BC CONSERVATION FOUNDATION

CAMERON LAKE WATER STORAGE WEIR UPGRADE FINAL REPORT

APRIL 2007

nhc northwest hydraulic consultants

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CAMERON LAKE WATER STORAGE WEIR UPGRADE FINAL REPORT

Prepared for:

BC Conservation Foundation
#3 - 1200 Princess Royal Ave
Nanaimo, BC V9S 3Z7

Prepared by:

northwest hydraulic consultants
3150 Island Highway
Nanaimo, BC V9T 1V9

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33986

DISCLAIMER

EXECUTIVE SUMMARY

The purpose of the project was to increase the water storage capacity of Cameron Lake by upgrading the existing weir located at the outlet of the lake, headwaters of the Little Qualicum River on Vancouver Island, BC. The stored water will be used by fisheries managers to augment flows in the river during the dry summer and early fall seasons to improve hydraulic conditions and productivity of freshwater fish habitats. The project entailed installing an aluminium fishway and flow control valve at the weir, and lowering the channel invert upstream and downstream of the weir to improve access to existing licensed water storage and enable access to potential new storage. Engineering design work took place from April to July 2006 and the project was constructed in August and September 2006. The total design and construction costs were $181,020.

CREDITS AND ACKNOWLEDGEMENTS

Key project members were James Craig (BCCF), Mel Sheng (DFO), Craig Wightman (MoE), Barry Genoe (Gencoast Construction Ltd), and Graham Hill (**nhc**).

Project funding was provided by Georgia Basin Living Rivers Program, Pacific Salmon Commission - Southern Fund, and the BC Ministry of Transportation.

Report prepared by:

Graham Hill

G. Hill, P.Eng

Report reviewed by:

Barry Chilibeck

B. Chilibeck, P.Eng.

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1. INTRODUCTION

Many scientists and water management agencies believe climate change may bring greater extremes in weather events including more intense storm-related flooding and more frequent and severe droughts (J. Craig, 2007). With this in mind the BC Conservation Foundation (BCCF), in partnership with Fisheries & Oceans Canada (DFO) and the Ministry of Environment (MoE) undertook a retrofit project at the Cameron Lake Weir located at the outlet of Cameron Lake, headwaters of the Little Qualicum River on Vancouver Island, BC. The objectives of the project were to:

- Fully develop the storage capacity in Cameron Lake. Prior to the project approximately 0.50 m out of 0.90 m of potential storage was available because of bedload and other natural accumulations upstream and downstream of the weir
- Accommodate future top-storage capacity of 0.15 m
- Improve the structure's ability to release incremental rearing flows to the Little Qualicum River by adding a vertical sluice gate
- Improve upstream juvenile fish passage

The construction stage of this project followed feasibility assessments that began in 2003 to determine if increased lake storage was possible. Northwest hydraulic consultants (**nhc**), in coordination with BCCF, completed hydraulic assessments and preliminary design work in 2004. After widespread public and agency consultations facilitated by BCCF staff, a modified strategy to achieve the storage target was developed in early 2006. The strategy involved installing a low-level valve and modified fishway, and excavating natural control inverts at the lake outlet to improve access to existing licensed and future storage (G. Morris, 2006). Work in 2006 included completing the detailed engineering designs and constructing the project during the fisheries work window in August and September.

The benefits of this project are improved access to Cameron Lake for juvenile trout via the fishway and increased flow in Little Qualicum River during the late summer and early fall seasons. Water discharged from storage will improve hydraulic conditions and productivity of freshwater fish habitats below the lake and above the anadromous barrier, as well as freshwater and anadromous habitats in the lower river. Additional flows will also aid upstream adult chum and chinook migrations in the early fall (J. Craig, 2007).

2. SITE CONDITIONS

2.1 SITE DESCRIPTION (PRE-PROJECT)

The weir is located 5 km upstream of the Little Qualicum River's anadromous barrier at the natural outlet of Cameron Lake immediately upstream of the Chalet Road Bridge. Upstream of the weir, the lake outlet is wide and shallow before deepening further out into the lake. Along the right bank upstream, a large gravel bar is present. The gravel bar was constructed at the lake outlet to enhance spawning habitat for the lake's trout stocks.

The weir, constructed in 1978, is a concrete slab spanning the channel with concrete abutments at each bank (Photo 1). Vertical steel beams and wood stoplogs form a 0.9 m high removable dam with approximately 0.5 m of pre-project usable storage. The left bank abutment incorporated a 2 m wide pool and weir fishway. The fishway pools were partially filled with sand, gravel, and organic debris in 2006.

The Chalet Road Bridge crosses the river approximately 10 m downstream of the weir. Downstream of the bridge, the Little Qualicum River channel narrows and the substrates coarsen to cobbles and boulders. The channel gradient is very flat until approximately 180 m downstream of the weir. In this reach the channel features several pieces of large woody debris, and the river banks are steep and well vegetated.

2.2 SITE SURVEY

The DFO conducted several site surveys in 2003 and 2006 using a total station. In 2003 the weir, stream bed and river banks were surveyed. In 2006 the outlet of the lake was surveyed. The survey data used approximate UTM horizontal coordinates and an assumed vertical datum.

Several Water Survey of Canada (WSC) benchmarks were relocated prior to construction. The WSC abandoned the gauging site in 2002; however, maintaining the vertical control for the historic gage records will make correlation of future gauging activities easier. The benchmarks were relocated by Pacific Land Surveying Ltd using a total station.

3. DESIGN

The project design phase required modeling low and high flows at the outlet of the lake, designing and drafting plans for a fishway, and creating a grading plan for the site.

3.1 HYDRAULIC MODEL

A numerical hydraulic model was used to estimate flows through and over hydraulic structures, and to calculate the effects of work at the outlet of the lake for normal operating conditions and flood events.

The model used for this study was HEC-RAS version 3.1.1, which is a one-dimensional hydrodynamic model developed by the US Army Corp of Engineers. It uses a backwater, step iteration process and channel roughness to calculate water surface elevations, flows and velocities through a series of model sections.

The results of the hydraulic model study can be found in the **nhc** report titled *Cameron Lake Weir Upgrade: Hydraulic Assessment and Design, May 2004,* and the memo titled *Cameron Lake Weir Negative Storage Assessment, April 2006.*

3.2 FISHWAY & FLOW RELEASE GATE

A single combined unit pre-fabricated aluminium fishway and gate chamber structure was selected for the site (Figure 1). Designs for the structure were drafted using AutoCAD software in May and June 2006. Fabrication commenced in July and was competed in August by Grey Rock Welding & Fabricating Ltd.

The fishway is 8.2 m long, 1.0 m wide and 2.5 m high. It features an aluminium trash rack at the upstream end to prevent large debris from entering the main chamber. Eight removable baffles slide into vertical glides at 1.1 m spacing. A vertical slot baffle design was selected with each baffle featuring an opening approximately 0.10 m wide by 0.35 m high. The fishway has 3 lockable grate panels on the top to prevent debris from entering and to increase public safety near the structure.

The gate chamber is welded to the right side of the fishway at the downstream end; it is 4.3 m long and 1.5 m wide. The gate chamber has a trash rack at the upstream end to limit large debris clogging the gate. The gate is an aluminium knife gate located near the center of the chamber. It has an opening width of 1.2 m and height of 0.9 m. It is controlled by a removable T-handle from on top of the structure. The gate was designed by Armtec Ltd. and fabricated by Grey Rock Welding. The gate chamber has 2 lockable grate panels on the top to prevent debris from entering and to increase public safety near the structure.

The gate is designed to release up to 2.5 m^3/s at full storage down to approximately 0.3 m^3/s with no storage remaining in the lake. The gate can be adjusted on an as needed basis to regulate the flow in the river.

3.3 GRADING PLAN

A grading plan was prepared in June and July 2006 for the project (Figure 2). The grading plan identified access points to key locations, specified sediment control strategies and grading elevations, and highlighted environmental and safety concerns. **NHC** prepared a memo titled *Cameron Lake Weir – Project Update*, *May 2006* to accompany the grading plan.

4. CONSTRUCTION

Gencoast Construction Ltd. was the general contractor for the construction phase of the project. Several pre-construction on site meetings were held with **nhc**, BCCF and Gencoast Construction staff in July and August. During the week of August 21st some construction materials were staged at the site. A list of the key project contacts and contractors is in Appendix A.

4.1 WEEK 1

Construction started on August 28th. The fishway installation was the priority component of this project, followed by grading the channel upstream and downstream of the weir. The first construction task was to build an access road down to the fishway on the left bank using a Hitachi EX 150 Excavator. A BC Hydro guy-wire was temporarily removed from a utility pole to allow the road to be built.

The area around the fishway was isolated using 2 – 1 m diameter by 15 m long Aquabags (Photo 2). A Flygt Model BS 2151.181 LT 30hp, submersible 150 mm pump was rented from Duncan Electric Motor Ltd. through ITT Flygt Canada to dewater the existing fishway and left bank of the river. A 600 volt diesel generator was borrowed from the DFO to provide power for the pump. Pumped water was discharged above the railway tracks on the left bank of the river approximately 15 m above the river elevation at a rate of approximately 65 L/s. The discharged water ran along the railway tracks for approximately 100 m and while slowly percolating into the ground.

A concrete cutting company, Cancor Cutting & Coring, Ltd, used a hydraulic saw with a diamond blade to cut the left concrete abutment to accommodate the width of the aluminium fishway and gate chamber structure (Photo 3). The excavator removed the concrete from the fishway and prepared the site near the left bank where the fishway was placed.

Formwork and rebar was prepared for the upstream fishway footing and footing expansion near the left bank. Approximately 2 m^3 of concrete was poured using the excavator to transfer the concrete from the ready-mix truck to the forms (Photo 4). The 600 volt electric pump was used to dewater the work site; a 75 mm gas pump was used to manage water within the site.

The fishway structure was positioned on the concrete footings and butted against the intact right concrete fishway wall using a John Deere 490D excavator (Photo 5). The fishway structure was secured to the footing and concrete wall using approximately 35 – 20 mm galvanized Hilti anchor bolts (Photo 6).

After the fishway was secured to the footings it was partially backfilled on the left bank. As the backfill was compacted the left fishway wall began to deflect under the load of the soil. The backfill was removed temporarily until a solution to reinforce the wall could be implemented.

4.2 WEEK 2

A steel reinforcement ladder was fabricated and delivered to the site. The ladder was attached to the middle of the left wall of the fishway using approximately 40 galvanized nuts and bolts. A concrete lock-block was set in the left bank beside the fishway and galvanized cables and turnbuckles were attached between the block and ladder to support the fishway from lateral forces imparted by the soil backfill. The concrete cut-off wall was also used as an anchor point for the cables to the ladder (Photo 7).

The fishway was backfilled with sandy soil and compacted lightly. Filter cloth and bags of concrete mix were used to seal the space between the concrete cut-off wall and the fishway near the left bank. Minimal fishway wall deflection was observed after backfilling and reconstructing the left bank.

The grading stage of the project was the next step. Sediment management began with the deployment of a silt curtain containment system. The silt curtains were 150 mm diameter PVC pipes with 10 mil poly construction film secured to them. The silt curtain concept did not work well in this application because it was difficult to prevent flow from entering the settlement area at the outlet of the lake, it was difficult to seal the poly on the uneven river bottom, and the sediment was very fine marine deposits that did not settle quickly.

4.3 WEEK 3

The next strategy for sediment management was to pump the river around the work zone. The diesel generator was moved to an area on the lakeshore beach near the outlet of the river. The river was blocked off at the weir and two Flygt model 3201.180 30hp 600 volt, submersible 250 mm pumps borrowed from the DFO were used to pump approximately 600 L/s of clear lake water into the river channel to maintain flow downstream of the project.

While the pump system was being set up a 25 tonne Komatsu excavator placed 200 – 800 mm riprap around the fishway inlet and outlet on the left bank.

After the pumps were set up and running the site was isolated at the outlet of the lake and the excavator constructed a low flow connector channel 0.3 m lower than the concrete weir. The channel is approximately 50 m long and 4 m wide and extends between the weir and the lake. The substrate was primarily marine deposits comprised of very fine silts and clays; all of the material was hauled off site, and imported gravel was used to line the channel (Photo 8).

The next stage was to re-grade the channel below the weir. The pumps and generator were moved to a location immediately upstream of the dam and clear water was pumped 200 m downstream. The Komatsu excavator constructed a low flow channel from the weir to approximately 50 m downstream of the weir. Much of the material was hauled off site. A second excavator, approximately 30 tonne class, was mobilized to the site. The second excavator was used to side cast the river bed material between 50 m downstream of the weir and 180 m downstream of the weir. The side cast cobbles and boulders were placed on the left bank amongst the vegetation. The invert of the re-graded channel is at approximately the same elevation as the weir. All of the instream work was completed September 15th (Photo 9).

Sediment concentrations were monitored about every ½ hour at a location 100 m downstream of the construction site using a McVan Instruments turbidity meter. The target turbidity level was below 55 Nephelometric Turbidity Units (NTU). When the turbidity rose above this value then construction was slowed, or in some instances, halted.

4.3 WEEK 4

The large equipment was demobilized and work crews cleaned up the site. The hoses and pumps were returned and the disturbed areas were graded with a small 4 tonne excavator. The road grade was re-established on the north side of the bridge near the utility pole and purchased crush rock was used to top the road to reduce dust.

4.4 ADDITIONAL WORK

BCCF crews and Qualicum Beach Streamkeeper volunteers completed revegetation of the disturbed areas in the fall, and the hydro guy-wire was reattached in the spring of 2007.

The project partners wish to install flow monitoring and gate automation equipment at the site. The project team is currently working towards developing 0.15 m of additional top storage. Several funding proposals are pending and work is anticipated during the summer of 2007 and 2008.

5. PROJECT COSTS

The project was funded by the Georgia Basin Living Rivers Program (GBLR), the Pacific Salmon Commission – Southern Fund (PSC), and the Ministry of Transportation (MoT) Environmental Enhancement Fund. The DFO and MoE had in-kind contributions. All of the accounting was performed by BCCF staff. The total costs for the project were $181,020. A summary of the costs is presented in Table 1.

6. References

Chilibeck, B.M. & Burkholder, D.R., *Cameron Lake Weir Upgrade: Hydraulic Assessment and Design*, May 2004.

Chilibeck, B.M. & Burkholder, D.R., *Cameron Lake Weir Negative Storage Assessment,* April 2006.

Craig, J., Letter to Leaseholders *"Re: Request for further feedback on Preferred Option for Cameron Lake Storage Project,"* February 2007.

Hill, G.R., *Cameron Lake Weir – Project Update*, May 2006

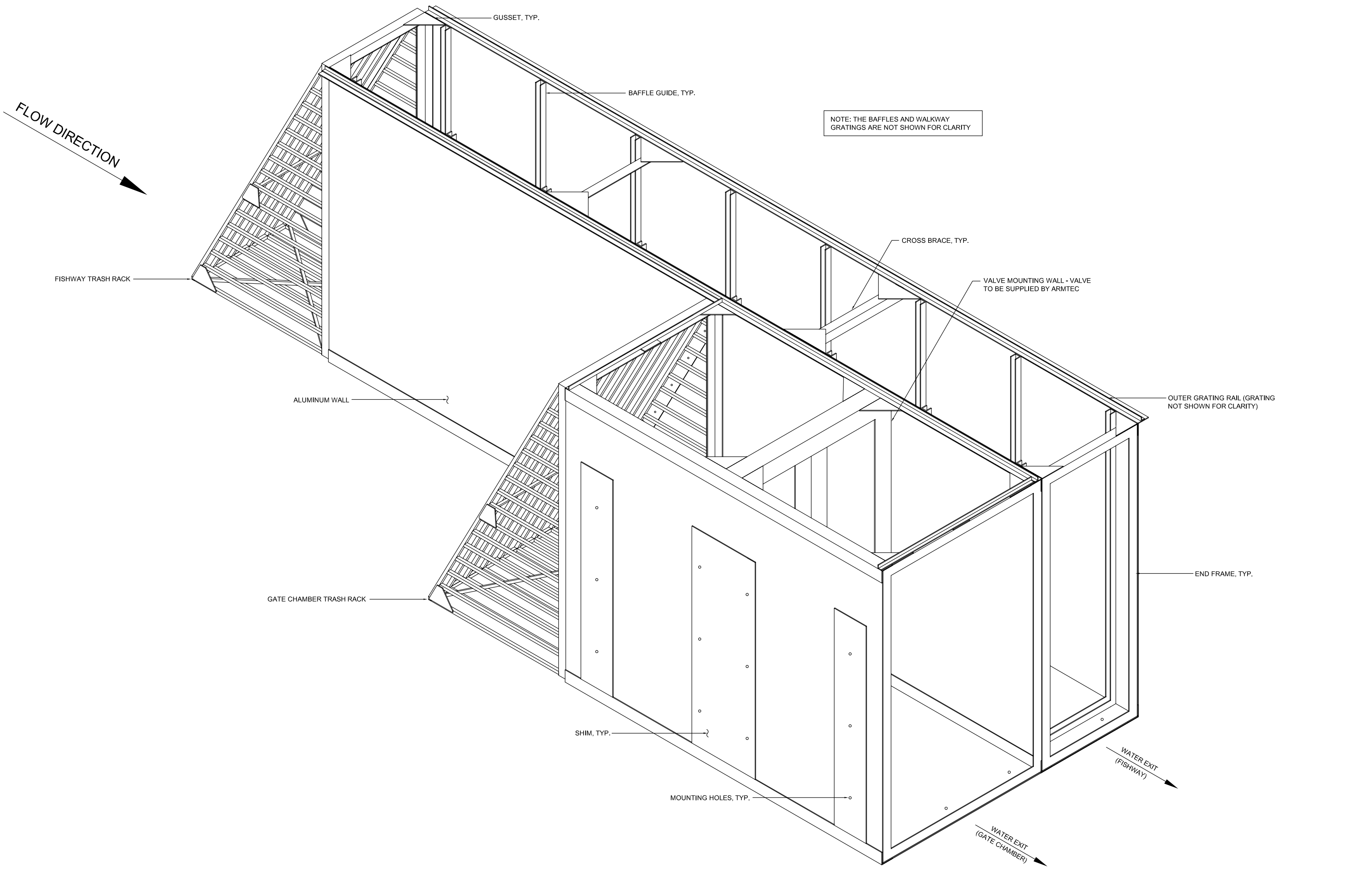
Morris, G. Letter to Water Management, *"Re: Proposed maintenance/upgrade of DFO storage weir at Cameron Lake outlet, Conditional Water License #C052485, File No. 0342743; your file #1412631 and #1002442,"* May 2006.

TABLES

Table 1. Project Costs

No.	Description	Cost ($)
1	Aluminum fishway and valve fabrication	30,044
2	Trucking	5,149
3	Excavation	22,188
4	Rock and gravel	8,251
5	Materials (wood, concrete, rebar, nails, etc)	8,666
6	Rentals (pumps, hoses, saws, trucks, outhouse, etc)	10,963
7	Subcontractor (electrical and concrete cutting)	3,168
8	Subcontractor labour (Gencoast)	19,537
9	Engineering design and construction supervision	40,190
10	Surveying services	527
11	BCCF labour	8,791
12	BCCF travel costs	666
13	BCCF admin	18,989
	GST (as reported by BCCF)	3,891
	Total	181,020

FIGURES



FISHWAY AND GATE CHAMBER STRUCTURE - ISOMETRIC SKETCH

NOT TO SCALE

REVISIONS			
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Drawn By: GRH	Project No: 33986
Reviewed By: BMC	Project Path:
Original Drawing Scale:	Drawing File Name:
	Plot Date:
Drawing Scale:	Revision No:

BC CONSERVATION FOUNDATION
3-1200 PRINCESS ROYAL AVENUE
NANAIMO, BC
(250) 716-8776

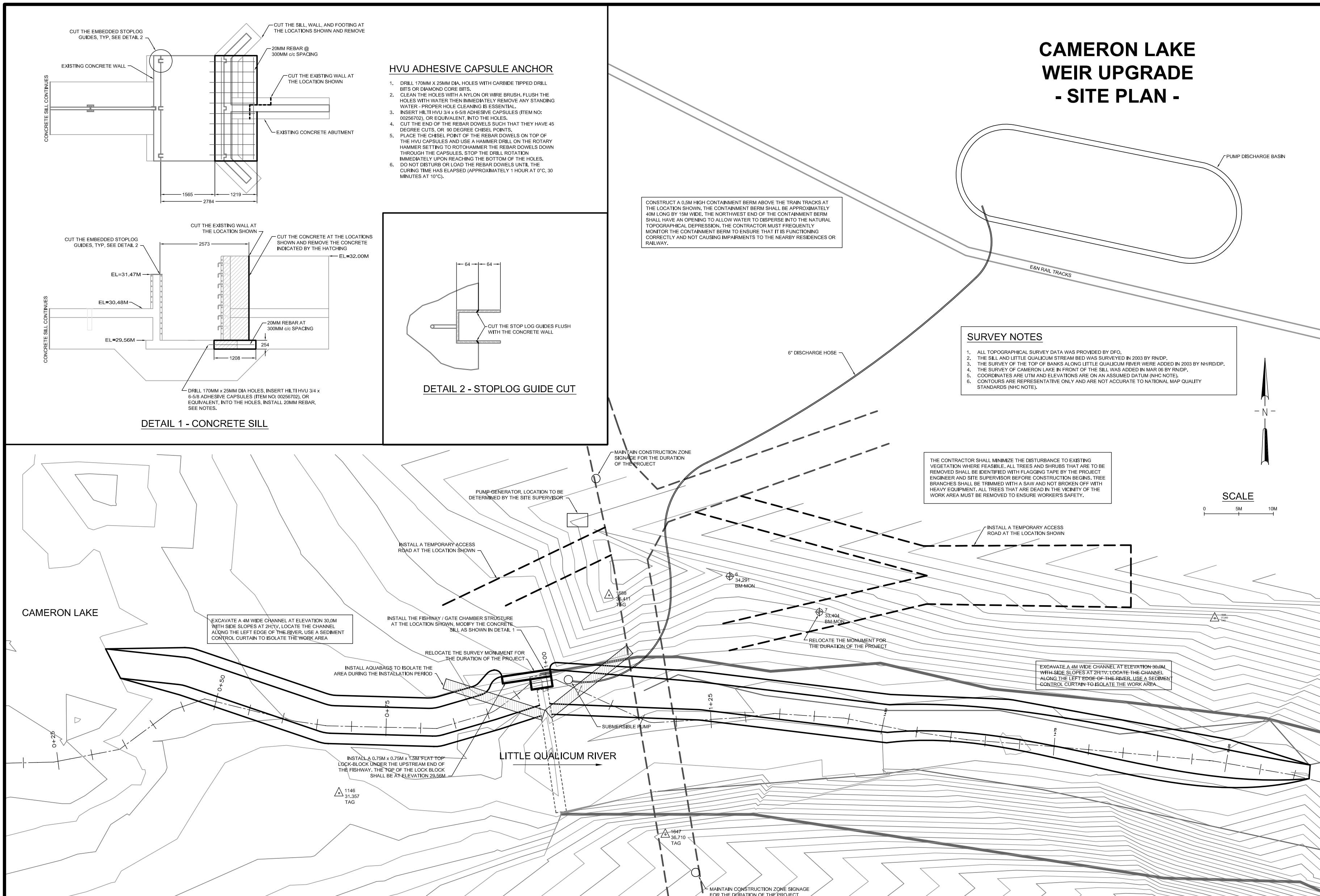
nhc

CAMERON LAKE WIER UPGRADE
- FISHWAY DESIGN -

FISHWAY AND GATE CHAMBER
ISOMETRIC SKETCH

Sheet Reference Number: 2

SHEET 2 OF 8



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Reviewed By:	Project Path:
Original Drawing Scale: 0 1/4" 1/2" 3/4" 1"	Drawing File Name:
	Plot Date:
Drawing Scale:	Revision No:

BC CONSERVATION FOUNDATION
3-1200 PRINCESS ROYAL AVENUE
NANAIMO, BC
(250) 716-8776

nhc
northwest hydraulic consultants, ltd
3150 island highway north
nanaimo, b.c., canada V9T 1V9
office: (250) 758-6425 fax: (250) 758-9264

CAMERON LAKE WEIR UPGRADE

SITE PLAN

Sheet Reference Number:
1
SHEET 1 OF 1

PHOTOGRAPHS

Photo 1. Pre-project conditions – note the fishway on the river's left.

Photo 2. Aquabags and a 600 volt, 150 mm submersible electric pump were used to isolate the fishway area.

Photo 3. A concrete saw was used to cut the fishway and left bank abutment. An excavator lifted the concrete sections out of the way.

Photo 4. Reinforced concrete footings were constructed for the fishway structure.

Photo 5. A hydraulic excavator positioned the fishway structure on the footings.

Photo 6. Concrete anchor bolts were used to secure the aluminium fishway to the concrete footings.

Photo 7. A steel reinforcement ladder was bolted to the side of the fishway. Galvanized steel cables linked the ladder to the concrete abutment and a block buried in the bank.

Photo 8. The area upstream of the weir was isolated and a low flow channel was excavated connecting the lake to the weir.

Photo 9. The gate was used to regulate flows in the river immediately after the construction was completed.

APPENDIX A

LIST OF PROJECT CONTACTS

Company Name	Service	Contact Person	Phone no.
BC Conservation Foundation	Fisheries Technician	James Craig	(250) 716-8776
Ministry of the Environment	Biologist	Craig Wightman	(250) 716-8776
Department of Fisheries and Oceans	Generator / pumps	Les Clint	(250) 757-8412
Department of Fisheries and Oceans	Biologist	Mel Sheng	(250) 756-7016
Northwest Hydraulic Consultants	Engineering	Graham Hill	(250) 758-6425
Gencoast Contracting Ltd	General contractor	Barry Genoe	(250) 752-5305
ITT Flygt	Pump rental	Don Chin	(604) 941-6664
Cancor Cutting and Coring Ltd	Concrete cutting		(250) 752-1287
Copcan Contracting Ltd	Excavating	Dave Gregson	(250) 754-7260
Angus Taschuk Excavating	Excavating	Angus Taschuk	(250) 752-9672
Rascal Trucking	Trucking		(250) 248-8155
J. Sheehan Trucking	Trucking	Joe Sheehan	(250) 923-4791
Armtec Ltd	Valve	Chuck Baynham	(250) 754-1238
Grey Rock Welding	Fishway fabrication	Gord Elliot	(250) 334-2202