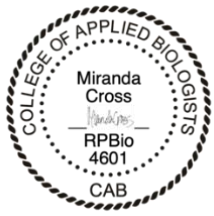
Cortes Island School Wetland Restoration Project Overview & Construction Environmental Management Plan

Students investigating the Quadra Elementary School Wetland constructed by the author in 2021 on Quadra Island, BC. Photo date: April 30, 2024.

Date: February 10, 2025
Prepared for: School District 72**,** Cortes Island School, Strathcona Regional District, & BC Ministry of Water, Land and Resource Stewardship
South Coast Natural Resource Region, District of Sunshine Coast



Prepared by: Rewilding Water and Earth Inc.: Miranda Cross, RPBio, & Robin Annschild & Wetland Restoration and Training: Thomas R. Biebighauser

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1. Introduction/Executive Summary

This document, prepared by Rewilding Water and Earth Inc. (RWE) and Wetland Restoration and Training LLC. provides a project overview, wetland restoration design, and environmental management plan for the Cortes Island School Wetland Restoration Project. The project will require a *BC Water Sustainability Act* (WSA) Notification of Authorized Changes for the proposed wetland restoration in the Cortes Island School (CIS) field, 950 Beasley Road, Cortes Island, BC (PID: 003-026-167). The proposed project includes 1350m^2 of wetland restoration in a wet and underutilized part of the playing field, approximately 1350m^2 of adjacent riparian restoration, and 300m^2 of ditch maintenance to improve drainage in of the sports field in areas that are currently overgrown with invasive species and/blocked.

Project partners and stakeholders include the CIS (SD 72), Strathcona Regional District (SRD), Klahoose First Nation, Friends of Cortes Island Society (FOCI), BC Wildlife Federation (BCWF), and Rewilding Water and Earth Inc. (RWE).

The proposed project will restore important habitat for species at risk and support climate change adaptation and resilience. Implementing this project will provide unparalleled opportunities for students and communities to engage with and learn about wetland ecosystems, the species they support, and the myriad ecosystem services they provide.

2. Project Details Summary

Site Name: Cortes Island School

Landowner: School District 72 (SD 72)

Project Designers: Rewilding Water and Earth Inc (RWE): Miranda Cross (R.P.Bio.), Robin Annschild; and Wetland Restoration and Training LLC.: Thomas R. Biebighauser

Assisting with the Design: Michael Datura (Cortes Island School Principal), Brent Wilken (former Cortes Island School Principal), Derek Armitage (Cortes Island School Grounds), Helen Hall (FOCI ED), Max Thaysen (FOCI President and soccer player)

Administrative Contacts: Michael Datura (Cortes Island School Principal), michael.datura@sd72.bc.ca; Jason Decksheimer (Director of Operations, SD72) Jason.Decksheimer@sd72.bc.ca; Mike McLeod (Capital Projects Manager) Mike.McLeod@sd72.bc.ca; Shaun Koopman (Manager, Emergency Services, Strathcona Regional District), SKoopman@srd.ca.

GPS coordinates (centre of planned wetland): 50.061826, -124.982174

3. Project Goals & Objectives

3.1 Goals

1. Restore wetlands at CIS to educate about and increase climate adaptation and resilience, while reducing the risks associated with natural disasters such as flooding, drought, and heatwaves.
2. Enhance student experiential learning and community access opportunities to an ecosystem which provides important habitat for wildlife.

3.2 Objectives

1. Restore up to 1400m^2 of shallow water wetlands

2. Provide an outdoor learning lab for STEM education (Science, Technology, Engineering, Mathematics)

3. Reduce the risks associated with natural disasters such as flooding, drought, and heatwaves

4. Mitigate the impacts of flooding in the school fields

5. Engage with local First Nations to restore and enhance education about culturally important ecosystems and plants

6. Restore the natural beauty of the school grounds to provide habitat for a diversity of local native fauna and flora

7. Improve habitat for Species at Risk including the Barn Swallow, Common Nighthawk, little brown myotis, and Red legged frogs

8. Provide habitat for a diversity of wildlife including warblers, hummingbirds, waterfowl, wading birds, shorebirds, frogs, toads, salamanders, and bats

9. Increase habitat for pollinators including bees, butterflies, and moths

4. Description of Proposed Works

4.1 Project Background and Rationale

A naturally appearing and functioning wetland may be restored at Cortes Island Elementary School (CIS) to provide students with an outdoor learning laboratory for science, technology, engineering, mathematics, and climate change adaptation and resilience. The wetlands would reduce risk from natural disasters by providing climate adaptation to mitigate risks of climate related natural hazards such as drought, heat, waves, and flooding. The school field is currently flooded seasonally, which limits

the school's use of the sports field. "The field is so wet, we don't let the students use the sports field during the winter months"[1].

The location of the current school field was historically a slough[2], where old timers would hunt in canoes[3]. When the school was constructed the slough was filled the stumps cleared from the school building site, and fill placed on top. The decay of the stumps and organics over time is assumed to be responsible for the lumpy/bumpy surface of the field today[4].

The wetland project is designed to restore a portion of the historic wetland extent in an underutilized portion of the school field. The wetlands will provide habitat for a diversity of native birds, pollinators, salamanders, and frogs. The soil around the restored wetland will be planted to attractive native flowering plants to improve habitat for pollinators including hummingbirds, bees, butterflies, and dragonflies.

Building a wetland at CIS will provide students with unparalleled opportunities to investigate animals, plants, soils, and water in an ecosystem that is uncommon in the area. The wetlands will provide a hands-on learning laboratory for experiential learning. The habitat will be safe for students to explore and help reinforce basic concepts in math and science.

Wetlands provide great opportunities for outdoor learning. Students may be taught science, mathematics, engineering, history, and art by experiencing lessons firsthand at a wetland. Because natural wetlands are rare habitats, they are often difficult to investigate without incurring the high cost of a field trip to visit them. The technology is now available to bring wetlands to schools as outdoor classrooms.

Students may be involved in design and building of the wetland. Here are some of the actions they would take and skills they would learn by helping to build a wetland at their school:

1. Determine soil texture using a soil auger and the ribbon test
2. Determine elevation of ground water using a soil auger
3. Measuring slope using a laser level and a clinometer
4. Measuring distance using a range finder and an imperial and metric tape measure
5. Using laser level to record elevations
6. Learning how to mark circles, ovals, rectangles, and irregular shapes on the ground using survey equipment
7. Identification and control of non-native invasive plants
8. Planting and seeding of native plants for pollinators
9. Use *Best Management Practices* to control soil erosion

[1] Michael Datura, Personal communication, February 12, 2024.
[2] Ritchie Manners, R.A Spence LTD. Consulting Engineers. Vancouver BC., *Log of Test Pits (Dug April 20, 1978)*, 1978, 1978.
[3] Derek Armitage, Personal Communication, February 8, 2021.
[4] Fred Savage, Personal Communication, December 2024.

10. Loosening compacted soils for plant growth and water percolation using shovels and rakes
11. Spreading straw for mulch
12. Learning when soil compaction is good and when it is bad

4.2 Description of Proposed Works

BC *Standards and Best Practices for Instream Works*[5] will be adhered to for the implementation of this wetland restoration project to protect wildlife and the integrity of the environment and Environmentally Sensitive Areas (ESAs) surrounding the project site. A detailed description of construction environmental management and mitigation measures is provided in section 9 of this report.

Qualified Environmental Professional (QEP), Wetland Restoration Specialist and Registered Professional Biologist (RPBio), Miranda Cross, will be on site prior to and during all phases of construction, and acting as Project Manager for the duration of the project. Prior to construction QEP will flag all ESAs to be avoided during construction and ensure that any sediment and erosion control measures are in place, if deemed necessary. Construction is planned for when the work site is dry, and there is no surficial flow in the ditch.

QEP has the authority to and will modify or halt any construction activity if it is deemed necessary to do so for the protection of wildlife populations or their habitats. QEP will have contact names and information immediately accessible if archaeological materials are encountered or a spill of contaminants occurs onsite. If either situation occurs, work will stop immediately, and best practices will be followed to address the situation. If archaeological materials are encountered the *Chance Find Procedure*[6] will be followed. The project team will ensure that spill kits are on site at all times, that all staff/contractors are trained to use them, and any spills above the reporting threshold will be reported immediately to the Provincial Emergency Program[7].

A copy of the BC *Standards and Best Practices for Instream Works* will be sent to all contractors prior to construction. QEP will mark the restored wetland perimeters on the ground with wire flags ahead of heavy equipment arriving on site. Once heavy equipment operators arrive on site, QEP will meet with the project team, walk the site with the equipment operators to explain the design, ESAs, BMPs to protect the environment, address safety issues, and agree on a work plan.

Specified heavy equipment is listed below in section 4.3 of this report. The heavy equipment will be in good working order, free of leaks and excessive grease, and be cleaned in advance to avoid introducing non-native plants[8].

[5] BC Ministry of Water, Land and Air Protection, "Standards and Best Practices for Instream Works" (Province of British Columbia, March 2004).
[6] Government of British Columbia, "Archaeological Chance Find Procedure" (Archaeology Branch, n.d.).
[7] BC Ministry of Water, Land and Air Protection, "Standards and Best Practices for Instream Works."
[8] BC Ministry of Water, Land and Air Protection; BC Parks; Invasive Species Council of BC, "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors.," 2018.

Please refer to the plan view technical drawing prepared specifically for this project Figure 1 below. The plan view drawing shows designated access routes, wetland areas to be excavated, inlet, spillway, and designated soil spoil areas.

Figure 1. Plan view map of the proposed wetland restoration project at Cortes Island School. February, 2025.

The project site is located in an underutilized portion of the CIS field, which is too wet to be used by students most of the year[9]. An access route to the site exists via Beasley Road, through the school's parking lot and over the adjacent field, south of the project site.

If deemed necessary by QEP, sediment control measures will be implemented before any heavy equipment work begins on site. Detailed discussion of sediment and erosion control measures is described in the *Erosion and Sediment Control* section 9.2.4 of this report. Hay or straw bales would be placed across the ditch below the project site to prevent sediment from flowing downstream. The Authors have found that straw bales do a much better job than erosion control fabric. Potential impacts to fish or fish habitat are null as QEP concluded that the potential for fish presence in the ditch at any time of the year is not feasible.

[9] Michael Datura, Personal communication.

A vegetation analysis has been conducted by QEP as part of the Environmental Assessment, which is summarized in section 6.3 of this report. Invasive species within the project site will be managed, removed, and disposed of appropriately before construction. More details on invasive species management provided in section 10.2.2 of this report.

Vegetation and topsoil will be removed from the wetland restoration work area and set aside on the fields directly adjacent to the restored wetland sites. The topsoil and debris from construction will be saved and spread over sub soil after excavation of the wetland and be used to recontour slopes where cut banks were created and to fill sections of ditches that will no longer be required.

Invasive species on site (English Holly, Himalayan Blackberry, Scotch Broom etc.) will be removed and buried as part of construction. Large Western Red Cedars surround the project site. No Cedar trees will be damaged or removed as part of this project. Excavators will be kept well away from and will not dig within the drip line of the forested tree line. Soil will not be piled on the roots of trees. Danger trees will be assessed and removed for safety. Any trees removed will be placed in the restored wetland for habitat.

Wetland basins with gradual slopes will be shaped for the wetland restoration with the deepest part in the center of the wetland. A "core trench" (formerly called a groundwater dam)[10] will be dug along the lower edge of the wetland being restored to cut across ditches, through topsoil, permeable layers of soil, and buried drainage structures. Soils removed from the trench will be mixed and returned to the trench, compacting in 15cm thick layers. An excavator will be used to locate and remove all buried drainage structures within the wetland being restored. No drainage structures are expected to be located within the wetland footprints, given the as-built site drawings showing field drainage (Figure 1; Appendix 22.2) .

The soil removed from digging the basin will be used to fill the core trench, to recontour the cut bank bordering the forest, and be shaped into naturally appearing ridges and mounds within and around the wetland being built. The majority of the soil removed from digging the wetland will be spread in the field adjacent to the restored wetland and planted with riparian vegetation. The soil would not be moved from the area in a dump truck. The current elevations of the bottom of the ditch at the inlet and outlet of the project will be maintained. Elevations within the wetland basin will be lowered by excavating. This project will not back up or impound water and the ditch will not be filled. This will be a flow through system that does not impound water. No dams, diversions, pipes, pumps, or water control structures would be used.

An inlet and spillway, each approximately 5m wide, will be constructed to carry water in and out of the restored wetlands. The inlet will be located to the south of the restored wetland #2, where water naturally flows into the project from the ditch. The spillway will be located along the lower edge of the marked perimeter of the wetland #1 and will flow to the north into the natural forested swamp. Both the wetland inlet and the wetland spillway (outlet) will be built to function as permanent vertical grade

[10] Thomas R. Biebighauser, *Wetland Restoration and Construction-A Technical Guide, Second Edition* (Thomas R Biebighauser, 2015).

control structures. Boulders (large diameter rock approximately 500mm to 800mm) will be installed across the floodplain to prevent erosion and the formation of gullies or channels, which would drain the restored wetland and could negatively impact downstream ecosystems. Water will flow over the inlet and spillway in a sheet-like pattern, reducing shear stress and therefore reducing the potential for erosion. The elevation of the project inlet and spillway would not be changed from original ground to avoid flooding fields located upstream of the wetland being built. Piles of soil, rocks, or logs would not be placed in the inlet or spillway, as they may trigger erosion.

An aquatic-safe liner (Section 12) will be used to extend the hydro period of wetland #2 and thus the climate mitigation function and of the wetlands at this site. The site characteristics allow for an ephemeral (dries in the summer) wetland to be restored at this site without the use of a liner. Without the use of an aquatic safe liner, the wetlands will have a shorter hydroperiod, and therefore provide less climate change adaptation during drought and heatwaves (water source and refuge for wildlife). A liner may be used to extend the hydro period to provide habitat for wildlife and opportunities for education year-round. Additionally, the impervious liner will prevent the sports field from becoming saturated, without a liner the wetland basins would inject water into the ground. The impermeable aquatic-safe liner would be protected by geotextile, and covered with 6-8 inches of soil. Students and community would be engaged to assist with the liner installation. Downstream of the liner wetland, ephemeral wetlands may be restored. The ephemeral wetland areas would allow for groundwater recharge and infiltration of precipitation, at an elevation that will not impact or saturate the fields, yet provide benefit the surrounding forest by injecting water into the ground for plants and surrounding trees.

Compacted soils surrounding the completed wetland would be prepared for seeding and planting using the *Rough and Loose Technique*[11]. Topsoil and organic matter will be re-applied to the surface. Rough and loose soil treatment reduces the potential for erosion, as water infiltrates more readily into loose soils. This treatment also creates optimal conditions for revegetation, allowing seeds to germinate and roots to penetrate the loosened soils[12].

Logs, branches, and rocks will be placed in and around the restored wetland to provide habitat for wildlife. Large and Coarse Woody Debris (CWD) will be placed over the surface of the soil after topsoil has been applied. Only clean, weed free CWD will be sourced from off-site. CWD from off-site will be inspected by the QEP prior to transport to ensure there are no invasive species present in the debris or the area they have been sourced from[13]. Large logs and rocks may be placed in and around the restored stream and wetland for students to climb and balance on. These will be great places for viewing and accessing the wetlands.

An adventure trail could be built around the wetland, using rocks and logs for students to climb on. Accessible trails may also be constructed for students in wheelchairs, or with mobility challenges.

[11] David Polster, "Making Sites Rough and Loose: A Soil Adjustment Technique.," *Boreal Research Institute*, December 16, 2021.
[12] David Polster.
[13] BC Parks; Invasive Species Council of BC, "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors."

Water's edge access areas will be constructed (Figure 1) to direct students and visitors to designated areas to access the water's edge which will help to prevent trampling of the sensitive wetland edges.

Immediately after heavy equipment is finished working, native wetland and riparian plant seed will be spread on all exposed wetland and riparian soils. This will be followed by a seeding of an annual wheat or rye (non-invasive/non-persistent agronomic species, only Canada Certified Number 1 Grade seed where possible[14]) over all exposed soils. This will be followed by a mulch of certified weed free straw or wood chips to retain moisture and aid seed germination. Seeding and mulching exposed soils immediately following construction will prevent erosion and establishment by invasive species[15].

Post-construction, once rains are consistent in the fall, a diversity of native wetland and riparian plants will be planted by school students, and community volunteers, supported by BCWF and paid contractors. Species list, and techniques, can be found in section 10.2 and 10.3 of this report. A detailed planting plan is currently being developed by RWE. Only native wetland and riparian species appropriate to the restoration area will be planted. Some of these species include Western red cedar (*Thuja plicata*), Black cottonwood (*Populus trichocarpa*), Willows (*Salix spp.),* Sitka spruce (*Picea sitchensis*), and Red alder (*Alnus rubra).* The planted areas will be fenced to protect plants from browse pressure. During the establishment phase post-construction, there will be a focus on managing invasive species, to support the establishment of naturally regenerating and planted native vegetation.

The restored wetlands will require little maintenance once riparian vegetation is established. Invasive species removal will be required for the first 3-5 years, until native plants can outcompete invasive weeds. The wetland site will be maintained by the students, with the support of project partners and community members in perpetuity.

Students may take part in hydrology, revegetation, and wildlife monitoring at the restored wetlands. Hydrology monitoring should be conducted in the establishment phase for signs of erosion at the inlets and outlets of wetland basins. If erosion is observed, QEP- Wetland Restoration Specialist should be retained to oversee repairs and action to address the erosion taken as soon as possible.

4.3 Equipment and Machinery

Heavy equipment with skilled operators will be contracted to complete the project. Each piece of heavy equipment will be operated by an experienced individual who is interested in building wetlands to help the environment.

A Service Contract will be used for hiring the heavy equipment and operators to restore the wetland. Under a Service Contract, the machines and operators are hired by the hour to build the project. The award of the contract will be based on a combination of factors that include ability to provide the

[14] BC Parks; Invasive Species Council of BC.
[15] BC Ministry of Water, Land and Air Protection, "Standards and Best Practices for Instream Works."

required heavy equipment, performance operating heavy equipment, experience restoring wetlands and stream, and price. The heavy equipment will be of the size and type needed for restoring wetlands.

Heavy equipment required for this project will include up to two excavators, a skid steer, and a dump truck to deliver materials. The specifications for equipment are as follows:

#1 Excavator with operator

John Deere 160G LC, or larger

Digging reach 30.62ft/Ground level reach 30.06ft

Operating Weight:29,526 lbs

Net HP: 122 Hp

Digging Bucket 1 yard, clean up bucket 2.5 yards

Thumb attachment

10-years old or less preferred

Falling Object Protective Structure (FOPS)

#2 Excavator with operator

Kubota KX080-3 Midi Excavator or equivalent

18364.6lb or greater

64.2HP Net or greater

Digging bucket and clean out bucket with thumb attachment

10-years old or less preferred

#3 Skid-steer (same operator as Excavator #2)

#4 Dump Truck (Tandem) with driver

The heavy equipment will access the field via the designated access route along pre-existing roads, driveway, and over the field. The equipment will be placed on the field in and around the restored wetland work site. None of the equipment will be working in the surrounding forest.

4.4 Timing of Proposed Works

The proposed construction work window is June 30th to October 31st, 2025, when the surficial flow in the ditch is expected to be dry. Works are currently planned for June 30th to July 15th 2025, pending permit approval, and contractor availability. Revegetation and invasive species management will take place during the establishment phase (year 1-5) until revegetation is deemed successful. Detailed information on the revegetation plan and timing provided in section 10.2 and 10.3 of this report.

4.5 Identification of Water Rights and Other Conflicts

The iMapBC tool, with the 'points of diversion' layer turned on, was accessed on January 29th, 2025, to identify water licences in the vicinity of the proposed works. No current water rights or conflicts were identified.

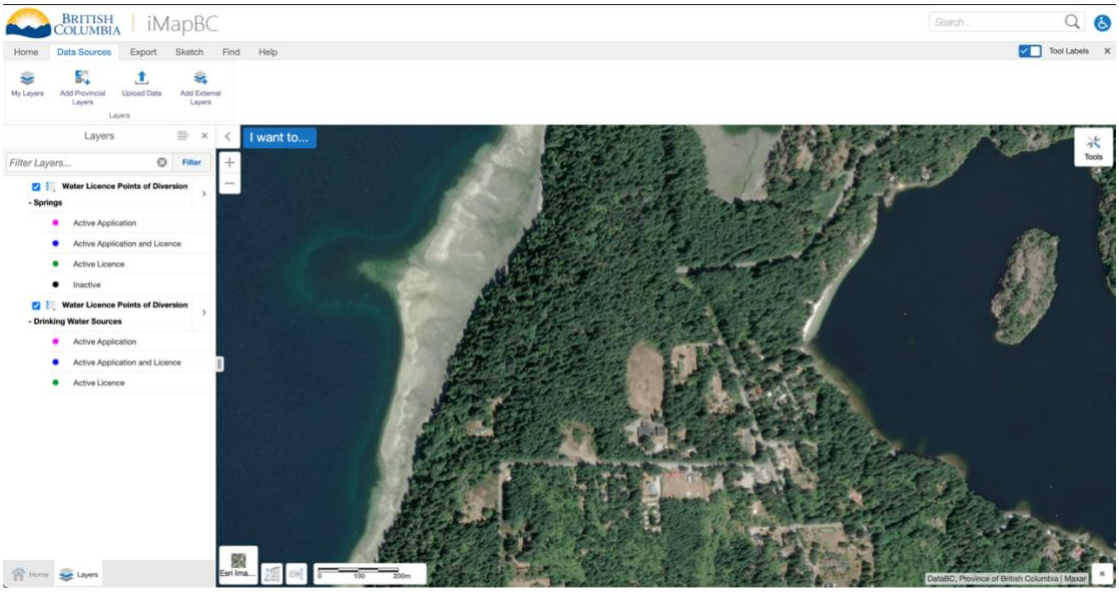

Figure 2. Screen shot of iMapBC showing water license points of diversion data[16].

[16] Province of British Columbia, *iMapBC, Water License Points of Diversion*, 2022, 2022, https://maps.gov.bc.ca/ess/hm/imap4m/.

4.6 Outline of Construction Steps and Timelines

1. Funding has been secured by SRD to construct the designed project. An MOU between SRD and SD72 is in place to administer the project.
2. Needed permits and approvals are obtained in advance (*Water Sustainability Act Section 11 Changes in and About a Stream; BC Wildfire Act* Wildfire Regulation High Risk Activity exemption).
3. Dates for construction are scheduled in advance with RWE (QEP- Miranda Cross). A contract or agreement is in place with SD72 for RWE to manage the project and supervise construction.
4. A contractor is chosen to provide heavy equipment and materials for the project. The heavy equipment contractor and operators are scheduled in advance.
5. CWD is sourced and stockpiled for the project, ensuring the source is weed free to reduce the potential for invasive plant introduction.
6. A utility check is completed before digging. Any buried utilities are marked on the ground prior to construction.
7. Heavy equipment is cleaned by the contractor prior to construction to avoid introducing non-native plants.
8. ESAs are delineated, and the perimeter of the planned shallow water wetland is marked on the ground using wire pin flags. Students can be involved with this step.
9. Elevation readings are taken around the planned wetland to identify the low edge of the marked perimeter, and the desired final depth in the center prior to construction. The location and elevation of the spillway is marked before construction begins.
10. Invasive species will be identified and removed using heavy equipment, disposed of appropriately offsite or buried on site.
11. Topsoil is cleared and set aside. The existing ditch along the field will be excavated for maintenance.
12. The core trench will be dug and re-packed.
13. The wetland basin and ditch will be excavated,
14. Rock is installed to create permanent vertical grade control structures and armour slopes where water enters and exits the wetland from the ditch and into the forest to control erosion. No dams would be built.
15. The aquatic safe liner is installed. Appendix 22.3 Building Wetlands using the aquatic safe liner technique.
16. The wetland would be shaped to appear natural, with no straight lines or steep slopes. The wetland would contain hummocks, mounds, gradual slopes, peninsulas, and woody debris.
17. A wide spillway would be created over gradual slopes to prevent erosion.
18. Compacted soils surrounding the new wetland are loosened using the rough and loose technique. This is done to provide ideal conditions for wildflower, tree, and shrub growth, and to control erosion.
19. CWD is applied to the surface of disturbed soil and in the wetland to enhance habitat quality.
20. Exposed soils are seeded to native forbs, grasses, and wildflowers, followed by wheat or rye, and then mulched using straw to control erosion.
21. Native plants nursery stock to be planted in fall 2025. Live stakes to be planted in the late winter/early spring 2026. A diversity of native plants will be established in and around the wetland for pollinators and riparian revegetation in 2025-26.

22. Plants that are attractive to deer will be fenced to prevent browsing, or treated with Plantskyyd®
23. The wetland will be monitored and maintained by students, community members, and contractors for invasive species and signs of erosion with supervision/consultation of QEP.
25. RWE will support the project with bi-annual monitoring site visits and to consult with local project stewards for ongoing project maintenance.
26. If erosion is observed, RWE will be contacted, and action taken to repair the erosion and prevent further erosion will be taken.

Table 1. Outline of construction steps, timelines, impacts, and mitigation measures[17]

Instream Activities/Works Construction Description and Construction Stage	**Area of Impact (Dimensions and Footprint)*** **(See Section 6 for more details)**	**Proposed Duration and Time of Year for Construction**	**Potential Aquatic and Riparian Benefits and/or Impacts (See Section 8 for more details)***			**Proposed Avoidance/ Mitigation measures*** **(See Section 9.2 for more details)**
			Aquatic Ecosystem Values (eg. aquatic species by life stage)	**Water Quantity**	**Water Quality**	
Construction of restored wetland habitat, excavating the wetland basin, re-contouring cut banks	Up to 2800m^2 of wetland and riparian habitat restored. Approx. 46 m long and averaging 61 m wide	June 30th to July 11th, 2025	Benefits to amphibians and wildlife at all life stages	Up to 1400m^2 of restored aquatic habitat will be created. Will increase water storage capacity and climate change adaptation and resilience of the forested landscape, which is currently being drained by the diversion ditch and cut bank	Will improve water quality and mitigate flooding of the field	QEP to sweep for birds and wildlife before construction. Nest areas and buffers marked as no-go zones to be avoided. Pre-construction meeting to be held with project team BMPs, environmental protection and safety. Ensure hydraulic machinery is kept clean and Spill containment kits on site, staff trained to use them. Working only in favourable weather conditions. Excavated soil will be placed above the high-water mark, on field and adjacent to wetland.

[17] Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC, South Coast Region, "Guidance for Applications or Notifications for Changes in and about a Stream under the Water Sustainability Act in the South Coast Region.," 2019.

Ditch maintenance	300m^2 of ditch maintained. Approx. 150m long and 2m wide	June 30th to July 11th, 2025	n/a Improved drainage of sports field.	n/a Improved drainage of sports field.	Will mitigate flooding of sports field	QEP to sweep for birds and wildlife before construction. Nest areas and buffers marked as no-go zones to be avoided. Pre-construction meeting to be held with project team BMPs, environmental protection and safety. Working only in favourable weather conditions. Ensure hydraulic machinery is kept clean and Spill containment kits on site. Staff trained to use them. Excavated soil will be placed above the high-water mark, on field and adjacent to wetland. Native wetland vegetation growing in the ditch will be salvaged and re-planted in the wetlands when possible and not contaminated with invasive species.
Construction of outlet-connection to adjacent downstream forested swamp	Approx. 25 m^2 (5m x 5m) outlet, will direct flows from wetlands to enter the forested swamp.	June 30th to July 11th, 2025	Potential to impact amphibians and/or birds in and around the forest	Will restore historical ground water elevation, increase water storage capacity and climate change adaptation and resilience of the forested landscape, which is currently being drained by the diversion ditch and cut bank	Will improve water quality, reduce and prevent erosion, and mitigate flooding downstream	QEP to sweep for birds and wildlife before construction. Nest sites marked as no-go zones. Sediment control (hay bales) in stream if surficial flow is observed. Wildlife is expected to move out of the way of heavy equipment. Equipment will work from banks of field on high ground and not be in the forest. Forest vegetation will be protected during construction. Working only in favourable weather conditions. Ensure hydraulic machinery is kept clean and Spill containment kits on site. Staff trained to use them. Excavated soil will be placed above the high-water mark, on field and adjacent to wetland.

Seeding and/or mulching of exposed soils for total project area	Approx. 3000m^2 of exposed soil as a result of construction	Immediately after heavy equipment is finished working. On or before July 15th, 2025	Benefits to amphibians and wildlife at all life stages	No gain or loss of water quantity	Erosion control preventing potential impacts to water quality	Erosion control-seeding and/or mulching of exposed soils for total project area to stabilize soils.
Planting of native riparian species	Approx. 2000m^2 to be planted includes soil spoil, edges of restored wetland, and re-naturalized ditch	September 2025 to April 2026 (and subsequent years as needed)	Benefits to amphibians and wildlife at all life stages	No net gain or loss in water quantity	Erosion control Preventing potential impacts to water quality	Erosion control-planting of native riparian species to stabilize soils.

4.6 Best Management Practices and Sediment and Erosion Control Measures

Best management practices (BMPs) and sediment and erosion control measures will be practised throughout the project to ensure the protection of the environment and ESAs. BMPs recommended by FLNRORD[18] will be used throughout the project as follows:

Summary List of BMPs relevant to this project:

- *"Working in favourable weather and low flow conditions;*
- *Comprehensive erosion and sediment control measures;*
- *Removing excavated material from the site or to a location above the high water mark;*
- *Protecting vegetation along access routes and banks of the stream;*
- *Ensuring equipment and imported materials are free of deleterious substances or invasive species fragments or seeds;*
- *Ensuring rip-rap is clean of any substances deleterious to aquatic life and constructed to resist movement by stream flow;*
- *Keeping a Spill Containment Kit readily accessible onsite in the event of a release of a deleterious substance to the environment and ensuring that on-site staff are trained in spill response;*
- *Ensuring hydraulic machinery is kept clean;*
- *Ensuring contact names and information are immediately accessible if archaeological materials are encountered or a spill of contaminants occurs onsite"*[19]

Furthermore, the Project Team will adhere to BMPs and sediment and erosion control measures as detailed in the *BC Standards and Best Practices for Instream Works*[20]. Detailed information regarding the project's construction mitigation measures is summarized in section 9.2 of this report, *Construction Environmental Management.*

4.7 Archeological Interests

The Archaeology Branch of BC, Ministry of Forests, was contacted in March 2024 with a request for archaeological information concerning the project site.

According to Provincial records, there are no known archaeological sites recorded on the subject property and a Provincial heritage permit is not required prior to commencement of land altering

[18] BC Parks; Invasive Species Council of BC, "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors."
[19] Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC, South Coast Region, "Guidance for Applications or Notifications for Changes in and about a Stream under the Water Sustainability Act in the South Coast Region."
[20] BC Ministry of Water, Land and Air Protection, "Standards and Best Practices for Instream Works."

activities. To mitigate a chance find of archaeological resources an Archaeologist will conduct a site review prior to construction, and be on site to monitor the chance find procedure to their satisfaction.

4.8 First Nation Interests, Consultation, and Engagement

The Cortes Island School is located on the traditional and ancestral territory of the toq qaymɩxʷ (Klahoose), ɬəʔamɛn qaymɩxʷ (Tla'amin), and ʔop qaymɩxʷ (Homalco) Nations. Klahoose First Nation have a village (on reserve) site at Squirrel Cove on Cortes Island.

Klahoose First Nation (KFN) has been consulted about this project. A letter sent to Chief and Council, March 2021 first introduced the project concept. KFN have an established relationship with the school (language classes and periodic cultural events at the school). Michael Datura, the Principal of CIS, has meet with KFN Chief Steven Brown to discuss the project and current application for funding on February 21, 2024. Chief Brown expressed support for the project, and offered to write a letter of support (Appendix 22.1). Additionally, Cultural and Indigenous Engagement Consultant/Liaison, Duane Hansen, met with Principal Datura, and Miranda Cross on March 18, 2024 to discuss potential for Indigenous Engagement, and to collaborate on the work plan and budget for Indigenous Engagement.

"This project and United Nations Declaration on the Rights of Indigenous (UNDRIP) allows Klahoose people to socially deconstruct, decolonize and to cultivate an open space to develop meaningful stewardship with the Indigenous "Two-Eyes Seeing" and opportunity to relearn, utilize initiate, and maximize Indigenous methodological approaches that includes a braiding of Indigenous and western knowledges to strengthen a cultural adaptation, revitalization, and reconciliation for the next generations on Cortes Island[21]"

Opportunities are available for Indigenous engagement and employment on the project as follows:

- Indigenous Liaison and Cultural Consultants (Cultural Awareness Training and Indigenous Engagement Coordination)
- Cultural Consultant, Indigenous Botanist and Traditional Medicines. Identifying food, traditional medicinal plants and future food sovereignty
- Indigenous Elder's tours/engagement
- Indigenous Land Guardian monitoring during construction
- Archaeologist review/monitoring chance find procedure during construction
- Post Construction Klahoose Land Guardians Monitoring and Maintenance

5. Permits: Federal, Provincial, and Municipal

- Federal: No fish are present at this site, a Department of Fisheries and Oceans (DFO) permit will not be required.
- Provincial: BC *Water Sustainability Act,* Notification of Authorized Changes in and About a Stream. Application in process, planned application submission February 14, 2025.

[21] Duane Hansen, "Indigenous Engagement Cortes Island School," March 21, 2024.

- Provincial: BC *Wildlife Act*, General Wildlife permit, not required. The ephemeral flow in the ditch will be dry during construction. No fish or amphibians salvage will be required for construction.
- Provincial: BC *Wildfire Act* and *Wildfire Regulation* High Risk Activity exemption may be required depending on wildfire risk during the time of construction. Applications submitted after June 1st may be subject to review and processing delays.

6. Environmental Assessment & Site Analysis

6.1 Environmental Assessment and Restoration Design Methods

Site investigation surveys of the project area have been completed by RWE (Miranda Cross) (October 8, 2020; February 17, 2021; October 22, 2023; February 12, 2024) the following information was gathered. Review of environmental resource databases was conducted (RWE) to determine the existing distribution and occurrence of species and environmentally sensitive habitats and/or Critical Habitat for *Species At Risk Act* (SARA)-listed species at the proposed project site and surrounding area.

Soil texture and elevation of groundwater using a 122cm long tile probe, and a 132cm long soil auger. Soil texture was determined using the ribbon test with reference to the *Field Handbook for the Soils of Western Canada*[22].

GPS locations of site data and/or features were recorded using either MapPlus GPS application on an iPhone or iPad. Photographs including drone imagery were taken.

A Trimble Spectra precision LL300S laser level was used to determine elevations and slopes.

A GPS was used to record the center and perimeter of the planned wetland. Photographs were also taken, including drone imagery.

The following criteria helped guide where the wetland project will be located:

1. The location would reduce impacts of climate related risks (ie. flooding of the sports field)
2. The location was accessible to students
3. There would be no conflict with planned development at the school
4. No conflict with current uses at the school or neighbouring property
5. No conflict with utilities, either above or below the ground
6. The project would enhance the beauty of the school grounds and the community
7. The site contained level ground with slopes less than 6-percent
8. Runoff would be cleaned by the project
9. The site is a historic wetland that has been drained
10. The site is adjacent to a natural forested swamp wetland

[22] Kent Watson, Dan Pennock, "Section 3: Soil Profile Description. From: Field Handbook for the Soils of Western Canada." (Pedology Subcommittee, Canadian Society of Soil Science, April 2016).

6.2 Background Research and Literature Review

A list of literature reviewed/referenced can be found in the References at the end of this report.

The following resources were accessed and reviewed during background research:

- BC Habitat Wizard GIS mapping database[23] viewing the following layers: Fresh Water Atlas, EcoCat, Invasive Species, Fisheries, Wildlife, Wildlife Habitat Features, Endangered Species and Ecosystems, Wildlife Management Units, Legal and Proposed GAR Designs, Sensitive Ecosystem Inventory Mapping, Old Growth Management Areas, Terrestrial Ecosystems
- Discovery Islands Ecosystem Mapping (DIEM)[24]
- BC Conservation Data Centre (CDC)[25]
- Species at Risk Act (SARA) Public Registry[26]
- E-fauna BC[27]
- iMap BC Fresh Water Atlas (FWA)[28]
- Fisheries Information Summary System (FISS)[29]
- Strathcona Regional District uMapIt[30]
- Wildlife Tree Stewardship Atlas (WiTS)[31]
- Sensitive Habitat Inventory and Mapping[32]
- Satellite Imagery
- Historical Air Photos[33]

[23] Government of British Columbia, "Habitat Wizard," September 6, 2023, https://maps.gov.bc.ca/ess/hm/habwiz/.
[24] B.C. Conservation Data Centre, "Discovery Islands Ecosystem Mapping (DIEM)," GIS mapping database (Discovery Islands Ecosystem Mapping, 2024), https://diemproject.org/.
[25] Government of British Columbia, "Conservation Data Centre," September 6, 2023, https://maps.gov.bc.ca/ess/hm/cdc/.
[26] Environment and Climate Change Canada (ECCC), "Species at Risk Act (SARA) Public Registry," Database, n.d., https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html.
[27] University of British Columbia, "E-Fauna BC Electronic Atlas of the Wildlife of British Columbia," Database, December 2021, https://ibis.geog.ubc.ca/biodiversity/efauna/.
[28] "iMap BC Fresh Water Atlas (FWA)," Database (Government of British Columbia, n.d.), https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater.
[29] Brad Mason and Rob Knight, *Fisheries Information Summary System (FISS)* (Community Mapping Network, March 17, 2017), https://cmnmaps.ca/DFO_FISS/.
[30] Rob, *Strathcona Regional District uMapIt* (Strathcona Regional District, March 17, 2017), https://srd.ca/services/mapping/.
[31] Rob Knight and Brad Mason, "Wildlife Tree Stewardship Atlas" (Government of British Columbia, n.d.), https://cmnmaps.ca/WITS_gomap/.
[32] Government of British Columbia, "Sensitive Ecosystem Inventory Mapping [Layer]," GIS mapping database (BC Habitat Wizard GIS mapping database, 2024), https://maps.gov.bc.ca/ess/hm/habwiz/.
[33] Government of British Columbia, "BC.1442:19," Historic Air Photo (Vancouver BC: The University of British Columbia Geographic Information Centre Air Photo Collection, 1952).

6.3 Environmental Assessment

6.3.1 General Description

The proposed project site is located in the underutilized and wet portion of the CIS field. A shallow diversion ditch re-directs surficial and groundwater flows along the west side of the field to the north. No streams enter the ditch.

Figure 3. Location overview map. Potential area for wetland restoration in relation to existing infrastructure and geography, Google Satellite image base map.

Figure 4. Aerial image looking north at the proposed wetland restoration site in the north end of the CIS sports field. Feb 12, 2024.

The sports field offers little to no habitat value for most wildlife and is often used by dog walkers after school hours. The fields are mostly too wet to be used for sports and are maintained by mowing. The ditch has pooling water during the wet months, due to being blocked by sand placed in the ditch for a long jump pit. The hydroperiod of the ditch is likely not long enough for successful amphibian rearing. The adjacent mature forest contains large trees, ephemeral wetlands, wildlife trees and offers habitat complexity, which provides important habitat for wildlife. These adjacent forests are designated as ESAs for the purposes of the project, and will be protected during construction.

Cortes Island School grounds lie in the Coastal Western Hemlock, Very Dry Maritime, Eastern (CWHxm1) Biogeoclimatic Ecosystem Classification[34]. "The CWHxm has warm, dry summers and moist, mild winters with relatively little snowfall. Growing seasons are long, and feature water deficits on zonal sites"[35]. Dominant vegetation in this zone includes Western hemlock, Amabilis fir, and Western red cedar. "Major understorey species include Alaskan blueberry, oval-leaved blueberry, false azalea, bunchberry, five-leaved bramble, and a well-developed moss layer"[36].

The historic air photos, 1947, 1952, and 1958 show evidence that the current CIS school and sports field was constructed in the place of a historic wetland.

Figure 5. 1952 historic air photo[37]. Historic wetland outlined in turquoise, approximate school property boundary in white.

[34] BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development., *Biogeoclimatic Ecosystem Classification Subzone/Variant Map for the Campbell River Resource District, West Coast Region.* (Government of BC, August 2016).
[35] Ministry of Forests, "A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region: Land Management Handbook 28" (Province of British Columbia, 1994), https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh28.pdf.
[36] Ministry of Forests.
[37] Government of British Columbia, "BC.1442:19."

The impacts of historic wetland drainage include; a significant landscape level loss of wetland habitat locally; reduced climate change adaptation and resilience of the forest such as resistance to drought, fire, insects and disease[38,39]; a reduction in forest productivity; and a reduction in the forest soil's ability to sequester and store carbon in saturated wetland peat soils[40]. This information is relevant to the project site in question because restoring wetlands at CIS will provide important wetland habitat and ecosystems services which have been drastically reduced locally due to drainage of historic wetlands and development within the project watershed.

6.3.2 Vegetation Description

The vegetation baseline description covers the proposed project site (field and ditches), as well as the vegetation observed in the adjacent forest which provides a reference ecosystem for the restoration project. The intact forest adjacent to the restoration site has mature Western red cedar, Sitka spruce, Western hemlock, with an understory of Salmonberry, sedges, and Sword ferns. This vegetation community composition is evidence of a forested swamp wetland[41].

Native plants:

Understory: *Carex obnupta* (Slough sedge), *Scirpus microcarpus* (Small fruit bullrush), *Juncus effusus* (Common rush), *Lysichiton* americanus (Swamp lattern), *Polystichum munitum* (Sword Fern).

Shrub Layer: *Gaultheria shallon* (Salal), *Rubus spectabilis* (Salmonberry), *Vaccinium parvifolium* (Red Huckleberry), *Struthiopteris spicant* (Deer fern), *Sambucus racemose* (Red elderberry), *Ribes sanguineum* (Red flowering currant).

Trees: *Thuja plicata* (Western red cedar (WRC)), *Picea sitchensis* (Sitka spruce), *Pseudotsuga menziesii* (Douglas fir), *Abies grandis* (Grand fir), *Prunus pensylvanica* (Pin Cherry), *Tsuga heterophylla* (Western hemlock), *Alnus rubra* (Red alder), Acer macrophyllum (Big leaf maple).

Invasive species:

Ilex aquifolium (English holly), *Rubus armeniacus* (Himalayan blackberry), *Cytisus scoparius* (Scotch broom), *Ranunculus repens* (Creeping buttercup), *Cirsium arvense* (Canada thistle), *Phalaris arundinacea* (Reed canary grass) and other unidentified agronomic grasses in and around the sports field.

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[38] C. M. Finlayson et al., "The Second Warning to Humanity – Providing a Context for Wetland Management and Policy," *Wetlands* 39, no. 1 (February 2019): 1–5, https://doi.org/10.1007/s13157-018-1064-z.

[39] Jack E. Williams et al., "Climate Change Adaptation and Restoration of Western Trout Streams: Opportunities and Strategies," *Fisheries* 40, no. 7 (July 3, 2015): 304–17, https://doi.org/10.1080/03632415.2015.1049692.

[40] Hiraishi, Krug, Tanabe, Srivastava, Jamsranjav, Fukuda, Troxler, *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands : Methodological Guidance on Lands with Wet and Drained Soils, and Constructed Wetlands for Wastewater Treatment* (Geneva, Switzerland: Ipcc, Intergovernmental Panel on Climate Change, 2014).

[41] William H. Mackenzie and Jennifer R. Moran, *Wetlands of British Columbia: A Guide to Identification*, vol. 52, Land Management Handbook (Province of British Columbia, BC Ministry of Forests, 2004).

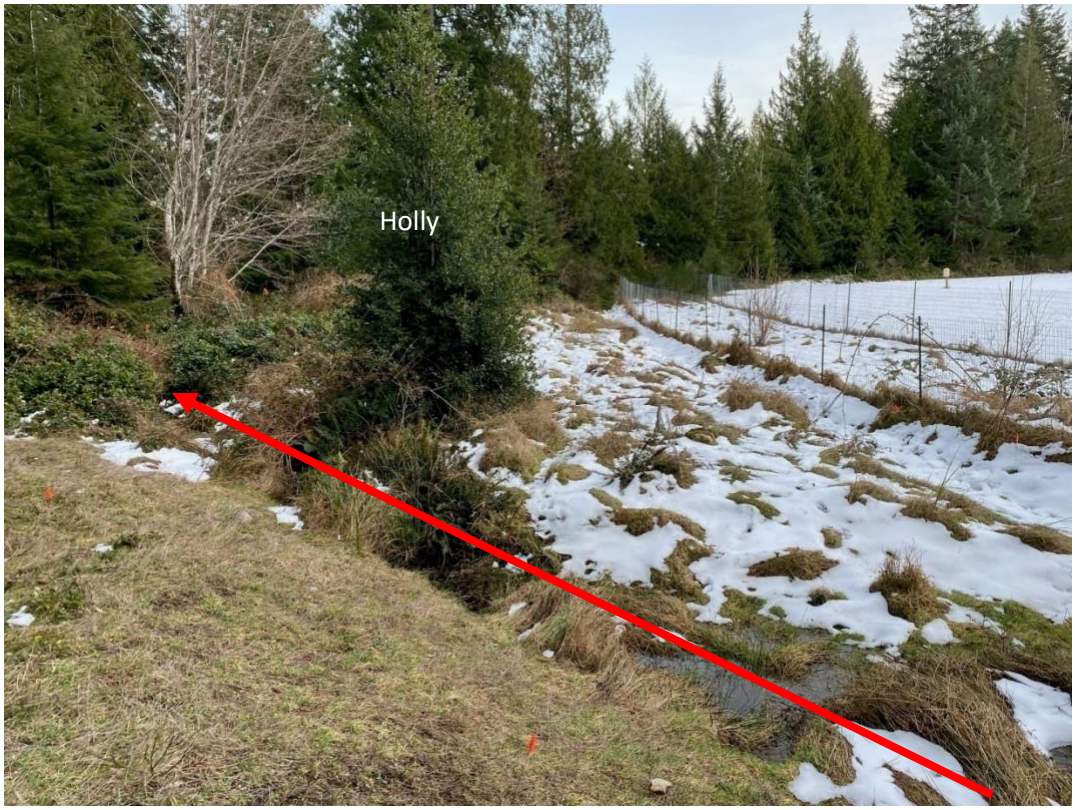

Figure 6. Sedges, rushes, and sword fern are growing along the ditch (red arrow). A large English Holly tree and other non-native invasive plants will be removed as part of this project. The red arrow indicates the direction of water flow in the ditch that runs through the site.

6.3.3 Fish and Fish Habitat

A review of the FISS, Eco-Cat, and iMap revealed no fish or fish habitat data for the project area. QEP conducted a site assessment (multiple dates listed above) of the ditch that runs along the perimeter of the school field and determined that the potential for fish presence in the ditch at any time of the year is not feasible.

6.3.4 Wildlife and Wildlife Habitat

A review of the afore mentioned databases and resources, listed in section 6.2 produced no known occurrences of and/or no identified Critical Habitat for SARA-listed species, Wildlife trees, or sensitive ecosystems at this project site.

Evidence of wildlife currently using the site include observation of Black-tailed deer (*Odocoileus hemionus columbianus)* droppings, and various songbirds in the adjacent forest.

Species At Risk (SAR) with high likelihood of being encountered in the adjacent forest and which are expected to benefit from the restored wetland include: Little Brown Myotis (*Myotis lucifugus*), Northern Red-legged Frog (*Rana aurora),* and Wandering Salamander *(Aneides vagrans).*

6.3.5 Wetland Restoration Site Assessment and Analysis

6.3.5.1 Groundwater Elevation

On February 17, 2021, surficial flow in the west ditch was observed up to 20cm deep. No flow has been observed in the east ditch. In the field adjacent to ditch, water was observed 5cm below surface, and in many areas of the field water is visible pooling on the surface. In the dry months (typically July-September), the ditch is dry. These observations indicate a seasonally perched water table above hard pan (compacted glacial till). Flooding in the fields provides evidence of additional high winter ground water table.

6.3.5.2 Soil texture:

Soil texture test with hand auger:

0-60cm organics & sand

60-90cm sand with small rocks

90+ hard pan layer (compacted glacial till)

Log of test pits dug for sewage disposal field 1978[42] **(average of test pits provided below, see appendix for site plans showing test pit details):**

0-30cm black sandy topsoil

30-110cm brown and yellow brown sand and gravel occasional rusty brown pockets (some water seepage)

110-168cm yellow/light grey medium fine sand (some water seepage)

168-200cm light grey silt hard “hard pan”

6.3.5.3 Percent Slope

2.92%

[42] Ritchie Manners, R.A Spence LTD. Consulting Engineers. Vancouver BC., *Test Pit Log Reference Drawings*.

6.3.5.4 Evidence of historic drainage (ditches/buried drain lines)

A ditch 1-2m wide, up to 1m deep, runs through the restoration site (Figure 7). A subsurface drain line runs north-east through sports field as indicated by site plans. This drain line is made of 6" diameter agricultural tile placed at a 0.6% grade, and approximately 3-3.5' deep[43]. Derek Armitage reports that "Old Timers" called this area a swamp and they hunted by canoe where the sports field is now located[44].

Historic air photos confirm this report. Historic wetland extents are depicted in Figure 5. Low spots in the field pool with water in the winter months. The west ditch, which drains the sports field, has been blocked by sand of the long jump pit and is causing flooding in the field. This area is very wet, water is pooling, and sedges (hydric plants) are established.

Figure 7. Proposed wetland restoration design plan showing existing infrastructure and features, including known drainage infrastructure.

[43] Ross Ritchie, *Proposed Field Interceptor Line*, Proposed Field Interceptor Line, 1':50" (1:600), Mason's Landing Elementary Junior Secondary School (Mason's Landing: J.D. Kern & Company Ltd. Consulting Professional Engineers, July 10, 1978).
[44] Personal communication, Derek Armitage. February 8, 2021.

Figure 8. Aerial photo showing the outlet of the wetland #1 restoration site. The red arrow indicates the direction of water flow in the ditch.

Figure 9. Pooling water on the field as a result of the long-jump pit blocking the ditch.

Figure 10. Water is pooling seasonally in the sports field which would be improved as part of the project.

6.3.5.5 Would a stream or drainage enter the planned wetland?

A diversion ditch with ephemeral flow (consistent winter flows) along the west side of field would drain into the restored wetlands. A ditch on the East side of the field may, during periods of high flow, direct water toward the restored wetlands, however no flow has been observed in that ditch by the author over multiple visits at different times of year.

Figure 11.The west ditch would flow into the restored wetlands, filling them seasonally. Notice the low wet area of the field on the right side of the photo, this would be restored wetland #2 basin. The red arrow indicates the direction of water flow in the ditch.

6.3.5.6 Are head-cuts located uphill or downhill from the planned wetland?

No

7. Site Design

An ephemeral wetland may be restored at this site without the use of an aquatic safe liner. However, a liner may be used to extend the hydroperiod of the wetland, which could provide wildlife habitat during times of drought. Additionally, the use of the liner will maintain the drainage of the fields, and ensure that the wetland doesn't make the field more wet. See figure 7 above.

8. Construction Impact/Benefit Assessment

Construction impacts could include bird nest disruption, fuel spills or leaks from machinery, fire ignition, and accidental release of sediments during earthworks. These potential impacts will be avoided and/or mitigated according to the construction mitigation measures detailed below in section 9.2.

Implementing the designed project would restore and improve habitat for a number of animals listed under the SARA. The author reviewed the E-Fauna BC[45] and SARA[46] to identify animals that may occur in the project area that would benefit from restoring the designed wetland and stream. In addition, background research and literature review (section 6.2) was performed to confirm the possible presence of species on Cortes Island.

Some of the SAR expected to benefit from the restored wetland include Great Blue Heron fannini subspecies (*Ardea herodias fannini*), Common Nighthawk (*Chordeiles minor*), Olive-sided flycatcher (Contopus cooperi), Band-tailed pigeon (*Patagioenas fasciata*), Blue Dasher Dragonfly *(Pachydiplax longipennis),* Little Brown Myotis (*Myotis lucifugus*), Northern Red-legged Frog (*Rana aurora),* and Wandering Salamander *(Aneides vagrans).*

The proposed changes include the restoration of wetland habitat in a field that provides little habitat value. Flow from the existing ditch will be re-aligned through the constructed wetlands, filling sections of the ditch that are no longer needed but are functioning to lower ground water elevations, and recontouring the slopes where cut banks were created bordering the forest. Sections of the ditch will be re-naturalized with habitat features like pools, riffles, and the addition of CWD. Furthermore, the restored wetland will be protected from erosion by the installation of vertical grade control structures and rock armoring. These actions are expected to improve and restore habitat and hydrology to the area and address erosion that is currently taking place in the ditch, while supporting ecosystems for climate change adaptation and resilience.

[45] University of British Columbia, "E-Fauna BC Electronic Atlas of the Wildlife of British Columbia."
[46] Government of Canada, "Species at Risk Act" (Minister of Justice, April 4, 2022), https://laws.justice.gc.ca/PDF/S-15.3.pdf.

Additional benefits resulting from the project include the riparian and native vegetation enhancement that will surround the restored wetlands, and the removal, management and control of invasive species which are currently outcompeting native vegetation along the ditch.

Implementation of this project will result in net gains of aquatic habitat (up to 1400m^2) and riparian area (up to 1400m^2), and a reduction in invasive species presence. Actions would be taken to improve the sports field such as: restoring the function of the perimeter drainage ditch along the west, and using soil excavated from the wetlands to fill and grade low spots in the field. Restoring wetlands at CIS will provide unparalleled opportunities for students and community members to learn about the value of wetlands for the myriad ecosystems services they provide, including climate change adaptation and resilience.

9. Construction Environmental Management

Construction environmental management and mitigation measures are listed below based on the *BC Standards and Best Practices for Instream Works*[47], additional guidelines, regulations, and Acts are referenced when relevant. It is the responsibility of the QEP to plan, implement and manage environmental mitigation during construction. QEP will be on site for the duration of construction, directing heavy equipment and conducting environmental monitoring.

9.1 Lest Risk Timing Windows

To avoid impacts and potential risks to wildlife during construction the proposed works are planned for July 2025, when the surficial flow in the ditch is expected to be dry. This project presents low risk to wildlife during construction, however the greatest risk will be to birds who could be nesting in the forest surrounding the project site. The construction impact area is a mowed field, and the ephemeral ditch which provide little to no habitat value. The general *Reduced Risk Work Windows for Fish and Wildlife for Vancouver Island* is June 15th to September 15th, no fish species are present at this site[48,49]. The regional bird nesting period is from late March to mid-August; however the majority of nesting activities are completed by the beginning of August.[50] Bird nest surveys will be conducted prior to construction

[47] BC Ministry of Water, Land and Air Protection, "Standards and Best Practices for Instream Works."
[48] BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, "Terms and Conditions For Changes In And About A Stream Specified By Ministry of Forests, Lands and Natural Resource Operations Habitat Officer, West Coast Region (Vancouver Island & Gulf Islands)" (Government of BC, February 2011), https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/terms_conditions_van_island.pdf.
[49] Lawrie Bowles, "Re: Quadra Island Elementary School Ditch Site Assessment for Fish Presence," March 26, 2022.
[50] Government of Canada, "Regional Nesting Periods Tables in Canada. Table 1a. Regional Nesting Period Table in Canada, Technical Information for Planning Purposes: Nesting Zone A.," accessed April 25, 2022, https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html#ZoneA.

and mitigation measures in place as described in Section 9.2 Construction Mitigation Measures. As the project site is a mowed field, bird nests are not expected to be impacted during construction.

9.2 Construction Mitigation Measures

9.2.1 Clearing and Vegetation Removal

Vegetation clearing along the ditch will be required to prepare the site for wetland restoration and the re-contouring of the cut bank slopes. Risks during clearing and vegetation removal of the work area include potential for bird nest disruption, and the introduction of non-native invasive plants to the site. These risks are considered low, as the ditch vegetation is sparse and low habitat value compared to the surrounding forest and shrub vegetation. Risks will be mitigated with pre-construction nesting surveys and delineation of BMPs as described below. Additionally, the site is already colonized by invasive species, and invasive species management BMPs will be employed during and post construction. Section 10.2.2 provides a details of invasive species abatement actions to be employed over the course of the project. Risks related to clearing and vegetation removal will be mitigated by the following measures:

- Heavy equipment and tools will be cleaned and free of soil prior to being mobilized to the site.
- All materials such as rock and/or CWD will be clean and free of weeds. Sources will be inspected by the QEP prior to transport to the site.
- Post construction seeding will take place as soon as possible to inhibit the establishment of invasive species and reduce the potential for erosion.
- Monitoring and invasive species management will take place during the establishment phase (at least 5 years) post construction.
- Prior to vegetation clearing, the QEP will conduct a bird nest scan of the work area. If a bird nest is discovered with a bird and/or egg, a vegetated buffer will be established around the nest and the area will be designated as an ESA[51]. ESAs will be flagged, pointed out to heavy equipment operators in the pre-work meeting, and avoided and protected during construction.
- Existing wildlife trees will be identified and maintained when possible.

9.2.2 Site Delineations and Protection of ESAs

The project site is adjacent to an intact forest, as such unnecessary expansion of the project footprint will be minimized to avoid damage to this ESA. The risk of negatively impacting surrounding ESAs is low, as the work site is located in a large field, with ample room for access, stagging, and equipment clearances. Risks to ESAs will be mitigated by the following measures:

- QEP will clearly mark the project footprint on the ground. ESAs and vegetation to be protected will be delineated and avoided during construction.

[51] Government of Canada, "Guidelines to Reduce Risk to Migratory Birds," 2022, https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html#toc5.

- QEP and Heavy Equipment Operators will meet prior to the commencement of construction, walk the site, looking at the ESAs and discuss best practices and strategies for avoiding impacts to ESAs and wildlife.
- When working near flow paths and ditches, heavy equipment will be located on the bank of the ditch in the field and reach into the ditch to install vertical grade control structures, rock armouring, and/or remove fill that was historically placed in the ditch.
- Access routes, staging areas, and re-fueling zones will be established to reduce impacts to ESAs.
- No soil, fuel, or machinery will be stored within the ESAs.
- Trees that are near the work area but outside the clearing limits may be pruned to remove lower branches, or tied back, rather than removing the entire tree to allow for machine swing or sightlines if necessary.

9.2.3 Wildlife Interactions

During construction there is the chance to encounter and/or impact wildlife. Due to the site being a mown field, and the ditch being dry during construction, the risk of encountering wildlife is considered low. This risk will be mitigated by the following measures:

- Project personnel will immediately report incidental encounters with wildlife to the QEP. Measures to avoid and protect wildlife will be employed, such as delineating an ESA/buffer zone if necessary, and/or temporarily moving equipment to another part of the work site until the animal has cleared the area.
- Efforts will be made to scare off large mammals or predators, which usually will avoid heavy equipment and noise from construction. If the animal persists, a Conservation Officer with the Ministry of Environment will be contacted to determine the best course of action. Conservation Officer 24-hour hotline: 1-877-952-7277.

9.2.4 Erosion and Sediment Control

Excavation of soils and earth moving poses the risk of triggering erosion and/or runoff of sediments leading to downstream impacts to aquatic habitats and surface water. Due to the timing of the proposed works, when the ephemeral ditch at the site is dry, this risk is considered low. The following mitigation measures will be employed to manage these risks:

- Construction activities are planned for July 2025, when no surficial flow is expected.
- If there is surficial flow during the work window, sediment and erosion control measures will be implemented, monitored, and maintained if deemed necessary by the QEP.
- Work will only take place during favorable weather conditions, and construction will be stopped during intense precipitation events with more than 20mm in 24 hours.
- Installation of rock rip rap along the re-naturalized ditch, and vertical grade control structures at the inlet and outlet of the restored wetland will prevent erosion and stabilize soils post-construction.

9.2.5 Fuels and Hazardous Materials/Spill Contingency and Response

The use of heavy equipment poses the potential risk of an accidental release or spill of hazardous materials such as petroleum, oil, hydraulic fluids, lubricants, anti-freeze etc. onto the land surface or water courses. The result of a spill could negatively impact wildlife, habitat, and/or human health. This risk is considered moderate, and will be mitigated with the following measures:

- Equipment contractors must ensure equipment and machinery are in good operating condition (power washed), free of leaks, excess oil, and grease. Daily documented inspections of all equipment for leaks and or worn hoses etc. will be performed by operators.
- Spill containment kits will be readily accessible onsite sufficient to contain a large spill, as well as a smaller kit located in each piece of equipment. Onsite staff will be trained to use the spill kits.
- All refueling and maintenance of equipment will take place at least 30m from any watercourse or surface drainage. All fuel and hazardous materials containers will be safely stowed and clearly marked. Any used containers for equipment products such as oil filters, grease cans etc. will be collected and securely stored by the equipment operators and disposed appropriately.
- All spills will be immediately cleaned up and any spill of a substance that is toxic, polluting, or deleterious to aquatic life of reportable quantities (e.g., 100 liters to land, or any quantity to water) will be immediately reported to the Provincial Emergency Program 24-hour phone line at **1-800-663-3456**.
- If/when a spill is noticed, work will stop immediately, and onsite personnel will be deployed to contain and clean up the spill.
- Contaminated soils and spill containment materials will be disposed of at an approved disposal facility.
- Treated wood products will not be used in any construction below the high-water mark of the stream channel, to prevent the release of preservatives that are toxic to fish.

9.2.6 Fire Prevention and Response Plan

The potential for fire ignition on site is a moderate risk given the time of year that construction is planned. Fire prevention measures are as follows:

- The QEP will be aware of current local wildfire danger class ratings and risk conditions[52], and take appropriate actions to follow shutdown thresholds and prevention procedures as described in the BC *Forest Fire Prevention and Suppression Regulation*[53].

[52] BC Wildfire Service, "Wildfire One: Fire Weather Danger Class Report" (Government of BC, n.d.), https://wfapps.nrs.gov.bc.ca/pub/wfwx-danger-summary-war/dangerSummary?fireCentre=Coastal%20Fire%20Centre.

[53] Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC, South Coast Region, "Forest Fire Prevention and Suppression Regulation," 2003, https://www.for.gov.bc.ca/ftp/HFP/external/!publish/FPC%20archive/fpc/fpcaregs/ffirepre/ffpasr1.htm#FFPASR_PART4Div2.

- The QEP will check local danger class ratings prior to the project construction and ensure that a BC *Wildfire Act* and *Wildfire Regulation* High Risk Activity Exemption is obtained if needed as described by Schedule 3 of the *Wildfire Regulation*[54] during the time of construction.
- In the event that an exemption is obtained, requirements for firefighting equipment and trained personnel set out in the *BC Wildfire Act* High Risk Activity Exemption will be adhered to. This may include but is not limited to observing fire hours, maintaining a fire watch, having an adequate supply of water and water delivery system on site, having firefighting tools and S-100 trained personnel on site.
- Smoking on site will be prohibited near dry fuels, explosives, fuels, and other hazardous materials.
- All equipment shall be outfitted with fire extinguishers, and personnel will be aware of firefighting techniques.
- Fuels will be stowed securely and out of direct sunlight.

10. Implementation and Effectiveness Monitoring Plan

10.1 Post Construction Monitoring Goals and Objectives

Goals:

1. Identify and control erosion
2. Identify and control weeds and non-native plants
3. Measure plant survival and assess the need for replanting

Objectives:

Hydrology: ensure that the following erosion events do NOT occur, with any required corrective measures implemented as soon as possible if erosion does occur:

1. Head-cuts and gully formation within the restoration project area.
2. Sheet erosion and sediment stability/mobility issues.

Revegetation: revegetate all areas of disturbed soil as per the Revegetation Plan, section 10.2 and 10.3 of this report including:

1. For riparian areas, complete seeding and planting with native grasses (or non-native non-persistent cover crops), sedges, and other native riparian vegetation to achieve 60% vegetation cover after one year.
2. For upland areas, complete seeding with native grasses and herbaceous species to achieve 70% vegetation cover after one year.

[54] Government of British Columbia, "Wildfire Legislation and Regulations," 2005, https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/governance/legislation-regulations.

10.2 Riparian Planting Plan

10.2.1 Duration and Frequency of Effectiveness Monitoring to Demonstrate Successful

Identifying and controlling weeds and non-native plants: The construction site will be examined for weeds and non-native plants by students, teachers, and maintenance contractors throughout the year, and management actions to control weeds will be planned between CIS, FOCI, with guidance from QEP for at least the first 3 years post construction. Invasive plant species will be monitored and treated using the guidelines detailed in the *BMPs for Invasive Plants in Parks and Protected areas of BC*.[55]

Measuring plant survival and replanting as needed: Permanent random sample plots will be established for each work area, students at the school will be engaged in monitoring for and determining revegetation success, with support from FOCI and guidance from RWE. Monitoring will be conducted in June and September each year, until the revegetation attempts have been deemed successful. Plots at the restoration site will be monitored for coverage density and distribution, health, and species richness.

10.2.2 Outline of Details for Invasive Abatement/Disposal and Replanting in the event of Mortality

Minimizing the spread of invasive species is a key concern during implementation of the designed project because the area of soil that is exposed may create conditions for non-native plants to become established.

During the establishment phase (Years 1-5) CIS with support from FOCI plan to organize a volunteer work parties to manage invasive species as needed. Current project funding covers one-year post-construction monitoring and maintenance.

The Project Team will incorporate BMPs targeting invasive plant prevention and control into all plans and management activities that will result in disturbance to native vegetation and soils. Applying these BMPs will help mitigate the adverse effects of invasive plants on native plants, wildlife, and the environment. This section was prepared with reference to the *Best Practices for Preventing the Spread of Invasive Plants During Forest Management Activities*[56] and the *BMPs For Invasive Plants in Parks and Protected Areas of BC* [57]*.*

- A vegetative baseline survey assessment has been completed by QEP, section 6.3.2 of this report, and invasive species on site have been identified. No aquatic invasive plants are present on site. Invasive species currently in the work site will be managed and removed by hand prior

[55] BC Parks; Invasive Species Council of BC, "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors."
[56] Invasive Species Council of BC & Ministry of Forest, Lands, and Natural Resource Operations, "Best Practices for Preventing the Spread of Invasive Plants During Forest Management Activities. A Pocket Guide for British Columbia Forest Workers." (Government of BC, 2013).
[57] BC Parks; Invasive Species Council of BC, "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia: A Pocket Guide for BC Parks Staff, Volunteers and Contractors."

to construction. The work site will be inspected 1 week prior to construction and new infestations will be reported and managed.

- Heavy equipment will be thoroughly washed, pressure washing all mud from vehicles and equipment, before entering the site to prevent the spread of invasive species. Infested sites will be avoided for staging and parking.
- Heavy equipment operators would avoid using their bucket or blades while moving equipment to the site to minimize exposing soil between access routes and the restoration sites.
- An excavator may be used to pull non-native plants out by the roots within project areas. Non-native shrub plant material may be disposed of off-site or deeply buried to prevent re-growth.
- The top layer of non-native grasses and associated soil/ seed bank may be scraped off and buried onsite. Although this takes extra time during the restoration project, it would greatly decrease the establishment of non-native plants.
- All fill and erosion control materials will be inspected to ensure they are free of invasive plants before transport and use.
- Clothes, boots, hand tools, and other equipment used for treating invasive plants will be carefully cleaned before leaving the site.
- Soil disturbance will be minimized, and native vegetation maintained. Natural regeneration and understory vegetation will be retained in areas where management activities could affect the cover, density, and species composition of the native plant community.
- Disturbed sites and exposed soils will be re-vegetated as soon as possible. Bare soil will be seeded immediately after heavy equipment has finished working. Seeds and soils will be mulched lightly to retain moisture and aid in seed germination. Composition of seed mixes to best suit each site is planned for disturbed area. When available, native seed will be used, as well as non-invasive/non-persistent agronomic species for erosion control. Only Canada Certified Number 1 Grade seed will be used where possible.
- Thick layers of weed-free mulch (1 bale of barley or wheat straw/10 m^2) may be used to suppress weeds and retain moisture for new plantings above the water line.
- Dense plantings of native plants both in the restored wetland and adjoining upland areas where soil is spread may be used to control non-native plants.
- Further disturbance on the restoration sites will be avoided and minimized as new seedlings establish.
- Invasive plants will be removed prior to seed set to prevent build-up of seed banks that will take years to control.
- Invasive plants will be carefully and properly disposed of based on species specific recommendations listed below from the Invasive Species Council of BC.
- The wetlands will be constructed with variable microtopography and soils de-compacted using the rough and loosen technique to encourage diversity in native plant establishment. For example: the bottom of wetland would contain uneven elevations with pits, mounds, and depressions; compacted soils would be loosened within and around the restored wetland; ridges, mounds, tufts, and scrapes would be created within the wetland.

- The restored wetland will be monitored for non-native plant and cattail colonization following construction. Cattails and non-native plants that begin growing in and near the wetland may be removed by hand following construction. This action would facilitate the establishment of an attractive diversity of native aquatic plants in the new wetland.

Invasive Species Council of BC recommendations:

"Reed Canary Grass: Cut plants frequently and regularly (3 times per year for 4 years at a minimum) to prevent seed production and weaken root reserves. Spreading rhizomes are very difficult to pull and any remaining fragments will readily re-sprout

Himalayan Blackberry: Use a pulaski, mattock, or backhoe to remove as much root as possible. Ensure biomass is disposed of at a landfill. Any remaining root fragments will re-sprout; be sure to re-inspect

Canada Thistle: Highly invasive plant. Incomplete pulling or cutting can stimulate remaining roots to re-sprout and worsen infestations. Continual, repeated cutting or pulling will deplete root reserves

Oxeye Daisy: Pull or cut prior to seed set. Pulling or cutting during or after flowering will disperse seeds. Plants will continue to flower and grow if soil is not shaken from roots

Scotch Broom: Small plants should be gently pulled from moist soil. Ensure all roots are removed. Large plants may be cut off as close to the soil surface as possible, without causing soil disturbance"[58].

Holly: "Small plants (up to 3 centimetres in diameter) removed by hand can be effective when the soil is moist. Small seedlings should be pulled soon after they first appear. For sprouts that don't come out easily by hand, digging around the plant with a shovel or pick will help loosen the soil"[59]

10.3 Revegetation Planting Plan

At the time of writing this report, the revegetation plan is being developed. Multiple project partners are being engaged in the design and planning for this project. Indigenous Elder's, students, and community members will be engaged over the coming months to develop a culturally relevant planting plan for native vegetation tailored to the site-specific conditions and constraints. A plant list of native plants to be planted at the restored wetland is provided below Table 2. The project construction team will ensure disturbed soils from construction will be seeded with native grasses (or non-native non-persistent cover crops), sedges, herbaceous and other native vegetation. In the fall post-construction, native nursery stock will be planted and fenced to prevent browsing. A community planting event will be hosted, with support from BCWF, FOCI, RWE and community volunteers and other stakeholders.

[58] BC Parks; Invasive Species Council of BC.
[59] Metro Vancouver and the Invasive species council of Metro Vancouver, "Best Management Practices for English Holly in Metro Vancouver Region.," 2021.

Additionally, in the winter-early spring following construction, riparian areas will be live staked with deciduous species native to the area (willow, cottonwood, red osier dogwood) to support the regeneration of Western red cedar swamps. The planting of deciduous trees will provide a cover of deciduous vegetation that will initiate successional processes that will support the establishment of wind-borne cedar seed that will naturally germinate and grow in the understory[60].

Table 2. Native plant list Cortes Island BC.

Latin Name	**Common Name**
Acer macrophyllum	Big Leaf Maple
Amelanchier alnifolia	Saskatoon
Cornus sericea	Red Osier Dogwood
Crataegus douglasii	Black Hawthorn
Dicentra formosa	Bleeding Heart
Gaultheria shallon	Salal
Holodiscus discolor	Ocean spray
Lonicera involucrata	Black Twinberry
Lysichiton americanum	Skunk Cabbage
Mahonia aquifolium	Tall Oregon grape
Mahonia nervosa	Short Oregon grape
Malus fusca	Pacific Crabapple
Oemleria cerasiformis	Indian Plum
Oplopanax horridus	Devil's club
Philadelphus lewisii 'Gordianus'	Mock Orange (Coastal)
Physocarpus capitatus	Pacific nine bark
Picea sitchensis	Spruce
Polystichum munitum	Sword fern
Populus balsamifera	Black Cotton Wood
Populus tremuloides var.vancouveriana	Trembling Aspen
Potentilla anserina	Silverweed
Rhododendron (Ledum) groenlandicum	Labrador tea
Ribes bracteosum	Stink currant
Ribes sanguineum	Red flowering currant
Rosa gymnocarpa	Baldhip rose
Rosa nutkana	Nootka Rose
Rubus parviflorus	Thimble berry
Sagittaria latifolia	Wapato, Arrowhead
Salix hookeriana	Hooker's Willow
Salix lucida (lasiandra)	Pacific Willow
Salix sitchensis	Sitka Willow
Sambucus cerulea	Blue Elderberry

[60] David Polster, "David Polster, Personal Communication," n.d., https://polsterenvironmental.com.

Latin Name	**Common Name**
Sambucus racemosa	Red elder berry
Scirpus acutus	Hard-stemmed Bulrush
Spirea douglasii	Hardhack
Symphocarpus albus	Snowberry
Taxus brevifolia	Pacific yew
Thuja plicata	Red cedar
Vaccinium ovatum	Evergreen huckleberry

10.4 Hydrology

10.4.1 Duration and Frequency of Effectiveness Monitoring to Demonstrate the New Channel is "Functioning as Intended"

Identifying and controlling erosion that may occur: Students and teachers at CIS, and monitoring and maintenance contractors, and other community members will be trained to identify erosion by the QEP Miranda Cross, RWE. These trained community members will conduct surveys to monitor erosion by walking on the ground following snowmelt, and after each rainfall with significant runoff for at least 1 year following construction. In addition, RWE will be retained to conduct hydrology monitoring of the restoration site 4 times per year in the first year following construction, and will be available in subsequent years as needed. Erosion will be controlled as needed, and as soon as possible after detection to prevent damage to the restored wetland and downstream ecosystem. The school may contact RWE for support in addressing erosion issues that may occur.

10.4.2 Metrics to Measure How the Channel is " Functioning as Intended"

This project will use metrics developed by The Province of BC for habitat and status evaluation protocols that include visual surveys for riparian and channel habitat, sediment transport, that are applicable to functional monitoring[61]. The *Forest & Range Evaluation Program Fish/Riparian Monitoring Protocols* requires addressing 15 distinct questions, adapted to measure restoration success, and listed below, relating to the characteristics of healthy streams and their aquatic and riparian habitats[62]. In addition to the qualitative questions, quantitative data may be gathered through the establishment of permanent hydrology transects at key locations (constructed vertical grade control structures) or in the event erosion or head cuts develop.

[61] Douglas C. Braun, Karen E. Smokorowski, Michael J. Bradford, Luc Glover, "A Review of Functional Monitoring Methods to Assess Mitigation, Restoration, and Offsetting Activities in Canada" (Fisheries and Oceans Canada, 2019), https://publications.gc.ca/collections/collection_2020/mpo-dfo/fs70-5/Fs70-5-2019-057-eng.pdf.
[62] Pickard, D., M. Porter, L. Reese-Hansen, R. Thompson, D. Tripp, B. Carson, P. Tschaplinski, T. Larden, and S. Casley., "Fish Values: Watershed Status Evaluation, Version 1.0." (BC Ministry of Forests, Lands, Natural Resource Operations and BC Ministry of Environment, 2014).

"Each of these questions are used to evaluate a main or overarching physical or biological indicator of stream channel or riparian area condition. The overarching ***indicators for the stream channel*** *are:*
(1) channel bed disturbance,
(2) channel bank disturbance,
(3) large woody debris (LWD)
characteristics,
(4) channel morphology,
(5) aquatic connectivity,
(6) fish cover diversity (for fish-bearing reaches only),
(7) moss abundance and condition,
(8) fine sediments, and
(9) aquatic invertebrate diversity.

The principal ***indicators for the adjacent riparian area*** *are:*
(1) windthrow frequency,
(2) riparian soil disturbance/bare ground,
(3) LWD supply/root network,
(4) shade and microclimate,
(5) disturbance increaser plants, noxious weeds, and invasive plants, and
(6) vegetation form, vigour, and structure"[63]

These fifteen questions will be used to assess the relative health, or "functioning condition" of the restored wetland and riparian habitat (adapted from Pickard et al., 2014):

Question 1. Is the channel bed undisturbed? (e.g. a disturbed channel bed includes: incision, gullies, head-cuts, or channels forming since construction).

Question 2. Are the channel banks intact? Not eroding?

Question 3. Was enough LWD placed during restoration? Has enough LWD been retained in this system?

Question 4. Is the channel morphology (size and shape) intact?

Question 5. Are all aspects of the aquatic habitat sufficiently connected to allow for normal, unimpeded movements of fish (if present), aquatic organisms, amphibians, organic debris, and sediments? Is the stream accessing the floodplain on an annual or biannual basis?

Question 6. Does the stream support a good diversity of fish and wildlife cover attributes to support wildlife presence use (fish/beaver/amphibians/waterfowl/birds)?

[63] Pickard, D., M. Porter, L. Reese-Hansen, R. Thompson, D. Tripp, B. Carson, P. Tschaplinski, T. Larden, and S. Casley.

Question 7. Does the amount of moss present on the substrates indicate the site is becoming a stable and productive system?

Question 8. Has erosion been minimized/controlled/prevented to limit the introduction of fine inorganic sediments to the stream/downstream waterbody?

Question 9. Does the stream support a diversity of aquatic invertebrates?

Question 10. Has the vegetation in the Riparian Management Area (20m from the stream) that was retained during construction been sufficiently protected from windthrow and other damage?

Question 11. Has the area of bare erodible ground in the riparian area/floodplain caused by construction disturbance lessened due to regenerating riparian vegetation?

Question 12. Has sufficient vegetation been established/retained in the riparian area/floodplain to maintain an adequate root network or LWD supply? (Are there enough roots to hold soil in place? Is there a supply of CWD, either placed, or natural?)

Question 13. Has sufficient vegetation been established/retained to provide shade and reduce bank microclimate change?

Question 14. Have the number of disturbance-increaser species, noxious weeds and/or invasive plant species present been limited to a satisfactory level?

Question 15. Is the riparian vegetation within the first 10m from the edge of the stream trending towards what the healthy, unmanaged riparian plant community would normally be along the reach?

"The assessment of the relative condition of the sampled site is based on the total number of No answers to the questions as follows:
0–2 No answers – the stream and riparian habitat at the sample site is in properly functioning condition (PFC);
3–4 No answers – the stream and riparian habitat at the sample site is in properly functioning condition, but at risk (also termed PFC with limited impacts or PFC-L);
5–6 No answers – the stream and riparian habitat at the sample site is in properly functioning condition, but at high risk (also termed PFC with intermediate-level impacts or PFC-I);
7 or more No answers – the stream and riparian habitat at the site is not properly functioning (NPF)" [64].

[64] Pickard, D., M. Porter, L. Reese-Hansen, R. Thompson, D. Tripp, B. Carson, P. Tschaplinski, T. Larden, and S. Casley.

11. Safety (Author: Thomas Biebighauser)

The wetland project would be safe for students to visit and investigate. There is no need to build a fence around the designed wetland. Thomas Biebighauser has built hundreds of wetlands at Elementary, Middle, and High Schools, and at universities since 1988. He has also lead thousands of students into wetlands on field trips. Here is a summary of his observations about student behaviour at wetlands.

Students are reluctant to step into a wetland. They stop at the water's edge. Students must be encouraged to venture into the water. They'll only do this if they have rubber boots on. They simply don't want to get their shoes muddy.

The wetland would be built shallow in the center with gradual slopes. Children may drown if they fall into a swimming pool that is over their head, and don't know how to swim. The wetlands built at schools are less than 0.5-meters deep in the center. The deepest water is in the middle of the wetland, and it's only up to the knees on children. In addition, the bottom of the wetland is soft, like falling on a mattress.

The author has observed their children and grandchildren take baths when only 2 or 3-years old. Should they slip in the tub, they quickly raise their head out of water. They also stand up and try to leave the bathtub when they're done. The same is true for students investigating a wetland. If they were to fall into the water, they simply kneel or stand up. The author has never heard of anyone, who after falling into shallow water, did not stand up, or raise their head out of water. The wetland would have gradual slopes, be shallow, and have a soft bottom.

The school may set rules guiding how students visit the wetland. Just as students are asked not to play in a parking lot or street without adults being present, they can be taught only to visit the wetland with adult supervision.

The authors know of three-schools that have built fences around their wetlands. Their wetlands are no longer being used by students or teachers. No one can ever find a key to the gate, and the plants have grown up so much around the wetland that teachers and students don't visit the site. Fences are always placed too close to the water's edge, leaving no room for classes to investigate the wetland if they wanted to.

The authors are unaware of any school districts that have had the cost of their insurance changed following the construction of a wetland at their school.

Student safety and school wetlands is discussed in two of the books written by Thomas Biebighauser, *Wetland Drainage, Restoration, and Repair*[65], and *Wetland Restoration and Construction – A Technical Guide*[66].

[65] Thomas R. Biebighauser, *Wetland Drainage, Restoration, and Repair* (The University Press of Kentucky, 2007).
[66] Thomas R. Biebighauser, *Wetland Restoration and Construction-A Technical Guide, Second Edition*.

12. Aquatic-Safe Liner and Wetland Construction

Author: Tom Biebighauser

12.1 Aquatic-Safe Liner

The *Aquatic-Safe Liner Technique* is recommended to build a perennial wetland (water all year), and to maintain drainage of the sports field. The clay content of the soil is too low to shape and compact so it would hold water year-round without the use of a liner.

The *Groundwater Technique* can be used to build an ephemeral wetland (dries in summer), as the elevation of the water table is at or above the surface of the ground in the wet season, but may be far below the surface at this location in the summer.

Wetlands built using liners can be expected to hold water very well, with primary losses being from evaporation. Tom Biebighauser has used aquatic-safe liners with success to build over 300-wetlands on permeable soils across North America.

It is not feasible to purchase soil that is high in clay, and haul it to the area so the *Compacted Clay Liner Technique* may not be used to build the wetland. Even if clay were present, it would be challenging to transport the clay to the worksite. In addition, the unit cost of using clay to build a wetland where clay is transported to the site can be over ten-times higher than using an aquatic-safe liner.

The liner used should be made from EPDM, 45-mil or thicker, certified fish-grade & aquatic safe, one piece and factory seamed, according to measurements listed. The majority of liners available are treated with fungicides and algaecides, and if used, would kill aquatic life in the new wetland. This is why it is critical that an aquatic-safe liner be purchased for the project.

Geotextile fabric would be used to protect the top and bottom of the liner. Thick 16oz geo-textile fabric would be placed over and under the liner. The geo-textile pads should measure the same size as the liner, and also be factory seamed. *The importance of ordering one-piece, factory seamed materials cannot be over emphasized.* These materials are expensive and almost impossible to join outdoors. It is critical that the liners and geo-textile pads be ordered from factory in one piece, and in matching sizes. It is much less expensive to use geo-textile to protect the liner compared to ordering a thicker liner.

The only source known in British Columbia for ordering one-piece, factory-seamed aquatic-safe liners and matching geotextile pads is:

Western Tank & Lining Ltd.
7192 Vantage Way
Delta, BC V4G-1K7
P: 604.241.9487 extension 107 M: 604.209.6784
Attention: Clint Powell
Email: clint@wtl.ca

When ordering liners and geotextile, please allow at least two-weeks for manufacture and delivery of the liners and geo-textile pads.

Figure 12. An aquatic-safe liner, sandwiched between layers of geotextile, is ready for covering with soil by the excavator. It is critical that the liner and geo-textile pads be ordered one piece, and factory seamed. Photo: Biebighauser.

Each liner and matching set of geo-textile pads is generally packaged on one wood pallet, with the size of the liner labelled on the outside, and delivered by a large semi-truck. One must let the company know in advance if a large semi-truck cannot access your delivery location when ordering. *It is critical you know in advance and inform the manufacture when ordering if a full-size semi-truck can access your delivery location.* The liner manufacture can request from the trucking company that delivery be made using a smaller truck, with a lift gate. Expect the cost of delivery to be higher with a small truck, compared to a semi-truck.

Each liner and set of geo-textile pads can weigh up to 1,400lbs, so it is important to use a fork-lift to unload the pallets from the truck. The liner would probably arrive wrapped in geo-textile, and sandwiched between two geotextile pads for protection. The entire package is bound by metal or plastic straps. These straps may be cut with a metal strips if needed.

The liner and pads should be kept wrapped on the pallet and stored indoors, or in a shelter where animals cannot cause damage. Mice and squirrels can be expected to build their homes in the liners and geotextile pads when stored outdoors. Once these mammals move in to the package, they quickly chew holes in the materials. Fortunately, this has not been a problem after the liners and geo-textile pads are installed.

A 4WD pickup may be used to transport the liner and matching set of geo-textile pads to the worksite. A forklift may be used to load the pickup truck with the liner and geotextile needed for the project. The pickup truck is backed up to the edge of the wetland being built, and the materials are unloaded, by hand, one piece at a time. It is very difficult to move the liner and geotextile any distance by hand, making it very important that the pickup or tractor deliver the materials immediately adjacent to the construction site.

Figure 13. A tractor with a forklift attachment is used to move a pallet containing a liner and set of geotextile pads to the wetland construction site at Morfee Elementary School. Photo: Biebighauser.

A group of 15 or more people will be needed to install the liner and set of geo-textile pads. There is a considerable amount of hand raking, shovelling, lifting, and pulling needed to build a wetland using a liner.

Miranda Cross is available to direct construction, and would work with individuals to place the liner and geo-textile pads. It is extremely difficult to install a liner and geotextile pads with small number of people helping. *The importance of organizing a large enough crew to help cannot be overemphasized.*

Figure 14. It takes careful measuring and takes time to prepare a site for placement of the liner and geo-textile pads. A person familiar with wetland construction and survey techniques must be onsite at all times monitoring and assisting with the construction of the wetland. Photo: Biebighauser.

It is essential that a laser level, tripod, and survey rod, made for use with a laser level, be used to monitor elevations for installing the liner and geo-textile pads. A 30-meter long tape measure, along with wire flags are also needed for marking and dry-fitting the liner and geo-textile pads.

The liner and geo-textile pads should be anchored by driving 12-inch landscape spikes along the top edge before covering with soil. This prevents the materials from shifting when being covered with soil. The corners and excess liner and geo-textile fabric should be trimmed before covering with soil. The materials should not be anchored by rolling them over and placing them in a narrow trench.

The landscape spikes used to anchor the liners can be twisted or smooth. They must be 12-inches long. Landscape spikes are available for purchase from major hardware stores such as Lowes and the Home Depot. *Shorter nails would not work*.

Figure 15. The excavator is used to place soil over the liner and geo-textile pads. Heavy equipment must be kept off of the liner at all times to protect it from damage. Photo: Biebighauser.

12.2 Bentonite

People often suggest using bentonite to build wetlands on permeable soils. Their suggestion is generally based on hearsay and tradition, not from experience building wetlands. *The use of bentonite to build or repair wetlands is not recommended.* Tom Biebighauser has had no success over 34-years using bentonite to build or repair leaking wetlands and wetlands. He has examined hundreds of sites where other people have tried to repair leaky wetlands using bentonite, and never with success. Bentonite is very expensive, and almost impossible to mix with water and compact on the large scale needed for wetland construction. Tom Biebighauser recently examined a failed wetland near Amado, Arizona where an individual spent over $30,000 on bentonite in an attempt to repair a leaky wetland, unfortunately, without success.

A major problem associated with using bentonite is how it causes and maintains high turbidity in the water. The author has spread bentonite in wetlands and has observed how the water becomes gray with suspended particles. It is likely that the turbid water is toxic to fish and aquatic animals.

Bentofix® Thermal Lock GeoSynthetic Clay Liners and Bentomat® Geosynthetic Clay Liners combine geo-textile outer layers and a core of high swelling powdered sodium bentonite clay, or high-density polyethylene (HDPE) geo-membrane with a spun-bonded geo-textile and powdered sodium bentonite clay to form a *low-permeable* barrier to water. Please note that the manufacture does not claim the material is impermeable to water, or aquatic-safe.

The bentonite liners are sold in rolls that are 17-feet 8-inches wide by 210-feet long. One roll can weigh 2,650lbs. A roll can be expected to cost $5,000.00, plus shipping. The liner is placed in a

constructed basin in strips, with overlapping edges. The material is very difficult to unload and install. The manufacture does not recommend using the material for wetlands containing water more than 12-

inches deep, due to leakage along the seams. The material is also not recommended for wetlands that may dry, such as ephemeral wetlands. The material is not labelled as Aquatic-Safe or Fish-Grade.

Tom Biebighauser performed a biological toxicity test of Bentomat® Geosynthetic Clay Liner material by filling two, 5-gallon buckets with water from a wetland (built from soils high in natural clay) on the author's farm. Green frog tadpoles (6), and dragonfly larvae (4) were placed in each bucket. The animals had been captured in the same wetland where water was removed to fill the buckets. A piece of Bentomat® Geosynthetic Clay Liner material, measuring 4 x 4-inches, was placed in one of the buckets. The buckets were placed in the shade, near the edge of the wetland.

The contents of the buckets were examined 24 and 48-hours after preparation. One-half of the green frog larvae died in the bucket containing the Bentomat® Geosynthetic Clay Liner material after 24-hours. All of the green frog larvae died in the bucket containing the liner material within 48-hours. Two of the dragonfly larvae died in the bucket containing the liner material after 24-hours, a third dragonfly larva died the next day. None of the green frog larvae or dragonfly larvae died in the bucket that did not contain liner material after 48-hours.

It should be assumed that any liner is toxic to fish and aquatic-life unless it is specifically labelled and tested to be fish grade and aquatic-safe. Tom Biebighauser has found that if a liner is fish-grade, then the liner is advertised as being fish-grade and safe for aquatic organisms. *One should assume that liners contain toxins if they are not specifically labelled as fish grade, or aquatic-safe. This information comes from the Engineers that work at liner companies.* Tom Biebighauser has observed wetlands where non-fish-grade/aquatic safe liners were used in their construction at schools. These wetlands did not support fish or aquatic life.

The author recommends that liner materials made with Bentonite not be used to build wetlands that would be used by animals. It is very possible the bentonite liner material is manufactured for landfills and industrial waste containment, and would poison amphibians and invertebrates.

Figure 16. This photo shows a roll of bentonite liner material being stored in a garage. It took 15-people to unroll the material 4-feet. The roll is lifted and moved using a long pipe, chain, and backhoe. Photo: Biebighauser.

Figure 17. A 4-inch square piece of bentonite liner material was placed in the bucket on the left (notice the dead green frog larvae floating on the surface after 24-hours). The bucket on the right does not contain the bentonite liner material. Photo: Biebighauser.

The author recommends using fish-grade and aquatic safe, one-piece, factory-seamed PVC or EPDM liners to build wetlands instead of bentonite liners for these reasons:

1. Lower unit purchase price
2. Lower shipping cost
3. One is able to move and install the liner by hand
4. Installation is faster, requires fewer pieces of heavy equipment, and no specialized attachments or long pipe
5. Lower cost installation
6. The materials are certified fish-grade and aquatic safe
7. The materials would not leak if the water is deeper than 12-inches
8. The materials would not leak if the wetland dries

13. Climate Risk Assessment

Two reports have recently assessed climate related risks for Cortes Island, *Risk Assessment Maps and Data*[67] and *Climate Change and Drought*[68]. These foundational reports provide data and knowledge that serve to inform and guide community land use planning decisions. They've detailed the increase of weather-driven natural hazards (including drought, heatwaves, change in temperature and precipitation patterns) leading to ecosystem impacts and flooding. Summer warm spells durations and hottest days are both expected to increase, as well as winter precipitation, leading to ecosystem, economic, and societal implications[69]. Wetland restoration is a nature-based solution that will serve to mitigate these climate related risks, while increasing climate adaptation and resilience.

Conradi, 2022 "*provides a baseline set of data, maps, and graphs to help guide the development of a Cortes Island Climate Action Plan (CAP)…All data included follows a high emissions scenario (RCP 8.5), which represents climate impacts under a "business as usual" scenario."*[70] (p.2)

Their analysis demonstrates that *"overall, precipitation is expected to increase in the winter months and decrease in the summer months. Increased precipitation in the winter months can contribute to flooding and storm surges. This has implications for the destruction of infrastructure and transportation lines, threatening food and housing security… Regarding environmental risks, flooding can increase the flow barrier for returning salmon, threatening both the species and the fisheries industry. Possible washout, river and stream erosion, and reduced water quality all resulting from flooding can also damage the spawning habitats of various fish species. On the other hand, decreased precipitation and resultant longer dry seasons during the summer months will contribute to an increased incidence of wildfires. Periods of drought also threaten the productivity and viability of crops, which can generate food insecurity."*[71] (p.4)

In 2022, Cortes Island experienced a level 5 drought[72]. *"According to BC's Drought and Water Scarcity Response Plan, level 5 droughts bring "adverse impacts to socio-economic or ecosystem values" which are "almost certain"*[73]*(p.16). Impacts can include the drying of shallow wells and wetlands, increased risk of wildfires and drying of streams during salmon spawning season (p.1)... The rain that follows drought brings its own problems. Long dry periods result in parched and compact soils, consequently, when the*

[67] Conradi, Sophia, "Risk Assessment Maps and Data. Cortes Climate Action Planning" (Simon Fraser University, Faculty of Health Sciences; Friends of Cortes Island Scociety, August 2022).
[68] Berman-Hatch, Forest, "FOCI Report: Climate Change and Drought" (Friends of Cortes Island Society, 2022).
[69] Conradi, Sophia, "Risk Assessment Maps and Data. Cortes Climate Action Planning."
[70] Conradi, Sophia.
[71] Conradi, Sophia.
[72] Berman-Hatch, Forest, "FOCI Report: Climate Change and Drought."
[73] Ministry of Water, Land, and Resources Stewardship, "British Columbia Drought and Water Scarcity Response Plan," 2022, https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/drought-info/drought_response_plan_final.pdf.

rain does come it can run off the surface rather than soak into the aquifers below[74,75]*. In this way, droughts increase the chances and damage of floods*[76] *(p.5)…IPCC report, which also warns that "Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all."*[77]*(p.4)… There are any number of ways our community could take action. We need to begin planning for thresholds to recommend water restrictions, how best to restore wetlands and reinforce the banks of salmon bearing streams."*[78]*(p.5)*

The Cortes Island School sports field was constructed by draining and filling a historic wetland (Section 6). Restoring wetlands at this site, will help to restore healthy watershed function and the ecosystems services that wetlands provide for climate adaptation and resilience. Wetland restoration will also serve to mitigate the impacts of flooding of the fields in the winter months, resulting in positive outcomes for the school and community use of sports infrastructure.

Wetlands are highly regarded natural infrastructure assets that are known to mitigate climate hazards such as increased rainfall, drought, erosion, flooding, freshwater availability, heatwaves, and wildfires[79, 80, 81,82].

This project will reduce risks to the Cortes Island community from natural hazards and climate-related risks and builds on the risk assessments and planning work summarized above.

[74] Wehner, M.F., J.R. Arnold, T. Knutson, K.E. Kunkel, and A.N. LeGrande, "Droughts, Floods, and Wildfires.," *Climate Science Special Report: Fourth National Climate Assessment* 1 (2017): 231-256, https://doi.org/doi: 10.7930/J0CJ8BNN.
[75] Gimbel, K. F., Puhlmann, H., and Weiler, M., "Does Drought Alter Hydrological Functions in Forest Soils?," no. 20 (2016): 1301–1017, https://doi.org/10.5194/hess-20-1301-2016.
[76] Sunder Katwala, "Responding to Change," *IPPR Progressive Review* 29, no. 1 (July 2022): 37–44, https://doi.org/10.1111/newe.12297.
[77] Intergovernmental Panel On Climate Change (Ipcc), *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1st ed. (Cambridge University Press, 2023), https://doi.org/10.1017/9781009325844.
[78] Berman-Hatch, Forest, "FOCI Report: Climate Change and Drought."
[79] Berman-Hatch, Forest, "FOCI Report: Climate Change and Drought."
[80] Dr. Musonda Mumba, "Human Wellbeing Is Irrevocably Tied to the State of the World's Wetlands," Wetlands International, February 1, 2024, https://www.wetlands.org/blog/human-wellbeing-is-irrevocably-tied-to-the-state-of-the-worlds-wetlands/.
[81] Finlayson et al., "The Second Warning to Humanity – Providing a Context for Wetland Management and Policy."
[82] Council of Canadian Academics, "Building a Resilient Canada" (The Expert Panel on Disaster Resilience in a Changing Climate, Council of Candian Academics, 2022), https://cca-reports.ca/wp-content/uploads/2022/01/Building-a-Resilient-Canada-EN-Final-for-web.pdf.

14. Technical Drawings

Author: Tom Biebighauser

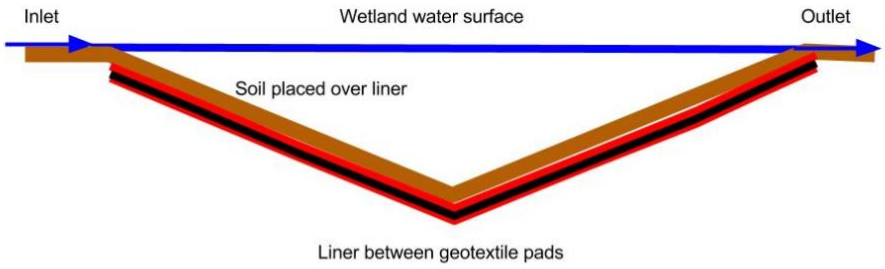

Figure 18. Typical profile view showing installation of the aquatic-safe liner and geotextile

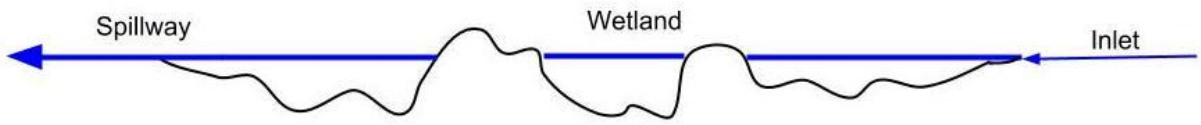

Figure 19. Typical profile view showing the finished bottom contours of the wetland to be built

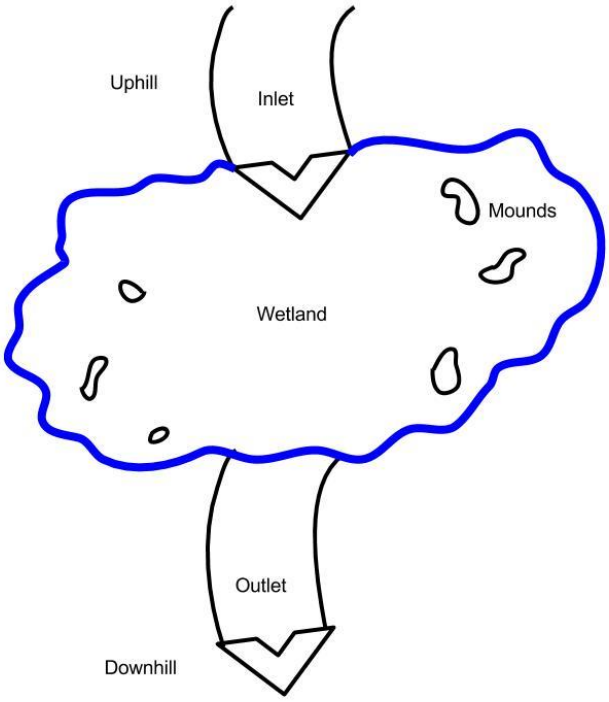

Figure 20. Typical plan view of the wetland to be built

15. Recommended Construction Steps

1. Funding secured
2. QEP-Wetland Restoration Specialist is retained to manage the project and supervise construction.
3. Needed permits and approvals are obtained in advance (*Water Sustainability Act Section 11 Changes in and About a Stream*)
4. A contractor is chosen to provide heavy equipment and rock for the project
5. A utility check is completed before digging. All buried utilities are marked on the ground prior to construction
6. A one-piece factory seamed aquatic-safe EPDM liner and 2-(16oz) geotextile pads are ordered from Western Tank and Lining Company Ltd., two or more weeks prior to construction.
7. Dates for construction are scheduled in advance with all contractors and project partners.
8. Heavy equipment is cleaned by the contractor prior to construction to avoid introducing non-native plants.
9. The perimeter of the planned shallow water wetland is marked on the ground using wire flags. Students can be involved with this step.
10. Elevation readings are taken around the planned wetland to identify the low edge of the marked perimeter, and the desired final depth in the center prior to construction. The location and elevation of the spillway is marked before construction begins.
11. Invasive species will be identified and removed or buried on site.

12. Top soil is cleared and set aside.
13. The core trench will be dug and re-packed.
14. The wetland basin and stream will be excavated, and soils will be rough and loose to benefit plant establishment.
15. For liner installation a group of 20 or more would be available to assist with raking, shovelling, placing, anchoring, trimming, and covering the aquatic-safe liner and geotextile pads. Each person would have a rake or shovel to use. Fire rakes work well to prepare a site for a liner. Pruning shears may be used to cut roots. FOCI is willing to help organize a training workshop where volunteers would help install the liner and geotextile pads.
16. The basin is dug deepest in the center, in relation to the lowest edge of the marked perimeter. The basin is dug approximately 20cm deeper than the planned final depth of the wetland to allow for soil being placed over the liner and geotextile pads. A one-piece factory seamed geotextile pad (same size as the liner) is placed in the basin. A one-piece factory seamed aquatic-safe/fish-grade liner is placed over the geotextile. Another layer of geotextile is placed over the liner. The three layers are anchored along the top edge using 3 or 4lb sledge hammers and 12-inch long landscape spikes with washers. The corners of the liners and geotextile pads are trimmed using utility knives with 18mm break-off blades. The excess fabric is removed and disposed of at a landfill.
17. The liner and geotextile pads are covered with approximately 20cm of soil. Soil onsite is used for this purpose. No heavy equipment is allowed on the liner and geotextile pads.
18. No dams would be built.
19. No bentonite or bentonite liners would be used.
20. The wetland would be shaped to appear natural, with no straight lines or steep slopes. The wetland would contain hummocks, mounds, gradual slopes, peninsulas, and woody debris.
21. A wide spillway would be created over gradual slopes to prevent erosion. It should not be necessary to place rock on the spillway.
22. Rock is used to armour slopes where water enters and exits the wetland from ditches to control erosion.
23. Compacted soils surrounding the new wetland are loosened using the rough and loosen technique. This is done to provide ideal conditions for wildflower, tree, and shrub growth, and to control erosion.
24.Coarse woody debris (CWD) is applied to the surface and in the wetland for habitat.
25. Exposed soils are seeded to native graminoids, grasses, and wildflowers, and seeded with a non-persistent annual cover crop (winter rye), and then mulched using straw to control erosion.
26. A diversity of native plants may be established in and around the wetland for pollinators.
27. Plants that are attractive to deer will be fenced to prevent browsing.
28. The wetland will be monitored by students for invasive species and signs of erosion.
29. Invasive species will be removed by students, community volunteers, and contractors.
30. If erosion is observed, a Wetland Restoration Specialist will be retained and action taken to repair the erosion and prevent further erosion will be taken.

16. Estimated Budget

The budget is available by contacting Rewilding Water and Earth Inc.

17. Project Risk Assessment

The greatest risk for this project is the potential to impact existing infrastructure in the school fields. This risk will be managed, and avoided, with the use of GIS technology to georeference the available as-built plans for septic and drainage in the fields, which has been done with the current design plan (Figure 7; Appendix 22.2). The wetland restoration plan was designed to avoid existing infrastructure, and so this risk is considered minimal. Contingency is built into the budget for materials and time to repair potentially damaged drain lines. Necessary equipment will be on site during construction to conduct any potential repairs. The septic field and lines will not be impacted, as it is located out of the project area and access routes.

Another potential risk for this project, is the ongoing project maintenance post construction in the establishment phase. This will be managed through partnerships with community groups such as Friends of Cortes Island, BC Wildlife Federation, and Klahoose First Nation. As the project is shovel ready, funding awarded may be used in year-1 to construct the project, with year-2 funding supporting monitoring, maintenance and adaptive management. Community partners can support with volunteer work-parties, local labour, and fundraising to support the project in the establishment phase.

18. Wetland Appearance

18.1 Quadra Elementary School Wetland, design/build by Miranda Cross, Rewilding Water and Earth Inc.

Figure 21. Quadra Elementary School wetland in the fall post-construction. November 9, 2022.

Figure 22. Coarse Woody Debris (CWD)s is placed in and around the restores wetlands for habitat structural complexity. November 22, 2022.

Figure 23. Students use the CDW for adventure play, exploring the shallow water wetland during the wetland celebration event. June 12, 2023.

18.2 Wetland examples, Robin Annschild

Photos of wetland restored by Robin Annschild can be viewed at: https://www.linkedin.com/in/robin-annschild-9b040890/?originalSubdomain=ca

18.3 Wetland examples, Tom Biebighauser

Additional information and photo albums showing wetlands built by Tom Biebighauser may be viewed by visiting:

https://wetlandrestorationandtraining.com/about/

These photos show some of the wetlands Tom Biebighauser has helped build at schools across North America:

Figure 24. This wetland was built to clean water from the roof of St. Francis Catholic School, Pikeville, Kentucky

Figure 25. This emergent wetland was built at McBrayer Elementary School in Morehead, Kentucky.

Figure 26. This emergent wetland was built to clean runoff from a soccer field at the Rowan County High School in Morehead, Kentucky

Figure 27. Wetland built to clean water from a football field at the Rowan County High School in Kentucky

Figure 28. Wetland built to clean water from a soccer field at the Rowan County High School in Kentucky

Figure 29. This ephemeral wetland cleans runoff from a farm field near Slade, Kentucky

Figure 30. Emergent wetland built in a stormwater basin at Glen Marshall Middle School, Richmond, Kentucky

Figure 31. Wetland built at the SK" ELEP School of Excellence in Kamloops, British Columbia

Figure 32. Forested & shrub wetland at the East Carter County Middle School, Grayson, Kentucky

Figure 33. Wet-meadow wetlands, ephemeral wetland, and restored stream at the Rowan County Middle School, Morehead, Kentucky

Figure 34. One of the wet-meadow wetlands and ephemeral wetlands at the Rowan County Middle School, Morehead, Kentucky

Figure 35.Wet-meadow wetland that cleans water from a parking lot at Rodburn Elementary School, Morehead, Kentucky. Photo taken before rain.

Figure 36.Wet-meadow wetland that cleans water from a parking lot at Rodburn Elementary School, Morehead, Kentucky. Photo taken after rain.

Figure 37.This emergent wetland was added to a stormwater basin at the Rowan County Middle School in Morehead, Kentucky. The compacted soils surrounding the new wetland were loosened as part of the project

Figure 38.These picnic tables were placed overlooking a restored stream and wetlands at the Rowan County Middle School in Morehead, Kentucky

Figure 39. This shelter was built near restored wetlands at McBrayer Elementary School near Morehead, Kentucky

19. Mosquitoes (Author Thomas Biebighauser)

The wetland to be established can be expected to lower mosquito populations in the community where it is located. The dragonfly larvae, damselfly larvae, water boatman, water striders, frogs, toads, and salamanders living in the wetland can be expected to control mosquitoes in as little as one year. Swallows, bats, and adult dragonflies flying near the wetland would consume adult mosquitoes. The wetland can be expected to become population “sinks” for mosquitoes.

Figure 40. Salamander larvae can be expected to control mosquitoes in the restored wetland. Photo: Biebighauser.

Figure 41. Dragonfly larvae living in the restored wetland can be expected to control mosquito larvae. Photo: Biebighauser.

20. About the Authors

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Miranda Cross is a Wetland Restoration Specialist and Registered Professional Biologist living on Cortes Island BC. Miranda graduated from University of Victoria with a Bachelor of Science, double major in Biology and Environmental Studies. She also earned a diploma in Organic Land Care from the Gaia College, as well as two Permaculture Design Certificates. Miranda operated an ecological landscape design and consultation business for 10 years on the West Coast, prior to joining the team at Rewilding Water & Earth Inc. (RWE) in 2021. Bringing skills and experience from her diverse background Miranda specializes in wetland & stream restoration including: site assessment & restoration design, permitting, project management, construction supervision, environmental monitoring, effectiveness monitoring & adaptive management, and reporting.

Miranda is an apprentice of Tom Biebighauser (Wetland Restoration and Training LLC.) and Robin Annschild (Rewilding Water and Earth Inc.) since February 2019. Tom and Robin are Wetland Restoration Specialists working to restore wetlands across BC and beyond. Since the start of her apprenticeship in 2019 she has joined both Tom and Robin on projects across BC to learn the restoration techniques developed by Tom Biebighauser. Miranda has worked with Tom and Robin to restore wetlands and streams on more than 34 project sites in BC. Miranda was a participant in the BC Wildlife Federation's Wetlands Institute of 2019 and 2020 where she was able to gain valuable knowledge from various experts and other participants.

Robin Annschild, B.Sc.

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Robin Annschild has directed the construction of 420 wetlands, restored on 41 sites across British Columbia and completed 11 stream restoration projects in the East & West Kootenay, the Cowichan Valley and the Gulf Islands.

Since 2014, Robin has completed over 1560 hours of wetland restoration field training with Tom Biebighauser and assisted Tom with the construction of 103 wetlands in BC, California, Arizona & South Carolina.

Robin uses low-cost, low-maintenance restoration techniques developed by Tom Biebighauser to design and build groundwater and surface-water supplied wetlands using core trenches, compacted clay liners

or aquatic-safe synthetic liners.

Robin developed project management and program planning skills in her former role as conservation director for the Salt Spring Island Conservancy.

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Tom Biebighauser is a Wildlife Biologist and Wetland Ecologist who has restored over 2,200 wetlands and streams and designed over 6,000 projects across Alberta, British Columbia, Ontario, in 25-States, New Zealand, Puerto Rico, and Taiwan since 1979. He retired in 2013 after working 34-years for the USDA Forest Service as a Wildlife Biologist, where he initiated wetland and stream restoration programs on National Forest lands across the United States. Tom has served as an instructor for the British Columbia Wildlife Federation Wetlands Institute for 16-years, and has restored over 200-wetlands across British Columbia since 2003. Having designed and built over 1,400-dams, and has since decommissioned over 300 -dams. He has studied drainage and irrigation for 36-years, learning from contractors who spent their lives destroying wetlands. Tom has developed highly effective and low-cost techniques for building wetlands and stream for rare species across North America. The wetlands he restores require little, if any maintenance, and do not involve the use of diversions, dams, dikes, pipes, or pumps. He teaches practical, hands-on workshops where participants learn how to restore wetlands by becoming involved in the design and construction of naturally appearing and functioning wetlands. Tom has written 4-books about wetland restoration, and instructs online college and field courses on the topic. He received the United States National Wetlands Award for Conservation and Restoration in 2015.

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22. Appendices

22.1 Letter of Support Klahoose First Nation

Klahoose FIRST NATION

Shaun Koopman M.A.
Manager, Emergency Services
Strathcona Regional District
990 Cedar St. Campbell River, BC V9W 7Z8
T: 250-830-6702
E: skoopman@srd.ca

Michael Datura, Principal
Cortes Island School
Email: michael.datura@sd72.bc.ca
Phone: (250) 935-6313
Address: 950 Beasley Rd, Mansons Landing, BC V0P 1K0

Cortes Island School Wetland Restoration Project

April 9, 2024

To Union of BC Municipalities,

Klahoose First Nation is pleased to offer our support to Cortes Island School on this important project of Wetland Restoration at the Cortes Island School site, located at 950 Beasley Rd, Mansons Landing, BC.

info@klahoose.org | (250) 935-6536 | Squirrel Cove, V0P 1T0 | Klahoose.org

Klahoose
FIRST NATION

We recognize the need for this type of community stewardship initiative; to provide a foundational educational opportunity to our youth and community members in the Mansons Landing region of Cortes Island.

This immersive educational experience will contribute to the growth of conscientious and sustainable knowledge within these diversified coastal communities and providing this knowledge to youth is essential. Sharing this vital knowledge with youth is important to Klahoose First Nation, as we recognize that the youth of today are the leaders of tomorrow, and we are proud to share community support of the Cortes Island School with the Wetland Restoration Project.

This project creates engagement opportunities for the Klahoose Community in regards to Cultural Consultation and our Land Guardian program. This project is designed to enhance habitat for wildlife, mitigate impacts from climate related natural disasters such as flooding, drought, and extreme heat, and provide traditional ecological and cultural learning opportunities for youth and community members.

We thank you for your consideration in funding this important project.

Respectfully

Brian Johnson
Chief Administrative Officer
Klahoose First Nation

info@klahoose.org | (250) 935-6536 | Squirrel Cove, V0P 1T0 | Klahoose.org

22.2 Cortes Island School Site Plans, Provided by School District 72

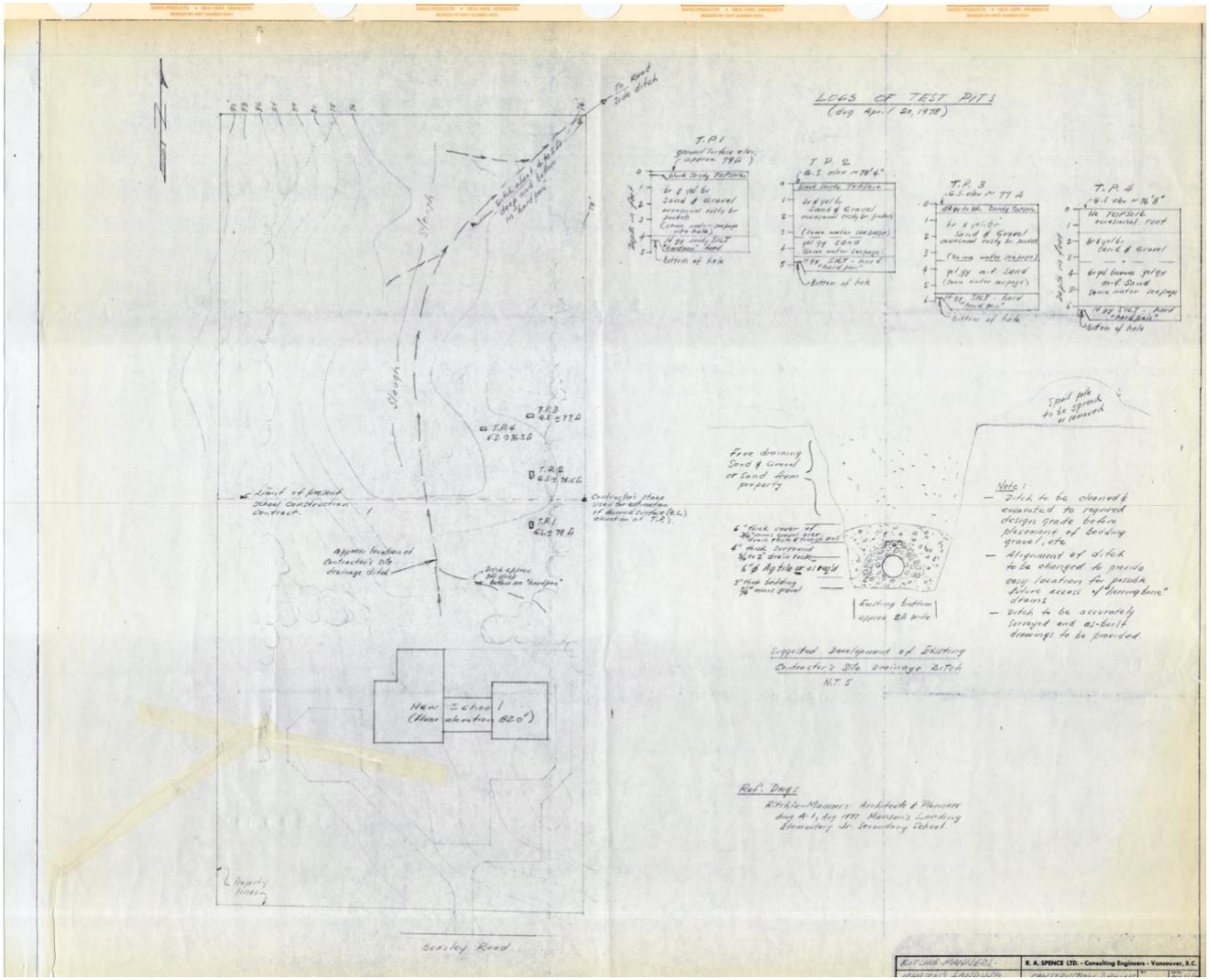


Figure 42. Log of test pits and documentation of historic slough where the sports fields are today, 1978.

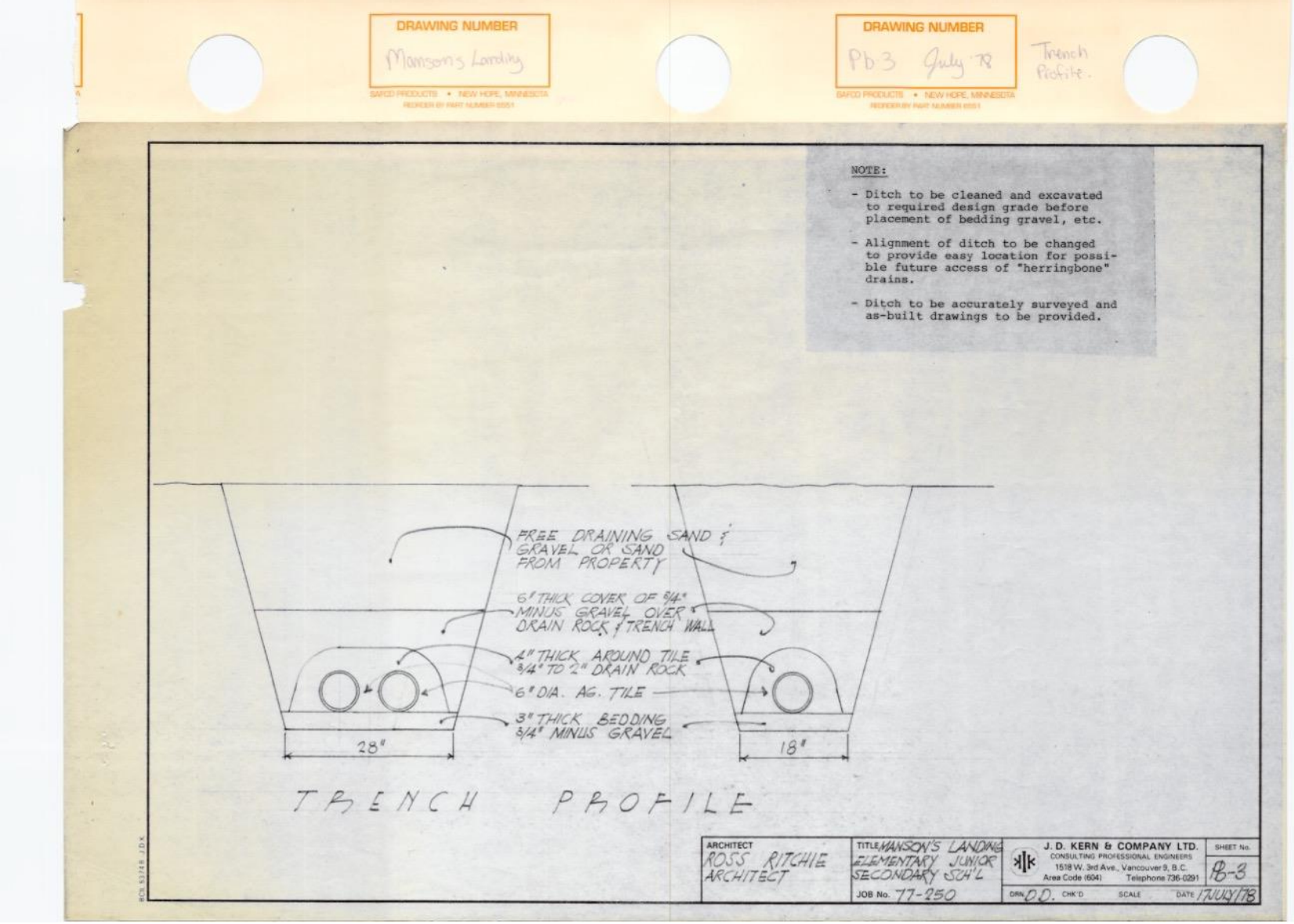


Figure 43. Trench profile

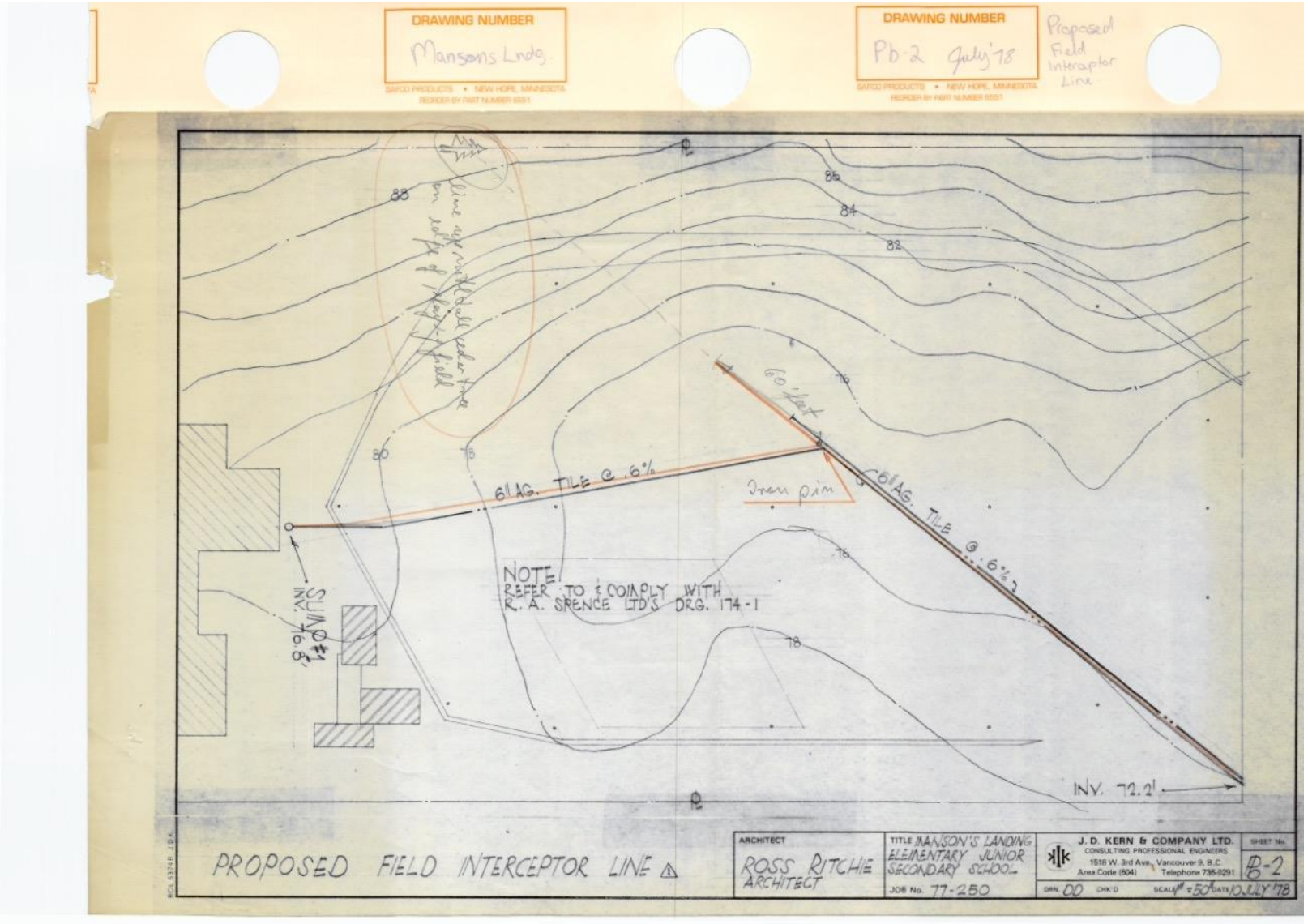


Figure 44. proposed field interceptor line. Ross Ritchie Architect. 1978.

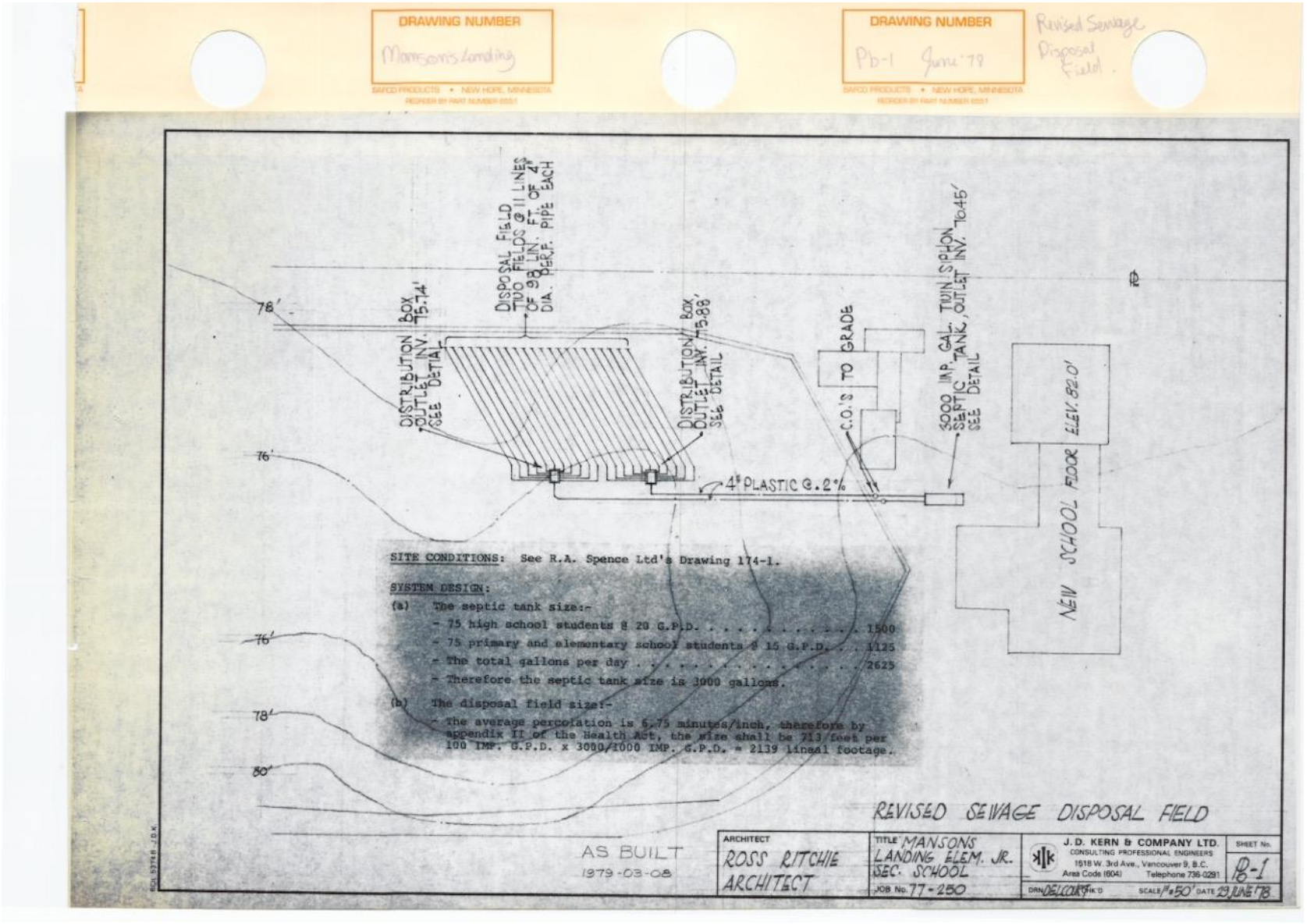


Figure 45. As-built sewage disposal field, 1979

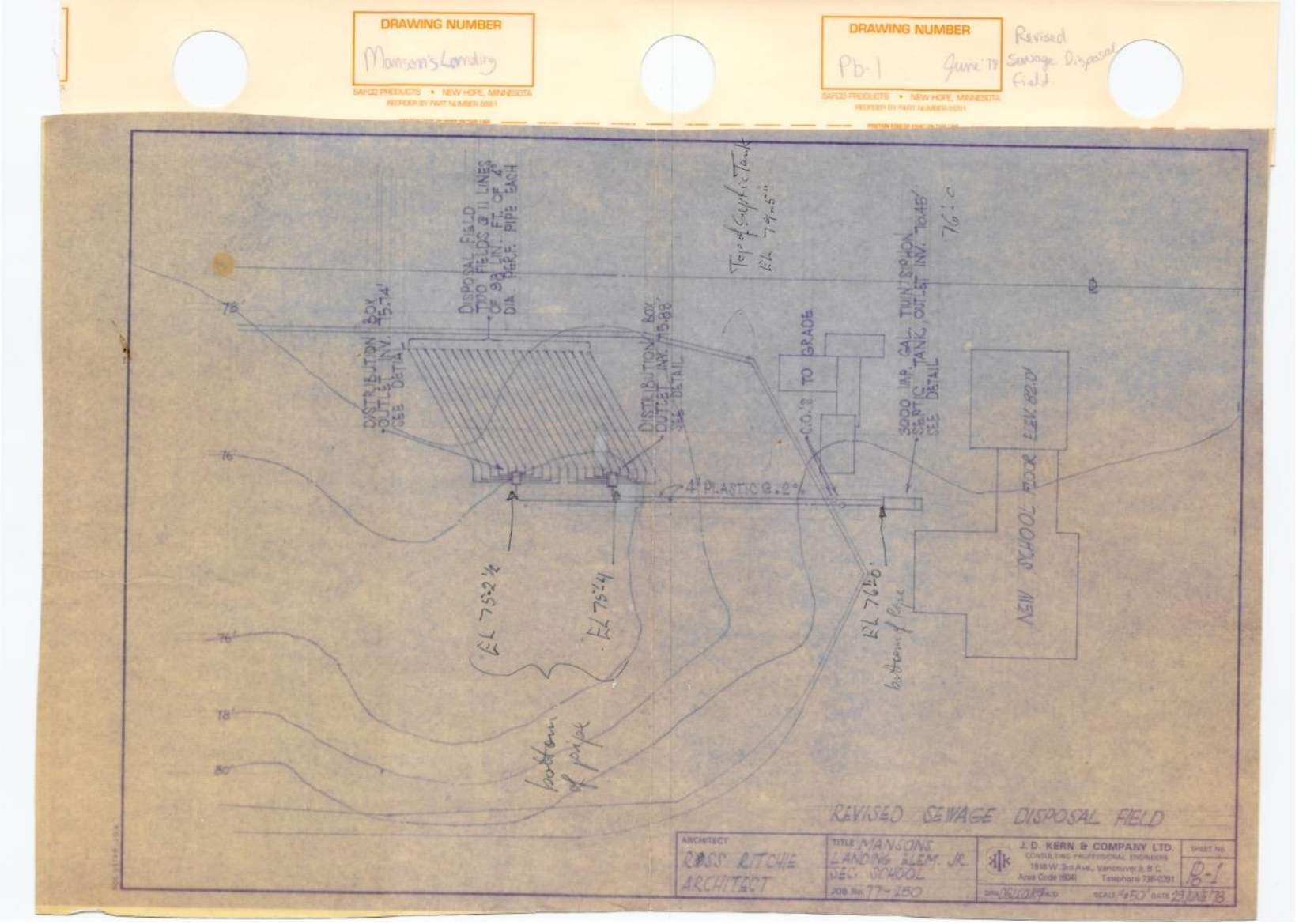


Figure 46. Revised sewage disposal field plan

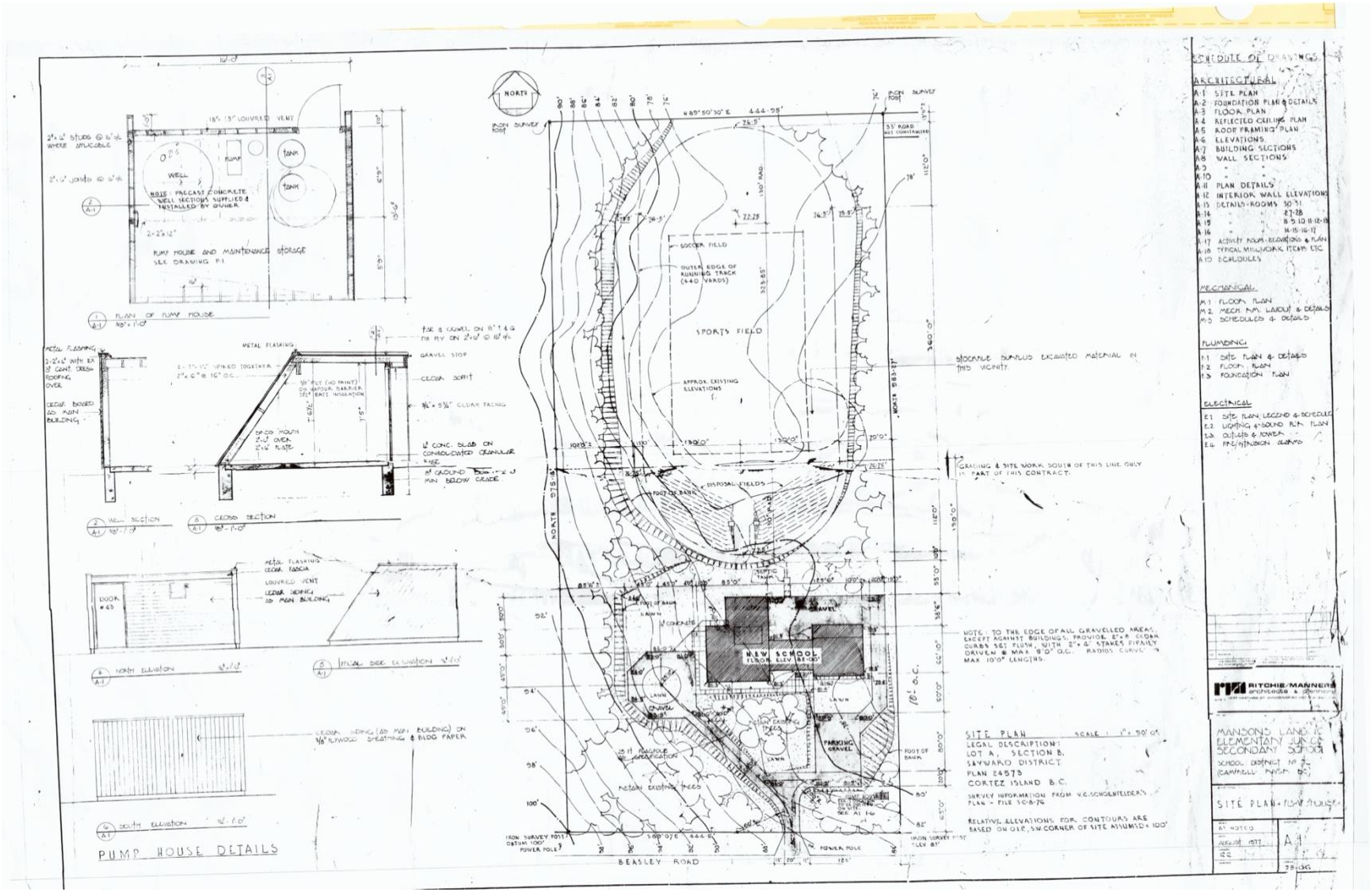


Figure 47. Site plan 1977

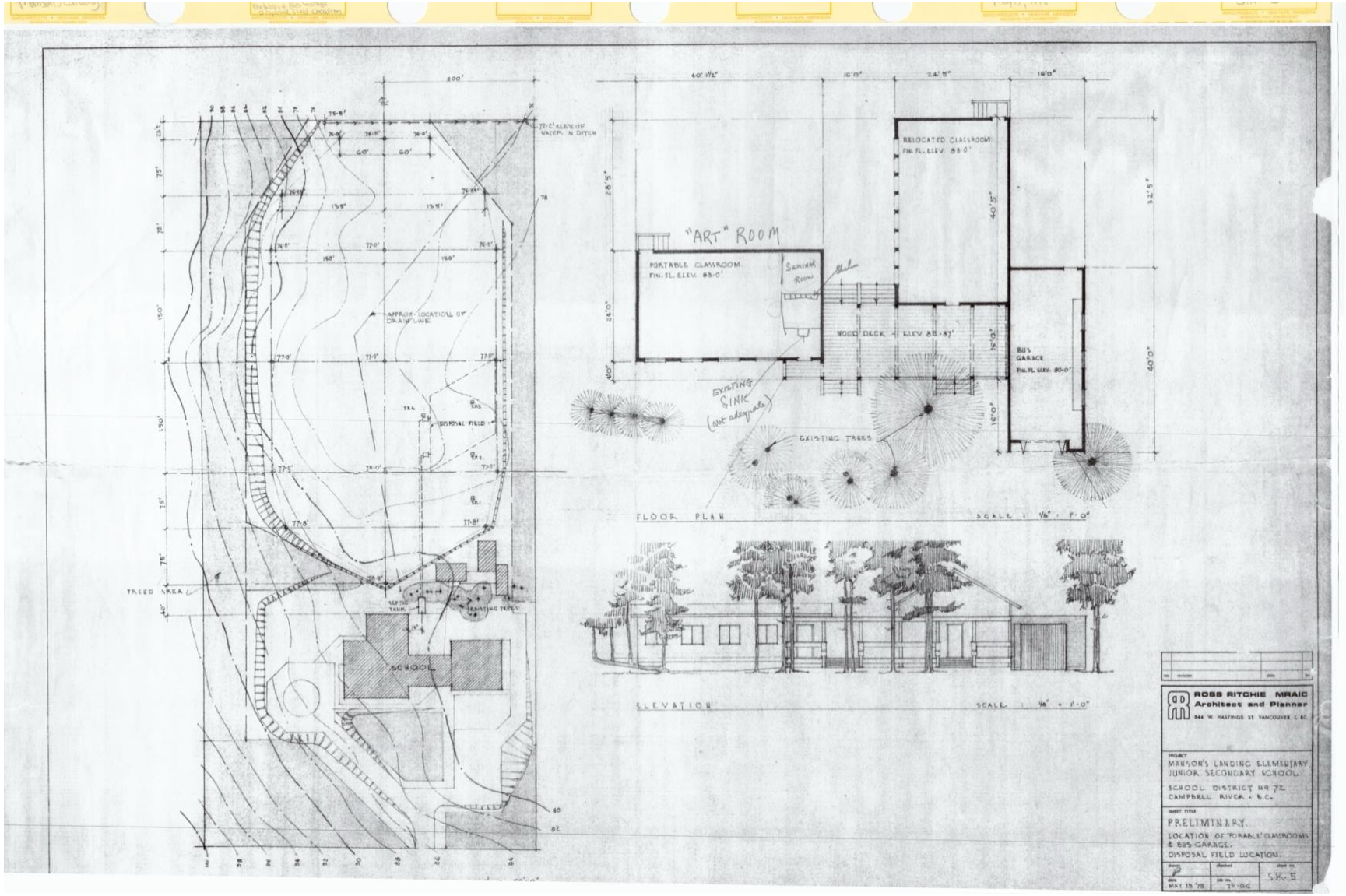


Figure 48. Preliminary site plans, 1978

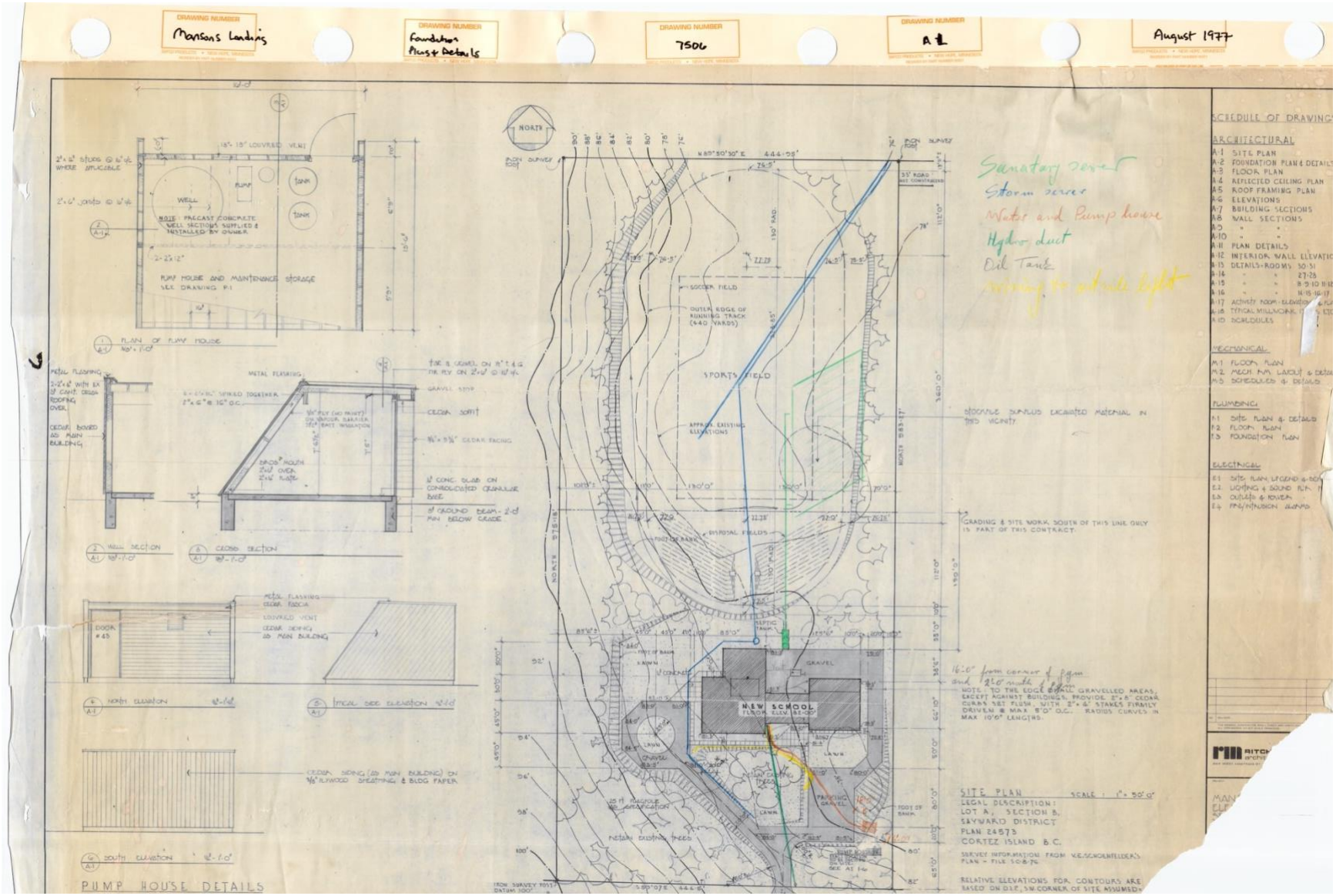


Figure 49. Site plan showing as-built.

22.3 Building wetlands using Aquatic-Safe Liners: step by step

Getting ready for your synthetic liner project:

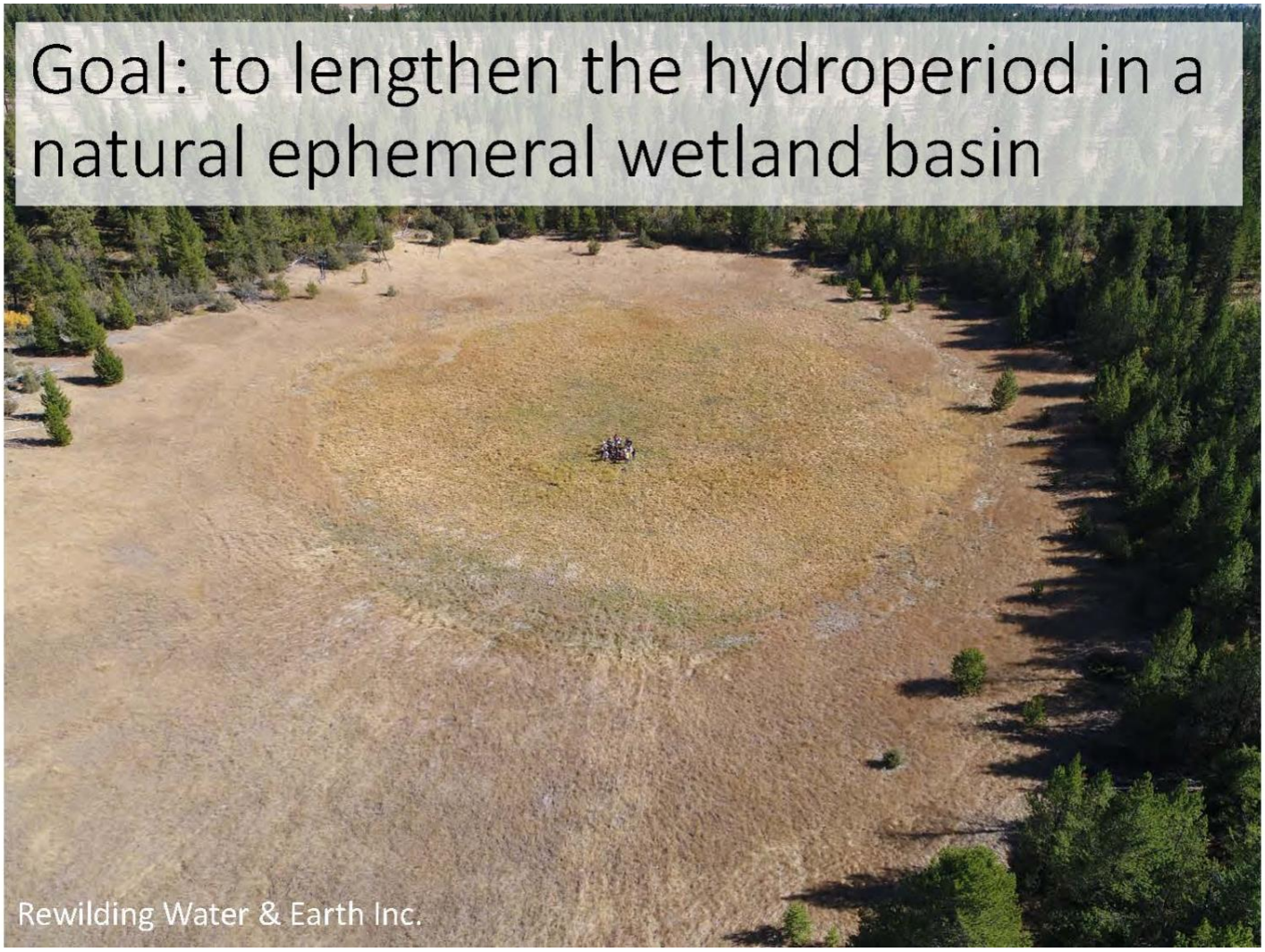
This series of photographs shows each step in building a wetland with an aquatic-safe synthetic liner. The purpose of these photos is to help you visualize what's involved, and help you prepare for the liner installation.

While we typically like to keep the excavator productive at all times, a synthetic liner installation is one instance where there will be some down time for the excavator. When multiple liners are being installed at one site, we will work to keep the excavator busy digging the next basin while we are installing the liner in the first one, and to concentrate the volunteer muscle needs in 1 or 2 days if possible.

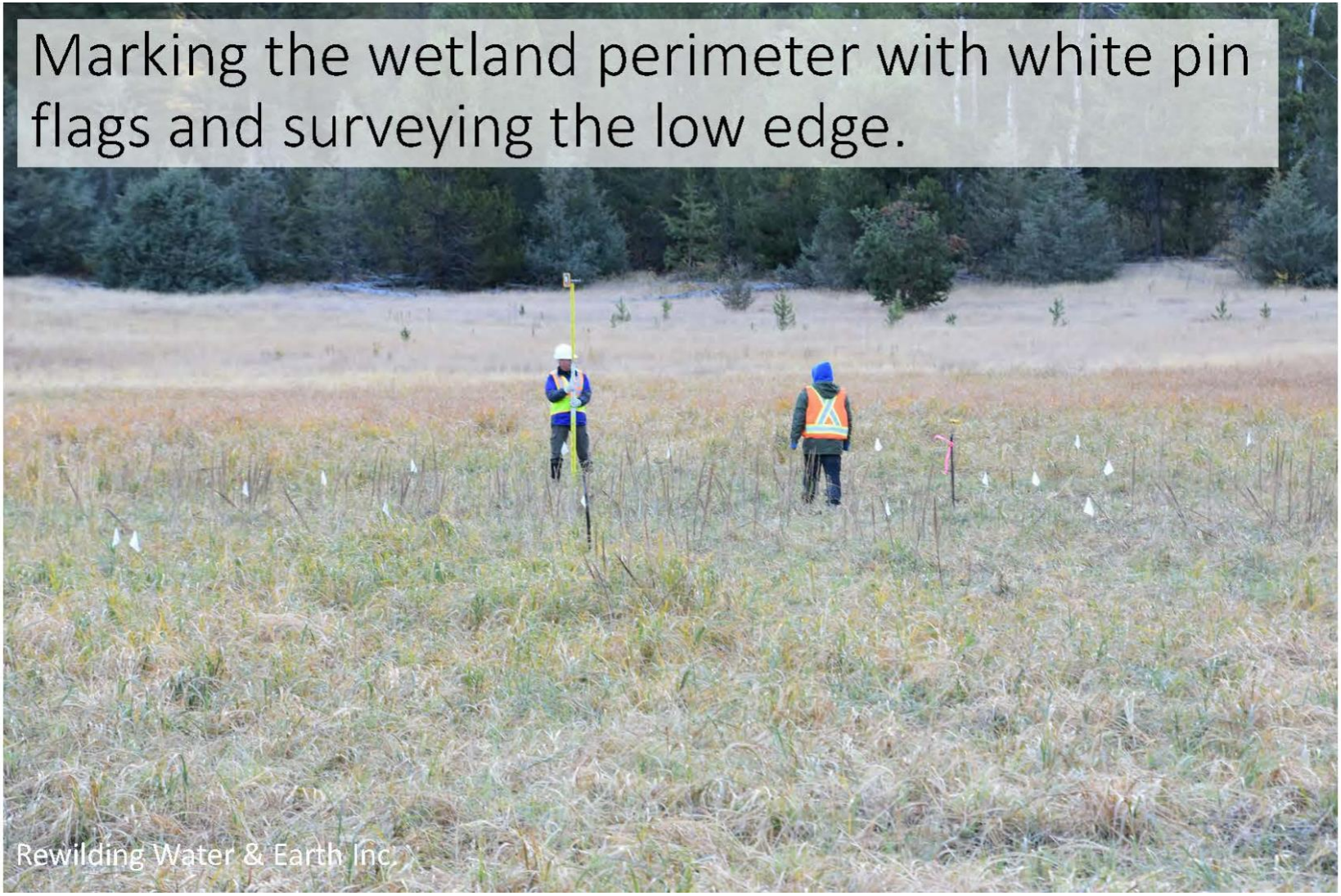
Once you've reviewed these images, please contact Rewilding Water & Earth with any questions.

Rewilding Water & Earth Inc.

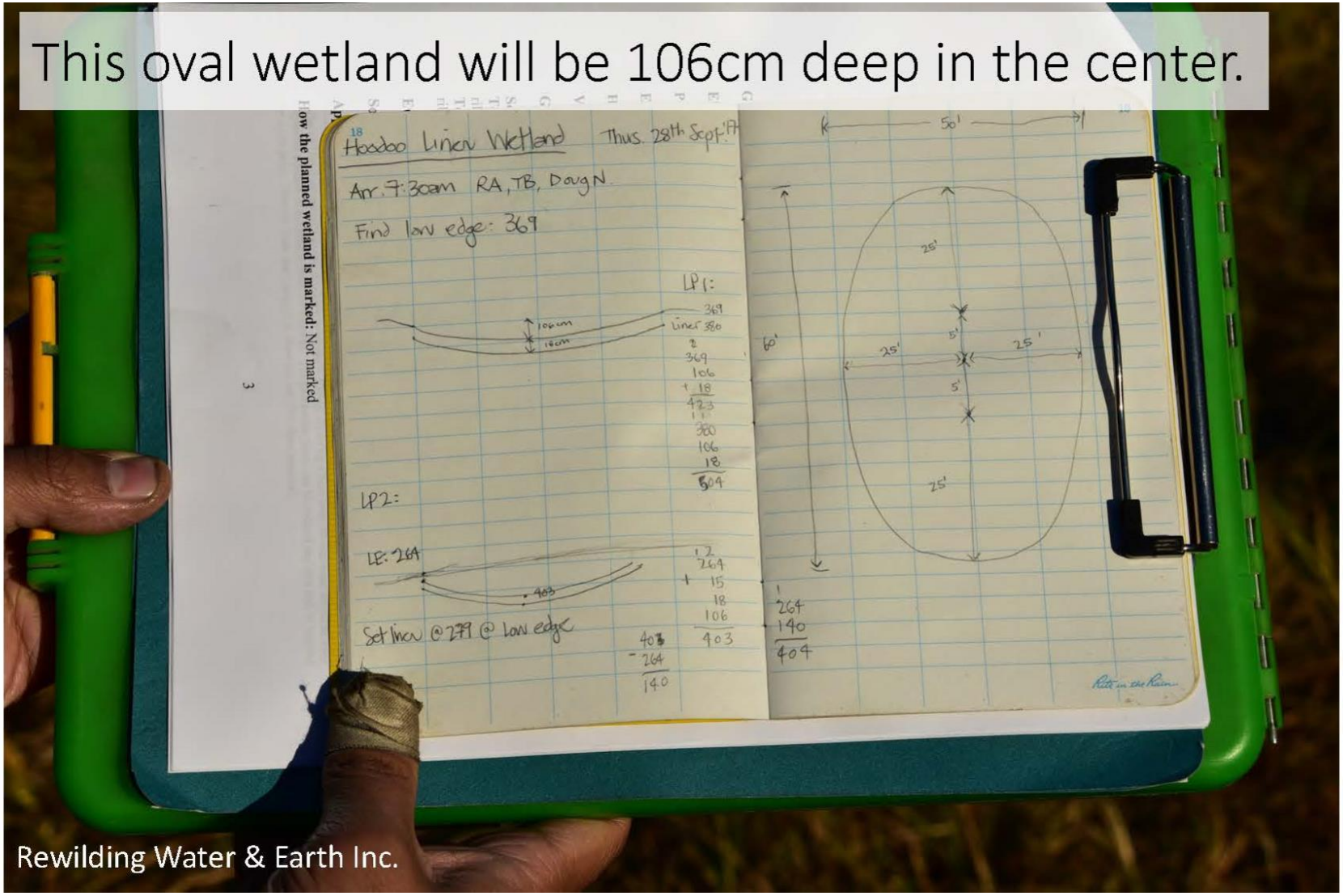

Hoodoos Conservation Lands, Nature Trust of BC, Fairmont Hot Springs
Rewilding Water & Earth Inc.


Goal: to lengthen the hydroperiod in a natural ephemeral wetland basin
Rewilding Water & Earth Inc.


Volunteer workforce: 20 participants in the BC Wildlife Federation 2017 Wetlands Institute
Rewilding Water & Earth Inc.


Marking the wetland perimeter with white pin flags and surveying the low edge.
Rewilding Water & Earth Inc.


Removing topsoil and saving it to cover the liner.
Surveying the elevation of the center of the wetland to determine how much soil to remove.
Rewilding Water & Earth Inc.


This oval wetland will be 106cm deep in the center.
How the planned wetland is marked: Not marked
Hoodoo Linen Wetland
Thurs. 28th Sept.
Arr. 7:30am RA, TB, Doug N.
Find low edge: 369
LP1:
LP2:
LE: 264
Set liner @ 279 @ low edge
50'
25'
60'
Rewilding Water & Earth Inc.


Shaping the wetland basin, taking care to make the rim level.
Rewilding Water & Earth Inc.


Digging the wetland basin. White flags show where the edge of the liner will be.
Rewilding Water & Earth Inc.


Removing the last of the soil.
Rewilding Water & Earth Inc.


Transporting the liner & geotextile for a 50’ x 60’ liner to the site (combined weight of 1,530 lbs).
Rewilding Water & Earth Inc.


Unloading the geotextile (660lbs in 2 layers) from the trailer.
CAT
330B
Rewilding Water & Earth Inc.

The liner is EPDM, made by Firestone.


Unloading the 870lb liner.
Rewilding Water & Earth Inc.

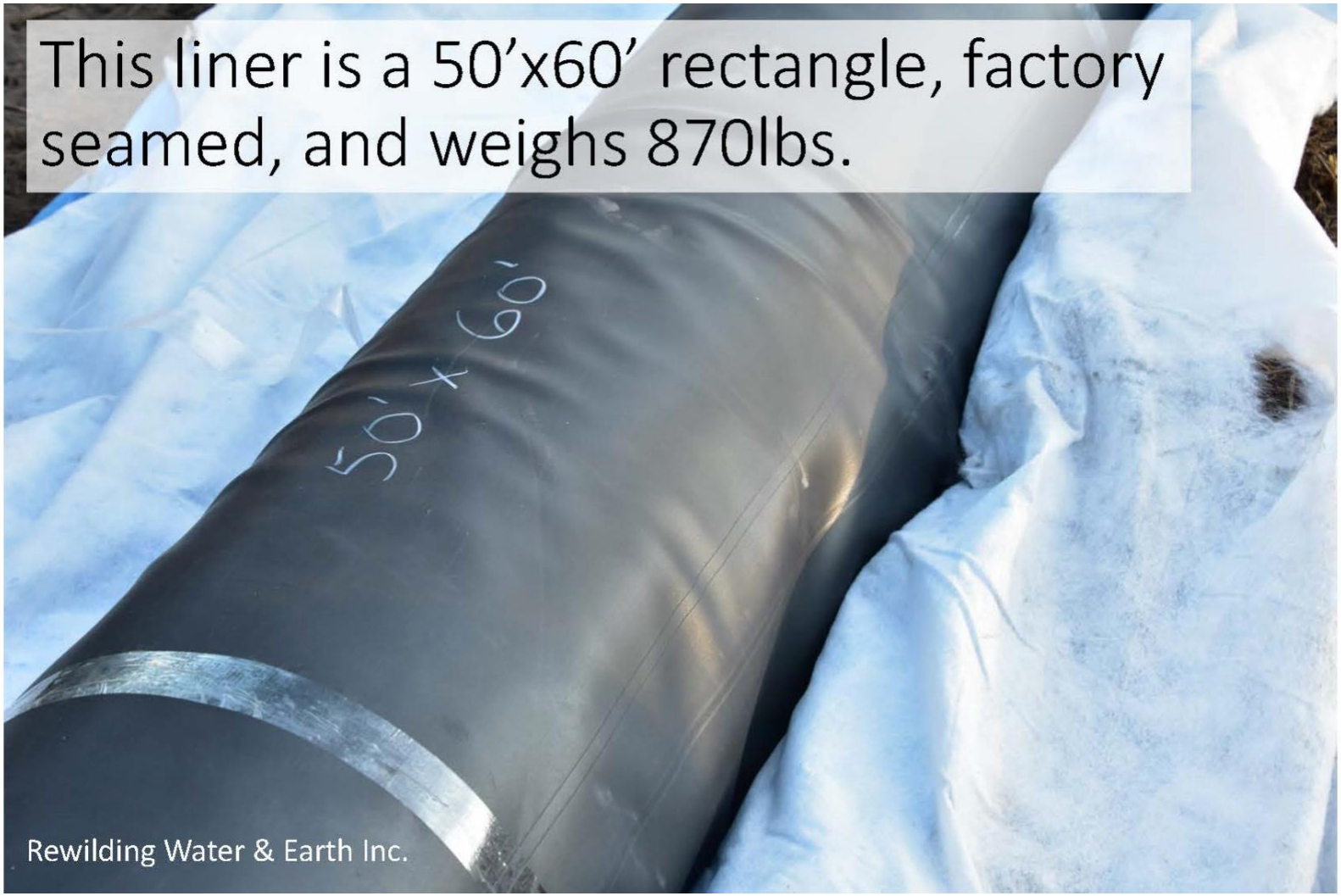

Placing the geotextile on the edge of the wetland basin.
CAT
Rewilding Water & Earth Inc


Tossing sharp rock and cobble into the excavator bucket to prevent the liner being punctured.
Rewilding Water & Earth Inc.


The wetland basin has been raked and sharp rocks removed. It's ready for the liner.
Rewilding Water & Earth Inc.


Lifting the liner into position on the edge of the basin. It's best to use straps to prevent damage to the liner.
CAT
Rewilding Water & Earth Inc.

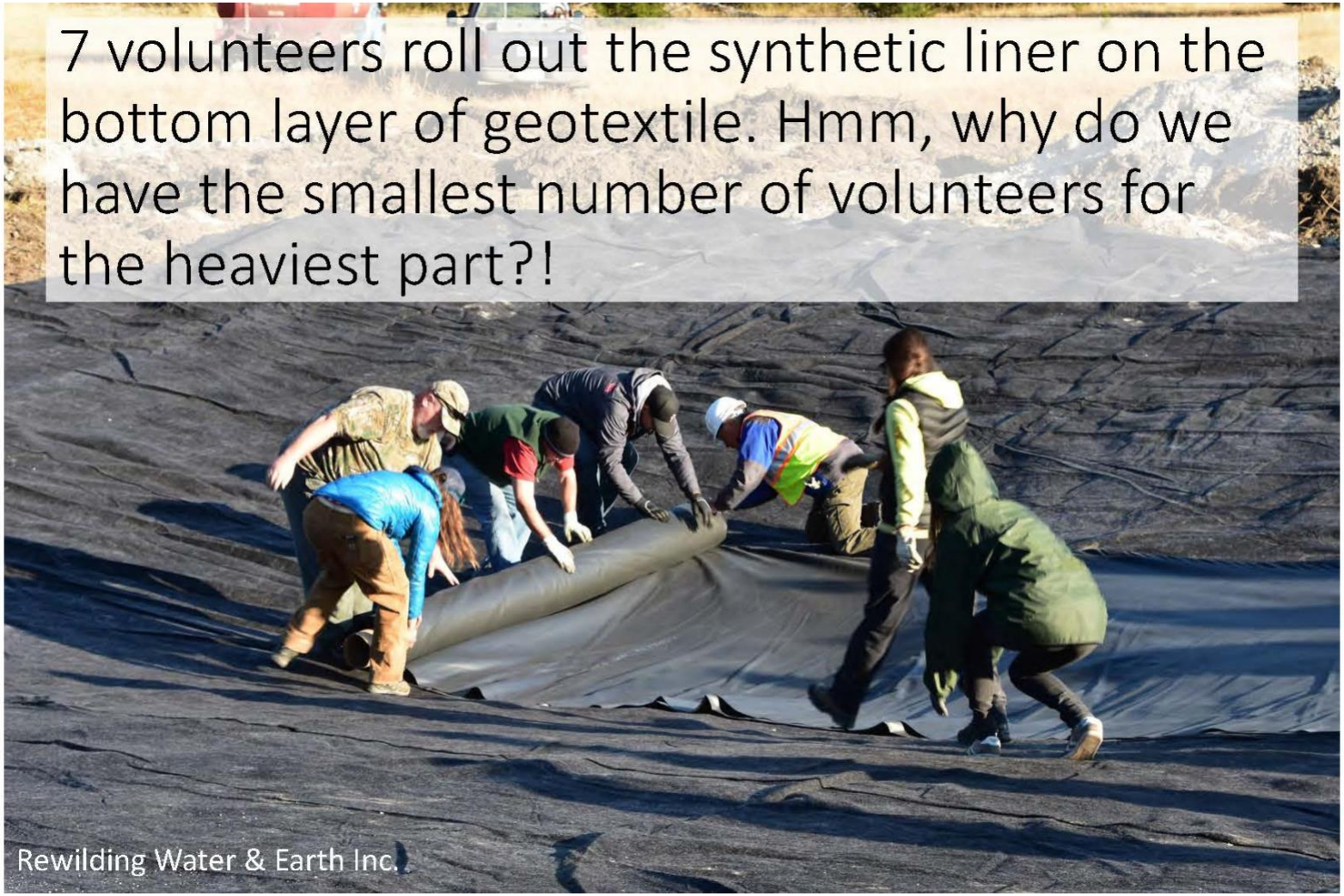

The liner is wrapped in protective packaging.
Rewilding Water & Earth Inc.


This liner is a 50’x60’ rectangle, factory seamed, and weighs 870lbs.
50' x 60'
Rewilding Water & Earth Inc.


14 volunteers spread the bottom geotextile layer in the basin. This layer weighs 330 lbs.
Rewilding Water & Earth Inc.


17 volunteers ensure the geotextile covers the pin flags marking the wetland edge on all sides.
Rewilding Water & Earth Inc.


Rewilding Water & Earth Inc.
Volunteers of all ages, sizes and ability can work together to restore wetlands.


7 volunteers roll out the synthetic liner on the bottom layer of geotextile. Hmm, why do we have the smallest number of volunteers for the heaviest part?!
Rewilding Water & Earth Inc.


Unfolding the liner into position on the geotextile layer.
Rewilding Water & Earth Inc.


Adjusting the liner over the geotextile.
Rewilding Water & Earth Inc.


Placing the top layer of geotextile (330lbs) over the liner.
Rewilding Water & Earth Inc.


Oops! I was called away from my photographic duties, and missed a few key steps in the construction of the Hoodoo wetland…
For the next few steps, let me take you to Snk'Mip Marsh at the north end of Slocan Lake where a small and very well-muscled team of 8 volunteers is installing a 30'x50' liner in a forested site in 2021…
Rewilding Water & Earth Inc.


Rewilding Water & Earth Inc.
After placing the second layer of geotextile over the liner, here they are showing off their muscles!


Rewilding Water & Earth Inc.
Fixing the 3 layers in place with 12” long, 3/8 inch diameter spiral or smooth spikes so the layers don’t move when being covered in soil.

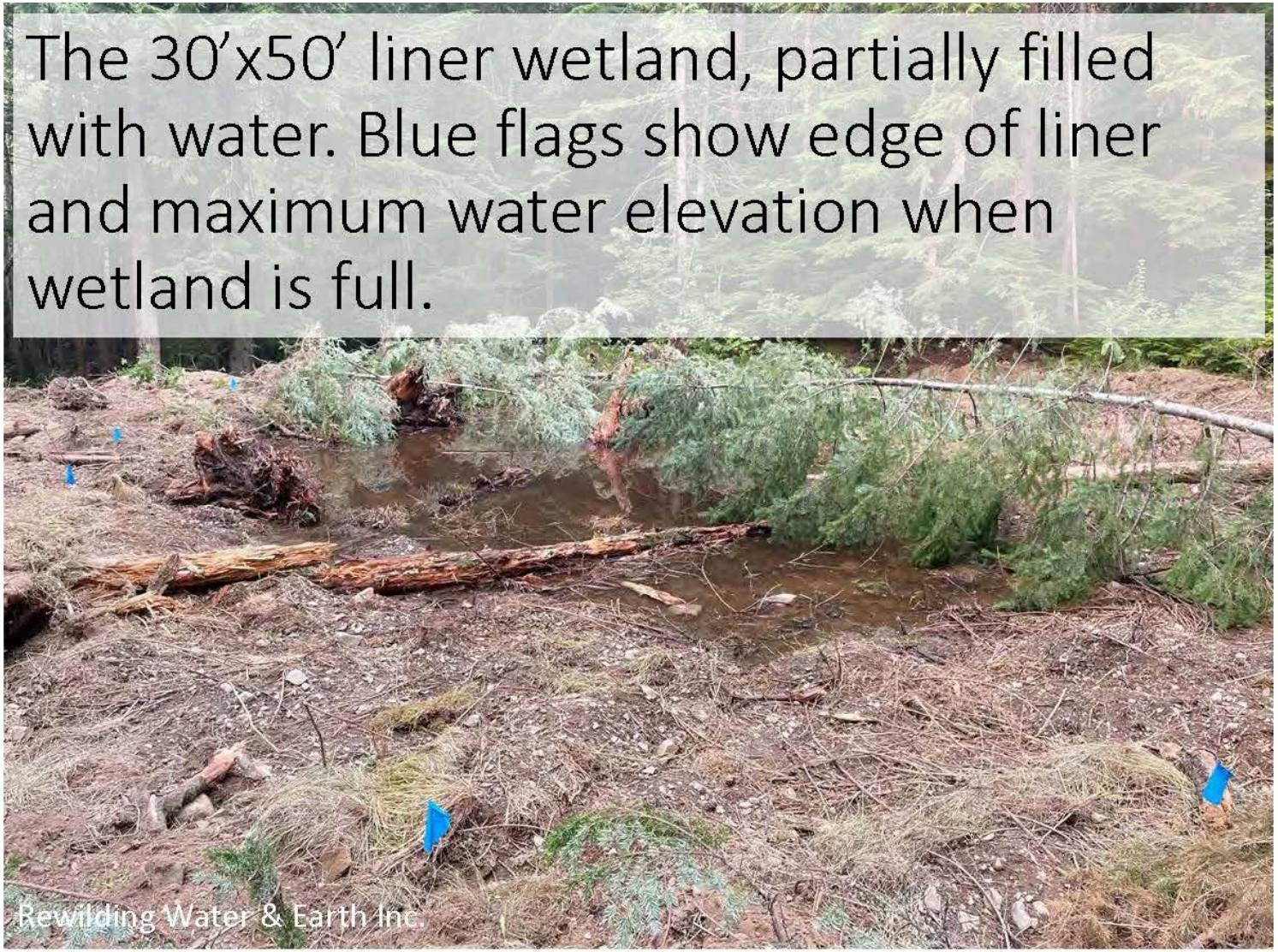

Rewilding Water & Earth Inc.
Trimming the corners to make an oval (or a circle, for 40’ to 60’ diameter round liners).


The liner is cut to shape and the edges are marked with pin flags. It is ready to be covered with soil.
Rewilding Water & Earth Inc.


Rewilding Water & Earth Inc.
Adding 15cm of soil to protect the liner from UV light and allow plants to grow. To avoid damage to the liner and geotextile, the excavator must not travel over them.


Rewilding Water & Earth Inc.
The excavator travelled ¾ of the way around the liner to cover it.


Rewilding Water & Earth Inc.
Woody debris added...blue flags mark liner edge so the operator can avoid traveling over the liner with the excavator.


The 30’x50’ liner wetland, partially filled with water. Blue flags show edge of liner and maximum water elevation when wetland is full.
Rewilding Water & Earth Inc.


The site before we started: it had been cleared of trees and topsoil and graded flat for a building site, but was never used.
Rewilding Water & Earth Inc.


Let’s go back to the Hoodoos in 2017, where the liner is now covered with soil…
Rewilding Water & Earth Inc.


Spreading soil excavated from the wetland on higher ground.
Rewilding Water & Earth, Inc.


Large woody debris has been added to the wetland basin that will be allowed to fill naturally from rain and snowmelt.
Rewilding Water & Earth Inc.


Spreading seed on the disturbed soil.
Rewilding Water & Earth Inc.

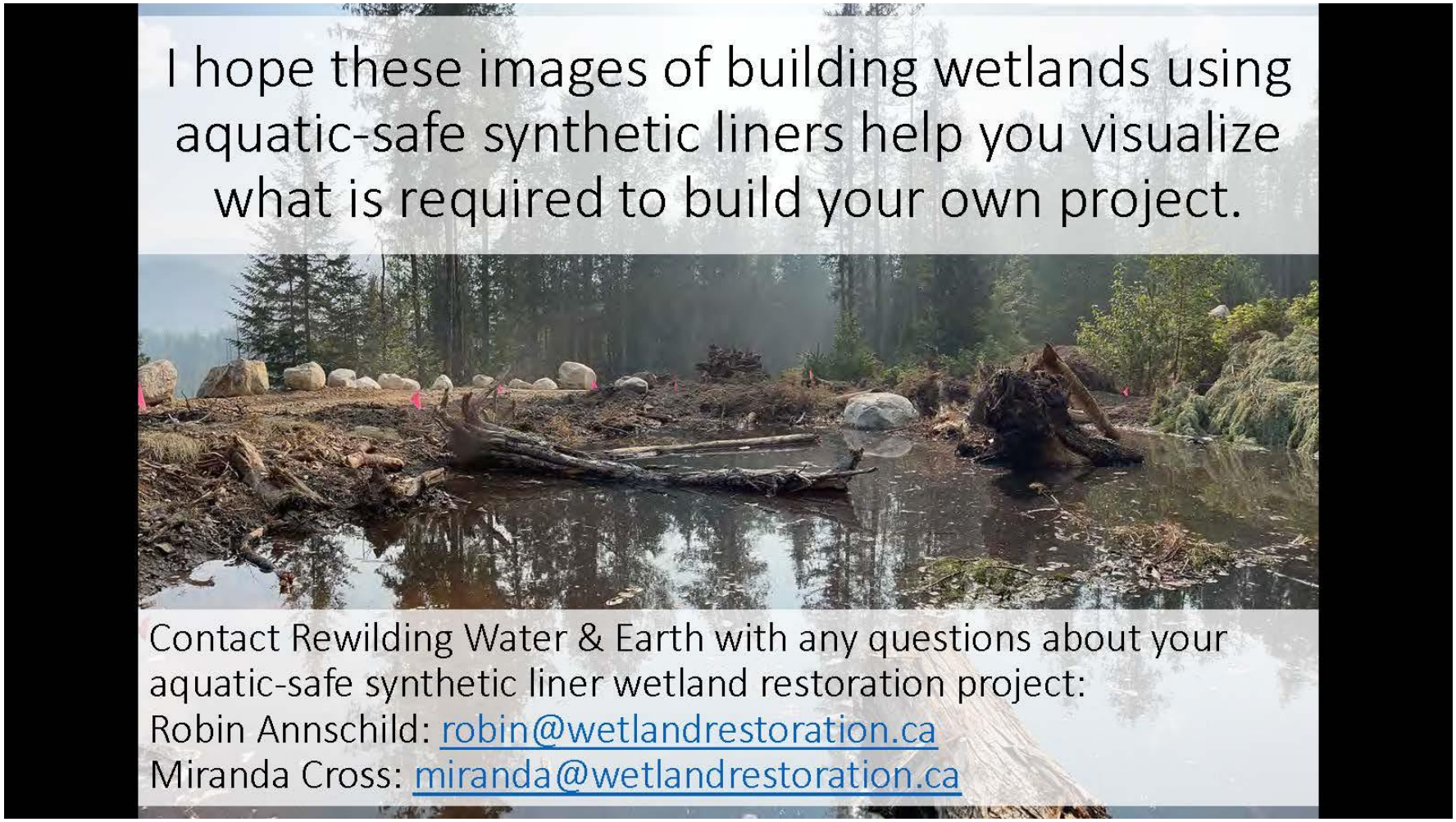

While synthetic liners are rarely used because of their high per-unit cost, they allow us to build wetlands where we otherwise could not:
This gravel pad was formerly a home site.
Rewilding Water & Earth Inc.


Rewilding Water & Earth Inc.
Entrance to a snake hibernaculum we built into the bank.
The same site with a 40’ diameter liner (partially filled with water). Liner edge marked with pink flags.


Rewilding Water & Earth Inc.
Pine & cottonwood clump.
Small pine.
This area had been cleared of trees and topsoil and levelled for a building site. A deep test hole showed over 2 metres of gravel.


Rewilding Water & Earth Inc.
Small pine.
The same site with a 40’x60’ liner. Pink flags mark liner edge. Liners were partially & very carefully filled to protect them from wildfire.


Rewilding Water & Earth Inc.
Pine & cottonwood clump.
An aquatic-safe liner can add a lot of ecological lift!


I hope these images of building wetlands using aquatic-safe synthetic liners help you visualize what is required to build your own project.
Contact Rewilding Water & Earth with any questions about your aquatic-safe synthetic liner wetland restoration project:
Robin Annschild: robin@wetlandrestoration.ca
Miranda Cross: miranda@wetlandrestoration.ca