EA3183

Protection and Restoration Strategy and Action Plan for Thames and Nash Creeks

***Prepared for*:**

Trout Unlimited Canada

Nile Creek Enhancement Society

Vancouver Island University

March 2011

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Protection and Restoration Strategy and Action Plan for Thames and Nash Creeks *(DRAFT)*

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOS

1 Introduction

The Nile Creek - Qualicum Bay Enhancement Program is a comprehensive habitat restoration and enhancement initiative being undertaken by Nile Creek Enhancement Society (NCES), Trout Unlimited Canada (TUC), and Vancouver Island University (VIU). The Program was designed as part of Trout Unlimited Canada's National Watershed Renewal Program and proposes to implement enhancement / restoration work in six tributaries of Qualicum Bay. The tributaries include: Thames, Nile, Annie and Nash creeks, and Westglade and Black brooks. The major objectives of the Enhancement Program are:

- To re-build sea-run cutthroat trout in creeks and streams flowing into Qualicum Bay on Vancouver Island by restoring degraded habitat and re-establishing and improving access to restored and productive anadromous cutthroat trout habitat from the inter-tidal area through to the headwaters of six streams; and

- To build and test a model for engaging the community and a post secondary education institution in the planning and delivery of a broader area conservation program with five components: a conservation component; a youth engagement component; a science development/project management component; a communication component; and a fund-raising component.

This report primarily addresses the first objective and lays a foundation for completing the second objective. The report includes a review of previously documented information on Thames and Nash creeks, as well as habitat assessment information, hydrological data and conceptual restoration designs from 2010-11 assessments and surveys. The report also describes some key activities that could be implemented by NCES and TUC to protect watersheds flowing into Qualicum Bay. As described in the following report, the main deliverables for this project included:

1. A list of feasible, high priority enhancement / restoration projects that could be implemented in two key tributaries, Nash and Thames creeks, of Qualicum Bay;
2. Conceptual habitat designs at up to six high priority enhancement / restoration sites in these two key tributaries; and
3. A framework for a protection and rehabilitation strategy for Qualicum Bay watersheds that would be delivered by the local community and Nile Creek Enhancement Society.

To achieve the deliverables for this project, the work program in 2010/2011 included the following activities:

1. Review existing habitat assessment reports and assess the feasibility of the recommended enhancement / restoration projects as proposed in previous reports of the Urban Salmon Habitat Program;
2. Interview individuals from TUC, NCES, VIU, Fisheries and Oceans (DFO) and BC Ministry of Environment (MOE) to determine other potential enhancement / restoration project sites. Assess the feasibility and habitat priority of these potential enhancement / restoration projects;

3. Conduct focused habitat assessments in Nash and Thames creeks as part of the feasibility assessments of previously recommended opportunities and to identify new instream, off-channel and riparian treatment opportunities;
4. Conduct topographic surveys at high priority enhancement / restoration sites;
5. Prepare conceptual design drawings for up to six high priority sites in these two Qualicum Bay tributaries;
6. Develop a preliminary cost estimate for implementation of the enhancement / restoration works at those sites where preliminary design drawings were prepared; and
7. Prepare a final report that:
    a. describes a framework for a protection and restoration strategy for Qualicum Bay tributaries; and
    b. includes field assessments, feasibility evaluations, project priority rankings, conceptual design drawings and preliminary cost estimates for proposed high priority rehabilitation projects.

1.1 Protection and Restoration Strategy for Qualicum Bay Tributaries

A habitat protection, restoration and enhancement strategy for the Qualicum Bay watersheds does not currently exist or at best exists as a fragmented approach by various groups or government departments. Our objective is to provide a strategy and action plan to identify, prioritize and implement projects that protect, restore and enhance primarily cutthroat trout and coho populations and their habitats in specific watersheds draining into Qualicum Bay. It is envisaged that implementation of the strategy will ensure that the survival and growth of each watershed's native fish populations and the current integrity and condition of their habitats are maintained or enhanced over the long term. The strategy and action plan is targeted at the Local Community / Municipal Government engagement platform. Once developed, this document will form a procedural methodology for the local community and NCES to work with government, First Nations (FNs) and other Streamkeeper Groups (SGs) to guide future land use developments and to implement high priority habitat projects that protect the integrity of these watersheds and maintains or enhances the current viability of the native fish populations that reside within. And we are hopeful that the approach outlined in this document will also provide a working model or template that could be used by other communities to protect, enhance or restore their watersheds and habitats.

Development of this habitat strategy and its implementation over the long term will require the establishment of successful working relationships and partnerships between individuals that are connected or concerned about Qualicum Bay coho and cutthroat trout including community conservation groups, local, provincial and federal governments, industry, First Nations, and other concerned citizens and volunteer organizations.

1.2 Spatial Scope

The study area for the broader Nile Creek - Qualicum Bay Enhancement Program includes six tributaries to Qualicum Bay: Thames, Nile, Annie and Nash creeks, and Westglade and Black

brooks. In 2010-11, the first year of the program, work concentrated on the Thames and Nash creek watersheds.

2 Watershed Profile

2.1 Thames Creek

2.1.1 Physical Setting

Thames Creek has a watershed area of 10.2 km^2. The creek originates in the Beaufort Range and flows in a north-easterly direction, entering Georgia Strait just south of Bowser. The length of the mainstem is 8.5 km but flows are typically sub-surface upstream of 6.8 km during the summer. Gradient of the creek ranges from 0.7-36% with a mean of 3.7% in the lower 6.8 km (Figure 1).

The shape of the Thames Creek longitudinal profile and surficial deposits found within the East Vancouver Island area are predominantly the result of glaciation during the Pleistocene epoch (Figure 2; Jungen 1985). Unconsolidated sands (loamy and gravelly loamy sands), gravels and tills are commonly found deposits within the Nash-Nile-Thames area (Figure 3; Day et al. 1959). Marine silts, clays, sands and gravels are also common at elevations low enough to be affected by episodes of sea level transgression.

The largest groundwater reserves in the area are contained in recent alluvial deposits, terraced fluvial and deltaic deposits, and in the Quadra Sand and other sediments of the Vashon Drift (Ronneseth 1984; 1985). The relatively high summer low flows and low water temperatures in the Nile to Thames area is evidence of the importance of these aquifers on maintaining high quality aquatic habitats for salmonids.

Land within the Thames Creek watershed is primarily owned by the Crown (59.44%), followed by TimberWest (21.11%) and private residential (12.16%) (Figure 4; Table 1). Most of the Crown land is found in the middle reaches of the creek, while TimberWest lands occur in the headwaters and private residential lands occur in the lower and middle reaches.

2.1.2 Hydrology

In 2010, we established a flow gauging station in Thames Creek approximately 140 m upstream of the Highway 19A crossing (Figure 4; Photo 1). The station was established on 14 January 2010 and continuous records using a level logger (Hobo Onset) began 21 January 2010. Water level measurements were recorded by the level logger from 21 January to 2 July and from 11 August to 4 November.

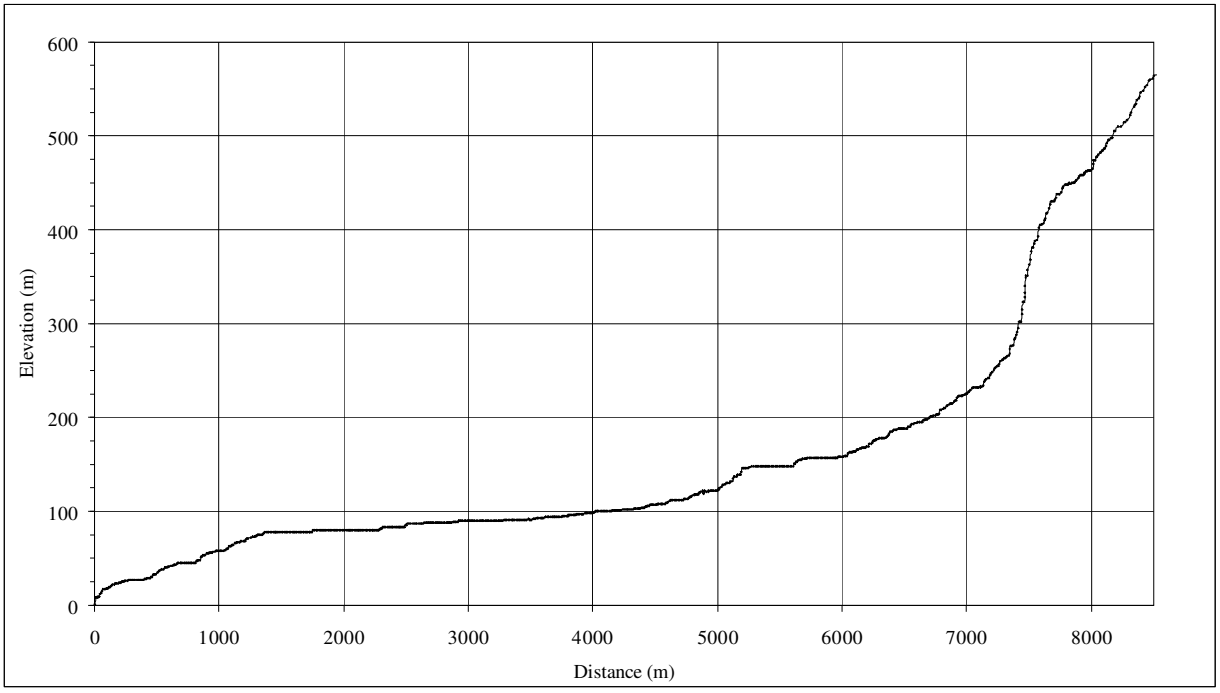

Figure 1. Longitudinal profile of Thames Creek.

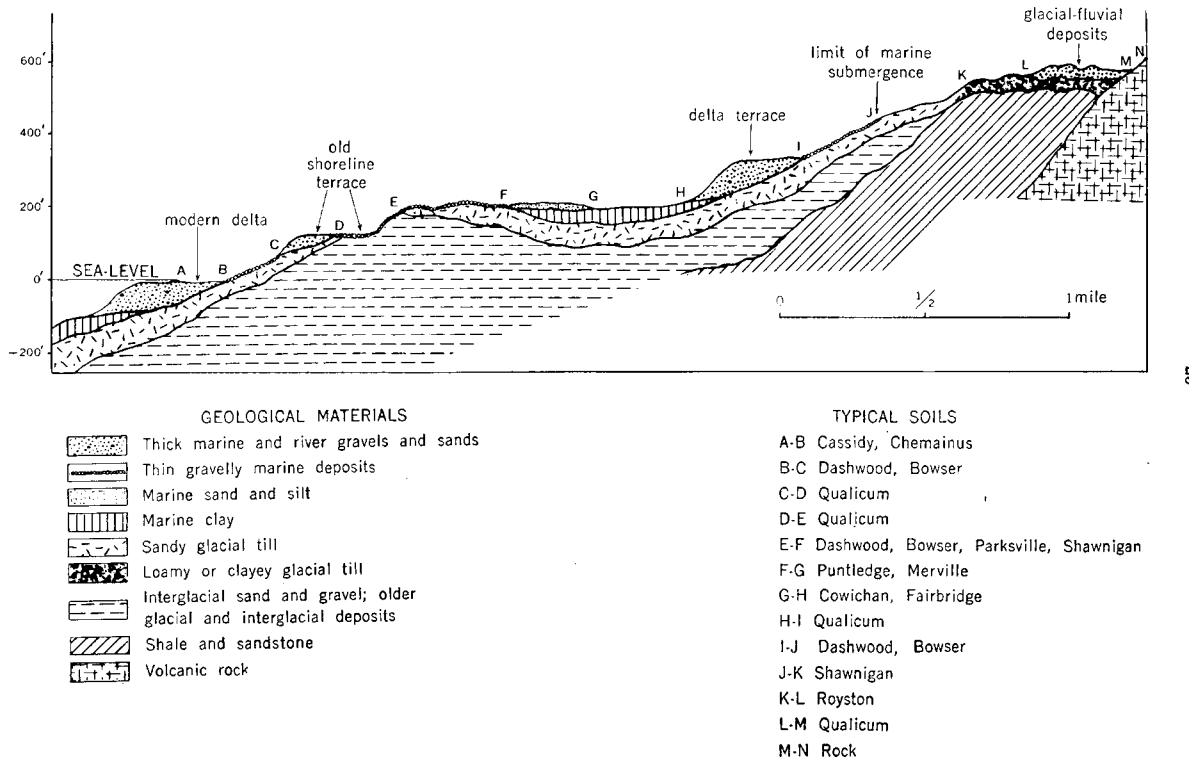

Figure 2. Diagrammatic vertical section showing materials beneath the eastern coastal lowland of Vancouver Island. Geological relations are typical of the country between Campbell River and Lantzville. Limit of marine submergence for Thames Creek estimated at 500 ft (~152 m). Reproduced from Soil Survey of Southeast Vancouver Island and Gulf Islands, British Columbia (Day et al. 1959).

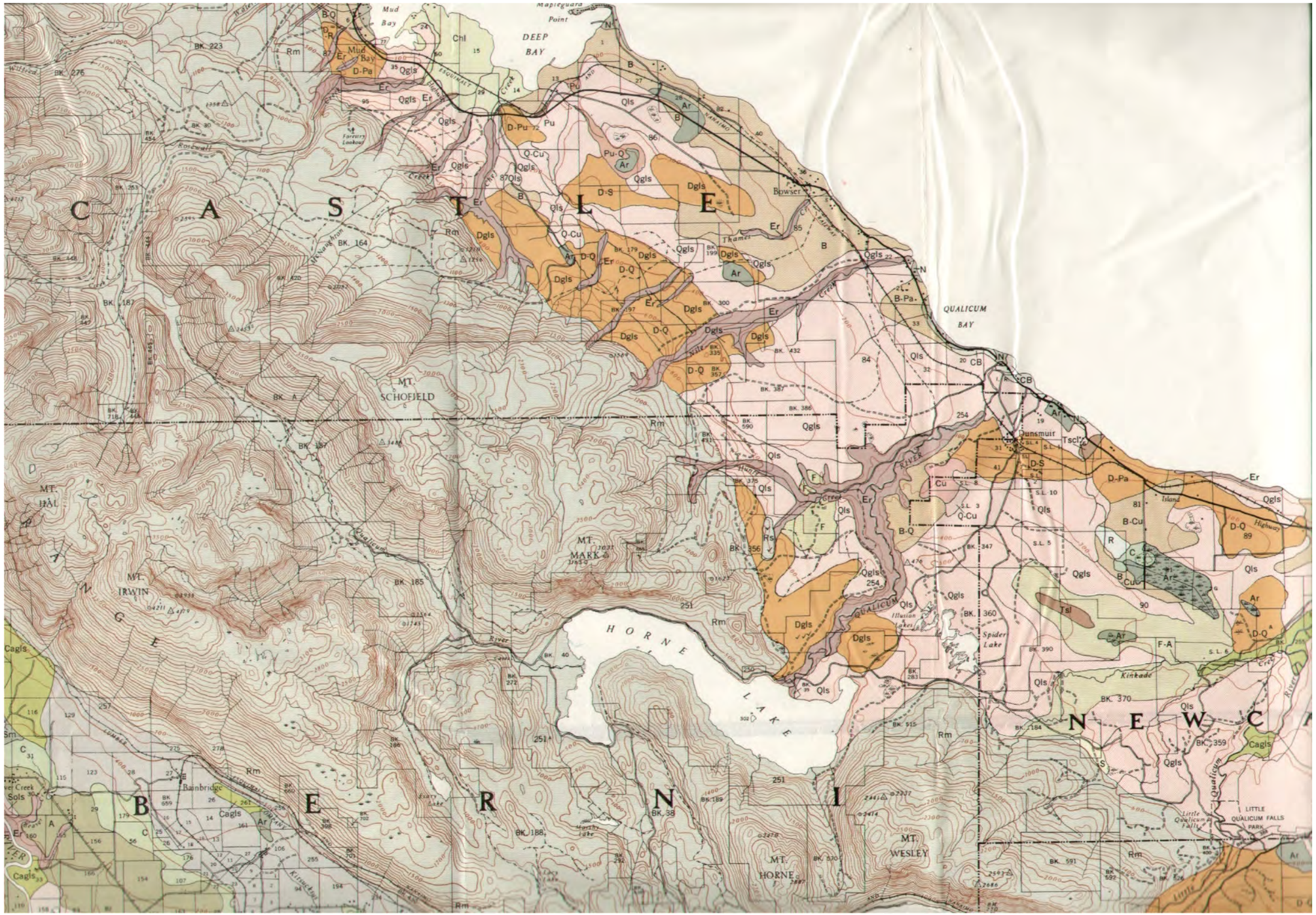

Figure 3. Surficial soil map of Qualicum Bay area. Classification series B (Bowser), D (Dashwood), Er (Eroded Land), and Q (Qualicum) predominate. Gravelly loamy sand (gls) and loamy sand (ls) are the predominant soil types. Reproduced from Day et al. (1959).

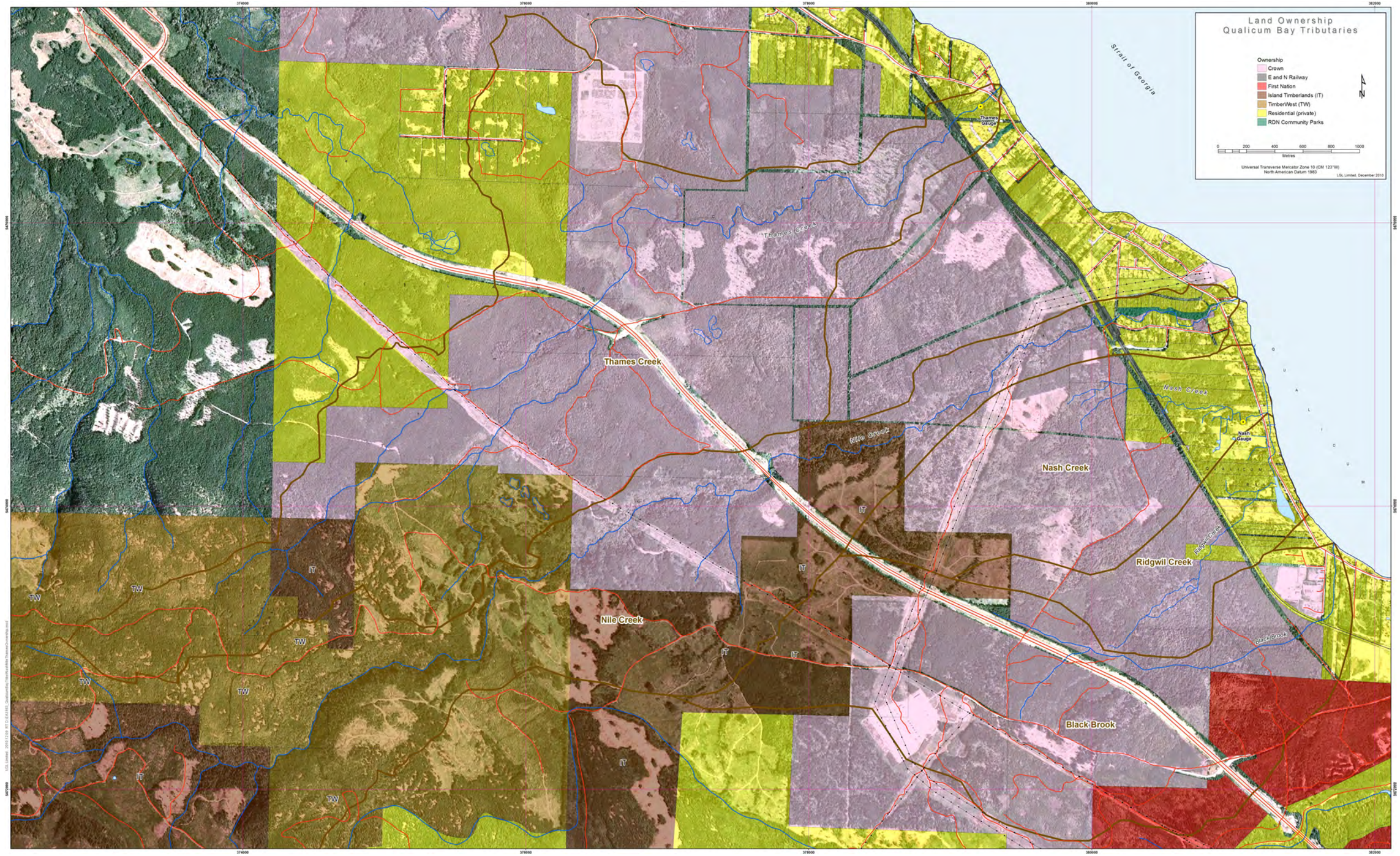

Figure 4. Landownership map for Qualicum Bay watersheds: Black Brook, Ridgwil Creek, Nash Creek, Nile Creek and Thames Creek.

Table 1. Land ownership for Qualicum Bay watersheds based on percentage of watershed area.

Watershed	Ownership Class	Percent of Watershed Area
Black Brook	Crown	60.75%
	First Nation	13.43%
	Island Timberlands	13.52%
	Residential (private)	3.80%
	Road R/W	8.51%
Nash Creek (without Ridgwil Creek)	Crown	65.94%
	E&N	0.79%
	Island Timberlands	10.48%
	Residential (private)	19.79%
	Road R/W	3.00%
Ridgwil Creek	Crown	62.00%
	Island Timberlands	4.14%
	Residential (private)	29.91%
	Road R/W	3.96%
Nash Creek (with Ridgwil Creek)	Crown	64.66%
	E&N	0.53%
	Island Timberlands	8.42%
	Residential (private)	23.08%
	Road R/W	3.31%
Nile Creek	Crown	13.25%
	E&N	0.15%
	Island Timberlands	59.33%
	RDN Community Parks	0.21%
	Residential (private)	1.92%
	TimberWest	23.85%
	Road R/W	1.30%
Thames Creek	Crown	59.44%
	E&N	0.18%
	Island Timberlands	3.51%
	RDN Community Parks	0.01%
	Residential (private)	12.16%
	TimberWest	21.11%
	Road R/W	3.59%

A stage-discharge relationship was developed based on five measured discharges and a continuous daily flow record for the creek was produced (Figure 5). In the period of record between 21 January 2010 and 4 November 2010, flows ranged between 0.006 and 3.196 cubic metres per second (cms) (Table 2). An estimated peak discharge of 3.196 cms occurred on 1 November. Minimum flows of 0.006 and 0.007 cms occurred during August and September.

Photo 1. Flow gauging station in glide habitat on Thames Creek, 21 January 2010.

Table 2. Minimum, maximum and mean discharges (cubic metres per second) recorded for Thames and Nash creeks between January and November 2010.

	Thames Creek			Nash Creek		
	Minimum	Maximum	Mean	0.000	Minimum	Maximum
January	0.172	0.749	-	0.029	0.179	-
February	0.075	1.614	0.260	0.007	0.220	0.044
March	0.090	1.341	0.266	0.014	0.333	0.056
April	0.111	1.911	0.258	0.017	0.683	0.098
May	0.084	0.292	0.136	0.005	0.063	0.016
June	0.059	0.479	0.103	0.005	0.100	0.012
July	0.064	0.075	-	0.004	0.011	-
August	0.006	0.030	-	0.0005	0.014	-
September	0.007	0.501	0.044	0.0004	0.038	0.007
October	0.019	0.946	0.083	0.003	0.101	0.013
November	0.146	3.196	-	0.033	0.448	-

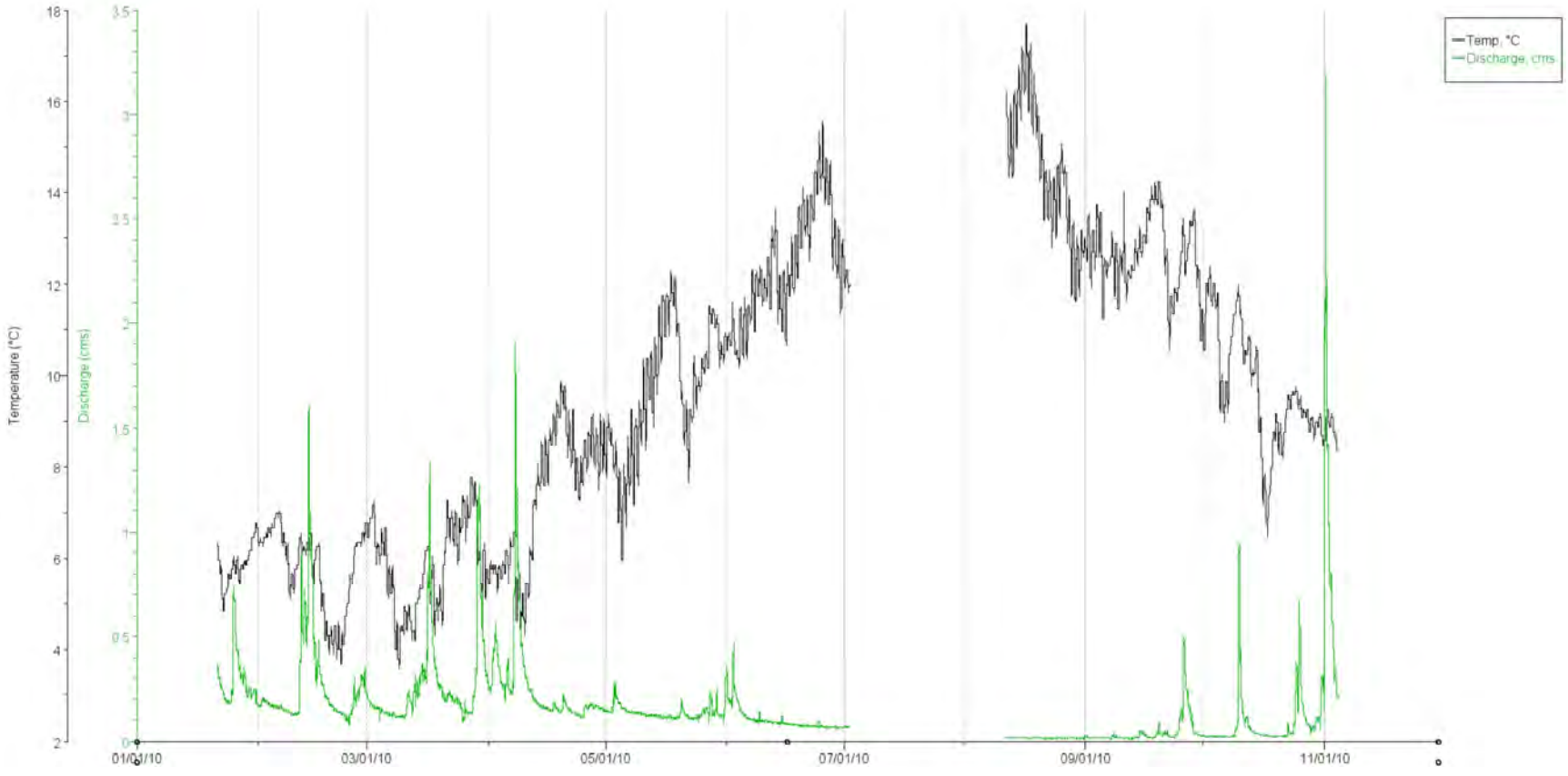

Figure 5. Temperature and discharge plots for Thames Creek, 21 January 2010 – 4 November 2010.

2.1.3 Fish Resources

Coho salmon, cutthroat trout (resident and anadromous), and steelhead are reported to occur in Thames Creek (Fish Wizard http://webmaps.gov.bc.ca/imf5/imf.jsp?site=awiz). VIU students electrofished the creek on 15 July 2008. With 6618 seconds of fishing in two reaches, the students caught 21 (0.003 fish/sec) cutthroat trout and 107 (0.016 fish/sec) coho salmon. Cutthroat trout length ranged from 31 to 210 mm, with a mean length of 59 mm (Figure 6). Weights ranged from 0.3 to 102.2 g with a mean weight of 24.0 g. Condition factor averaged 1.1 with a standard deviation of 0.8.

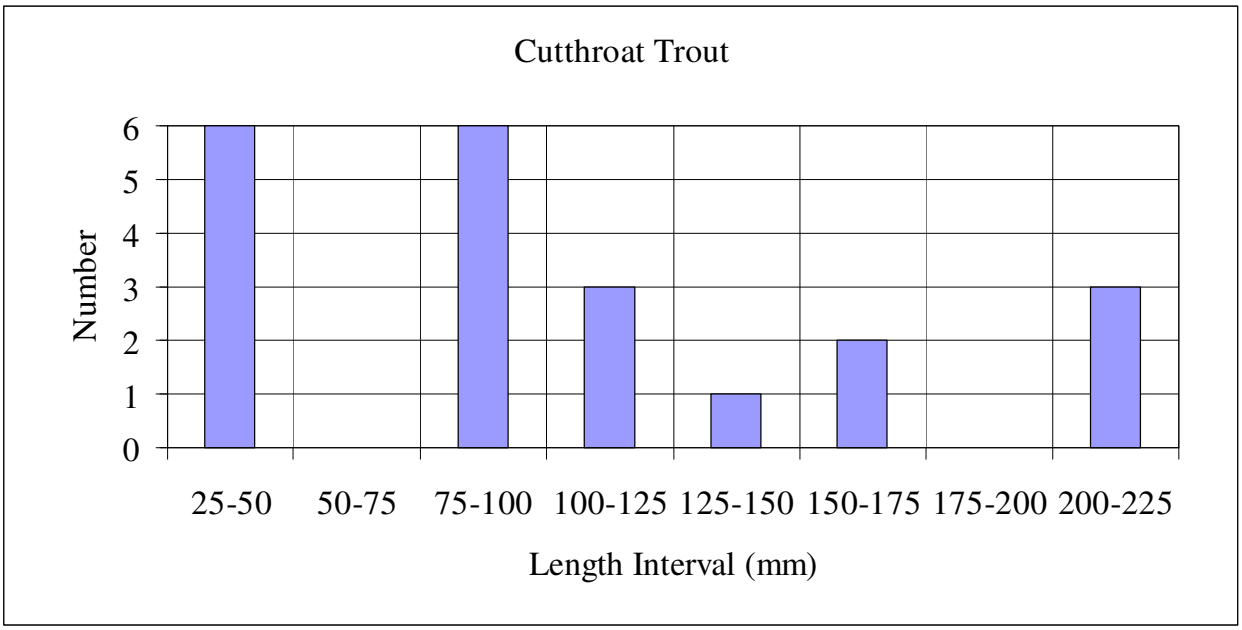

Figure 6. Length-frequency for cutthroat trout captured in electro-fishing surveys in Thames Creek, 2008.

Coho salmon length ranged from 33 to 98 mm, with a mean length of 51 mm (Figure 7). Weights ranged from 0.4 to 11.7 g with a mean weight of 2.1 g. Condition factor averaged 1.5 with a standard deviation of 0.5.

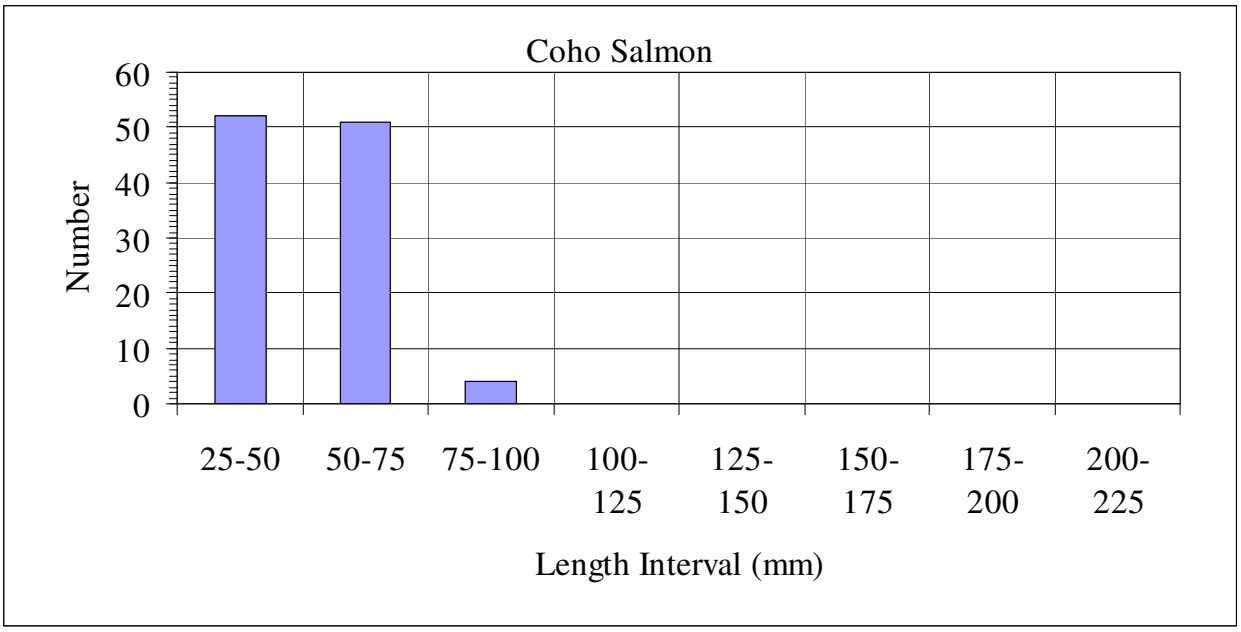

Figure 7. Length-frequency for coho captured in electro-fishing surveys in Thames Creek, 2008.

2.1.4 Habitat Description and Condition

An Urban Salmon Habitat Program (USHP) habitat assessment was completed by NCES between 2000 and 2003 (NCES 2003). Channel characteristics for pool habitats measured during the NCES (2003) assessment are summarized in Table 3. No visible discharge was found upstream of chainage 6.8 km in Reach 6, located in a steeper channel section below the BC Hydro transmission corridor. Also, subsurface flows were documented over a short section of gravel and cobble aggradation in Reach 3, between the Southern Railway culvert and Highway 19. Also, NCES identified several limiting factors including: a lack of large wood debris (LWD), a low percentage of boulder cover and wetted area, and a high percentage of fines.

Although no detailed habitat surveys were conducted in this project, it was apparent that Thames Creek is flow-limited during the summer period, which in turn affects aquatic habitat quality and the capacity of the creek to rear fish. However, beaver ponds located immediately downstream of Highway 19 are maintained at relatively high water levels throughout the year, providing excellent rearing and overwintering habitat for coho and cutthroat trout (Photo 2). High quality rearing habitats were also found in the stream between Highway 19A and the Southern Railway crossing (Photo 3). Large areas of high quality spawning habitat for coho and cutthroat trout were also found throughout the mainstem, particularly in the lower gradient reach above the Southern Railway crossing (chainage 1+179 m) to the beaver ponds near Highway 19, and the reach from Highway 19 (chainage 5+050 m) upstream to chainage 5+400 (Photo 4 and Photo 5).

Observations of an overwidened channel and a large bar of coarse substrate at chainage 5+265 m (Photo 6) provided evidence of some disturbance in the upper watershed suggesting either a bank or road crossing failure. However, the occurrence of disturbed channels was very infrequent. In most of the reaches walked, the channel was stable (Photo 7) with numerous full-spanning sill logs and a frequent occurrence of woody debris cover in pools (Photo 8).

Two locations were identified that may potentially be impediments to upstream fish migration. The Highway 19A crossing has a smooth, concrete apron at the downstream end of the culvert that results in a section of high velocity water during the late fall period when chum and coho spawners are migrating upstream. NCES members indicated that the high velocities appear to be limiting access by chum spawners into the baffled culvert. Designs to rehabilitate this site are described in Section 4.2.1 and construction works to rehabilitate this site were completed in September 2010.

The second access impediment is located at the Southern Railway culvert crossing. The crossing has a concrete apron at the downstream end that is perched above the tailwater surface. Also, two concrete baffles inside the culvert are broken and, therefore, are not functioning to create a backwater effect. Over 4 km of high quality spawning and rearing habitat exists upstream of the railway crossing. Designs to rehabilitate this site are described in Section 4.2.1 and construction is proposed for August or September 2011.

Temperature measurements were recorded continuously by the level logger from 21 January to 2 July and from 11 August to 4 November (Figure 5; Table 4). Between 21 January 2010 and 4 November 2010, recorded temperatures ranged between ~3.6 ^{0}C in March and 17.7 ^{0}C in August. These temperatures are quite suitable for salmonids and would not limit their growth and survival.

Table 3. Summary of pool habitat characteristics based on USHP inventory report (NCES 2003).

				Estimated	Substrate Composition (%)				
Reach	Reach Length (m)	Wetted Width (m)	Bankfull Width (m)	Reach Gradient (%)	Boulder	Cobble	Gravel	Fines	Comments
1	144	7.9	-	2.0	0	30	70	0	Between mouth & Hwy 19A
2	415	-	-	-	-	-	-	-	Hwy 19A to Southern Railway culvert; No pools in Reach
3	5050	4.4	6.3	1.5	1	5	45	48	Southern Railway culvert to Inland Hwy 19
4	238	3.2	3.8	2.0	0	2	55	44	Inland Hwy 20 to logging road bridge
5	486	3.4	6.8	5.8	0	0	45	55	Logging road bridge to high gradient Reach
6	471	3.5	5.0	6.3	0	57	38	2	High gradient Reach up to point where flows go sub-surface @ 6803 m

Photo 2. Beaver pond complex in Thames Creek downstream of Highway 19.

Photo 3. Deep pool with large woody debris cover providing excellent salmonid rearing habitat in Thames Creek at chainage 1+280 m upstream of Highway 19A, 4 March 2010.

Photo 4. Looking upstream in Thames Creek at high quality spawning gravel, chainage 5+150 m (located upstream of Highway 19).

Photo 5. Looking upstream in Thames Creek at full-spanning sill log, rearing habitat in plunge pool, and high quality spawning gravel, chainage 5+396 m (located upstream of Highway 19).

Photo 6. Large accumulation of coarse bedload in Thames Creek, chainage 5+265 m.

Photo 7. Typical morphology for undisturbed sections of Thames Creek channel, chainage 5+330 m.

Photo 8. Thames Creek showing two full-spanning sill logs, rearing pools and spawning gravel, chainage 5+169 m.

Table 4. Minimum, maximum and mean temperatures recorded for Thames and Nash creeks between January and November 2010.

	Thames Creek			Nash Creek		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
January	4.83	6.78	-	5.24	6.67	-
February	3.68	7.08	5.78	4.10	6.98	5.96
March	3.58	7.78	5.85	4.31	7.38	6.02
April	4.31	9.87	7.35	4.83	8.78	7.15
May	5.96	12.30	9.64	6.17	10.65	8.94
June	10.16	15.57	12.40	9.37	13.37	11.16
July	11.82	12.40	-	11.04	14.90	-
August	11.63	17.67	-	11.53	15.95	-
September	10.55	14.23	12.66	10.65	13.94	12.50
October	6.47	12.40	9.71	7.08	12.69	10.13
November	8.38	9.28	-	8.58	9.67	-

2.2 Nash Creek

2.2.1 Physical Setting

Nash Creek is a small watershed that includes one named tributary, Ridgwil Creek. Ridgwil Creek alone has a watershed area of 1.4 km^2 and the total drainage area of Nash Creek watershed is 4.4 km^2. The creek originates near the BC Hydro transmission line corridor and generally flows in a south-easterly direction until it reaches the foreshore where it flows northerly behind the gravel beach ridge for about 471 m before entering the ocean (Photo 9). The length of the mainstem is ~2.5 km but flows are typically sub-surface upstream of 1.7 km during the summer. Gradient of the creek ranges from 0.3-8.8% with a mean of 1.7% in the lower 1.5 km (Figure 8).

Surficial soils and geology is similar to that described for Thames Creek in Section 2.1.1 above (Figure 2; Figure 3). Also, as with Thames Creek, evidence of groundwater outfalls and low summer water temperatures in Nash Creek were found in our surveys which emphasizes the importance of aquifers on maintaining high quality aquatic habitats for coho and cutthroat trout.

Photo 9. Looking downstream in Nash Creek flowing north and parallel to beach ridge, 14 January 2010.

Nash Creek is within Woodlot Licence W1464 as managed by the Ministry of Forests and Range, South Island District (Figure 9). Four cutblocks (2, 3, 9 and 10) are within the watershed boundary of the creek. Nash Creek is classified an S3 stream under the Forest and Range Practices Act in this woodlot licence.

Land within the Nash Creek watershed (not including Ridgwil Creek) is primarily owned by the Crown (65.94%), followed by private residential (19.79%) and Island Timberlands (10.48%) (Figure 4; Table 1). Most of the Crown land is found in the middle reaches of the creek, while Island Timberlands lands occur in the headwaters and private residential lands occur in the lower reaches.

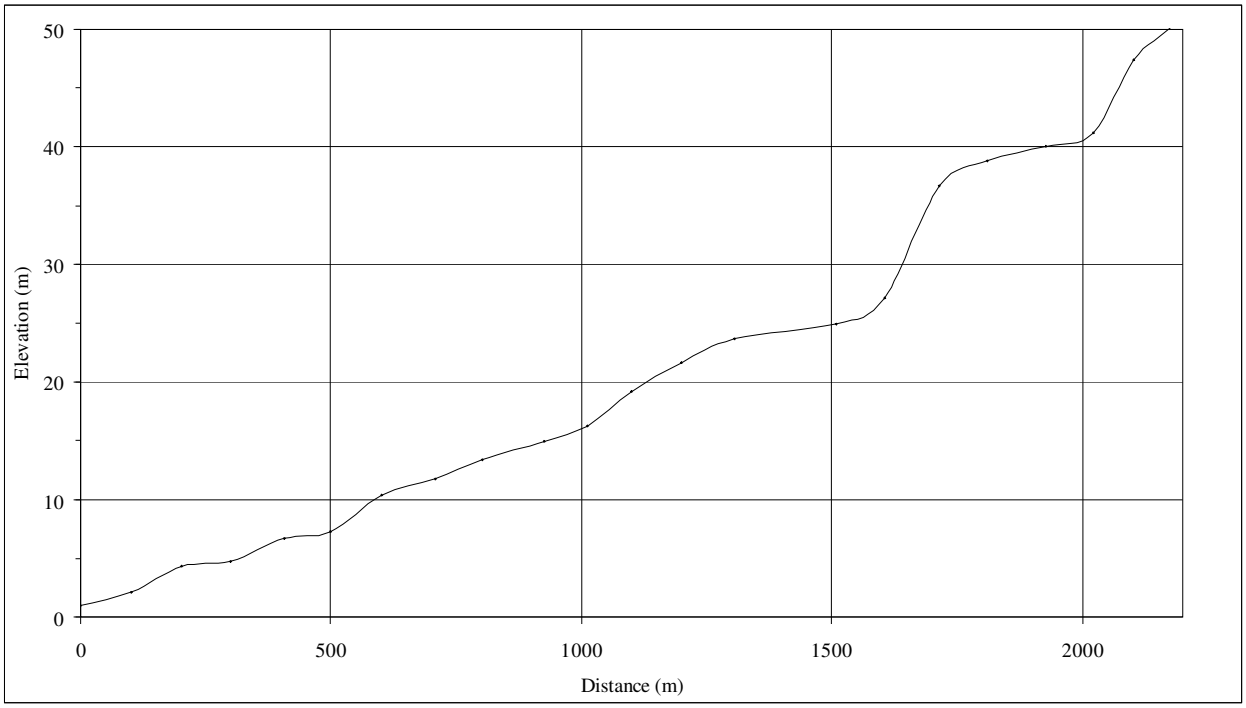

Figure 8. Longitudinal profile of Nash Creek.

2.2.2 Hydrology

A flow gauging station was established in Nash Creek on Dale and Brenda Wilson's property (Figure 4; Photo 10). The station was established on 14 January 2010 and continuous records using a level logger (Hobo Onset) began 21 January 2010. Water level measurements were recorded by the level logger from 21 January to 16 July and from 11 August to 4 November. A stage-discharge relationship was developed based on five discharge measurements and a continuous daily flow record for the creek was produced (Figure 10). In the period of record between 21 January 2010 and 4 November 2010, flows ranged between 0.0004 and 0.683 cms (Table 2). An estimated peak discharge of 0.683 cms occurred on 8 April. Minimum flows of 0.0005 cms (0.5 L/s) and 0.0004 cms (0.4 L/s) occurred during August and September, respectively.

Construction of two floodway structures in 1997 adjacent to the beach ridge now convey the higher flood discharges in Nash Creek directly to the ocean (Northwest Hydraulic Consultants 1998). The diversion of flood flows through the floodway structures reduces the opportunity for natural freshets to scour the gravels at the creek mouth and as a consequence a distinct surface water channel between the creek and ocean is typically absent between mid-April until late October.

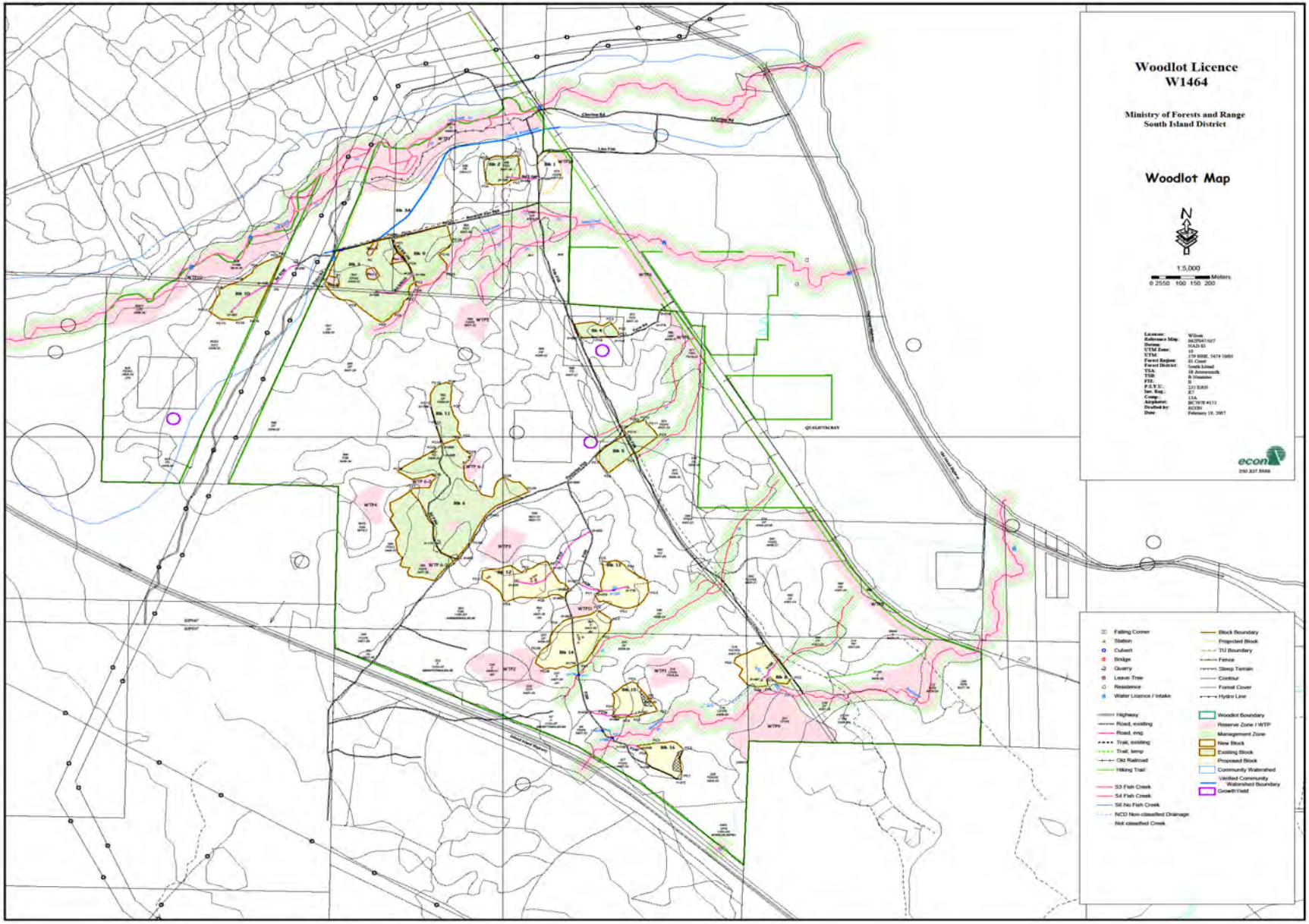

Figure 9. Map of Woodlot Licence W1464.

Photo 10. Flow gauging station on Nash Creek, 21 January 2010.

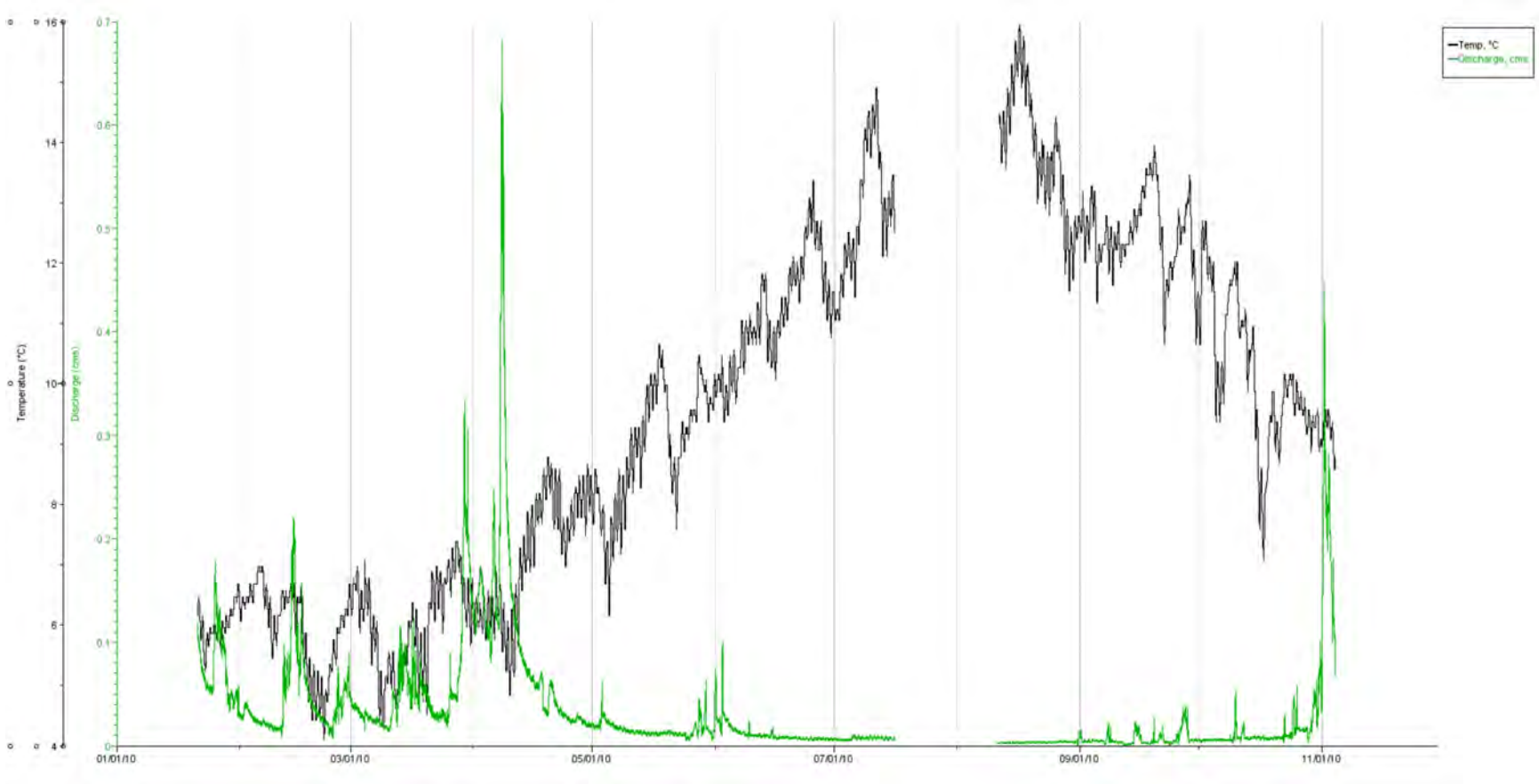

Figure 10. Temperature and discharge plots for Nash Creek, 21 January 2010 – 4 November 2010.

2.2.3 Fish Resources

Coho and cutthroat trout have been captured in Nash Creek. VIU students electrofished the creek on 14 July 2008. With 6412 seconds of fishing in two reaches, the students caught 75 (0.012 fish/sec) cutthroat trout and 65 (0.010 fish/sec) coho salmon. Cutthroat trout length ranged from 26 to 220 mm, with a mean length of 66 mm (Figure 11). Weights ranged from 0.3 to 106.5 g with a mean weight of 11.4 g. Condition factor averaged 2.2 with a standard deviation of 1.2.

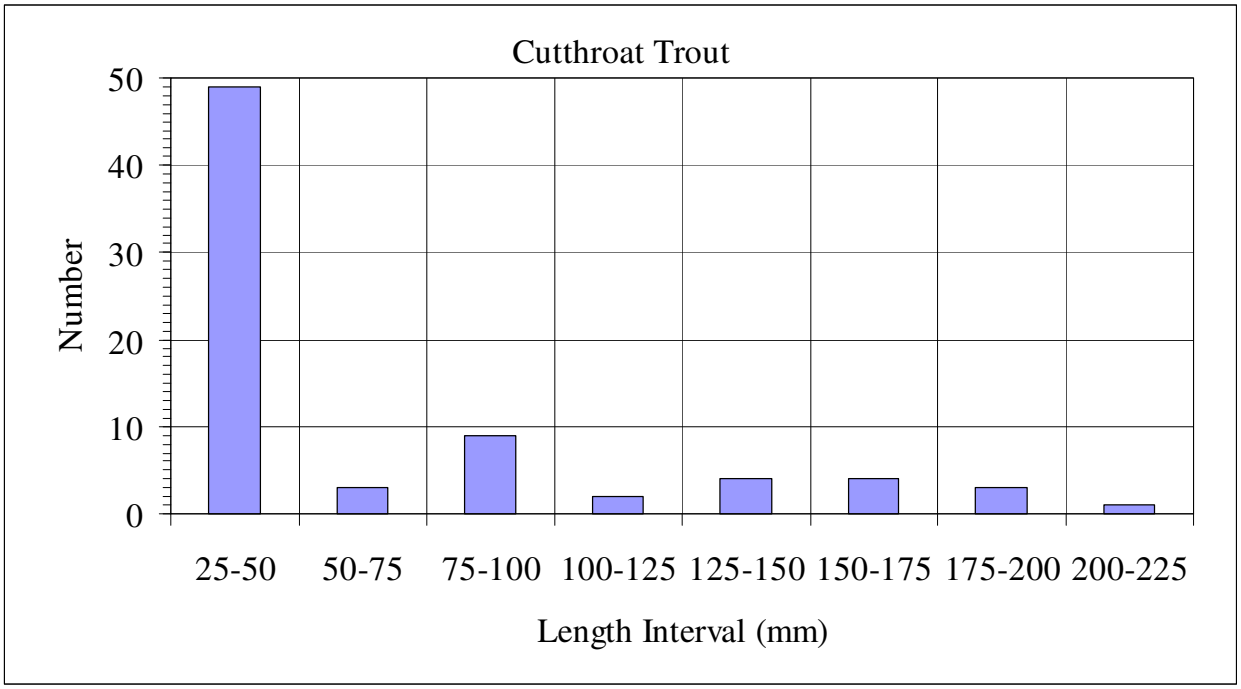

Figure 11. Length-frequency for cutthroat trout captured in electro-fishing surveys in Nash Creek, 2008.

Coho salmon length ranged from 30 to 160 mm, with a mean length of 49 mm (Figure 12). Weights ranged from 0.3 to 45.8 g with a mean weight of 4.6 g. Condition factor averaged 3.1 with a standard deviation of 2.4.

Cutthroat trout and coho salmon smolts are prevented from entering the ocean annually each spring because of a build-up of gravels on the beach ridge that blocks the Nash Creek mouth. Discharges in Nash Creek decrease significantly after early April and as a consequence the discharges are not sufficient to maintain channel connectivity between the creek and the ocean. The low discharges in the creek during the smolt migration period are lost as flows pipe through the porous gravel beach ridge, effectively straining out the cutthroat and coho smolts. As a result, members of NCES annually trap coho and cutthroat trout smolts and transfer them to Nile Creek, from which the smolts then migrate to the ocean (Table 5). Two fish of 120 and 160 mm captured during the VIU electrofishing surveys (Figure 12) also substantiates NCES assessment results that smolt emigration from Nash Creek is impeded.

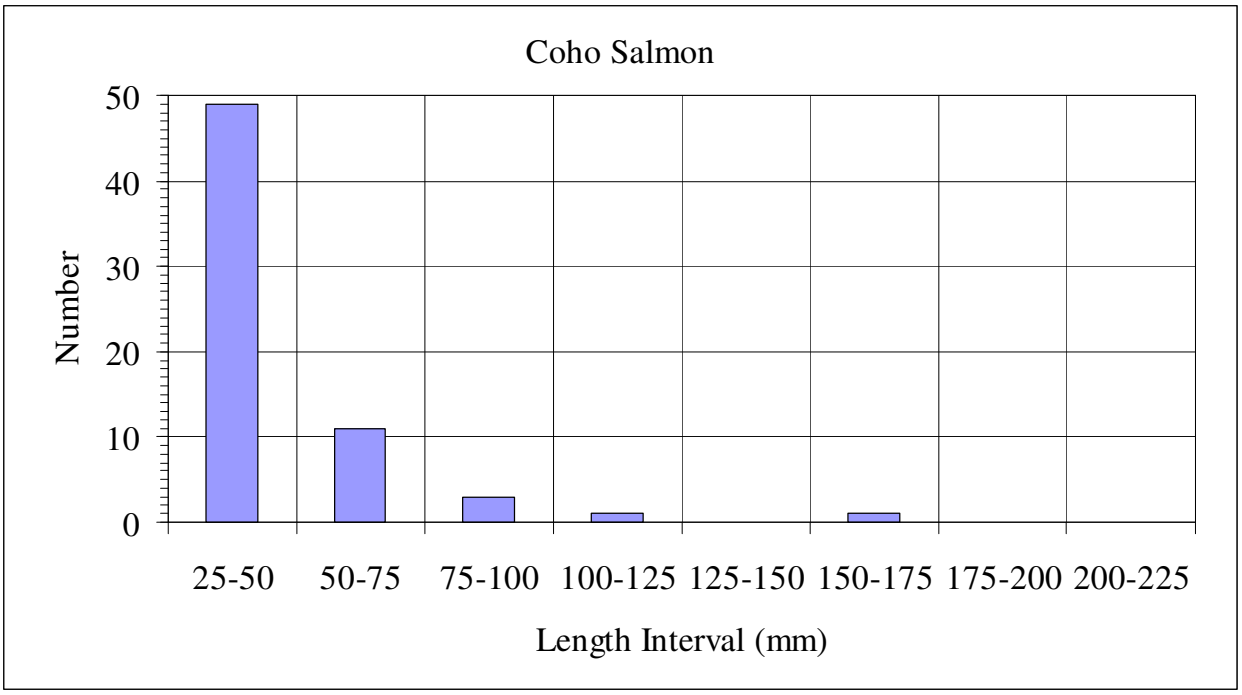

Figure 12. Length-frequency for coho captured in electro-fishing surveys in Nash Creek, 2008.

Table 5. Annual catch summary of NCES trap data for coho smolts and cutthroat trout juveniles transferred from Nash Creek to Nile Creek (catch data provided by E. Buckley of NCES).

Year	Coho	Cutthroat Trout
2003	352	16
2004	647	2
2005	89	0
2006	543	0
2007	138	21
2008	1410	53
2009	390	3
2010	1522	12

2.2.4 Habitat Description and Condition

An Urban Salmon Habitat Program (USHP) habitat assessment was completed by NCES in August and September 1998 (NCES 1998). Channel characteristics for pool habitats measured during the NCES assessment are summarized in Table 6. Isolated pools with no visible discharge between the pools were found 106 m upstream of the Southern Railway crossing or at chainage 1+730 m upstream of the creek mouth. The USHP habitat assessment found that the main factor limiting fish production was low flow during the summer (NCES 1998). NCES recommended that a hydrological study be undertaken to determine the feasibility of supplementing discharge to the creek. Limitations in the amount of LWD cover in Reaches 1-3 and 5 and in the amount of boulder cover in Reaches 1-5 were also identified. The addition of LWD and boulders was recommended as a potential instream habitat project.

Table 6. Summary of pool habitat characteristics for Nash Creek based on USHP inventory report (NCES 1998).

Reach	Reach Length (m)	Wetted Width (m)	Bankfull Width (m)	Estimated Reach Gradient (%)	Substrate Composition (%) Boulder	Cobble	Gravel	Fines	Comments
1	471	1.5	2.7	-	20	10	0	70	Mouth to confluence with Ridgwil Ck.
2	32	2.0	4.1	1.8	0	20	40	40	Ridgwil Ck. to Highway 19A
3	349	2.5	5.6	1.0	0	0	73	28	Highway 19A to footbridge
4	772	1.8	5.5	0.5	0	0	40	60	Footbridge to Southern Railway crossing

Although no detailed habitat surveys were conducted in this project, it was apparent that Nash Creek is flow-limited during the summer period, as documented by NCES (1998). However, five ponds located downstream of the Southern Railway crossing are groundwater fed and are maintained at relatively high water levels throughout the year, providing excellent rearing and overwintering habitat for coho and cutthroat trout (see more detailed description of ponds in Section 4.2.3).

A brief habitat assessment was conducted in this project on 26 August 2010. Over a 778 section of wetted channel surveyed between Highway 19A and Southern Railway crossing, 521 m (67%) of the channel length was considered good to excellent spawning habitat for cutthroat trout and coho, and 289 m (37%) of the channel length was considered good rearing habitat with four overwintering alcoves recorded (Photo 11 to Photo 13). Good spawning habitat was composed of 5% fines, 95% gravel and 5% cobbles. Low quality spawning habitat was composed of 70-80% fines and 20-30% gravel but only occurred in 18% of the total surveyed channel length of 778 m. Similar to the 1998 assessment by NCES, a wetted channel extended up to approximately 110 m upstream of the Southern Railway crossing or at chainage 1+734 m upstream of the creek mouth. Upstream of this point flows in the creek were not evident as the stream was likely flowing below the substrate surface.

Temperature measurements were recorded continuously by the level logger from 21 January to 16 July and from 11 August to 4 November (Figure 10; Table 4). Between 21 January 2010 and 4 November 2010, recorded temperatures ranged between ~4.3 ^{0}C in March and 16.0 ^{0}C in August. These temperatures are quite suitable for salmonids and would not limit their growth and survival.

Photo 11. Looking downstream in Nash Creek at high quality spawning habitat for coho, chainage 0+135 m upstream of flow gauging station.

Photo 12. Looking upstream in Nash Creek at high quality spawning and rearing habitat for coho and cutthroat trout, chainage 0+431 m upstream of flow gauging station.

Photo 13. Looking downstream in Nash Creek at high quality rearing and spawning habitat for coho and cutthroat trout, chainage 0+527 m upstream of flow gauging station.

3 Protection Measures

3.1 Protection Through Existing Legislation

3.1.1 Water Act

Maintaining an adequate flow regime in streams is a fundamental habitat component necessary to the survival of all life stages of cutthroat trout and coho salmon. The Water Act may provide a mechanism to protect the natural flow regime and ensure instream flows remain in the channel to sustain fish populations through critical life stage periods, such as through summer low flow periods when rearing habitat area becomes constricted in area and restrictive in stream discharge and water quality (i.e., dissolved oxygen and water temperature). Obtaining a water licence for the purpose of conservation is potentially one avenue under the Water Act regulation to provide long term protection of the flow regime for fish, wildlife and other aquatic fauna.

The following provides some background on the conditions and principles governing water licencing under the BC Water Act. The applicant for a water licence must have ownership or have substantial interest (i.e., leaseholder) in the land where the water is to be used. The water rights pass to the new landowner upon the sale or transfer of the land. A water licence can be obtained by:

- Owner of land;
- Owner of a mine;

- Municipality;
- Improvement or development district;
- Water users community;
- Crown (provincial and federal governments) or a party responsible for administering land, a
- Mine or other property of the federal or provincial governments;
- Water districts;
- BC Hydro; and
- Holders of a certificate of convenience under the *Public Utilities Act* or *Water Utility Act*.

The comptroller or regional water manager may issue a licence for up to three purposes. Licences may be held for the following purposes:

- Conservation - use and storage of water or the construction of works in and about streams for the purpose of conserving fish or wildlife ("Storage" means collecting, impounding or conserving water);
- Domestic - use of water for household requirements, sanitation and fire prevention, the watering of domestic animals and poultry and the irrigation of a garden not exceeding 1012 square metres adjoining and occupied with a dwelling house;
- Industrial – any use of water designated by regulation as an industrial use;
- Irrigation - beneficial use of water on cultivated land and hay meadows to nourish crops;
- Land Improvement - diversion or impounding of water to protect property, to facilitate the development of a park or the reclamation, drainage or other improvement of land or to carry out a project of a similar nature;
- Mining – use of water under head for recovering mineral from the ground or from ore, or for moving earth, sand, gravel or rock;
- Power - use of water in the production of electricity or other power;
- River Improvement Purpose - clearing and improving the bed, channel and banks of a stream to facilitate the driving and booming of timber;
- Storage - collecting, impounding and conserving of water; and
- Waterworks - carrying or supplying water by a municipality, improvement district, development district or person for the use of the residents of an area in BC.

All licences held for conservation purposes must involve physical works. Although there is no current ability under the *Water Act* to hold a licence solely for the maintenance of instream flows to protect fish populations, it could function as such if associated with the 'construction of works in and about streams'. It is unclear how extensive these works would need to be to be considered appropriate under a water licence. Presumably, it could involve instream works such as spawning platforms, and instream cover and fish passage structures.

3.1.2 Forest and Range Practices Act

The Forest Planning and Practices Regulation under the Forest and Range Practices Act (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/12_14_2004#section47)

provides rules and regulations to guide forest harvesting on Crown lands. The Regulation has been developed under the expectation that adherence to these regulations during forest harvesting operations ensures protection of water quality and fish habitat (among other environmental

components) in streams bordered by Crown land. Several clauses (or portions thereof) of this Regulation that are particularly pertinent to protection of the Qualicum Bay watersheds include:

Objectives set by government for water, fish, wildlife and biodiversity within riparian areas
8 The objective set by government for water, fish, wildlife and biodiversity within riparian areas is, without unduly reducing the supply of timber from British Columbia's forests, to conserve, at the landscape level, the water quality, fish habitat, wildlife habitat and biodiversity associated with those riparian areas.

Stream riparian classes

47 (2) A stream that is a fish stream or is located in a community watershed has the following riparian class:

(a) S1A, if the stream averages, over a one km length, either a stream width or an active flood plain width of 100 m or greater;

(b) S1B, if the stream width is greater than 20 m but the stream does not have a riparian class of S1A;

(c) S2, if the stream width is not less than 5 m but not more than 20 m;

(d) S3, if the stream width is not less than 1.5 m but is less than 5 m;

(e) S4, if the stream width is less than 1.5 m.

(3) A stream that is not a fish stream and is located outside of a community watershed has the following riparian class:

(a) S5, if the stream width is greater than 3 m;

(b) S6, if the stream width is 3 m or less.

(4) Subject to subsections (5) and (6), for each riparian class of stream, the minimum riparian management area width, riparian reserve zone width and riparian management zone width, on each side of the stream, are as follows:

Riparian Class	Riparian Management Area (m)	Riparian Reserve Zone (m)	Riparian Management Zone (m)
S1-A	100	0	100
S1-B	70	50	20
S2	50	30	20
S3	40	20	20
S4	30	0	30
S5	30	0	30

S6	20	0	20

(5) If the width of the active flood plain of a stream exceeds the specified width for the riparian management zone, the width of the riparian management zone extends to the outer edge of the active flood plain.

(6) The minister may specify a riparian reserve zone for a stream with a riparian class of S1-A if the minister considers that a riparian reserve zone is required.

(7) The riparian reserve zone for a stream begins at the edge of the stream channel bank and extends to the width described in subsection (4) or (6).

(8) The riparian management zone for a stream begins at

(a) the outer edge of the riparian reserve zone, or

(b) if there is no riparian reserve zone, the edge of the stream channel bank, and extends to the width described in subsection (4) or (5).

Restrictions in a riparian management area

50 (1) A person must not construct a road in a riparian management area, unless one of the following applies:

(a) locating the road outside the riparian management area would create a higher risk of sediment delivery to the stream, wetland or lake to which the riparian management area applies;

(b) there is no other practicable option for locating the road;

(c) the road is required as part of a stream crossing.

(2) If a road is constructed within a riparian management area, a person must not carry out road maintenance activities beyond the clearing width of the road, except as necessary to maintain a stream crossing.

(3) A person who is authorized in respect of a road must not remove gravel or other fill from within a riparian management area in the process of constructing, maintaining or deactivating a road, unless

(a) the gravel or fill is within a road prism,

(b) the gravel or fill is at a stream crossing, or

(c) there is no other practicable option.

Restrictions in a riparian reserve zone

51 (1) An agreement holder must not cut, modify or remove trees in a riparian reserve zone, except for the following purposes:

(a) felling or modifying a tree that is a safety hazard, if there is no other practicable option for addressing the safety hazard;

(b) topping or pruning a tree that is not wind firm;

(c) constructing a stream crossing;

(d) creating a corridor for full suspension yarding;

(e) creating guyline tiebacks;

(f) carrying out a sanitation treatment;

(g) felling or modifying a tree that has been windthrown or has been damaged by fire, insects, disease or other causes, if the felling or modifying will not have a material adverse impact on the riparian reserve zone;

(h) felling or modifying a tree under an occupant licence to cut, master licence to cut or free use permit issued in respect of an area that is subject to a licence, permit, or other form of tenure issued under the *Land Act*, *Coal Act*, *Geothermal Resources Act*, *Mines Act*, *Mineral Tenure Act*, *Mining Right of Way Act*, *Ministry of Lands, Parks and Housing Act*, *Petroleum and Natural Gas Act* or *Pipeline Act*, if the felling or modification is for a purpose expressly authorized under that licence, permit or tenure;

(i) felling or modifying a tree for the purpose of establishing or maintaining an interpretive forest site, recreation site, recreation facility or recreation trail.

Restrictions in a riparian management zone

52 (1) A holder of a minor tenure who fells trees in a cutblock within a riparian management zone of a class described in Column 1 must ensure that

(a) the percentage of the total basal area within the riparian management zone specified in Column 2 is left as standing trees, and

(b) the standing trees are reasonably representative of the physical structure of the riparian management zone, as it was before harvesting:

Column 1 **Riparian Class**	**Column 2** **Basal Area to be Retained** **Within Riparian Management Zone (%)**
S1-A or S1-B stream	≥20
S2 stream	≥20
S3 stream	≥20
S4 stream	≥10
S5 stream	≥10

S6 stream	Not applicable
All classes of wetlands or lakes	≥10

(2) An authorized person who cuts, modifies or removes trees in a riparian management zone for an S4, S5 or S6 stream that has trees that contribute significantly to the maintenance of stream bank or channel stability must retain enough trees adjacent to the stream to maintain the stream bank or channel stability, if the stream

(a) is a direct tributary to an S1, S2 or S3 stream,

(b) flows directly into the ocean, at a point near to or where one or more of the following is located:

(i) a herring spawning area;

(ii) a shellfish bed;

(iii) a saltwater marsh area;

(iv) an aquaculture site;

(v) a juvenile salmonid rearing area or an adult salmon holding area, or

(c) flows directly into the ocean at a point near to the location of an area referred to in paragraph (b) and failure to maintain stream bank or channel stability will have a material adverse impact on that area.

Temperature sensitive streams

53 An authorized person who fells, modifies or removes trees in a riparian management area adjacent to a temperature sensitive stream, or a stream that is a direct tributary to a temperature sensitive stream, must retain either or both of the following in an amount sufficient to prevent the temperature of the temperature sensitive stream from increasing to an extent that would have a material adverse impact on fish:

(a) streamside trees whose crowns provide shade to the stream;

(b) understory vegetation that provides shade to the stream.

Fish passage

56 (1) An authorized person who carries out a primary forest activity must ensure that the primary forest activity does not have a material adverse effect on fish passage in a fish stream.

(2) An authorized person who maintains a fish stream crossing built after June 15, 1995, must ensure that the crossing does not have a material adverse effect on fish passage.

(3) Despite subsections (1) and (2), an authorized person may temporarily allow a material adverse effect on fish passage to construct, maintain or deactivate a road, including a stream crossing, if

(a) fish are not migrating or spawning, and

(b) the source of the material adverse effect is removed immediately on completion of the construction, maintenance or deactivation.

Protection of fish and fish habitat

57 An authorized person who carries out a primary forest activity must conduct the primary forest activity at a time and in a manner that is unlikely to harm fish or destroy, damage or harmfully alter fish habitat.

Maximum cutblock size

64 (1) If an agreement holder other than a holder of a minor tenure harvests timber in a cutblock, the holder must ensure that the size of the net area to be reforested for the cutblock does not exceed

(a) 40 hectares, for the areas described in the Forest Regions and Districts Regulation that are listed in Column 1, and

(b) 60 hectares, for the areas described in the Forest Regions and Districts Regulation that are listed in Column 2:

(NOTE: The Coast Forest Region falls into Column 1).

Under this regulation, Thames and Nash creeks would be considered Riparian Class S3 streams, with a minimum 40 m Riparian Management Area comprised of a 20 m Riparian Reserve Zone and a 20 m Riparian Management Zone. The current condition of Thames and Nash creeks as coldwater streams that provide ideal temperature regimes for coho salmon and cutthroat trout affords the opportunity for these streams to be designated as **fisheries sensitive watersheds** and/or **temperature sensitive streams**. There are currently no streams designated as Temperature Sensitive. Government Actions Regulation (2004) (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/17_582_2004#section14) under the Forest and Range Practices Act sets out the conditions for the designation of fisheries sensitive and temperature sensitive watersheds as follows:

Fisheries sensitive watersheds and objectives

14 (1) The minister responsible for the *Wildlife Act* by order may identify as a fisheries sensitive watershed an area of land in a watershed that has significant downstream fisheries values and significant watershed sensitivity if satisfied that the area requires special management to protect fish, that is not otherwise provided for under this regulation or another enactment, by

(a) conserving

(i) the natural hydrological conditions, natural stream bed dynamics and stream channel integrity, and

(ii) the quality, quantity and timing of water flow, or

(b) preventing cumulative hydrological effects that would have a material adverse effect on fish.

(2) The minister responsible for the *Wildlife Act* by order may establish a fisheries sensitive watershed objective respecting a matter referred to in subsection (1).

Temperature sensitive streams

15 The minister responsible for the *Wildlife Act* by order may designate a portion of a fish stream as a temperature sensitive stream if satisfied that

(a) trees are required adjacent to the stream to manage the temperature of the designated portion for the protection of fish, and

(b) management of the temperature of the designated portion is not otherwise provided for under this regulation or another enactment.

3.1.3 Private Managed Forest Land Act

The upper portion of Thames Creek includes privately managed forest lands (Figure 4). In the mid-1990's the provincial government negotiated a set of regulations under legislation to protect public resources affected by forest practices on these lands. Public resources included drinking water, fish and fish habitat, conservation of soils and conservation of species at risk.

In 2003, the government amended the legislation to establish the Private Managed Forest Land Council with two representatives from industry and government respectively and an independent Chair appointed by the four other members. Over the past couple of years the Council has refined the regulations under the Act to reflect more closely the objectives of the results-based Forest and Range Practices Act. These new regulations strengthen objectives to maintain vegetation and functioning condition in watersheds. DFO has approved the new regulations as being equivalent to its legislation under the Federal Fisheries Act (O'Riordan 2007).

Under the Private Managed Forest Land Act (2003) (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_03080_01) the objective of fish habitat protection is achieved if the conditions specified in clause 14, as reproduced below, are maintained.

14 (1) The forest management objective for private managed forest land with respect to the protection of fish habitat, both during and after harvesting, is to retain sufficient streamside mature trees and understory vegetation to protect all of the following:

(a) a natural variation in water temperatures;
(b) sufficient cover for fish;
(c) a continual source of large woody debris for stream channel stability purposes;
(d) a vigorous mass of roots capable of controlling stream bank erosion;
(e) a filter to prevent the transport of sediment into stream channels;
(f) woody debris sufficient for in-stream habitat;
(g) a source of nutrients to the stream through litter fall.

(2) Nothing in subsection (1) requires an owner to retain additional streamside trees or additional understory vegetation to address problems with fish habitat that originate outside of the owner's private managed forest land.

The Private Managed Forest Land Council Regulation (2007) (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/11_182_2007#section15)

under the Private Managed Forest Land Act describes specific objectives and practices designed to protect water quality and fish habitat. The clauses of this regulation that are particularly pertinent to Thames Creek, as well as other Qualicum Bay tributaries, are reproduced below:

Sediment transport or deposition
15 An owner carrying out a primary forest activity must not cause sediment or other material to be transported to, or deposited in, a stream if that sediment or material will have a material adverse effect on

(a) fish habitat, or
(b) water that is diverted by a licensed waterworks intake.

Roads adjacent to streams
16 An owner must not construct a road within

(a) 30 m of a class A stream,
(b) 30 m of a class B stream,
(c) 10 m of a class C stream,
(d) 10 m of a class D stream, or
(e) 10 m of a class E stream unless one or more of the following applies:
(f) complying with paragraphs (a) to (e) would create a higher risk of sediment delivery to the stream than not complying with paragraphs (a) to (e);
(g) there is no other practicable option for locating the road;
(h) the road construction is part of a stream crossing.

Stream crossings
17 (1) An owner who builds a stream crossing as part of a road or logging trail must locate, build and use the crossing in a manner that

(a) protects the stream channel and stream bank immediately above and below the stream crossing, and
(b) mitigates disturbance to the stream channel and stream bank at the crossing to the extent necessary to avoid causing a material adverse effect on fish habitat or water that is diverted by a licensed waterworks intake.

(2) An owner who builds a stream crossing as part of a logging trail must remove the crossing when it is no longer required by the owner.

Retention of trees adjacent to class B streams
28 (1) An owner carrying out timber harvesting activities in a cutblock adjacent to a class B stream must, on each side of every 100 m of that stream that is adjacent to the cutblock, retain at least 25 trees that are selected in accordance with subsections (2) and (4).
(2) For the purposes of subsection (1), the owner must select trees sequentially in accordance with the criteria set out in paragraphs (a) to (f), until a total of at least 25 trees have been selected:

(a) all trees that are
    (i) within 10 m from the edge of the stream channel,
    (ii) 30 cm or more in diameter,
    (iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand, and

(iv) necessary to maintain the same range of sizes, for both coniferous and deciduous trees, as in the pre-harvest stand;

(b) all trees that are

(i) within 10 m from the edge of the stream channel,

(ii) 20 cm or more in diameter, and

(iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand;

(c) all trees that are

(i) within 20 m from the edge of the stream channel,

(ii) 30 cm or more in diameter

(iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand, and

(iv) necessary to maintain the same range of sizes, for both coniferous and deciduous trees, as in the pre-harvest stand;

(d) all trees that are

(i) within 20 m from the edge of the stream channel,

(ii) 20 cm or more in diameter, and

(iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand;

(e) all trees that are

(i) within 30 m from the edge of the stream channel,

(ii) 30 cm or more in diameter,

(iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand, and

(iv) necessary to maintain the same range of sizes, for both coniferous and deciduous trees, as in the pre-harvest stand;

(f) all trees that are

(i) within 30 m from the edge of the stream channel,

(ii) 20 cm or more in diameter, and

(iii) necessary to maintain the same proportion of coniferous to deciduous trees as in the pre-harvest stand.

(3) Despite subsection (1), if fewer than 25 trees meet any of the criteria set out in subsection (2) (a) to (f), the owner is required to retain only those trees within that area that meet the criteria.

(4) The trees selected under subsection (1) must be distributed as evenly as is practicable along all of the 100 m length of the stream unless

(a) the area on the opposite side of that 100 m portion of the stream meets the tree retention requirements of subsection (1), and

(b) the tree species present on the area to be harvested are not suitable for partial cutting silvicultural systems.

(5) An owner may remove a tree that is otherwise required to be retained under subsections (1) to (4) only if the tree falls by natural causes outside the stream channel.

Retention of trees adjacent to class C streams

29 (1) An owner carrying out timber harvesting activities in a cutblock adjacent to a class C stream must, on each side of every 100 m of the stream that is adjacent to the cutblock, retain at least 15 trees that

(a) are within 10 m of the edge of the stream channel,
(b) are 20 cm or more in diameter, and
(c) maintain
(i) the same proportion of coniferous to deciduous trees as in the pre-harvest stand, and
(ii) the same range of sizes, for both coniferous and deciduous trees, as in the pre-harvest stand, if the gradient of the stream is 8% or less.

(2) Despite subsection (1), if fewer than 15 trees meet the criteria set out in that subsection, the owner is required to retain only those trees within that area that meet the criteria in that subsection.
(3) If the stream referred to in subsection (1) has a stream gradient of more than 8%, the owner must not harvest a tree selected to be retained under subsection (1) or (2) unless the owner selects and retains in its place another tree that is 20 cm or greater in diameter.
(4) If the stream referred to in subsection (1) has a stream gradient of 8% or less, the owner must not harvest a tree selected to be retained under subsection (1) or (2) unless the tree falls by natural causes outside the stream channel.

Retaining non-commercial trees and understory vegetation
30 (1) An owner carrying out a primary forest activity must retain all non-commercial trees and understory vegetation within

(a) 30 m of a class A stream,
(b) 30 m of a class B stream,
(c) 10 m of a class C stream,
(d) 10 m of a class D stream, and
(e) 10 m of a class E stream.

(2) Despite subsection (1), an owner may

(a) fall and remove non-commercial trees, or
(b) disturb understory vegetation
if the falling and removal of the trees or the disturbance of the vegetation
(c) is necessary to enable the owner to comply with section 31,
(d) is associated with a road constructed under section 16 or 17,
(e) is associated with a logging trail constructed under section 17, or
(f) will not cause a material adverse effect on fish habitat or water that is diverted by a licensed waterworks intake.

Stream riparian classes
1 (1) A portion of a stream that is a fish stream or is located upstream of the point where water is diverted by a licensed waterworks intake has the following riparian class:

(a) A, if the stream channel width is 10 m or wider;
(b) B, if the stream channel width is 3 m or wider but narrower than 10 m;
(c) C, if the stream channel width is 1.5 m or wider but narrower than 3 m;
(d) D, if the stream channel width is narrower than 1.5 m.

(2) A portion of a stream has a riparian class E if the portion of the stream

(a) has a stream channel width of 1.5 m or wider, and
(b) is a direct tributary to a class A, B, C or D stream.

Under the Private Managed Forest Land Act, Thames Creek would be considered a Class B stream.

3.1.4 Fish Protection Act

The Fish Protection Act (http://www.env.gov.bc.ca/habitat/fish_protection_act/act/documents/act-theact.html) was enacted in May 1997 by the Government of British Columbia. The Act focuses on four major objectives: ensuring sufficient water for fish; protecting and restoring fish habitat; improved riparian protection and enhancement; and stronger local government powers in environmental planning. The *Fish Protection Act* provides protection to fish and fish habitat by:

- Prohibiting stream-blocking dams on major rivers;
- Mandating the consideration of fish habitat issues by provincial water managers before approving new licences, amendments to licences or applications under the Water Act requiring approval for work in or near streams;
- Establishing special rules in relation to water licences on streams designated as being particularly sensitive to impact on fish and fish habitat and providing for the development of recovery plans for such streams;
- Allowing "water for fish" streamflow protection licences to be issued to community-based organizations;
- Allowing temporary reductions in water use rights in circumstances where drought threatens the survival of a fish population;
- Providing a process for water management plans to propose means by which additional water is to be preserved for fish and fish habitat; and
- Allowing the Provincial government to establish directives for local governments in preserving streamside areas.

The Fish Protection Act provides legislative authority for the designation of a stream as a "sensitive stream", as per the following clause:

6 (2) The Lieutenant Governor in Council may, by regulation, designate a stream as a sensitive stream under this section if the Lieutenant Governor in Council considers that the designation will contribute to the protection of a population of fish whose sustainability is at risk because of inadequate flow of water within the stream or degradation of fish habitat.

The process of designating Sensitive Streams—which will involve consultation with stakeholders, municipalities, First Nations, communities and the public —is being led by the BC Ministry of Environment. The following set of criteria has been developed to help identify candidate Sensitive Streams:

- The stream is located in a watershed containing a significant population of salmon (coho used as an indicator species);
- The stream is a high priority for designation at present because of the precarious nature and value of fish stocks at risk, and the potential for high productivity given the nature of existing fish habitats;

- The stream is located in an area of the province with sensitive yearly flows and significant human populations or industrial water users;
- The stream flow limits fish production from achieving historic levels;
- Water abstraction and associated weirs, intakes, etc. are adversely affecting stream flows and fish migration;
- The stream offers good potential for recovery of fish populations, either with or without a recovery plan; and
- The stream is not otherwise being addressed under the BC Hydro Water Use Planning licence review process.

Although not yet in force, Section 8 of the Fish Protection Act enables community organizations to hold water licences for streamflow protection purposes without having to own land adjacent to the watercourse or to have constructed works in the watercourse. Pertinent clauses from Section 8 of the Act are reproduced below:

Streamflow protection licences

8 (1) A licence for a streamflow protection purpose

(a) may only be issued on the direction of the Lieutenant Governor in Council,

(b) may only be issued to an organization that the Lieutenant Governor in Council considers has a community based interest in the stream for which the licence would be issued,

(c) may be issued to an organization even though it would not otherwise be eligible as a licensee under section 7 of the Water Act,

(d) may not be issued in combination with any other purpose,

(e) must specify the point or points on the stream in relation to which the streamflow rights under the licence apply, and

(f) must include a condition that the licensee organization undertake works in relation to fish and fish habitat in the stream to which the licence applies.

(2) An organization that wishes to obtain a licence for a streamflow protection purpose must submit to the minister

(a) an application for a licence in accordance with the Water Act, and

(b) a proposal respecting

(i) works in relation to fish and fish habitat in the stream to which the licence applies, and

(ii) any other works or activities related to fish or fish habitat that the applicant will undertake if the licence is granted.

(3) Without limiting the works and activities that may be included in a proposal under subsection (2), the organization may propose works or activities

(a) to enhance fish habitat,

(b) to provide educational programs about fish and fish habitat, and

(c) to promote the more efficient use of water for the purposes of protecting fish and fish habitat.

(8) Despite section 13 of the Water Act, no appurtenancy is required for a licence under this section.

3.1.5 Riparian Area Regulation

The Riparian Areas Regulation (RAR), enacted under Section 12 of the Fish Protection Act in July 2004, calls on local governments to protect riparian areas during residential, commercial, and industrial development by ensuring that proposed activities are subject to a science based assessment conducted by a Qualified Environmental Professional (QEP). Local governments (municipalities and regional districts) have been targeted to implement the policies of this regulation as they are the primary bodies responsible for planning and regulating these forms of development. The Riparian Areas Regulation requires local governments to protect their riparian areas in accordance with the regulation by amending their current zoning bylaws and/or Official Community Plans.

The purpose of the Regulation is to protect the features, functions and conditions that are vital in the natural maintenance of stream health and productivity. These vital features, functions and conditions are numerous and varied and include such things as:

- Sources of large organic debris, such as fallen trees and tree roots;
- Areas for stream channel migration;
- Vegetative cover to help moderate water temperature;
- Provision of food, nutrients and organic matter to the stream;
- Stream bank stabilization; and,
- Buffers for streams from excessive silt and surface runoff pollution.

The Regional District of Nanaimo (RDN) has now passed the required Bylaw amendments to bring its Official Community Plans into compliance with the newly enacted Provincial Riparian Areas Regulation. The regulation applies to all new residential, commercial, and industrial developments adjacent to a freshwater waterbody. Waterbodies include all streams, rivers, creeks, ditches, ponds, lakes, springs and wetlands connected by surface flow to a waterbody that provides fish habitat. The regulation does not apply to properties adjacent to the ocean, nor does it apply to reconstruction or repair of existing structures, farm uses on agricultural lands, mining activities, hydroelectric facilities or lands subject to the Forest Act or Private Managed Forest Land Act. Also, the regulation does not apply to waterbodies that are disconnected from fish habitats nor to marine or estuarine shorelines.

For waterbodies within Area H, the RDN predetermines the Streamside Protection and Enhancement Area (SPEA) using a simple assessment with any variations in the SPEA based on a QEP's assessment and recommendations. The simple assessment criteria for specific SPEA widths are summarized in Table 7.

Table 7. Streamside protection and enhancement area widths for the simple assessment. See http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf for more detail on the assessment methodology.

Vegetation Category	Existing or Potential Streamside Vegetation Conditions	Streamside Protection and Enhancement Area Width*		
		Fish Bearing	Non-Fish Bearing	
			Permanent	Non-Permanent
1	Continuous areas ≥30 m or discontinuous but occasionally >30 m to 50 m	30 m		Minimum 15 m Maximum 30 m
2	Narrow but continuous areas = 15 m or discontinuous but occasionally >15 m to 30 m	Minimum 15 m Maximum 30 m	15 m	
3	Very narrow but continuous areas up to 5 m or discontinuous but occasionally >5 m to 15 m	15 m	Minimum 5 m Maximum 15 m	

* SPEA width is measured from top of bank or top of ravine bank

Under the Regulation, local governments may allow development within 30 m of the high water mark of a stream or top of a ravine bank – provided the prescribed riparian assessment methods have been followed. The riparian assessment method requires a Qualified Environmental Professional (QEP) to provide an opinion – in an Assessment Report – that the development will not result in a harmful alteration of riparian fish habitat. "Bending" of the SPEA boundary must not result in any portion of the boundary being less than 10 m from the high water mark. The QEP can help plan any new development so that it will avoid impacting fish habitat. The Assessment Report also identifies measures that will be required to maintain the integrity of the riparian area in the development project.

Long-term riparian protection requires a form of legal protection of setback areas that resides with the land through successive owners of the property. Local governments are encouraged to use their authorities and tools to gain long-term protection of SPEAs. Legal protection can take several forms: dedication of riparian areas as park or greenspace, conservation covenants, restrictive covenants and dedication to a land conservancy organization.

3.1.6 Fisheries Act

Under the federal *Fisheries Act* (http://www-heb.pac.dfo-mpo.gc.ca/habitat_policy/hab_law_article/hablaw_partb_e.htm#B21

- No person may damage fish habitat without prior authorization (see section 35); and
- No person may pollute water frequented by fish (see section 36).

These sections of the *Act* are for the conservation and protection of fish habitat. They apply to all Canadian waters including, for example, rivers, streams, ditches, lakes, estuaries, salt marshes, coastal waters, and marine offshore areas. They also apply to work on areas that are not always under water, such as shorelines, riverbanks, and floodplains, even on privately owned land. Pertinent clauses within these two sections of the *Act* are reproduced below:

Damage to fish habitat
Section 35(1): No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat.
Authorization
Section 35(2): No person contravenes subsection (l) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act.

Pollution
Section 36(3): Subject to subsection 36(4), no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.

Section 36(4): No person contravenes subsection 36(3) by depositing or permitting the deposit in any water or place of

a. waste or pollutant of a type, in a quantity and under conditions authorized by regulations applicable to that water or place made by the Governor in Council under any Act other than this Act; or
b. a deleterious substance of a class, in a quantity or concentration and under conditions authorized by or pursuant to regulations applicable to that water or place or to any work or undertaking or class thereof, made by the Governor in Council under subsection 36(5).

3.2 Official Community Plan for Area H

The RDN has prepared an Official Community Plan (OCP) for Electoral Area 'H' (http://www.rdn.bc.ca/cms.asp?wpID=411) that provides objectives and policies pertaining to the protection of environmentally sensitive features, that include watercourses, streams, lakes, swamps, other wetlands, and known aquifers (see Environmentally Sensitive Features on Figure 13). As stated in the OCP, "Environmentally sensitive areas within the Plan Area include, but are not limited to, the Big Qualicum River and Big Qualicum Fish Hatchery, Nile Creek, Thames Creek, Quadra Sands Aquifers, Deep Bay estuary, all streams and watercourses, and the marine foreshore out 1000 metres from Deep Bay Spit to the southeast boundary of Electoral Area 'H'."

Protection of groundwater resources, particularly the area delineated as 'Aquifer' in Figure 14, is important as residents rely on these resources for both domestic water and agricultural supplies. In addition, direct groundwater contributions to streams and waterbodies maintain streamflows and moderate water temperatures for fish and other aquatic organisms. The RDN considers the potential impact on aquifers from the increased demand or contamination as a result of new development proposals when making any land use decisions for Area H. The OCP states that "The protection and sustainability of groundwater and surface water supplies are critical to maintaining the rural character of the Plan Area and protecting the natural environment."

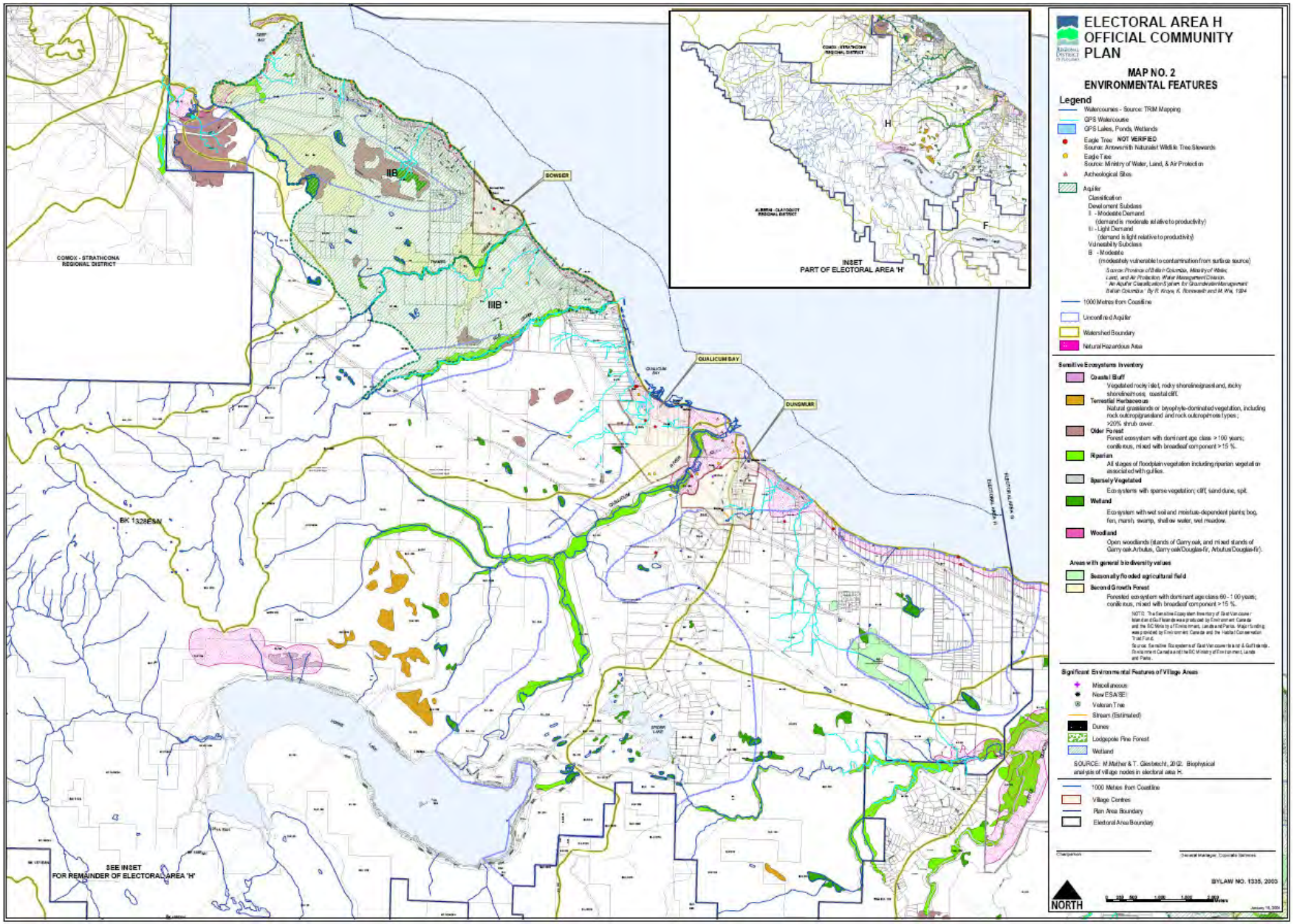

Figure 13. Environmental features for Electoral Area H. Reproduced from the Official Community Plan for Area H of the Regional District of Nanaimo.

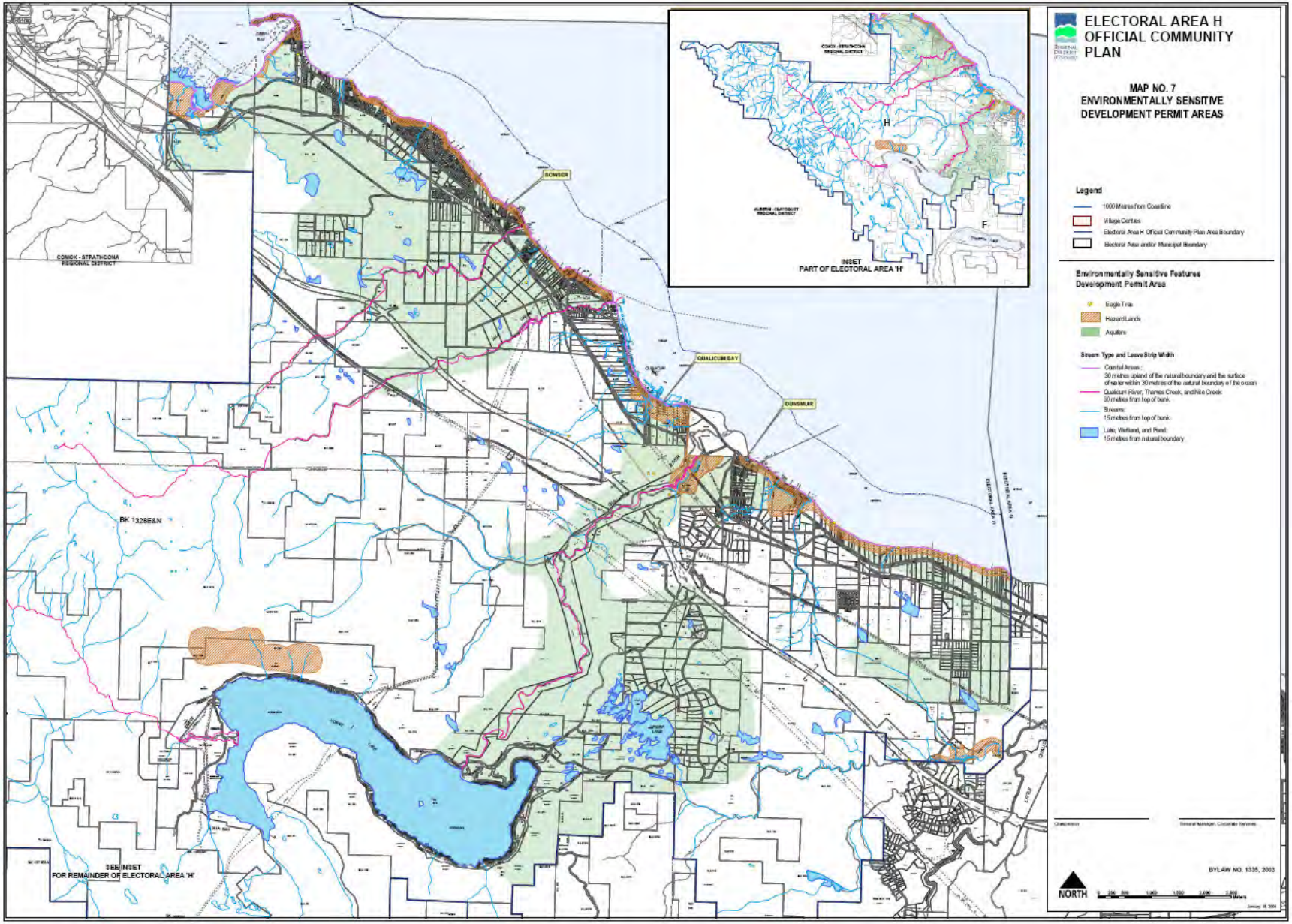

Figure 14. Environmentally sensitive development permit areas for Electoral Area H. Reproduced from the Official Community Plan for Area H of the Regional District of Nanaimo.

The designation of Development Permit Areas under the OCP defines the spatial boundaries that necessitate a permit when a new development is proposed and, as a result, it facilitates the protection of environmental features such as aquifers, swamps, wetlands, streams and waterbodies through subsequent review of these development permits by the RDN and, if necessary, regulatory agencies. The Development Permit Area, shown on Figure 14, is intended to protect coastal areas, lakes, streams, and riparian areas, nesting trees, floodplain areas, and other environmentally sensitive areas. The development permit area is defined as follows:

1. For all **Coastal Areas** – the development permit area shall be 30 metres upland of the natural boundary and the surface of water within 30 metres of the natural boundary of the ocean.
2. For the **Big Qualicum River, Thames Creek** and **Nile Creek** – the development permit area shall be 30 metres as measured from the top of the bank.
3. For **Lakes, Wetlands,** and **Ponds -** the development permit area shall be 15 metres as measured from the natural boundary.
4. For all other **Watercourses** and **Streams -** the development permit area shall be 15 metres as measured from the top of the bank.
5. For all known **Aquifers-** the development permit area shall be those lands above the aquifer as designated.
6. For **Eagle Nesting Trees -** the development permit area shall be a 60-metre radius from the nesting tree.
7. For **Heron Nesting Trees -** the development permit area shall be a 100-metre radius from the nesting tree.

The Fish Habitat Protection Development Permit Area on Figure 15 consists of the following Riparian Assessment Areas, as defined by the Riparian Areas Regulation (see Section 3.1.5), within and adjacent to all streams, which by definition includes wetlands and lakes:

1. for a stream, a 30 metre strip on both sides of the stream measured from the natural boundary;
2. for a ravine less than 60 metres wide, a strip on both sides of the stream measured from the high water mark to a point that is 30 metres beyond the top of the ravine bank; and,
3. for a ravine 60 metres wide or greater, a strip on both sides of the stream measured from the natural boundary to a point that is 10 metres beyond the top of the ravine bank.

For development proposals where the Riparian Area Regulation applies, the RDN must not approve or allow a development to proceed until the RDN has been "notified by the Ministry of Environment that the Ministry of Environment and Fisheries and Oceans Canada have been notified of the development proposal and have been provided with a copy of the assessment report prepared by a QEP or that the Minister of Fisheries and Oceans Canada has authorized the harmful alteration, disruption, or destruction of the natural features, functions, and conditions that support fish life process (HADD) in a riparian assessment area."

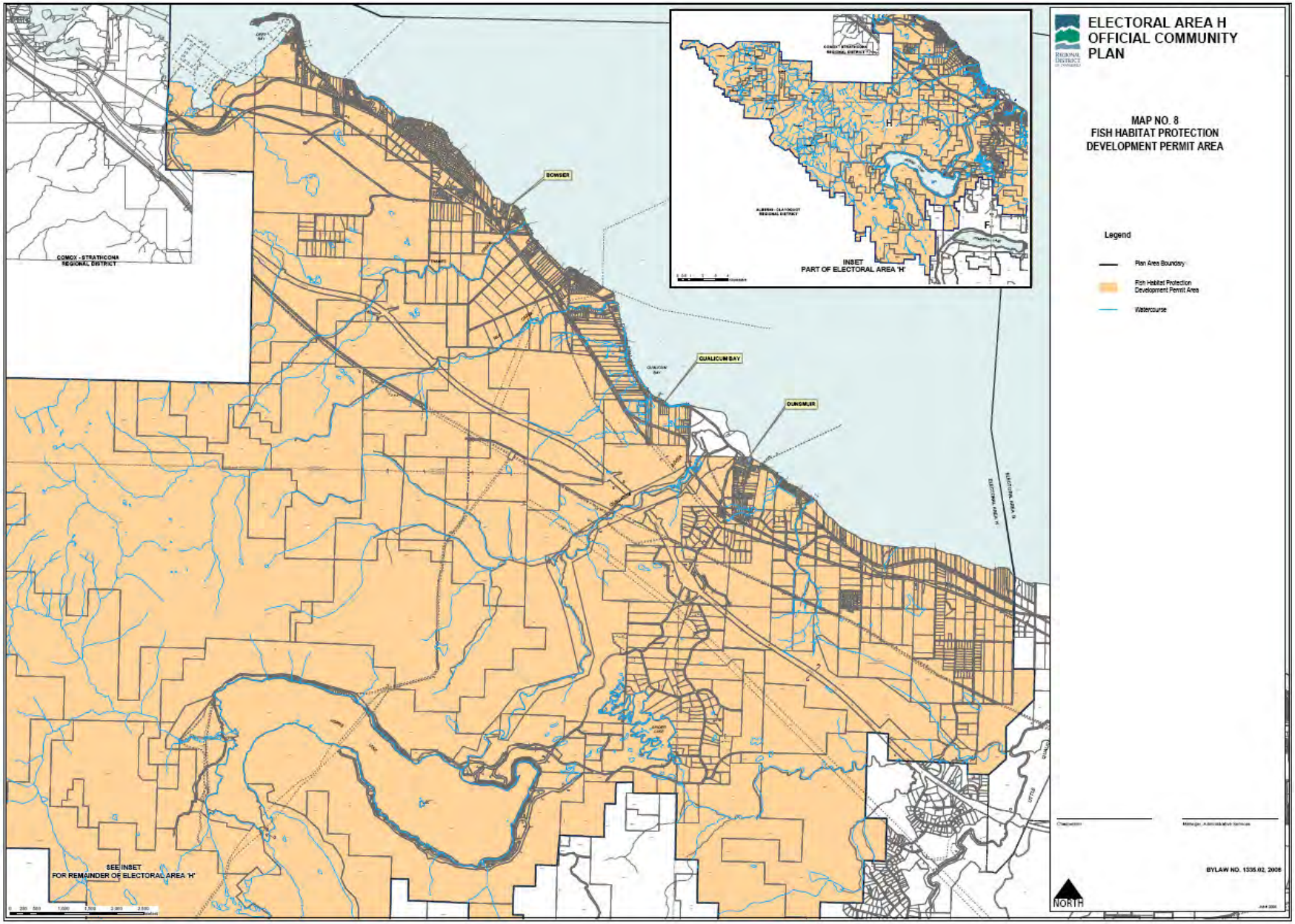

Figure 15. Fish habitat protection development permit area for Electoral Area H. Reproduced from the Official Community Plan for Area H of the Regional District of Nanaimo.

4 Recommended Implementation Actions

The protection and restoration of Nash and Thames creeks as well as numerous other Qualicum Bay tributaries will require NCES to focus on specific targeted actions to achieve the goals and objectives described in this strategy. A summary of the goals, objectives and recommended implementation actions for the protection and restoration of Qualicum Bay watersheds is presented in Table 8. The table provides a suite of options for review, re-prioritization and revision by the Program Partners.

One of the recommended primary actions that is considered a high priority relates to NCES establishing or participating in land and aquatic resource roundtables and becoming more involved in the formal vetting process for development proposals. NCES involvement in these discussions and processes would allow for greater influence on decisions relating to water use and management, land use and development, and by-law and environmental regulation amendments. Other recommended protection and restoration activities identified in Table 8 are described in greater detail below.

Table 8. Goals, objectives and recommended implementation actions for the protection and restoration of Qualicum Bay watersheds.

Goal	Objectives	Primary Actions	Timeframe	Secondary Actions	Timeframe
1 Protect the biological integrity of Qualicum Bay watersheds	1.1 Participate in and influence the management and development of land and aquatic resources	Become involved or spearhead the development of regional water boards or roundtables that encompass their watersheds	2011 & beyond	Become involved in the development of Water Management Plans and Watershed Management Plans	2011 & beyond
2 Protect the integrity of unconfined aquifers	2.1 Maintain current volume and quality of aquifers	Monitor land use development to ensure land use practices do not impact aquifers	2011 & beyond	Work with MOE to regulate the extraction and use of groundwater	2012 & beyond
	2.2 Maintain groundwater water quality and delivery volumes to wetlands and streams	Monitor stream flows and water quality in QB tributaries; Collaborate with VIU on water quality assessments and water table mapping	2010 & beyond	Work with VIU to assess & monitor water levels and water quality of existing domestic wells within the QB area	2010 & beyond
3 Protect instream flows	3.1 Influence and develop water management and watershed management plans for Qualicum Bay watershed(s)	Become involved or spearhead the development of regional water boards or roundtables that encompass their watersheds	2012	Become involved in the development of Water Management Plans and Watershed Management Plans	2012 & beyond
	3.2 Obtain water rights licence for conservation purposes on a Qualicum Bay tributary	Construct instream works in Nash Creek (as pre-requisite for obtaining Water Licence under Water Act)	2013	Apply to obtain water rights licences for conservation purposes to maintain instream flows	2013
	3.3 Use existing regulations to dedicate streams	Encourage dedication of a specific flow-limited salmon and trout stream as a Sensitive Stream under the Fish Protection Act	2011	Identify and encourage the Ministry of Environment to reserve flows for conservation purposes	2011
	3.4 Amend or bring into force regulations to protect instream flows	Encourage the Ministry of Environment to mandate instream flow requirements into the Water Act and water rights licence.	2011	Encourage the provincial government to bring Section 8 of the Fish Protection Act into force so that the Lieutenant Governor of Canada (provincial Cabinet) can direct water licences for streamflow protection purposes	2012
4 Protect quality of surface waters	4.1 Maintain existing temperature, dissolved oxygen, sediment and bedload conditions in Thames and Nash creeks	Develop an assessment program to regularly monitor temperature, dissolved oxygen, turbidity and channel morphology and condition in Thames and Nash creeks	2011	Collect and evaluate water quality data on Thames and Nash creeks	2015 & every 5 yrs after
	4.2 Maintain existing temperature, dissolved oxygen, sediment and bedload conditions in QB tributaries	Monitor stream flows and water quality in QB tributaries	2010 & beyond	Monitor to ensure surface water discharge from land developments and land use activities do not impact the water quality and levels of aquifers that discharge groundwater to streams and associated	2011 & beyond
5 Protect riparian corridor vegetation	5.1 Meet and expand statutory requirements for riparian buffers	Monitor to ensure that regulations within RAR, FRPA and PFFLA concerning riparian buffers, reserves and management zones/areas are adhered to and enforced	2011 & beyond	Through discussions with private landowners and provincial government, expand protection of riparian buffers on private land beyond the requirements under the Privately Managed Forest Land Act and Riparian Area Regulation	2012 & beyond
	5.2 Increase the contiguous area of riparian buffer reserves under permanent protection	Identify and establish permanent riparian zone reserves in key rearing and spawning habitats for coho and cutthroat trout in Thames and Nash creeks	2012 & beyond	Limit encroachment or development within 30 m (minimum) of the creek through a designation of a riparian corridor reserve on Crown lands	2013 & beyond
		Establish stream corridor easements or covenants with private landholders through purchase or voluntary donation	2013 & beyond	Monitor to confirm that landowners are complying with terms of easements	2013 & beyond
		Collaborate with RDN to spearhead development of incentives to attract landowners to permanently protect riparian buffers	2013	Purchase stream corridor lands outright from a voluntary seller	2013 & beyond
6 Restore historic native fish distributions	6.1 Restore migration access at culvert crossings	Install oversize boulders on concrete apron of Highway 19A culvert on Thames Creek	Completed	Repair damaged baffles and construct riffles at Southern Railway culvert crossing in Thames Creek	2011
	6.2 Restore migration access at confluence of creeks with the ocean	Install small diameter pipe in southern flood relief structure of Nash Creek to allow emigration of smolts to ocean	2011	Develop a formal agreement with government to maintain connectivity between the creeks and ocean during critical migration periods	2012
7 Restore the hydrological regimes of the watersheds	7.1 Restore drainage networks	Restore historic watershed boundary and re-direct run-off into the headwaters of Nash Creek	2011	Monitor land development proposals and projects to ensure drainage networks are maintained, and watercourses are not modified	2011 & beyond
8 Restore riparian vegetation	8.1 Identify zones where riparian vegetation has been removed	Survey riparian corridor of Nash and Thames Creeks and identify locations where width of treed buffer is <10 m	2012	Prioritize degraded riparian sites, develop riparian prescriptions for high priority sites and replant	2013
		Survey riparian corridor of other QB tributaries and identify locations where width of treed buffer is <10 m	2014	Prioritize degraded riparian sites, develop riparian prescriptions for high priority sites and replant	2015
9 Restore habitat and productive capacity for native salmonids	9.1 Restore off-channel habitat	Excavate aggraded sediments and stabilize banks at existing ponds on Nash Creek	2011	Examine QB streams for potential off-channel enhancement opportunities that would expand rearing and overwintering habitat	2011 & beyond
	9.2 Restore instream habitat	Examine QB streams for potential instream restoration opportunities that would improve rearing and overwintering habitats	2011 & beyond	Implement high priority instream restoration opportunities	2012 & beyond

4.1 Protection Measures

4.1.1 Aquifers and Groundwater Recharge/Discharge

Groundwater withdrawals are essentially unregulated in BC. Unrestrained groundwater withdrawals can tax hydrological systems resulting in falling water tables and reduced groundwater inputs to streams and wetlands. As surface water rights become fully allocated, groundwater extraction becomes the primary source of additional water. NCES, its partners and the local community need to protect the quality of their existing aquifers within the Qualicum Bay area (Figure 13) to ensure the quality and quantity of groundwater flows to watercourses persists into the future. NCES and partners should work with MOE to regulate the extraction and use of groundwater. In addition, NCES and partners should monitor land use development to ensure land use practices do not impact the quality and water levels of aquifer or groundwater discharge volumes to watercourses and wetlands. Further recommended activities are described below under Section 4.1.3 Water Quality.

NCES and its partners are working with S. Earle, PhD, PGeo of VIU to create an understanding of groundwater – surface water interactions and pathways in the Qualicum Bay watersheds with the objective of estimating the contribution of groundwater discharge to Nile Creek, and to summarize the effects of that discharge on water quality and quantity. Activities that will be undertaken by S. Earle and the VIU hydrogeology students in 2011 include:

1) Collect data on water temperature, pH and conductivity from Nile Creek and adjacent creeks;
2) Access as many wells as possible within a few kilometers of Nile Creek to get static levels, temperature, pH and conductivity, and to collect water samples for more comprehensive analysis;
3) To the extent possible, map the water table around Nile Creek and use that information to estimate groundwater flow patterns; and
4) Acquire and study discharge data for as many creeks in the region as possible.

4.1.2 Instream Flows

Provincial regional water managers are typically responsible for decisions pertaining to water allocation and water licencing and, at their discretion, will consider the maintenance of instream flows for the protection of the fisheries resource before making these decisions. Regional water managers refer to Water Allocation Plans to provide background on the hydrological conditions in specific watercourses. A Water Allocation Plan for Nile Creek to Trent River (Braybrook et al. 1995) was prepared by the Ministry of Environment to guide future water licencing decisions that arise within this area. This Water Allocation Plan includes basic hydrological information on Nash, Thames and numerous other Qualicum Bay tributaries.

The estimated hydrology and incidence of meeting the Tennant (1976) stream flow targets are presented for Nash and Thames creeks in the Water Allocation Plan (Braybrook et al. 1995). Figure 16 indicates that Nash Creek likely falls below 10% of the estimated mean annual discharge (MAD) during the months of July, August and September suggesting that water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. As per MOE guidelines, no water is available from Nash Creek when the flow is below 60% MAD or 157 litres/second.

Similarly, Figure 17 illustrates that the estimated mean monthly flow in Thames Creek falls below 10% of the mean annual discharge (MAD) during the months of July to September. Therefore, water is only available for extractive use during the months of October through June when the mean monthly discharge is above 60% MAD. No water is available from Thames Creek when the flow is below 60% MAD or 338 litres/second.

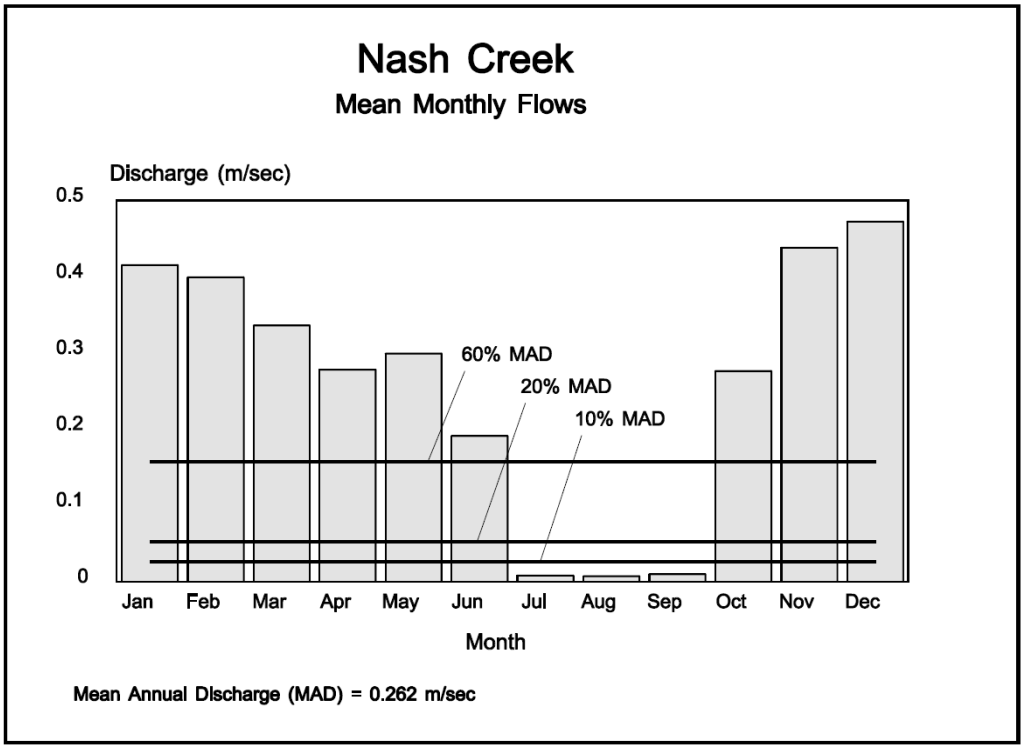

Figure 16. Estimated mean monthly flows (m^3/sec) and Tennant (1976) instream flow targets for Nash Creek. Reproduced from Braybrook et al. (1995).

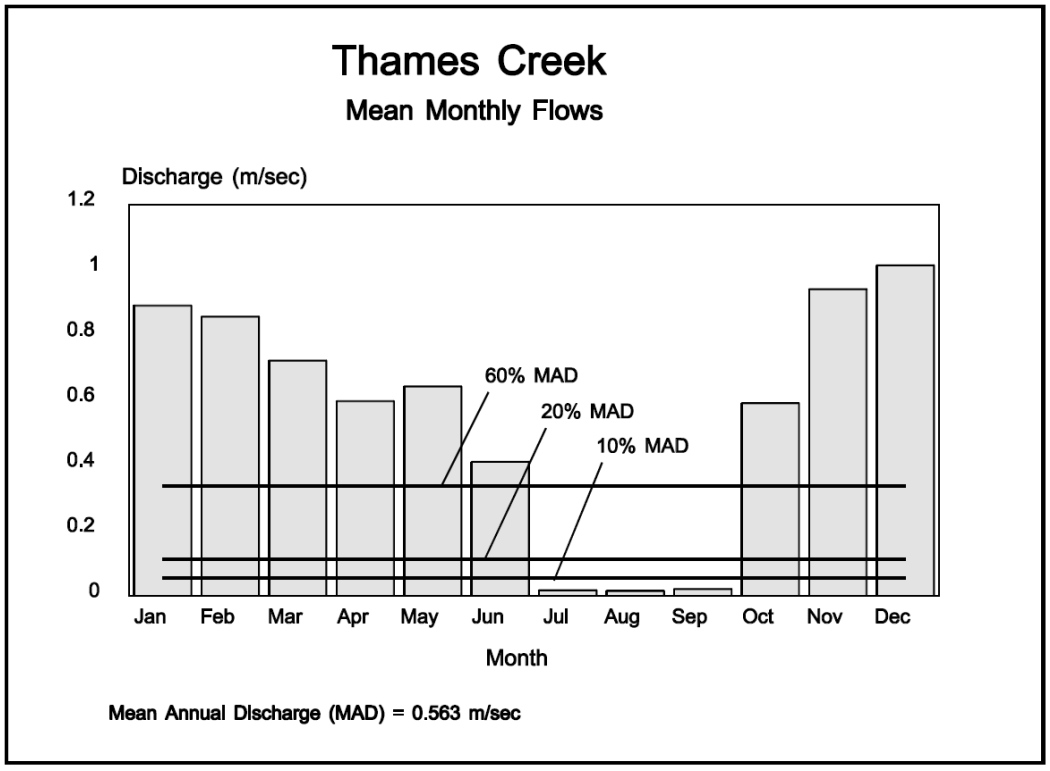

Figure 17. Estimated mean monthly flows (m^3/sec) and Tennant (1976) instream flow targets for Thames Creek. Reproduced from Braybrook et al. (1995).

The 2010 discharge data from the stream gauges on Thames and Nash creeks (Table 9) suggests that the mean monthly and MAD estimates from Braybrook et al. (1995) are likely overestimates, particularly for October and the January to June period. It should be noted that Walther (2009) had serious concerns on the mean monthly and mean annual discharge statistics for Thames and Nash creeks presented by Braybrook et al. (1995), suggesting the values were distorted and biased upwards, respectively, because of the inclusion of data from high elevation streams in the unit flow estimates for these low elevation streams.

Table 9. Comparison of discharges (L/s) from the Nile Creek to Trent River water allocation plan (Braybrook et al. 1995) with 2010 mean monthly discharges in Thames and Nash Creeks.

Stream	Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	MAD
Thames Ck	Water Allocation Plan	890	856	721	597	642	411	18	16	22	591	940	1013	563
	2010 Discharges	294	260	266	258	136	103	70	14	44	83	-	-	-
Nash Ck	Water Allocation Plan	415	399	336	278	299	191	8	7	10	276	438	472	262
	2010 Discharges	74	44	56	98	16	12	7	3	7	13	-	-	-

Braybrook et al. (1995) also indicated that "Most of the streams in the Nile Creek to Trent River Water Allocation Plan area are naturally limiting to fish habitat and, therefore, fish survival." It is presumed that the authors were speaking of hydrologic limitations on fish habitat.

The Ministry of Environment on Vancouver Island has been proactive on ensuring water allocation and licencing decisions consider the maintenance of instream flows. The Vancouver Island Region has applied a provincial instream flow policy to those drainages specified in the Nile Creek to Trent River Water Allocation Plan (and to those drainages specified in fourteen other Plans on Vancouver Island) to give direction to the regional manager when making water allocation or water licencing decisions. The policy in the Plan states:

> Maintaining the natural stream environment and instream uses is of paramount importance for present and future generations. Maintaining water for the fisheries resource is a key factor in maintaining instream flow requirements for water quality, recreational, aesthetic and cultural values. The Ministry of Environment Provincial policy is:
>
> **In situations where a water allocation decision will significantly impact instream uses of water, the comptroller or regional water manager may refuse the application or include water licence conditions to protect the instream use.**
>
> Instream fisheries flow requirements are based on a provincially modified version of the Tennant (1976) method (see below).

Modified Tennant (Montana) Method Instream Flow Requirements	
Flows	**Description**
30-60% MAD	Excellent spawning/rearing
20-30% MAD	Good spawning/rearing
10-20% MAD	Fair spawning/rearing
5-10% MAD	Poor spawning/rearing
>5% MAD	Severely degraded spawning/rearing

> In drainages where fish are present, the minimum flow required to sustain the fisheries resource for fair spawning and rearing habitat is 10% of the Mean Annual Discharge (MAD). Therefore, the Regional policies to implement the Provincial policy are:
>
> The minimum flow required to sustain the fisheries resources for spawning and rearing is 10% of the Mean Annual Discharge (MAD); unless a more rigorous analysis indicates a different minimum flow requirement.
>
> For streams where the natural mean monthly flow falls below 10% of the MAD, extractive demands should only be allowed for the period of months when the mean monthly flow is above 60% of the MAD.
>
> For streams where the mean 7-day average low flow falls below 10% of the MAD, extractive demands should only be allowed for the period of months when the mean

monthly flow is above 60% of the MAD. Where the mean 7-day average low flow remains above 10%, then the 7-day low flow amount above 10% MAD is available.

Withdrawals from natural water bodies (lakes, ponds, swamps and marshes) supporting natural fisheries resources shall not reduce the shoal area more than 10%.

However, Brandes and Curran (2008) believe "the current water management and licensing regime in British Columbia does not adequately protect ecological health or ensure the basic instream flow needs that provide the foundation for functioning watersheds and aquatic ecosystems." Furthermore, they suggested that "the *Water Act* and the licensing regime in British Columbia must, at minimum, explicitly allow for conservation purposes to be included in existing licences as a valid water use where the water is not taken out of the ecological system. Given the embedded nature of the existing allocation system and over-allocation that currently exists in some regions, reforms must also include mechanisms for the comptroller, regional water manager, or regional water boards to designate a portion of licence allocations as instream flows to return adequate flows in compromised ecosystems."

Several alternatives exist for community organizations to protect instream flow regimes on fish-bearing streams by improving the regulatory mechanisms or vehicles that legally enforce the minimum streamflow rates on a seasonal basis. These alternatives include:

1. Encouraging the Ministry of Environment to mandate instream flow requirements into the Water Act and water rights licence.
2. Holding water rights licences for conservation purposes to maintain instream flows;
3. Identifying and encouraging the Ministry of Environment to reserve flows for conservation purposes;
4. Encouraging dedication of a specific flow-limited salmon and trout stream as a Sensitive Stream under the Fish Protection Act;
5. Encouraging the provincial government to bring Section 8 of the Fish Protection Act into force so that the Lieutenant Governor of Canada (provincial Cabinet) can direct water licences for streamflow protection purposes;
6. Becoming involved in the development of Water Management Plans and Watershed Management Plans; and
7. Becoming involved or spearheading the development of regional water boards or roundtables that encompass their watersheds.

4.1.2.1 Mandate Instream Flow Requirements

BC's water licensing and allocation system is based on "first in time, first in right" which means that older licences take precedence over newer ones if there is not enough water in a stream to satisfy all licences. This prior allocation system does not promote conservation and protect ecosystem health. A more adaptable and flexible system is required that mandates instream flows to protect ecological function of aquatic ecosystems. Changes to the allocation and licensing system are even more relevant under predicted warming and decreased precipitation with future climate change on Vancouver Island.

Mandating a seasonally variable or minimum instream flow rate based on reliable and direct streamflow measurements would provide greater protection for BC streams. The instream flow rate could be established as a reserve on the watercourse to ensure long term sustainability of aquatic ecosystems. Similar allocation approaches that recognize the importance of environmental protection for rivers and streams have been established in South Africa, Australia, Japan and Europe (Brandes and Curran 2008).

4.1.2.2 Water Rights Licence for Conservation Purposes

NCES and partners should work with the provincial and federal fisheries ministries to obtain a water rights licence for conservation purposes on a Qualicum Bay tributary that requires protection. In some circumstances it may be of greater benefit if NCES encourages DFO or MOE to hold the water licence. Under the specified conditions of the Water Act, NCES or the government as the licensee would need to own land adjacent to the stream reach where the instream flow is licensed and would need to construct some instream works to justify the need for a conservation flow. Land trusts or registered society may be able to transfer water licences to the Crown in some circumstances.

NCES and TUC in collaboration with DFO should work with MOE to reform the Water Act to allow conservation agencies to hold water licences for conservation purposes without appurtenance and without constructed works. Although there are several cases in BC where water licences are held by senior government agencies for conservation purposes, we are not aware of any cases where a conservation organization has obtained a water licence solely to maintain instream flows for aquatic organisms in a natural watercourse (i.e., a watercourse without 'constructed works'). Water trusts and other conservation organizations in Washington and Oregon either hold licences for instream uses to achieve watershed health goals or work with government agencies that hold water rights for conservation purposes (Brandes and Curran 2008). Through discussions with the Ministry of Environment, community-based conservation organizations in BC, such as the Nile Creek Enhancement Society and Trout Unlimited Canada, should endeavour to modify the conditions under the Water Act to allow the organization to obtain a water licence for conservation purposes to ensure instream flows are maintained at historic levels during critical low flow periods and that any extraction of water does not limit the abundance, growth and survival of native fish populations.

4.1.2.3 Reserve Flows for Conservation Purposes

As of June 5, 2009 there are 4589 waterbodies in BC with water allocation restrictions registered in the Water Rights Information System (http://www.env.gov.bc.ca/wsd/water_rights/reserves_restrictions/cabinet/restrictions.pdf). For the Nanaimo-Courtenay district in which the Qualicum Bay tributaries are located, there are 91 waterbodies with restrictions. Nash and Thames creeks are not included in this list of streams. The restrictions indicate that for example, the streams are fully recorded or that they have possible water shortages or no water available for allocation. Although perhaps inferred by placing these restrictions, there are no examples within the Nanaimo-Courtenay district where a reserve has been placed to maintain minimum flows to protect aquatic resources. NCES should identify the watersheds or stream systems that need secure instream flows and encourage the Ministry of Environment to reserve those flows for public interest (conservation) purposes.

4.1.2.4 Sensitive Stream Designation

NCES and partners should spearhead the designation of flow-limited Qualicum Bay tributaries as sensitive streams and work with the Ministry of Environment to develop recovery plans for these streams. Some of the rationale for this designation may come from work being done by VIU to determine groundwater – surface water interactions. To date, only 15 streams in BC have been designated as sensitive under the Sensitive Streams Designation and Licensing Regulation of the Fish Protection Act. Under Sections 6 and 7 of the of the *Fish Protection Act* the province can designate streams as sensitive where the designation will contribute to the protection of fish populations at risk because of inadequate water flows or the degradation of fish habitat. With this designation the comptroller or regional water manager can require mitigation for water licences on designated sensitive streams. Development of a recovery plan for the designated stream may also be requested by the BC Minister of Environment.

4.1.2.5 Water Licence for Streamflow Protection Purposes

NCES and TUC should encourage the provincial government to bring Section 8 of the Fish Protection Act into force so that the Lieutenant Governor of Canada (i.e., provincial Cabinet) can direct the issuance of water licences for streamflow protection purposes. The conditions that apply to holding a water licence for streamflow protection purposes under Section 8 of the FPA are that:

- Organizations that have a community-based interest in the stream for which the licence is issued are eligible;
- The licensee is required to construct works related to fish and fish habitat at designated locations on a stream; and
- No appurtenancy is required, which means NCES would not have to own land or an undertaking to qualify to hold this type of licence.

4.1.2.6 Watershed Management Planning

Watershed management planning can assist in addressing water supply issues, preventing conflicts between water users and maintenance of instream flow requirements, or identifying and addressing risks to water quality. NCES with help from TUC should become involved with the Ministry of Environment in the development of Water Management Plans and Watershed Management Plans and spearhead the development of regional water boards or roundtables that encompass their watersheds.

NCES and partners should initiate and participate in the development of regional watershed management plans that will assist in better understanding the state of water allocation and use in a watershed or region, and provide decision-makers with direction on protecting instream flows. At a minimum, the plans should include the existing status (quality and quantity) and predicted condition / demands for fish, fish habitat, instream flows, aquifers, groundwater, and surface water runoff.

The establishment of regional water boards or roundtables provides a mechanism for bringing community organizations together with interested parties from industry, governments, and First Nations, and others to discuss pertinent watershed issues and develop watershed management

plans. The boards or roundtables also provide a vehicle for community organizations such as NCES to be part of the formal public vetting process for new land development proposals, water rights licence applications, and other regulatory permitting processes within the community's watersheds.

4.1.3 Water Quality

Protection of the existing high quality water (i.e., temperature, dissolved oxygen, suspended sediment and bedload) in Qualicum Bay tributaries, such as Thames and Nash creeks, is critical to sustaining the currently abundant native coho and cutthroat trout populations. The high quality water is linked to the current quality and quantity of groundwater inflows to streams that predominate in the middle reaches of these watersheds. In addition, the maintenance of adequate vegetative buffers along the stream corridor will maintain water quality and the integrity of the channel by reducing bank and channel erosion, providing proper filtration of surface run-off to reduce sediment and nutrient inputs, and providing shading, litterfall and terrestrial insect inputs, as well as LWD inputs to the stream. As stewards of the Qualicum Bay watersheds, NCES should ensure the high water quality in its watercourses is maintained in the future by:

- Ensuring land developments or land use activities do not negatively impact the water quality or water volumes of aquifers that discharge groundwater to streams and associated wetlands; and
- Ensuring that the regulations within the RAR, FRPA and PFFLA concerning riparian buffers, reserves and management zones/areas are adhered to and enforced.

As discussed above in Section 4.1.2.6, NCES's involvement on a regional water board or watershed roundtable would facilitate the implementation and achievement of these objectives. NCES and partners should also consider monitoring or conducting audits of private and public lands to gather information on current activities and any notable infractions of these regulations.

4.1.4 Riparian Corridor

A significant portion of the critical spawning, rearing and overwintering habitats in Thames and Nash creeks are on lands under Provincial Crown ownership (Figure 4). As a first priority, it would be prudent to establish long term protection of the riparian corridor by limiting encroachment or development within 30 m (minimum) of the creek through a designation of a riparian corridor reserve on these Crown lands. Key zones for riparian zone protection on Thames Creek include rearing and spawning habitats for coho and cutthroat trout downstream of the BC Hydro transmission corridor and overwintering habitat in beaver ponds immediately downstream of Inland Island Highway 19. The key zone for riparian zone protection on Nash Creek includes spawning, rearing and overwintering habitat for coho and cutthroat and extends from Highway 19A to ~110 m upstream of the Southern Railway culvert crossing.

On private lands within the lower portions of Thames and Nash creeks and the upper watershed in Thames Creek, NCES and TUC should discuss with private landowners and the provincial government the available alternatives to expand protection of riparian vegetation and buffers beyond the requirements under the Privately Managed Forest Land Act and Riparian Area Regulation. In addition to the regulations and potential activities on riparian buffers described in Section 4.1.2.6 above, perpetual protection of riparian corridor vegetation would ensure the

integrity of the stream channel, aquatic habitats and associated aquatic fauna is maintained over the long term. Protection could be obtained through protective easements and covenants or fee-simple purchases.

4.1.4.1 Easements and Covenants

NCES or RDN could establish, through purchase or voluntary donation, narrow, stream corridor easements or covenants with private landholders to improve and protect water quality of Qualicum Bay tributaries. Alternatively, the RDN may consider partnering with NCES to obtain the easements and have NCES monitor them to confirm that landowners are complying with the terms of the easements. NCES should collaborate with the RDN to spearhead the development of incentives, such as tax relief for donated riparian lands, to attract landowners to protect buffers through perpetual conservation easements, rather than through deed restrictions.
As another alternative, the RDN could make an easement or covenant a requirement on construction permits where the proposed development property has riparian areas.

4.1.4.2 Fee-simple Purchase

In some cases, the RDN or NCES or a multi-stakeholder partnership with provincial or federal governments may find it beneficial to purchase stream corridor lands outright from a voluntary seller. The objective might be to create a linear park with public access or to protect a strategically critical reach of stream that has a high degree of environmental sensitivity or is critical habitat for native salmonids. An advantage of this approach over an easement is that the purchaser has complete control over the given riparian corridor land parcel.

4.1.5 Habitat Diversity and Condition

As stewards of the Qualicum Bay watersheds, NCES and partners should monitor and maintain the distribution, diversity and abundance of existing high quality spawning, rearing and overwintering habitats in all streams with salmonids. Maintaining high quality habitats in Qualicum Bay watersheds is dependent on achieving the stated protection measures described above for aquifers and groundwater resources, instream flows, surface water quality, and riparian corridors. In addition, restoration or enhancement measures may be required to re-establish historic fish distributions or biological productivity. As discussed below, these measures could include restoring the density and distribution of instream cover by constructing Large Woody Debris (LWD) structures, and restoring historic fish access and fish distributions by improving access through culverts.

4.2 Restoration Measures

4.2.1 Fish Access

Access at the mouth of Nash Creek for coho and anadromous cutthroat trout smolts emigrating in the spring and coho spawners immigrating in the fall has been a chronic long term problem for this small stream. NCES members also believe that migration accessibility was further reduced after the construction of the two flood relief structures in 1997 (Northwest Hydraulic Consultants 1997a; 1997b; 1998). Providing consistent access for adult and juvenile salmonids is a high priority restoration objective for Nash Creek through the Nile Creek – Qualicum Bay Program.

Several restoration measures to improve fish access are proposed for Nash Creek, in order of preference:

1) Prepare an engineering design to provide fish access through the southern flood relief structure. This alternative would involve installing a ~20 cm diameter pipe with manhole that extends from the inlet headwall to below the low tide elevation in Qualicum Bay, a distance of ~120 m. KWL (C. Sutherland PEng. pers. comm.) has prepared a preliminary construction cost estimate (Level-D) of ~$65,000 for this project. This cost is based on budget quote (2010) from a pipe supplier and typical unit rates for equipment and materials. They estimated that the work would take about 1 week to complete, including site prep and clean up. The estimate includes mobilization/demobilization, construction inspection and environmental monitoring (assumed to be 15% of construction) plus a 30% contingency. It is anticipated that site surveys, rehabilitation design and construction of the works will be completed in 2011.
2) Establish a formal agreement with federal (DFO) and provincial (MOE) agencies that NCES would be responsible for maintaining the existing mouth of the creek open during periods of fish migration. This would involve removing the accumulated gravels on the beach at the creek mouth using a small bobcat or excavator. Excavation of accumulated gravels may be required frequently on Nash Creek if a low maintenance fish passage alternative, such as the pipe installation as proposed in #1 above, is not constructed.
3) Explore alternatives for reducing the amount of gravel accumulations on the beach at the mouth of the creek. An off-shore breakwater, and a beach groyne similar to Thames Creek are two potential alternatives to reduce gravel build-up at the mouth of Nash Creek. A preliminary conceptual drawing of the groyne structure for Nash Creek mouth has been prepared (Figure 18). An engineer specializing in coastal processes and the design of remedial measures to reduce gravel accumulations in localized zones should be requested to examine alternative approaches.

Similar to Nash Creek, the mouth of Thames Creek is occasionally blocked by a build-up of gravels on beach. The groyne constructed on the beach at the mouth of the creek has helped to mitigate this migration impediment for juvenile and adult salmonids. However, there are some occasions when removal of the beach gravels would improve fish access.

Upstream access for adult salmon and juvenile salmon and trout on Thames Creek is impeded at the Highway 19A culvert and the Southern Railway culvert. NCES members have reported that access is impeded for chum salmon migrating upstream because of the high velocity flows across the concrete apron at the Highway 19A culvert (Photo 14). Also, the Southern Railway culvert is likely impeding upstream migration of juvenile salmonids and possibly adult cutthroat trout and coho during low flow periods. The culvert is perched above the creek channel and has two broken concrete baffles (Photo 15). Several restoration measures to address these fish impediment problems are proposed for Thames Creek, in order of preference:

1) Improve fish access at the Highway 19A crossing by placing oversized boulders on the concrete apron downstream of the culvert invert to create localized low velocity zones for fish to hold in during their upstream migration. Design drawings were prepared for the

placement of the boulders (Figure 19 and Figure 20) and the project was constructed in 13 September 2010 (Photo 16 and Photo 17).

2) Repair two concrete baffles that have failed in the Southern Railway crossing culvert.
3) Construct two riffles downstream of the railway culvert crossing to create a stepped water surface profile and a backwater pool up to the first downstream baffle in the culvert. The existing profile of the channel showing the perched culvert is shown in Figure 21. A rehabilitation design has been prepared and is shown in Figure 22.
4) Establish a formal agreement with federal and provincial agencies that NCES would be responsible for maintaining the existing mouth of the creek open during periods of fish migration. This would involve removing the accumulated gravels on the beach at the creek mouth using a small bobcat or excavator.

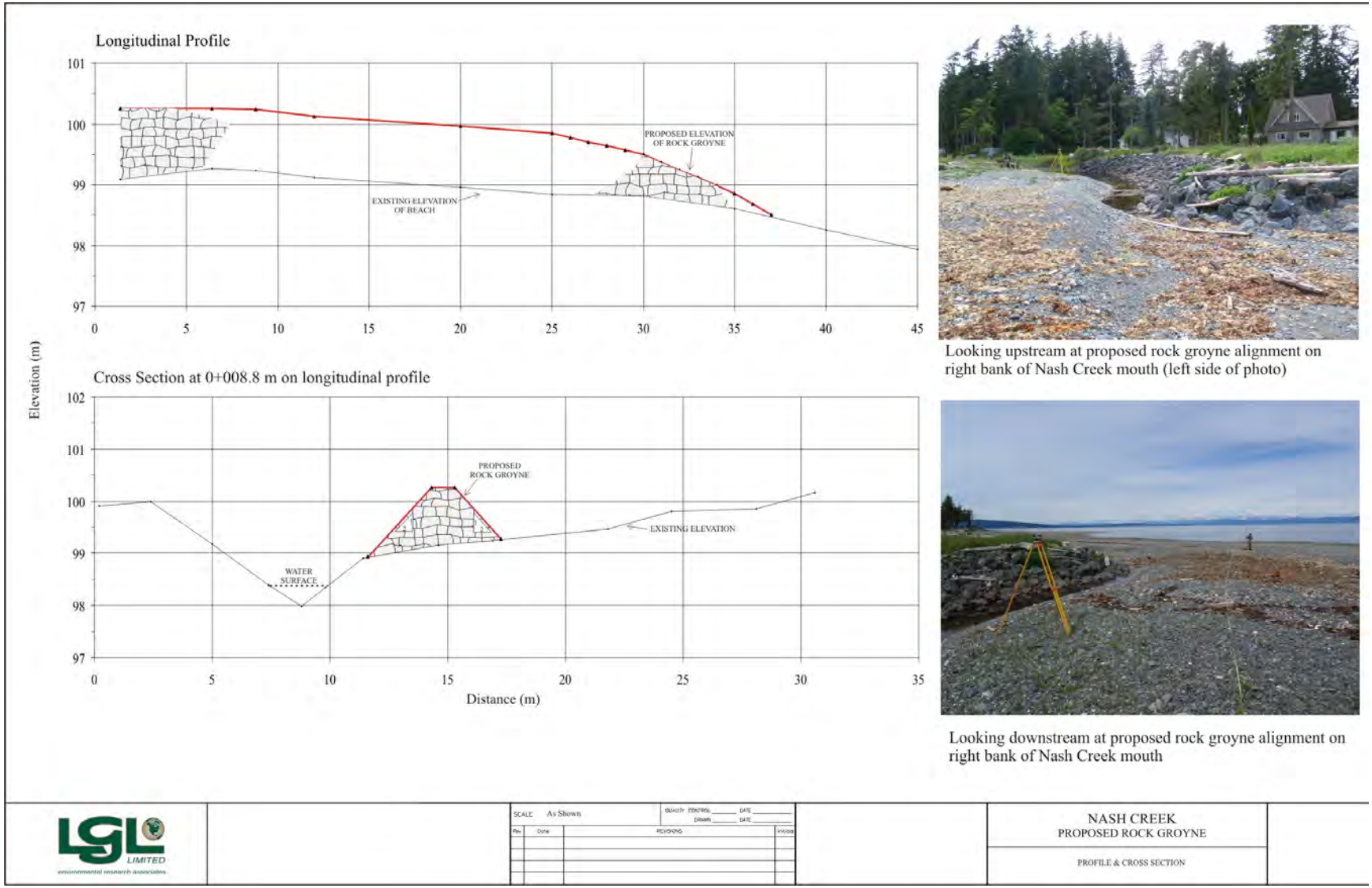

Figure 18. Profile and cross section for potential groyne structure at mouth of Nash Creek

Photo 14. High velocity discharge across concrete apron in Thames Creek at Highway 19A crossing, 14 January 2010.

Photo 15. Downstream side of perched Southern Railway culvert crossing in Thames Creek, 4 March 2010.

Figure 19. Plan view of proposed boulder placement on the downstream side of the Highway 19A culvert in Thames Creek.

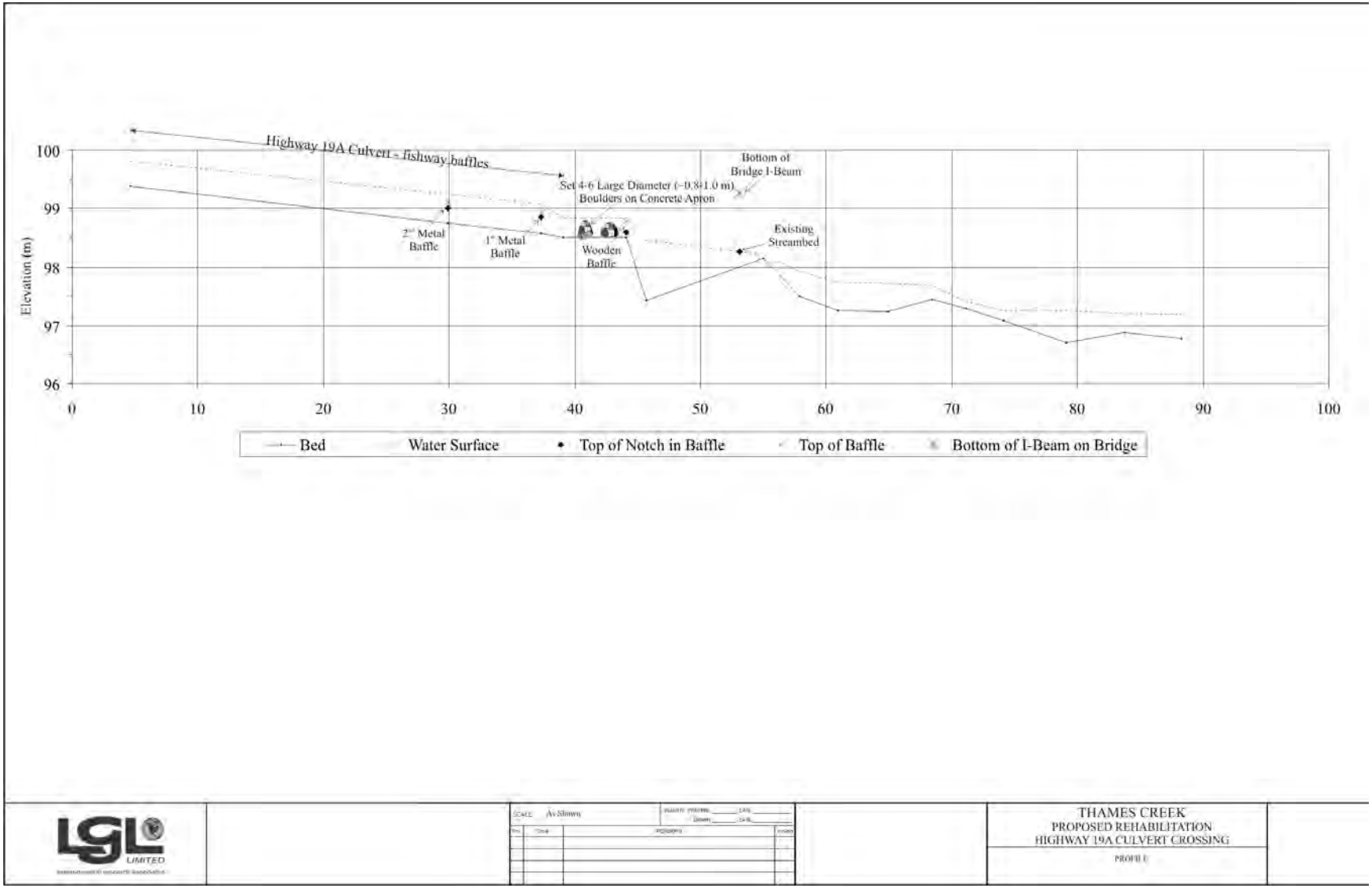

Figure 20. Profile of Thames Creek showing proposed boulder placement on the downstream side of the Highway 19A culvert.

Photo 16. Installation of over-sized boulders using 30 ton boom truck at Highway 19A culvert in Thames Creek.

Photo 17. Six over-sized boulders placed on downstream side of Highway 19A culvert in Thames Creek.

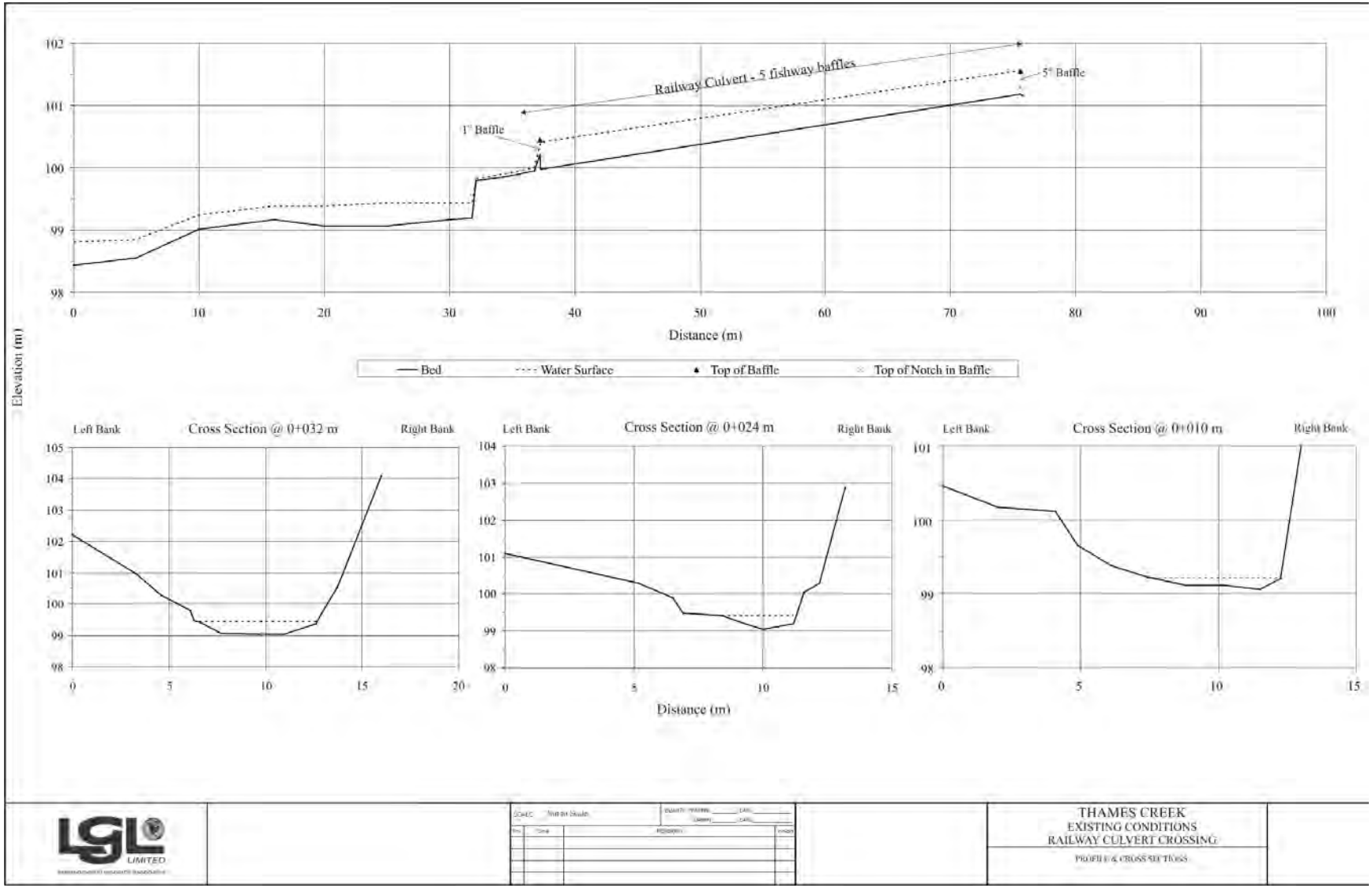

Figure 21. Existing profile and cross sections of Thames Creek at Southern Railway culvert crossing.

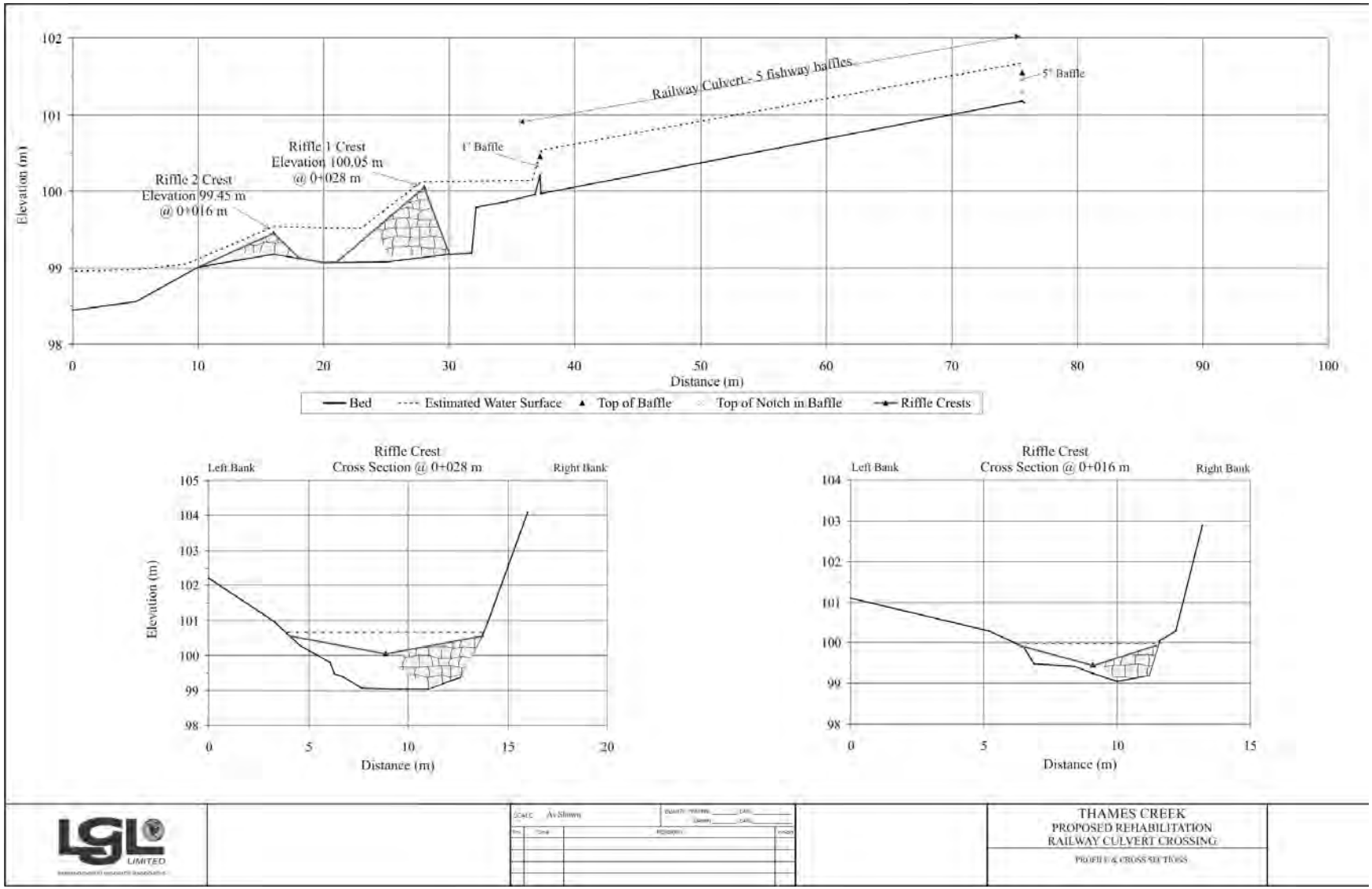

Figure 22. Proposed rehabilitation profile and cross sections for Thames Creek at Southern Railway culvert crossing.

4.2.2 Watershed Hydrology

A portion of the upper Nash Creek watershed was diverted to Nile Creek when the BC Hydro transmission line was installed. In the process of managing run-off within the woodlot, the woodlot manager will re-establish the historic drainage network for Nash Creek. As per the conceptual design drawing (Figure 23), a channel will be excavated to re-capture flows and re-direct them to Nash Creek. The channel will continue as a ditch along an existing drive lane and then be re-directed to ephemeral channels in the forest. The channel is considered ephemeral and would only discharge to Nash Creek during wetter periods of the year.

4.2.3 Habitat Condition and Complexity

Five small off-channel and in-channel ponds were previously constructed in Nash Creek on Dale and Brenda Wilson's private property (Figure 24). The ponds were developed in part for stock watering and also as rearing ponds for juvenile coho and cutthroat trout. Pond water levels remain relatively high even throughout the summer period and are maintained primarily by groundwater upwellings in the ponds and some inflowing groundwater-fed surface water channels. Surface water temperatures on June 24, 2010 were 16.4C for Ponds 1 and 4, 16.5C for Pond 5, and 22.4C for Ponds 2 and 3.

Some restoration work is proposed for the ponds and connector channels. Pond 1 on Nash Creek has in-filled with sediments and should be re-excavated (Photo 18). The side slopes along the west edge of the pond should be reduced to a low slope (4 or 5h:1v) to reduce bank sloughing and promote vegetation growth on the bank. Pond depths should average ~0.6-0.7 m with a maximum of 1.5-2.0 m in a small area of the pond.

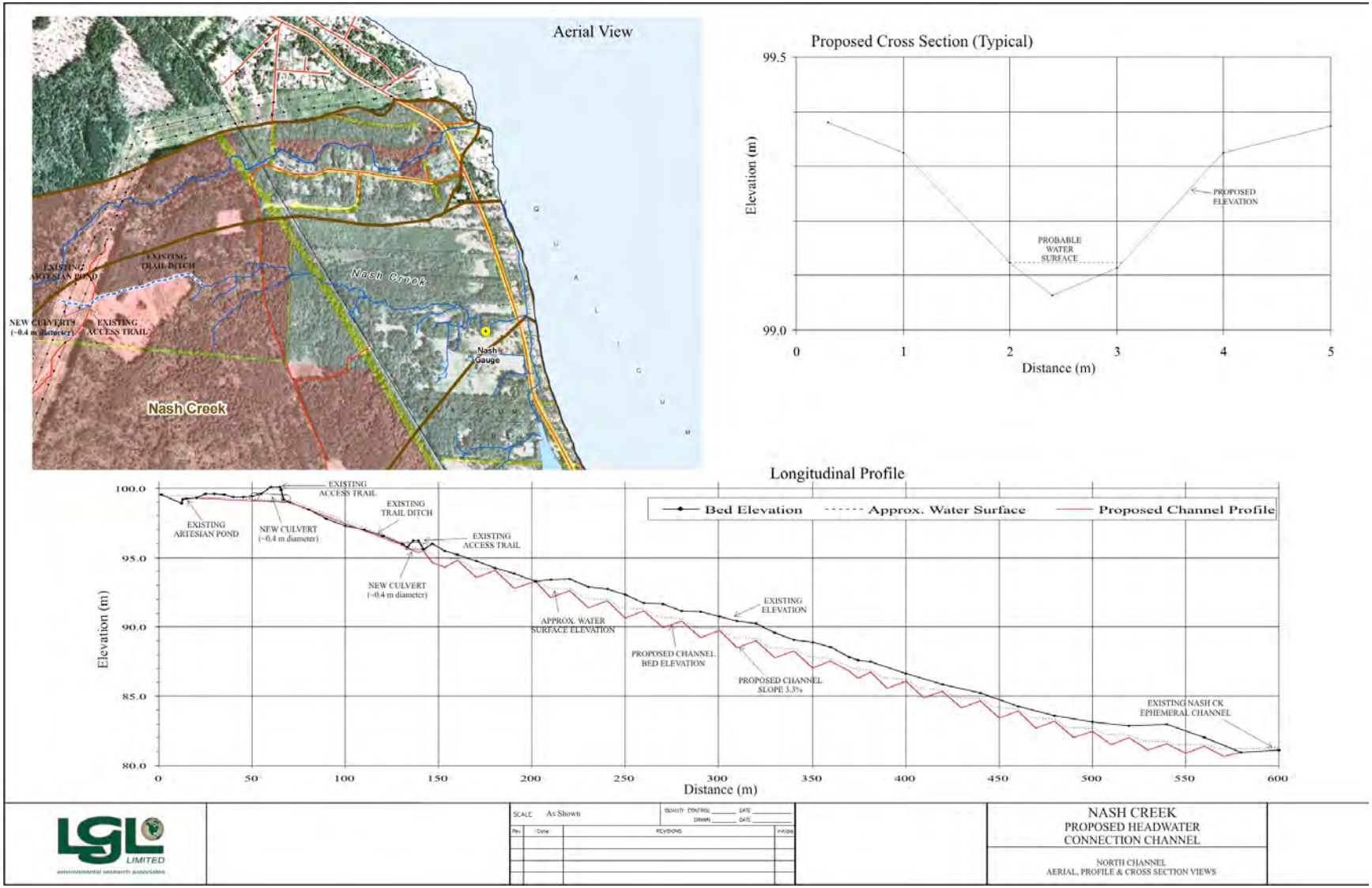

Figure 23. Conceptual drawing of headwater drainage network re-connection on Nash Creek.

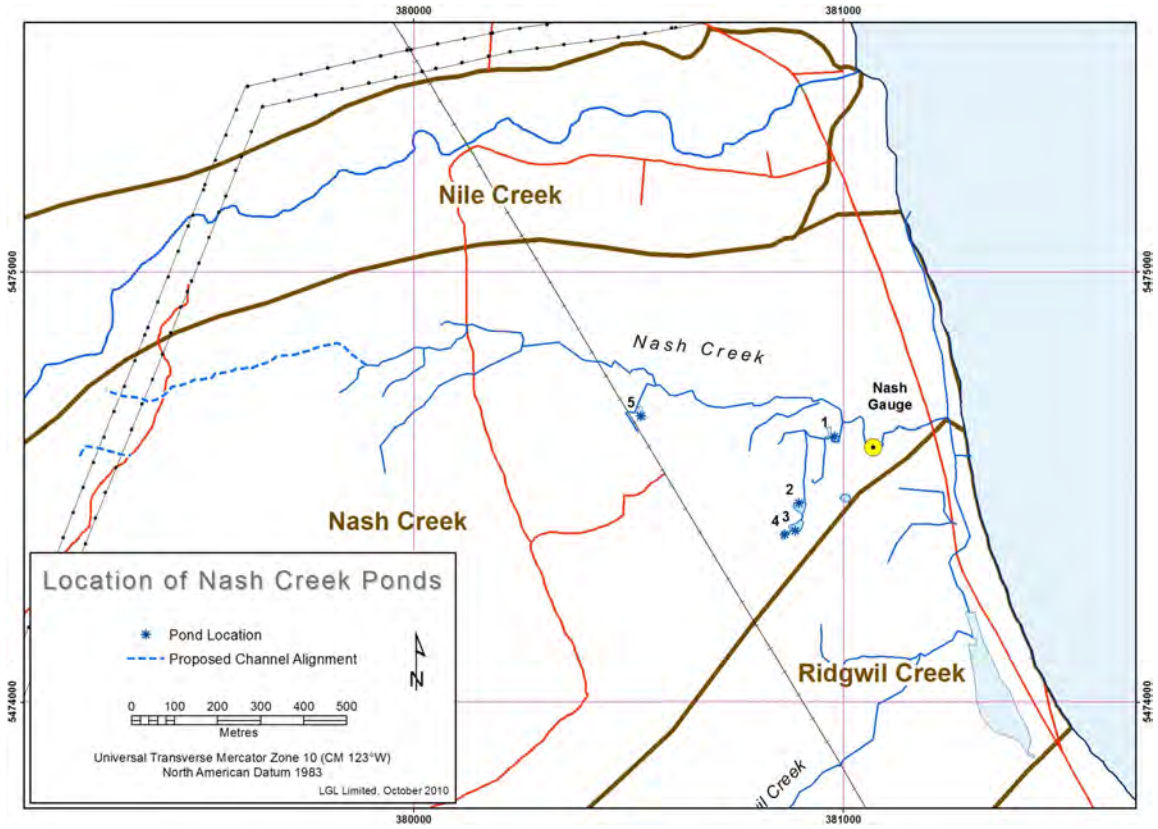

Figure 24. Location map for five off-channel and in-channel ponds on Nash Creek.

Photo 18. Looking south at off-channel Pond 1 on Nash Creek.

Re-excavation of Ponds 2-4 (Photo 19 to Photo 21) is not required but the steel pipes used to connect the ponds should be replaced with an open channel. The channels would be quite narrow and shallow. Dimensions for the trapezoidal channel would be ~0.5 m wide by 0.15-0.20 m deep. Side slopes of the short channel would be ~2h:1v. In addition, tree planting should be considered for the south and west banks of Ponds 2 and 3 to provide shading and to lower the water temperatures in these ponds.

Photo 19. Looking south at off-channel Pond 2 on Nash Creek.

Photo 20. Looking south at off-channel Pond 3 on Nash Creek.

Photo 21. Looking south at off-channel Pond 4 on Nash Creek.

The banks at Pond 5 need to be lined with clay to reduce seepage (Photo 22). To maintain the same side slopes for the pond, ~0.2 m of existing bank material should be removed and replaced with clay. Deepening at the north end of the pond to create 1.5-2.0 m deep pockets is also recommended (Photo 23).

Photo 22. South end of off-channel Pond 5 on Nash Creek.

Photo 23. North end of off-channel Pond 5 on Nash Creek.

5 Priority Activities

Table 10 summarizes a prioritized list of activities recommended for implementation by NCES and its partners in 2011 and beyond. Many of the activities in a given year would be undertaken concurrently and some activities may be opportunistically implemented earlier than proposed. This activity plan is flexible and would be adaptively managed by NCES as new or existing priorities arise and supersede those priorities that were previously identified.

The success of this plan will depend on strong coordination among all parties with interest in the protection and restoration of Qualicum Bay watersheds. NCES are well situated to lead this initiative with extensive support from Trout Unlimited Canada, DFO, MOE, local government, non-government organizations and the Qualicum Bay community-at-large. Implementation of the plan will require considerable annual effort on the part of key individuals who will ensure coordination with all parties, facilitate funding initiatives, and ensure that implementation of actions occurs following accepted priorities.

Table 10. Action plan priorities for protection and restoration of Qualicum Bay tributaries to be reviewed and revised by Program Partners.

2010 & beyond		2011 & beyond		2012 & beyond		2013 & beyond		2014 & beyond		2015 & beyond	
Priority	Activity	Priority	Activity	Priority	Activity	Priority	Activity	2014 & beyond	Activity	Priority	Activity
1	Monitor stream flows and water quality in QB tributaries	1	Install small diameter pipe in southern flood relief structure of Nash Creek to allow emigration of smolts to ocean	1	Encourage the provincial government to bring Section 8 of the Fish Protection Act into force so that the Lieutenant Governor of Canada (provincial Cabinet) can direct water licences for streamflow protection purposes	1	Prioritize degraded riparian sites, develop riparian prescriptions for high priority sites and replant	1	Survey riparian corridor of other QB tributaries and identify locations where width of treed buffer is <10 m	1	Prioritize degraded riparian sites, develop riparian prescriptions for high priority sites and replant
2	Monitor stream flows and water quality in QB tributaries	2	Restore historic watershed boundary and re-direct run-off into the headwaters of Nash Creek	2	Implement high priority instream restoration opportunities	2	Collaborate with RDN to spearhead development of incentives to attract landowners to permanently protect riparian buffers			2	Collect and evaluate water quality data on Thames and Nash creeks (ongoing monitoring program every 5 yrs)
3	Monitor water levels and water quality of existing domestic wells within the QB area	3	Collaborate with VIU on their investigations of groundwater – surface water interactions and pathways in the Qualicum Bay watersheds	3	Survey riparian corridor of Nash and Thames Creeks and identify locations where width of treed buffer is <10 m	3	Limit encroachment or development within 30 m (minimum) of the creek through a designation of a riparian corridor reserve on Crown lands				
		4	Excavate aggraded sediments and stabilize banks at existing ponds on Nash Creek	4	Identify and establish permanent riparian zone reserves in key rearing and spawning habitats for coho and cutthroat trout in Thames and Nash creeks	4	Construct instream works in Nash Creek (as pre-requisite for obtaining Water Licence under Water Act)				
		5	Repair damaged baffles and construct riffles at Southern Railway culvert crossing in Thames Creek	5	Through discussions with private landowners and provincial government, expand protection of riparian buffers on private land beyond the requirements under the Privately Managed Forest Land Act and Riparian Area Regulation	5	Apply to obtain water rights licences for conservation purposes to maintain instream flows				
		6	Become involved or spearhead the development of regional water boards or roundtables that encompass their watersheds	6	Work with MOE to regulate the extraction and use of groundwater	6	Establish stream corridor easements or covenants with private landholders through purchase or voluntary donation				
		7	Become involved in the development of Water Management Plans and Watershed Management Plans	7	Develop a formal agreement with government to maintain connectivity between the creeks and ocean during critical migration periods	7	Monitor to confirm that landowners are complying with terms of easements				
		8	Encourage dedication of a specific flow-limited salmon and trout stream as a Sensitive Stream under the Fish Protection Act			8	Purchase stream corridor lands outright from a voluntary seller				
		9	Identify and encourage the Ministry of Environment to reserve flows for conservation								
		10	Encourage the Ministry of Environment to mandate instream flow requirements into the Water Act and water rights licence								
		11	Monitor land development proposals and projects to ensure drainage networks are maintained, and watercourses are not modified								
		12	Monitor land use development to ensure land use practices do not impact aquifers								
		13	Monitor to ensure surface water discharge from land developments and land use activities do not impact the water quality and levels of aquifers that discharge groundwater to streams and associated wetlands within the QB area								
		14	Monitor to ensure that regulations within RAR, FRPA and PFFLA concerning riparian buffers, reserves and management zones/areas are adhered to and enforced								
		15	Examine QB streams for potential instream restoration opportunities that would improve rearing and overwintering habitats								
		16	Examine QB streams for potential off-channel enhancement opportunities that would expand rearing and overwintering habitat area								
			Develop an assessment program to regularly monitor temperature, dissolved oxygen, turbidity and channel morphology and condition in Thames and Nash creeks								

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