RAR STREAM IDENTIFICATION OF THE FORD CREEK AND LOWER BEULAH CREEK WATERSHEDS

Prepared for: **The Islands Trust**

Suite 200, 1627 Fort Street
Victoria, BC V8R 1H8
March 2012

Prepared by: *Mimulus Biological Consultants*
1135 Arden Road
Courtenay, BC V9N 9K3

EXECUTIVE SUMMARY

The purpose of the report was to identify and map all *streams* as defined under the Riparian Areas Regulation (RAR) within two Hornby Island watersheds. In order to become compliant with the provincial RAR, the Islands Trust is in the process of adopting RAR bylaws and other regulations to protect fish habitat. The Ministry of Environment completed preliminary field surveys in an attempt to identify island watersheds where RAR would apply. On Hornby Island, several watersheds have been identified as being RAR-applicable, including Ford and Beulah Creeks. Within the Ford and Beulah Creek drainage areas, the locations of the *streams* were identified and mapped with a high level of accuracy (within 1-5 meters). This will allow the Islands Trust to accurately identify the Riparian Assessment Area (RAA) for each watercourse and any proposed development inside a RAA would trigger the RAR process.

Within the Ford Creek and lower Beulah Creek watersheds, all watercourses, wetlands, and ditches were assessed as to whether they meet the RAR criteria for a *stream*. Field surveys of the Ford Creek and Beulah Creek watersheds were conducted November 12 to December 11, 2011 in order to locate streams as defined under RAR. No fish were observed in either drainage area during the field survey.

Within the Ford Creek drainage area, three watercourses (Ford Creek and two tributaries), ten drainages, eleven ditches, one large wetland, and four ponds were observed that met the definition of *stream* under RAR and therefore are subject to the RAR assessment procedure. The many associated headwaters and pocket wetlands would also be RAR applicable. Provincial reports suggest that Ford Creek has provided habitat for Coho salmon and Cutthroat trout. Local information indicates that Cutthroat trout were introduced in the 1950s and 1990s and are currently present in the system.

Accessing the Ford Creek mainstem from the estuary would be difficult for fish; it had a steep gradient and smooth bedrock substrate. For most of the creek's length, the streambed was composed of bedrock, hardpan, with patches of small gravels and cobbles. The watercourse meandered within a ravine, containing floodplain benches along the ravine bottom. Woody debris was abundant. There were occasional cascades and small waterfalls over bedrock or large woody debris. In some stream sections, bars composed of small gravels were common along the channel edges. There was little to no undercutting along the banks and little indication of flashiness. Additional water entered into the Ford Creek mainstem downstream of the Ford Wetland from one tributary, three drainages, and three roadside ditches.

Ford Creek was directed under roads and a driveway through several culverts. Water also entered the mainstem through culverts. Some of these culverts would present a barrier to fish passage. Approximately 5 meters downstream from the Strachan Road culvert, the stream was blocked by an accumulation of woody debris, soils, and gravels, much of which was consistent with adjacent roadbed material. At high water levels, it appears that the stream flows around the obstruction.

At the upstream end of Ford Creek is a large wetland, partially used for agriculture. The wetland water levels fluctuate seasonally, with the mowed upper wetland area containing

drainage ditches. Several watercourses entered the wetland over a broad floodplain, conveying water to the wetland from the surrounding slopes.

Within the Beulah Creek drainage area, six watercourses (Beulah Creek and tributaries), 32 drainages, 42 ditches, nine wetlands, and ten ponds were observed that met the definition of *stream* under RAR and therefore are subject to the RAR assessment procedure. The many associated headwaters and pocket wetlands would also be RAR applicable. Due to time constraints and the extent of the Beulah Creek drainage area, only the downstream reaches and their associated streams were mapped. No information from provincial or federal databases contain any records of fish presence in Beulah Creek. Local information states that historically Beulah Creek was salmon-bearing and has had salmon enhancement activities in the past. Local schools have historically released Coho fry and more recently Chum fry into the creek annually.

The entrance into Beulah Creek contained no obstructions to fish passage. Throughout the length of Beulah Creek surveyed, the channel had a low gradient (usually <5%), which meandered within a steep-sided forested ravine. Beulah Creek's streambed consisted of sections of hardpan or bedrock interspersed with gravel patches and occasional cobbles and boulders. Abundant woody debris was present throughout the watercourse length, creating instream structures, and small waterfalls and cascades. There was evidence of flashiness including erosion, alluvial deposits, and undercutting.

Tributaries, drainages, and ditches brought water into Beulah Creek from adjacent sub-basins. The largest of these were the Tributary 4 system, the Tributary 3 system, and the Ditch 7 system. These systems contained a complex arrangement of watercourses, ditches, and wetlands. Fish access into Beulah Creek's associated watercourses would be more difficult at the downstream reaches where watercourses flowed over the ravine banks into the Beulah Creek mainstem. Frequently the stream gradient of the tributaries, drainages, and ditches near the mainstem confluence was between 10% and 25%. Given the seasonal nature of almost all of the watercourses, this would limit fish access into upper reaches.

Additional surveys will be required to complete the stream identification and mapping within the upper Beulah Creek drainage area. There were at least three unmapped tributary systems entering Beulah Creek from the south and several drainages that contributed flow to the Beulah Creek mainstem.

Furthermore, aquatic habitat and watercourses encountered during the survey that did not meet the definition of *stream* under RAR were excluded from the maps in this report. Although these sites may be important and valuable habitat for other wildlife species besides fish and may provide important functions within the watershed, their assessment was not part of this project. These sites may be protected by other bylaws or permits within the Islands Trust.

As development on Hornby Island occurs, it is likely that watercourses may be altered, added, or disturbed. At some point, additional watercourses may become connected by surface flow to potential fish habitat and would become *streams* where RAR would apply. Maintaining current maps as development proceeds on the island is recommended. Several recommendations are included for future mapping projects.

TABLE OF CONTENTS

LIST OF MAPS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Background

The Riparian Areas Regulation (RAR) was enacted in 2004 under Section 12 of the Fish Protection Act. The Fish Protection Act (1997) provides the legislative authority for RAR. The Act focuses on four major objectives: ensuring sufficient water for fish, protecting and restoring fish habitat, improving riparian protection and enhancement, and providing stronger local government powers in environmental planning. Section 12 of the Fish Protection Act enables the Province to provide direction to local governments in order to protect riparian fish habitat through zoning bylaws and permits in accordance with the directive or meeting or exceeding that of the directive. Local government powers include enforcement through bylaws, official community plans, and permits under Section 26 of the Local Government Act.

RAR is a joint initiative, which includes Fisheries and Oceans Canada (DFO), the Ministry of Forests, Lands, and Natural Resource Operations (formerly Ministry of Environment), and local government. RAR uses a science-based approach that is proactive in order to prevent harmful alteration, disruption, or destruction (HADD) of fish habitat from land development activities.

The definition of fish habitat in British Columbia includes all aquatic and terrestrial areas that affect fish life processes. Thus, fish habitat includes riparian areas, which are the areas directly adjacent to aquatic habitat. Riparian areas support fish by providing various features, functions, and conditions necessary for fish survival. Sufficiently wide riparian areas provide space for channel movement over time. Riparian areas are typically treed and are therefore a source of woody debris. In streams, large woody debris provides fish habitat and is important in the maintenance of channel morphology. The woody species within a healthy riparian area provides localized bank stability, prevents erosion, and protects slopes. The vegetation from these areas provides food for the stream ecosystem, including litter fall and insect drop, which supports fish. A healthy riparian area also provides shade to the aquatic habitat it encompasses. This keeps water temperatures cool and maintains a more moderate climate surrounding fish habitat.

In order to become compliant with the provincial RAR, the Islands Trust is in the process of adopting RAR bylaws and other regulations to protect fish habitat. The Ministry of Environment completed preliminary field surveys in an attempt to identify island watersheds where RAR would apply. On Hornby Island, several watersheds have been identified as being RAR-applicable, including Ford and Beulah Creeks.

1.2 Purpose of Report

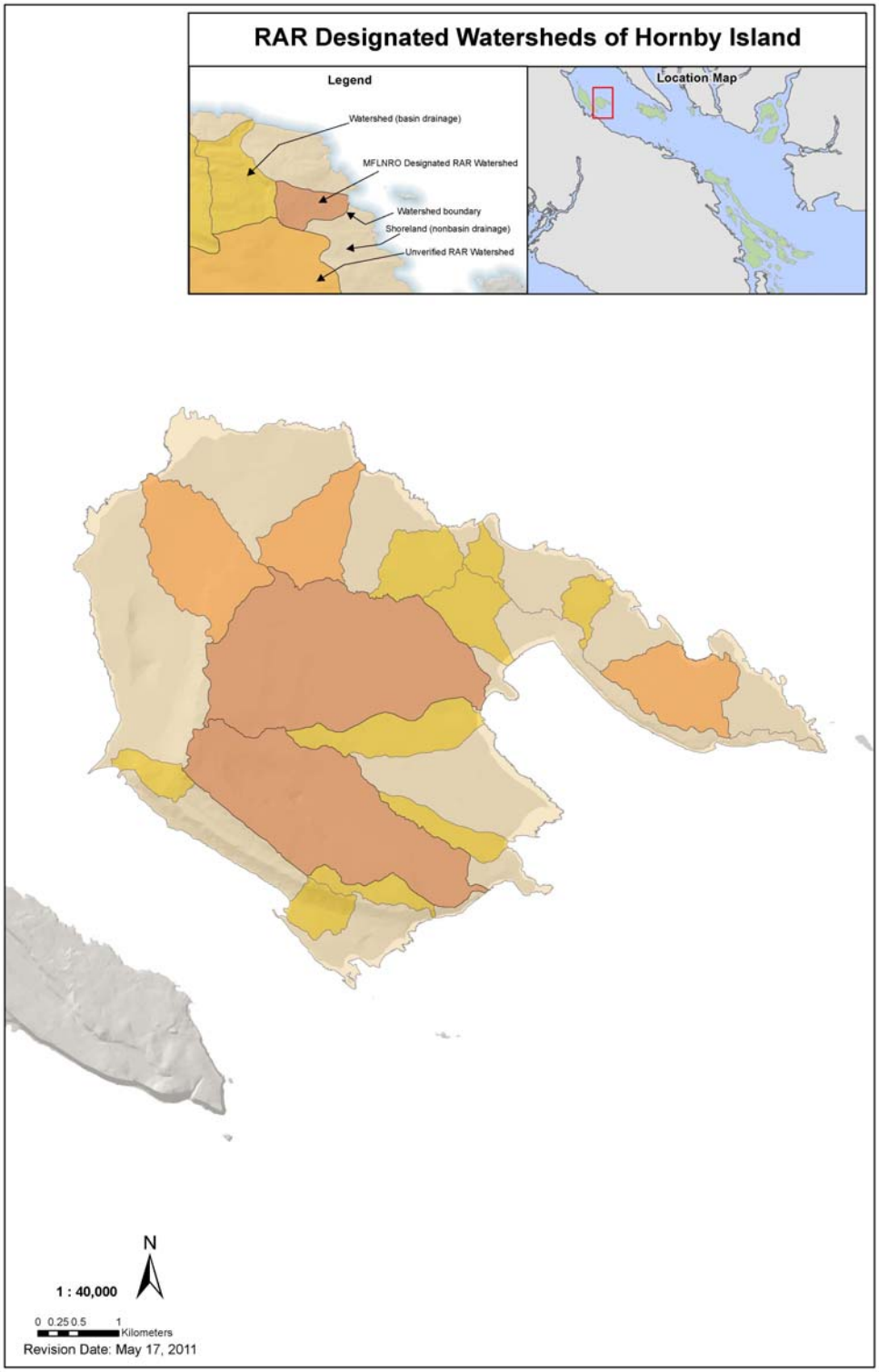
The primary objectives of the Stream Identification Survey described in this report were to identify watercourses, streams and/or wetlands that fit the definition of *stream* under RAR, and to map the locations of the streams with a high level of accuracy (within 1-5 meters) within the MOE-designated watersheds. This would allow the Islands Trust to accurately identify the Riparian Assessment Area (RAA) for the watercourses. Any proposed development inside a RAA would trigger the RAR process. Development within the RAA would be permitted if a Qualified Environmental Professional (QEP)

completes an assessment and submits a Riparian Areas Regulation Assessment Report to the local government, DFO, and the MFLNRO.

The RAA is the 30-meter area measured from the High Water Mark (HWM) or, in the case of ravines, the Top of Ravine Bank (TORB) of applicable watercourses. The scope of this project did not include locating the High Water Mark or the Top of Ravine Bank.

1.3 Study Area

Two of the designated RAR watersheds identified by the Ministry of Environment prior to this contract were the Ford Creek watershed and the Beulah Creek watershed (Map 1). The Ford Creek watershed commences in the south-central portion of Hornby Island and flows southeastwards to the Strait of Georgia. The Beulah Creek watershed is located north of the Ford Creek watershed. It also flows southeastward with its outflow into the Georgia Strait at Tribune Bay on the southeast end of the island. Due to time constraints and the extent of the Beulah Creek watershed, only the lower watershed was included in the study area.



Map 1. Watersheds identified by the Ministry of Environment on Hornby Island. Excerpt from map courtesy of the Island Trust[1].

[1] The Islands Trust. 2010. "Islands Trust Watersheds and MOE Designated RAR Watersheds".

2 METHODS

2.1 Background Research

Local, regional, and provincial sources were contacted for information relating to the area. Prior to field reconnaissance, maps and reports were reviewed in order to establish historical and documented information regarding fisheries resources in the study area and to determine access points and probable locations of watercourses and wetlands. Within the study area, all available data on watercourses, wetlands, and ditches within the Ford Creek and Beulah Creek watersheds were delineated on the air photos to facilitate ground-truthing and to ensure that all potential watercourses were adequately assessed during the field survey.

2.2 Survey Timing and Area

Within the Ford Creek and lower Beulah Creek watersheds, all watercourses, wetlands, and ditches were assessed as to whether they meet the RAR criteria for a *stream*. Field surveys of the Ford Creek and Beulah Creek watersheds were conducted November 12 to December 11, 2011 in order to locate streams as defined under RAR.

2.3 Definition of a *Stream* under the RAR

"The Riparian Areas Regulation defines a stream as any watercourse, natural or man-made, that provides fish habitat, that contains water on a perennial or seasonal basis, is scoured by water or contains observable deposits of mineral alluvium, or has a continuous channel bed including a watercourse that is obscured by overhanging or bridging vegetation or soil mats"[2]. Specifically, the RAR defines a *stream* as including "any of the following that provides fish habitat:

a) a watercourse, whether it usually contains water or not;

b) a pond, lake, river, creek, brook;

c) a ditch, spring, or wetland that is **connected by surface flow** to something referred to in paragraph (a) or (b)."[3]

A watercourse does not have to be inhabited by fish. If water from a watercourse flows into fish-bearing waters, it may provide food, nutrients, and water to the downstream areas that do support fish. "Side channels, intermittent streams, seasonally wetted contiguous areas are included by the definition of a stream which includes active

---

[2] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

[3] BC Ministry of Environment. 2004. Fish Protection Act: Riparian Areas Regulation. Available at: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/10_376_2004.

floodplains and wetlands connected to streams."[4] Therefore, if a barrier to fish migration is identified (either permanent or non-permanent), the watercourse upstream of the barrier would still be considered a *stream* as it is connected by surface flow to the downstream fish-bearing habitat and the watercourse would be subject to the RAR process. Due to the limited scope of this assessment, only those wetlands and ditches with an obvious, direct surface flow connection to watercourses were examined.

A default of potential fish-bearing status was used for low gradient streams that connected directly to the ocean, as there would be access to the watercourse by anadromous fish. A stream is considered to be fish-bearing even if it provides habitat for fish during a very short period, such as overwinter shelter and rearing, high flow ephemeral off-channel security habitat, adult instream holding prior to spawning, or seasonal spawning and/or rearing habitat.

Features that could potentially limit the distribution of fish were not a primary focus of the assessment, as a *stream* under RAR is not necessarily fish-bearing. If a watercourse or wetland is connected by surface flow then it was considered a *stream* under RAR. However, barriers encountered at the interface of the watercourse and its estuary could prevent anadromous fish from entering the watercourse. If a barrier was encountered at the mouth of a stream, providing insufficient fish habitat for anadromous fish, and there was no perennial habitat for resident fish, the watercourse was not considered a *stream* under RAR. If there was perennial habitat and/or a source of fish was identified upstream of the barrier, then the watercourse was considered potentially fish-bearing and therefore was classified as a *stream*.

Watercourses that do not support fish or connect by surface flow to fish habitat are not considered *streams* under the RAR. These non-RAR applicable watercourses were not included in the scope of the project and therefore not mapped. However, although not covered under RAR, aquatic habitat such as isolated ponds, wetlands, and linear drainages still have high wildlife value and provide important functions within the landscape. Some of the most important functions include flood and erosion control, stormwater retention, and habitat to various amphibian species.

2.4 Field Assessment Procedures

The study area was surveyed in November and December 2011, which are wet times of the year so flows could be noted. Field crews commenced at the downstream end of each creek and walked upstream, following each drainage to its headwaters. As a component of this survey was to search for potential barriers to fish movement, it made sense to begin at the downstream end and work upstream as a fish might swim. Evidence of erosion and water flow were documented and locations of watercourses were mapped, including the collection of GPS information to determine geospatial locations for map-making purposes. Several measurements within streams were taken, including channel

[4] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

width and depth, water flow, stream gradient, morphology, substrate composition, and streamside vegetation (see Section 2.5 below).

Observations relating to the community structure of the existing riparian areas and anthropogenic use or disturbances were noted during the survey. The assessment included the identification of the dominant or diagnostic species and a broad classification of vegetation community types. Plant lists were intended to provide an overview of community composition and were not comprehensive. Plant names used were from the most recent British Columbia government databases[5]. Photographs were taken to document each stream reach.

2.5 Mapping Procedures

Watercourses within the study area were mapped using Trimble Pathfinder Pro XR Equipment. The following table and text summarizes the data collection equipment, settings and data processing resources and methods used.

Table 1. GPS Equipment, settings, and data processing resources used.

GPS Receiver:	Trimble Pathfinder Pro XR
GPS Antenna:	Trimble Pathfinder Pro XR
GPS Data Logger:	TSC1
GPS Data Logger Software:	Asset Surveyor v4.01 & v4.04
GPS Office Software:	GPS Pathfinder V4
GIS Software:	ArcGIS 9.3
GPS Base Stations:	Cansel Vancouver, BC 49˚ 16’ 30”, 123˚ 01’ 19”
GPS Settings:	
PDOP:	8 or less
Minimum Satellite:	4
Minimum Elevation Mask:	15 degrees
Static Point Position Fixes:	50 fixes within 150 sec
Dynamic Mode Line Features:	Typically no more than 2.5m unless under heavy canopy or in a ravine.
Datum Used:	NAD 83
Projection:	UTM

The GPS settings used throughout the survey reflect those recommended by the Resource Information Standards Committee to achieve 10 m accuracy targets (pre-correction) under difficult tracking conditions such as those experienced within the Ford and Beulah

[5] Meidinger, D.; Lee, T.; Douglas, G. W.; Britton, G.; MacKenzie, W.; and Qian, H. 2009. British Columbia plant species codes and selected attributes. Version 6 Database. Research Branch. BC Ministry of Forests and Range.

Watersheds (e.g. under tree canopy or in ravines). The horizontal accuracy target for this project was 5 metres, at the 95% confidence level which was accomplished through post correction of the raw data. Data collection methods used in the field reflect the "Standards and Procedures" described in the document titled **Global Positioning System Specifications** prepared by the Islands Trust.

2.6 Assessing for Fish Presence or Potential Fish Presence

Watercourses were assessed with methodologies to determine fish access, fish presence, and habitat suitability of identified watercourses. The methods employed were:

1. Walking the subject streams to determine habitat suitability and to assess physical parameters such as channel width, water flow, morphology, gradient, and substrate composition, combined with collection of GPS information.
2. Fish distribution and other information for the stream were researched on the Fisheries Information Summary System (FISS) database: (http://a100.gov.bc.ca/pub/fidq/main.do), as well as within reports and maps from local and regional sources.

No fish trapping was completed as part of this assessment. This type of sampling requires rigorous sampling procedures during specific times of the year. As the purpose of the project was to identify fish-bearing or **potential** fish-bearing drainages, no detailed sampling procedures were conducted.

3 FORD CREEK RESULTS

3.1 Ford Creek Drainage Area Overview

3.1.1 Ford Creek drainage area description

The Ford Creek watershed drainage area is located near the south end of Hornby Island and runs in a south-easterly direction (see Map 2). Much of the drainage area is within the Strachan Valley, bordered along the southwest side by a ridge, which includes Mount Geoffrey. Ford Creek's flow enters the Georgia Strait southwest of Downes Point, immediately south of Porpoise Crescent.

The Ford Creek drainage area is comprised of a series of channels, small drainages, ditches, and wetlands that feed into and form the mainstem channel called Ford Creek. Based on local geographic features and for descriptive purposes, Ford Creek has been divided into the Ford Creek mainstem, two tributary systems, and ten drainages (Map 3). Tributaries were defined as watercourse systems that received water from a sub-basin and connected to the Ford Creek mainstem. These watercourse systems had defined watercourse channels at the downstream end. Drainages were defined as ephemeral watercourses that had poorly defined channels but still met the definition of *stream* under RAR[6]. Ditches were defined as man-made watercourses or channelized watercourses. Unlike the definition of *ditch* under RAR[7], mapped ditches in this report may have had headwaters. For the purposes of this report, ravines were defined as fluvial landforms that have relatively steep sides. Given the scope of this project, ravines were generally classified as a landform and may not all meet the 33% (3:1 H:V) slope as defined in the RAR methodology[8]. As developments are proposed, a QEP will need to determine if ravines, as defined under RAR, are present on the individual properties.

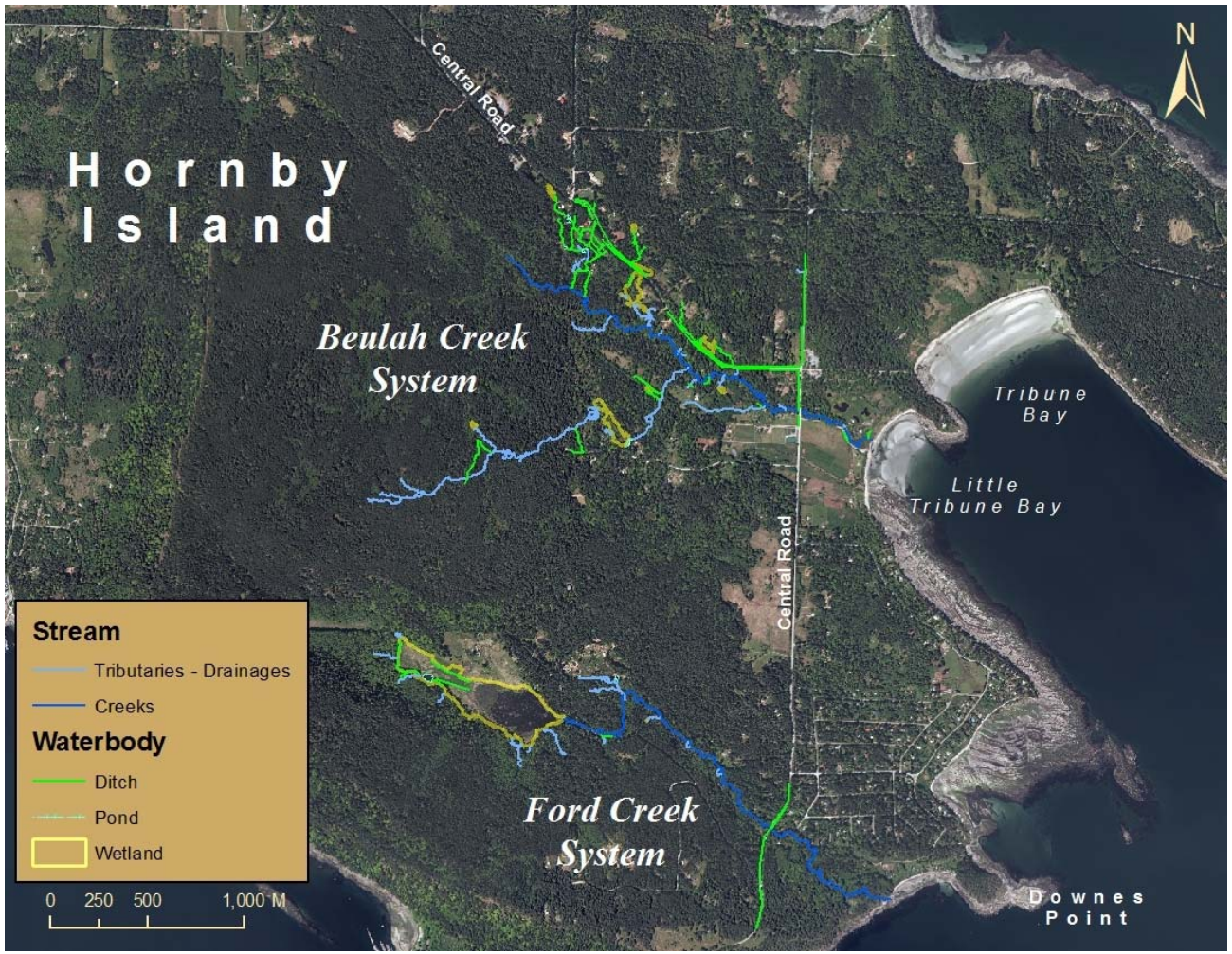
During the field survey, three watercourses (Ford Creek and two tributaries), ten drainages, eleven ditches, one large wetland, and four ponds were observed that met the definition of *stream* as described in Section 2.3 and therefore are subject to the RAR assessment procedure. The many associated headwaters and pocket wetlands would also be RAR applicable. Reports and public maps contained various stream information, much of which was either incorrect or has changed since publication. Other than the mainstem of Ford Creek, none of the streams found in this survey were mapped prior to this assessment. Watercourses and waterbodies were numbered for descriptive purposes

---

6 BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

7 BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

8 BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.



Map 2. Ford Creek and lower Beulah Creek drainages[9]. Orthophoto courtesy of the Islands Trust.

[9] GIS Applications by Redtail Environmental Services.

Map 3. Ford Creek drainages. Orthophoto courtesy of the Islands Trust.

in the order of when they were surveyed in the field. If a watercourse joined a numbered watercourse, then the new water course was given a letter (i.e. Ditch 2A would flow into Ditch 2). No fish were observed in any of the watercourses during the field surveys.

The characteristics of each reach identified within the study area are provided below. Photographs documenting the reach and various features are located in Appendix One. Plant species noted during the survey are included in Appendix Three.

3.1.2 GPS Results

An estimated 7,278 GPS positions were collected to map watercourses and significant features within the Ford Creek Watershed. Of these positions, 6797 (93%) were spatially corrected using Trimble Pathfinder post correction software. The data files used for post correcting were accessed from the Cansel base station files in Vancouver. 480 positions were not corrected. Of these, 479 were not corrected due to missing base station data. The remaining one position was not corrected due to excessive multipath error (interference caused by reflected GPS signals arriving at the receiver) and high DOP values. However, those positions that were not post corrected were predominantly estimated to within a 5 m accuracy range by the Trimble Pathfinder Software.

Estimated accuracies for the 6,797 post corrected positions were as follows:

Range in metres	Range in %
0.3-0.5 m	41%
0.5-1 m	52%
1-2 m	7%

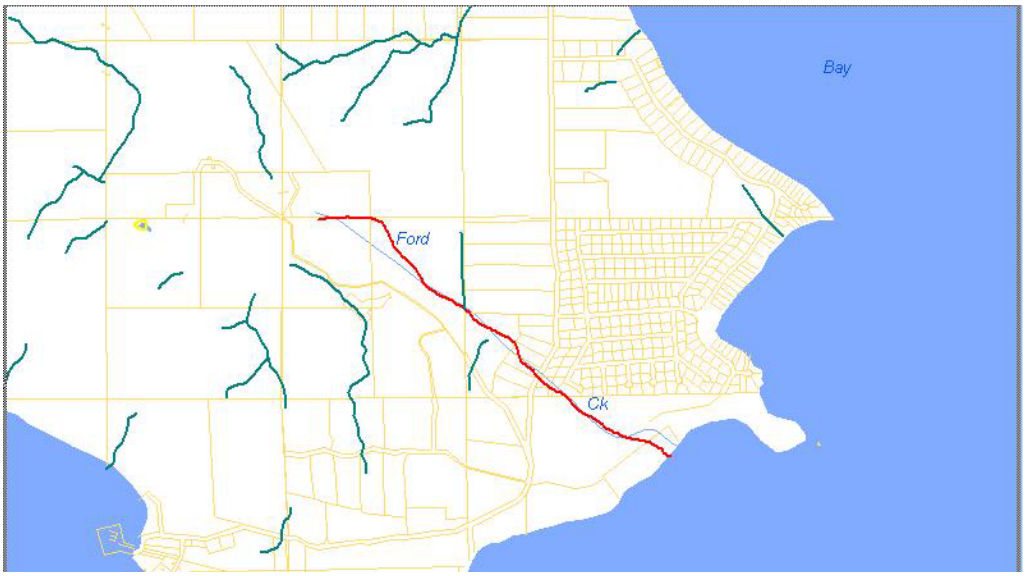
3.2 Documented Stream Data

Research for Ford Creek (watershed code 905-125800-92800) resulted in little information (Map 4). Provincial reports suggest that Ford Creek has provided habitat for Coho salmon and Cutthroat trout[10]. Local information indicates that Cutthroat trout were introduced in the 1950s and 1990s and are currently present in the system. Results from the Sensitive Ecosystem Inventory indicated that three sensitive plant community types were present within the watershed; marsh wetland, older coniferous forest, and older second-growth forest (Map 5). One listed plant community and one listed plant species were found within the Conservation Data Center watershed research (Map 6).

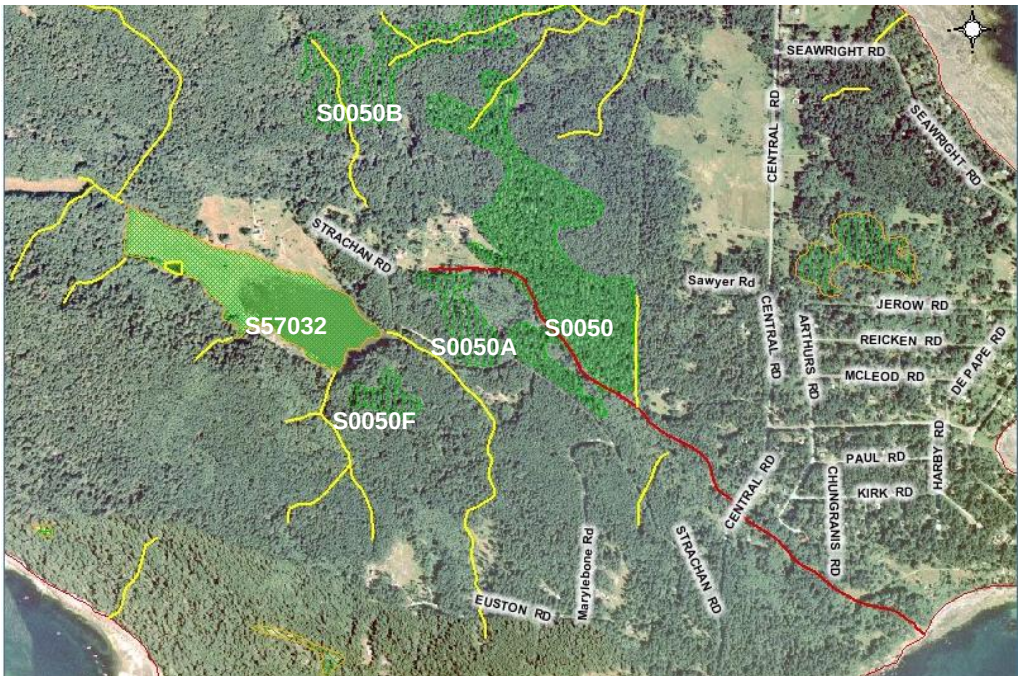
3.3 Ford Creek Drainage Description

Based on local geographic features and for descriptive purposes, the Ford Creek drainage system has been divided into several sections; Ford Creek mainstem, tributary systems,

[10] BC Ministry of Environment. 2011. Fisheries inventory data query. Fisheries Information Summary System (FISS). November 9, 2011. Search Results Available. http://a100.gov.bc.ca/pub/fidq/fissReportProcess.do;jsessionid=6a8dbc69b19183e104b84b8c6c8f559e87102ee0a8d2ec9f18fa9791993ed50f.e3uMah8KbhmLe3qSbhuObh8Sci1ynknvrkLOlQzNp65In0



Map 4. Ford Creek watershed with existing provincial mapping of stream[11]. Scale 1:22,000.



Map 5. Orthophoto of Ford Creek watershed existing provincial and local mapping of stream and sensitive ecosystems[12]. Scale 1:15,000. Polygon S57032 (Marsh wetland), S0050A/B/F (Older coniferous forest), and S0050 (Older second-growth forest).

---

[11] Sensitive Habitat Inventory and Mapping. 2011. Community Mapping Network. Accessed November 9, 2011. Available: http://www.shim.bc.ca/atlases/shim/SHIM_public.htm.

[12] Comox Valley Regional District. Sensitive Habitat Atlas. iMAP. 2007 orthophoto. Accessed November 9, 2011. Available at: http://www.imap.rdcs.bc.ca/imap/onpoint

Map 6. Conservation Data Center (CDC) map of Ford Creek Watershed with wetlands identified[13]. Scale approximately 1: 17,000. See Appendix 4 for further information. 8652 (Douglas-fir / dull Oregon-grape plant community: red-listed) and 6984 and 8974 (Coastal Wood Fern: blue-listed).

drainages, ditches, and ponds. Each watercourse type has a separate section within the report to allow easy access to individual watercourse information. Maps of the different areas of the Ford Creek drainage area are included. The following will describe watercourse features and locations.

3.3.1 Ford Creek Mainstem

The Ford Creek mainstem was divided four sections for descriptive purposes: a) the downstream section east of Central Road, b) Ford Creek between Central Road and Drainage 1, c) Ford Creek upstream of Drainage 1 and downstream of the Ford Wetland, and d) the upstream section of the Ford Creek watershed from the Ford Wetland to the various headwaters. General features of the Ford Creek mainstem are found in Table 2.

[13] BC Ministry of Environment. 2011. Conservation Data Center. Available at: http://webmaps.gov.bc.ca/imfx/imf.jsp?session=939656832187&sessionName=Conservation Data Centre&theme-path=Ministry+of+Environment%2FConservation_Data_Centre.ssn.

Table 2. Ford Creek mainstem information.

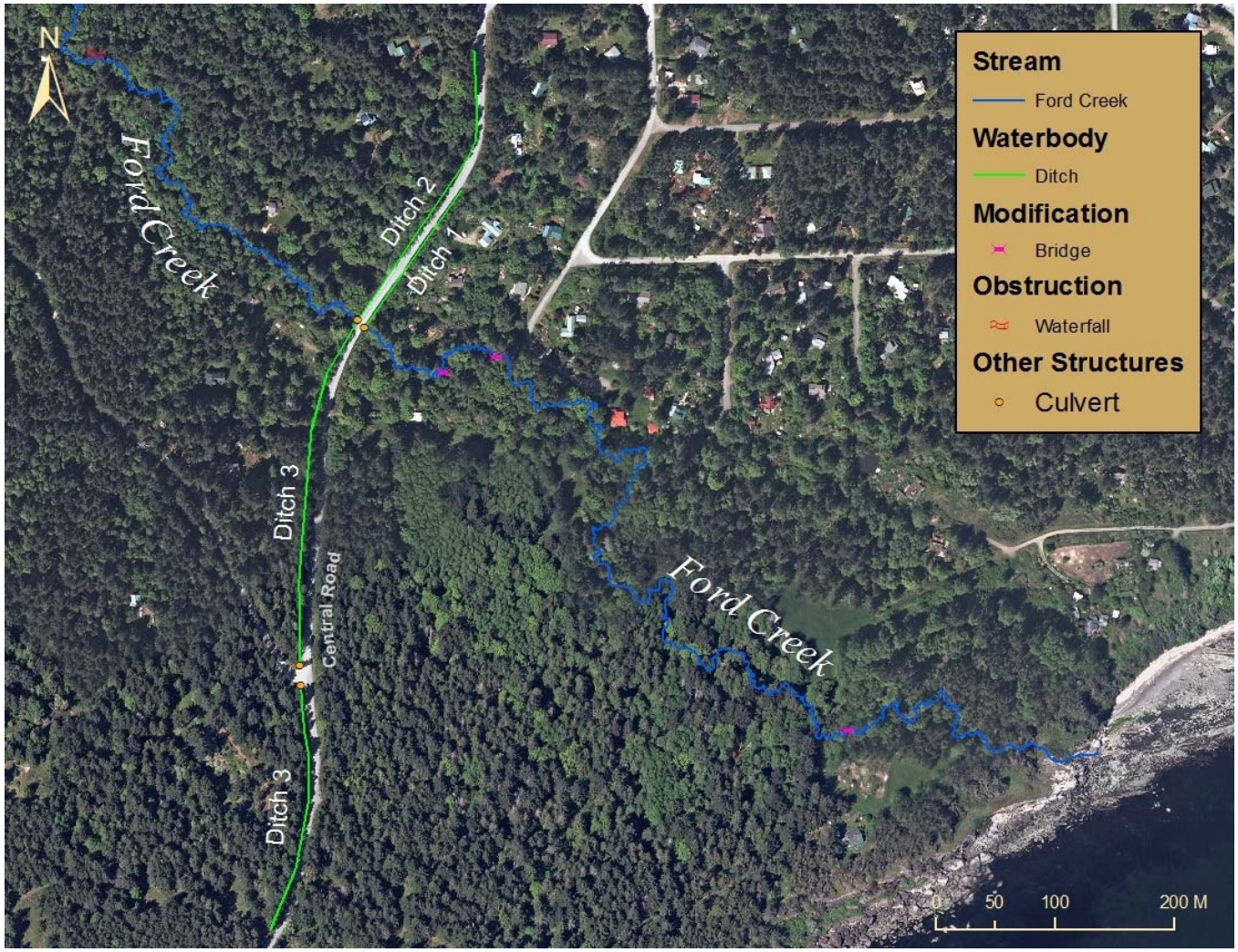
Stream location	Channel Width (m)	Channel Depth (m)	Wetted Width (m)	Wetted Depth (m)	Aspect (°)	Gradient
20m upstream of estuary	4.5	0.5	2.4	0.15	110	20%
Downstream of Central Road	6.0	0.7	3.0	0.05	120	5%
Upstream of Central Road	5.3	0.5	4.1	0.03	146	2%
Downstream of Strachan Road	7.3	0.6	0.5	0.07	164	11%
Upstream of Strachan Road	4.1	0.9	1.4	0.1	120	5%

3.3.1.1 Ford Creek Mainstem: *Estuary to Central Road*

Fresh water from Ford Creek discharges into the Strait of Georgia south of Downes Point (see Maps 3 and 7). The streambed of the estuary portion of the Ford Creek was composed of bedrock with a gradient ranging from 20% to 5%. The lower 20 meters of the creek was the steepest and had low to no channel walls. Water flowed over the rock surface as a sheet (Figures 1 and 2). Within the bedrock were a few shallow pools. It is unlikely that fish would get up this smooth, steep surface to access the main channel. However, at an extreme high tide, fish could potentially fin over the moss and algal-covered rocks in order to access the upstream channel.

In the stream section from the estuary to Central Road, Ford Creek travels northwest within a shallow ravine (Figure 3). The stream gradient lessens to between 2% and 5%. As one progresses upstream from the estuary, the streambed substrate has less bedrock. It is replaced by a combination of hardpan with sands, gravels, and cobbles. There are also a few large cobbles and boulders. The creek had a riffle-pool morphology and meandered within a shallow ravine with ravine walls ranging from 2 meters to 4 meters in height.

In general, fish refuge habitat such as woody debris and deep pools was moderate to abundant. There was little undercutting of the channel banks and few boulders. Most of the pool habitat was created by water flowing over large woody debris. The creek was surrounded by a forested riparian area. Within this riparian community, dominant tree species included western redcedar, red alder, and bigleaf maple. Dominant understory species included sword fern, salmonberry, stinging nettle, lady fern, red elderberry, stink current, and patches of sedges in wetter areas. Along the upper ravine areas and in drier habitat, the forest included Douglas-fir with salal and Oregon-grape in the understory.



Map 7. Ford Creek drainages: Estuary to Central Road. Orthophoto courtesy of the Islands Trust.

In the area immediately downstream of Central Road, the riparian buffer lessens as residential development encroaches from the northeast side. In one location, a cabin was situated at streamside (Figure 4). Several footbridges had also been placed across the stream (Figure 5).

3.3.1.2 Ford Creek Mainstem: *Central Road to Drainage 1*

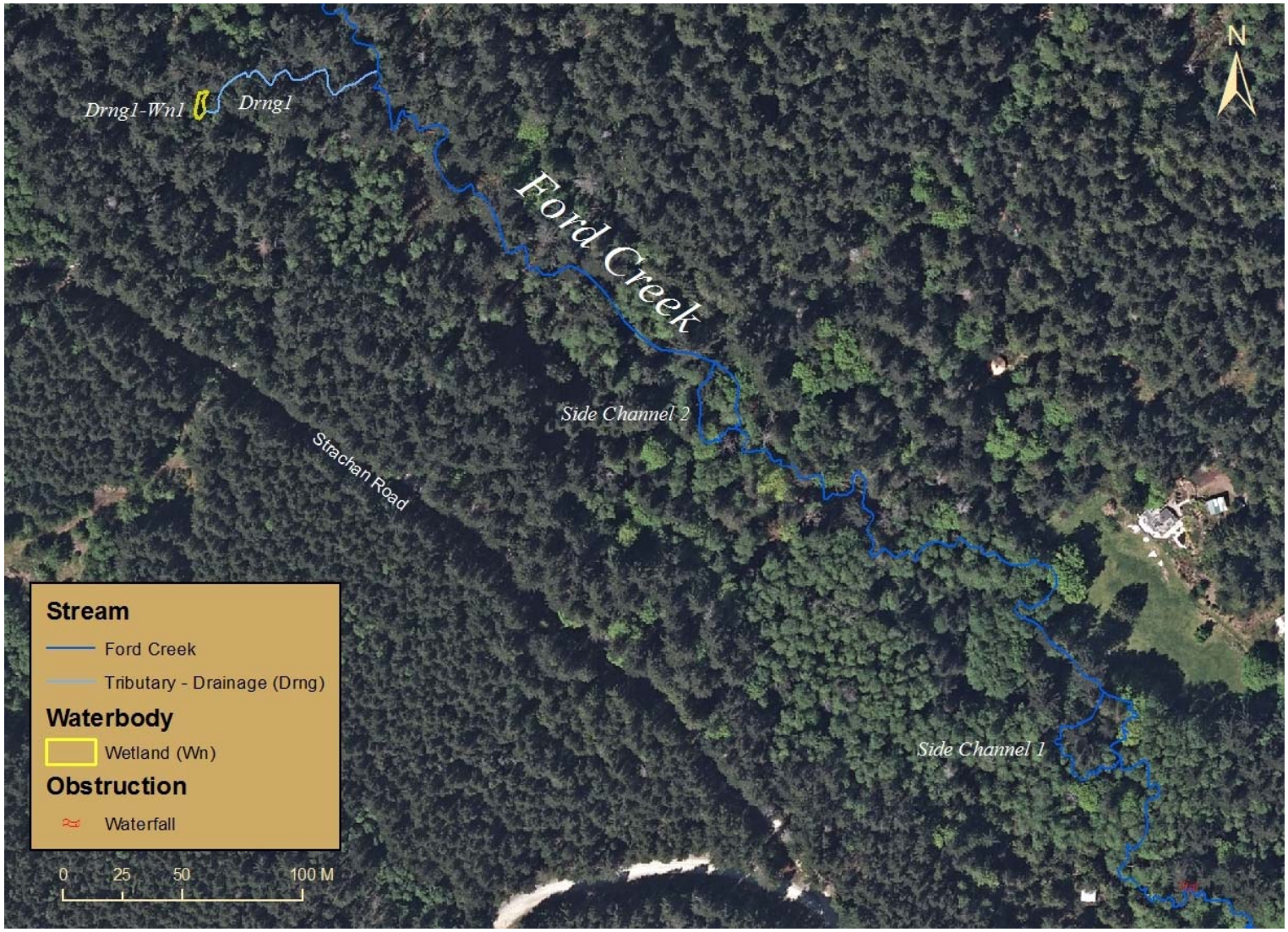
Ford Creek flows under Central Road through a 190 cm diameter culvert. At the base of the downstream end of the culvert was a large pool (8 meters wide by 10 meters long). There was a 50 cm drop from the culvert bottom to the water surface of the pool (Figure 6).

Ford Creek's substrate upstream of the Central Road culvert was composed of bedrock with occasional cascades and small waterfalls over bedrock or large woody debris (Figure 7). In some stream sections, bars composed of small gravels were common along the channel edges. There was little to no undercutting along the banks and little indication of flashiness. Woody debris was abundant.

Upstream of the Central Road culvert, Ford Creek continues to meander within a ravine (Map 8). The ravine in this stream section had taller and steeper walls. The ravine walls were often greater than eight meters tall and had slopes ranging from 20% to 70% (Figure 8). The ravine was narrow, usually less than 60 meters across from the top of the ravine banks. Along this stream segment, there were several floodplain benches bounded by the hillside slopes. These benches were frequently within the 2-5 year floodplain. The benches were sometimes 50 cm to one meter above the streambed and were often located at meander bends. Many benches had depressions or short drainages in and/or through them, emptying into the mainstem (Figure 9). The benches were dominated by sword fern with sedge patches either along the channel banks or in low areas. Frequently they had young to mature red alder, salmonberry, and occasional patches of salal. The ravine and floodplain areas contained large pieces of coarse woody debris. Most of the woody debris was Douglas-fir. This large woody debris formed forest floor complexing and some diversionary structures in and around the stream.

In several areas within this stream section, ephemeral drainages along the base of the ravine slopes created side channels (see Map 8). These side channels consisted of a series of short channels with connecting shallow depressions (Figure 10). Depressions were devoid of litter and contained moist mud or shallow pools (generally less than 3 cm standing water at the time of the survey). Between the side channels and the mainstem were floodplains vegetated with mature red alders, juvenile western redcedar, and an understory of sword fern with stink current and sedges in wetter locations. Gradients of the side channels ranged from 0% to 6%.

Drainage 1 enters the Ford Creek mainstem in this section from the west side (right bank) (see Section 3.3.3.1).



Map 8. Ford Creek drainages: Upstream of Central Road to Drainage 1. Orthophoto courtesy of the Islands Trust.

3.3.1.3 Ford Creek Mainstem: *Drainage 1 to Ford Wetland*

The Ford Creek mainstem between Drainage 1 and the Strachan Road crossing was similar to downstream sections (Map 9). The stream flowed within a ravine and was surrounded by a mixed forest consisting of red alder, bigleaf maple, and western redcedar. At the base of the ravine slopes were short sections of sword-fern dominated floodplain communities. The stream gradient ranged from 1% to 5%. There was abundant instream large woody debris, which created instream structures such as small cascades and deeper pools below.

Within this stream section, there was one small waterfall over bedrock (Figure 11). The drop was approximately 2 meters. At the base of the falls, there was a deep pool. The pool was over one meter deep and was approximately 8 meters wide by 10 meters long. This waterfall would not be considered an obstruction to adult fish passage.

Tributary 1 and Drainage 2 enter the Ford Creek mainstem in this section downstream of the Strachan Road crossing (see Sections 3.3.2.1 and 3.3.3.1 respectively).

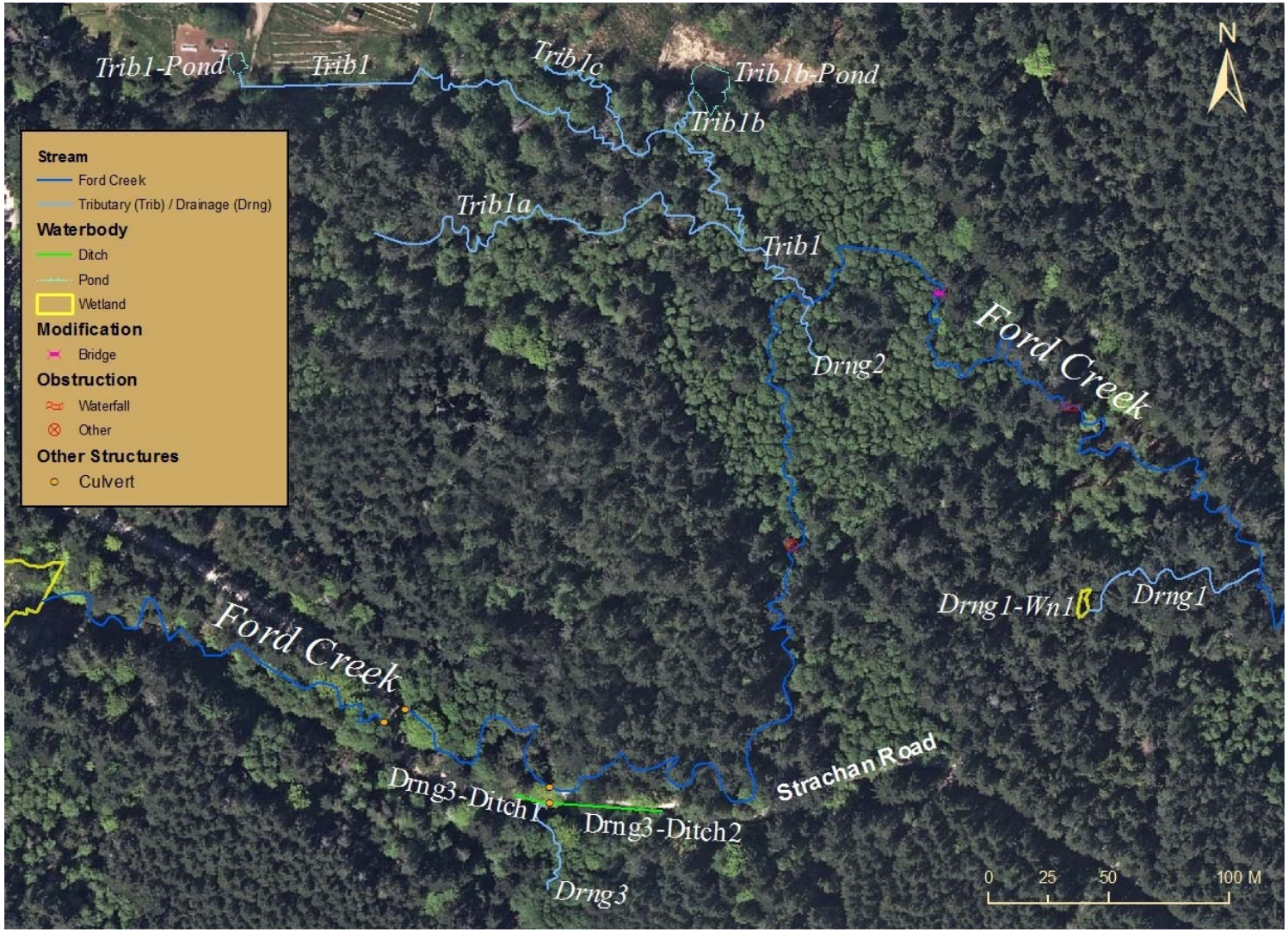
As Ford Creek flows north-eastwards, there is a short section of the stream that flows parallel to and alongside Strachan Road. Eventually, the creek flow is directed under Strachan Road through a round metal culvert (Figure 12).

Approximately 5 meters downstream from the culvert, there was a blockage in the stream. The obstruction was composed of woody debris, soils, and gravels, much of which were consistent with adjacent roadbed material (Figure 13). Creek water seeped through the blockage materials. At high flows, there was evidence of water flowing around the obstruction. Water flow would have to be at least 20 cm or higher to go around the blockage. Currently, this would be a barrier to fish passage during low flows. At the upstream end of the Strachan Road culvert, materials from the road edge had started to collapse over the end of the culvert (Figure 14). At the time of the survey, this material was not blocking the stream.

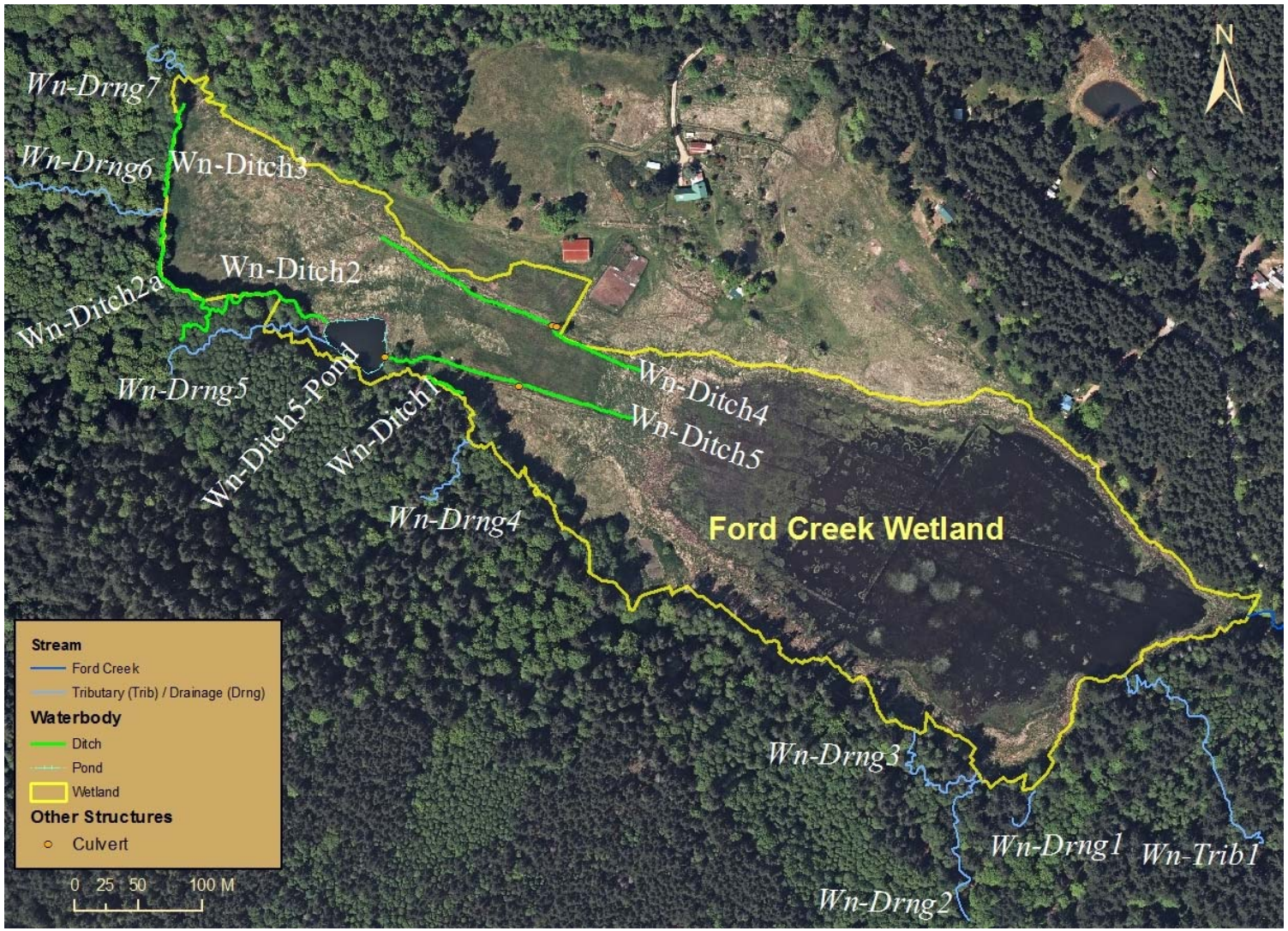
The Ford Creek mainstem between the Strachan Road crossing and the Ford Wetland was situated in a ravine and surrounded by mixed forests dominated by red alder, bigleaf maple, and western redcedar. The mainstem channel was wider near the wetland outflow (Figure 15). The channel had steep walls and showed some signs of erosion (Figure 16). This channel may have been widened or constructed to encourage wetland drainage.

3.3.1.4 Ford Creek Mainstem: *Ford Wetland to Headwaters*

At the upstream end of Ford Creek is a large wetland/wet meadow complex surrounded by a mixed forest (Map 10 and Figure 17). The downstream end of the wetland was classified as a marsh. Locals know the area as the "beaver pond". At one time, there was a beaver dam. This appears to have been removed. Evidence of beaver activity (old chews) was observed, but little evidence was found of recent beaver activity. At the time of the survey, trumpeter swans and a diversity of waterfowl were using the open water of the marsh. The wetland was shallow with emergent and floating vegetation apparent. The perimeter was vegetated with reed canarygrass, cattails, salmonberry, sedges, and sword fern. Most likely the water levels fluctuate seasonally within the wetland complex.



Map 9. Ford Creek drainages: Drainage 1 to Ford Wetland. Orthophoto courtesy of the Islands Trust.



Map 10. Ford Creek drainages: Ford Wetland to Headwaters. Orthophoto courtesy of the Islands Trust.

The upstream end of the wetland consisted of a wet area that had been converted for agricultural use. This includes a constructed pond, fences, and a series of ditches, some of which extend into the wetter marsh area (Figures 18 and 19). Fence posts in the marsh indicate previous and/or current agricultural usage. Evidence of seasonal drying includes thistle patches in amongst the reed canarygrass.

Within the Ford Wetland was a constructed pond (see Map 10 and Section 3.3.5). The pond was designed to either drain fields or provide water for irrigation during drier months. Water enters pond through several drainages. The pond also collects water from adjacent wet forests and their surrounding hillsides. Pond water was contained by an earthen berm along the eastern side of the pond. Two overflow culverts were placed high into the berm (Figure 20). Pond outflow from the culverts falls 1.5 meters to the ditch channel below (Wetland Ditch 5, see Section 3.3.4.2). These culverts would present a barrier to fish passage into the pond.

Forested hillsides surrounded the Ford Wetland except a section along the wetland's north side. Most of the slopes, ranging from 15% to 65%, had shallow soils over bedrock. The forests contained western redcedar, bigleaf maple, red alder, Douglas-fir and the occasional Garry oak. The understory was dominated by sword fern and salal, with patches of sedges in wetter areas.

A broad floodplain at base of the forested slopes collects and distributes surface runoff. Shallow depressions within the floodplain would receive groundwater or collect surface runoff during wetter seasons or during large rain events. Water within the forest was either dispersed within the floodplain or directed through shallow channels or ephemeral drainages to the Ford Wetland (Figure 21). Along the perimeter and within the wetland were a series of ditches designed to collect and direct water around fields and/or into the marsh or pond. In addition, there was one tributary that contributed flow to the Ford Wetland (see Section 3.3.2.2 below).

3.3.2 Ford Creek drainage area: *Tributaries*

There were two tributary systems within the Ford Creek drainage area. The first tributary entered the Ford Creek mainstream downstream of the Strachan Road crossing. The second tributary was associated with the Ford Wetland. It flowed into the wetland from the south side. These two systems are described below.

3.3.2.1 Ford Creek mainstem: Tributary 1

Ford Creek Tributary 1 was a narrow ephemeral watercourse that joined the Ford Creek mainstem downstream of Strachan Road (see Map 9). At the time of the survey, the tributary had flowing water. In the downstream reach, the watercourse flowed within a ravine. The ravine walls averaged 3 meters in height and had an average slope of 55%. Upstream, Tributary 1 left the ravine and meandered through a wet forest (Figure 22).

Water from three small tributaries entered Tributary 1 in the upper forested area. At the upstream end of Tributary 1, the watercourse had been modified by ditching (Figure 23). A pond at the upstream end of the ditched watercourse formed part of the headwaters and pond water flowed over a depression on the ground into the ditch (see Section 3.3.5 and Figure 24). The ditched portion of Tributary 1 was surrounded by wet pastures and wet

agricultural lands. It is most likely that this area was originally wetland and was converted for agricultural purposes.

The three small tributaries that flowed into Tributary 1 had narrow channels that meandered through the forest to join Tributary 1. Tributary 1A commenced from a wet sword-fern dominated forest (Figure 25). During wet times of the year, this forest would have multiple drainages many of which would flow into Tributary 1A. Tributaries 1B and 1C conveyed water from a wet meadow and pond through a forested area to Tributary 1 (see Section 3.3.5 and Figures 26 and 27).

None of the tributaries had obstacles that would prevent fish passage. However, all of them were ephemeral and would only provide fish habitat during the wettest seasons.

Table 3. Ford Creek Tributary 1 and associated watercourse information.

Stream name	Channel Width (m)	Channel Depth (m)	Wetted Width (m)	Wetted Depth (m)	Aspect (°)	Gradient
Tributary 1 (downstream end)	1.6	0.4	1.0	0.03	147	5%
Tributary 1 (upstream end)	0.9	0.6	0.6	0.07	80	6%
Tributary 1A	0.6	0.3	n/a	n/a	125	7%
Tributary 1B	0.9	0.2	0.6	0.02	-	5%
Tributary 1C	0.8	0.5	n/a	n/a	-	5%

3.3.2.2 Ford Wetland: Tributary 1

A second tributary within the Ford Creek drainage area flowed into the marsh section of the Ford Wetland from the south side (see Map 10). This was an ephemeral watercourse that collected water from hillside areas and directed it to the lower floodplain and wetland beyond. Working upstream from the wetland, the water flowed along an old road, through a channel in a forested community, and then across a hiking trail (Figure 28). There were no culverts under the road or under the trail above. Upstream of the trail, there was generally one main channel (Figure 29). However, in several places the channel divided. Sometimes these other channels rejoined the main channel and other times water dissipated into the forest. The headwaters to this tributary was a sword fern-dominated forest with multiple intermittent channels draining adjacent hillside runoff.

3.3.3 Ford Creek drainage area: *Drainages*

3.3.3.1 Ford Creek mainstem: Drainages

Three drainages were observed contributing water to the Ford Creek mainstem. All of the drainages meandered through wet forests (Figures 30 and 31). Water from pocket wetlands and/or water from the forests entered the drainage channels and flowed towards Ford Creek. Average drainage channel widths ranged from 1.1 to 3.7 meters and the

average drainage channel depths were usually 0.2 to 0.5 meters. At the time of the survey, all drainages either had intermittent flow or wet substrates. Drainage channel gradients ranged from 1% to 10%.

Only one drainage had flow that entered the Ford Creek mainstem through a culvert. The downstream end of Drainage 3 (see Map 9) travelled under Strachan Road through a round metal culvert (52 cm diameter). The downstream end of the culvert was approximately 2 meters above the mainstem channel (Figure 32). This drainage had similar headwaters and flow patterns (Figure 33) as the other Ford Creek mainstem drainages but it also had two roadside ditches contribute flow into the upstream end of the hanging Strachan Road culvert (see Section 3.3.4.1).

Most of the drainages had channels that would allow fish passage. However, Drainage 3 had a hanging culvert that was considered a significant detriment to any fish entering this watercourse. In addition, all of the drainages were small and ephemeral providing fish habitat only during the wettest seasons.

3.3.3.2 Ford Creek Wetland: Drainages

Seven drainages were identified as contributing surface water to the Ford Wetland. All of the drainages meandered through wet forests and were ephemeral (see Map 10). Table 4 provides information about each drainage.

Water from pocket wetlands and/or water from the forests entered the drainage channels and flowed towards the Ford Creek wetland. Average drainage channel widths ranged from 0.4 to 3.7 meters and the average drainage channel depths were usually 0.3 meters. At the time of the survey, all drainages either had intermittent flow or wet substrates. Drainage channel gradients ranged from 2% to 15%.

Table 4. Ford Creek Wetland Drainage information. Figures are located in Appendix 1.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comments
Ford Wetland-Drainage 1	1.1	0.3	34	Blocked culvert under access road.
Ford Wetland-Drainage 2	0.4-0.7	0.2	35	Headwaters is a pocket wetland adjacent to an old access road.
Ford Wetland-Drainage 3	1.1-3.7	0.2	36	Drainage from a 5-meter wide pocket wetland. U-shaped drainage; water flows from each end of wetland.
Ford Wetland-Drainage 4	0.8	0.2	37	Headwaters is surface runoff from forested slope. Some of the runoff forms small channels that coalesce into main drainage channel. However, small runoffs occur in flatter benches, dissipating into the surrounding forest.
Ford Wetland-Drainage 5	1.0	0.4	38	Headwaters is Ford Wetland-Drainage 5-Pond (see Section 3.3.5) that collects hillside runoff. Pond also feeds Wetland-Ditch 2 (see Section 3.3.4.2). Drainage 5 flows into the Ford Wetland pond (see Section 3.3.5).
Ford Wetland-Drainage 6	1.2	0.3	39	Upstream end is a sedge patch in a large, flat, mixed forest. Forest had depressions with sedges and many short, intermittent channels. No water in any channel or depression at the time of the survey.
Ford Wetland-Drainage 7	0.6	0.3	40	Upstream end divides into many small intermittent channels; unable to follow any one channel.

3.3.4 Ford Creek drainage area: *Ditches*

There were two types of ditches in the Ford Creek drainage area, roadside ditches and agricultural/residential ditches. Roadside ditches typically collected roadside runoff and water from adjacent lands. Agricultural and residential ditches are generally designed to divert water around fields and/or properties or to assist in draining wet areas, taking the

water to a downstream area. Both types of ditches were observed in the Ford Creek drainage area.

3.3.4.1 Ford Creek drainage area roadside ditches

Three roadside ditches contributed water flow to the Ford Creek mainstem (Table 5). All three ditches were located along Central Road (see Map 7), two contributing water at the upstream end of the Central Road Culvert and one discharging to the downstream end of the Central Road Culvert. None of the ditches contained headwaters and were designed to collect roadside runoff and water from adjacent lands. There were culverts under driveways that intersected the ditches to allow clear water passage. None of the ditches contained instream habitat for fish. However, as these watercourses contribute water and nutrients to downstream fish habitat, they were classified as *streams* under RAR.

Two other roadside ditches contributed water flow to Drainage 3 (see Table 5). They were located on the south side of Strachan Road (see Map 9). Water from the ditches entered Drainage 3 at the upstream end of the culvert under Strachan Road. The outflow from this culvert entered the Ford Creek mainstem north of Strachan Road. Neither of these ditches contained instream habitat for fish but they do contribute water and nutrients to downstream fish habitat.

Table 5. Ford Creek drainage area roadside ditch information. Figures located in Appendix 1.

Ditch	Top of Ditch Bank (m)	Invert Width (m)	Invert Depth (m)	Aspect (°)	Gradient	Figure #
Ditch 1	1.1	1.6	0.3	204	7%	41
Ditch 2	0.8	1.5	0.4	212	4%	42
Ditch 3	0.8	1.6	0.4	12	5%	43
Drainage 3-Ditch 1	0.1-0.6	0.7	0.3	-	-	44
Drainage 3-Ditch 2	0.9	0.7	0.3	-	-	45

3.3.4.2 Ford Creek drainage area agricultural and residential ditches

The agricultural and residential ditches within the Ford Creek drainage area were located in and around the Ford Wetland (see Map 10). Most of the ditches were designed to drain and/or divert water through or around fields. Some of the ditches directed water from one area to another. Table 6 summarizes some of the information about the ditches.

Many of the ditches had little riparian vegetation buffering the ditch as mowing occurs along the sides. As these watercourses connect to downstream fish habitat, they were considered *streams* under RAR.

Table 6. Ford Creek drainage area agricultural and residential ditch information. Figures located in Appendix 1.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Figure #	Comments
Ford Wetland-Ditch 1	-	-	46	Perimeter field ditch, flow goes into field.
Ford Wetland-Ditch 2	1.0	1.2	47	Receives water from Ford Wetland-Drainage 5-Pond (see Section 3.3.5). Contains PVC pipe. Discharges into Ford Wetland-Pond (see Section 3.3.5).
Ford Wetland-Ditch 2A	0.6-0.9	1.3	48	Ditch along field edge; flows into Ford Wetland-Ditch 2.
Ford Wetland-Ditch 3	0.3	1.3	49	Ditch along field edge.
Ford Wetland-Ditch 4	0.5	2.0	50	Ditch in field; culvert (50 cm diameter) under access road.
Ford Wetland-Ditch 5	0.2-0.6	1.0-2.0	51	Receives water from Ford Wetland-Pond (see Section 3.3.5) overflow culverts. Ditch in field; culvert (60 cm diameter) under access road.

3.3.5 Ford Creek drainage area: *Ponds*

There were four ponds within the Ford Creek drainage area. Most of the ponds were either constructed or were naturally wet areas that had been modified. Table 7 lists the ponds and the watercourses with which they are associated.

Table 7. Ford Creek drainage area pond information. Figures located in Appendix 1.

Pond Name	Figure #	Pond location
Tributary 1-Pond	52	Upstream terminus of Tributary 1 (see Section 3.3.2.1).
Tributary 1B-Pond	53	Upstream terminus of Tributary 1B (see Section 3.3.2.1).
Ford Wetland-Pond	54	South side of wetland, adjacent to wet agricultural field. Outflow into Ford Wetland-Ditch 5 (see Section 3.3.4.2).
Ford Wetland-Drainage 5-Pond	55	Upstream terminus of Ford Wetland- Drainage 5 (see Section 3.3.3.2) that collects hillside runoff. Pond also feeds Ford Wetland- Ditch 2 (see Section 3.3.4.2).

4 LOWER BEULAH CREEK RESULTS

4.1 Beulah Creek Drainage Area Overview

4.1.1 Beulah Creek drainage area description

The Beulah Creek drainage area is located north of the Ford Creek Watershed and discharges at the southeast end of Hornby Island into Little Tribune Bay (see Map 2). A series of sub-basins, small watercourses and drainages, ditches, and wetlands feed into and form the mainstem channel called Beulah Creek. Based on local geographic features and for descriptive purposes, the section of Beulah Creek included in this survey has been divided into the Beulah Creek mainstem, five tributary systems, and six drainages. Tributaries were defined as watercourse systems that received water from a sub-basin and connected to the Beulah mainstem. These watercourse systems had defined watercourse channels at the downstream end. Drainages were defined as ephemeral watercourses that had poorly defined channels but still met the definition of *stream* under RAR[14]. Ditches were defined as man-made watercourses or channelized watercourses. Unlike the definition of *ditch* under RAR[15], mapped ditches in this report may have had headwaters. For the purposes of this report, ravines were defined as fluvial landforms that have relatively steep sides. Given the scope of this project, ravines were generally classified as a landform and may not all meet the 33% (3:1 H:V) slope as defined in the RAR methodology[16]. As developments are proposed, a QEP will need to determine if ravines, as defined under RAR, are present on the individual properties.

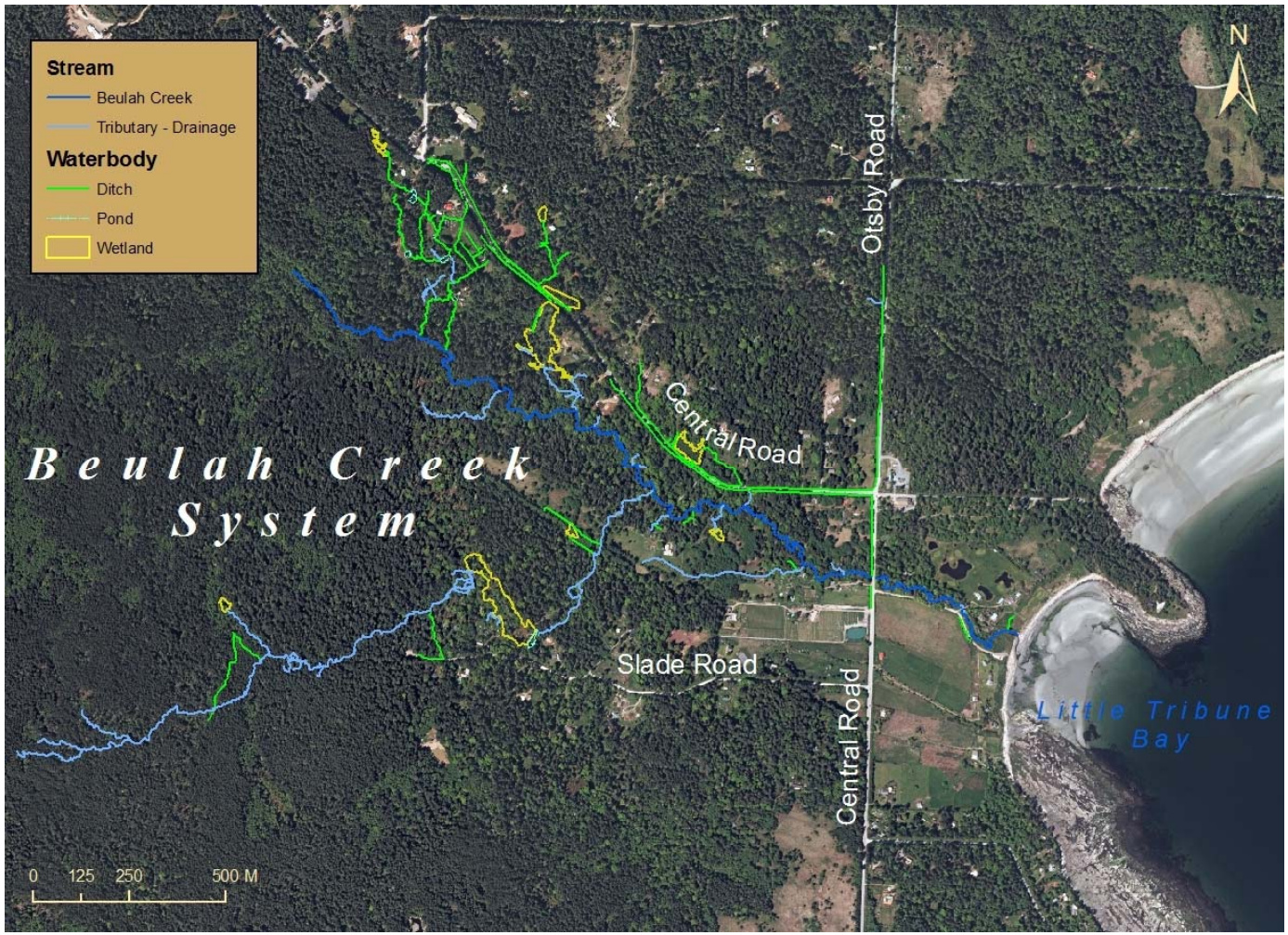
During the field survey, one mainstem and five tributary systems were observed (Map 11). Together six watercourses (Beulah Creek and tributaries), 32 drainages, 42 ditches, nine wetlands, and ten ponds were observed that met the definition of *stream* as described in Section 2.3 and therefore are subject to the RAR assessment procedure. Reports and public maps contained various stream information, much of which was either incorrect or has changed since publication. Other than the mainstem of Beulah Creek, none of the streams found in this survey were publicly available prior to this assessment. Watercourses and waterbodies were numbered for descriptive purposes in the order of when they were surveyed in the field. If a watercourse joined a numbered watercourse, then the new water course was given a letter (i.e. Ditch 2A would flow into Ditch 2). If a watercourse flowed into a watercourse that had a letter, it was given a number (i.e. Ditch

---

[14] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

[15] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

[16] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.



Map 11. Lower Beulah Creek drainages[17]. Orthophoto courtesy of the Islands Trust.

[17] GIS Applications by Redtail Environmental Services.

2A-1 would flow into Ditch 2A), and so on. No fish were observed in any of the watercourses during the field surveys.

The characteristics of each reach identified within the study area are provided below. Photographs documenting the reach and various features are located in Appendix Two. Plant species noted during the survey are included in Appendix Three.

4.1.2 GPS Results

An estimated 20,521 GPS positions were collected to map watercourses and significant features within the Beulah Creek Watershed. Of these positions, approximately 18,309 (89%) were spatially corrected using Trimble Pathfinder post correction software. The data files used for post-correcting were accessed from the Cansel base station files in Vancouver. 2212 positions were not corrected. Of these, 2173 were not corrected due to missing base station data and 25 positions were not corrected due to excessive multipath error (interference caused by reflected GPS signals arriving at the receiver) and high DOP values. However, those positions that were not post corrected were predominantly estimated to within a 5 m accuracy range by the Trimble Pathfinder Software.

Estimated accuracies for the 18,309 positions were as follows:

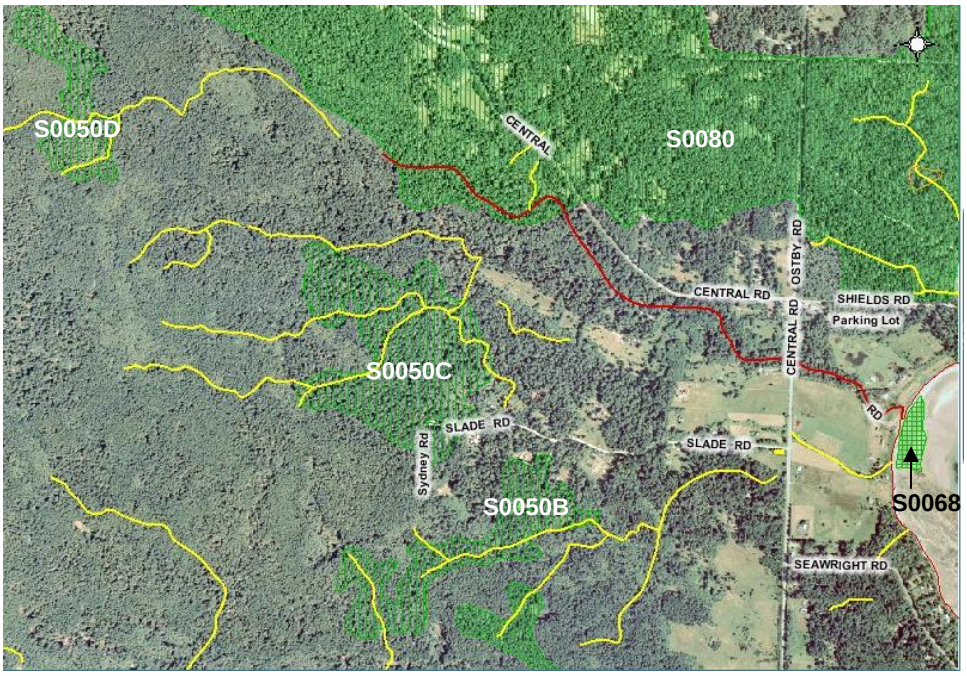
Range in metres	Range in %
0.3-0.5 m	42%
0.5-1 m	54%
1-2 m	4%

4.2 Documented Stream Data

Research for Beulah Creek (watershed code 905-125800-80800) resulted in little information (Map 12). No information from provincial or federal databases contain any records of fish presence[18]. Local information states that historically Beulah Creek was salmon-bearing and has had salmon enhancement activities in the past. Local schools have historically released Coho fry and more recently Chum fry into the creek annually. Results from the Sensitive Ecosystem Inventory indicated that three sensitive plant community types were present within the watershed, sparsely vegetated, older coniferous forest, and older second-growth forest (Map 13). One listed plant community and one listed plant species were found within the Conservation Data Center watershed research (Map 14).

[18] BC Ministry of Environment. 2011. Fisheries inventory data query. Fisheries Information Summary System (FISS). November 9, 2011. Search Results Available. http://a100.gov.bc.ca/pub/fidq/fissReportProcess.do;jsessionid=6a8dbc69b19183e104b84b8c6c8f559e87102ee0a8d2ec9f18fa9791993ed50f.e3uMah8KbhmLe3qSbhuObh8Sci1ynknvrkLOlQzNp65In0

Map 12. Beulah Creek watershed with existing provincial mapping of stream[19]. Scale 1:22,000.

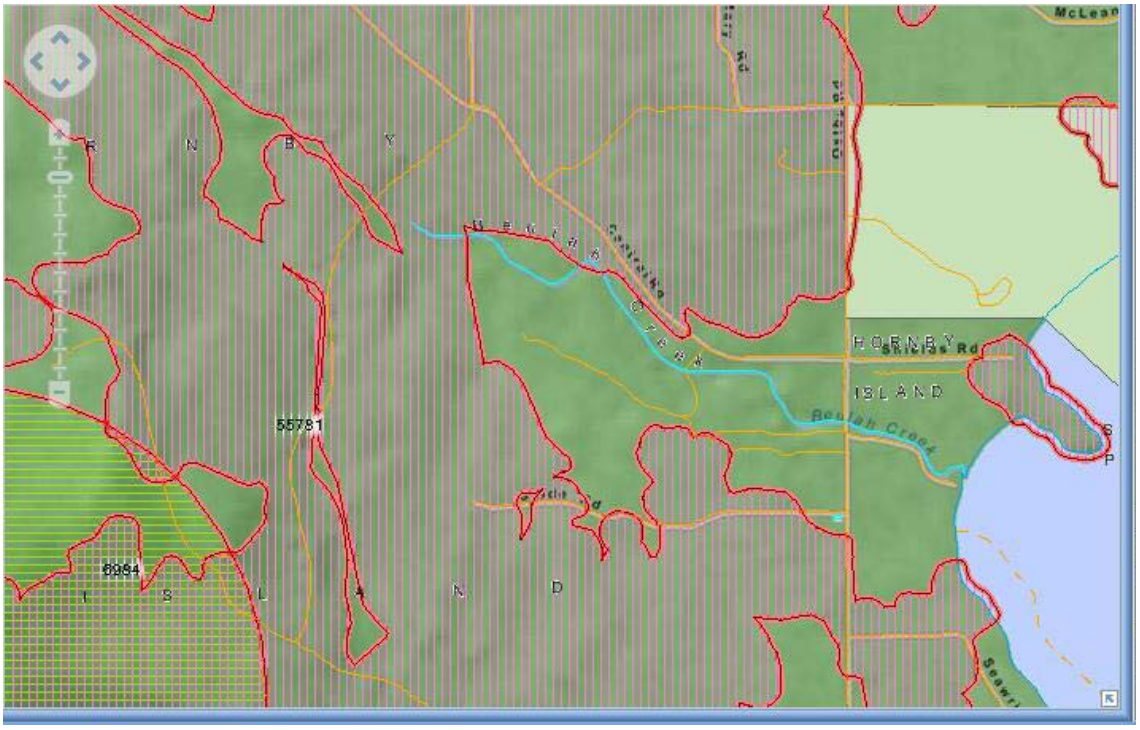


Map 13. Orthophoto of Beulah Creek watershed existing provincial and local mapping of stream and sensitive ecosystems[20]. Scale 1:15,000. Polygon S0068 (Sparsely vegetated), S0050B/C/D (Older coniferous forest), and S0080 (Older second-growth forest).

---

19 Sensitive Habitat Inventory and Mapping. 2011. Community Mapping Network. Accessed November 9, 2011. Available: http://www.shim.bc.ca/atlases/shim/SHIM_public.htm.

20 Comox Valley Regional District. Sensitive Habitat Atlas. iMAP. 2007 orthophoto. Accessed November 9, 2011. Available at: http://www.imap.rdcs.bc.ca/imap/onpoint



Map 14. Conservation Data Center (CDC) map of Beulah Creek Watershed with wetlands identified[21]. Scale approximately 1: 14,500. See Appendix 4 for further information. 8652 (Douglas-fir / dull Oregon-grape plant community: red-listed) and 6984 (Coastal Wood Fern: blue-listed).

4.3 Lower Beulah Creek Drainage Description

Based on local geographic features and for descriptive purposes, the lower (downstream) Beulah Creek drainage system has been divided into several sections; the Beulah Creek mainstem, tributary systems, drainage systems, ditches, wetlands, and ponds that ultimately contribute water to the Beulah Creek mainstem. Each watercourse type has a separate section within the report to allow easy access to individual watercourse information. Maps of the different areas of the Beulah Creek drainage area are included. The following will describe watercourse features and locations

4.3.1 Lower Beulah Creek Mainstem

The lower Beulah Creek mainstem was divided six sections for descriptive purposes: a) the downstream section east of Central Road, b) Upstream of Central Road to Drainage 1, c) Upstream of Drainage 1 to Drainage 6, d) Upstream of Drainage 6 to Tributary 4, e) Upstream of Tributary 4 to Tributary 3, and f) upstream of Tributary 3 to end of study area. General features are found in Table 8.

---

[21] BC Ministry of Environment. 2011. Conservation Data Center. Available at: http://webmaps.gov.bc.ca/imfx/imf.jsp?session=939656832187&sessionName=Conservation Data Centre&theme-path=Ministry+of+Environment%2FConservation_Data_Centre.ssn.

Table 8. Lower Beulah Creek mainstem information.

Stream location	Channel Width (m)	Channel Depth (m)	Wetted Width (m)	Wetted Depth (m)	Aspect (°)	Gradient
Upstream of estuary	4.1	0.6	2.0	0.10	038	2%
Upstream of Central Road	12.0	0.9	3.0	0.20	074	4%
Upstream of Tributary 2	5.4	0.6	3.4	0.14	240	2%
Upstream of Tributary 3	3.0	0.9	1.8	0.12	160	1%
Downstream of Ditch 7	2.8	0.7	2.3	0.30	110	3%
Upstream of Ditch 7	3.0	0.6	2.0	0.20	095	10%

4.3.1.1 Lower Beulah Creek mainstem: Estuary to Central Road

The entrance into Beulah Creek contained no obstructions to fish passage. The channel had a low gradient (<5%), which meandered within a narrow ravine (Figure 56). The ravine slopes were steep (>50%) and were approximately 3 to 4 meters tall. Beulah Creek's streambed was predominantly hardpan with gravel patches and occasional cobbles and boulders. Debris accumulations included woody debris of all sizes and decay classes. There was evidence of flashiness including elevated erosion and undercutting.

The riparian area on both sides of the stream near the estuary was vegetated with Nootka rose, dune grass (high tide mark), and western redcedar shrubs, with the occasional Douglas-fir. Upstream of the estuary, the creek was vegetated with red-osier dogwood, salmonberry, sword fern, juvenile red alder, and the occasional young western redcedar. Other species included trailing blackberry, Himalayan blackberry (introduced species), and reed canarygrass (introduced species).

The downstream end of Beulah Creek was surrounded by rural residential properties and agricultural lands (Map 15). The creek flowed within a distinct ravine, frequently with very steep walls. There were several footbridges and narrow vehicular bridges over the creek, allowing access from Little Tribune Bay Road to individual residences. In addition, roadside runoff from Little Tribune Bay Road was diverted through ditches (see Section 4.3.4.1) into the riparian area along Beulah Creek.

Approximately 400 meters upstream from the estuary, Beulah Creek is directed under a driveway through a metal culvert that had a 130 cm x 145 cm diameter at the downstream end. There was a pool (60 cm deep) at the downstream end of the culvert that had chunks of asphalt at the downstream pool edge (Figure 57). The culvert bottom was rusted away at both ends and also in some places in the middle. Woody debris, boulders, and cobbles were found inside of the culvert.

Map 15. Lower Beulah Creek drainages: Estuary to Central Road. Orthophoto courtesy of the Islands Trust.

Another round metal culvert (82 cm diameter) had been recently placed at the outer edge of the Beulah Creek floodplain, directing additional water under the driveway. A side channel has been formed by the placement of this additional culvert (Side Channel 1 on Map 15). During high flows, water enters from the upstream side of the Beulah Creek floodplain, flows through the additional culvert, and exits the culvert in the Beulah Creek floodplain downstream of the larger driveway culvert. There is an 80 cm drop from the downstream end of the smaller culvert to the shallow channel in the floodplain (Figure 58). At low flows, it is unlikely that fish would enter the side channel or the smaller culvert.

Upstream from the side channel culvert, the ravine banks had started to slump, forming benches. Most of the lower benches were approximately one meter above the bankfull channel. The ravine slopes and benches were vegetated with grasses, blackberry, horsetail, salmonberry, and clumps of young red alder (Figure 59). There was more reed canarygrass along the channel banks and the riparian area immediately surrounding the creek was heavily vegetated with shrubs such as salmonberry and Himalayan blackberry (Figure 60). The streambed substrate in this area consisted of mostly fines with some gravels.

Beulah Creek was directed under Central Road through a 1.5 meter diameter culvert (Figure 61). A pool was located at the base of the downstream end of the culvert. This pool was approximately 15 m wide by 12 m long and was greater than 0.6 m deep at the time of the survey. The distance from the pool's water surface to the culvert bottom was approximately 0.5 m. Chunks of asphalt were located at the pool outflow. The upstream end of the culvert had a section of fencing with wire and an accumulation of large woody debris, smaller debris, and sediments (Figure 62). This debris caused the culvert to be partially blocked and flooding occurred upstream of the culvert during rain events.

This section of Beulah Creek from the estuary to Central Road provided marginal to good fish habitat. There were a few deep pools, a few sections of shallow, rooted, undercut banks, with moderate amounts of large woody debris that provided some instream structures. There were a few infrequent patches of gravels and small cobbles that would provide poor spawning substrate.

4.3.1.2 Lower Beulah Creek Mainstem: *Upstream of Central Road to Drainage 1*

This section of the stream between Central Road and Drainage 1 provided marginal to good fish habitat. There were a few deep pools and moderate amounts of large woody debris that provided some instream structures (Figure 63). There were patches of gravels and small cobbles that would provide some spawning substrate. Along the base of the ravine slopes along the floodplain boundary, there were often small drainage channels. Most of these small channels and drainages were not mapped, as they were contained within the 5-year floodplain (below the high water mark[22]).

[22] BC Ministry of Environment. 2006. Riparian Area Regulations Assessment Methods, version 3.3. April 2006. Available: http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf.

Throughout this section of the Beulah Creek mainstem, there was evidence of flashiness. Rafted debris was often observed 0.5 to 0.9 meters above the bankfull channel edges. Fines were deposited on channel bars and on the floodplain from recent rain events. Other evidence included undercut banks, bank erosion, and embedding of streambed substrate.

The Beulah Creek mainstem was partially obstructed at the upstream end of the Central Road culvert causing flooding in that area during rain events (see previous section). Upstream of the Central Road culvert, the mainstem had one primary channel with smaller ephemeral channels and islands in between. These islands were almost always vegetated, some with young alders, some with sword fern or salmonberry with sedge patches (Figure 64). The floodplain in this area was often 30 m across and was contained within a wider ravine than in the downstream sections.

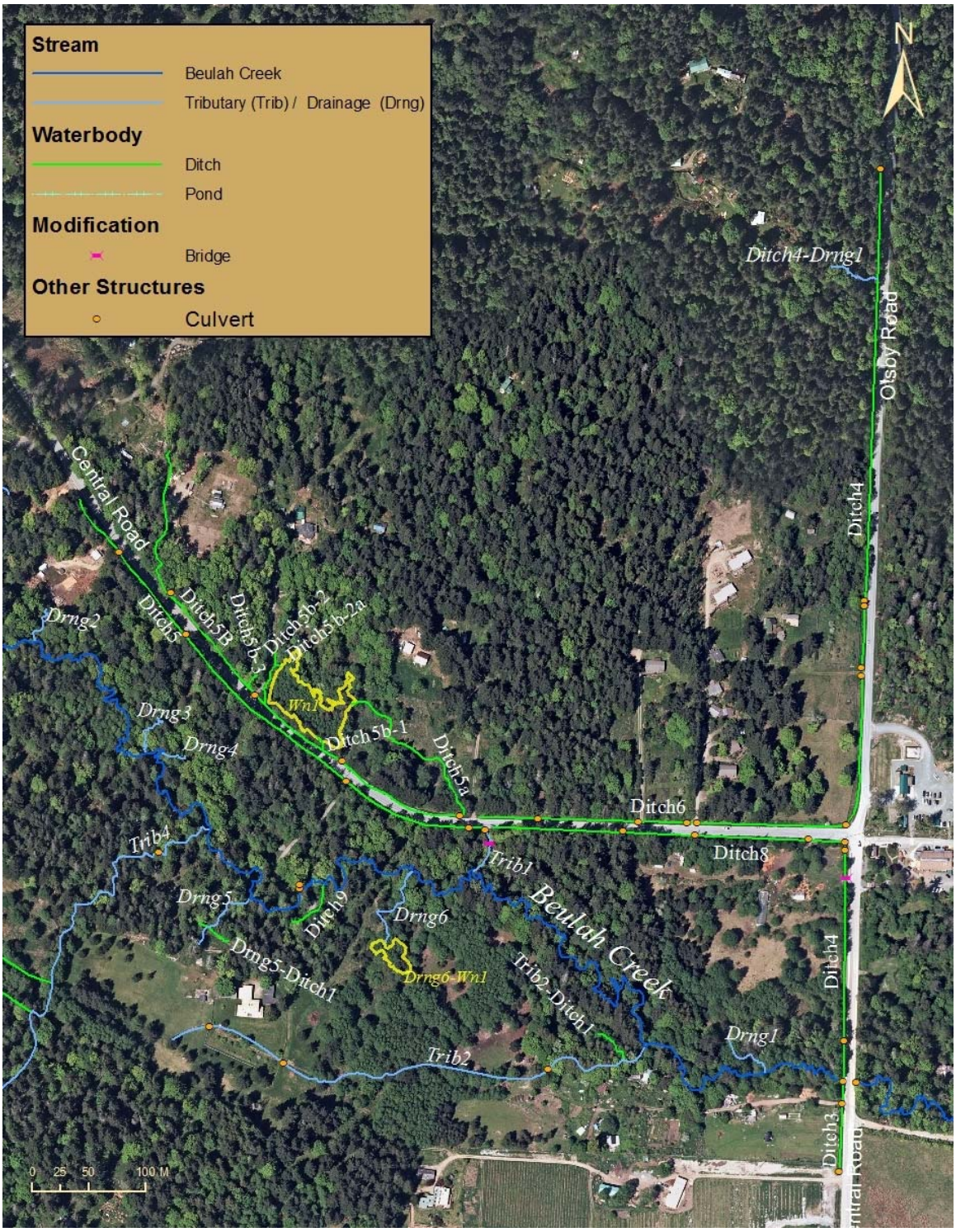
Several watercourses enter the mainstem in this section (Map 16). This includes Drainage 1 (see Section 4.3.3.1), and Ditches 3, 4, 6, and 8 (see Section 4.3.4.1). Drainage 1 enters the Beulah Creek mainstem upstream of the Central Road culvert. Flow from Ditches 3 and 4 enter the Beulah Creek mainstream at the upstream end of the Central Road culvert. Ditches 6 and 8 flow westwards along the edges of Central Road east, entering Ditch 4 at the culvert ends on the west side of the Central Road intersection.

4.3.1.3 Lower Beulah Creek Mainstem: *Upstream of Drainage 1 to Drainage 6*

Upstream of Drainage 1, the Beulah Creek mainstem meanders within a wide ravine (approximately 50 m wide). Water collects at the base of the ravine slopes, sometimes forming short channels to the mainstem, other times pooling within the floodplain formed at the ravine bottom. There are broad floodplain benches that alternate sides as the stream meanders. These benches are vegetated with a young to mature mixed forest. Trees include bigleaf maple, red alder, western redcedar, Douglas-fir, and western hemlock. Common understory species include sword fern, salmonberry, and Himalayan blackberry, with sedge patches (Figure 65).

This section of the Beulah Creek mainstem contained moderate fish habitat. The streambed substrate had small gravels with few patches of cobbles. There were ample amounts of instream large woody debris but only shallow undercuts that have limited habitat value. The large woody debris created small waterfalls and cascades with pools associated with them. One of the deeper pools in this stream section was 0.8 m deep at the time of the survey. There was evidence of flashiness in the mainstem including freshly eroded soil along the bankfull channel banks and evidence of decoupling (Figure 66).

Watercourses that contributed water to the Beulah Creek mainstem in this section (see Map 16) were Tributaries 1 and 2 (see Section 4.3.2), Drainage 6 (see Section 4.3.3.1), and the Ditch 5 system (see Section 4.3.4).



Map 16. Lower Beulah Creek drainages: Central Road to Drainage 2. Orthophoto courtesy of the Islands Trust.

4.3.1.4 Lower Beulah Creek Mainstem: *Upstream of Drainage 6 to Tributary 4*

The Beulah Creek mainstem upstream of Drainage 6 to Tributary 4 was similar to the stream section immediately downstream. The creek continued to flow at the base of a ravine. In many places, there were steep slope gradients (>65%) with wet forests at the top of the ravine banks (Figure 67). It is likely that during wet periods or after large rain events, flow comes over the ravine crests in multiple small intermittent channels. Runoff would flow down onto the floodplain benches below or flow a short distance directly into the mainstem.

Upstream of Drainage 6 (see Section 4.3.3.1), Beulah Creek flows under a gravel access road through a culvert (see Map 16). The culvert was a round metal culvert (1.5 m diameter) encased in concrete at the upstream end (Figure 68). Another smaller overflow culvert (30 cm diameter) had been placed under same access road (Figure 69). This smaller culvert was approximately 4 m north of the main culvert and installed in the upper bank, near the road surface. The small culvert was at least half filled with sediments at the upstream end. Ditch 9 (see Section 4.3.4.1) discharged into the floodplain immediately downstream of the larger culvert.

Beulah Creek continued to show evidence of flashiness. Some locations contained sections of exposed bedrock stream substrate. At the junction of Tributary 4, the Beulah Creek mainstem substrate was composed of hardpan.

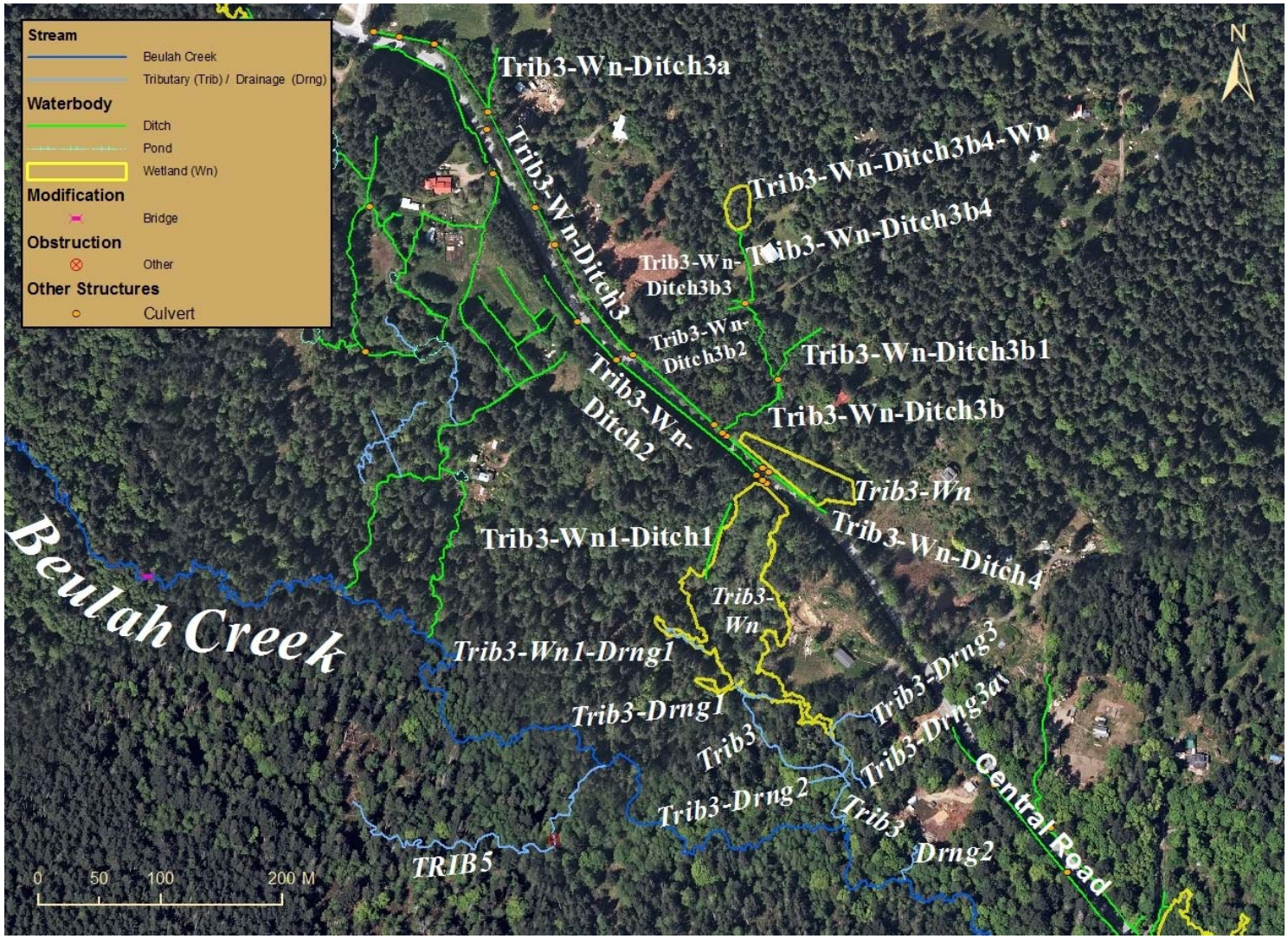
Tributary 4 (see Section 4.3.2.4) was a major watercourse system that discharged into the Beulah Creek mainstem in this stream section. In addition, Drainage 5 (see Section 4.3.3.1) and Ditch 9 (see Section 4.3.4.1) joined the Beulah Creek mainstem in this stream section.

4.3.1.5 Lower Beulah Creek Mainstem: *Upstream of Tributary 4 to Tributary 3*

The Beulah Creek mainstem continued to meander at the bottom of a well defined ravine with steep ravine walls. At the base of the ravine slopes, there were broad floodplain benches that alternated sides as the stream meandered. The benches were vegetated with sword fern, bigleaf maple, western redcedar, and the occasional salmonberry or sedge patch. Within the stream, there were sections of exposed bedrock substrate. Ample large woody debris added instream complexing and created small waterfalls (Figure 70). Continued evidence of flashiness was observed within the stream and surrounding floodplain.

In a few areas, there are linear depressions or gullies that lead towards the mainstem. Often these features were vegetated by young red alder, salmonberry, sword fern, and the occasional deciduous snag. At the time of the survey, there was no evidence of water flow. It is likely that in these areas, water seeps downhill but has no obvious surface connectivity. These sites were not included in the maps, as they did not meet the definition of *stream* under RAR.

Several watercourses enter the mainstem in this section (see Maps 16 and 17). These include Tributary 3 (see Section 4.3.2.3) and Drainages 2, 3, and 4 (see Section 4.3.3.1).



Map 17. Lower Beulah Creek drainages: Drainage 2 to Tributary 5. Orthophoto courtesy of the Islands Trust.

4.3.1.6 Lower Beulah Creek Mainstem: *Upstream of Tributary 3 to the end of the study area*

The survey within the Beulah Creek drainage area upstream of Tributary 3 was incomplete (Maps 17 and 18). Due to time constraints, only one ditch system (Ditch 7) and a section of the Beulah Creek mainstem were surveyed. At a minimum, there were at least three unmapped tributaries entering from the south and several drainages that contributed flow to the Beulah Creek mainstem. Several footbridges crossed the mainstem and at least one dirt road passed through the mainstem channel (Figures 71 and 72).

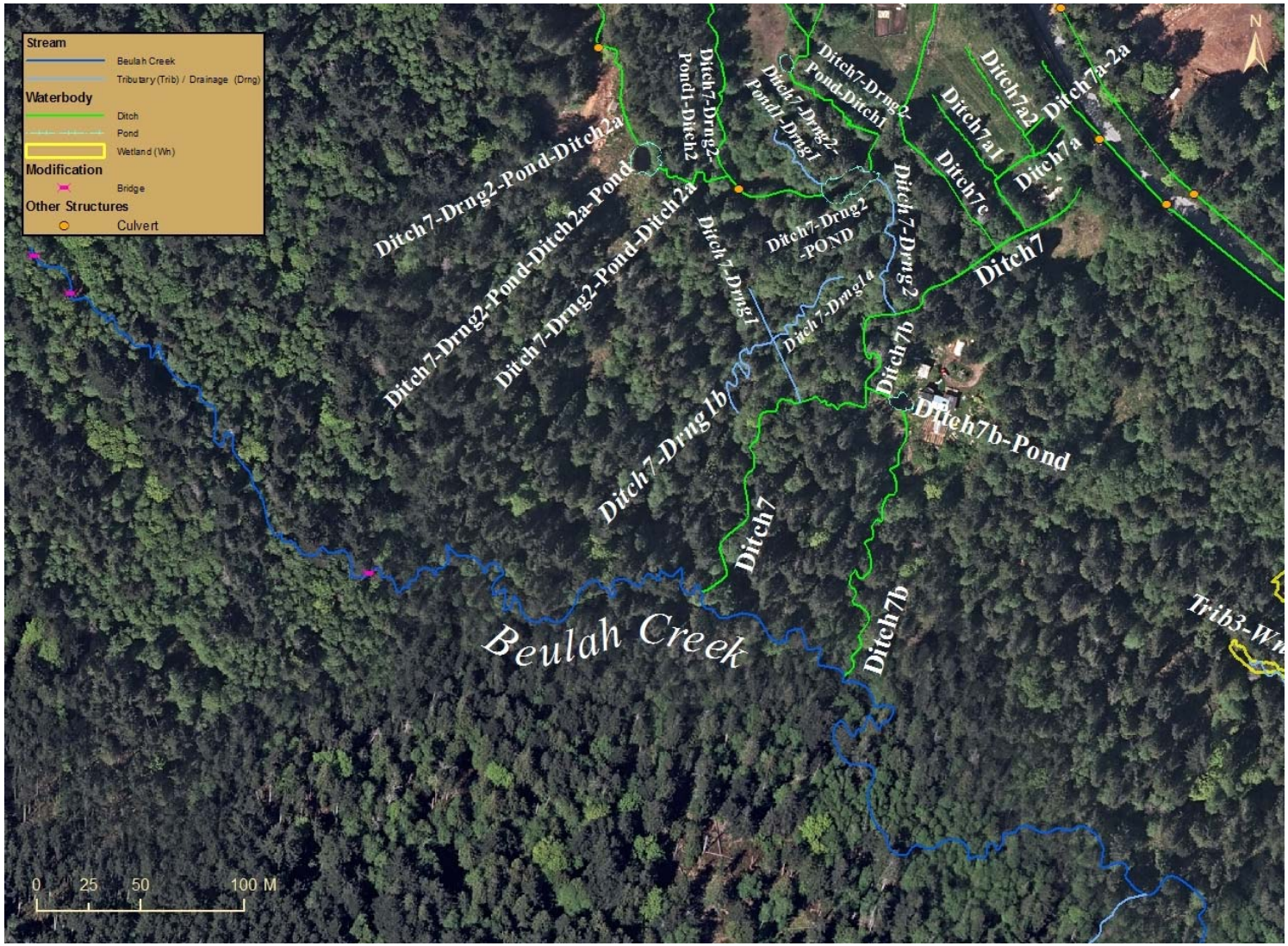
Upstream of Tributary 3, the ravine walls surrounding the Beulah Creek mainstem become more variable. There are areas where the ravine walls are lower and their slopes less steep. In other areas, the stream still meanders at the base of a ravine with steep walls. Floodplain benches remain at the base of the ravine, generally alternating sides as the stream meanders. Occasionally, there are floodplain side channels running along the base of the ravine slopes and creating sword fern floodplain "islands". There are some patches of exposed bedrock in channel bed, along with sections of gravels and small cobbles.

With the exception of the estuary, ravine slopes and upslope areas were occupied by wet forests. In this upstream section, drier forests were interspersed between the wet forests of Tributary 3 and Ditch 7 (see Map 17). The forests remain as mixed forests. They were fairly open with a salal/sword fern understory. In some areas, there were a several large diameter grand fir, Douglas-fir, and a few large diameter western redcedar. Older stumps in the area indicate past harvesting. The forest floors and riparian areas contained abundant coarse woody debris in all sizes and age classes. When found in the stream channel, this woody debris created many small waterfalls and deep pools, often with 40-50 cm water. In one location downstream of the Ditch 7 junction, there were considerable amounts of large woody debris within Beulah Creek. This material would be a challenge for large fish to pass (Figure 73).

The upstream end of the study area appears less flashy. Beulah Creek had no undercutting in this section and water flowed in and around logs. Within the stream, pools were created immediately downstream of where water flowed over large logs or log accumulations. There were short sections of cascade-pool habitat, based on log/pool configuration and stream gradient. Longer segments (~20-50 m) of riffle-pool habitat with stream gradients of 2-5% were interspersed between the steeper areas.

At the upstream end of the Beulah Creek mainstem survey area, the steam flows through a young, mixed forest dominated by red alder and sword fern (Figure 74). The area had a low gradient (< 3%) and water flow meandered through the sword fern community. In several areas, the stream channel divided, travelling around ferns or the large woody debris in the area. Upstream of the sword fern community, Beulah Creek flows through a forested ravine again.

The Ditch 7 system (see Section 4.3.4) and several incompletely mapped tributaries and drainages join the Beulah Creek mainstem upstream of Tributary 3 (see Map 18).



Map 18. Lower Beulah Creek drainages: Upstream of Tributary 5. Orthophoto courtesy of the Islands Trust.

4.3.2 Lower Beulah Creek drainage area: *Tributaries*

There were five tributary systems within the lower Beulah Creek drainage area. Each tributary system is described below. Tributary 5 was only mapped at the downstream end near the Beulah Creek confluence. Table 9 contains general watercourse information.

Table 9. Lower Beulah Creek tributary information.

Stream name	Channel Width (m)	Channel Depth (m)	Wetted Width (m)	Wetted Depth (m)	Aspect (°)	Gradient
Tributary 1	1.4	0.3	1.0	0.01	160	25%
Tributary 2	2.3	0.4	1.4	0.04	96	5-45%
Tributary 3	1.5	0.5	0.9	0.03	196	2-18%
Tributary 4	1.5	0.7	1.3	0.2	065	5%
Tributary 5	2.8	0.7	2.0	0.03	110	3%

4.3.2.1 Beulah Creek mainstem: Tributary 1

Tributary 1 joined the Beulah Creek mainstem south of Central Road East (see Map 16). The tributary commenced at the downstream end of a culvert under Central Road and received water from Ditch 5 and its associated watercourses (see Section 4.3.4). The culvert under Central Road is a 40 cm by 80 cm squashed plastic culvert (Figure 75). Tributary 1 was a narrow watercourse that flowed along the top and then down the sides of the forested ravine bank (25% slope) to the Beulah Creek mainstem (Figure 76). The watercourse had abundant large woody debris and the streambed substrate consisted primarily of hardpan with exposed cobbles. Tributary 1 was flashy, showing evidence of erosion, scouring, and rafted piles of debris.

4.3.2.2 Beulah Creek mainstem: Tributary 2

Flowing directly into the Beulah Creek mainstem downstream of Tributary 1, Tributary 2 was a natural watercourse located in a narrow ravine (see Map 16). The upstream portion of the tributary had been modified. According to one landowner, portions of the watercourse had been created for drainage and irrigation. Along its length were two areas that appeared to have springs.

Progressing from the downstream end, the tributary had a steeper gradient near Beulah Creek (45%). The gradient lessened and the ravine walls flattened moving upstream from the mainstem (Figure 77). Tributary 2-Ditch 1 brought additional water into the tributary in the natural section of the watercourse (see Section 4.3.4.2).

Stream modifications began at upstream end of the natural watercourse. Water in Tributary 2 flowed under a dirt access road. There was a small culvert, blocked by soil, under the access road. Upstream of the access road, water from upstream had ponded. The pond was approximately 6 m wide x 5 m long and may have been purposely dug (see Section 4.3.6). Upstream of the pond, Tributary 2 was no longer contained within a

ravine. The watercourse meandered through an area where livestock grazed, then through a wet, young forest (Figure 78). Water seeped into the watercourse from several areas in the forest, but no distinct channels were observed. Tributary 2 continued upstream from the wet forest as a ditched watercourse, flowing through a residential yard and horse pasture. Within this section of the tributary, there were two 10-cm PVC pipes under the lawn that connected the lower ditch to upper ditched areas. There was also a PVC pipe section under approximately 10 m of lawn and the fenced lawn area had two small footbridges (Figure 79). The point of commencement of Tributary 2 was a ditch through a wet field. The ditch was filled with grasses including reed canarygrass (Figure 80).

4.3.2.3 Beulah Creek mainstem: Tributary 3

Tributary 3 is a fairly straight, narrow watercourse that occasionally spreads out into sedge-dominated pocket wetlands (see Map 17 and Figure 81). Near the junction with the Beulah Creek mainstem, the tributary was contained within a ravine with steep walls (70% slope gradient). Tributary 3 is steeper near the Beulah Creek mainstem (18% stream gradient) and flatter (<5% slope gradient) uphill of the mainstem ravine.

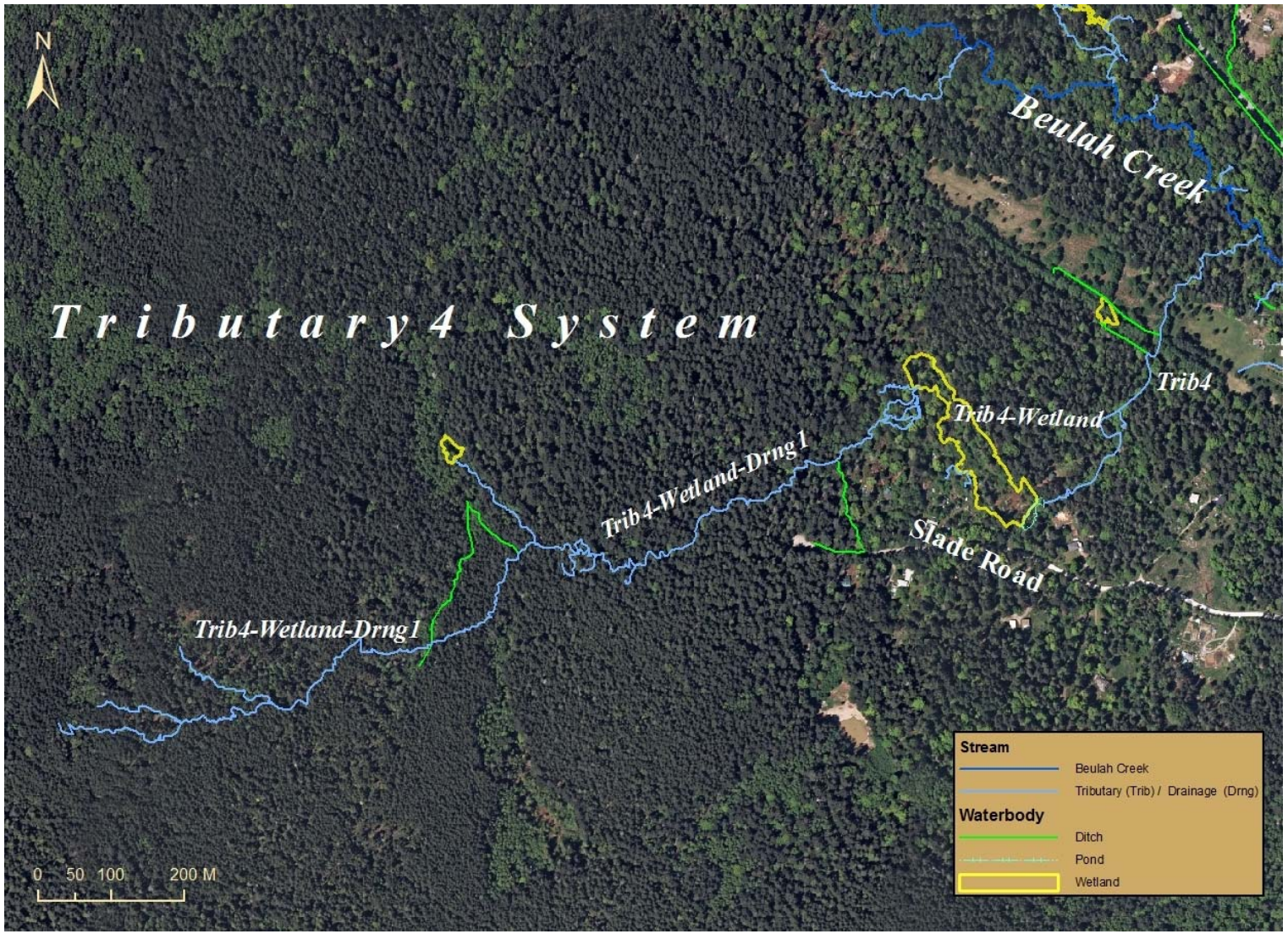
Water enters the tributary from Tributary 3-Drainages 1, 2, and 3 (see Section 4.3.3.2), Tributary 3-Wetland (see Section 4.3.5.1), as well as from the surrounding wet forests. The riparian forests are young to mature mixed forest containing bigleaf maple, grand fir, red alder, and western redcedar with sword fern and salmonberry patches in the understory. There are several old stumps in area indicating past harvesting.

4.3.2.4 Beulah Creek mainstem: Tributary 4

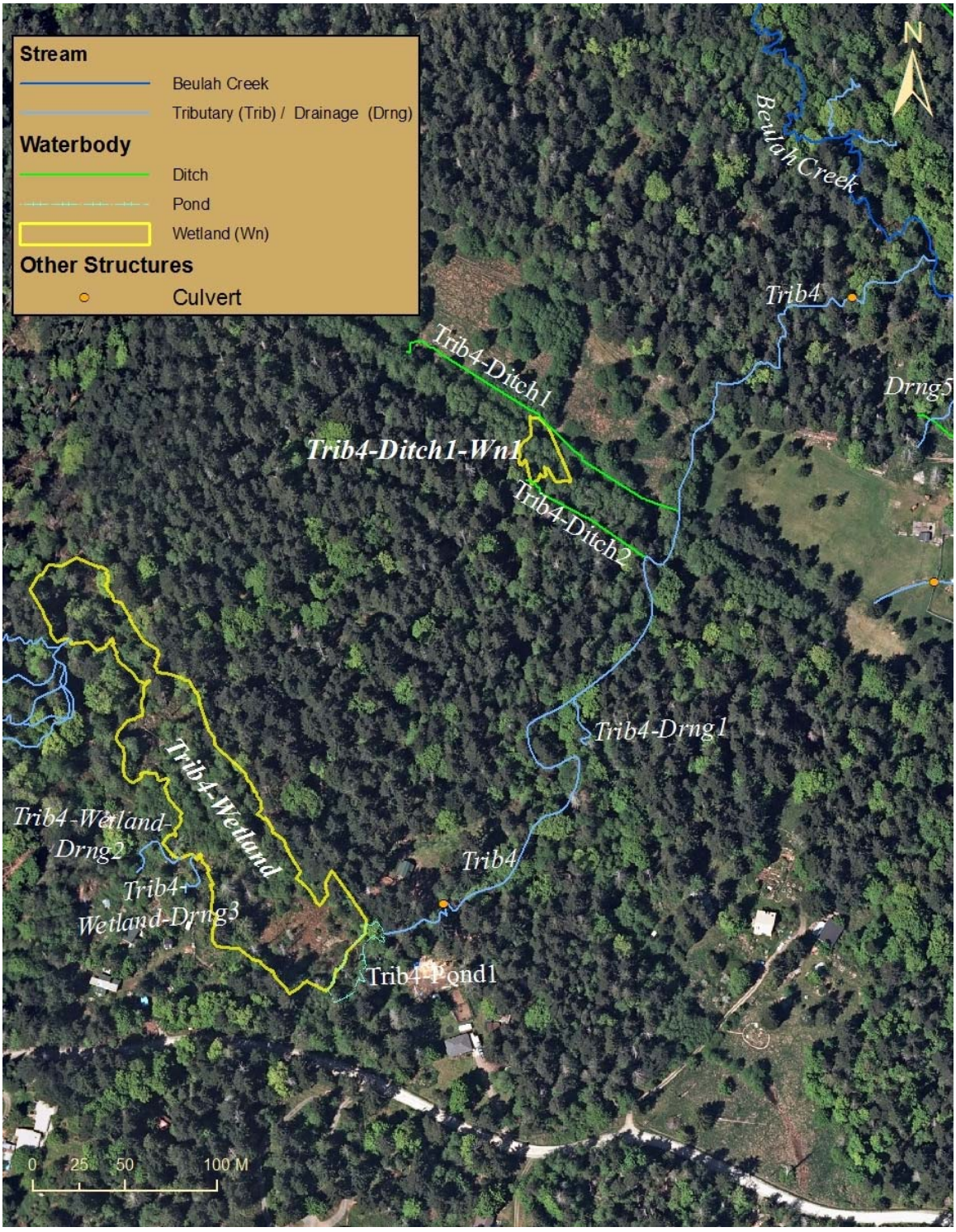
Tributary 4 entered the Beulah Creek mainstem upstream of Drainage 5 (Map 19). This was one of the largest sub-basins within the Beulah Creek drainage study area. Overall, Tributary 4 would provide marginal to good fish habitat. The access from the Beulah Creek mainstem would be the greatest challenge for fish passage (approximately 15% to 20% slope). Tributary 4 had cascade-pool habitat in the downstream section and riffle-pool habitat upstream. The tributary had ample large woody debris and some patches of gravels and cobbles. However, the tributary system was flashy, with sections of accumulated debris and scoured habitat.

At the downstream end, Tributary 4 flows in a forested ravine (approximately 10 m wide and 4 m high) with an average gradient of 15% (Map 20 and Figure 82). A black PVC pipe runs much of its length at the downstream end. In one location, plastic sheeting had been placed to form a temporary dam (Figure 83). The plastic sheeting across stream had collapsed on the right side (facing downstream). There was evidence of flashiness in the tributary, including rafted vegetation and alluvium along the channel banks.

Mid-way up the ravine, the stream gradient of Tributary 4 lessened to between 2% and 5%. The tributary was directed under a grassed access road through a culvert. The culvert was partially blocked by woody debris and soil (Figure 84). Upstream of the culvert, the stream continued to meander in a ravine (Figure 85). Large old-growth Douglas-fir stumps and coarse woody debris were present in forested ravine.



Map 19. Tributary 4 system. Orthophoto courtesy of the Islands Trust.



Map 20. Tributary 4 system: Downstream section to Tributary 4 Wetland. Orthophoto courtesy of the Islands Trust.

Continuing upstream, the ravine surrounding Tributary 4 opened up and the watercourse meandered within a narrow corridor of remnant mixed forest and through pastures (Figure 86). Tributary 4-Ditch 1 entered Tributary 4 in this area (see Section 4.3.4.2).

Upstream of the pasture, the watercourse becomes more natural, flowing through a mixed, young to mature, wet forest. Tributary 4 receives seepage from the adjacent wet forests. During wetter seasons, it is likely that water from the wet forests forms many small intermittent channels, dispersing water flow through ferns towards the stream. Tributary 4-Ditch 2 (see Section 4.3.4.2) and Tributary 4-Drainage 1(see Section 4.3.3.3) joins Tributary 4 in this area.

Another culvert (65 cm diameter) directs Tributary 4 under a dirt access road. Upstream of this culvert, the tributary widens and sedges were observed growing in the channel. Approximately 40 m upstream of the culvert Tributary 4 widens into a pond (see Section 4.3.6). Upstream of the pond is a short wide channel that leads to Tributary 4-Wetland (see Section 4.3.5.4).

4.3.2.5 Beulah Creek mainstem: Tributary 5

Only the downstream section of Tributary 5 at the Beulah Creek confluence was mapped during this survey (see Map 17). Water was flowing in the tributary at the time of the survey. There were some patches of exposed bedrock in the stream bed, as well as patches of gravels and cobbles (Figure 87). The watercourse junction was congested with recent large woody debris. Upstream of the junction, there was abundant large woody debris in the channel, providing instream structures and small waterfalls. Some of these waterfalls would be considered obstructions to passage by smaller fish. Several deep pools containing 40-50 cm of water were observed. Tributary 5 showed some indicators of flashiness, including undercut banks.

4.3.3 Lower Beulah Creek drainage area: *Drainages*

4.3.3.1 Lower Beulah Creek mainstem: Drainages

Beulah Creek had several drainages contribute water to the mainstem. All of the drainages were ephemeral and typically received water from pocket wetlands and/or water from adjacent forests. As the lower Beulah Creek mainstem was contained within a ravine, many of the drainages had steeper gradients at their downstream ends as water flowed down the mainstem ravine slopes. These steeper gradients and the seasonal nature of the water flow would make it difficult for fish passage. However, as water and nutrients are contributed to the mainstem, these watercourses were still considered *streams* under RAR.

Table 10. Lower Beulah Creek mainstem drainage information. Figures are located in Appendix 2.

Wetland Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Drainage 1	0.9	0.2	88	Short channel from hillside across floodplain joining Beulah Creek mainstem.
Drainage 2	1.4	0.3	89	Spillway from a disturbed sedge-dominated pocket wetland on the top of slope. Where drainage enters the mainstem, there are several small braided channels.
Drainage 3	-	-	90	Spillway from a wet area on the top of slope. One main path downslope then braids out at the slope toe.
Drainage 4	0.5	0.1	-	Small drainage that comes from a depression at the top of ravine bank and flows through sword fern.
Drainage 5	1.1	0.5	91	Drainage to Beulah Creek is through a narrow ravine; steep near the mainstem (28% slope). Drainage 5-Ditch 1 discharges into Drainage 5 (see Section 4.3.4.2). Headwaters is a wet field.
Drainage 6	-	-	92	Water flow enters Beulah Creek from a ravine slope (55%). Barrier to fish passage (approximately 10 m distance). Most of drainage dominated by salmonberry. Headwaters is a pocket wetland (see Section 4.3.5.6).

4.3.3.2 Tributary 3 Drainages

Several watercourses that flowed into the Beulah Creek mainstream had drainages associated with them. In the lower Beulah Creek drainage area, Tributaries 3 and 4 had drainages associated with them. Table 11 contains information about the Tributary 3 drainages (see Map 17 and Section 4.3.2.3).

Table 11. Beulah Creek Tributary 3 drainage information. Figures are located in Appendix 2.

Wetland Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Tributary 3-Drainage 1	0.5	0.1	93	Short drainage that commences in a sedge patch at a slope break. The drainage appears to follow an old road or trail, joining with Tributary 3.
Tributary 3-Drainage 2	1.2	0.3	94	Old road that slopes towards Tributary 3. Footbridge over Tributary 3 at base of Tributary 3-Drainage 2. Water would only flow along the ruts of this herbaceously vegetated track during wet periods.
Tributary 3-Drainage 3	1.2	0.3	95	Grassed access road that leads to a footbridge over Tributary 3. During rain events water flows down the ruts into Tributary 3. Additional water joins Tributary 3-Drainage 3 from another grassed access road (Tributary 3- Drainage 3A).
Tributary 3-Drainage 3A	0.9	0.3	96	Water flows in ruts within a grassed access road that leads to Tributary 3. Some of this water comes from Tributary 3-Wetland (see Section 4.3.5.1). The road (Drainage 3A) veers northwest and becomes a roadside ditch with a steeper gradient along a dirt access driveway. At the time of the survey, only a couple pools of standing water in the lower section, but moist ground the entire length.
Tributary 3-Wetland-Drainage 1	1.5	0.1	97	Drainage that commences at a pocket wetland ($40m^2$) at a slope break. The drainage appears to follow an old grass-covered road.

4.3.3.3 Tributary 4 Drainages

Tributary 4 was a long watercourse commencing at a large wetland with an extensive sub-basin and discharging into Beulah Creek (see Section 4.3.2.4 and Maps 19 and 20). There was one drainage associated with the Tributary 4. Upstream of the Tributary 4 Wetland, Tributary 4-Wetland-Drainage 1 was another lengthy watercourse with many

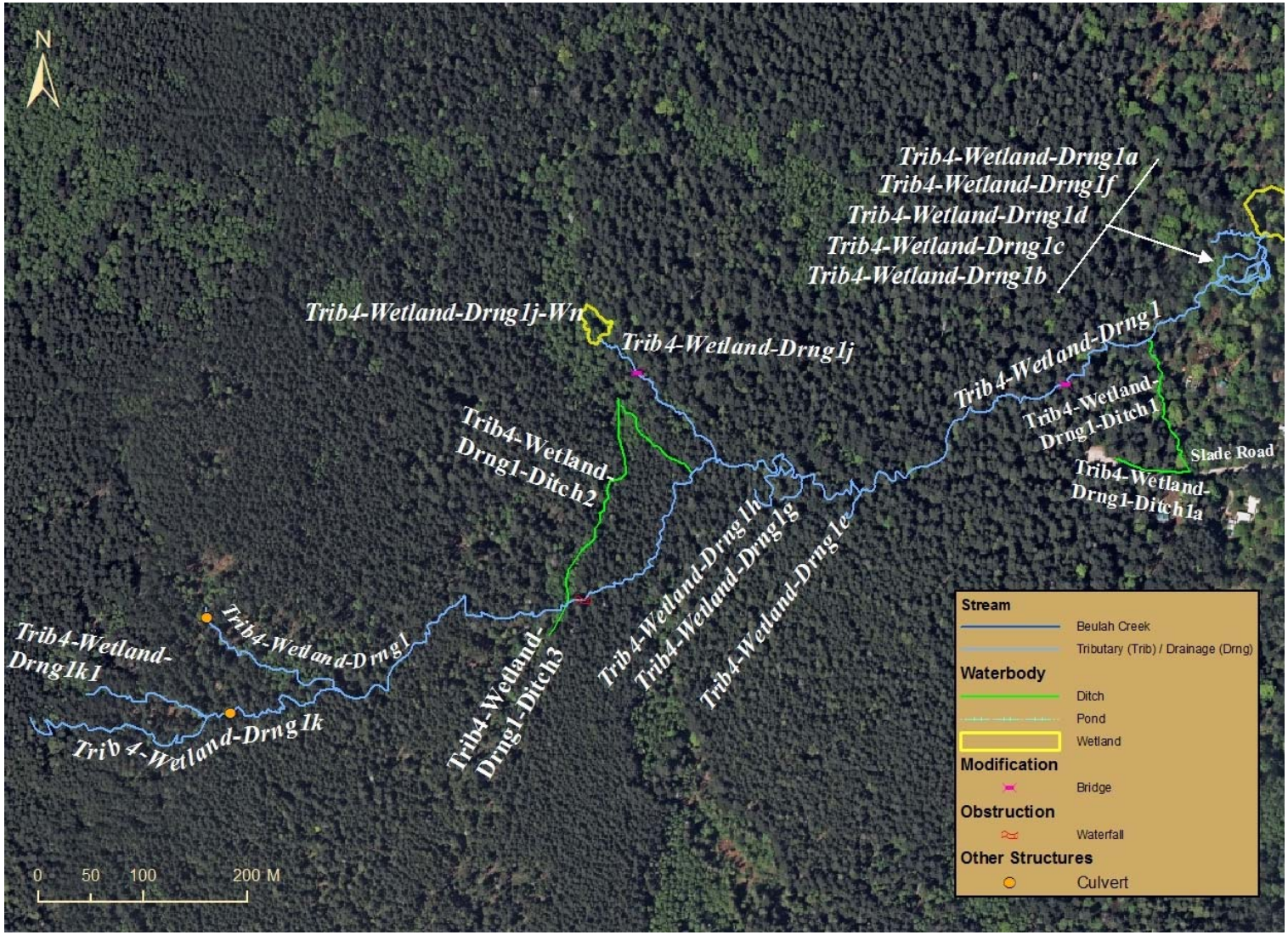
associated drainages, ditches, and wetlands (Map 21). Information about the Tributary 4 drainages is contained within Table 12.

Tributary 4-Wetland-Drainage 1 discharged into the Tributary 4-Wetland (see Section 4.3.5.4) at the northwest end (see Map 19). Upstream from the wetland, Tributary 4-Wetland-Drainage 1 flows along the remnants of an old road that was vegetated with grasses and had seasonal drainage. At the time of the survey, there was flowing water in Tributary 4-Wetland-Drainage 1. Several small drainages discharge into Tributary 4-Wetland-Drainage 1 near Tributary 4-Wetland, including Tributary 4-Wetland-Drainages 1A, 1B, 1C, 1D, and 1F. Surrounding this area is a wet mixed forest containing bigleaf maple, red alder, western redcedar, and grand fir with a sword fern/salal understory. The forested area had multiple seasonal drainages, pockets of standing water, and interconnected channels that flowed into Tributary 4-Wetland and Tributary 4-Wetland-Drainage 1 with its associated drainages.

Upstream from the Tributary 4-Wetland, Tributary 4-Wetland-Drainage 1 flowed from a rural residential area into a regional park. There were several footbridges over the stream and the tributary received water flow from several drainages and ditches. Additional flow came from unconfined and groundwater sources on the surrounding forested slopes. Tributary 4-Wetland-Drainage 1 showed evidence of flashiness and the reaches upstream of Tributary 4-Wetland-Drainage 1G appeared ephemeral.

Upstream of the Tributary 4-Wetland-Drainage 1J junction, Tributary 4-Wetland-Drainage 1 crossed over Coltsfoot Trail (no culvert). Tributary 4-Wetland-Drainage 1-Ditch 2 discharged into the drainage on the upstream side of the trail. Upstream of Coltsfoot Trail, Tributary 4-Wetland-Drainage 1 continued upslope, following along the base of the hillside, and then through a gully between hills (15% stream gradient). A 4-meter tall waterfall is located upslope of the gully and east of Washing Machine Trail (Figure 98). Upstream of the waterfall, Tributary 4-Wetland-Drainage 1 crosses over Washing Machine Trail. Water enters the drainage from Tributary 4-Wetland-Drainage 1-Ditch 3 (see Section 4.3.4.1) at the trail crossing.

Upstream of Washing Machine Trail, Tributary 4-Wetland-Drainage 1 flows through an open mixed forest. There were many fallen trees and abundant large woody debris. The drainage flows through two small (12 cm diameter) plastic pipes under a biking trail (Yer Mom Trail) (Figure 99). Near the headwaters of the drainage, there was a young, wet, alder grove with two small sedge patches (Figure 100). Water seemed to settle in this shallow bowl forming a channel that becomes Tributary 4-Wetland-Drainage 1. Tributary 4-Wetland-Drainage 1K joined Tributary 4-Wetland-Drainage 1 from the southwest side. Tributary 4-Wetland-Drainage 1 continued upstream from the alder grove as a narrow channel formed in between two small hills. The channel ended at a watershed break. Twenty meters from channel terminus was a sedge-dominated marsh, which drained into the adjacent watershed (north).



Map 21. Tributary 4 system: Tributary 4 Wetland to upstream end. Orthophoto courtesy of the Islands Trust.

Table 12. Beulah Creek Tributary 4 drainage information. Figures are located in Appendix 2.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Tributary 4-Drainage 1	0.9	0.2	101	Small drainage in a wet forest. Headwaters is a pocket wetland with multiple inflows.
Tributary 4-Wetland-Drainage 1			102, 103	Lengthy drainage with associated drainages, ditches, and wetlands. Drainage flows into Tributary 4-Wetland (see Section 4.3.5.4).
Tributary 4-Wetland-Drainage 1A	1.0	0.2	104	Headwaters was a wet forest. Enters Tributary 4-Wetland-Drainage 1 near its wetland junction.
Tributary 4-Wetland-Drainage 1B			105	Joins Tributary 4-Wetland-Drainage 1east of Tributary 4-Wetland-Drainage 1A. Water from Tributary 4-Wetland-Drainage 1B splits to form Tributary 4-Wetland-Drainage 1C upstream of Tributary 4-Wetland-Drainage 1 junction.
Tributary 4-Wetland-Drainage 1C			106	Tributary 4-Wetland Drainage 1C commences from Tributary 4-Wetland-Drainage 1B and flows down through wet forest to Tributary 4-Wetland-Drainage 1D.
Tributary 4-Wetland-Drainage 1D	0.9	0.3	107	Joins Tributary 4-Wetland-Drainage 1 in two places, upslope of and near Tributary 4-Wetland. Receives water from Tributary 4-Wetland-Drainage 1C. Variable gradient and channel, sometimes braided.
Tributary 4-Wetland-Drainage 1E	0.8	0.3	108	Joins Tributary 4-Wetland-Drainage 1upstream of Tributary 4-Wetland-Drainage 1-Bridge 3. Headwaters is a sword fern-dominated mixed forest. At the downstream end, the drainage splits and one outflow has a small sedge bench.

Table 12. (continued) Beulah Creek Tributary 4 drainage information. Figures are located in Appendix 2.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Tributary 4-Wetland-Drainage 1F	2.8	0.3	109	Commences at Tributary 4-Wetland-Drainage 1B upstream junction. Joins Tributary 4-Wetland-Drainage 1 near wetland.
Tributary 4-Wetland-Drainage 1G	-	-	110	Gully that leads to Tributary 4-Wetland-Drainage 1 upstream of Bridge 3. Slope gradient was 11%.
Tributary 4-Wetland-Drainage 1H	-	-	111	Gully that leads to Tributary 4-Wetland-Drainage 1 upstream of Tributary 4-Wetland-Drainage 1G. Slope gradient was 12%.
Tributary 4-Wetland-Drainage 1J	-	-	112	Drainage that joins Tributary 4-Wetland-Drainage 1 upstream of Tributary 4-Wetland-Drainage 1H. Footbridge over stream upstream of Tributary 4-Wetland-Drainage 1 junction. Headwaters was a small wetland (see Section 4.3.5.5).
Tributary 4-Wetland-Drainage 1K	1.8	0.5	113, 114	Tributary 4-Wetland-Drainage 1K joins Tributary 4-Wetland-Drainage 1 upstream of Northwind Trail culvert. Multiple shallow drainages enter the drainage from surrounding forest; all ephemeral and most intermittent. Headwaters is a shallow depression at base of hillsides.
Tributary 4-Wetland-Drainage 1K-1	-	-	115	Drainage that enters Tributary 4-Wetland-Drainage 1K upstream of Northwind Trail culvert. Headwaters is a small depressed basin in forest that receives flow from surrounding forest and small ephemeral drainages.
Tributary 4-Wetland-Drainage 2	0.6	0.6	116	Travels through a rural residential parcel to Tributary 4-Wetland, south of Tributary 4-Wetland Drainage 1. Downstream end is ditched through a small garden plot.

Table 12. (continued) Beulah Creek Tributary 4 drainage information. Figures are located in Appendix 2.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Tributary 4-Wetland-Drainage 3	-	-	117	Travels through a rural residential parcel to Tributary 4-Wetland, south of Tributary 4-Wetland-Drainage 2. It appears to commence near the wetland edge of the property and is associated with a small pond (see Section 4.3.6).

4.3.3.4 Lower Beulah Creek drainage area: Ditches with drainages

Several ditches had drainages discharging into them. In many cases, ditches were constructed to divert water or drain wet areas. The original downstream drainage may have been modified or the ditches were constructed to direct or convey upstream water flow. In the lower Beulah Creek drainage area, Ditches 4 and 7 (see Section 4.3.4) had drainages connected to them. Table 13 contains general ditch information.

Table 13. Drainage information for drainages associated with ditches in the lower Beulah Creek drainage area. Figures are located in Appendix 2.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Ditch 4-Drainage 1	1.5	0.3	118	Drainage into Ditch 4, near Tribune Bay Provincial Park entrance.
Ditch 7-Drainage 1	1.0	0.2	119	Discharges into downstream section of Ditch 7. Water flows down what appears to be a trail with several pocket wetlands adjacent to drainage. Additional water enters Ditch 7-Drainage 1 from Ditch 7-Drainages 1A and 1B.
Ditch 7-Drainage 1A	-	-	-	Drainage originating in field ditch runoff. Water flows along a trail and through sedge-dominated wetlands, treed swamps, and wet forest communities. Water enters Ditch 7-Drainage 1.
Ditch 7-Drainage 1B	-	-	120	Carries water into Ditch 7-Drainage 1 from west. Wet forest runoff along shallow depression and shallow linear drainage. Sedge-dominated pocket wetlands located along watercourse.

Table 13. (continued) Drainage information for drainages associated with ditches in the lower Beulah Creek drainage area. Figures are located in Appendix 2.

Drainage #	Channel Width (m)	Channel Depth (m)	Figure #	Comment
Ditch 7-Drainage 2	-	-	121	Ditch 7-Drainage 2 is a long drainage with several watercourses that contribute water. Upstream of the Ditch 7 junction, Drainage 2 flows along a trail and through sedge-dominated wetlands, treed swamps, wet forest communities, and agricultural lands. Headwaters is Ditch 7-Drainage 2-Pond (see Section 4.3.6). There are four ponds and one wetland associated with this drainage system.
Ditch 7-Drainage 2-Pond-Drainage 1	-	-	122	Flows into Ditch 7-Drainage 2-Pond (see Section 4.3.6). Drainage is a shallow linear depression.

4.3.4 Lower Beulah Creek drainage area: *Ditches*

There were two types of ditches in the Beulah Creek drainage area, roadside ditches and agricultural or residential ditches. Roadside ditches typically collected roadside runoff and water from adjacent lands. Agricultural or residential ditches are generally designed to divert water around fields or residential properties or to assist in draining wet areas and take the water to a downstream area. Both types of ditches were observed in the lower Beulah Creek drainage area.

4.3.4.1 Lower Beulah Creek Roadside Ditches

There were many roadside ditches that contributed water flow to the Beulah Creek mainstem, its tributaries, or to ditch systems. These included ditches along paved and unpaved roads. Some of the ditches contained headwaters, but most were designed to collect roadside runoff and water from adjacent lands. Driveways that crossed the ditches were culverted to allow clear water passage along the ditches. None of the roadside ditches contained instream habitat for fish. However, as these watercourses contribute water and nutrients to downstream fish habitat, they were classified as *streams* under RAR.

Table 14. Lower Beulah Creek drainage area roadside ditch information. Figures located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Invert Width (m)	Map #	Figure #	Comments
Tributary 4-Wetland-Drainage 1-Ditch 2	0.3	0.9	21	123	Downstream end: West side and in ruts of a dirt road (Coltsfoot Trail), flowing southeast. Upstream end: Southeast side and in ruts of a dirt road (Washing Machine Trail), flowing north. Additional water seeps onto the road from the forest upslope of the road. Some water on upper road (Washing Machine) flows off into forest, directed by water bars.
Tributary 4-Wetland-Drainage 1-Ditch 3	0.3	0.9	21	124	East side and in ruts of a dirt road (Washing Machine Trail), flowing north. Enters Tributary 4-Wetland-Drainage 1 (see Section 4.3.3.3) immediately upstream of waterfall.
Ditch 1	0.6	0.6	15	125, 126	West side of Little Tribune Bay Road, flowing south to culvert (0.4 m diameter). Downstream end of culvert is a fish barrier: steep drop (65% slope on hillside down to Beulah mainstem) from hanging culvert (0.6 m culvert to slope).
Ditch 2	0.2	0.5	15	127	West side of Little Tribune Bay Road, flowing north to culvert (see Ditch 1 Comments).
Ditch 3	1.3	0.9	16	128	West side of Central Road, flowing north. Enters Beulah Creek mainstem at upstream end of Central Road culvert.

Table 14. (continued) Lower Beulah Creek drainage area roadside ditch information. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Invert Width (m)	Map #	Figure #	Comments
Ditch 4	0.9	0.9	16	129, 130	West side of Ostby and Central Roads, flowing south. Flows under Central Road west through culvert. Enters Beulah Creek mainstem at upstream end of Central Road culvert. Ditch 6 joins Ditch 4 upstream of Central Road culvert. Ditch 7 joins Ditch 4 downstream of the Central Road culvert. Ditch 4-Drainge 1 joins Ditch 4.
Ditch 5	0.8	1.0	16	131	Ditch along south side of Central Road, flowing east. Water from Ditches 5A and 5B enter at downstream end of Central Road culvert. Ditch 5 flows into Tributary 1 (see Section 4.3.2.1) upstream of Ditch 8 terminus.
Ditch 5B	0.8	1.2	16	132	Ditch along north side of Central Road, flowing east. Receives property drainage at upstream end and flow from Ditch 5B-1, 5B-2, and 5B-3 (see Section 4.3.4.2). Downstream end joins with Ditch 5A upstream of Central Road culvert. Joins Ditch 5 downstream of Central Road culvert.
Ditch 6	0.6	1.1	16	133	Ditch on north side of Central Road, flowing east. Joins Ditch 4 upstream of Central Road culvert.

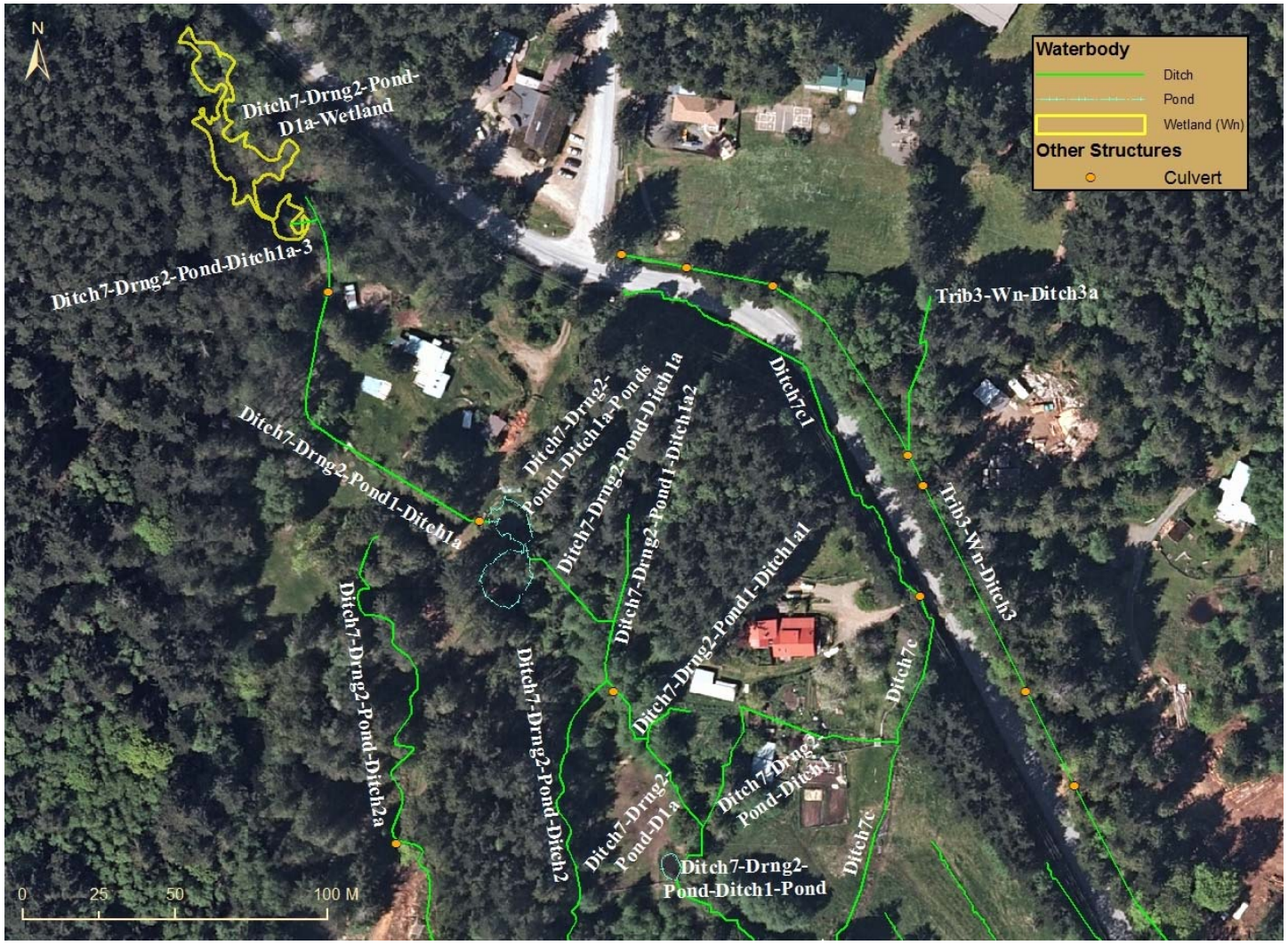
Table 14. (continued) Lower Beulah Creek drainage area roadside ditch information. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Invert Width (m)	Map #	Figure #	Comments
Ditch 7C-1	0.9	0.3	22	134	South side of Central Road, flowing southeast. Culvert under driveway. Discharges into Ditch 7C downstream of driveway culvert.
Ditch 8	0.8	0.9	16	135	South side of Central Road, flowing east. Joins Ditch 4 downstream of the Central Road culvert. Upstream end east of Ditch 5/Tributary 1 confluence.
Ditch 9	0.3	0.5	16	136	South side of gravel access road, flowing east. Flows into Beulah Creek floodplain downstream of the access road culvert.

4.3.4.2 Lower Beulah Creek Agricultural and Residential Ditches

Agricultural and residential ditches were observed in many locations within the lower Beulah Creek drainage area. Most of the ditches were designed to drain and/or divert water through or around fields or residential properties. Some of the ditches directed water from one area to another. Many of the agricultural ditches had very narrow riparian vegetation buffering the ditch flow as mowing often occurred up to the ditch edge. As these watercourses connect to downstream fish habitat, they were considered *streams* under RAR. Table 15 lists the agricultural and residential ditches and their associated watercourses, with the exception of the Ditch 7 system.

Ditch 7 was a complex ditch system, containing many agricultural ditches, ponds, and drainages (Maps 18 and 22). It was designed to drain and convey water from wet forests and agricultural areas to Beulah Creek. Roadside ditches also contribute water flow to this system. Ditch 7 joins Beulah Creek downstream of a small Beulah Creek waterfall over instream old-growth Douglas-fir logs. Upstream from the Beulah Creek junction, Ditch 7 travelled through a wet forest as a naturalized watercourse. Ditch 7-Drainage 1 (see Section 4.3.3.4) enters the watercourse in this natural section. Ditch 7 widens upstream, forming a pond-like area (Figure 137). Water flow divides immediately upstream of this area into Ditch 7 to the north and Ditch 7B to the east. Upstream of the divide, Ditch 7 is contained within distinct ditch banks and travels along a northwest property boundary towards Central Road (Figure 138). The ditch is surrounded by a very wet forest that contains treed pocket wetlands. Ditch 7-Drainage 2 and Ditch 7C enter



Map 22. Upper Ditch 7 system. Orthophoto courtesy of the Islands Trust.

Ditch 7 in this forested area. Ditch 7 continues upstream near agricultural fields to the northwest and south of a mobile home. Ditch 7A enters Ditch 7 east of the fields. The upstream end commences in a moist scouring rush-dominated patch at the east end of the mobile home.

The general features of Ditch 7 and its associated agricultural and residential ditches are contained in Table 16. Roadside ditch information is contained in Table 14. Drainage and pond information are listed in Sections 4.3.3.4 and 4.3.6 respectively.

Table 15. Lower Beulah Creek drainage area agricultural and residential ditch information, excluding the Ditch 7 system. Figures located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Map #	Figure #	Comments
Tributary 2-Ditch 1	1.3	1.1	16	139	Drainage ditch enters Tributary 2 (see Section 4.3.2.2) from top of ravine bank.
Tributary 3-Wetland-Ditch 1	1.0	0.3	17	140	Old drainage ditch that joins Tributary 3-Wetland on west side (see Section 4.3.5.1). Western redcedar and red alder growing in it. Wet community at upstream end.
Tributary 3-Wetland-Ditch 3A	2.2	0.2	17	141	Old watercourse path that directs water from a wet forest and sedge-dominated pocket wetland through a culvert to Tributary 3- Wetland-Ditch 3 (see Section 4.3.4.1). Upstream end is an unknown pipe from under school athletic fields, probably drainage from fields.

Table 15. (continued) Lower Beulah Creek drainage area agricultural and residential ditch information, excluding the Ditch 7 system. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Map #	Figure #	Comments
Tributary 3-Wetland-Ditch 3B	0.9	0.3	17	142	West side of the 4785 Central Road driveway, flowing south. Water enters Tributary 3-Wetland-Ditch 3 (see Section 4.3.4.1) through a round metal culvert at downstream end of driveway. Upstream, ditch veers west and goes through a culvert under neighbor's driveway. Tributary 3-Wetland-Ditch 3B-1 enters at upstream end of culvert. Ditch travels through a wet forest into another property with a culverted driveway at upstream end. Three drainage ditches discharge into Ditch 3B at this culvert (Tributary 3-Wetland-Ditches 3B-2, 3B-3, and 3B-4).
Tributary 3-Wetland-Ditch 3B-1	0.9	0.5	17	143	Driveway edge ditch that conveys water along driveway to Tributary 3-Wetland-Ditch 3B at upstream (west) end of driveway culvert.
Tributary 3-Wetland-Ditch 3B-2	0.9	0.8	17	144	Ditch along east side of driveway, flowing north. Joins Tributary 3-Wetland-Ditch 3B at downstream end of driveway culvert.
Tributary 3-Wetland-Ditch 3B-3	0.8	0.6	17	145	Ditch along west side of driveway, flowing north. Discharges into Tributary 3-Wetland-Ditch 3B at the upstream end of driveway culvert.

Table 15. (continued) Lower Beulah Creek drainage area agricultural and residential ditch information, excluding the Ditch 7 system. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Map #	Figure #	Comments
Tributary 3-Wetland-Ditch 3B-4	0.8	0.6	17	146	Ditch along west side of driveway, flowing south. Flows from a small wetland (Tributary 3-Wetland-Ditch 3B-4 Wetland, see Section 4.3.5.2) through a residential property. Near the driveway, there are two small ponds connected to the ditch. The ditch turns south at the driveway to discharge into Tributary 3-Wetland-Ditch 3B at the upstream end of driveway culvert.
Tributary 4-Ditch 1	0.7	1.0	20	147	Drainage ditch through pasture. Headwaters is a treed wetland (see Section 4.3.5.3) that also drains into Tributary 4-Ditch 2.
Tributary 4-Ditch 2	0.6	0.7	20	148	Drainage ditch through forest near pasture. Headwaters is a treed wetland (see Section 4.3.5.3) that also drains into Tributary 4-Ditch 1.
Tributary 4-Wetland-Drainage 1-Ditch 1	0.5	0.7	21	149	Ditched watercourse along a grassed access road. Upstream end of ditch is at Slade Road. Tributary 4-Wetland-Drainage 1-Ditch 1A (see Section 4.3.4.1) joins Tributary 4- Wetland-Drainage 1-Ditch 1 at upstream end. Joins Tributary 4- Wetland-Drainage 1 at upstream end of Tributary 4-Wetland-Drainage 1-Bridge 1.

Table 15. (continued) Lower Beulah Creek drainage area agricultural and residential ditch information, excluding the Ditch 7 system. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Map #	Figure #	Comments
Drainage 5-Ditch 1	0.9	0.9	16	150	Short drainage ditch that discharges into Drainage 5 (see Section 4.3.3.1). Located on the downhill (east) side of depressed wet field.
Ditch 0	0.8	0.8	15	151	Water enters from a sedge/hawthorn wetland (see Section 4.3.5.7.
Ditch 5A	0.4	0.3	16	152	Residential property ditch. Water came from Ditch 5-Wetland (see Section 4.3.5.8). Joins with Ditch 5B upstream of Central Road culvert. Joins Ditch 5 downstream of Central Road culvert.
Ditch 5B-1	0.3	0.3	16	153	Water came from Ditch 5-Wetland (see Section 4.3.5.8) and joins Ditch 5 on north side of Central Road.
Ditch 5B-2	0.8	0.8	16	154	Ditch along east side of driveway joining Ditch 5B downstream of the driveway culvert. Water came from Ditch 5-Wetland (see Section 4.3.5.8) east of driveway. Additional water comes from dug pond (see Section 4.3.5.8) and Ditch 5B-2A.
Ditch 5B-2A	0.4	0.4	16	155	Water came from Ditch 5-Wetland (see Section 4.3.5.8) and from dug pond flowing into Ditch 5B-2.
Ditch 5B-3	0.4	0.3	16	156	Ditch along west side of driveway joining Ditch 5B upstream of the driveway culvert.

Table 16. Agricultural and residential ditch information in the Ditch 7 system. Figures located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Figure #	Comments
Ditch 7	0.8	0.4	137, 138	Complex ditch system with multiple ditches, drainages, and ponds (see description above).
Ditch 7-Drainage 2-Pond-Ditch 1	0.9	0.3	157	Discharges into north side of Ditch 7-Drainage 2-Pond (see Section 4.3.6). Upstream of Ditch 7-Drainage 2-Pond, ditch flows through wet forest to another small pond (Ditch 7-Drainage 2-Pond-Ditch 1-Pond). Ditch 1 flows north, branching into Ditch 7-Drainage 2-Pond-Ditch 1a and Ditch 7-Drainage 2-Pond-Ditch 1. Ditch 7-Drainage 2-Pond-Ditch 1 travels through agricultural fields, receiving flow from Ditch 7C (headwaters).
Ditch 7-Drainage 2-Pond-Ditch 1A	1.6	0.4	158	Discharges into Ditch 7-Drainage 2-Pond-Ditch 1, upstream of Ditch 7-Drainage 2-Pond-Ditch 1-Pond (see Section 4.3.6). Ditch continues upstream, receiving water from Ditch 7-Drainage 2-Pond-Ditch 1A-1, and travelling through a culvert under a grassed access road. Flow from Ditch 7-Drainage 2-Pond-Ditch 1A-2 and Flow from Ditch 7-Drainage 2-Pond-Ditch 2 enters at upstream end of culvert. Upstream of culvert, Ditch 7-Drainage 2-Pond-Ditch 1A flows through two other ponds (Ditch 7-Drainage 2-Pond-Ditch 1A-Ponds 1 and 2), along a fence line, to headwaters wetland (Ditch 7-Drainage 2-Pond-Ditch 1A-Wetland)
Ditch 7-Drainage 2-Pond-Ditch 1A-1	0.4	0.3	159	Short ditch from poultry pen to Ditch 7-Drainage 2-Pond-Ditch 1A.

Table 16. (continued) Agricultural and residential ditch information in the Ditch 7 system. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Figure #	Comments
Ditch 7-Drainage 2-Pond-Ditch 1A-2	0.7	0.5	160	Enters Ditch 7-Drainage 2-Pond-Ditch 1A upstream of grassed road culvert. Flows through a wet, young, mixed forest in an old and partially naturalizing channel. Patches of scouring rush are common in the forest along with salmonberry.
Ditch 7-Drainage 2-Pond-Ditch 1A-3	0.6	0.1	161	Small wetland channel flowing from Ditch 7-Drainage 2-Pond-Ditch 1A-Wetland to Ditch 7-Drainage 2-Pond-Ditch 1A.
Ditch 7-Drainage 2-Pond-Ditch 2	0.8	0.5	162	Flows into west side of Ditch 7-Drainage 2-Pond (see Section 4.3.6). Ditch 2 is situated along the boundary between a field and wet forest. Flows through culvert under grassed road, continues north along road edge. Upstream end is at an undetermined watershed break. Some water flows into Ditch 7-Drainage 2-Pond-Ditch 1A at upstream end of culvert. Ditch 7-Drainage 2-Pond-Ditch 2A joins Ditch 7-Drainage 2-Pond-Ditch 2 at upstream end of grassed road culvert.
Ditch 7-Drainage 2-Pond-Ditch 2A	1.2	0.5	163	Joins Ditch 7-Drainage 2-Pond-Ditch 2 at upstream end of grassed road culvert. Watercourse travels through wet forest to a newly constructed pond (see Section 4.3.6), then along a clearing, under an access road through a round metal culvert (30 cm), along west side of access road, and across a grass driveway, terminating at a treed area.

Table 16. (continued) Agricultural and residential ditch information in the Ditch 7 system. Figures are located in Appendix 2.

Ditch	Top of Ditch Bank (m)	Ditch Width (m)	Figure #	Comments
Ditch 7A	1.1	0.4	164	Agricultural drainage ditch, does not connect to any Central Road roadside ditches. Joins Ditch 7 immediately south of the mobile home.
Ditch 7A-1	2.1	0.5	165	Grass-filled depression through a field that drains into Ditch 7A just upstream of Ditch 7A's bend.
Ditch 7A-2	2.5	0.3	166	Grass-filled ditch through field, roughly parallel to Ditch 7A-1. Flows into Ditch 7A.
Ditch 7A-2A	2.1	0.2	167	Grass-filled ditch through field. Flows into Ditch 7A-2 upstream of a clump of trees in Ditch 7A-2. Ditch 7A-2A does not connect to any Central Road roadside ditches.
Ditch 7B	3.0	0.4	168, 169	Ditch 7B flows from Ditch 7, through a short channel, into Ditch 7B Pond (see Section 4.3.6). Ditch 7B continues flowing from the pond in a ditched watercourse. The channel widens containing reed canarygrass then sedges with flowing water. Downstream, Ditch 7B is contained within a naturalized channel, flowing down to Beulah Creek.
Ditch 7C	-	0.2	170	Discharges into Ditch 7 southeast of Ditch 7A. Ditch 7C is a drainage ditch through agricultural fields: ditch divides with some water flowing through Ditch 7-Drainage 2-Pond-Ditch 1. Upstream end receives water from roadside ditch 7C-1 (see Section 4.3.4.1).

4.3.5 Lower Beulah Creek drainage area: *Wetlands*

There were several wetlands within the lower Beulah Creek drainage area. Wetlands were mapped only if they met the definition of *stream* under RAR. Wetlands included in this report had surface water at some time during the year and were connected to watercourses by this surface water. Small wetlands and some of the headwater wetlands may not appear on the maps but are noted in watercourse descriptions and/or in the sections below.

4.3.5.1 Beulah Creek Tributary 3: Wetland

Tributary 3-Wetland 1 is a complex wetland that was composed of swamp communities and small marshes, with pockets of standing or flowing water throughout. It is divided by Central Road into a north and south wetland community. A culvert (42 cm x 48 cm metal culvert) under Central Road connects the two parts of the wetland (Figures 171 and 172) and conveys water from Tributary 3-Wetland-Ditch 3 to southern section of Tributary 3-Wetland (Figure 173).

The wettest areas in the wetland were dominated by sedges. There were patches with young red alders, tall salmonberry, and sword fern. Trees in the wetland included red alder, cascara, bigleaf maple, western redcedar, grand fir, and the occasional Douglas-fir. Some conifers were situated on higher (drier) mounds in the wetland. It is likely that the water table drops in the summer, allowing larger trees to flourish. There were many snags and uprooted large trees. Water collected in the hollows created by the overturned tree root masses.

The wetland receives water from Tributary 3-Wetland-Ditches 1-4 (see Section 4.3.4) and Tributary 3-Wetland-Drainage 1 (see Section 4.3.3.2), as well as from the surrounding wet forests. The wetland has been disturbed and had multiple outflows. The wetland flowed into Tributary 3 and Tributary 3-Drainage 3A (see Sections 4.3.2.3 and 4.3.3.2 respectively). Some of the wetland flow discharged into the surrounding wet forest. Ultimately, some of this water would seep into Tributary 3 and/or the Beulah Creek mainstem.

4.3.5.2 Beulah Creek Tributary 3-Wetland-Ditch 3B-4: Wetland

At the upstream end of Tributary 3-Wetland-Ditch 3B-4 (see Section 4.3.4.2) is a small wetland. The wetland is sedge-dominated and a mixed forest surrounds it (Figure 174). At the time of the survey, the wetland had 10 cm of standing water.

4.3.5.3 Beulah Creek Tributary 4-Ditch 1: Wetland

Tributary 4-Ditch 1 Wetland is a small sedge-dominated alder swamp (Figure 175) located along the right bank (south side) of Tributary 4-Ditch 1 and north of Tributary 4-Ditch 2 (see Map 20). This wetland contributes water into both Tributary 4-Ditch 1 and Tributary 4-Ditch 2 (see Section 4.3.4.2).

4.3.5.4 Beulah Creek Tributary 4: Wetland

Tributary 4-Wetland is a large wetland, east of Slade Road (see Map 19). The wettest portion of the wetland was near the downstream end. At the time of the survey, most of

the wetland had standing water, with flowing water near south end. The center of the wetland was sedge-dominated with wetland shrubs dominating the wetland perimeters (Figure 176). There were several patches of snags and salal was frequently observed growing on woody debris or on hummocks. The Tributary 4-Wetland was forested on all sides, however, there were several rural residences on the south and west sides. In these areas, the treed buffer narrower.

Water enters the Tributary 4 Wetland from primarily from Tributary 4-Wetland-Drainage 1 (see Section 4.3.3.3) and exits through the Tributary 4 channel leading into the Tributary 4 Pond (see Section 4.3.6). Additional inflow entered through Tributary 4-Wetland Drainages 2 and 3 (see Section 4.3.3.3). The watershed boundary at north end of the Tributary 4-Wetland is subtle. It appeared that some of the water near the north end of the wetland drains towards the north and into another watershed (not mapped: outside of the study area).

4.3.5.5 Beulah Creek Tributary 4-Wetland-Drainage 1J: Wetland

This sedge-dominated wetland was located in a depression within a mixed forest (Figure 177). The wetland receives water from the surrounding forests and directs the outflow to Tributary 4-Wetland Drainage 1J (see Section 4.3.3.3).

4.3.5.6 Beulah Creek Drainage 6: Wetland

This wetland was a sedge-dominated pocket wetland at the upstream end of Drainage 6 (see Map 16 and Section 4.3.3.1). Water from this headwater area flowed northwards through the broad salmonberry community that comprised most of Drainage 6. At the time of the survey, there was wet mud but no standing water in the wetland (Figure 178).

4.3.5.7 Beulah Creek Ditch 0: Wetland

A linear depression paralleled the Little Tribune Bay shoreline. A wetland community composed of black hawthorn and some Nootka rose had a sedge understory (Figure 179). Evidence of inundation included lack of litter and a moist mud substrate. Ditch 0 was a newly constructed ditch that directed water from the wetland to the Beulah Creek mainstem (see Section 4.3.4.2).

4.3.5.8 Beulah Creek Ditch 5: Wetland

A treed wetland/wet forest community was situated between Beulah Creek Ditches 5A, 5B-1, 5B-2, and 5B-2A (see Section 4.3.4.2). Water flowed from this plant community in several directions. It appears that the ditches were placed to direct water flowing from this area towards Central Road and ultimately into Beulah Creek. The plant community was dominated by red alder, with a sedge and salmonberry understory (Figure 180).

A pond had been excavated in the northwest corner of the wetland (Figure 181). Beulah Creek Ditches 5B-2 and 5B-2A carried water from the pond to Beulah Creek Ditch 5 along Central Road.

4.3.5.9 Beulah Creek Ditch 7-Drainage 2-Pond-Ditch 1A: Wetland

Ditch 7-Drainage 2-Pond-Ditch 1A-Wetland is a sedge-dominated wetland with both standing water and some flowing water (Figure 182). It contains a few hummocks containing salmonberry, bracken fern, sword fern, and young western redcedar. The wetland is surrounded by a young coniferous forest dominated by Douglas-fir and western redcedar, with a salal and sword fern understory. Water flows from this wetland into Ditch 7-Drainage 2-Pond-Ditch 1A and Ditch 7-Drainage 2-Pond-Ditch 1A-3 (see Section 4.3.4.2).

4.3.6 Lower Beulah Creek drainage area: *Ponds*

The lower Beulah Creek drainage area contained several ponds. In general, these were small waterbodies that were constructed to hold water and their waters discharged into watercourses, ultimately contributing to Beulah Creek. Table 17 lists the ponds and their associated watercourses.

Table 17. Lower Beulah Creek drainage area pond information. Figures are located in Appendix 2.

Pond Name	Figure #	Pond location
Tributary 2-Pond	183	Pond at pasture edge, upstream of natural section of Tributary 2 (see Section 4.3.2.2). Pond discharges into culvert under dirt access road.
Tributary 3-Wetland-Ditch 3B-4 Pond	184	Two small ponds are located west of a residential driveway and north of Tributary 3-Wetland-Ditch 3B-4. Water flows from the ponds into Ditch 3B-4 (see Section 4.3.4.2).
Tributary 4-Pond	185	Pond is part of Tributary 4, downstream of the Tributary 4-Wetland (see Section 4.3.5.4). Located near a rural residence with a small hobby farm.
Tributary 4-Wetland-Drainage 3-Pond	-	Pond (20 m^2) located near the edge of a cleared area of a rural residential property north of Slade Road. Water flows into Tributary 4-Wetland-Drainage 3 (see Section 4.3.3.3) and enters the Tributary 4-Wetland (see Section 4.3.5.4).
Ditch 7-Drainage 2-Pond	186	Pond is situated in a low spot, near fields but in forest, with young alder and sedges surrounding it. Pond outflow is Ditch 7-Drainage 2 (see Section 4.3.3.4). Inflow to the pond is from two ditches (Ditch 7-Drainage 2-Pond-Ditch 1 and Ditch 7-Drainage 2-Pond-Ditch 2, see Section 4.3.4.2) and a drainage (Ditch 7-Drainage 2-Pond-Drainage 1, see Section 4.3.3.4).

Table 17. (continued) Lower Beulah Creek drainage area pond information. Figures are located in Appendix 2.

Pond Name	Figure #	Pond location
Ditch 7-Drainage 2-Pond-Ditch 1-Pond	187	Small pond located on the right bank (west side) of Ditch 7-Drainage 2-Pond-Ditch 1 (see Section 4.3.4.2). Water also enters this pond from Ditch 7-Drainage 2-Pond-Ditch 1a.
Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 1	188	Part of Ditch 7-Drainage 2-Pond-Ditch 1A (see Section 4.3.4.2), downstream pond. Water flows from Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 2 through a short channel (~ 10 meters long).
Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 2	189	Part of Ditch 7-Drainage 2-Pond-Ditch 1A (see Section 4.3.4.2), upstream pond. Water flows into Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 1 through a short channel (~ 10 meters long).
Ditch 7-Drainage 2-Pond-Ditch 2A-Pond	190	Newly constructed pond that receives and flows into Ditch 7-Drainage 2-Pond-Ditch 2A (see Section 4.3.4.2).
Ditch 7B Pond	191	This is small duck pond is part of Ditch 7B (see Section 4.3.4.2). Ditch 7B flows from Ditch 7 through a short channel and into the west side of Ditch 7B Pond. Water from the pond exits the southeast side, continuing in Ditch 7B.

5 COMMENTS

5.1 RAR and the Ford Creek and Beulah Creek Drainage Areas

The field survey resulted in the identification of one creek with two tributaries, ten drainages, eleven ditches, one large wetland, and four ponds within the Ford Creek drainage area that met the definition of *stream* under the Riparian Areas Regulation. Within the lower Beulah Creek drainage area, the field survey resulted in the identification of one creek with five tributaries, 32 drainages, 42 ditches, nine wetlands, and ten ponds that met the definition of a *stream*. These streams represent potential fish habitat or connect by surface flow to potential fish habitat. Proposed development within 30 meters of these waterbodies would trigger the RAR process and would be subject to a RAR assessment procedure. No fish were observed in either drainage area during the field survey. However, under the definitions within the Regulation, a stream does not have to be inhabited by fish, but only needs to have the potential to support fish

Overall, Ford Creek provides marginal fish habitat. There were few patches of spawning gravel of adequate size and the marine access for salmon into the creek was very poor. Most of streambed materials were composed of bedrock and/or hardpan substrates. Several improperly placed culverts, the obstruction downstream of Strachan Road, and a few small waterfalls would deter fish movement, particularly small fish. Most of the tributaries, drainages, and ditches contained seasonal flow that would limit fish movement during drier months. However, there were frequent pools, ample large woody debris, a significant wetland, and forested riparian areas that contribute to good fish habitat. There were sections of gravels that would be adequate for spawning trout.

Most of the watercourses surveyed within the Beulah Creek watershed exhibited good to marginal capacity to support fish. Other than a few poorly placed culverts, the lower Beulah Creek contained no permanent obstructions to fish passage. The mainstem channel had a low gradient (<5%), which meandered within a steep-walled ravine. Beulah Creek's streambed contained areas of bedrock and hardpan with gravel patches and occasional cobbles and boulders. The Beulah Creek drainage area contained many wet forests and pocket wetlands. Instream debris accumulations included woody debris of all sizes and decay classes. Several floodplain side channels were observed within the ravine bottom.

Tributaries, drainages, and ditches brought water from adjacent sub-basins. The largest of these were the Tributary 4 system, the Tributary 3 system, and the Ditch 7 system. These systems contained a complex arrangement of watercourses, ditches, and wetlands. Fish access into Beulah Creek's associated watercourses would be most difficult at the downstream reaches where watercourses flowed over the ravine banks into the Beulah Creek mainstem. Frequently the stream gradient of the tributaries, drainages, and ditches near the mainstem confluence was between 10% and 25%. Given the seasonal nature of almost all of the watercourses, this would limit fish access into upper reaches.

There was evidence of flashiness throughout the Beulah Creek study area. This was a larger, more developed watershed. There was greater agricultural use and more ditching. There were also more introduced plant species encountered within the riparian areas.

Directing roadside runoff into the watercourses, removing native plant species, and ditching/draining wet habitats contribute to increased water levels during rain events.

Additional surveys will be required to complete the stream identification and mapping within the upper Beulah Creek drainage area. There were at least three unmapped tributary systems entering Beulah Creek from the south and several drainages that contributed flow to the Beulah Creek mainstem.

Aquatic habitat and watercourses encountered during the survey that did not meet the definition of *stream* under RAR were excluded from the maps in this report. Although these sites may be important and valuable habitat for other wildlife species besides fish and may provide important functions within the watershed, their assessment was not part of this project. These sites may be protected by other bylaws or permits within the Islands Trust.

As development on Hornby Island occurs, it is likely that watercourses may be altered, added, or disturbed. At some point, additional watercourses may become connected by surface flow to potential fish habitat and would become *streams* where RAR would apply. Maintaining current maps as development proceeds on the island is recommended.

5.2 Mapping Recommendations

- Five meter or less accuracy in creek ravines with surrounding mature to older growth forests was apparently unrealistic for this area. Although the elevation mask was set to 15 degrees, in many areas solid ravine embankment obstruction did not allow for reception of signal in excess of 30 degrees. This reduction of reception capacity was further compounded by a near solid canopy of large trees lining the crest of the ravine.
- Although locating streams is easiest during the wet times of the year, it is preferable to conduct large mapping projects when there are more daylight hours available to conduct field work. The short daylight hours throughout much of November and December allowed for very small windows of exceptional satellite numbers and geometry.
- The efficient pursuit of PDOP<8 and Satellite numbers > 4 was hard to achieve due to the combination of the above factors.
- If this mapping information is going to be used by local governments besides the Islands Trust, it would be beneficial to list the data dictionaries used by the local government websites and/or mapping programs. This would allow the new mapping information to be displayed on regional district websites (i.e. compatibility with iMap or SHIM databases). Completing projects with the preferred format and data dictionary will save time at a later time trying to make them sync.

6 DISCLAIMER/STATEMENT OF LIMITATIONS

This report was prepared for the Islands Trust by Mimulus Biological Consultants. The quality of information, conclusions, and estimates contained herein is consistent with the level of effort expended and is based on i) information available at the time of preparation; ii) data supplied by outside sources; and iii) the assumptions, conditions, and qualifications set forth in this report.

APPENDIX ONE: FORD CREEK WATERSHED PHOTOGRAPHS

Figure 1. Ford Creek estuary, facing Little Tribune Bay.

Figure 2. Ford Creek cascade near estuary.

Figure 3. Ford Creek upstream of estuary, facing downstream.

Figure 4. Cabin at streamside edge of Ford Creek.

Figure 5. Footbridge over Ford Creek, downstream of Central Road.

Figure 6. Downstream end of Central Road culvert.

Figure 7. Cascade waterfall upstream of Central Road culvert.

Figure 8. Ford Creek from top of ravine bank.

Figure 9. Floodplain bench along Ford Creek, facing downstream.

Figure 10. Side channel along Ford Creek floodplain.

Figure 11. Bedrock waterfall (2 meters).

Figure 12. Ford Creek is directed under Strachan Road through a culvert, downstream end.

Figure 13. Stream obstruction downstream of Strachan Road culvert.

Figure 14. Upstream end of Strachan Road culvert; road material sloughing into creek.

Figure 15. Ford Creek near Ford Wetland outflow, facing upstream towards wetland.

Figure 16. Steep channel walls of Ford Creek near Ford Wetland outflow.

Figure 17. Ford Wetland at the marsh end.

Figure 18. Ford Wetland with fence posts.

Figure 19. Ford Wetland-Ditch 4 extends into the marsh.

Figure 20. Ford Wetland-Pond overflow culverts, downstream end. Flows into Wetland-Ditch 5.

Figure 21. Headwater pocket wetland connects by surface flow to Wetland-Drainage 2.

Figure 22. Tributary 1 downstream section in forest, facing downstream.

Figure 23. Ditched upstream section of Tributary 1, facing downstream.

Figure 24. Pond runoff into upstream end of Tributary 1.

Figure 25. Tributary 1A.

Figure 26. Tributary 1B, facing upstream.

Figure 27. Tributary 1C, facing upstream.

Figure 28. Ford Wetland-Tributary 1, downstream end.

Figure 29. Ford Wetland-Tributary 1, upstream section, facing upstream.

Figure 30. Drainage 1, facing downstream.

Figure 31. Drainage 2, facing upstream.

Figure 32. Drainage 3 culvert under Strachan Road, downstream end.

Figure 33. Drainage 3, facing downstream.

Figure 34. Ford Wetland-Drainage 1, facing upstream.

Figure 35. Ford Wetland-Drainage 2.

Figure 36. Ford Wetland-Drainage 3.

Figure 37. Ford Wetland-Drainage 4.

Figure 38. Ford Wetland-Drainage 5.

Figure 39. Ford Wetland-Drainage 6.

Figure 40. Ford Wetland-Drainage 7.

Figure 41. Ditch 1, facing upstream.

Figure 42. Ditch 2, facing upstream.

Figure 43. Ditch 3, facing upstream.

Figure 44. Drainage 3-Ditch 1, facing downstream.

Figure 45. Drainage 3-Ditch 2, facing upstream.

Figure 46. Ford Wetland-Ditch 1, facing downstream.

Figure 47. Ford Wetland-Ditch 2, facing downstream.

Figure 48. Ford Wetland-Ditch 2A, facing downstream.

Figure 49. Ford Wetland-Ditch 3, facing upstream.

Figure 50. Ford Wetland-Ditch 4, facing downstream.

Figure 51. Ford Wetland-Ditch 5, facing upstream.

Figure 52. Tributary 1-Pond.

Figure 53. Tributary 1B-Pond.

Figure 54. Ford Wetland-Pond.

Figure 55. Ford Wetland- Drainage 5-Pond.

APPENDIX TWO: LOWER BEULAH CREEK WATERSHED PHOTOGRAPHS

Figure 56. Beulah Creek estuary, facing upstream.

Figure 57. Beulah Creek culvert under driveway, approximately 400 meters upstream from mouth, downstream end.

Figure 58. Side channel culvert adjacent to 400 m driveway culvert, downstream end.

Figure 59. Slumping ravine slopes in lower Beulah Creek, facing downstream.

Figure 60. Beulah Creek, downstream of Central Road, facing downstream.

Figure 61. Central Road culvert, downstream end.

Figure 62. Partially blocked Central Road culvert, upstream end.

Figure 63. Beulah Creek: Small waterfalls over woody debris.

Figure 64. Beulah Creek upstream of Central Road culvert with gravel bars and multiple channels, facing upstream.

Figure 65. Beulah Creek: Riparian vegetation in the floodplain community.

Figure 66. Beulah Creek: Eroding channel.

Figure 67. Looking down on Beulah Creek from the top of steep ravine banks.

Figure 68. Upstream end of Beulah Creek culvert under gravel access road, upstream of Drainage 6.

Figure 69. Upstream end of Beulah Creek overflow culvert under gravel access road, upstream of Drainage 6.

Figure 70. Beulah Creek waterfall over large woody debris.

Figure 71. Footbridge over Beulah Creek, upstream of Ditch 7 junction.

Figure 72. Access road through Beulah Creek channel near upstream end of study area.

Figure 73. Recent large woody debris in Beulah Creek channel would limit fish passage in this area.

Figure 74. Beulah Creek travelled through a sword fern-dominated area instead of within a ravine.

Figure 75. Upstream end of Central Road culvert receives Ditch 5 flow discharging into Tributary 1 at the downstream culvert end.

Figure 76. Tributary 1, facing downstream.

Figure 77. Tributary 2, downstream end, facing downstream.

Figure 78. Tributary 2 flowing through livestock area, facing downstream.

Figure 79. Tributary 2 flowing through upstream residential area, facing downstream.

Figure 80. Tributary 2, upstream end, facing upstream.

Figure 81. Tributary 3, facing upstream.

Figure 82. Tributary 4, downstream section, facing downstream.

Figure 83. Tributary 4 plastic sheeting across channel, facing downstream.

Figure 84. Tributary 4, culvert under grassed road, downstream end.

Figure 85. Tributary 4, downstream of pastures.

Figure 86. Tributary 4 channel through narrow riparian corridor, facing upstream.

Figure 87. Tributary 5, facing upstream.

Figure 88. Drainage 1, facing downstream.

Figure 89. Drainage 2, facing downstream.

Figure 90. Drainage 3, facing downstream.

Figure 91. Drainage 5, facing downstream.

Figure 92. Drainage 6, facing upstream.

Figure 93. Tributary 3-Drainage 1, facing upstream.

Figure 94. Tributary 3-Drainage 2, facing upstream.

Figure 95. Tributary 3-Drainage 3, facing upstream.

Figure 96. Tributary 3-Drainage 3A upper section, facing upstream.

Figure 97. Tributary 3-Wetland-Drainage 1, facing upstream.

Figure 98. Tributary 4-Wetland-Drainage 1 waterfall, facing upstream from near the base.

Figure 99. Tributary 4-Wetland-Drainage 1 flows through two plastic pipes under Yer Mom Trail.

Figure 100. Alder grove near headwaters of Tributary 4-Wetland-Drainage 1.

Figure 101. Tributary 4-Drainage 1, facing downstream.

Figure 102. Tributary 4-Wetland-Drainage 1, near Tributary 4-Wetland junction.

Figure 103. Tributary 4-Wetland-Drainage 1, upstream of Tributary 4-Wetland-Drainage 1-Ditch 2.

Figure 104. Tributary 4-Wetland-Drainage 1A, facing downstream.

Figure 105. Tributary 4-Wetland-Drainage 1B, facing downstream.

Figure 106. Tributary 4-Wetland-Drainage 1C, facing upstream.

Figure 107. Tributary 4-Wetland-Drainage 1D, facing upstream.

Figure 108. Tributary 4-Wetland-Drainage 1E, facing downstream.

Figure 109. Tributary 4-Wetland-Drainage 1F, facing upstream.

Figure 110. Tributary 4-Wetland-Drainage 1G, facing downstream.

Figure 111. Tributary 4-Wetland-Drainage 1H, facing downstream.

Figure 112. Tributary 4-Wetland-Drainage 1J footbridge, facing left bank.

Figure 113. Tributary 4-Wetland-Drainage 1K, facing upstream.

Figure 114. Tributary 4-Wetland-Drainage 1K culvert, upstream end.

Figure 115. Tributary 4-Wetland-Drainage 1K-1, facing upstream.

Figure 116. Tributary 4-Wetland-Drainage 2 in garden area, facing downstream.

Figure 117. Tributary 4-Wetland-Drainage 3, facing upstream.

Figure 118. Ditch 4-Drainage 1, facing downstream.

Figure 119. Ditch 7-Drainage 1, facing upstream.

Figure 120. Ditch 7-Drainage 1B, facing downstream.

Figure 121. Ditch 7-Drainage 2, facing downstream.

Figure 122. Ditch 7-Drainage 2-Pond-Drainage 1, facing downstream.

Figure 123. Tributary 4-Wetland-Drainage 1-Ditch 2, facing upstream.

Figure 124. Tributary 4-Wetland-Drainage 1-Ditch 3 junction with Tributary 4-Wetland-Drainage 1, facing upstream.

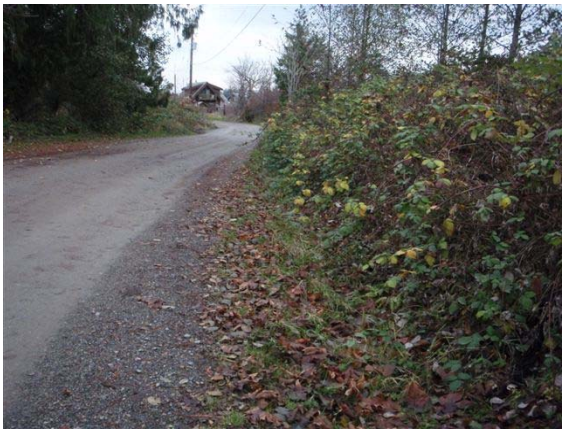


Figure 125. Ditch 1, facing downstream.

Figure 126. Ditch 1 culvert over Beulah Creek ravine slope, downstream end.

Figure 127. Ditch 2, facing downstream.

Figure 128. Ditch 3, facing upstream.

Figure 129. Ditch 4, facing downstream.

Figure 130. Ditch 4 culvert under Central Road, downstream end.

Figure 131. Ditch 5, facing upstream.

Figure 132. Ditch 5B, facing upstream.

Figure 133. Ditch 6, facing upstream.

Figure 134. Ditch 7C-1, facing upstream.

Figure 135. Ditch 8, facing upstream.

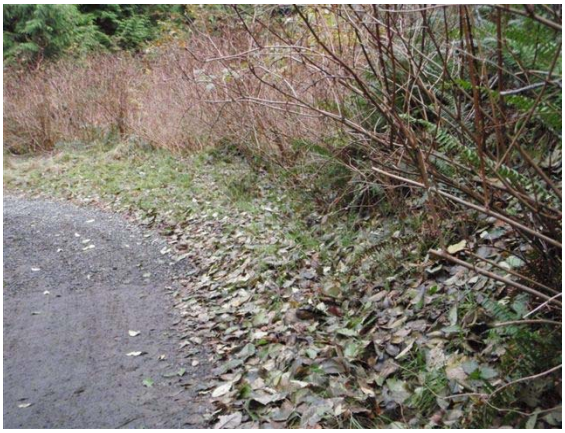


Figure 136. Ditch 9, facing downstream.

Figure 137. Ditch 7 pond-like area downstream of Ditch 7B junction, facing downstream.

Figure 138. Ditch 7 along property boundary, facing upstream.

Figure 139. Tributary 2-Ditch 1, facing upstream.

Figure 140. Tributary 3-Wetland-Ditch 1, facing upstream.

Figure 141. Tributary 3-Wetland-Ditch 3A, facing upstream.

Figure 142. Tributary 3-Wetland-Ditch 3B, facing upstream.

Figure 143. Tributary 3-Wetland-Ditch 3B-1, facing upstream.

Figure 144. Tributary 3-Wetland-Ditch 3B-2, facing upstream.

Figure 145. Tributary 3-Wetland-Ditch 3B-3, facing upstream.

Figure 146. Tributary 3-Wetland-Ditch 3B-4, facing downstream.

Figure 147. Tributary 4-Ditch 1, facing upstream.

Figure 148. Tributary 4-Ditch 2, facing upstream.

Figure 149. Tributary 4- Wetland-Drainage 1-Ditch 1, facing downstream.

Figure 150. Drainage 5-Ditch 1, facing downstream.

Figure 151. Ditch 0, facing upstream.

Figure 152. Ditch 5A, facing upstream.

Figure 153. Ditch 5B-1, facing upstream.

Figure 154. Ditch 5B-2, facing upstream.

Figure 155. Ditch 5B-2A, facing downstream.

Figure 156. Ditch 5B-3, facing downstream.

Figure 157. Ditch 7-Drainage 2-Pond-Ditch 1, facing downstream.

Figure 158. Ditch 7-Drainage 2-Pond-Ditch 1A, facing downstream.

Figure 159. Ditch 7-Drainage 2-Pond-Ditch 1A-1, facing downstream.

Figure 160. Ditch 7-Drainage 2-Pond-Ditch 1A-2, facing downstream.

Figure 161. Ditch 7-Drainage 2-Pond-Ditch 1A-3, facing upstream.

Figure 162. Ditch 7-Drainage 2-Pond-Ditch 2, facing downstream.

Figure 163. Ditch 7-Drainage 2-Pond-Ditch 2A, facing upstream.

Figure 164. Ditch 7A, facing downstream.

Figure 165. Ditch 7A-1, facing upstream.

Figure 166. Ditch 7A-2, facing upstream.

Figure 167. Ditch 7A-2A, facing upstream.

Figure 168. Ditch 7B downstream of duck pond, facing downstream.

Figure 169. Ditch 7B upstream of Beulah Creek confluence, facing downstream.

Figure 170. Ditch 7C, facing downstream.

Figure 171. Tributary 3-Wetland, wetter area in southern section.

Figure 172. Tributary 3-Wetland, swamp area.

Figure 173. Central Road culvert that connects northern and southern sections of Tributary 3-Wetland, upstream end.

Figure 174. Tributary 3-Wetland-Ditch 3B-4 Wetland, facing north.

Figure 175. Tributary 4-Ditch 1-Wetland.

Figure 176. Tributary 4-Wetland, facing west.

Figure 177. Tributary 4-Wetland Drainage 1J Wetland, facing upstream.

Figure 178. Drainage 6 Wetland, facing upstream.

Figure 179. Ditch 0-Wetland was a sedge-hawthorn wetland.

Figure 180. Ditch 5-Wetland.

Figure 181. Constructed pond in northwest corner of Ditch 5-Wetland.

Figure 182. Ditch 7-Drainage 2-Pond-Ditch 1A-Wetland.

Figure 183. Tributary 2-Pond.

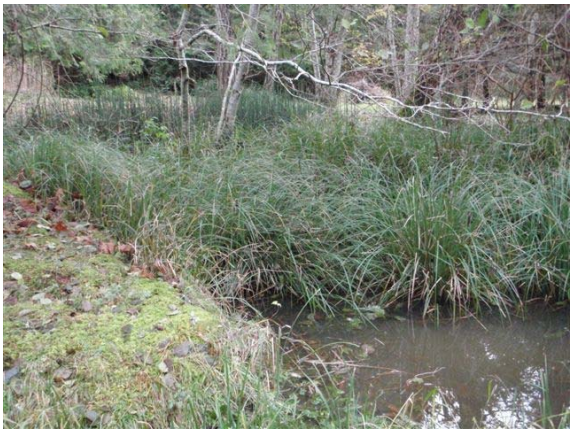


Figure 184. Tributary 3-Wetland-Ditch 3B-4 Pond.

Figure 185. Tributary 4-Pond facing upstream towards Tributary 4-Wetland.

Figure 186. Ditch 7-Drainage 2-Pond.

Figure 187. Ditch 7-Drainage 2-Pond-Ditch 1-Pond.

Figure 188. Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 1, facing downstream towards Ditch 7-Drainage 2-Pond-Ditch 1A.

Figure 189. Ditch 7-Drainage 2-Pond-Ditch 1A-Pond 2, facing downstream.

Figure 190. Ditch 7-Drainage 2-Pond-Ditch 2A-Pond, facing upstream.

Figure 191. Ditch 7B-Pond, facing downstream.

APPENDIX THREE: PLANT SPECIES LOCATED IN THE FORD CREEK AND LOWER BEULAH CREEK WATERSHED STUDY AREAS

- Consolidated Vegetation List.

Table 18. Consolidated Vegetation list. Plants found in the Ford Creek and Lower Beulah Creek Watershed study areas. This general plant survey was completed December 11, 2011. This is not a comprehensive list.

Common Name	Scientific Name
Tree species	
bigleaf maple	*Acer macrophyllum*
coast Douglas-fir	*Pseudotsuga menziesii var. menziesii*
Garry oak	*Quercus garryana*
grand fir	*Abies grandis*
red alder	*Alnus rubra*
western hemlock	*Tsuga heterophylla*
western redcedar	*Thuja plicata*
Shrub species	
coastal red elderberry	*Sambucus racemosa var. arborescens*
cutleaf evergreen blackberry*	*Rubus laciniatus**
dull Oregon-grape	*Mahonia nervosa*
Himalayan blackberry*	*Rubus armeniacus**
Nootka rose	*Rosa nutkana*
red-osier dogwood	*Cornus stolonifera*
salal	*Gaultheria shallon*
salmonberry	*Rubus spectabilis*
stink current	*Ribes bracteosum*
tall Oregon-grape	*Mahonia aquifolium*
trailing blackberry	*Rubus ursinus*
Herbs	
bamboo*	*
bracken fern	*Pteridium aquilinum*
common cattail	*Typha latifolia*
dune grass	*Leymus mollis*
grasses	*Poaceae*
lady fern	*Athyrium filix-femina*
Pacific water-parsley	*Oenanthe sarmentosa*
reed canarygrass*	*Phalaris arundinacea**
rushes	*Juncus spp.*
scouring-rush	*Equisetum hyemale*
sedges	*Carex spp.*
slough sedge	*Carex obnupta*
stinging nettle	*Urtica dioica*
sword fern	*Polystichum munitum*
thistle*	*Cirsium spp.**

* Introduced or invasive plant species.

APPENDIX FOUR: CONSERVATION DATA CENTER REPORTS FOR LISTED PLANT COMMUNITIES AND PLANT SPECIES

- Douglas-fir / dull Oregon-grape Plant Association (red-listed)
- Coastal Wood Fern (blue-listed): 2 Reports

BC Conservation Data Centre: Occurrence Report **(55781)**

December 13, 2011

Pseudotsuga menziesii / Mahonia nervosa
Douglas-fir / dull Oregon-grape

Field definition document available at **http://www.env.gov.bc.ca/atrisk/ims.htm**

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID:	8652	**Status:**	
Shape ID:	55781	Global:	G2
Type:	Ecological Community	Provinicial:	S2
		BC List:	Red
Data Sensitive:	N		

Locators

Survey Site: HORNBY ISLAND

Directions:

Survey Information

First Obs. Date:	1998	**Last Obs. Date:**	2007

Occurrence Data: This occurrence contains Douglas-fir dominated forests that are mostly in the young forest structural stage, but with significant area in the mature forest structural stage and some areas also in the pole/sapling structural stage. Some stands have a mixture of tree species including arbutus, western redcedar, western hemlock, grand fir, and red alder.

Occurrence Rank and Occurrence Rank Factors

Rank:	E Verified extant (viability not assessed)	**Rank Date:**	

Rank Comments:

Condition of Occurrence:

Size of Occurrence:

Landscape Context:

Description

General Description: This occurrence covers most of Hornby Island, which rises to Mt. Geoffery and then descends down a steep escarpment on its western slopes.

Habitat:

BGC: CDF mm

Documentation

References:

Canadian Wildlife Service, Ministry of Environment, Lands and Parks Vancouver Island Region, and B.C. Conservation Data Centre. 1993-1996. Sensitive Ecosystems Inventory groundtruthing forms. Unpub. field forms.

Canadian Wildlife Service, Ministry of Environment, Lands and Parks Vancouver Island Region, and B.C. Conservation Data Centre. 1997. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands. Clover Point Cartographics Ltd., Victoria.

	Sensitive Ecosystems Inventory [SEI] of East Vancouver Island and Gulf Islands: Sensitive Ecosystems Mapping, Disturbance Mapping and Re-evaluation of Major Riparian Corridors. 2004. Prepared by Axys Environ. Consulting Ltd. for Environ. Can., Can. Wildl. Serv., B.C. Minist. Sustainable Resour. Manage., and B.C. Minist. Water, Land and Air Prot., and the Habitat Conserv. Trust Fund. 66 mapsheets, 1:20 000 scale. Terrestrial Ecosystem Mapping [TEM] of the Coastal Douglas-fir Biogeoclimatic Zone. 2008. Prepared for B. Zinovich, Integrated Land Management Bureau, B.C. Minist. of Agric. and Lands, Nanaimo B.C. by Madrone Environmental Services, Duncan B.C. 1:20,000 spatial data.
Version	
Version Date:	16-MAR-11
Mapping Information	
Estimated Representation Accuracy:	Medium
Confidence Extent:	?

December 13, 2011

BC Conservation Data Centre: Occurrence Report (6984)

December 13, 2011

Dryopteris arguta
coastal wood fern

Field definition document available at **http://www.env.gov.bc.ca/atrisk/ims.htm**

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID:	3087	**Status:**	
Shape ID:	6984	Global:	G5
Type:	Vascular Plant	Provinicial:	S3
		COSEWIC:	SC (NOV 2001)
Taxonomic Class:	ferns	BC List:	Blue
		SARA Schedule:	1
Data Sensitive:	N		

Locators

Survey Site: HORNBY ISLAND, MOUNT GEOFFREY

Directions:

Survey Information

First Obs. Date:	1982-04-29	**Last Obs. Date:**	1982-04-29

Occurrence Data: Fir/oak forest on east slope.

Occurrence Rank and Occurrence Rank Factors

Rank:	E Verified extant (viability not assessed)	**Rank Date:**	1982-04-29

Rank Comments: Insufficient data for ranking.

Condition of Occurrence [No data].

Size of Occurrence: [No data].

Landscape Context: [No data].

Description

General Description:

Vegetation Zone: Lowland

Habitat: TERRESTRIAL; FOREST MIXED

Documentation

References: Royal British Columbia Museum. 675 Belleville Street, Victoria, BC. V8V 1X4.

Version

Version Date: 17-DEC-94

Mapping Information

Estimated Representation Accuracy:
Confidence Extent:
December 13, 2011

BC Conservation Data Centre: Occurrence Report (8974)

December 13, 2011

Dryopteris arguta
coastal wood fern

Field definition document available at **http://www.env.gov.bc.ca/atrisk/ims.htm**

This is a summary report. For a complete record contact the CDC (cdcdata@gov.bc.ca).

Identifiers

Occurrence ID:	1997	**Status:**	
Shape ID:	8974	Global:	G5
Type:	Vascular Plant	Provinicial:	S3
		COSEWIC:	SC (NOV 2001)
Taxonomic Class:	ferns	BC List:	Blue
		SARA Schedule:	1
Data Sensitive:	N		

Locators

Survey Site: HORNBY ISLAND

Directions: From Norman Point, ca. 1650 metres southeast of Ford's Cove marina, along the shoreline to Downes Point, ca. 150 metres behind main promontory and to the west along cliff.

Survey Information

First Obs. Date: 1968-08-26 **Last Obs. Date:** 1998-04-23

Occurrence Data: **Norman Point:** Two small clumps of 3 plants over one square metre, and 25 plants over six square metres, respectively. Plants are growing on rocks overhanging the beach in pockets of soil between sandstone boulders; smaller clump is in almost full light, larger clump is under isolated Garry oak and *Holodiscus*. Slope 20%, aspect south 50 west. Area is generally dry and exposed and the population appears stressed; some threat to population. 1968-08-26: Sandstone ledges in fine soil in shade. At sea-level and on steep hillside under *Quercus* and *Pseudotsuga* on private property. **Heron Rocks 1**: 400 to 500 plants in a more or less continuous band for about 200 metres, tapered to isolated clumps and ca. 20 metres apart for approximately 100 metres at each end. Behind and above beaches in filtered to bright light at Douglas fir and Garry oak forest/beach interface. Exposure south to south 10 degrees east and 0 degree slope. **Heron Rocks 2**: 3000 to 4000 plants in 140 ha [may be incorrect (G.W. Douglas, pers. comm.)], occurring over a band ca. 30 metres wide and 400 metres long, 3-5 metres between clumps; some plants reaching 1 metre in height. Dryopteris arguta forms a dominant understory on a southeast facing grassy slope in Douglas-fir forest with Garry oak and Polystichum munitum. Slope 45-50%. **Downes Point West 1 and West 2** : Six clumps of 50-100 plants on seaside cliffs in Pseudotsuga menziesii - Arbutus menziesi - Holodiscus discolor association with Prunus emarginata, and Salix. **Downes Point Southwest:** Plants in two clumps, 20 plants over ca. 50 sq. m with 4 juveniles and 1 plant ca. 10 metres west; not likely threatened by development due to steep, inaccessible slope. On shady, forested slope above shoreline dominated by *Pseudotsuga menziesii*, and *Arbutus menziesii*; aspect south 40 degrees west; slope 30-40%. **Downes Point**: In filtered light under small clumps of *Pseudotsuga menziesii, Quercus garryana, Arbutus menziesii*, isolated by brush and bright light, and by sheer rock face; aspect south 30 degrees west; slope 60%; plants in two clumps, ca. 80 mature plants over 20 sq. m and ca. 30 plants over 10 sq. m about 15 metres further west.

Occurrence Rank and Occurrence Rank Factors

Rank:	A Excellent estimated viability	**Rank Date:**	1998-04-23
Rank Comments:	Norman Point has fair estimate viability whereas the four Downes Point sub-populations have good probability of persistence. Both Heron Rocks sub-populations have excellent viability. Since at least one of the sub-populations has excellent viability, the overall occurrence has excellent viability.		
Condition of Occurrence	Norman Point: C - Two small clumps of 3 and 25 plants respectively; population appears stressed; Heron Rocks 1 - A - Large extensive population. Current use precludes clearing and building, major threat would be trampling by pedestrian traffic during the summer season. Heron Rocks 2 - A - Large vigorous population; no threats as owner vows stewardship of the land. Downes Point West 1: B - Good-sized population which spreads out in clumps. Downes Point West 2: B - Good-sized population which spreads out in clumps. Downes Point Southwest: B - Healthy population, no apparent threats. Downes Point: B - Healthy population spread out in clumps, inaccessible site. Erosion and storm damage are most likely threats.		
Size of Occurrence:			
Landscape Context:			

Description

General Description:	On south and southeast-facing grassy and forested slopes, behind and above beaches at forest/beach interface and on sandstone ledges and cliffs above sea.
Vegetation Zone:	Lowland
Habitat:	TERRESTRIAL; ROCK OUTCROP; FOREST NEEDLELEAF

Documentation

References:	Douglas, G.W. Personal communication. Douglas, G.W., H. Janszen, J. Penny, and S. Hartwell. 1998. Field survey of northern Gulf Islands for rare vascular plants, April 19-24, 1998. Conserv. Data Cent., B.C. Minist. Environ., Lands and Parks, Victoria. Royal British Columbia Museum. 675 Belleville Street, Victoria, BC. V8V 1X4. University of British Columbia. Dep. Bot., Dep. Zool., Biol. Sci. Bldg., 6270 Univ. Blvd., Vancouver, BC.

Version

Version Date:	26-OCT-05

Mapping Information

Estimated Representation Accuracy:	Medium
Confidence Extent:	?

December 13, 2011