vole	*Microtus townsendii*

Fish sampling did not occur in the marsh, however based on past reports, and observed site conditions, salmonid species (i.e., trout) are not expected to occur in Coats Marsh, although they are assumed to be present in Hoggan Lake and could potentially spawn in the lowest reach of the Coats Marsh stream. Doe (2023) reports that the Gabriola Island Streamkeepers have identified fish further up the Coats Marsh Creek, but their presence has not been confirmed.

Table 3-5. Fish documented in Hoggan Lake

Cutthroat Trout	*Oncorhynchus clarkia*
Rainbow Trout	*Oncorhynchus mykiss*
Threespine Stickleback	*Gasterosteus aculeatus*

3.6 LIST OF BIOPHYSICAL EFFECTS

When the weir is decommissioned, there will be likely be changes to local hydraulics, to seasonal water level ranges, and to flow attenuation compared to existing conditions (NHC 2023). However, these changes are expected to be minor because most of the marsh storage volume is located upstream of the beaver dam. Seasonal high-water levels are expected to remain similar for most of the marsh, except for the smaller area between the beaver dam and the existing weir. The loss of storage volume between the beaver dam and the weir will modify peak flow attenuation through the marsh.

Given that the water flows and retention are anticipated to be similar to past conditions, no significant changes are anticipated with other biophysical conditions of the water (e.g., water chemistry, water temperature, dissolved oxygen).

3.7 DESCRIPTION OF PROPOSED UNDERTAKING

The proposed works and rationale are described extensively by NHC (2023) in the preliminary Decommissioning Plan. The weir, which is co-owned by the Regional District of Nanaimo (RDN) and The Nature Trust of BC (TNT) on Gabriola Island, is currently unlicensed but is classified as a dam under the BC Dam Safety Regulation (DSR) because of its reservoir storage volume. Previous engineering studies have identified several deficiencies with the weir and its associated structures concerning current dam safety standards. In response to these issues, the RDN and TNT have evaluated options and decided to propose the decommissioning of the weir. The primary reasons for choosing decommissioning over replacement include lower capital costs and a more favorable long-term asset management outlook. Therefore, the proposed solution involves decommissioning the weir and allowing the marsh to return to a naturally regulated condition.

Currently, the preliminary scope of dam decommissioning includes the following elements:

- leaving the existing upstream beaver dam in place to maintain habitat value,
- removal of the existing weir and appurtenant structures, including the existing berm,
- construction of a grade control structure at the marsh outlet to mitigate complete drainage of the marsh, which would otherwise occur due to historical lowering of the marsh outlet channel,
- construction of an overflow channel adjacent to the main outlet channel to better manage water levels near private property boundaries, and
- revegetation planting with native species.

3.8 MEASURES AND METHODS FOR AVOIDING OR MITIGATING NEGATIVE IMPACTS TO AT RISK AREAS

The following mitigation measures should be implemented to reduce potential affects to wildlife and ecological communities associated with the proposed dam decommissioning:

- Work to be timed during period of low water levels (e.g., late summer/early fall) and dry, favourable weather.
- When possible, work activities should be scheduled to avoid the breeding bird period (typically March 1 – August 31) for both migratory and resident birds that could potentially use the affected proposed disturbance areas for breeding and nesting. If working during the breeding bird period can not be

avoided, then pre-clearing breeding bird surveys must be completed, and mitigations taken if any active nests are identified. We anticipate having to complete pre-clearing nest surveys in late August (Aug 15-31) as instream works will be likely be under way at this time. Bird surveys would apply to any major terrestrial disturbance or vegetation clearing of trees, shrubs or tall grass areas.

- A survey of large stick nests and nesting cavities should be completed to identify if there are any nests that are offered year-round protection. These include the nests of eagles, ospreys, herons, and pileated woodpecker. If any nests are identified, a Nest Management Plan will be needed to address specific mitigations and monitoring requirements.

- Any planned work activities should be planned during applicable least-risk windows to avoid potential affects to native amphibians. Although no formal window exists for amphibians in BC, northern red-legged frogs breed in February until April. Hatching typically occurs during the first half of May and the larval (tadpole) period lasting another 11-14 weeks. Most tadpoles have metamorphosed into adults by early July to early August. Important times of the year when increased numbers of adult frogs may be observed by the pond and adjacent upland areas are during the breeding season (February – April) and during dispersal of newly metamorphosed adults (July – August). Weir and berm removal should be timed to coincide after adult red-legged frog dispersal, typically ending in August.

- Adult northern red-legged frogs (and all other amphibian specimens encountered) should be salvaged and relocated prior to any ground clearing or earthworks by a qualified professional with the appropriate wildlife handling permits.

- Coats Marsh is not identified as critical habitat under SARA or provincially an Approved Wildlife Habitat Area (WHA) for northern red-legged frogs. As such, no specific permitting for species at risk is anticipated.

- For construction, it is assumed that Cutthroat Trout in Hoggan Lake access the lowest reach of Coats Marsh stream for spawning, although various barriers are supposed to prevent upstream passage to the marsh. Instream construction should be timed to the least risk work window for Cutthroat Trout. This spans from August 15 to September 15 for Vancouver Island and the Gulf Islands.

- Although no salmonid species are anticipated, the dewatered area will be observed for any stranded fish and salvaged as necessary.

- Considering the various environmental timing windows (i.e., fish, birds, amphibians), we would **recommend following the least risk work window for Cutthroat Trout, from August 15 to September 15**. This avoids the most critical times for northern red-legged frogs and breeding birds.

- Monitoring for invasive hydrophytic vegetation species should be implemented since there is the potential for the further spread of reed canarygrass or the introduction of new species such as yellow flag iris.

- Restoration works will be implemented with a focus on planting locally appropriate native wetland and riparian plant species to stabilize dewatered and disturbed areas while promoting the establishment of self-sustaining wetland habitat. High density planting of native grass and shrub species will be utilized in the dewatered area of the weir pool to provide competition with invasive plant species like reed canarygrass.

3.9 DESCRIPTION OF PROPOSED MONITORING PLANS

A monitoring program must be implemented to ensure that environmental impacts are avoided during the dam decommissioning and to evaluate the effectiveness of the proposed mitigation measures, including the protection of water quality and revegetation of the disturbed site.

Monitoring plans will be incorporated into the broader Construction Environmental Management Plan. This document will include sections that address:

- **Construction Monitoring** –environmental monitoring will be required during construction. The Construction Environmental Management Plan will include the frequency and timing of environmental monitoring for the duration of the dam decommissioning work. Regular inspections should be conducted to ensure compliance with environmental regulations, management plans and permits. Full-time environmental monitoring is anticipated during all instream works or during any other critical periods that are identified.

- **Water Quality Monitoring** – water quality monitoring will be required during the removal of the weir structure and berm, ensuring that water quality standards for turbidity are maintained. Water quality monitoring will be based on criteria from BC Water Quality Guidelines for turbidity.

- **Restoration Monitoring** – monitoring will be required to gauge the success of site restoration, with a particular focus on documenting the survivorship, vigor, and overall cover of planted specimens. Restoration monitoring will begin the summer after the completion of the prescribed planting.

- **Weed and Invasive Plant Monitoring** – weed and invasive plant monitoring will be addressed as part of the restoration monitoring program. The focus will be on documenting the spread (or containment) of well-established invasive plant species (e.g., reed canary-grass) and identifying and preventing the establishment and spread of new invasive species (e.g., yellow flag-iris).

3.10 DESCRIPTION OF PROPOSED ENHANCEMENT OPPORTUNITIES

3.10.1 RESTORATION OVERVIEW

Revegetation and enhancement will be required at the dewatered areas of the weir pond, the excavation areas at the berm location, and any selected soil spoil sites. As noted in the Dam Decommissioning Checklist (Ministry of Forests, Lands, Natural Resource Operations and Rural Development 2010), there is a

requirement to leave the site in a condition that is safe and does not alienate the property for future use or enjoyment of the public. Additionally, in environmentally sensitive areas (ESAs), such as wetlands, the revegetation of disturbed soils should be completed in a manner that avoids the establishment and spread of invasive species.

It is important to note: this restoration plan should be considered conceptual at this stage. The restoration plan will be refined and finalized based on feedback from the public and regulators and with a better understanding of the actual water elevations and site conditions following construction. The survey data that is currently available is limited. As such, the wetland extents (annual and intermittent) presented in the design drawings are only estimates based on a small selection of available topographical points and site photos taken by NHC during low water conditions. The treatment unit boundaries for restoration will be refined during construction once the plans have been reviewed by local stakeholders. Restoration works will need to be somewhat flexible, with planting species and densities being somewhat "field fit" based on site conditions.

3.10.2 ASSESSMENT AND PLANNING

The nature of the work and the anticipated changes to ecosystems are described in detail in the sections above. Overall, the project involves the decommissioning of the existing weir, excavation of the berm, establishment of overflow channel, and deposition of excavated soils. Removal of the weir structure will result in a reduction in water levels in the weir pond area, resulting in drier conditions and exposing previously wetted areas between the beaver dam and weir structure.

At present, the affected area is predominantly shallow water habitat, with marsh and swamp habitat types located on the periphery. The shallow water ecological community is dominated by water smartweed (*Persicaria amphibia*), yellow pond lily (*Nuphar variegate*) and a bladder wort species (*Utricularis* sp.). The marsh area is described as vegetated with a dense coverage of sedges (*Carex* sp.) and interspersed with cattails (*Typha latifolia*). The marsh component of this complex is often dominated by reed canarygrass (*Phalaris arundinacea*) in the project area although there are patches of cattails (*Typha latifolia*) along the edges of the beaver dam and the weir berm. Adjacent to the marsh habitat, areas that experienced slightly less flooding (e.g. dry during the September site visit) had increasing cover of pink spirea (*Spirea douglasii*) and other shrubs, indicating that these areas were more of a pink spirea swamp than marsh.

Based on current design plans and our predictions for future site conditions (i.e., post-dam decommissioning), the restoration area has been divided into four general treatment units based on anticipated ground elevation, water availability, and construction disturbance.

3.10.3 STAKEHOLDER ENGAGEMENT

The proposed restoration plan is currently in draft form only, as it will need to be refined based on any changes to the overall project design, input from stakeholders and regulators, and an updated assessment of site conditions, particularly site drainage, once the work has commenced.

It is recommended that stakeholders are engaged in the development of the revegetation plan. Involving local residents, naturalists, environmental groups, and indigenous communities ensures that the plan aligns with regional conservation objectives, incorporates valuable local knowledge, and garners community support.

Additionally, collaboration with stakeholders facilitates educational initiatives, raising regional awareness about the significance of the marsh ecosystem and fostering a sense of community ownership for the project's long-term success.

3.10.4 RESTORATION GOALS

The proposed conceptual restoration plan was developed with the following goals:

- To restore disturbed areas to regionally appropriate functional ecosystems.
- To avoid erosion and sediment transport.
- To provide a diversity of habitats.
- To minimize the spread of invasive plant species.

The restoration plan proposes the following ecological targets as measures in determining if the restoration works have achieved the intended goals:

- 80% survival rate of planted specimens for the first 5 years.
- At least 75% of the surface of replacement area reestablished with native wetland plant species within two growing seasons.
- Turbidity in the stream at the restoration area is within BC Water Quality Guidelines when compared to an upstream control.

3.10.5 DESIGN CONSIDERATIONS

a. Hydrological Restoration: - The removal of the weir structure and berm, addition of a back-up channel, and re-contouring of the channel outlet are all intended to remove the currently unmaintained weir structure while allowing natural hydrologic function of the channel. The existing beaver dam will be retained to support the continued presence of shallow open water habitat while maintaining a diversity of marsh and swamp habitat on the peripheries.

b. Vegetation Planning: - Based on an understanding of existing wetland conditions on site, and the anticipated change in pond water levels, soil moisture and exposed surfaces (as a result of excavation and dewatering), vegetation planting will only be required downstream of the beaver dam, within the dewatered weir pond area and construction areas with exposed soils.

c. Wildlife Considerations: - Coats Marsh has known occurrences of the northern red-legged frog. This species prefers emergent vegetation in shallow open ponds for breeding. Most of the open water pond habitat is assumed to remain unchanged upstream of the beaver dam. Conditions immediately downstream of the beaver dam will be drier, with less flooding and better drainage, likely resulting in marsh conditions rather than a shallow pool. Revegetation will focus on establishing emergent vegetation along the peripheries of the permanent wetted channel to provide habitat for amphibians.

3.10.6 IMPLEMENTATION PLAN

Phased Approach

Restoration works will be completed in phases, considering time and ecological dependencies. Once the weir and berm have been removed and the outlet channel re-configured, the project will move to demobilization and restoration. The restoration plan will need to be re-visited during construction to ensure that actual site conditions following weir removal are consistent with the predicted conditions (used in this conceptual restoration plan).

- Restoration works should be timed to favourable weather. Drier, more upland locations will be restored first, allowing time for the dewatered areas within the old weir pool area to dry.
- Planting should occur in Fall (September or October) or Spring (March or April).
- Excavated topsoil will be stored and replaced on site and then be vegetated. Topsoil placement is more appropriate for locations above current high-water mark (HWM) which are more likely to have a comparable surficial mineral soil layer.

Treatment Areas

Revegetation of the site has been divided into four treatment units. For each of these treatment units, plant species were initially selected from native trees, shrubs, grasses and groundcover appropriate for planting in wetland and riparian ecosystems in the South Coast of B.C. (MOE 2008). These species lists were further refined based on anticipated moisture conditions, flooding frequency, site disturbance, and a confirmed presence within the local area. A description of the proposed treatment areas and a conceptual planting list are described below and depicted in Figure 3-3.

- Treatment Unit 1 (TU1) – Low elevation marsh (within annual high-water mark with annual flooding anticipated) – estimated 627 m^2 area adjacent to the weir pool channel that will be flooded annually. Currently this is open pond habitat but with the weir removal, the water table will drop, making this area seasonally flooded only. The anticipated flooding periodicity suggests that this area will transition from an open water pond to marsh. Target species will include cattails, beaked sedge and rushes.
- Treatment Unit 2 – Mid elevation swamp (above annual HWH but below 200-year high water mark) – 1,135 m^2 area in a slightly drier position above the annual high-water mark. Frequently saturated

soils and a shallow water table are anticipated. Based on the new site conditions, these areas are anticipated to transition from marsh to swamp conditions. Target species will include hardhack, Pacific willow, Sitka sedge and bluejoint.

- Treatment Unit 3 – Riparian areas (above the 200-year high water mark) – comprised of three areas (total area of 956 m^2), these areas are generally at a slightly higher elevation and outside of the 200-year high water mark. This treatment unit will focus on those areas that will be physically disturbed by construction, either through construction activities, soil removal and excavation (e.g., berm and weir work site) or soil placement (e.g., 2 soil spoil sites on the upper wetland perimeter). Target species will include red alder, western redcedar, salal, red elderberry and osoberry.

- Treatment Unit 4 – Transitional Zone (above the 200-year high water mark) – comprised of two areas on the peripheries of the potential dewatering zone. These areas are currently vegetated with a mix of marsh and swamp conditions, with occasional pockets of standing water. The proposed work will reduce water levels, which is anticipated as dewatering any standing pools of water. No clearing or grubbing is anticipated. Although these two areas comprise a total area of 626 m^2, we have assumed that only infill planting will be needed, with a particular focus on replanting any dewatered pools as these will likely be under-vegetated with exposed soils. In total, EDI has roughly estimated that 35% of these areas will need planting, for a total area of 219 m^2, although this will need to be refined based on actual site conditions. Target species will include red alder, hardhack, osoberry, salal and bluejoint.

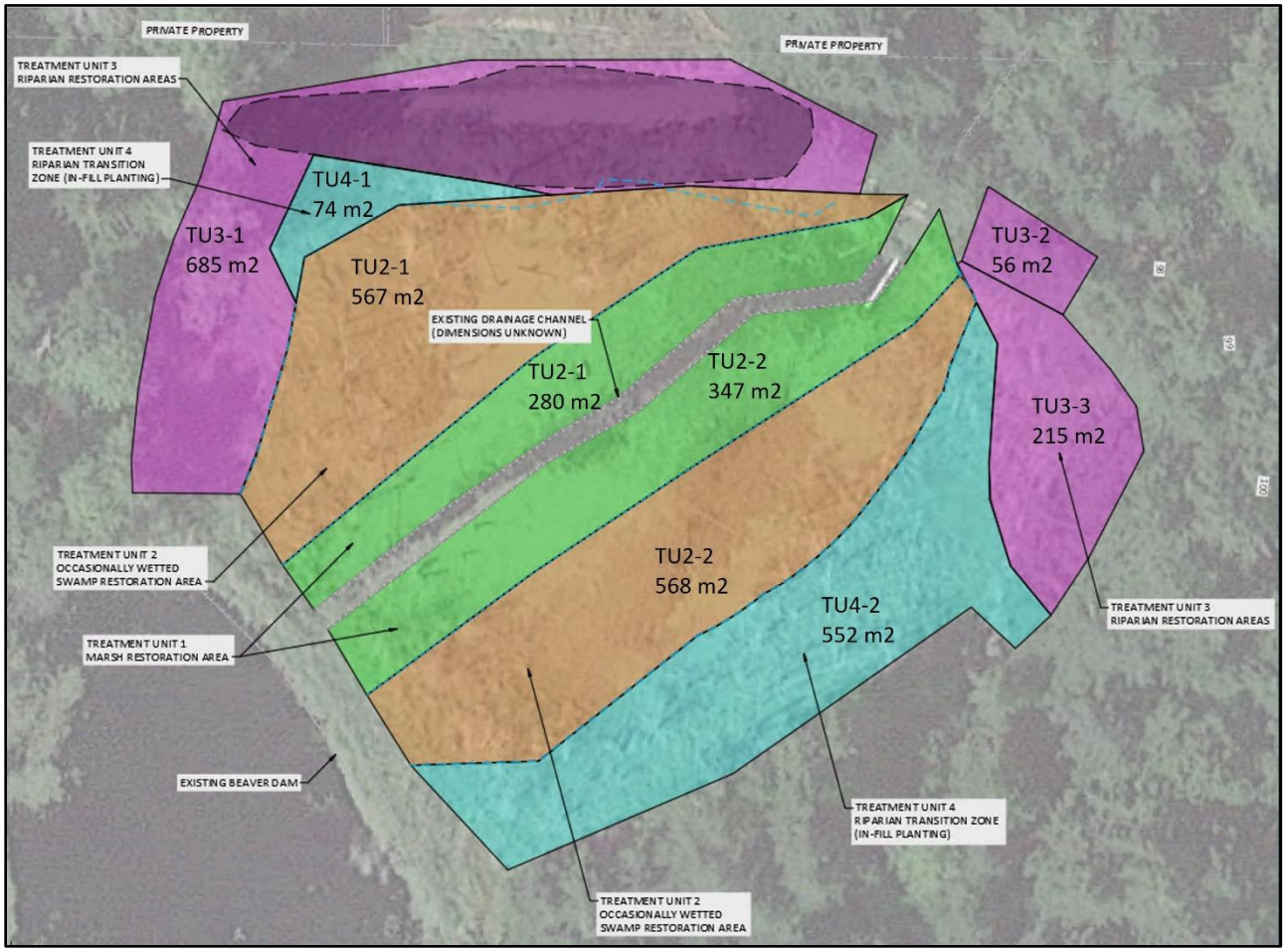


Figure 3-3. Proposed treatment units for restoration works

Management of Existing Trees

- Native trees located within the restoration area will be retained to the extent possible. No tree removals are currently anticipated.
- Dead standing trees should also be retained to the extent possible. If any dead standing trees need to be cut, the tree should be left on site as coarse woody debris, providing wildlife habitat value.
- Efforts will be taken to avoid disturbing existing trees. Basic prescriptions for the preservation of existing trees includes:
    - Do not trench through the drip zone of any tree.
    - Do not pave around trees.
    - Do not change the ground level around the tree.
    - Do not allow any parking under trees.

- Do not allow concrete washout or other pollutants to contaminate the soil around trees.
- Monitor the impacts of construction activities. If roots have been cut make sure they weren't shattered by a backhoe or other equipment. Broken roots should be cut cleanly with a saw.
- Prune any broken limbs with clean cuts.

Site Preparation

- Following the removal of the weir and other planned site works, excavated soils will be placed in one of the two preselected areas for disposal. Soils will be placed to avoid trees and their rooting zones. Soils will be graded and contoured so that the discarded soils are flat and fit into the landscape.
- Minimize clearing and grubbing in areas with native vegetation to the extent possible.
- All plants should be installed into the native topsoil of the area wherever possible.
- Scatter any coarse wood salvaged during the clearing and grubbing phase within the wetland area to provide terrestrial habitat diversity and soil nutrients as available. Coarse wood may be scattered laying on the ground, on top of other coarse wood or may be secured vertically. Safety permitting, the ends of logs can be buried vertically to create 3 – 5 m high wildlife snags.

Preliminary Planting List

- General planting prescriptions for the revegetation areas have been drawn from the provincial *Riparian Restoration Guidelines* (MOE 2008) and *Wetland Ways – Interim Guidelines for Wetland Protection and Conservation in British Columbia* (Cox and Cullington 2009) and include:
  - All tree/shrub species should be of guaranteed nursery stock.
  - Plant stock should be planted at an average density of 1 specimen per square metre. Shrubs and ground cover will be planted with 1 m spacing. Trees will be planted with 2 m spacing. Ground cover species will be planted with 0.5 m spacing (i.e., TU 1).
  - Shrubs should be planted from 3-gal pots; trees should be planted from 5-gal pots.
  - The botanical name should be used when ordering stock to ensure that the desired native species is being purchased. Each specimen should be tagged with the botanical name and the tag should be left attached after planting.
  - Stock planted during the fall (Sept. - Oct.) and spring (March - April) has the greatest likelihood of surviving. Regular watering may be required until the plants are established. Additional advice on proper planting procedures should be obtained from the nursery supplying the stock.

- Planting on a given area being enhanced must be successful to an 80% take for shrubs and trees. If more than 20% of specimen die over one year, replanting is required.
- Browsing deterrent (e.g., beaver deterrent at least 0.9 m height) will be applied to all planted deciduous tree stock that are at risk of being browsed. For larger deciduous planted specimens, rigid breathable trunk protection (with a minimum height of 0.9 m) will be applied as protection against beaver browsing.

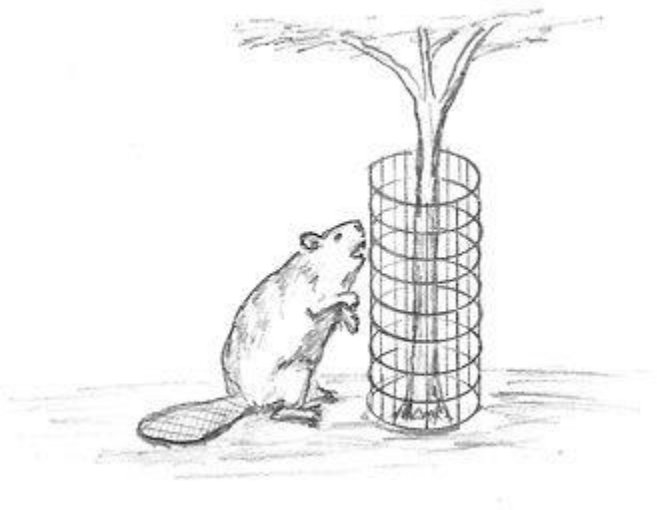


Figure 3-4. Sample image of rigid beaver deterrent (wire mesh construction)

A suggested planting list has been compiled for consideration and is presented in Table 3-6.

Table 3-6. Suggested Planting List for Coats Marsh

	Botanical Name	Common Name
Treatment Unit 1		
Ground cover (aquatic)	*Typha latifolia*	Common cattail
Ground cover (aquatic)	*Juncus effuses*	Common rush
Ground cover (aquatic)	*Carex spp.*	Beaked sedge (or Sitka sedge)
Treatment Unit 2		
Tree	*Salix lucida*	Pacific willow
Shrub	*Spirea douglasii*	Pink spirea (hardhack)
Ground cover	*Carex spp.*	Sitka sedge (or beaked sedge)
Ground cover	*Calamagrostis canadensis*	Bluejoint
Treatment Units 3		
Tree	*Alnus rubra*	Red alder
Tree	*Thuja plicata*	Western red cedar
Shrub	*Gaultheria shallon*	Salal
Shrub	*Sambucus racemose*	Red elderberry
Shrub	*Oemleria cerasiformis*	Osoberry (Indian-plum)

Treatment Units 4		
Tree	*Alnus rubra*	Red alder
Shrub	*Spirea douglasii*	Pink spirea (hardhack)
Shrub	*Gaultheria shallon*	Salal
Shrub	*Oemleria cerasiformis*	Osoberry (Indian-plum)
Ground cover	*Calamagrostis canadensis*	Bluejoint

Table 3-7. Estimated quantities of plants for each treatment unit

Trees		**TU1**	**TU2**	**TU3**	**TU4***	**TOTAL**
Red alder	*Alnus rubra*	0	0	143	22	**165**
Western redcedar	*Thuja plicata*	0	0	48	0	**48**
Pacific willow	*Salix lucida*	0	114	0	0	**114**
Total		**0**	**114**	**191**	**22**	**327**
Shrubs						
Hardhack	*Spiraea douglasii*	0	454	0	88	**542**
Osoberry	*Oemleria cerasiformis*	0	0	191	22	**213**
Salal	*Gaultheria shallon*	0	0	239	22	**261**
Red elderberry	*Sambucus racemosa*	0	0	143	0	**143**
Total		**0**	**454**	**574**	**131**	**1159**
Groundcover						
Bluejoint	*Calamagrostis canadensis*	0	454	0	88	**542**
Cattail	*Typha latifolia*	627	0	0	0	**627**
Sitka sedge	*Carex sitchensis*	0	454	0	0	**454**
Beaked sedge	*Carex rostrata*	314	0	0	0	**314**
Common rush	*Juncus effusus*	314	0	0	0	**314**
Total		**1254**	**908**	**0**	**88**	**2250**
Total Plants		***1254***	***1476***	***765***	***241***	***3735***

*Assumes in-fill planting only – estimate that 35% of total area requiring planting (35% x 625 m^2 = 219 m^2)

3.10.7 LONG-TERM MAINTENANCE AND MONITORING:

- Implement annual monitoring and maintenance to ensure survival targets are met and invasive species colonization is controlled.
- A five-year maintenance and inspection period is considered to be appropriate. Monitoring may be extended if survival targets are not achieved after five years.
- Each spring, and as needed through the year, reed canarygrass shall be mechanically brushed by the owner using manual methods. Reed canarygrass is pervasive through some areas of the marsh and requires care to prevent further spread of the species. To improve native plant growth and establishment within the treatment units, reed canarygrass and other non-native species will be mechanically managed to limit the height and reduce competition. This may include brushing and

physical stomping down of the grass cover. Mulching may be utilized where required to help control invasive species regrowth.

- Maintenance activities will also include the "as needed" replacement of plants. Maintenance efforts will be documented and included in the annual restoration monitoring report discussed above.
- A QEP shall inspect the site annually in the mid to late summer for 5 years. Each inspection shall include:
    - An estimate of percent survival of planted specimen (trees, shrubs, ground cover).
    - An estimate of percent area coverage of invasive plants.
    - A QEP shall provide a brief summary report with a list of recommendations to the Regional District of Nanaimo (RDN). The report shall include general observations, overall health and growth of plants (poor, fair, moderate, good etc.), number and species of replacement plants needed, where replacement plants are needed, areas in which invasive species management is needed and watering needs. The summary shall list when each of the recommendations should be completed.
    - The owner shall then implement the recommendations made in each annual report.
    - Provided that the results of the fifth annual inspection are favourable, the final post-development report shall be submitted to the RDN to complete the restoration requirements for this project.
    - The target survival rate of planted specimens shall be 80%. When less than 80% plant survival is observed in a given year, replacement planting shall be recommended to bring the areas back up to at least 90% survival. All failed trees will be replaced in the next planting season.
    - After three years, the site shall be considered to be successfully restored if at least 80% of planted specimens are established and healthy.

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