Final Report

Reservoir Wetland Enhancement in the Ash River Watershed

BCRP Project Number: 11.W.ASH.03

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Executive Summary

Wetlands are critical habitats for a variety of species, including amphibians, a taxonomic group that is experiencing high rates of decline on a global scale. Areas that contain dams and reservoirs have the combined impacts of the loss of ephemeral wetlands during inundation, fluctuating water levels that scour away organics and hinder vegetative growth, and the introduction of non-native species (e.g., stocked fish). One of the best ways to protect native amphibian populations in the face of environmental stressors such as habitat fragmentation, introduced species, and disease is through habitat protection and enhancement, especially small, ephemeral wetlands. The goal of this project was to enhance reservoir habitat in Elsie Lake by investigating the use of artificially created wetland features via the construction of semi-permeable rock berms along the reservoir shoreline that would create isolated areas that could naturally develop into wetlands, and the use of floating vegetation islands that would increase habitat structure and diversity for wildlife.

Numerous site visits were made to Elsie Lake in spring 2011, and discussions were held with engineers, and local timber and construction companies to determine whether a semi-permeable rock berm could be constructed somewhere along the shoreline of the lake. It was determined that the concept is sound and that opportunities do exist at the site. However, the cost associated with building berms was higher than anticipated in the original 2011 budget, with the main hindrance being the cost of purchasing and hauling the berm materials to the site. A solution to this would be to use local, shoreline material such as gravel deposits (berms) that already occur at various locations within the lake and are visible and accessible during low water periods.

Homemade floating vegetation islands were installed at Elsie Lake and at another smaller wetland in 2011 to test the feasibility of making and using cost-effective islands to increase habitat structure. Unfortunately, none of these small homemade islands survived—some appeared to be damaged by wildlife while others may have been dragged off with floating wood debris when water levels rose at Elsie Lake. A large, professionally designed and built island was obtained from a company in California in early 2012 and installed at Elsie Lake at the end of the year when reservoir water levels were low. Long–term monitoring will be needed to ensure that this island survives the conditions at the lake, especially vandalism, and to determine whether wildlife utilize the created habitat. Floating islands have been used in many locations to meet a wide variety of objectives (e.g., water purification at sewage lagoons; nesting habitat for endangered waterfowl). The concept is a natural fit with the conditions wetland-associated species face at reservoirs.

ACKNOWLEDGEMENTS

Steve Tatoosh from the Hupacasath First Nation, Purnima Govindarajulu from the Ministry of Environment, Bill Waugh from Island Timberlands, and the Arrowsmith Naturalists provided letters of support for this project. Breanne Patterson from BC Hydro and Michele Jones from Mimulus Biological Consultants provided assistance in the field. Karla Robison (BC Hydro) provided information on archaeology sites around Elsie Lake. Thanks to Graham Hill from Northwest Hydraulic and Chris Dodd from Coastal Bridge Construction for their help with island installation. This project was funded by BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program.

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1.0 INTRODUCTION

Southwestern British Columbia (BC) has a unique climate and terrain that have resulted in relatively high species diversity and endemism. However, these conditions have also made the area highly desirable for agriculture and urban development. As a result, natural areas are becoming increasingly isolated and fragmented (e.g., Ward et al. 1998). One group of organisms particularly vulnerable to habitat fragmentation and isolation is amphibians—population declines have occurred on a global scale, and amphibians have been identified as indicators of environmental health. Almost 70% of native amphibians in southwest BC are dependent on both aquatic and terrestrial environments to meet their annual life history needs and the ability to migrate between these habitats is critical. Many of these species utilize small, ephemeral wetlands for breeding as they do not contain predators (e.g., fish). However, small wetlands are difficult to identify from air photos and maps and they have no legal protection. As a result, large numbers have been impacted or lost as a result of development.

Areas that contain dams and reservoirs have the combined impacts of the loss of ephemeral wetlands, fluctuating water levels, and the introduction of non-native species (e.g., stocked fish). At least 72 ha of wetland habitat were lost when the 672 ha area was flooded after dam construction at Elsie Lake (Conlin et al. 2000). In 2008, amphibian and small wetland surveys took place within a 1-km radius around Elsie Lake and within the lake itself. From the 46 small wetlands surveyed outside of the Elsie Lake shoreline, the average size of the wetlands was 0.05 ha and most did not contain fish. In these fishless environments, amphibians are the dominant predator. Wetland habitat within the drawdown zone of the lake was identified in a number of areas, but conditions in the reservoir result in wetland inundation during the spring breeding period creating cool water conditions for developing eggs and larva, and larval co-habitation with fish. Two amphibian species of interest in the area are the Western Toad (*Anaxyrus boreas*) and Red-legged Frog (*Rana aurora*), both of which are species listed as *Special Concern* federally.

1.1 Objectives

Experts agree that one of the best ways to protect native amphibian populations in the face of environmental stressors such as habitat fragmentation, introduced species, and disease is through habitat protection, especially small, ephemeral wetlands. The goal of this project was to enhance reservoir shoreline wetland habitat in Elsie Lake by meeting the following objectives:

- Investigate the possibility of constructing a semi-permeable rock berm along the reservoir shoreline that creates an isolated area that could naturally develop into a wetland. The berm would allow water to flow in and out as it fluctuates within the reservoir but would exclude fish from the wetland(s) to increase amphibian survival and avoid fish stranding. Berms such as this have been used successfully elsewhere to create / protect wetland habitat and to avoid fish stranding (e.g., along the Trinity River in northern California).

- Investigate and experiment with the use of floating vegetation islands, that move up and down with water level changes, to increase habitat structure and diversity for wildlife species in reservoirs and wetlands (e.g., the vegetation provides egg attachment sites and cover for amphibians and invertebrates, the island could be used as a nesting platform for waterfowl, etc.).

Although the primary focus of this project has been amphibian populations, numerous other wetland-associated species will benefit from the completed work as the variety of wetland habitats available to local flora and fauna increases at Elsie Lake (e.g., shrews, bats, birds, and invertebrates).

2.0 METHODS

2.1 Study Area

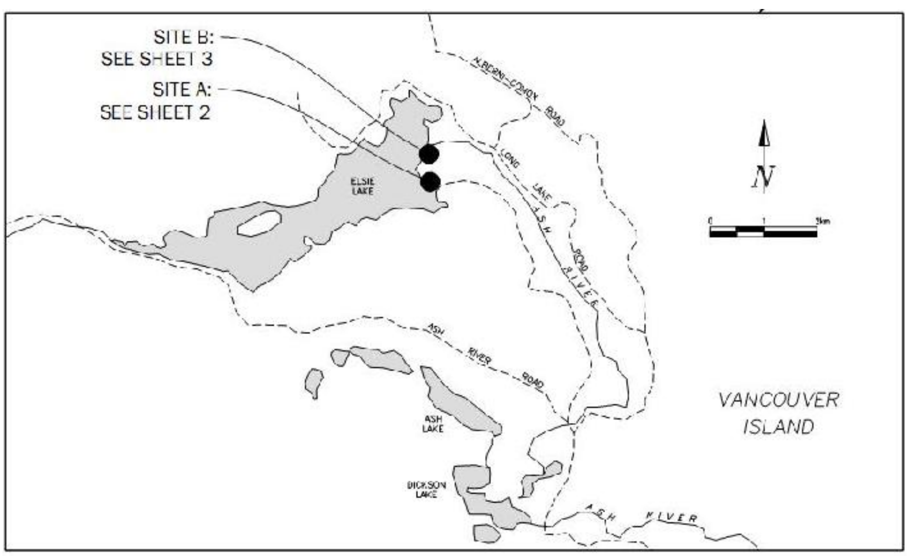
The Ash River watershed is located on central Vancouver Island (VI) north of Port Alberni, BC. The watershed is located within the South Island Forest District and the Coastal Western Hemlock biogeoclimatic zone. Elsie Lake sits at an elevation of approximately 320 m and is 672 ha in size (7 km long and 1 km wide). The normal drawdown range of the lake is 15 m, and the mean and maximum depths of the lake are 8 m and 30 m respectively. The majority of the area surrounding the lake consists of mature second-growth forest approximately 20 to 60+ years old.

2.2 Berm Construction

Northwest Hydraulic Consultants (NHC) was retained by E. Wind Consulting to investigate and design a semi-permeable berm and wetland at Elsie Lake. The concept outlined to Graham Hill (engineer from NHC) was to construct a semi-permeable berm along the shoreline of Elsie Lake that would isolate a pocket of shallow water (create wetland habitat) for amphibians and exclude fish, reducing predation on larva and avoiding fish stranding. In addition, the site would be graded at elevations that provide a variety of hydroperiods for amphibian breeding and facilitate vegetative growth. Other considerations discussed included managing the risk of vandalism / habitat destruction (e.g., ATVs) and construction costs.

On April 29, 2011 G. Hill visited the project site with Elke Wind (E. Wind Consulting) to review the wetland concept and Elsie Lake shoreline geomorphology. Two preferred sites (Sites A and B; Fig. 1), were identified in the field and surveyed with a total station. The horizontal datum was approximated based on hand-held GPS coordinates and compass bearings. The vertical datum was estimated from Elsie Lake water levels reported on the BC Hydro website.

Once the sites were selected, the logistics and costs associated with building a semi-permeable berm were estimated through discussions with Island Timberlands and Bridge Coastal Construction, who could supply local materials, equipment, and labour.



SITE LOCATION

Figure 1. Location of proposed wetland / berm construction sites at Elsie Lake.
(Taken from report provided by G. Hill)

2.2.1 Archaeology

The two sites selected as possible wetland / berm construction sites were discussed with Karla Robison from BC Hydro. Archaeology reports from Elsie Lake and site coordinates were sent to E. Wind and specific archaeology sites and issues were discussed in terms of buffer zones required to protect the sites.

2.3 Floating Vegetation Islands

In spring 2011 information was obtained from Jack Minnard about floating vegetation islands he has constructed and installed at fish restoration sites in Courtenay, as part of the investigation into the concept of using islands to create wetland habitat. He sent some images and advice about island designs. From this, and through various other discussions, materials were gathered to construct seven homemade, floating vegetation islands that were built and installed in spring 2011. A goal was to see if a cost-effective design and materials could be used to create small islands of vegetation. The largest floating island built and installed was created from a plastic palette, framed by wood, covered with erosion control matting to contain the soil and vegetation, and Styrofoam added to the bottom for floatation (Fig. 2). In addition, six smaller islands were made of Styrofoam packing blocks (Fig. 3).

The criteria for site selection and island design included:

- Cost – affordable and repeatable.
- Durability / longevity – ability to withstand weather and water level fluctuations.
- Vegetative growth – ability to allow plant growth (surface for soil substrate, allows/retains moisture).
- Vandalism – many reservoirs are well used by the public, including campers, anglers, and ATV users.
- Anchoring – the anchoring system needed to withstand dramatic water level changes, as well as wind and wave action, and floating debris.

The largest island, plus three of the smaller Styrofoam islands, were constructed and installed in a shallow area of Elsie Lake. Three additional small Styrofoam islands were installed at a small, isolated constructed wetland where the risk of vandalism would be very low, in case the Elsie Lake islands were lost. Small, laminated educational signs were also attached to each platform to try and reduce the risk of vandalism.

a) Bottom of largest homemade floating island—it was constructed from a plastic pallet, framed by wood, covered with erosion matting, and made buoyant with Styrofoam.

b) The amount of floatation needed was tested before the island was installed at Elsie Lake.

c) Largest island installed and anchored at Elsie Lake, with soil and vegetation added.

Figure 2. Largest homemade floating vegetation island constructed and tested at Elsie Lake in 2011.

a) Three small vegetation islands made of Styrofoam installed at Elsie Lake (anchoring via rope attached to submerged and weighted bucket).


b) Three small vegetation islands installed at a small constructed wetland with low risk of vandalism.

Figure 3. Example of smaller homemade floating vegetation islands installed and tested at two sites in 2011.

Due to issues with the homemade islands (see Results below), a larger, professionally designed and constructed island was purchased for installation at Elsie Lake. A company called Floating Island International (FII; http://www.floatingislandinternational.com/) was investigated as a potential source for floating vegetation islands in late summer 2011—this company had been contracted for the design and construction of other islands used by BC Hydro to enhance wildlife habitat at reservoirs.

Numerous discussions were held with the FII company engineer and the project engineer (G. Hill) about what was required. The objectives and criteria discussed in terms of the design for amphibians included:

- Water depth and temperature—amphibians seek out shallow, warm water areas (e.g., 30 cm deep) for early spring breeding
  - e.g., create a warm water area as part of the island, and / or the island would be situated in a shallow water area of the reservoir
- Provide egg attachment sites—vegetation is limited along the shoreline of the reservoir
  - Attachment sites could be live (plants) or possibly structural (wood) – amphibians do not necessarily need vegetation for egg laying (e.g., provide a variety of 2 - 8 mm diameter thin-stemmed structures)
- Predation—the island could provide cover from predators
  - e.g., provide vegetation and habitat structure (and possibly “netting” to exclude birds or larger fish)
- Other resources—if possible, the island could provide resources for amphibian prey (e.g., warm water and vegetative cover)
  - e.g., presence of algae and small invertebrates

Other factors discussed with the FII company engineer in terms of the conditions at Elsie Lake that would influence the design included:

- Water level fluctuations (e.g., 10+ m)
  - Vegetation (if used) may be exposed to low / no water for extended periods
- Wind and wave action (fetch) at the lake

- The desire to use native plants
- The presence of floating logs / debris in the lake
  - Parts of the reservoir have large accumulations of wood that float and move around when water levels rise
- Vandalism
  - Parts of the reservoir are accessible to the public at both high (via boats) and low (via walking and ATVs) water conditions, and it is a popular place to camp and party
- Snow / ice
  - Elsie Lake experiences winter freeze up and wind storms
- Island anchoring / attachment
  - The island must remain in place (it cannot come free and threaten the dam)
  - Thin soil layer overlaying bedrock
  - High density of shoreline stumps
- Scouring
  - If possible, it was desirable to limit the amount of movement of the island under shallow water conditions to minimize scouring of the substrate or possibly crushing eggs attached to nearby vegetation
- Aquatic safe—i.e., constructed of non-toxic, aquatic safe materials

Discussions with the FII engineer resulted in a project-specific island design that looked similar to a “kiddie pool” (Fig. 4). The concept was that, when the island was sitting at the desired water level, the upper island edges would be almost flush with the water surface. The inner area of the island would contain a central pool of shallow water that would warm with the sun and provide egg attachment sites (vegetation), while the sides of the island would contain narrow tubes that would allow larva to enter and exit the inner pool. This low position in the water column would also make it less visible / obvious to vandals.

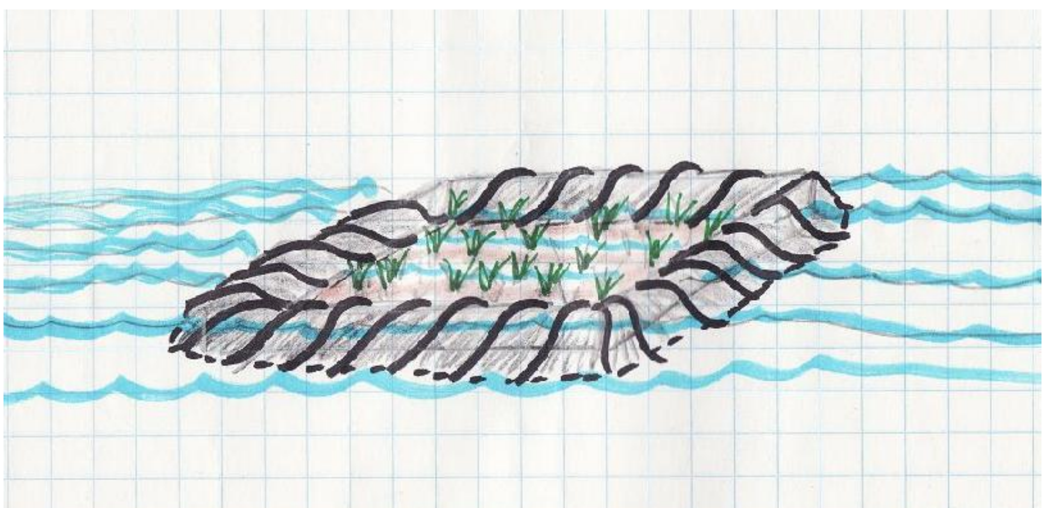


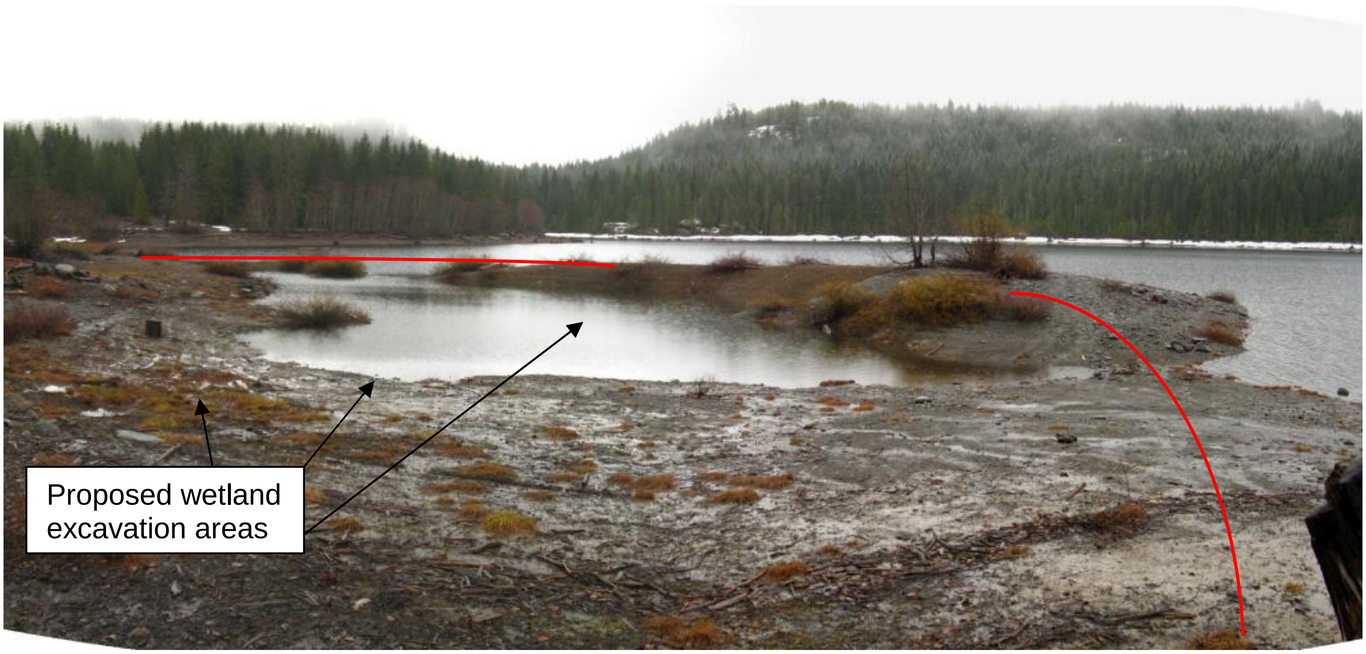
Figure 4. Drawing of the partially submerged, “kiddie pool” floating vegetation island concept E. Wind sent to FII during design discussions.

3.0 RESULTS

3.1 Berm Construction

3.1.1 Engineering

See Appendix A for the complete final report submitted to E. Wind by G. Hill—summary details are provided below. G. Hill designed two shoreline wetland areas for this project, referred to as Sites A and B. Site A would have a crescent-shaped berm creating a wetland of approximately 2,100 m^2 (for reservoir water levels of 330.0 m; Fig. 5). Site B would have a short linear berm that would impound a wetland area of about 2,300 m^2 (for water levels of 330.0 m; Fig. 6).



a) View southwest towards lake and partial existing berm.

b) View east from existing partial berm.

Figure 5. Proposed wetland / berm construction Site A with red line indicating approximate berm location.

a) View westward from road towards Elsie Lake.


b) View eastward towards road at west end.

Figure 6. Proposed wetland / berm construction Site B with red line indicating approximate berm location.

Water Levels and Wetland Grading
G. Hill analysed twenty years of water levels for Elsie Lake from 1990 to 2010. From that data he determined that the minimum water level / elevation at Elsie Lake was 316.0 m and the maximum was 332.0 m (Fig. 7). Critical amphibian wetted habitat months at Elsie Lake are from April through July, as adults lay eggs from late March to June and larva do not start to metamorphose until July. Median water levels for this period were from 328.8 to 330.7 m. Water levels normally start to drop in July as the reservoir is drawn down for power generating purposes. However, in some years, water levels are also low during the spring breeding period—the minimum water level from April through July was 318.4 m.

In order to maintain water within the constructed wetlands through July, some grading (deepening / excavating) of the wetland will be necessary. G. Hill recommended grading the wetland bottoms to a depth based on most normal reservoir draw-down cycles versus the lowest reservoir level on record, as the water depth would be too great for vegetation to be established and costs would likely exceed the available resources. The grading recommended included a series of cupped terraces to provide wetland amphibian habitat at a range of elevations. The terraces would be between elevations 226.0 and 330.0 m with the project biologist determining the final grading of the terraces in the field during construction. G. Hill noted that wetland habitat could be created without the construction of berms, which would greatly reduce costs.

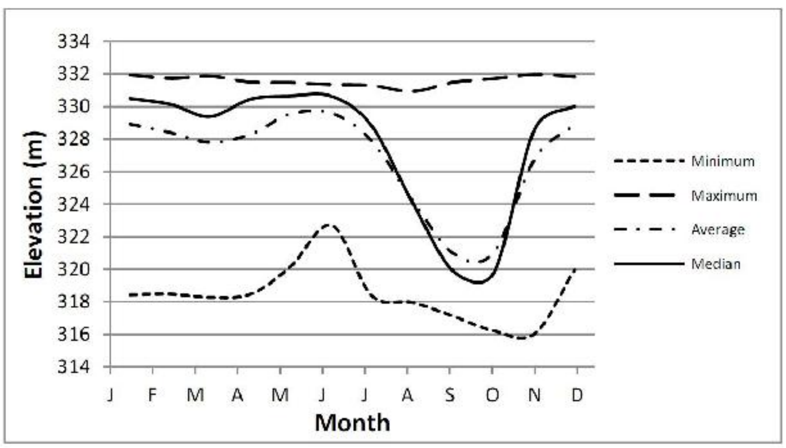


Figure 7. Elsie Lake water levels from 1990 to 2010.

Wetland Berms and Materials
In order to ensure that the berms exclude fish from entering the wetlands to avoid amphibian predation and fish stranding issues, G. Hill recommended a berm height of 332.4 m based on the maximum water level observed (332.0 m), runup (0.10 m), and freeboard allowance (0.30 m). Wave setup was incorporated into the freeboard allowance.

G. Hill recommended that the berms be constructed using materials with particle sizes generally less than 150 mm, and with about 15% of the material passing US Standard Sieve #200. The filter layer between the bulk berm material would be either (i) a 300-mm thick layer of gravel, or (ii) a non-woven geotextile. It was recommended that the decision to use the granular filter or the geotextile be based on available material (granular filter) and costs. An armour layer of 450 mm diameter riprap was also recommended (see Appendix A). During the April 29 site visit a stock pile of riprap was investigated near the site. The rock appeared to meet the specifications for the berm riprap component. Acid leachate testing may be required. Material volume estimates have been included in tables on the engineered drawings (Appendix A) and are summarized below:

Material Needed	Amount Needed
Rip Rap	1010 m^3
Gravel	700 m^3
Till (berm material)	2500 m^3

The availability of berm materials was investigated by E. Wind and Rod Christie from Island Timberlands on Aug. 8, 2011. Eight sites were visited and assessed within a 15 km distance of the east side of Elsie Lake for the three berm material components—rip rap, gravel, and till. Of these eight sites, three contained enough material of each rock component (Table 1). Island Timberlands confirmed that they would allow berm material to be purchased from these sites at the following cost (excluding hauling costs):

- 1000 m^3 rip rap (already developed in a pile) - \$50 to \$60 m^3 = \$50,000 to \$60,000
- 700 m^3 gravel = *unclear - depends on the size (it can vary)*
- 2500 m^3 till pit run (not screened) - \$10 to \$16 m^3 = \$25,000 to \$40,000

Table 1. Availability of berm materials from Island Timberlands, including hauling distances (preferred sites are highlighted in pink).

Site	GPS file	Easting	Northing	Location	Material Available	Amount Available	Comments	Hauling Distance
1				***Pit at dam (ASH 376-37)***	***Rip Rap***	6000 m^3		1 km
					Gravel	maybe 200 m^3		
2	259	347287	5480389	Elsie Lake shoreline (campsite and ATV site)	Till (berm material)	250 m^3	Need to fix road approaching lake (e.g., grater and excavator for 1 day); might have bedrock under hill	
3	260	349505	5478400	Along ASH 376-37	Till (berm material)	240 m^3	Need to knock down trees and deal with debris; get merch. trees to road and IT would haul away; dig a couple of test holes (once get machine here); need an engineer to survey and map (2 days); probably need a faller (2) for a day $1800/day for both	
4				ASH 376-23 (spur road)	Till (berm material)	300 m^3	Road has possible locations for berm/till material; excavation in cutslopes; need to knock down trees and deal with debris; get merch. trees to road and IT would haul away; strip organics (sort, store and put back)	
5	261	350337	5477174		Rip Rap		not needed (use lake site above)	
					possible Till		at south side of rock face (small opening);look at it with Chris and see if it has till component (looks like gravel) - preferable to last two options as it is already disturbed)	
6	262	349953	5475350	ASH pit	Gravel	200-300 m^3	might need to clear a little material/trees and move road back (take material from existing road along edge)	
7	263	351321	5477183	***Comox fill (where creek blew through old road)***	***Till (berm material)***	6400 m^3	need to stabilize slopes and plant grass after; same restrictions on what is taken on creek side?; take a soil sample	11 km
8	264	350164	5479330	***Long Lake Rd pit***	***Gravel***	about 600 m^3	need to dig test hole; a couple trees have to come out; organics off, sorted, put back and slope pit down for safety	13.7 km

3.1.2 Archaeology

According to Stafford et al. (2010), no archaeology sites have been identified within the two proposed wetland construction areas for either Sites A or B (Fig. 8). In terms of the proposed berms, archaeology site DiSg-13 is the closest identified location to Site A, but it is outside of the berm project area. Archaeology site DiSg-12 is the closest identified location to Site B, the boundary of which is over 100 m from the proposed berm at site B (Fig 9).

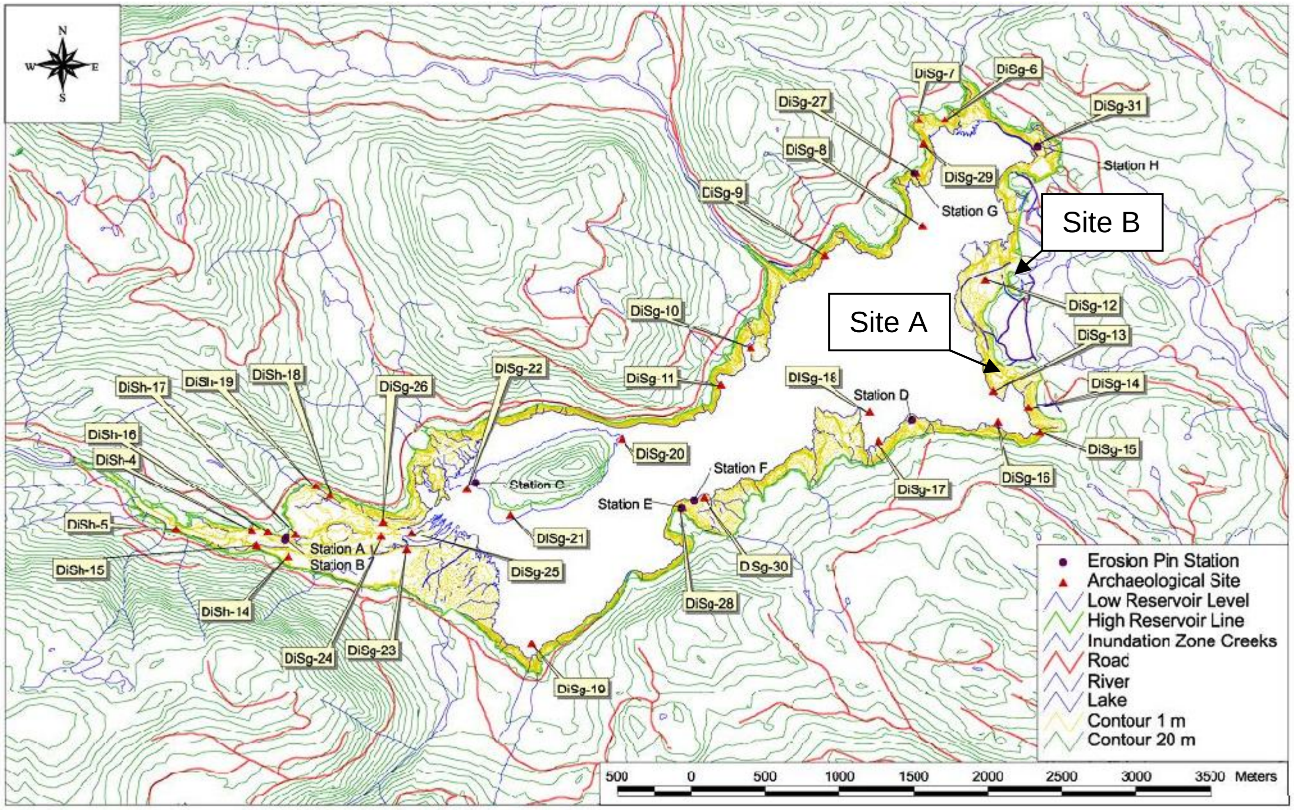


Figure 8. Location of archaeology sites at Elsie Lake in relation to the two proposed wetland / berm construction sites (A and B).
(Taken from: Stafford et al. 2010)

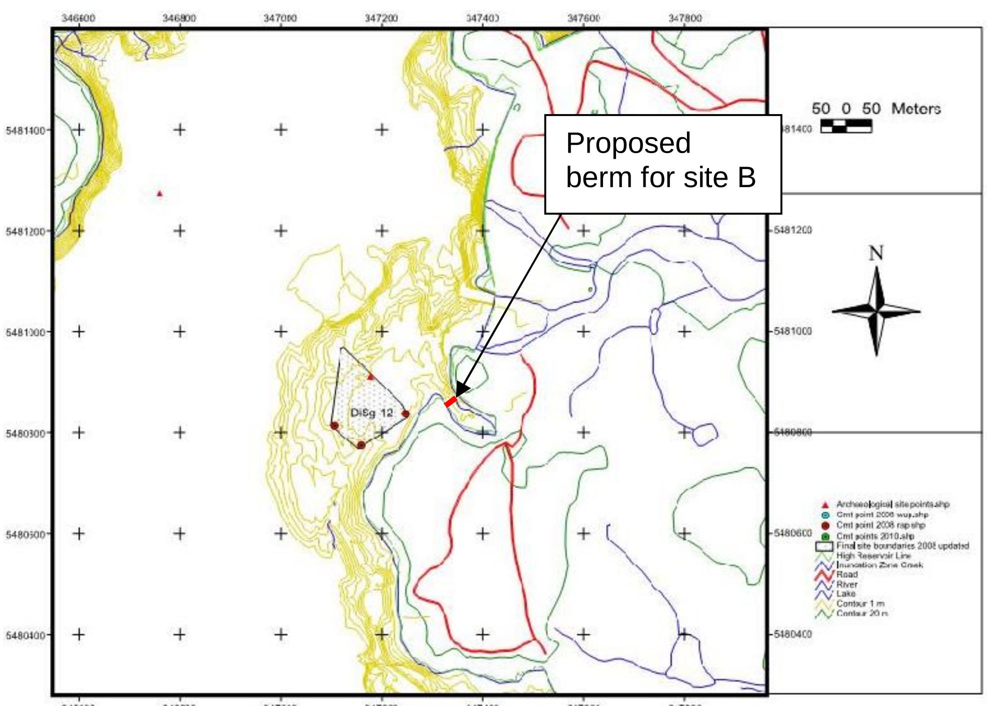


Figure 9. Proximity of archaeology site DiSg-12 to proposed berm for wetland construction site B.
(Provided by: Karla Robison).

3.2 Floating Vegetation Island

The small, homemade floating vegetation islands were visited in late summer to re-measure the planted vegetation (e.g., growth and survivorship) and to determine impacts from water level changes and potential public vandalism. Unfortunately, all of the homemade islands installed at the constructed wetland site and at Elsie Lake were unsuccessful. The islands at the constructed wetland site had been destroyed and the materials were found scattered throughout the site, suggesting that they were disturbed by wildlife (e.g., a bear). Only one island remained at the installation site at Elsie Lake—however, this small Styrofoam island was empty and floating (soil and vegetation absent). The ropes / anchor materials were still on site but the large and two other small islands were absent. It is unclear whether they were removed / destroyed by floating log debris or by humans (e.g., the large root wad used to anchor one rope of the large island was gone, suggesting that the islands may have been dragged away with floating debris).

The professionally designed and constructed floating vegetation island from FII was completed in late fall / early winter 2011-12. It was shipped in four pieces from California to Port Alberni in winter 2012 (Fig. 10), which was too late for installation due to access issues related to snow and ice at the lake and high reservoir water levels. The island was securely stored at Coastal Bridge Construction in Port Alberni for the winter. Permission for island installation and a contract extension were obtained from BC Hydro to install the island at Elsie Lake in late summer / early fall 2012 when reservoir levels would be low enough to allow land access for anchoring.

A site visit was conducted on Sept. 12, 2012 by E. Wind, G. Hill (and engineer from Northwest Hydraulics) and Chris Dodd (Coastal Bridge Construction) to determine the exact site for island installation. Various sites around the lake were surveyed that would meet as many criteria as possible, focusing particularly on suitable water elevations in spring, low probability of vandalism, and low wind and wave action (exposure). A location on the northwest side of the lake was selected (Fig. 11). This site is fairly well hidden from boaters and ATV riders during low lake water level periods, but it is accessible for monitoring via the north logging road.

Island installation took place on Sept. 27, 2012. An island anchoring system was developed by G. Hill using cables attached to four stumps (Fig. 12). The final design components outlined by G. Hill regarding the island installation and anchoring included:

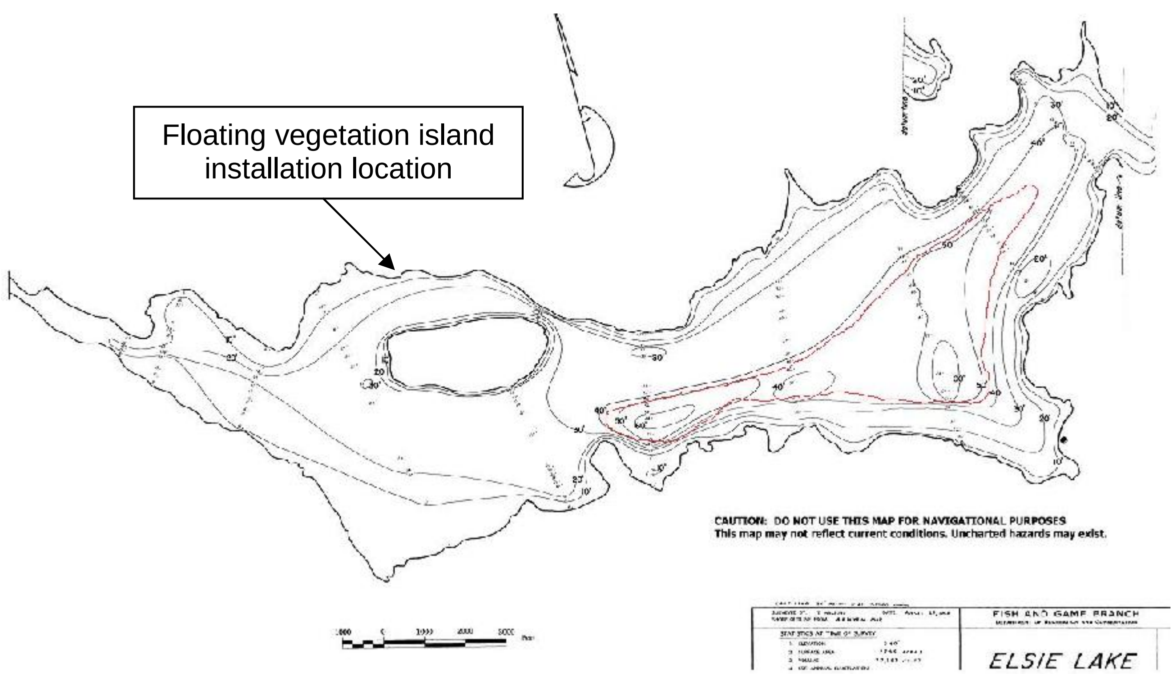
- Island size: 4.25 m x 4.25 m
- Four anchor stump elevation ranges: 328m to 324.6 m
- Island vertical range 332 m (historic high water) to ground out at 327.7 m (lowest water desirable during the chronological target range). Allowing for the depth of the island, low water should be designed at 327 m.
    - To allow for the island to float up from 327 to 332 m, the extra cable needed is about 2 m.

Cable lengths required:

Cable	Center of stump to island	Cable required with allowances
1	15	19.5m (63’)
1	15	19.5m (63’)
3	29.5	34.0m (111’)
4	25.8	30.3m (99’)
	Total	103.3 (~340’)

A 500' long coil of ½" wire rope 'standard' 6x19 was used for the anchoring because it was easy to work with and it is flexible. Crosby clips were used to attach the cable to the stumps and to the island. A cold chisel was used to damage the threads on the clips to reduce the risk of theft. The four island sections were assembled in the field using the supplied bolts from FII. Local soil, rocks, and native thin-stemmed graminoid vegetation were added to the island (Fig. 13).

Figure 10. Delivery of floating island, in four parts, from California to Port Alberni in winter 2012.



a) The floating island was installed in a protected bay behind the large island on the northwest side of Elsie Lake.

b) View of site looking southeast and southwest.

Figure 11. Surveying the floating island installation site characteristics at Elsie Lake.

Figure 12. The island was anchored to four stumps with cables and Crosby clips that allow the island to rise and fall with water level changes.

a) Putting the four island sections together on site.

b) Initial (pre float) amount of soil, rocks, and vegetation added until floatation can be determined (once water levels rise).

Figure 13. Construction and completion of the floating vegetation island.

4.0 DISCUSSION

The estimated cost for wetland / berm construction after field assessments were far higher than estimated in the original BCFWRP proposal hindering construction in 2011. Shoreline wetland habitat can be developed through the use of permeable berms, but the use of local material (e.g., along the shoreline) would likely need to be considered to keep costs down. For example a large gravel deposit / berm, accessible during low water periods, exists immediately behind Site A. This material could be used to build the proposed permeable berm as long as there were no archaeological or fisheries concerns.

Another strategy for enhancing habitat for amphibians and other wetland species at reservoirs is the use of floating vegetation islands. Vegetation living on these floating islands would not be exposed to the scouring action that plants growing on the lake substrate experience during fluctuating water levels. Small, homemade floating vegetation islands were unable to withstand local conditions (e.g., wind and wave action, impacts from floating debris) and / or the effects of vandalism. As such, professionally engineered islands are likely required for long-term sustainability. The floating vegetation island purchased from FII and installed in fall 2012 could provide warm, shallow water habitat for amphibian and invertebrate egg laying or developing larva. It could also provide habitat for many other wetland-associated species (e.g., birds, rare plants, invertebrates). Future islands of this sort could be purchased from FII at a reduced cost now that the design and prototype have been completed.

Once water levels rise and the island installed at Elsie Lake is floating it should be monitored to determine whether more soil and vegetation are needed to ensure that the position that the island takes within the water column is suitable (i.e., the upper edges should be almost flush with the water surface). The anchoring and cable systems should also be monitored for wear and tear, and effects / signs of vandalism. Long-term monitoring will be required as the weight of the island will change as vegetation grows. Monitoring will also provide information on whether this island design can withstand the local conditions, including weather, floating debris, water level fluctuations, and vandalism. As well, monitoring will tell us whether islands such as this can provide important habitat for local wildlife in reservoirs.

5.0 RECOMMENDATIONS

Recommendations:

- Consider the installation of a semi-permeable berm and constructed wetland at Site A at Elsie Lake as this could reduce shoreline impacts from campers and ATV users by limiting access to certain locations.
    - Island Timberlands may be interested in discussing the use of berms and wetlands as access deterrents at certain locations around the lake where vandalism is an issue.
- Investigate the availability of using local material (e.g., gravel deposits) found along the lower elevations of the reservoir shoreline that could be used for berm development and wetland construction.
- Support and develop a long-term monitoring program for the installed floating vegetation island at Elsie Lake. Monitoring is required for various issues: wildlife use of the island, determining and maintaining the appropriate weight of soil and vegetation within the island, sustainability of the anchoring system, and effects or signs of vandalism.
- Floating vegetation islands should be considered for use at all BC Hydro reservoirs, especially those that contain steep-sided shorelines with little to no wetland habitat (e.g., Daisy Lake).

6.0 References

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Appendix A. Summary Report from Northwest Hydraulics

See separate NCH pdf report.

Appendix B. Budget Summary

	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
INCOME				
Total Income by Source	$41,068	$8,766	$38,522.86	$
Grand Total Income (BCRP + other)	***$49,834.00***		***$38,522.86***	
EXPENSES	**Note: Expenses must be entered as negative numbers (e.g. – 1000, etc.) in order for the formulas to calculate correctly.**			
Project Personnel				
Wages	-$12,550	-$1,800	-$6,799	-$
Consultant Fees	-$19,050		-$12,982.20	
(List others as required)				
Materials & Equipment				
Equipment Rental	-$		-$873.64	
Materials Purchased	-$700	-$6,700	-$12,797.23	
Travel Expenses	-$5,416		-$5,070.79	-$
Permits				
(List others as required)				
Administration				
Office Supplies				
Photocopies & printing				
Postage				
General admin.	-$3,402	-$216		
Total Expenses	***-$41,118***	***-$8.716***	***-$38,522.86***	***-$***
Grand Total Expenses (BCRP + other)	***-$49,834***		***-$38,522.86***	
BALANCE (Grand Total Income – Grand Total Expenses)	The budget balance should equal $0 ***$0***		*The actual balance might not equal $0** ***$0***	

APPENDIX C: PERFORMANCE MEASURES

A copy of the final report for the ***Reservoir Wetland Enhancement in the Ash River Watershed*** project were provided to BC Hydro, the Hupacasath FN, the Ministry of Environment, and the Arrowsmith Naturalists.

Media coverage of and public presentations related to the project will be somewhat limited until some monitoring has taken place. This will help reduce the risk of vandalism and provide a clearer picture of whether the project was considered a success. Once monitoring has taken place (e.g., through 2013), results will be communicated to the public in the Port Alberni and Qualicum areas via a Powerpoint presentation given by E. Wind. These events will be organized by the Arrowsmith Naturalists, the Hupacasath FN, and advertised in local newspapers.

Project Outcomes:

- A greater understanding of the potential to construct wetland habitat along the east shoreline of Elsie Lake, including the feasibility of building semi-permeable berms to exclude fish from wetland areas.

- A map showing the location of proposed wetland construction sites that take into account sensitive areas such as archaeology sites.

- Partnerships were established with BC Hydro, the Hupcasath FN, Arrowsmith Naturalists, Island Timberlands, and the Ministry of Environment that will likely result in continued amphibian and wetland work in the area.

APPENDIX D. CONFIRMATION OF BCFWRP RECOGNITION

BC Hydro has been highlighted as the key funding source for and supporter of this project during all communications with various individuals and companies that have been brought in to the project. BC Hydro will be acknowledged in any results communicated via oral presentations or media coverage that take place in the future.