HORNBY ISLAND RIPARIAN AREA REGULATION STREAM IDENTIFICATION –

BEULAH CREEK AND THREE UN-NAMED WATERSHEDS

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TABLE OF CONTENTS

1.0 INTRODUCTION AND OBJECTIVES 1

2.0 METHODOLOGY 2
2.1 Background Research 2
2.2 Assessment Area 3
2.3 Landowner Contact 6
2.4 Definition of a "Stream" under the RAR 6
2.5 Field Assessment Procedures 7
2.5.1 Fieldwork Timing 7
2.5.2 Potential RAR Watersheds 8
2.5.3 Beulah Creek Watershed 8
2.5.4 Tidal Boundary Considerations 9
2.5.5 Collection of Field Data 10
2.5.6 Bankfull Stream Widths and Implementation of the RAR Methodology for Planning Purposes 10
2.5.7 GPS Data Collection Parameters 12
2.6 Assessing for Fish Presence or Potential Fish Presence 12
2.7 Field Assessment Limitations 12
2.8 GPS Data Management and GPS Limitations 13

3.0 RESULTS 14
3.1 Documented Fish Distribution Data 14
3.2 Watershed Summaries 14
3.2.1 Beulah Creek Watershed – Figure 3 15
3.2.1.1 Beulah Creek Main-Stem 15
3.2.1.2 Tributary 1 and Tributary 1-1 15
3.2.1.3 Tributaries 2, 3, 4, and 5 18
3.2.1.4 Unconnected Watercourse 18
3.2.1.5 Southern Sub-basin Tributary Extension 19
3.2.2 Potential RAR Watershed 1 – Figure 4 21
3.2.3 Potential RAR Watershed 2 – Figure 5 24
3.2.3.1 Tributary 1 26
3.2.4 Potential RAR Watershed 3 – Figure 6 28
3.2.4.1 Tributary 1 30

4.0 DISCUSSION AND RECOMMENDATIONS 32

5.0 REFERENCES 37

APPENDIX I – PHOTOS 38

Hornby Island - Riparian Area Regulation
Stream Identification

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1.0 INTRODUCTION AND OBJECTIVES

The Riparian Areas Regulation (RAR) is the basis of streamside protection in British Columbia. The RAR was enacted in 2004 under Section 12 of the Fish Protection Act. The RAR is a joint initiative with Fisheries and Oceans Canada (DFO), the Ministry of Environment (MoE) and local government. The RAR uses a science-based approach to help ensure land development activities do not result in a harmful alteration, disruption or destruction (HADD) of fish habitat.

In BC, the definition of fish habitat includes all aquatic and terrestrial areas that affect fish life processes. Fish habitat, therefore, includes the area directly adjacent to a stream (*i.e.*, the riparian area) because it provides food, nutrients, and other functions vital to fish survival.

It is understood that two watersheds were identified by the MoE on Hornby Island as containing either confirmed fish habitat or potential fish habitat: Beulah Creek and Ford Creek. Of these watersheds, part of the Beulah Creek watershed had been mapped and the Ford Creek watershed had been fully mapped by Mimulus Biological Consultants (2012) prior to the completion of this project. Three potential RAR watersheds were also identified on Hornby Island, which lacked the information required to determine applicability to the RAR.

In order to continue the process of becoming compliant with the provincial RAR, Islands Trust contracted Madrone Environmental Services Ltd. (Madrone) to conduct fieldwork to identify RAR-applicable drainages on Hornby Island.

The target watersheds included the three potential RAR watersheds and part of the Beulah Creek watershed. As Beulah Creek had been subject to previous stream mapping, the scope of Madrone's work was to map the remaining watershed. Islands Trust will use the stream-mapping data to develop a process that recognizes focus areas adjacent to applicable streams (e.g. by incorporating Development Permit Areas or implementing other regulations) to ensure the protection of fish habitat.

The primary objective of the project was to map the centre-line of streams with a high level of accuracy (within 1 m – 5 m), to allow Islands Trust to accurately identify RAR applicable watercourses. As per the RAR, any development within the Riparian Assessment Area (RAA) triggers the requirement for an assessment completed by a Qualified Environmental Professional (QEP). The RAA occurs within 30 m of applicable watercourses, and is measured from the Top of Bank (TOB), or in the case of ravines, from the High Water Mark (HWM) to a point that extends either 10 m or 30 m back from the Top of Ravine Bank (TORB), depending on the width of the ravine. The RAA for wetlands is measured from the HWM. The scope of this project did not include locating the TOB, TORB, or HWM, but the linear extent of ravines were identified during the fieldwork.

Under the Detailed Assessment methodology of the RAR, bankfull widths are used to determine the width of the riparian setback area (referred to under the regulation as Streamside Protection and Enhancement Areas – SPEAs). In order to help determine the extent of riparian setbacks and the dimensions of future management areas, bankfull stream width measurements were taken during fieldwork. The objective of this exercise was to supply Islands Trust with additional data to help with the implementation of planning tools to manage riparian areas. As per the RAR, SPEAs are measured as horizontal distances from the HWM.

2.0 METHODOLOGY

2.1 Background Research

Background research was carried out using the Fisheries Information Summary System (FISS) (http://www.env.gov.bc.ca/fish/fiss/index.html) and Habitat Wizard (http://webmaps.gov.bc.ca/imf5/imf.jsp?site=moe_habwizdatabases) to determine whether any documented stream information existed for the study area. Background stream mapping data contained in the Environmentally Sensitive Area Official Community Plan map (Schedule D1 – Bylaw 104) was also assessed.

Sensitive Ecosystem Inventory (SEI) maps specific to Hornby Island were also assessed to determine the known distribution of wetland and riparian ecosystems on the island. These maps were accessed through the Hornby Island Trust Area Mapping webpage (http://www.islandstrust.bc.ca/maps/trust-area-mapping.aspx). The Denman and Hornby Islands Water Allocation Plan (Pitt and Bryden, 1994) was also included in the background research phase. The report associated with the previous mapping work on Hornby Island (completed by Mimulus Biological Consultants – 2012) was also studied.

2.2 Assessment Area

The scope of the stream mapping work consisted of the three potential RAR watersheds and the Beulah Creek watershed, with boundaries of the four focus watersheds provided by Islands Trust (Figures 1 – 2). The eastern segment of the Beulah Creek watershed had been mapped previously (Mimulus Biological Consultants 2012). The scope of the project did not include field checking this existing mapping, but rather continuing from the end point and completing the stream mapping for the remainder of the watershed. No assessments were carried out on streams flowing through any other watershed beyond the focus watershed boundaries identified in Figures 1 – 2.

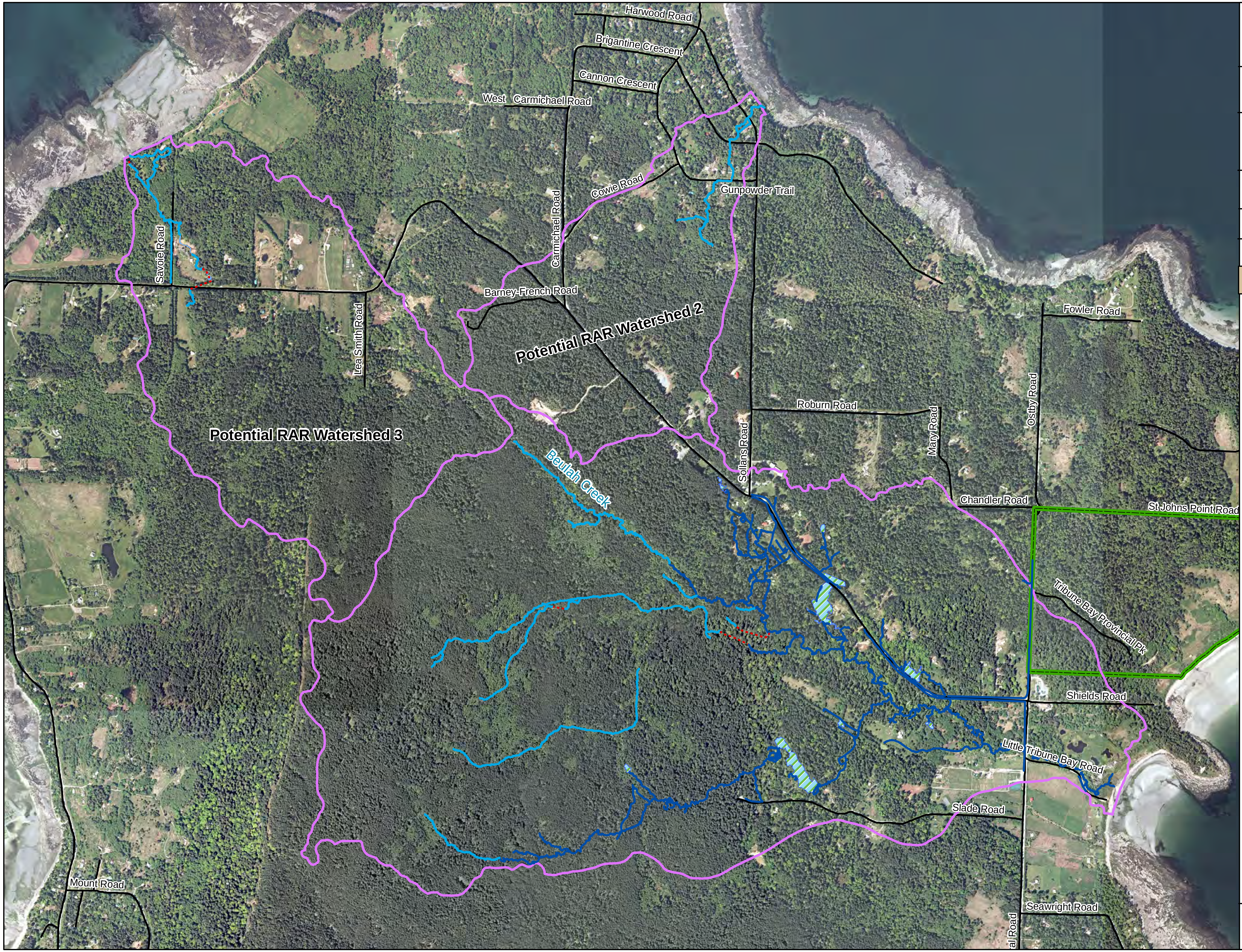

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Figure 1: Beulah Creek and Potential RAR Watersheds 2 and 3 - Overview

PROJECT:
Hornby Island Riparian Area Stream Mapping

CLIENT:
Islands Trust

MAP SCALE:
1:15,000

MAPPING DATE:
December 18, 2013

DOSSIER NO:
13.0315

DRAWN BY:
Anna Riionheimo

LEGEND

Watershed Boundary

Streams

Not field verified due to lack of access permission

Previous stream mapping data (Mimulus 2012)

Wetlands from previous stream mapping data

Wetlands Observed in Field

Pond

Base Symbols

Roads

Parks and Protected Areas

0 100 200 400 600 m.

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Figure 2: Potential RAR Watershed 1

PROJECT: Hornby Island Riparian Area Stream Mapping	
CLIENT: Islands Trust	
MAP SCALE: 1:10,000	MAPPING DATE: December 18, 2013
DOSSIER NO: 13.0315	DRAWN BY: Anna Riionheimo

LEGEND

Watershed Boundary

Streams

Wetlands Observed in Field

Wetland

Base Symbols

Roads

Parks and Protected Areas

N

0 100 200 400 m.

2.3 Landowner Contact

Using stream data collated as part of the research phase, field maps were produced with imagery and cadastral information provided by Islands Trust. Where known streams intersected with private properties, landowner contact information for the affected properties was recorded in a data base. Prior to fieldwork occurring, landowners with streams on their property were contacted by telephone. Landowners were advised of the objectives of the mapping project and asked for access permission.

Field maps were modified accordingly to reflect those properties where access was permitted and those where access had been denied. Attempts were made to contact all affected property owners, although there were several instances where landowners were absent during the landowner contact phase. Sections of streams that could not be field verified, based on lack of access permission, have been identified in the map products (Figures 3 – 6). Where field verification was not possible, the location of streams was delineated using imagery and/or contour interpretation (where appropriate).

During fieldwork, further efforts were made to make contact with property owners by knocking on doors and explaining the objectives of the mapping work. This approach was not always practical, based on the spatial extent of some of the properties and/or landowners being absent during the field assessment. Each field crew also carried copies of a letter from Islands Trust explaining the purpose of the project, for distribution to the public during fieldwork.

2.4 Definition of a "Stream" under the RAR

In order to identify applicable drainages in the field, the definition of a "stream" as listed under the provincial RAR, was used as a standard. As per Section 1.4.2 of the RAR Assessment Methodology; (http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf), a "stream" is defined as follows:

"…any watercourse – natural or human 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. A watercourse may not itself be inhabited by fish, but may provide water, food and nutrients to streams that do support fish."

The RAR further identifies a stream as:

"…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).

If a barrier (either definitive or non-permanent) to the migration of fish occurs on a stream, a watercourse is classified as a "stream" above the barrier if there is potential fish habitat downstream of the barrier. A watercourse can also support resident fish above a barrier if suitable perennial habitat exists. Any part of a watercourse that is not inhabited by fish (e.g. above a barrier with no perennial habitat available) that connects by surface flow to fish habitat is considered a stream under the RAR process.

Watercourses that do not support fish or connect by surface flow to fish habitat (e.g. isolated wetlands) are not considered "streams" under the RAR process. No focused mapping of isolated wetlands was carried out as part of this assessment. It should be noted that wetland ecosystem types still provide benefits to a range of species and provide important functions (e.g. stormwater retention).

Where encountered in the field, constructed ditches were identified. The definitions under the RAR Assessment Methodology were used as a basis in determining whether a watercourse qualified as a stream or ditch. This additional classification was carried out in order to provide Islands Trust with information that could affect the planning phase, as ditches are associated with narrower riparian setbacks under the RAR.

2.5 Field Assessment Procedures

2.5.1 Fieldwork Timing

The field assessment was completed using one two person crew over the course of 4 field days on November 25th, 26th, and 29th and December 6th, 2013. Personnel involved in fieldwork included Trystan Willmott, B.Sc., A.Sc.T., Kyle Rezansoff, B.Sc., B.I.T., A.Sc.T., Justin Lange, B.Sc., R.P.Bio., A.Sc.T., and Jennifer Morgen, M.Sc., B.I.T., A.Sc.T. Justin Lange and Jennifer Morgen carried out the fieldwork on November 25th, and 26th and Trystan Willmott and Kyle Rezansoff completed the mapping work on November 29th and December 6th 2013.

All members of the field crew have completed the provincial RAR-implementation training course and are all Qualified Environmental Professionals (QEPs) under the RAR. All crew members have also completed the Resources Information Standards Committee (RISC) field operator GPS training course.

Stream surveys were carried out during the late fall, during a time of year that typically corresponds with high stream flow conditions. The fall of 2013, however, was unseasonably dry, with very little rain falling during October 2013, which was followed by a drier than average November (a weather pattern that continued through December 2013). As a result, streams on Hornby Island appeared to be flowing at a relatively low level for the time of year. In some cases in the Beulah Creek watershed, these conditions made it difficult to determine the location and full extent of streams, especially where low-magnitude tributaries flowed through low gradient forests. Streams were followed to their source, which necessitated the determination of the point where no further evidence of surface flow (including ephemeral flow) could be detected.

2.5.2 Potential RAR Watersheds

The outlet streams of the three potential RAR watersheds on Hornby Island were assessed to determine whether the watersheds contained potential fish habitat. One of the main factors to consider was the potential occurrence of a barrier to upstream fish movement at tidewater. If a definitive barrier occurs at tidewater preventing anadromous fish access, the watershed would not be included as a RAR-applicable watershed unless suitable perennial fish habitat exists upstream of the barrier.

If no barrier occurs at tidewater, there is the potential that the stream could contain anadromous fish. Even if a stream flows on a seasonal basis, there is still the potential for the occurrence of species that do not require a perennial source of water to complete their life cycle, such as chum salmon (*Oncoryhnchus keta*) and pink salmon (*O. gorbuscha*).

2.5.3 Beulah Creek Watershed

Digital stream mapping data for the mapped eastern portion of the Beulah Creek watershed provided by Islands Trust was used to determine the starting point of the mapping exercise. The report accompanying the previous mapping work (Mimulus 2012) was also studied to determine the extent of mapping and to ensure that all areas of the watershed were assessed in the field.

To ensure coverage of the watershed and to check for tributaries, the previously mapped portion of the Beulah Creek main-stem was traversed from the confluence of the last tributary mapped by Mimulus, which enters on the south side of Beulah Creek. As per the Mimulus report, only the lower section of this tributary had been mapped. The inability to access property along the south side of Beulah Creek prevented this tributary from being followed from the confluence. Instead, evidence of this watercourse was determined by traversing the western edge of the inaccessible property and commencing mapping once located. Mapping the upstream extent of the Beulah Creek main-stem and associated tributaries was also completed from the upper limit of the previous mapping carried out by Mimulus (2012).

The Mimulus report identified one main sub-basin flowing close to the southern edge of the watershed. While the Mimulus report did not suggest this sub basin was incomplete, field checks were completed to ensure that the mapped western extent of the tributary represented the full upstream limit and that there were no additional tributaries entering from the extensive watershed area to the north of the main tributary.

Due to the relatively dry conditions, it was difficult to locate watercourses in the low relief area to the immediate west of the inaccessible property in the watershed area south of the Beulah Creek main-stem. The inability to access this property also made it difficult to determine the drainage network.

In addition to following the previously mapped extent of the Beulah Creek main-stem from the last mapped tributary on the south side of the stream, the breadth of the watershed was traversed from north to south between Beulah Creek and the previously mapped tributary to the south to check for tributaries. This strategy of traversing the side slope to the west of the inaccessible property allowed watercourses to be picked up where the gradient was such that allowed for channel incision. Where encountered, streams were mapped to the full upstream extent and the downstream sections were mapped up to the edge of the inaccessible property, or to a point where a stream could no longer be defined.

2.5.4 Tidal Boundary Considerations

The upper limit of tidal influence is relevant in the implementation of the RAR, as the regulation does not apply to marine or estuarine habitats, as per Page 14 of the RAR assessment methods:

> *"The Riparian Areas Regulation does not apply to marine or estuarine shorelines; these waters are still considered fish habitat under the Fisheries Act and DFO should be contacted regarding appropriate setback widths to ensure that development activities do not result in a harmful alteration, disruption or destruction of fish habitat. The boundary between freshwater habitats and estuarine habitats is considered the upstream extent of tidal influence."*

Due to the low magnitude of the outlets of the three potential RAR watersheds, no typical "estuarine" habitat exists. As a result, the stream mapping commenced at the interface between the foreshore riparian vegetation and the intertidal area. Traversing the streams from the upper limit of tidewater allowed for the identification and subsequent mapping of all tributary drainages entering the main-stem.

2.5.5 Collection of Field Data

Concurrently with stream mapping, basic habitat data was also collected along each stream. Data collected included gradient, channel morphology (e.g. riffle-pool/cascade pool or step-pool), extent of riparian vegetation and fish habitat potential. Fish habitat attributes such as cover/security, Large Woody Debris (LWD) and spawning substrate were also noted.

Representative site photographs were taken during each stream traverse (Appendix I). GPS way points were collected to depict the location of features such as barriers to upstream fish movement (e.g. waterfalls). The downstream and upstream boundaries of ravines were also identified with GPS way points.

The edges of wetlands and lakes were not mapped in the field, although their dimensions and attributes were recorded during the assessment. The level of detail shown on the orthophoto coverage, in addition to ground-truthing, allowed for the accurate digitizing of wetland/lake edges on the final maps.

2.5.6 Bankfull Stream Widths and Implementation of the RAR Methodology for Planning Purposes

As part of the field assessment, bankfull widths were taken along each stream traverse in order to provide Islands Trust with more data for planning purposes. As per the RAR methodology (using the "Detailed Assessment"), SPEA dimensions for streams are based on multiplying the average channel width by three. The "Simple Assessment" is another standard used under the RAR, which derives the SPEA from the depth of potential riparian vegetation, stream periodicity and fish presence/absence. Under the Simple Assessment, the SPEA is measured from the TOB or TORB, and is generally more than 15 m wide, but cannot be greater than 30 m.

Using the Detailed Assessment, the SPEA can never be less than 10 m, with the maximum being 30 m, and is measured as a horizontal distance from the HWM. Bankfull widths taken in the field were used to determine the estimated SPEA dimensions for the streams indicated in the map product, using the Detailed Assessment procedure (Figures 3 – 6). Wetlands (including lakes and ponds) are associated with default 15 m – 30 m SPEAs depending on aspect, under the Detailed Assessment. North facing banks receive a maximum 30 m SPEA, based on the function provided by shade, where-as south, west and east facing banks are associated with 15 m SPEAs.

It should be noted that the SPEAs shown on the maps should only be used as a guide for planning purposes, as the scope of the project did not include the completion of a full detailed RAR assessment on the mapped streams. It should also be noted that the scope of the project did not include the identification of the HWM, TOB, or TORB.

Under the RAR, the 30 m RAA is measured as a horizontal distance from the TOB in the case of a stream, and from the HWM when considering wetlands and lakes. As per the regulation, any developments within the RAA trigger the completion of an assessment using the RAR methodology. When assessing ravines, the RAA extends from the HWM to a point that is either 10 m or 30 m back from the TORB. If a ravine is less than 60 m wide, the RAA is 30 m from the TORB; ravines that are greater than 60 m wide are associated with a RAA that extends 10 m back from the TORB.

While mapping the streams, the downstream and upstream extent of ravines (as defined in the RAR methodology – http://www.env.gov.bc.ca/habitat/fish_protection_act/riparian/documents/assessment_methods.pdf) was identified. The purpose of this exercise was to provide Islands Trust with data for planning purposes, based on the fact that the RAA for ravines extends from the TORB, as discussed in detail above. As stated, the scope of the project did not include the identification of the TORB, or measuring the width of ravines.

2.5.7 GPS Data Collection Parameters

Each field crew collected data using a Trimble GEOXH 6000 GPS unit connected to an external receiving antenna. These units have the capability of receiving position data from GPS and GLONASS satellites, which results in increased accuracy. Data collection thresholds were set on the GPS units to fit within the standards required by Islands Trust, including: a minimum elevation angle to satellites of 15° above the horizon; a maximum Horizontal Dilution of Precision (HDOP) of five; a maximum Position Dilution of Precision (PDOP) of eight; and a minimum number of four satellites for position fixes. As per RISC standards, a minimum of 45 individual fixes were taken for static features such as tributary confluences and barriers. During each stream traverse, position fixes were taken every second. Terra Sync software was used for the collection of field data.

2.6 Assessing for Fish Presence or Potential Fish Presence

While background research using databases is useful in determining the general distribution of fish, it cannot be relied upon as a complete inventory. For example, a lack of data for any given stream or watershed cannot be interpreted as indicating that the stream or watershed does not contain fish. Proving non fish presence generally requires rigorous sampling procedures during optimal seasons. Given the fact that the project was focused on identifying fish bearing or potentially fish bearing watercourses, no detailed sampling procedure was carried out. Fish sampling, therefore, was beyond the scope of this assessment.

As the Beulah Creek watershed had already been associated with extensive stream mapping and had been included as a RAR-applicable watershed by the MoE, it was assumed that potential fish habitat exists in this watershed.

As per Section 2.5.2, the absence of a barrier at tidewater that allows for potential anadromous fish access (even on a seasonal basis), or the occurrence of perennial habitat for resident fish upstream of a tidewater barrier would indicate that a watercourse applies as a “stream” under the RAR. These parameters were used to determine whether the 3 potential watersheds applied to the RAR.

2.7 Field Assessment Limitations

In some instances, the density of vegetation growing in the mapped streams did not make it feasible to follow the drainage with the GPS, as the external antenna would become significantly fouled and/or impeded, leading to poor GPS operating conditions. In these cases, the GPS data collection was paused briefly and resumed where access to the stream channel was possible. These conditions were generally only a factor along short segments of the upper Beulah Creek main-stem.

Lack of access permission precluded the mapping of the full extent of streams in one of the three potential RAR watersheds and prevented access to part of the central portion of the Beulah Creek watershed assessment area. Unseasonably dry weather, watershed morphology and low stream magnitude also led to challenging conditions when trying to map the location of streams in the field, especially in the Beulah Creek watershed. Where feasible, orthophoto interpretation was used to determine the location of the stream channel for areas that could not be accessed. The portions of streams that could not be field verified due to lack of permission, or where conditions were such that prevented surface connectivity being identified have been depicted in the map products (refer to Figures 3 – 6).

2.8 GPS Data Management and GPS Limitations

After field assessments were completed, the GPS data was downloaded and post-processed using the closest base station relative to the study area (located in Nanoose). The post-processed data was then viewed in Pathfinder Office software, which is used in conjunction with Trimble GPS units and the Terra Sync field collection software. The data was converted to shapefile format and imported into ArcGIS10, which included the creation of a metadata report of all the data collected, including Dilution of Precision (DoP) values, Horizontal Precision and number of satellites used for each position fix.

Using GPS for stream mapping does have obvious limitations, as characteristics in the field play a significant role in the accuracy of data. Traversing obstacles in the creek, or ducking under overhead obstructions (e.g. vegetation) can also lead to temporary loss of locational accuracy, based on the fact that the external antenna is forced out of the optimal position. For example, when climbing over a log, the antenna can either be on a horizontal plane, or pointing towards the ground, leading to poor accuracy. The temporary “zingers” created when the antenna was in a sub optimal position that prevented an accurate location fix was readily identifiable in the data set. Based on the high data logging interval (one locational fix per second), the correct line of the stream could easily be identified in the data by ignoring the “zingers”.

It should be noted that the vast majority of data collected met the required accuracy standards. The GPS units performed well, even under tree canopy, and accuracy in open areas (following post-processing) was generally sub-metre.

Having a high data logging interval allowed for an increased number of points to be taken along each stream traverse, leading to increased accuracy. It should be noted, however, that it was generally not possible to follow the exact centre of the stream, unless the stream was completely open, with a uniform depth and no obstructions. During the stream traverses, there would often be the need to move sideways in the creek bed to avoid an obstruction or sections of deep water. The high accuracy of the GPS units allowed for these sideways movements to be depicted in the data, often leading to a "jagged" appearance to the mapped stream line. The creek lines were, therefore, smoothed using the Smooth tool in the Advanced Editing Toolbar in ArcGIS. Smoothing the line features created a more natural stream appearance, while not losing the locational accuracy (sideways movements around obstacles etc. were always within the confines of the channel).

3.0 RESULTS

3.1 Documented Fish Distribution Data

While completing the background research phase, no documented fish distribution data was found for Beulah Creek or the three potential RAR watersheds (using Habitat Wizard and FISS databases). The only documented fish occurrence for Hornby Island was associated with the Ford Creek watershed, which is known to contain coho salmon (*O. kisutch*) and coastal cutthroat trout (*O. clarkii clarkii*). The report associated with the previous mapping work for Beulah Creek (Mimulus Biological Consultants 2012) discussed historical fish (salmon) presence in Beulah Creek, and noted that school groups from the community have undertaken fry release (coho and chum salmon) in the creek.

3.2 Watershed Summaries

Figures 3 – 6 depict the mapped drainage network in each of the target watersheds. All watercourses shown on the maps are considered "streams" under the RAR. The maps also indicate the locations of barriers to upstream fish movement and the extent of ravines. The dimensions of the SPEAs, based on bankfull widths in the field, are also noted on the maps.

The following descriptions summarize the characteristics of each watershed outlet stream and associated tributaries. In all cases, excluding the Beulah Creek watershed, streams are described in an upstream direction, starting from the confluence with the ocean. Representative photographs are included in Appendix 1.

3.2.1 Beulah Creek Watershed – Figure 3

3.2.1.1 Beulah Creek Main-Stem

The upper segment of the Beulah Creek main-stem flows through uninterrupted young forest, with western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*) and Douglas-fir (*Pseudotsuga menziesii*) dominating. Red alder (*Alnus rubra*) is common in the immediate riparian zone, especially in the moister forest types in the lower section of the mapped area. The riparian vegetation is providing proper biological function in the form of shade, litter fall, insect drop, bank stability and provision of LWD. Throughout the mapped section of the stream, the bankfull width did not exceed 2.9 m.

The stream flows through a well-defined, low gradient (approximately 2%) channel, with a riffle-pool morphology. The substrate consists mainly of small gravel, with sand also occurring in lower energy sections of the channel. Potential fish habitat exists, with stable LWD and undercut banks providing security/cover habitat and sections of suitably-sized substrate to allow for salmonid spawning (especially for resident trout). Fish habitat is likely limited, however, by a lack of water during the summer months. Based on the stream magnitude in the upper reaches, residual water depth in the pool habitat units is likely insufficient to retain an adequate depth of water to provide summer time habitat refugia.

Fish habitat potential in the main-stem decreases in the upper segment of the mapped area, where water flow becomes increasingly restricted to shallow, unconfined flow over soft organic substrates through slough sedge (*Carex obnupta*). The stream was mapped up to a depression at the base of a steep ridge adjacent to the left bank. This depression contains patchy slough sedge, organic substrate and pockets of shallow standing water. Water collects in this depression at the edge of the watershed and represents the source of Beulah Creek.

3.2.1.2 Tributary 1 and Tributary 1-1

While it cannot be confirmed due to a lack of property access permission, it is assumed that Tributary 1 connects with the incompletely mapped tributary included in the Mimulus (2012) report. Tributary 1 was mapped from close to the western edge of the inaccessible property (allowing for a buffer to ensure no trespassing occurred) and followed to its source.

At the starting point, the stream is poorly defined where it flows through an area exhibiting very low relief. Shallow surface flow through dense sword fern (*Polystichum munitum*) and sections of slough sedge indicate the direction of water flow. Approximately 50 m from the start point, the stream has been ditched immediately downstream of a trail crossing point (wooden foot bridge). As a result of the ditch construction, the watercourse becomes very well defined, although no water was flowing at the time of the assessment.

A secondary ditch flows in a southerly direction from the trail crossing point, which is directed to the east underneath the trail. This watercourse is ditched for approximately 20 m downstream of the trail crossing, at which point no further evidence of water flow could be identified. The ditch was likely constructed to keep water off the trail surface, re-directing the water and allowing it to dissipate over the forest floor on the down-slope side of the trail.

Tributary 1 continues as a wide (up to 1.5 m bankfull) ditched watercourse along the western side of the trail, where it flows from north to south. At the point where the watercourse becomes unrestricted by the ditch along the trail edge, it flows from west to east as a very poorly defined system, with patchy slough sedge and soft organics indicating the direction of water flow. The poorly defined nature of the watercourse continues up to the next trail crossing, where it is directed underneath the trail via a culvert. Upstream of the trail crossing, the gradient increases (up to 15%) and the watercourse becomes relatively well defined. Despite a lack of water during the assessment, the cobble substrate in this area indicates significant water flow during a "normal" late fall period.

The watercourse becomes confined in a ditch adjacent to the edge of a trail, where it displays evidence of high flashy flows and resultant channel instability. The watercourse flows over the Spasm Chasm trail for a distance of approximately 30 m, where seasonal water flow was evidenced during the assessment from scour and deposits of alluvial material. Where the watercourse leaves the trail surface, it becomes confined in a high-sided ditch parallel to the edge of the trail. Sections of the ditch are very unstable, with pronounced down-cutting from flashy flows, which have created high, unstable banks and accumulations of woody debris.

Up slope of the Spasm Chasm trail, the gradient of the watercourse increases again (up to 25%), with an associated increase in channel confinement through confined draws. The watercourse flows over Lox's Bagel trail for approximately 10 m, where it is still well defined, with a cobble substrate. The gradient decreases close to the upper extent of the watercourse, with the source of the stream represented by a shallow depression close to the edge of the watershed. The watercourse splits into two poorly defined watercourses close to the source, which consists of a wide low-relief area at the height of land. At the source, patches of slough sedge occur in depressions surrounded by an otherwise dry young forest ecosystem dominated by Douglas-fir.

Tributary 1-1 represents a poorly defined watercourse. Evidence of scour and minimal deposits of alluvial material indicate the presence of seasonal water flow at the confluence point. Based on a lack of indicators and no apparent channel definition, the stream could not be identified for a distance of approximately 50 m immediately upstream of the confluence. This section has been indicated on Figure 5. Where the gradient increases upslope of this area, the watercourse becomes relatively well defined, although sections are very difficult to identify through lower gradient segments.

The watercourse crosses Northwind Trail, before flowing through a steep draw up to the source. The origin of the watercourse consists of a wide depression close to the height of land, comprising of young Douglas-fir and red alder. The bankfull width of the watercourse does not exceed 1.5 m.

It is assumed that Tributary 1 connects with the partially mapped tributary completed by Mimulus (2012). Based on a lack of fish habitat attributes, it is extremely unlikely that the mapped section of Tributary 1 contains fish, even on a seasonal basis. The confluence of this tributary with the main-stem was observed while the previously mapped section of Beulah Creek was checked for other unmapped tributaries. It should be noted that the confluence does not occur on the property that could not be accessed. At the confluence, the stream is well defined and represents potential fish habitat. Where it flows through the low-relief young forest close to the mapping start point, it is reasonable to assume that fish do not occur due to a complete lack of habitat attributes. In addition, there are no sections of the stream that would support resident fish, based on a lack of perennially-available habitat.

The upstream extent of available fish habitat from the Beulah Creek confluence upstream could not be assessed, as the remainder of the previously mapped portion of the stream flows through the property that could not be accessed. At the very least, the stream represents a significant tributary to the Beulah Creek system. Apart from the minimal areas where walking trails parallel the watercourse, riparian vegetation consists of continuous forests adjacent to both banks. The stream will, therefore, contribute water and nutrients to the Beulah Creek system.

3.2.1.3 Tributaries 2, 3, 4, and 5

Tributaries 2, 3, and 4 represent very poorly defined watercourses. Shallow surface flow over an organic substrate characterizes the morphology of the streams. The watercourses were followed up to a point where no further evidence of scour or hydrophytic vegetation could be detected. These watercourses will contribute water and nutrients to the Beulah Creek main-stem, but it is very unlikely that fish are present (even on a seasonal basis), due to a lack of habitat attributes.

Tributary 5 joins Beulah Creek close to the upper edge of the watershed. It is similar to Tributaries 2, 3, and 4 in morphology. The watercourse flows over an organic substrate through slough sedge and originates in a moist depression consisting of red alder, slough sedge and dense sword fern. The lower segments of the stream have the potential of supporting fish, at least on a seasonal basis. The bankfull widths of Tributaries 1 – 5 do not exceed 1.5 m.

3.2.1.4 Unconnected Watercourse

This watercourse was located while traversing the watershed to check for streams that could have been missed in the low-gradient area to the west of the inaccessible property. The watercourse is defined at the Coltsfoot trail crossing, where it flows parallel to the trail as a wide (approximately 1 m) ditch. Immediately downslope of the trail, the ditch is no longer defined. The watercourse was dry during the assessment, but it appears that any water in the system dissipates over the forest floor in the low-gradient area to the east of the trail. Despite searching for a defined channel, or any evidence of scour downslope of the trail, no watercourse could be identified.

Despite the fact that no connectivity with either Beulah Creek or any other tributary could be detected, the watercourse was mapped upstream from the point where evidence of surface flow could be identified. At the very least, the watercourse will provide water on a seasonal basis to the Beulah Creek main-stem, albeit via a sub-surface route or via convoluted surface flow over the forest floor.

The watercourse flows parallel to the Coltsfoot trail prior to flowing over the trail surface, where evidence of scour and alluvial deposits occur. Further upslope, the watercourse becomes more defined adjacent to Slick Rock trail, at which point it contained surface-flowing water (very minimal) during the field assessment. Up slope of the trail, the watercourse steepens over bedrock, where it is confined through narrow draws. The watercourse crosses Northwind trail via a plastic culvert, where it is well defined. The source of the watercourse consists of a wide, flat area close to the height of land, with young red alder, western redcedar and Douglas-fir occurring.

3.2.1.5 Southern Sub-basin Tributary Extension

While checking the southern portion of the study area for watercourses connecting to the previously mapped tributary along the southern edge of the watershed, it was discovered that the tributary extends further than the upper extent indicated on the pre-existing mapping layer. The mapped addition to the watercourse consists of a well-defined channel in places, with evidence of scour and alluvial deposits indicating the presence of surface-flowing water. Where the gradient increases, the channel becomes confined, with an associated increase in channel definition. These steeper segments consist of large gravel and cobble, indicating high energy seasonal flows. The watercourse was followed up to a point where no further evidence of seasonally-flowing water could be identified. The bankfull width of the watercourse did not exceed 1.5 m throughout the mapped segment.

Based on the gradient (in excess of 20% in places), a lack of habitat attributes and absence of perennially-available habitat, it is very unlikely that the mapped segment of the stream will support fish, even on a seasonal basis. As indicated by the previous mapping completed by Mimulus (2012), this tributary connects with Beulah Creek and will provide water and nutrients to the main-stem. The Mimulus report (2012) also indicates that this tributary (albeit in the lower reaches close to Beulah Creek) represents “marginal to good” fish habitat.

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Figure 3: Beulah Creek Watershed

PROJECT:
Hornby Island Riparian Area
Stream Mapping

CLIENT:
Islands Trust

MAP SCALE: 1:10,000	MAPPING DATE: December 18, 2013
DOSSIER NO: 13.0315	DRAWN BY: Anna Riionheimo

LEGEND

Watershed Boundary
Streams (10m SPEA under detailed RAR Assessment based on bankfull width)
Not field verified due to lack of access permission
Previous stream mapping data (Mimulus 2012)
Wetlands from previous stream mapping data

Onstream Ravine Extents
Upstream
Downstream

N

Base Symbols
Parks and Protected Areas
Roads
Properties
Inaccessible property (no access permission)

0 100 200 400 m.

3.2.2 Potential RAR Watershed 1 – Figure 4

Where the watershed outflow stream enters the ocean, it flows as a narrow, shallow watercourse over a sand beach. At the natural boundary of the marine environment, it was difficult to define a stream channel as water flow was within dense reed canary grass (*Phalaris arundinacea*) beds and an accumulation of drift wood. Mapping of the watercourse was initiated immediately upstream of the freshwater-marine interface where a definitive channel was observed.

The lower portion of the watercourse lacks natural sinuosity where it flows adjacent to Carling Road through a deep (approximately 1 m), incised channel. The morphology of the watercourse is consistent with that of an excavated ditch. Where the watercourse flows adjacent to Carling Road, it possesses an average bankfull width of 1.5 m.

Further upstream, the watercourse flows under Anderson Road and along the boundaries of three residential properties. The morphology of the upper reach remains consistent with that of a deep (up to 1.5 m deep) constructed ditch. The bankfull width of the channel is consistent and does not exceed 2 m. As the watercourse consists of significant headwaters (extensive wetland), it is defined as a "stream" as opposed to a "ditch" under the RAR. The watercourse may represent a natural channel that has been historically modified (*i.e.*, deepened and straightened).

Along the entire length of the drainage, riparian vegetation is composed mainly of grasses and slough sedge; however, several Douglas-fir, western redcedar and red alder were also documented. Substrate throughout the ditch is composed entirely of organic materials (*i.e.*, decomposing leaves and woody debris).

The watercourse was mapped up to the headwaters, which is a wetland complex composed of hydrophytic vegetation and open water habitat. The wetland is approximately 50 m wide and 250 m long. Within the wetland, vegetation is dominated by Red-osier dogwood (*Cornus stolonifera*), willows (*Salix spp.*), and slough sedge. Along the riparian fringe, the tree layer is composed mainly of red alder. Shrubs noted at the time of the assessment included: baldhip rose (*Rosa gymnocarpa*), evergreen blackberry (*Rubus laciniatus*), and willows. Sword fern dominates the herb layer within the riparian fringe.

It is likely that this watercourse only contains water seasonally, based on retention of stormwater by the headwater wetland during the winter months. This system represents low quality fish habitat as there is a lack of spawning areas (*i.e.*, alluvial substrate) and the flow regime is seasonal. However, due to the fact there is no definitive barrier (*i.e.*, high gradient slope) at tidewater to prevent upstream migration of fish, there remains the potential for anadromous fish species to enter the watercourse.

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Figure 4: Potential RAR Watershed 1

PROJECT:
Hornby Island Riparian Area
Stream Mapping

CLIENT:
Islands Trust

MAP SCALE: 1:2,500	MAPPING DATE: December 18, 2013
DOSSIER NO: 13.0315	DRAWN BY: Anna Riionheimo

LEGEND

Watershed Boundary

Streams (10m SPEA under detailed RAR Assessment based on bankfull width)

Wetlands Observed in Field

Wetland

N

Base Symbols

Parks and Protected Areas

Roads

Properties

0 15 30 60 90 120 m.

3.2.3 Potential RAR Watershed 2 – Figure 5

At the tidal boundary, the stream flows over a bedrock ledge (approximately 1 m in height) and onto a cobble beach. During periods of high stream flows and high tides this feature would likely be passable for anadromous fish species. The lower reaches of the creek flow through mature forest, with red alder, western redcedar and Douglas-fir dominating the tree layer. Pacific ninebark (*Physocarpus capitatus*) and salmonberry (*Rubus spectabilis*) compose a dense shrub layer that extends up to the high water mark of the stream. This vegetation on both banks of the creek is intact and providing proper biological function.

Runs and glides dominate the stream morphology, which is characteristic of a riffle-pool system. Throughout the lower reaches, the stream bed is composed of alluvial substrate in the form of small cobbles and gravels. The stream exhibits a low gradient (3%) and is up to 2.3 m wide in the lower reaches downstream of the Harwood Road crossing. At Harwood Road, the stream flows through a closed metal pipe with a diameter of approximately 800 mm.

Upstream of Harwood Road, the stream flows through a residential property and splits near the southeast property corner. The West Fork of the stream has been subjected to anthropogenic influences. The channel has been historically excavated and straightened, with the morphology currently consistent with that of a ditch. Manicured lawn extends up to the high water mark of the creek and functioning riparian vegetation is lacking.

The East Fork of the watercourse is approximately 50 m — 60 m in length, flows in a northerly direction along the eastern boundary of the property and has been ditched adjacent to Harwood Road. Water flows through the roadside ditch for approximately 25 m before re-converging with the West Fork at Harwood Road. The morphology of the East Fork is also typical of a historically straightened/excavated ditch (*i.e.,* straight with a uniform channel depth) and the bankfull width ranges between 1 m and 1.4 m over its length. The watercourse also forms a boundary between two residential properties.

At the time of the assessment the East Fork contained minimal flow, and at the very least will supply the West Fork of the stream with nutrients and water. The East Fork of the watercourse represents marginal fish habitat; however, there is potential for fish to gain access during periods of high flow.

Near Brigantine Crescent, the stream meanders through an intact Douglas-fir/western redcedar forest. Fish habitat potential increases throughout this section of the stream due to the diversity of the habitat. This portion of the stream is dominated by runs and glides, which provide potential for spawning. Also, several large pools with abundant LWD were documented and will provide suitable security habitat for fish. At Brigantine Crescent the stream is directed under the road via a 600 mm closed metal pipe. This culvert does not appear to be a barrier to the upstream movement of fish.

The middle reaches of the stream, between Brigantine Crescent and Gunpowder Trail flow through a series of residential properties. At Gunpowder Trail, the stream flows through a roadside ditch for approximately 30 m. The morphology of the stream and characteristics of the riparian zone change significantly. The quality of habitat and potential for fish to inhabit the middle reaches is low as the stream has been historically subjected to anthropogenic influences. On average, the bankfull width of the channel is 1.2 m and the gradient is between 2% and 4%. Substrate throughout the middle reaches is composed mainly of organic materials; however, pockets of gravel were noted in areas with high velocity flow (*i.e.,* the Gunpowder Trail roadside ditch).

Riparian vegetation is lacking throughout the middle reaches and in most cases manicured lawn extends up to the high water mark of the stream. On the southern-most property, two ponds have been created by excavating the stream channel. Each of the ponds is approximately 5 m wide by 5 m long and 2 m – 3 m deep. Anecdotal evidence suggests that the ponds were created to provide a continuous source of water for livestock.

Upstream of the ponds, the stream exhibits a low gradient (2% – 3%) and flows through a mature mixed forest for approximately 150 m. Dominant tree species include Douglas-fir, western redcedar and red alder. Dull Oregon-grape (*Mahonia nervosa*), salal (*Gaultheria shallon*) and red huckleberry (*Vaccinium parvifolium*) dominate the shrub layer. Herb growth is extensive and composed almost entirely of sword fern.

The upper reaches of the stream represent low quality fish habitat. Channel definition is lacking and portions of the stream flow under tree roots. Organic substrate persists throughout the upper reaches and there were no signs of scour or alluvial deposits.

At the southern extent of the watercourse, the headwaters are represented by an expansive sedge (*Carex* sp.) wetland. The wetland is approximately 25 m wide and 75 m long and confined to the east, south and west by elevated ridges.

Overall, this system represent low quality fish habitat. However, due to the fact there are no definitive barriers (*i.e.*, high gradient slope) at any point along the stream to prevent upstream migration there remains potential for anadromous fish species to enter the drainage. The most suitable fish habitat exists in the lower reaches of the drainage as there is potential spawning areas (*i.e.*, alluvial substrate) and rearing habitat (*i.e.*, pool habitat units).

3.2.3.1 Tributary 1

Tributary 1 joins the main-stem on the left bank, approximately 250 m upstream of Gunpowder Trail. This watercourse flows in a northeasterly direction through a young red alder forest and dense “blankets” of slough sedge. The channel exhibits a low gradient (3% slope) and possesses an average bankfull width of 0.5 m. Over its length, substrate within the drainage is composed entirely of organic materials.

This watercourse was mapped for approximately 150 m, up to a point where access was prohibited by a property owner. It was noted that the drainage continued on an adjacent property to the southwest of the termination point. Anecdotal evidence indicates that the drainage channel was excavated as a measure to deal with storm water run-off. This watercourse represents poor quality fish habitat as it is likely ephemeral and lacks suitable spawning and rearing habitat.

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Figure 5: Potential RAR Watershed 2

PROJECT: Hornby Island Riparian Area Stream Mapping	
CLIENT: Islands Trust	
MAP SCALE: 1:2,500	MAPPING DATE: December 18, 2013
DOSSIER NO: 13.0315	DRAWN BY: Anna Riionheimo

LEGEND

Watershed Boundary

Streams (10m SPEA under detailed RAR Assessment based on bankfull width)

Wetlands Observed in Field

Pond

Base Symbols

Roads

Properties

0 15 30 60 90 120 m.

3.2.4 Potential RAR Watershed 3 – Figure 6

At the natural boundary of the marine environment, the main watercourse flows over a gravel/cobble beach and into the ocean. Immediately upstream of the confluence with the ocean, the stream flows through a steep sided ravine. The first 20 m – 25 m of the drainage exhibits a low gradient (2% slope) and is up to 3 m wide (bankfull width). In the upper portion of the ravine, the stream channel becomes more confined and is approximately 1.5 m to 2 m wide. The vegetation growing on the ravine walls is contributing biological function by providing bank stability, nutrient input, LWD and shade. Tree growth is composed of both mature and young Douglas-fir, western redcedar and red alder.

The channel morphology throughout the lower reaches of the stream is consistent with a riffle-pool system. The diversity of habitat throughout the lower reaches of the stream provides potential fish habitat, as glides and pools were noted.

Upstream of the ravine, the stream flows through a residential property and has been altered through extensive levels of vegetation removal and channel manipulation (*i.e.*, re-direction). Manicured lawn extends up to the high water mark and in some cases down into the stream bed. Morphology of the stream remains similar to the lower reaches; however, the substrate compositions shifts from alluvium to organic materials.

In the south-central portion of the residential property, the stream is directed under an access road via a 400 mm culvert. At the southern boundary of the property a dam system has been installed to regulate the flow of water. During periods of low flow, water will be retained behind the dam and provide water for domestic use (*i.e.*, irrigation). At the time the stream was traversed, water withdrawal lines were observed within the stream. The dam structure would not represent a definitive barrier to upstream migration by anadromous salmonids as it would be passable, particularly during high flows.

At the dam structure the stream forks, forming a secondary channel (West Fork) that flows to the northwest and drains into the ocean. On the West Fork, a second dam structure exists. Downstream of the dam, the watercourse comprises a low-gradient (between 3% and 5% slope) and has an average bankfull width of 1.3 m. The channel morphology is consistent with that of a historically straightened watercourse, and portions of the right bank have been stabilized using rip-rap. The watercourse has been excavated through a mixed forest. Dominant tree species include red alder, Douglas-fir and western redcedar. Salmonberry and sword fern were noted as being the dominant shrub and herb species within the riparian zone of the ditched section.

Over the length of the watercourse, substrate is composed of a mixture of organic materials and gravel. At the natural boundary of the marine environment, the West Fork flows down over a moderately steep (40% – 45% slope) ledge and over the cobble beach. This ledge represents a barrier to the upstream migration of anadromous fish species from the ocean.

Due to the fact the West Fork is likely ephemeral, there is a lack of spawning and rearing habitat and water levels are somewhat regulated by the dam system, the quality of fish habitat is poor. The only potential for fish to enter the West Fork is if they migrate up the main fork and water levels are optimal to pass down over the dam.

The middle reaches (between the dam structures and Savoie Road) of the main fork of the stream flow through a young forest which is composed mainly of Douglas-fir, red alder, salmonberry and sword fern. Portions of the stream bank also contain dense slough sedge growth. This riparian vegetation is providing proper biological function in the form of bank stability, shade, insect drop and LWD.

The channel morphology within the middle reaches is consistent with that of a historically straightened watercourse. The channel is linear and consistent with respect to width (average bankfull width of 1.25 m) and depth (up to 1 m deep). The middle reaches of the stream exhibit low gradient and range between 3% and 5% slope. Approximately 50 m downstream of Savoie Road, the stream flows into a constructed (approximately 10 m wide and 15 m long) ditch under a residential access road via three 400 mm culverts. At Savoie Road, the stream flows through a woodbox culvert that is approximately 2 m wide. The culvert is partially overgrown with vegetation; however, it does not represent a barrier to upstream fish migration.

Upstream of Savoie Road, the stream flows through a portion of a residential property that is composed of an undisturbed mature forest, dominated by western redcedar and Douglas-fir. Dull Oregon-grape and salal were also noted as being abundant. This section of the stream is characteristic of a riffle-pool system. The channel contains spawning gravel and several pools with undercut banks and LWD. Within this section of the stream, the bankfull width ranges between 1.5 m and 2 m.

Immediately upstream of the forested ecosystem, the stream has been extensively altered through the creation of two ponds and installation of a 3 m – 4 m high rock waterfall, which is a barrier to the upstream movement of fish. Each pond is approximately 5 m wide and 10 m long. It was not possible to determine the exact depth of the ponds at the time of the assessment; however, it appeared as though the water level was approximately 2 m deep. Riparian vegetation is lacking and either manicured lawn or areas of exposed soil extend up to the edge of the watercourse. Mapping was ceased in the middle portion of this property at the request of the property owner. Preliminary observations indicated that the quality of habitat throughout the impacted area was poor.

Mapping of the watercourse resumed to the south of Central Road for approximately 100 m, through a sedge wetland and was ceased at a point where evidence of surface water flow could no longer be identified. The termination point coincided with an elevation increase.

No definitive barriers were located on the main-stem, downstream of Savoie Road. The diversity of fish habitat decreases in the upper-most reaches of the watershed, based on the historical and recent modifications to the watercourse. The most likely segments of the stream to support fish occur in the lower reaches, downstream of Savoie Road.

3.2.4.1 Tributary 1

Tributary 1 enters the main-stem creek on river left, immediately downstream of the Savoie Road crossing. At the confluence, the watercourse flows down over a gravel ledge of approximately 7% – 8% slope. Immediately upstream of the ledge, the watercourse represents a well-defined roadside ditch as it flows in a northerly direction along Savoie Road. Along the assessed length, the ditch ranges between 0.85 m and 1.1 m and the substrate is a mixture of small gravel and organic material. Near Central Road, the ditch channel is inconspicuous as it flows through a dense blanket of reed canary grass.

Tributary 1 can be classified as having poor habitat potential for fish. The watercourse will only contain water after heavy rainfall events and dense vegetation growth likely makes the upper portion of the ditch is inaccessible. Mapping of this drainage was terminated at Central Road.

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Figure 6: Potential RAR Watershed3

PROJECT:
Hornby Island Riparian Area Stream Mapping

CLIENT:
Islands Trust

MAP SCALE:	MAPPING DATE:
1:3,000	December 18, 2013
DOSSIER NO:	DRAWN BY:
13.0315	Anna Riionheimo

LEGEND

- Watershed Boundary
- Streams (10m SPEA under detailed RAR Assessment based on bankfull width)
- 5m. (Potentially Fish-Bearing Ditch)
- Not field verified due to lack of access permission

Onstream Ravine Extents

- Upstream
- Downstream
- Barrier

Wetlands Observed in Field

- Pond

Base Symbols

- Roads
- Properties
- Inaccessible property (no access permission)

N

0 15 30 60 90 120 m.

4.0 DISCUSSION AND RECOMMENDATIONS

Stream mapping performed in the target watersheds on Hornby Island resulted in the identification of approximately 9 km of streams that are applicable to the provincial RAR process. Connected wetlands, lakes and ponds located along each mapped stream are also applicable to the RAR.

While there may be no documented fish occurrence, potential fish habitat (albeit marginal) occurs in the outlet streams associated with the three "potential" RAR watersheds. As a result, these watersheds were included in the mapping process. Based on habitat conditions described in the Mimulus report (2012), habitat encountered in the upper Beulah Creek watershed and anecdotal evidence contained in the Mimulus report (2012), Beulah Creek represents the best fish habitat in any of the mapped watersheds.

Due to the RAR methodology, any watercourses that connect by surface flow to potential fish bearing systems, including modified watercourses and ditches, are subject to the regulation. A stream may not itself be inhabited by fish, but if it has a reasonable connection by surface flow to fish habitat, it is considered a stream under the RAR.

All streams were mapped for inclusion into appropriate bylaws to be set up by Islands Trust to allow conformance with the provincial RAR process. The edges of lakes, wetlands and ponds located along the stream traverses were not mapped in the field as part of the assessment process, but the edges were delineated using field observations and orthophoto interpretation. It is important that these features are included as RAR-applicable water bodies.

All efforts were made to establish a complete representation of the stream network in each of the target watersheds. It should be noted that lack of access permission prevented the mapping of certain areas. In all cases, areas that could not be mapped were identified on the mapping layers, and efforts were made to map the streams using contour and imagery analyses. In some instances where low-magnitude streams were being mapped in the Beulah Creek watershed, the dry conditions and lack of surface flow made it difficult to identify the location of streams, especially through low gradient areas.

As part of the project scope, bankfull widths were measured on each applicable stream to help determine the width of the SPEA under the RAR methodology (using the detailed assessment methodology). This information can be used by Islands Trust as a planning tool to help implement bylaws that "meet or beat" the RAR. If this option is chosen, it is important to note that any bylaw that is set up would need to account for the fact that under the detailed RAR assessment methodology, a suite of measures are considered that help ensure the integrity of the SPEA during development activities. These measures include, but are not limited to: slope stability; erosion and sediment control; encroachment; management of danger trees; and windthrow.

Based on the low-magnitude of the streams throughout all the assessed watersheds and the measured bankfull widths, all mapped streams would be associated with 10 m SPEAs under the Detailed Assessment. No bankfull measurements were completed for those areas of the Beulah Creek watershed that had previously been mapped by Mimulus (2012). The level of detail contained in the Mimulus report (2012) appears sufficient to determine SPEA widths and to implement planning measures in the previously mapped areas.

It should be noted that the vast majority of mapping that was completed for Beulah Creek occurred throughout a regional park (Mt. Geoffrey Nature Park). The RAR would not currently apply to this park area, but future land use may change. In places, the mapped tributaries (e.g. Tributary 1) become part of the trail system, with water flowing over the trail surface.

One potential planning opportunity would be to add depth to the edge of the minimum SPEA DPA boundary (*i.e.,* increasing the DPA beyond the widths that have been provided in this project). This would help ensure the integrity of the setback area is maintained in the absence of detailed assessment measures. Landowners could then be given the opportunity to have a detailed assessment completed by a QEP if they were not prepared to accept the default bylaw riparian setback. If the default "meet or beat" setback option is accepted by a landowner, a site visit by a planner, building inspector or QEP may be required to ensure that the setback is being maintained and is being measured from the correct location. If a landowner chooses to complete a detailed assessment by a QEP, the precise location of the HWM and SPEA would be identified as part of the reporting procedure.

Setting up permanent riparian setbacks that would "meet or beat" the RAR would also need to take into account the fact that numerous riparian areas are currently developed, or encroached upon. Landowners should be encouraged to enhance riparian areas, especially adjacent to sensitive areas, or areas that are experiencing erosion due to the removal of riparian vegetation.

It is important that landowners are aware of the benefits of riparian areas. Landowners adjacent to streams often do not realize the financial incentives of maintaining a functioning riparian zone. For example, intact riparian vegetation can help prevent lateral bank movement, thus protecting valuable property from erosion. Potential hazards associated with flooding can also be ameliorated as a result of maintaining a functioning riparian area.

The SPEA dimension data could also be used to educate the public about the extent of riparian setbacks should 30 m DPAs be set up, which represents the maximum extent of the Riparian Assessment Area (RAA). Any new development proposed within any RAA would trigger the completion of a detailed assessment under the RAR methodology. In the case of all the assessed watersheds, SPEAs would be 10 m throughout, based on the low stream magnitude and corresponding bankfull widths.

Under the detailed assessment, wetlands and lakes that either provide fish habitat or connect by surface flow to fish habitat receive either a 30 m or 15 m setback, depending on aspect. Southern edges of wetlands and lakes are associated with 30 m setbacks, based on the function of shade, where-as north, west and east banks are associated with 15 m setbacks. In some cases where smaller ponds and wetlands are located on a main stream channel, a Qualified Environmental Professional may decide that the feature is part of the lotic system as opposed to being a separate lentic system. In such cases, the pond or wetland may be associated with the SPEA derived for the stream under the Detailed Assessment, as opposed to the default 15 m or 30 m setbacks associated with ponds and wetlands.

One ditch was identified during the assessment – Tributary 1 in potential RAR watershed 3. This ditch represents potential fish habitat, and also connects to a potentially fish bearing watercourse. As a result, the ditch is associated with a SPEA under the RAR. The identified ditch is a constructed waterway, with no significant headwaters or springs.

Under the RAR, fish bearing ditches can receive SPEAs up to a maximum width of 10 m (based on ditch width). The SPEA indicated for the ditch in this report is based on the average width of the ditch and the SPEA dimensions shown in the RAR Assessment Methodology for fish-bearing ditches. Based on the fact that ditches are associated with narrower SPEAs, the DPA that is implemented by Islands Trust could be less than the DPA associated with watercourses that are not classified as ditches.

The scope of the project involved the identification of stream centre lines. Under the RAR methodology, the RAA is measured as a horizontal distance from the TOB or TORB, where-as the SPEA is measured from the HWM. In the case of wetlands, lakes and ponds, the RAA and SPEA are measured as a horizontal distance from the HWM. During the fieldwork, the lateral extent of ravines was identified, in order to identify those sections of streams where the RAA (or DPA) would extend back from the TORB. In the case of wide ravines that exceed a width of 60 m, the RAA extends from the HWM to a point that is 10 m back from the TORB; ravines that are less than 60 m wide are associated with a RAA that extends 30 m beyond the TORB from the HWM. The scope of the project did not include surveying the width of ravines.

A means of addressing the issue of recognizing the TOB, TORB, or HWM at the bylaw implementation stage would be to ensure that any proposed development that is close to a point that is 30 m from the stream would trigger site specific confirmation. On extensive acreages, it would be a relatively straightforward task to determine whether the proposed development occurs within a DPA. Smaller properties may require a site visit by a building inspector, planner or QEP to determine whether the proposed development occurs within a DPA.

It is worth noting that farming activities are not subject to the RAR, but are subject to the federal Fisheries Act. The RAR does apply, however, to non-farming activities on ALR land.

The RAR does not apply to existing land uses and structures, as these are considered legally non-conforming. Any new developments inside a previously developed SPEA or RAA would trigger the RAR, and the new development would be subject to the RAR. Enhancement of riparian areas using appropriate techniques (e.g. replanting with native vegetation to stabilize banks) is encouraged in previously impacted riparian areas.

As part of the RAR bylaw planning and implementation phase, Islands Trust should liaise with the provincial government. Liaison with appropriate government personnel will help ensure that the bylaws that are enacted meet or beat the standards of the RAR.

If you have any questions or comments about the mapping project, please do not hesitate in contacting the undersigned.

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APPENDIX I – PHOTOS

Beulah Creek Watershed
Beulah Creek main-stem

Typical characteristics of Beulah Creek at the mapping start point (Coltsfoot trail crossing) – looking upstream.

Looking upstream along the middle segment of the mapped portion of Beulah Creek.

Typical characteristics of the upper segments of the mapped portion of Beulah Creek. Note poorly defined channel morphology and shallow surface flow over an organic substrate.

Dense sword fern and slough sedge at the source of Beulah Creek.

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Tributary 1 and Tributary 1-1

Shallow surface flow through sword fern indicating the characteristics of Tributary 1 at the point where mapping commenced.

Looking downstream from the first trail crossing over Tributary 1. Note well defined ditch banks merging into a poorly defined channel in the low gradient forested ecosystem downstream.

Looking downstream along the ditch branching to the north from the main Tributary 1 ditch line.

Looking upstream along the ditch pictured above at the crossing under the trail. Note well defined ditch banks.

Looking downstream along the ditch pictured above. Note lack of channel definition beyond the ditched section.

Looking upstream along Tributary 1 where it is ditched immediately upstream of the first trail crossing.

Looking upstream along Tributary 1 where it is not confined along the trail in a ditch. Note poorly defined channel morphology and minimal surface flow through slough sedge.

Looking upstream along Tributary 1 immediately upstream of the Coltsfoot trail crossing.

Looking upstream along Tributary 1 where it flows adjacent to a trail.

Looking upstream along Tributary 1 where it flows over Spasm Chasm trail.

Looking upstream along Tributary 1 where it flows in a high-sided ditch parallel to Spasm Chasm trail.

Looking upstream along Tributary 1 upstream of Spasm Chasm trail. Note channel/bank instability and evidence of high, flashy flows.

Looking upstream along Tributary 1 upstream of Lox's Bagel trail.

Patchy slough sedge in a depression close to the height of land represents the source of Tributary 1.

Tributary 1-1

Looking downstream along the middle segment of Tributary 1-1.

Looking downstream along Tributary 1-1 where it flows through a narrow draw immediately upstream of the Northwind trail.

Looking upstream along Tributary 1-1 at the Northwind trail crossing.

Wide flat area close to the height of land represents the source of Tributary 1-1.

Tributary 2

Looking upstream along Tributary 2 close to the confluence with Beulah Creek. Note poorly defined channel morphology and shallow surface flow over an organic substrate.

Tributary 3

Looking downstream along Tributary 3 at the confluence with Beulah Creek.

Tributary 4

Looking upstream along Tributary 4 close to the confluence with Beulah Creek.

Tributary 5

Looking upstream along Tributary 5 close to the confluence with Beulah Creek. Note shallow surface flow through slough sedge over an organic substrate.

Slough sedge and patches of sword fern and surrounding red alder represents the source of Tributary 5.

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Unconnected Watercourse

Looking upstream along the watercourse where it is defined in a ditch adjacent to Coltsfoot trail.

Looking downslope from the defined ditched segment of the watercourse towards the moist, flat forest where water from the drainage appeared to dissipate.

Looking upstream along the watercourse where it flows over Coltsfoot trail.

Looking upstream along the watercourse where it flows adjacent to (and over) the Slickrock trail surface. Note surface flowing water (albeit minimal) and cobble substrate.

Looking upstream along the watercourse where it is defined adjacent to Slickrock trail.

Looking upstream along the watercourse upslope of Slickrock trail.

Moist depression with red alder, western redcedar and Douglas-fir represents the source of the watercourse.

Southern Tributary Sub-basin Extension

Looking upstream along the mapped extension of the tributary. Note relatively well defined channel and alluvial deposits.

Looking upstream along a higher gradient segment of the mapped extension of the tributary. Note cobble substrate, which indicates high energy seasonal flows.

Potential RAR Watershed 1

Looking upstream from the natural boundary of the marine environment. Note the accumulation of drift wood and dense reed canary grass growth.

Looking downstream at the subject drainage. Note the channel morphology, which is consistent with that of a constructed ditch.

Looking upstream at the headwaters of the subject drainage. This wetland contains a component of both open water habitat and densely vegetated areas.

Potential RAR Watershed 2

Looking east at the area where the stream flows into the intertidal habitat near Hidden Beach Park.

Typical channel morphology of the lower sections of the stream. Note the channel definition and alluvial substrate.

Looking downstream at the channel morphology of the East Fork of the drainage. Note the straight channel and excavated sidewalls, which are typical of ditches.

Looking west at the area where the East Fork flows through a roadside ditch immediately upstream of its convergence with the West Fork of the stream.

A photo depicting the anthropogenic influence on the subject stream. Note the lack of biologically functioning riparian vegetation, a common observation where the stream flows through residential areas.

Looking north at a portion of the stream which was excavated, forming a pond. Anecdotal evidence indicated this pond was constructed to provide a viable source of water for residential use.

Looking northwest from the high water mark of the slough sedge wetland, which is the headwaters of the watershed. Throughout this area channel definition is lacking and organic substrate dominates.

Tributary 1

The confluence of Tributary 1 and the main drainage channel. Note Tributary 1 flows from the southwest.

A photo depicting the general channel morphology of Tributary 1 throughout the assessed area. The upper section of Tributary 1 displays evidence suggesting that it is a constructed watercourse.

Potential RAR Watershed 3

Looking southeast from the natural boundary of the marine environment. Note the placement of boulders, cement and sandbags for the purpose of stabilizing the bank.

Looking south (upstream) at the stream as it nears Savoie Road.

Looking south at a dam system that was likely installed for the purpose of retaining water in particular areas of the stream to provide a water source for residential use.

Looking north (downstream) at the West Fork of the stream, which was excavated as a drainage ditch. Note the consistent depth and width of the channel.

Looking north at the area where the West Fork of the stream flows into the ocean. The drainage flows over a moderately steep ledge and is extensively overgrown.

Looking upstream at the culverts that direct the stream under a residential access road.

Tributary 1

The confluence of Tributary 1 with the main stem of the stream. Note that Tributary 1 is the watercourse in the foreground of the photo.

Tributary 1 flows north, adjacent to Savoie Road and possesses channel morphology typically observed in roadside ditches.