

Crystal Mountain Ecosystem-based Land-use Plan

**Parcel A of DL89 except part in plan 27287
& Lot 9 Plan 31200 DL90
Galiano Island, BC**



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1.1 Background and Purpose of the Crystal Mountain Society

The following is an excerpt from the “Crystal Mountain 2008 – 2009 Priorities” document:

The purpose of Crystal Mountain Society is to support the awakening of individuals and thus their compassionate involvement with others through short and long-term meditation retreat instruction year round.

Operation and development of the Society and its properties should:

- *Encourage the unfoldment and awakening of individuals*
- *Be low maintenance*
- *Scaled to the available human resource and financial capacity of the Society*
- *Rely on multiple sources of revenue generation (other than just teaching)*
- *Meet the physical needs and comforts of teachers and students to comfortably study meditation*
- *Be ecologically managed (green development, low impact and ecological harvesting)*

It is Crystal Mountain’s goal to create a forest retreat facility on Galiano Island in support of the practice of meditation. The following is an excerpt from the “Crystal Mountain Visioning Session Report” (included as Appendix 2). It is a portion of the brief review of the history of the land read by John de Jardin at a meeting held on August 19th, 2007.

In 1978, a group of us living here on the West Coast incorporated Crystal Mountain as a registered non-profit educational and charitable society, with the stated objectives of performing charitable works and promoting the study of religion and philosophy through the teaching and practice of meditation. Finding ourselves with a rare fiscal surplus in the summer of 1980, the members of the society decided to buy some land for a retreat centre and, in November of that year, we purchased two 10-acre lots at the end of Devina Drive on Galiano.

Our first summer kitchen, with its’ hyperbolic paraboloid roof, must have left more than a few observers scratching their heads in bewildered amusement. Gradually, however, enough was accomplished to make the centre capable of handling modest summer retreats, and over the years the Venerable Namgyal Rinpoche and a number of his students, who have become qualified meditation teachers themselves, have led many successful courses on the property.

While most of our activities have had some connection with what might be called ‘the lineage’ of the Venerable Namgyal Rinpoche, our charter is purposefully non-denominational to reflect the universalist and eclectic flavour of this teaching. Rinpoche continues to draw on his early training as a Theravadin monk, while skilfully incorporating elements of Western mysticism, science and psychology into the ever-expanding Tantric mandala of his Vajrayana teaching.

‘Buddha dharma’, in its widest sense, means simply ‘the laws that underlie the awakening of human beings’, and it cannot be confined to any particular religion or culture. Though we recognize the value and necessity of preserving and supporting traditional forms, our primary concern is with furthering the inevitable development of a Western expression of Buddhism.

1.2 Purpose of the Report

The purpose of this report is to:

1. Determine how to protect, maintain and where necessary, restore functioning ecosystems on the Crystal Mountain land; and,
2. Recommend ways to minimize the impacts of Forest Retreat uses within the context of the identified ecological constraints.

To meet this purpose, an ecosystem-based approach has been used. An ecosystem-based approach focuses first on what to protect and second on what to use.

1.3 Consultation Process

This report has been developed in consultation with several Crystal Mountain members. Primary direction has been provided by Stephen Foster, Helen Foster, Mark Webber and Jamie van Dam. Jamie van Dam and Stephen Foster also assisted with some of the data collection. Consultation included project development via e-mail and telephone with Kim Lenglet and Stephen Foster, four group visits to the property, several personal meetings and many e-mails and phone conversations with the primary contacts as well as an educational/planning workshop attended by 12 Crystal Mountain members.

1.4 Limitations, Assumptions and Disclaimer

Most of the proposed uses within this document are not currently permitted by local land-use regulations. Proceeding with land use that includes a Retreat Centre will require a rezoning process and revisions to the current Official Community Plan (OCP). While a property plan that specifically addresses ecosystem protection goals and sustainable forest use is likely to be an essential component of a rezoning proposal, Crystal Mountain's success will also likely depend on favorable public input during rezoning and a willingness on the part of the Galiano Community to include educational / spiritual retreat facilities in Galiano's forests.

The contribution of some of the data used to create maps for this report was generously provided by the Galiano Conservancy Association. However, the provision of data does not imply support for the recommendations in this report or for any related land-use or planning.

1.5 Location of Properties

The Properties are located on the northern end of Galiano Island, one of the southern Gulf Islands in the Strait of Georgia, British Columbia. The lower portions of the properties can be accessed from Porlier Pass Road through an easement across Lot B, Plan VIP68079, DL 88/89 and from the terminus of Devina Road. The upper portion of Lot A can be accessed from Cook Road across an easement through Lots B and C VIP68079 DL88/89 and the upper portion of Lot 9 can be accessed from the end of Devina road through Lot 10. Please refer to MAP 1 for the location of the Properties.

1.6 Legal Description and Size of the Properties

The Properties are legally described as:

Parcel Identifier: 024-351-041

Lot A, District Lot 88 and 89, Plan VIP68079, Galiano Island, Cowichan Land District.
20.25 hectares (50 acres)

Parcel Identifier: 000-851-035

Lot 9, District Lot 90, Plan 31200, Galiano Island, Cowichan Land District.
4.05 hectares (10 acres)

1.7 Land Use Designation, Zoning and Regulations

1.7.1 Lot A Zoning Regulation

Lot A has a current Land Use Designation in the Galiano Island Official Community Plan (Consolidated Oct, 30 2013) of 'Forest'. These OCP policies state the following objectives for 'Forest':

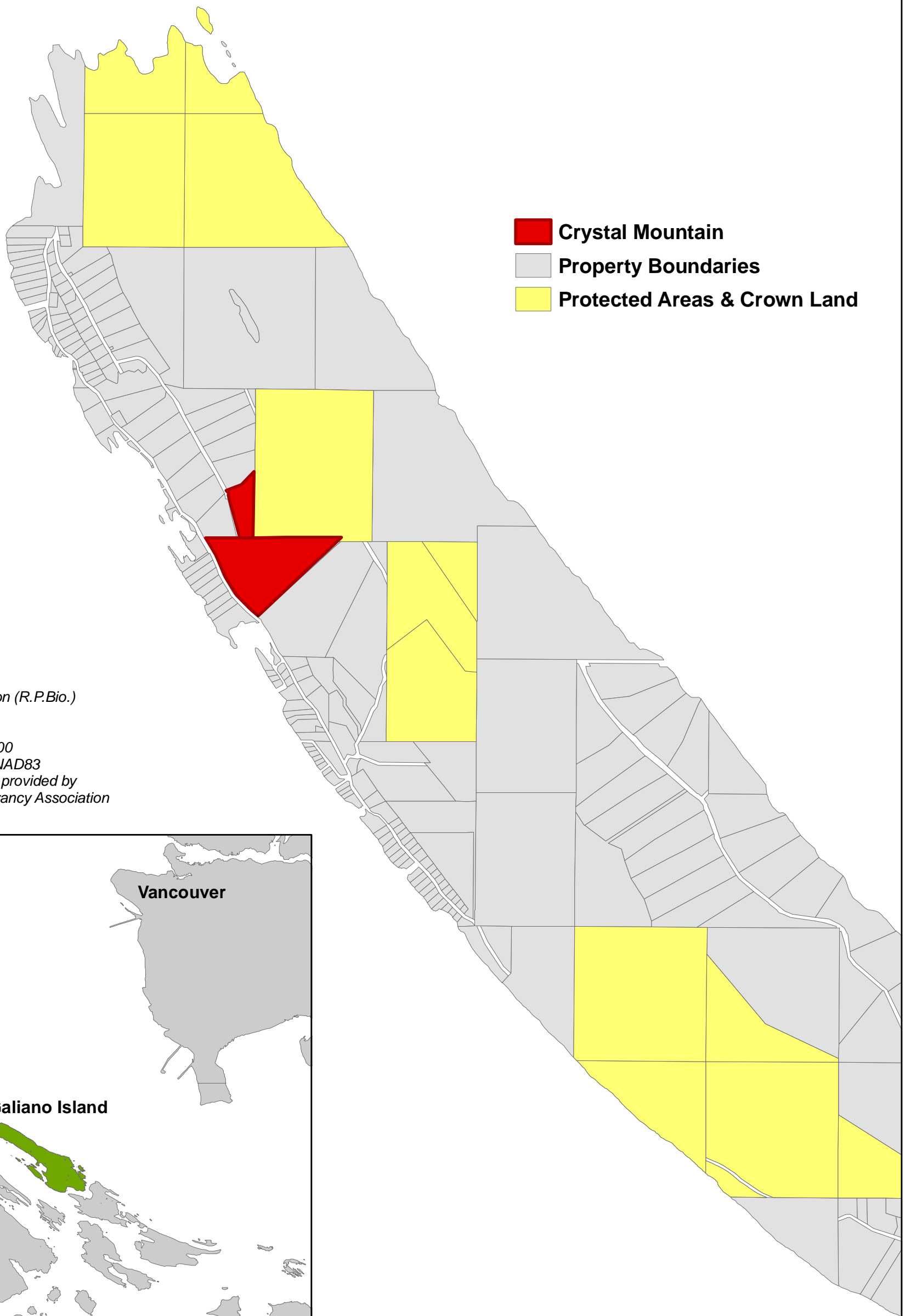
1. to preserve a forest land base,
2. to preserve and protect the forest, its biodiversity, integrity and ecological services,
3. to encourage ecosystem-based sustainable forest management for all forested lots and to encourage economic opportunities through this forest management practice,
4. to encourage ecological restoration of degraded forest stands, and
5. to maintain or enhance carbon storage and sequestration.

1.

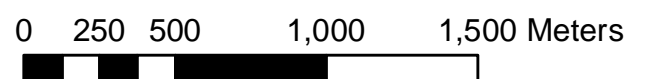
The Properties have a current zoning designation of "Forest 1" under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013).

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-- Property Location and Surrounding Protected Areas --



Produced by: Keith Erickson (R.P.Bio.)
Map Date: January 2009
Scale: 1 : 25,000
Inset Map Scale: 1 : 600,000
Projection: UTM Zone 10 NAD83
Data: Property boundaries provided by
the Galiano Conservancy Association



Under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013), Section 7.1, the following uses are permitted in the Forest 1 Zone:

1. Timber production and harvesting
2. Accessory forest uses including the sawmilling and planing of timber harvested on the same lot and the growing of seedlings in nurseries.

Under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013), Section 7.1, the following Buildings and Structures are permitted in the Forest 1 Zone for Forestry Uses:

A single non-residential unenclosed building or structure with a floor area not exceeding 93 square metres is permitted in each lot and every such building or structure must be screened by a landscape screen not less than 9 metres in height and complying with the requirements of subsection 15.1.1 of this bylaw.

1.7.2 Lot 9 Zoning Regulation

Lot 9 has a current Land Use Designation in the Galiano Island Official Community Plan (Consolidated October 30, 2013) of 'Residential'. These OCP policies state the following objectives for 'Residential':

1. to maintain the rural character, minimize impacts to ecosystems and services they provide and support social diversity of the Galiano Island Local Trust Area, and
2. to encourage affordable, rental and special needs housing.

1. .

The Property has a current zoning designation of "Rural 2" under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013Consolidated November 4, 2013).

Under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013Consolidated November 4, 2013), Section 5.5, the following uses are permitted in the Rural 2 Zone:

1. Dwellings
2. Cottages
3. Home occupations
4. Farm use

Under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013), Section 5.5, the following density of residential use is permitted on Lot 9:

1. One dwelling and one cottage

Under Galiano Land Use Bylaw NO. 127 (Consolidated November 4, 2013), Section 5.5, the following minimum setbacks are enforced: Buildings and structures must be sited

1. at least 7.5 metres from front and rear lot lines;
2. at least 6 metres from each interior side lot line; and
3. at least 6 metres from an exterior side lot line.

Buildings and structures for the accommodation of farm animals including poultry must be sited

1. at least 7.5 metres from a front lot line;
2. at least 30 metres from rear and interior side lot lines; and
3. at least 6 metres from an exterior side lot line.

1.7.3 Development Permit Areas

The *Municipal Act* prohibits the subdivision of land, the construction of buildings and the alteration of land in a Development Permit Area unless the owner first obtains a development permit.

Both Lot 9 and Lot A are subject to *Development Permit Area 3 – Tree Cutting and Removal*, *Development Permit Area 5 – Sensitive Ecosystems*, and *Development Permit Area 7 – Steep Slope Hazard Areas* described in ‘Section V’ of the Galiano Island Official Community Plan (Consolidated October 30, 2013). The OCP stipulates that:

Lot A is also subject to Development Permit Area 1 – Riparian Areas as described in ‘Section V’ of the Galiano Island Official Community Plan (Consolidated October 30, 2013).

2.1 Land Management Philosophy

In accordance with consultations with Crystal Mountain members, and in keeping with the vision expressed in the “Crystal Mountain 2008-2009 Priorities” and “Crystal Mountain Visioning Session” reports, the overarching philosophy behind the management of the land is to keep things simple – to minimize the ecological impacts, the overhead costs and the ongoing maintenance associated with the development and operation of all required services and infrastructure. The permaculture concept of layering or achieving multiple goals through a single action is central to keeping things simple.

Management and use of the land will strive to maintain or promote the inherent natural aesthetic and ecological composition, structure and function within property boundaries and across the landscape in perpetuity.

2.2 Objectives

1. Educational and Spiritual

To support the awakening of individuals and thus the compassionate involvement with others through short and long-term meditation retreat instruction and practice, year round.

2. Conservation

To protect and enhance the integrity of Provincially significant Coastal Douglas-fir forest and associated aquatic ecosystems within the properties and to contribute to landscape level conservation values (ie. large contiguous natural areas, healthy groundwater recharge areas) through maintaining and enhancing ecological connections with adjacent protected areas and natural areas on other surrounding lands.

3. Ecological Restoration

To help the land heal – to aid in the recovery of ecosystems that have been damaged primarily by destructive logging practices and to promote compositional diversity (the parts), structural diversity (the arrangement of the parts) and functional diversity (interactions among the parts).

4. Eco-forestry

To provide opportunities for the harvest of wood products (such as firewood, poles or timber for construction) or wildcrafting products (such as greenery, edible plants and mushrooms, or medicinal plants) in a manner that is consistent with the stated conservation and ecological restoration objectives.

3.1 Biological and Geographical Inventory

3.1.1 Climate¹

The rainshadow effect of the Olympic and Vancouver Island mountains and the moderating effects of the ocean are the dominant influences on the climate of Galiano Island. Kerr (1951) describes the Island as having a “Transitional, Cool Mediterranean Climate”. Galiano exhibits a pattern of warm, dry summers and mild, wet winters with an average of approximately 1,900 to 2,000 hours of sunshine (Renneseth and Barr, 1982) and 254 frost free days (Agriculture Canada, 1989) per annum. The average annual rainfall recorded at the North Galiano Atmospheric Environment Service station is 920 mm (from 1977 to 1988). Annual rainfall ranges from 597.3 mm to 1152.6 mm (Harrison, 1994). Over 75% of the total annual precipitation falls during the winter months (Nov. to Feb.), with less than 10% falling as snow.

The months of January and February produce the coldest mean temperatures of 4° to 5° Celsius, while July and August are the warmest months with mean temperatures of 17° to 19° Celsius. The combined effects of low precipitation, warm temperatures, and high number of sunshine hours often result in an annual moisture deficit on Galiano Island from mid-June to early October (Harrison, 1994). This deficit can often reach drought conditions in areas of recent clearcuts, such as those found on Lot A, and can result in an extreme forest fire hazard.

3.1.2 Topography

The properties exhibit a complex topography through a series of 4 major southeast to northwest running ridges with their associated steep southwest facing slopes and cliffs, gentle northeast facing slopes and wet depressions or flat benches. The elevation ranges from approximately 10 meters at the lowest point along Porlier Pass road to 125 meters at the highest point near the northeastern corner of Lot A. All areas of the property are below 140 meters in elevation and are not part of “Development Permit Area 4: Elevated Groundwater Catchment Areas” described in the Galiano Island Official Community Plan (Consolidated October 30, 2013).

3.1.3 Hydrology

The properties fall within the North Trincomali Groundwater Region, with a surface flow that empties into the Trincomali Channel. Approximately 10 hectares or just over 40% of the properties are designated as Groundwater Recharge Areas. Recharge areas generally incorporate the higher elevation portions of the properties including the teaching platform ridge and its associated steep southwest facing slope and gentle northeast facing slope and the area including

¹ Excerpt from: *Erickson, Keith. 2008. Heritage Forest Management Plan. Galiano Conservancy Association. Galiano Island.*

and above the major cliff/ridge that bisects the properties. The moist forest, wetland and creek areas in the depressions are considered to be part of the groundwater discharge zone. Elevated water recharge areas such as those found on the property are considered of great value to the maintenance of water quality in aquifers, of special significance for wells drilled at lower elevations along the shoreline with regard to salt water intrusion.

Spotlight Creek is the major drainage system associated with the properties running roughly from northwest to southeast through the lower portion of the properties. The creek originates from the large wetland complex adjacent to Devina Drive flowing under the main driveway access to Lot 10. The Spotlight Creek watershed is relatively small, even by Galiano standards, totaling approximately 60 hectares in size. The creek is intermittent and runs only during peak rainfall months from November through to the spring. In accordance with the BC Riparian Areas Regulation assessment methodology, Spotlight Creek is considered a non-fish bearing system and does not support salmonids, game fish or regionally significant fish. Fish absence was determined based on stream gradient and the presence of a human made permanent impassible barrier as the creek enters Spotlight Cove. The impassible barrier is a 20 meter long culvert at a 10% slope with a measured 2cm maximum stream depth at high flow (December 30, 2009). The creek gradient increases to 30% for a 15 meter stretch just upstream from the culvert and then flattens back down to 10% for close to 300 meters. The stream is completely dry over the summer months, eliminating the possibility for presence of any resident fish species.

The upper portion of the properties located roughly above 100 meters in elevation are a part of the Jack Creek Watershed, however, stream channels or any above ground flow associated with the Jack Creek were not observed on the properties.

3.1.4 Soil

According to the Agriculture Canada report, *Soils of the Gulf Islands of British Columbia Volume 3*, the Properties are characterized by three different soil types:

1. Saturna: Saturna is the dominant soil type on the properties covering the majority of the gently to moderately sloping areas over roughly 55% of the property. Saturna soils are well-drained and droughty during the summer. They have developed on shallow deposits of channery, sandy loam to channery, loamy sand textured, colluvial and glacial drift materials over sandstone bedrock within 100cm of the surface. Areas of the property are characterized by very shallow lithic Saturna soils often associated with bedrock exposures or very thin mineral soil layers less than 50 cm deep. Coarse fragment content varies between 20 and 50%.
2. Rock-Saturna: Rock-Saturna soils are found along the ridges and associated steep southwest facing slopes on the properties and account for roughly 30% of the area. They are characterized by patches of exposed sandstone bedrock often covered with moss, mixed with

areas covered with a shallow well drained Saturna mineral soil layer. Mineral soils are either colluvial or glacial drift derived, generally between 10 and 50cm thick and have a coarse fragment content that varies between 20 and 50%.

3. Parksville: Parksville soils are a minor component of the properties accounting for roughly 15% of the area. They occur on nearly level to very gently sloping (0.5 – 5%) topography in depressional areas, swales and drainageways between bedrock ridges. Parksville soils are poorly drained with a layer of sandy or silty loam of fluvial origin overlying deep silty clay loam to silty clay textured marine deposits that are virtually stone free. Distinct mottles are often present within 50 centimeters of the surface. They are saturated with water to within 30cm of the surface from late fall to spring. During summer, the water table drops to below 60cm, allowing the surface horizons to become dry. Soil receives seepage and runoff water from surrounding slopes, which tends to keep the soil moist during dry periods.

3.1.5 Wildlife

The diversity of ecosystems on the properties supports many species of animals. Fauna observed while surveying the lot are listed below. Surveys took placed between September 2009 and December 2009.

List of bird species observed:

Turkey Vulture	Northern Flicker	Winter Wren
Red-tailed Hawk	Pileated Woodpecker	Varied Thrush
Bald Eagle	Common Raven	American Robin
Barred Owl	Northwestern Crow	Dark-eyed Junco
Rufous Hummingbird	Chestnut-backed Chickadee	Pine Siskin
Downy Woodpecker	Common Bushtit	
Hairy Woodpecker	Brown Creeper	

Other fauna observed include:

<u>Mammals</u>	<u>Amphibians</u>	<u>Reptiles</u>
Red Squirrel	Red-legged Frog (blue-listed)	Northwestern Garter Snake
Raccoon	Pacific Tree Frog	
Black-tailed Deer	Rough-skinned Newt	
Deer Mouse		

3.1.6 Ecosystem Types

The Crystal Mountain Lands are characterized by a wide range of ecological conditions due to their topographic complexity and past logging activities. Ecosystem types are determined by two primary factors – the site characteristics (such as soil, slope and aspect) and the disturbance

history (the type of disturbance and time since it occurred). The soils and the topography determine the various species and assemblages of plants that will grow on a site and the disturbance history determines the present condition of the plant communities and their successional status (eg. plant communities that form immediately after a disturbance such as a regenerating clearcut vs. plant communities that form 300 years after disturbance - an old-growth forest).

Soil conditions generally follow topographic trends with deeper, moister, nutrient rich soils occurring in the depressions and shallow, dry, nutrient poor soils occurring on the ridge tops. The general pattern of vegetation from a wet depression to a dry ridge top is as follows:

- Depressions are often dominated by broadleaf trees with scattered large diameter conifers growing on rich raised mounds. The understory is diverse and lush in appearance, often characterized by a mix of shrubs, ferns, sedges, rushes, grasses and mosses.
- Moist depression areas generally transition to conifer dominated lower to mid-slopes with patchy but robust shrub and fern dominated understories that generally coincide with canopy gaps. The composition of the trees and understory varies depending on the aspect (the direction that the slope faces) and how steep or gentle the slope is.
- Upper slope and ridge-top areas are generally comprised of a mix of conifer and broadleaf (primarily *Arbutus* (*Arbutus menziesii*)) with a more consistent cover of understory shrubs and mosses with fewer ferns. The shallow and poor soils on the ridge-tops generally produce smaller diameter trees that are gnarly or weathered in appearance.

Succession ranges from undisturbed mature climax forest on some of the very steep southwest facing slopes to highly disturbed, non-vegetated sites where the soil disturbance from logging related activities was so severe that pioneering vegetation has not yet been able to establish. The general pattern of vegetation development after a clearcut is as follows – a flush of herbaceous and shrubby vegetation emerges as tree seedlings begin to establish about 3 years after the disturbance leading to a diverse mixed pole/sapling forest with a robust, diverse understory for about 20 years. The pole/sapling forest then moves into the young forest phase characterized by a very dense conifer dominated tree canopy with a sparse understory and general loss of diversity. The young phase lasts for roughly 40 to 50 years as the forest slowly thins itself out through natural competition and the onset of various root diseases and other pathogens. These natural processes lead to the young forest's transition into a more complex, multi-layered, mixed species mature and eventually old-growth forest diverse in composition (the parts), structure (the arrangement of the parts) and function (how the parts work).

The majority of Lot A is recovering from an intense clearcut which took place in 1993. The land is currently in the pioneering seral stage characterized by patchy and diverse pole / sapling forest of varied vegetative composition depending on slope position, aspect, slope and soil depth. The moist depression sites are generally dominated by red alder (*Alnus rubra*) with sword fern

(*Polystichum munitum*) and patches of salmonberry (*Rubus spectabilis*) in the understory. The drier, gently sloping logged areas are characterized by dense patches of Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) poles with very little understory vegetation scattered within a more open mix of Douglas-fir, red alder, bitter cherry (*Prunus emarginata*), big-leaf maple (*Acer macrophyllum*), grand fir and arbutus with salal (*Gaultheria shallon*), Oregon-grape (*Mahonia nervosa*) and sword fern dominant in the understory.

Remnant patches of healthy mature forest are located in thin strips along the ridge tops and down the associated southwest facing steep slopes where logging was not practical. The majority of Lot 9 is also characterized by mature forest growing under a variety of ecological conditions. Ecosystem types range from western redcedar (*Thuja plicata*), Douglas-fir, big-leaf maple dominated northeast facing, moderate slopes to red alder, salmonberry dominated seasonally flooded wetland depression to Douglas-fir, arbutus dry rocky ridge top.

Each of the 30 ecosystem types identified on the Crystal Mountain Lands has been listed and described according to its site characteristics, vegetation, and soils as well as its related disturbance history, successional trajectory and restoration issues. Ecosystem types have been identified through field work conducted between September 2009 and December 2009. The detailed ecosystem type descriptions have been included as Appendix 1 of this document. MAP 2 shows the locations of the various ecosystem types.

3.2 Disturbance History

The primary disturbance on the properties over the past century has been logging. Lot A has been logged at least twice and Lot 9 once. MacMillan Bloedel records suggest that the upper portion of Lot A was cut in the late 1870's while the lower portion was cut in the early 1920's. Timbermarks suggest that Lot A was clearcut by the owner previous to Crystal Mountain between 1993 and 1996. It appears that the property was not planted and is regenerating naturally. The clearcut was intensive and appears to have been completed with excavators and skidders resulting in significant impacts to the soils, especially in moist and seasonally flooded areas.

3.3 Conservation Significance

The Crystal Mountain lands are located within the Coastal Douglas-fir Biogeoclimatic Zone (CDF), an ecological classification that has recently been identified as imperiled (a high risk of extinction) both Provincially and globally in Biodiversity BC's "Taking Nature's Pulse: The Status of Biodiversity in British Columbia". The fact that the Crystal Mountain lands have not

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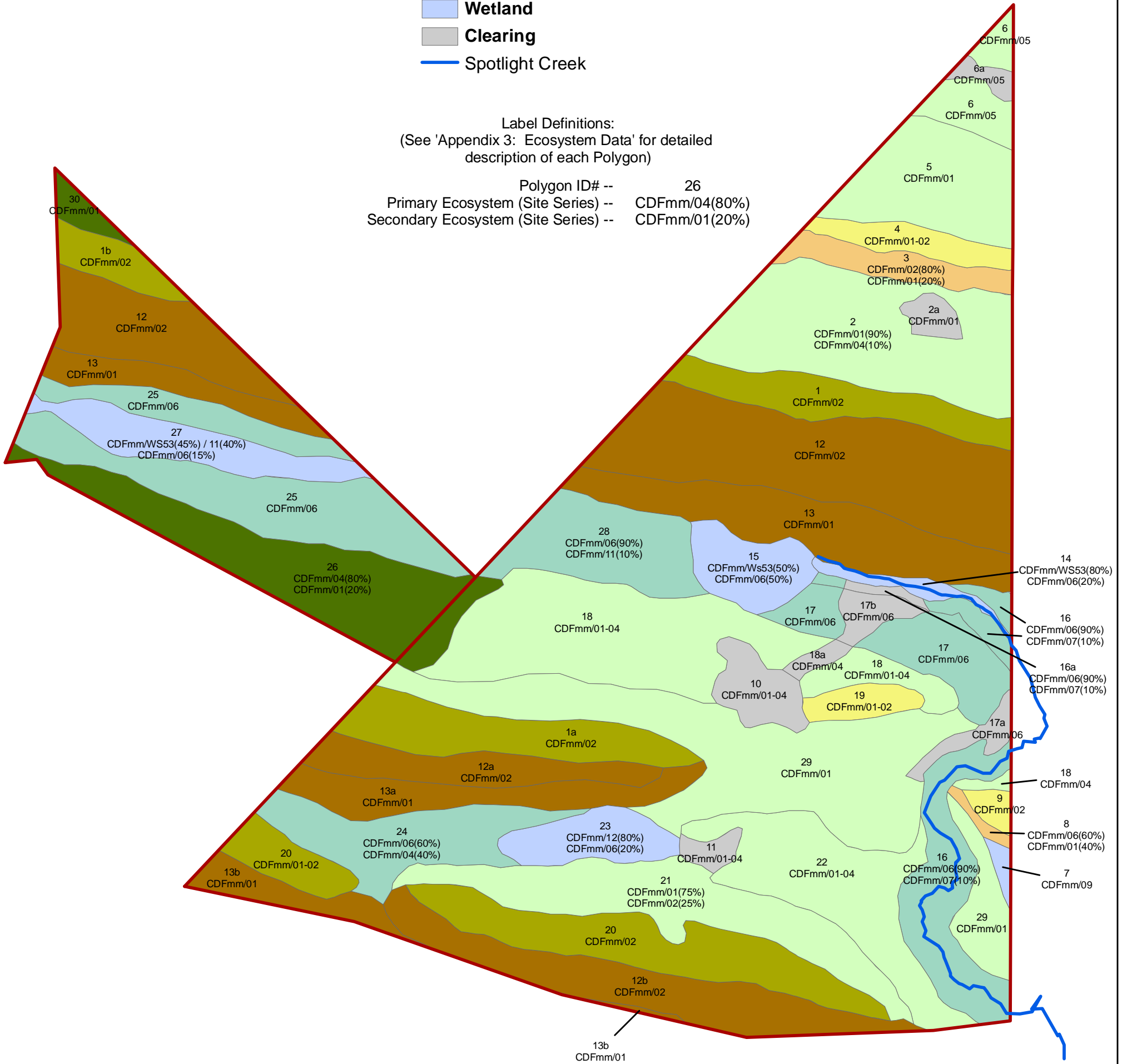
-- Ecosystem Types --

2

- Property Boundary
- Mature Forest
- Mature Forest Ridge
- Mature Forest Steep Slope / Cliff
- Pole Forest
- Pole Forest Ridge
- Pole Forest Steep Slope / Cliff
- Moist Soil / Riparian Forest
- Wetland
- Clearing
- Spotlight Creek

Label Definitions:
(See 'Appendix 3: Ecosystem Data' for detailed description of each Polygon)

Polygon ID# --	26
Primary Ecosystem (Site Series) --	CDFmm/04(80%)
Secondary Ecosystem (Site Series) --	CDFmm/01(20%)



Produced by: Keith Erickson (R.P.Bio.)
 Map Date: December 2009
 Scale: 1 : 2,850
 Projection: UTM Zone 10 NAD83
 Rotation: 46.5 degrees W of N



been developed or permanently altered is a significant conservation achievement within the most densely populated region of the Province. Despite the industrial scale logging that has occurred on the lands in the past, there are a number of remnant patches of healthy mature and old-growth forest that have been identified along the steep slopes and ridge-tops of Lot A and over most of Lot 9. These areas are of significant conservation importance. In addition, a seasonal stream, a variety of small wetlands and the associated riparian ecosystems provide important habitat for wildlife. The diversity of ecological conditions and associated vegetation communities and wildlife resulting from the remarkable topographic complexity of the properties is also of high conservation significance – and is of particular importance when considering adaptation to climate change and migration routes of flora and fauna from drier to wetter sites or vice versa.

3.3.1 Ecosystems and Species at Risk

The properties include intact mature examples of two provincially red-listed ecological communities recognized by the British Columbia Conservation Data Centre:

- Community: Douglas-fir - arbutus (*Pseudotsuga menziesii* - *Arbutus menziesii*)
Global Rank: Not Ranked
Provincial Rank: Red (S2) – Imperiled
Site Series: CDFmm/02
Location (MAP2): Polygons 1, 12 and 20
- Community: Douglas-fir / dull Oregon-grape (*Pseudotsuga menziesii* / *Mahonia nervosa*)
Global Rank: G2 – Imperiled
Provincial Rank: Red (S2) – Imperiled
Site Series: CDFmm/01
Location (MAP2): Polygons 1, 12 and 20

The properties also include a young early successional example of the following listed ecological community:

- Community: red alder / skunk cabbage (*Alnus rubra* / *Lysichiton americanus*)
Global Rank: Not Ranked
Provincial Rank: Blue (S2S3) – special concern, vulnerable to extirpation or extinction
Site Series: CDFmm/11
Location (MAP2): Polygon 14

The properties are also home to a robust population of the provincially blue-listed (species of special concern, vulnerable to extirpation or extinction) red-legged frog (*Rana Aurora*). Red-legged frogs were observed in, but are not limited to, the following locations on MAP 2: Polygons 2, 6, 7, 8, 14, 15, 16, 17, 25, 27 and 28.

3.3.2 Landscape Connections

Ecosystems located on the Crystal Mountain properties are part of a larger generally southeast to northwest running ridge and valley system that includes several significant wetland complexes and mature forest stands. Large portions of the system have been protected within Dionisio Provincial Park to the northwest, the Provincial Ecological Reserve #128 to the southeast and most recently within District Lot 87, immediately adjacent and wedged between the Crystal Mountain properties (See MAP3: Landscape Connections). District Lot 87 was acquired by the Provincial Government and is intended to become a BC Park’s managed protected area, but has not been officially transferred or designated at this time. Its transfer to BC Parks management may be contingent on additional rezoning and development of privately held lands linking District Lot 87 with Dionisio Park.

Protection of ecosystems on the Crystal Mountain lands will directly contribute to overarching goals for landscape connectivity on the northern portion of Galiano Island. It will specifically conserve portions of the Spotlight Creek watershed and will preserve ecosystem integrity along north/south and cross-island landscape level corridors.

3.4 Identified Threats to Ecosystem Values

Threats to ecosystem values are determined by identifying and assessing all current and potential uses or activities associated with the Crystal Mountain properties and surrounding areas. Threats have been identified and classified using criteria developed by the International Union for Conservation of Nature (IUCN) – a now generally accepted standard methodology. Threats and associated impacts will be addressed through the development of management zones and through the strategies and recommendations outlined in the remainder of this document.

IUCN Threat Category	Specific Threat	Associated Impacts
Residential and Commercial Development – Tourism and Recreation Areas	Development of retreat huts, service buildings, managers cottage, septic system	Habitat loss Habitat fragmentation Encroachment on sensitive ecosystems
Human Intrusions and Disturbance – Recreational Activities	Meditation sites - clearing for light or view sites on ridges	Habitat loss Soil erosion and compaction
	Walking / Hiking - trail network	Minor habitat fragmentation Soil erosion and compaction
Transportation and Service Corridors	Access roads and parking lot(s)	Habitat loss Habitat fragmentation Soil erosion and compaction
	Utility and Service Lines – hydro lines, water lines	Habitat loss Habitat fragmentation

Natural System Modifications – Fire Suppression	Fire suppression – general fire suppression and fuel load buildup	Habitat loss from catastrophic fire Alteration of natural disturbance regimes
Natural System Modifications – Water Management / Use	Damming of creek and use of water (for neighbouring water license)	Downstream habitat loss
	Excessive use of groundwater (wells) by Crystal Mountain and on surrounding properties within the groundwater region	Degraded groundwater quality
Invasive Species – Non-native Species	Scotch broom, Himalayan / Evergreen blackberry	Habitat loss
Pollution – Household Sewage	Leaking septic systems	Degraded stream water quality Degraded groundwater quality
	Seepage from Outhouses	Degraded stream water quality Degraded groundwater quality
Biological Resource Use – Gathering Terrestrial Plants	Uncontrolled harvest of native plants / fungi	Species loss Habitat loss
Biological Resource Use – Logging / Wood Harvesting	Unsustainable harvest of timber	Habitat loss Habitat fragmentation Degraded stream water quality Degraded groundwater quality Soil erosion and compaction
Climate Change	Droughts	Species loss Decrease in groundwater recharge
	Storms and Flooding	Species loss
	Habitat shifting	Species loss

5.1 Introduction to Management Zones

Management zones provide a framework for defining where and how various activities and uses may occur. They have been designed in a manner that facilitates the communicated vision of the Crystal Mountain Society for a forest retreat centre while protecting areas of conservation significance and minimizing the impacts of development and associated uses (threats) on ecological values.

Three Management Zones have been created:

<u>Zone:</u>	<u>Percentage of total Management Area:</u>
1. Protected Ecosystem Network	15.68%
2. Short-term Retreat Zone	6.62%
3. Long-term Retreat Zone	2.25%

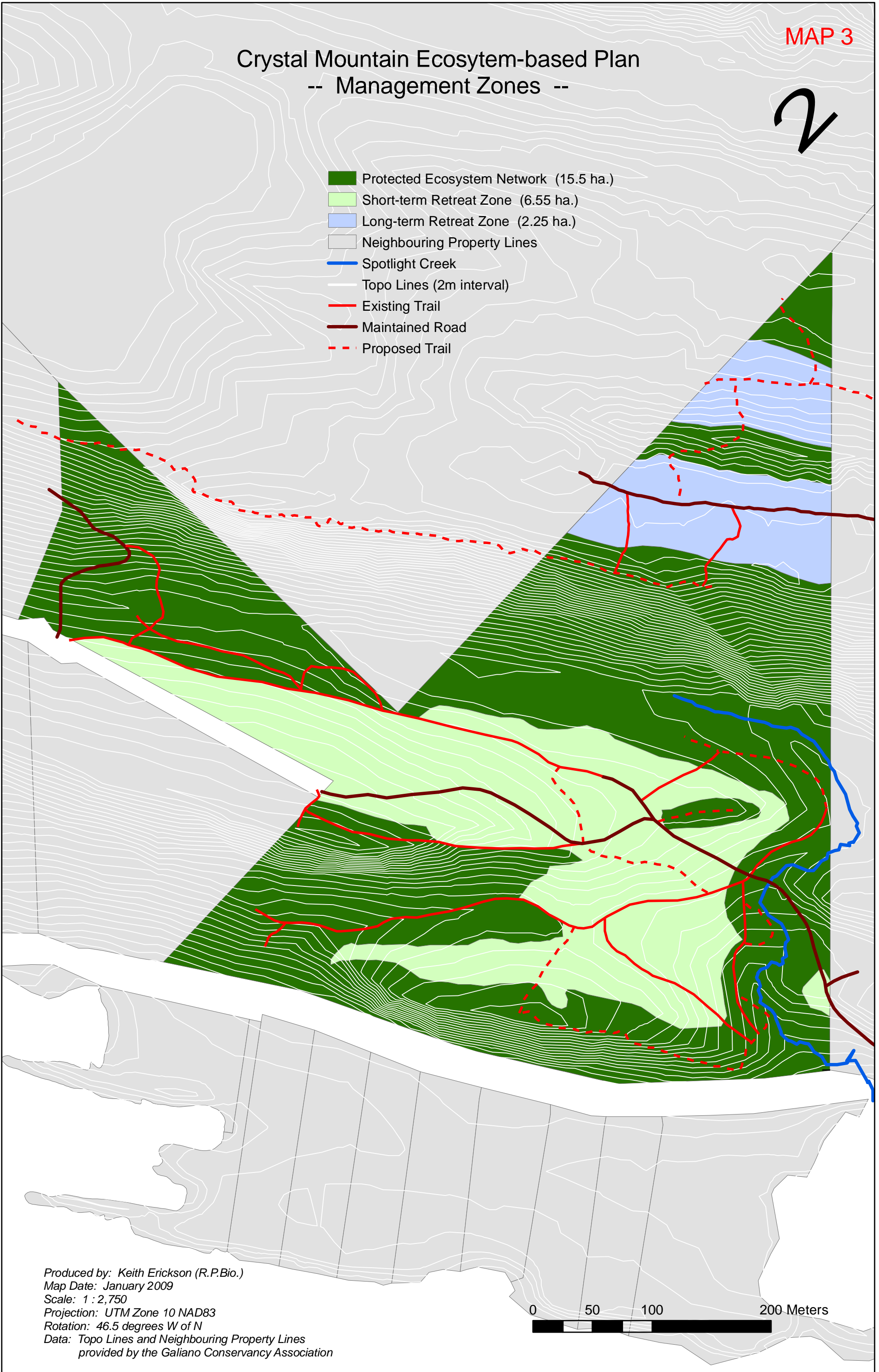
The extent and locations of the management zones are shown on MAP 3. Designation of the zones considered the conservation of ecological integrity first, and then user or activity based considerations. Considerations included:

- Protecting sensitive, rare or threatened species and ecological communities occurring on the property.
- Connectivity - maintaining or enhancing functioning ecosystems and the connections between them within the property and in relation to surrounding lands.
- Minimizing ecological fragmentation from utilities, roads and development/infrastructure.
- Minimizing disturbance in elevated water catchment areas.
- Restricting sustainable forestry to ecosystems and areas where the impacts from harvesting and related access are minimized.
- Maximizing spatial separation between short and long-term retreat accommodations.
- Minimizing infrastructure costs and maintenance for Crystal Mountain.
- Utilizing existing heavily impacted sites (old forestry landings etc) for location of buildings and structures.
- Utilizing the existing forestry road network to service building sites and as utility corridors.
- Maintaining privacy from and for neighbours.
- Using Porlier Pass Road as the main public access point.
- Focusing development on flatter areas that are also well drained.

Crystal Mountain Ecosystem-based Plan -- Management Zones --

2

- Protected Ecosystem Network (15.5 ha.)
- Short-term Retreat Zone (6.55 ha.)
- Long-term Retreat Zone (2.25 ha.)
- Neighbouring Property Lines
- Spotlight Creek
- Topo Lines (2m interval)
- Existing Trail
- Maintained Road
- Proposed Trail



Produced by: Keith Erickson (R.P.Bio.)
Map Date: January 2009
Scale: 1 : 2,750
Projection: UTM Zone 10 NAD83
Rotation: 46.5 degrees W of N
Data: Topo Lines and Neighbouring Property Lines
provided by the Galiano Conservancy Association



5.2 Management Zone Definitions and Permitted Uses

A description of each Management Zone including a list of suggested uses and special restrictions is provided below. Specific strategies and recommendations related to the various listed uses are described later in this Plan.

5.2.1 Protected Ecosystem Network:

The Protected Ecosystem Network (PEN) consists of areas representative of all ecosystem types (Site Series) found within the properties and includes all unique, rare or sensitive ecosystems. The primary purpose of this Management Zone is to enhance the Conservation objective of this Plan and to mitigate threats to ecosystem values identified in Section 3.4 of this document. The following criteria were used to create the Protected Ecosystem Network:

1. Protect all ecologically sensitive areas (consistent with Islands Trust Sensitive Ecosystem Mapping). Ecologically sensitive areas are areas that are important for the maintenance of ecological values (eg. habitat for breeding and overwintering birds) or important for providing ecosystem services (eg. water recharge areas) or are rare or endangered. They may also have greater sensitivity to impacts from development such as soil compaction, erosion or disturbance to wildlife. Ecologically sensitive areas included in the PEN are:
 - **Riparian Ecosystems:** Areas adjacent to water bodies (streams and wetlands etc) that are directly influenced (flooding) by the water body or provide a direct influence to the water body (nutrient input, shading, erosion control, cover for wildlife etc.). For the purpose of this plan, a 30 meter buffer has been created around all wetlands and stream channels to represent the riparian area. The size of the buffer is consistent with maximum riparian protections for non-fish bearing systems outlined in the British Columbia *Riparian Areas Regulation (Fish Protection Act)*. Riparian ecosystems provide critical habitat for a wide variety of wildlife – including corridors for migration, and are vital for maintaining healthy functioning stream and wetland ecosystems.
 - **Wetlands:** Areas that are saturated or inundated with water for long enough periods of time to develop vegetation and biological activity adapted to wet environments. This may result from flooding, fluctuating water tables or poor drainage conditions. These areas provide critical habitat for a wide variety of wildlife. Wetland soils are extremely sensitive to disturbance and are generally not suitable for development of any kind.
 - **Forest Ecosystems characterized by wet soils:** These are moisture receiving areas in the lower slope and toe meso-slope positions often exhibiting fluctuating water tables and/or seasonally saturated soils. On the Crystal Mountain properties they include ecosystems characterized by Site Series CDFmm/05, CDFmm/06, CDFmm/07, CDFmm/11, and CDFmm/12 and are generally rich, good growing sites where soils are particularly sensitive to compaction. Impacts from development, roads or inappropriate

use can significantly alter the hydrology of these sites and surrounding areas and result in serious erosion issues. These areas often overlap with the 30 meter Riparian buffer created around streams and wetlands.

- **Forest Ecosystems characterized by dry, poor and shallow soils and Cliffs:** These areas include ridges, cliffs and associated steep southwest facing slopes. On the Crystal Mountain Properties they include ecosystems characterized by Site Series CDFmm/02 and are typically very slow growing sites that are particularly vulnerable to erosion and compaction. The combination of shallow, dry and nutrient poor soils along with considerable exposure to sun and wind results in ecological communities that are very sensitive to disturbance and require relatively long periods of time for recovery.
2. Provide protection for all identified Provincially red and blue listed species and ecological communities identified in Section 3.3.1 of this Plan.
 3. Provide the maximum protection for riparian areas in a non-fish bearing system in accordance with British Columbia Riparian Areas Regulation - Streamside Protection and Enhancement Area (SPEA) width calculations (30 meters). This also exceeds all requirements outlined in the Galiano Island Official Community Plan (Consolidated October 30, 2013) under Section V.1 – Development Permit Area 1: Riparian Areas.
 4. Contribute to landscape level conservation by including ecosystems that provide connectivity with surrounding Parks and Protected Areas and with unprotected natural areas located on neighbouring properties. In addition to sensitive and rare ecosystems defined in criteria 1 through 3, less sensitive areas exhibiting more zonal or common ecological characteristics were used to create connectivity within the property and at the landscape level. This also ensures that the PEN is representative of the full diversity of ecological conditions on the property.

Activities or uses within the Protected Ecosystem Network:

Activities occurring within the Protected Ecosystem Network should be consistent with the conservation objective of this plan and should be conducted in a manner which maintains or enhances the ecological integrity of the properties and surrounding areas. Uses or activities suitable for the PEN include:

1. Hiking and walking on a planned trail network.
2. Day-use meditation including temporary shelters (tent, tarp, small movable pad/floor).
3. Education, research and ecological monitoring activities.
4. Ecological restoration.
5. Removal of timber as part of an ecological restoration initiative that has as its primary objective the initiation or acceleration of the recovery of an ecosystem with respect to its health, integrity and sustainability.

6. Harvesting of wildcrafting or non-timber forest products that are not readily available within any other Management Zone. Such a product may only be harvested in a manner which does not compromise the integrity of the ecosystem from which it is being removed or threaten the viability of the local population.
7. No facilities or permanent structures (other than the existing Pagoda) should be located within the PEN. Permanent structures cannot easily be removed and do not biodegrade in the short-term – they are usually fixed to the ground through foundation or other means.

5.2.2 Short-term Retreat Zone:

The Short-term Retreat Zone (SRZ) consists of ecosystems that are more resilient to disturbance from development of retreat infrastructure, sustainable forestry and associated uses of the land. The SRZ is restricted to the lower portion of the property and is easily accessible from both Devina Drive and the easement across Lot B from Porlier Pass road. It encompasses most of the existing heavily disturbed forestry landing sites where land clearing has already occurred and soils are compacted. It also includes all of the existing facilities on the Property including the wells, the kitchen platform and the main teaching platform. The primary objectives for the SRZ are to provide accommodations and support for short-term forest meditation retreats and to provide opportunities for sustainable harvest of timber and wildcrafting products.

Activities or uses suitable for the Short-term Retreat Zone:

1. Multi-day forest meditation retreats and educational programs.
2. Single-day educational workshops and programs.
3. Day-use meditation including temporary shelters (tent, tarp, movable pad/floor).
4. Low impact, non motorized recreational activities including hiking and walking on the planned trail network.
5. Small scale organic food production through the establishment and maintenance of garden and / or orchard areas.
6. Ecological research and monitoring activities.
7. Ecological restoration.
8. Sustainable harvesting of timber.
9. Sustainable harvesting of wildcrafting or non-timber forest products.
10. Facilities and structures required for the accommodation and support of multi-day and single-day meditation retreats, educational programs and for sustainable forestry including:
 - a. Accommodation huts
 - b. Teaching platform
 - c. Group kitchen and dining area
 - d. Bathroom / bathing facility

- e. Manager's cottage
- f. Related accessory buildings including pump house and power shed, wood, food or equipment storage sheds, greenhouse etc.
- g. Tent sites (small, flat area for a tent or similar temporary shelter) for low-budget, seasonal overnight accommodation of retreat participants.

5.2.3 Long-term Retreat Zone:

The Long-term Retreat Zone (LRZ) also consists of ecosystems that are more resilient to disturbance from development of retreat infrastructure, sustainable forestry and associated uses of the land. The LRZ is restricted to the upper portion of the property and is accessible from an easement across Lot B and Lot C from Cook Road. It encompasses most of the existing heavily disturbed forestry landing sites in the upper portion where land clearing has already occurred and soils are compacted. The primary consideration for the location of the LRZ was to ensure privacy for long-term meditation retreat participants. The primary objectives for the LRZ are to provide accommodations and support for long-term forest meditation retreats and to provide opportunities for sustainable harvest of timber and wildcrafting products.

Due to the location of the LRZ within elevated water catchment areas (not subject to Galiano OCP Development Permit Area 4) it is recommended that the footprint of permanent structures is minimized and that no new utilities, service corridors or roads are created that may alter the surface drainage patterns or impair local groundwater recharge. It is also recommended that outhouses are equipped with composting toilets with contained tanks in order to prevent groundwater contamination.

Activities or uses suitable for the Long-term Retreat Zone:

1. Multi-day or long-term forest meditation retreats and educational programs.
2. Day-use meditation including temporary shelters (tent, tarp, movable pad/floor).
3. Low impact, non motorized recreational activities including hiking and walking on the planned trail network.
4. Ecological research and monitoring activities.
5. Ecological restoration.
6. Sustainable harvesting of timber.
7. Sustainable harvesting of wildcrafting or non-timber forest products.
8. Facilities and structures required for the accommodation and support of multi-day or long-term meditation retreats and educational programs
 - a. Self-contained off-grid accommodation huts
 - b. Food storage shed
 - c. Outhouses / composting toilets

6.1 Siting of Facilities and Accommodations

The Crystal Mountain Society has determined a number of key criteria to guide the layout and general siting of buildings and facilities within the Short-term Retreat Zone (SRZ) and the Long-term Retreat Zone (LRZ). These guiding principles are deemed critical to the successful operation of short and long-term forest meditation retreats. They provide the overarching framework within which a number of “fine-filter” ecological criteria can be applied. The “fine filter” ecological criteria will help to buffer or enhance the ecological protection achieved through the delineation of the Protected Ecosystem Network and will further address threats to ecosystem values identified in Section 3.4 of this document. Key overarching criteria for siting buildings and facilities within the SRZ and LRZ are:

1. Accommodation huts in the SRZ and in the LRZ must be located in a manner which provides both a visual screen and an auditory buffer between buildings.
2. Accommodation huts in the SRZ must have visual and auditory separation from the kitchen and washroom/bathing facilities.
3. Retreat facilities including accommodations, teaching areas, the kitchen facility and the washroom facility must be isolated from the manager’s cottage, parking areas and access routes (driveways).
4. Vehicle access to the manager’s cottage must not interfere with retreat participants or programming.
5. The food storage shed in the LRZ must be located so that stocking can occur without intrusion on any retreat participants.
6. Good air circulation and light exposure are more subjective but equally important qualities to consider when siting accommodation huts.

Consideration of the following ecological criteria is recommended for determining general siting or layout of buildings and facilities within the SRZ and the LRZ in order to mitigate threats to ecosystem values identified in Section 3.4:

1. Minimize fragmentation of forest cover by clustering buildings and services. Utilize existing infrastructure and facilities on the properties as centers or hubs for clustering. Clustering structures will also:
 - Minimize the construction and maintenance costs of utilities and services such as hydro lines and sewage treatment (eg. septic fields and outhouses/composting toilets).
 - Minimize area of forest clearing for sunlight and airflow.
 - Minimize length of road required for construction and for emergency access.
2. Minimize impact to soils by using existing forestry roads and old landings or staging areas for building sites and access routes as much as possible.

3. Minimize encroachment by retreat related infrastructure and use on sensitive ecosystems within the Protected Ecosystem Network where possible by retaining undeveloped buffer areas around PEN boundaries.
4. Where possible, promote ecological connectivity by maintaining undeveloped connections or corridors that link areas within the Protected Ecosystem Network.
5. Minimize fragmentation of forest cover by using the existing driveway easement across Lot B from Porlier Pass road as the main access to facilities and buildings within the SRZ and as a power line corridor.
6. Minimize fragmentation by clustering facilities and structures that require power near the main access from Porlier Pass Road and/or near the electrical shed/supply.
7. Minimize fragmentation of forest cover by using the existing driveway easement across Lot B and Lot C from Cook Road to access buildings within the LRZ on the upper portion of Lot A. Buildings should be clustered near this access.

Once the general siting or layout has been established, consideration of the following ecological criteria is recommended to help to determine the specific site locations of buildings or other infrastructure within the SRZ and LRZ. The mitigation of threats to ecosystem values identified in Section 3.4 should be considered at every level or step.

1. Protect remnant old forest structures that were not degraded or removed during the most recent clearcut. Significant structures to be protected include:
 - Mature or old-growth trees and any remnant young trees (taller and larger than main forest canopy) that survived the clearcut. Leave a buffer around these trees to protect the rooting zone and any remaining soil mycorrhizal fungi associations from soil compaction and/or erosion.
 - Large diameter snags or “wildlife trees” (greater than 30cm in diameter).
 - Large fallen logs greater than 50cm in diameter.
2. Structures should be located adjacent to existing roads to minimize forest fragmentation and disturbance resulting from utilities, construction access, ongoing maintenance and emergency access.
3. Locate structures on sites where soil has already been disturbed.
4. Minimize forest clearing required for sunlight and airflow around structures by:
 - Locating structures in sites where natural canopy gaps exist to the south.
 - Site structures in north – south patterns so that more than one structure will benefit from any thinning or tree removal.
 - Locate structures near existing cleared areas such as roads or landings.
5. Avoid draws and micro-depressions where soils may be moister than immediately surrounding areas and more susceptible to compaction or erosion.

6.2 Access, Roads and Parking

In accordance with the criteria mentioned in previous sections of this plan the primary access to

the Crystal Mountain property is from the easement across Lot B from Porlier Pass road. This access could be used by the property manager, by all visitors, for general maintenance and services and for utilities such as power lines. The secondary access point is from the end of Devina Drive. This access would primarily be used by retreat participants for parking their cars. Access to the upper portion of the property for long-term retreat participants and for the provision of supplies is over an easement across Lot B and Lot C from Cook Road.

It is recommended that an emergency access/evacuation route linking the southeast end of Devina Drive with Porlier Pass Drive be maintained.

Long-term parking will be required for retreat participants. While Crystal Mountain encourages car pooling for all participants and will likely require far less parking area than might be designated, it is recommended that long-term parking accommodate at least:

- 1 space per staff,
- 1 space per student
- 20 spaces total with manouvering aisles not less than 7.5m and spaces 5.5m x 2.5m in size (in accordance with Galiano Island LUB 127).

Property Manager and visitor parking will also be required. This should accommodate 1 space for the manager and up to 4 spaces for visitors to the property.

6.3 Trail Network and Temporary or Day-use Meditation Sites

Low impact recreational and spiritual activities such as hiking and meditation are consistent with the objectives for all management zones including the PEN. A trail network along with a number of designated day-use or temporary meditation sites are required to facilitate these uses and are shown on Map 4.

6.3.1 Day-use Meditation Sites

Day use meditation sites are intended to be temporary in nature in order to reduce impacts from use on the surrounding ecology. Structures required for day-use meditation such as meditation platforms or shelters should be small in scale and temporary in their construction. These could include small movable (6'x6' or so) temporary platforms, tents or tarps for cover on rainy days or possibly just a bench to sit on. Day-use sites should be set-up as required to meet the needs of individual retreats and then dismantled afterward. Within the PEN, the maintenance of day-use sites should only include minor pruning of trees or vegetation to enhance views and site lines and should not include the removal or clearing of trees and vegetation unless it is consistent with objectives for ecological restoration.

6.3.2 Trail Network

A designated trail network will facilitate both physical and spiritual objectives of forest retreats. Trails within the network primarily follow old logging roads where compaction and

fragmentation have already occurred. However, several new routes that provide access to ridge tops and riparian areas have also been recommended. Recommendations for minimizing impacts of existing and new trails are:

- New trails in sensitive areas such as ridge tops or riparian areas should not run the length of the ecosystem, ensuring the retention of areas that are free from regular human use.
- Well defined trails, particularly in sensitive areas such as steep slopes, ridge tops and along streams, will help to minimize the spread of related impacts such as soil compaction and erosion.
- Minimize trail widths.
- Avoid constructing trails in areas with seasonally saturated or flooded soils.
- Where existing trails cross wetlands or moist soils such as the trail leading to the Pagoda, construct elevated boardwalks to minimize soil compaction in drier months and to ensure accessibility during wetter months.
- Avoid constructing trails on very steep slopes where soils are susceptible to erosion.

6.4 Ecological Restoration

A large portion of Crystal Mountain has been impacted by intensive forestry and associated road building over the past century. This has created long-term impacts to soil ecosystems, altered the hydrology, destroyed wildlife habitat, caused the spread of invasive exotic species and resulted in an overall reduction in biotic diversity. Over time, natural processes will heal the damaged landscape. However, there is potential for helping the land heal through the initiation of ecological restoration projects. The Society for Ecological Restoration (SER) International Primer on Ecological Restoration defines ecological restoration as:

“The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. It is an intentional activity that initiates or accelerates ecosystem recovery with respect to its health (functional processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience).”

The SER International Primer on Ecological Restoration (Society for Ecological Restoration International Science and Policy Working Group, Version 2, October 2004 – available at http://www.ser.org/content/ecological_restoration_primer.asp)

Proposed ecological restoration projects or programs should generally follow the Society For Ecological Restoration (SER) International’s “Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Edition” (Clewel, Rieger and Munro, 2005 – available at http://www.ser.org/content/guidelines_ecological_restoration.asp)

6.4.1 Control of Invasive Exotic Species

Invasive exotic species such as Scotch broom and Himalayan blackberry are pervasive in areas such as landings, staging areas and roads where heavy soil disturbance has occurred and in naturally open ecosystems such as cliffs and ridge tops. Controlling the spread of invasive exotic vegetation will reduce impacts to biodiversity and improve the general ecological health of the properties. It is a high restoration priority and will require a long-term commitment.

Recommendations focused on the control of invasive exotic species are as follows:

Scotch Broom Control

- Scotch broom grows on sites where soils have been disturbed and in naturally open sites such as cliffs and ridge tops. They produce tens of thousands of seeds annually which can last in the soil for over 50 years before germinating. Scotch broom requires a long-term strategy for control which focuses on repeated removal that eliminates further seed production and exhausts the seed bank in the soil.
- Remove all flowering or seed producing plants on an annual basis.
- Ideally cut Scotch broom plants at or below the root collar while they are flowering between May and July. This is the most effective time to kill Scotch broom as it invests most of its energy in flower and seed production, leaving the roots with little reserve for re-sprouting.
- Small diameter plants which are not flowering can be left – do not cut these as they will likely re-sprout the following year and create a plant form that is more difficult to remove (multi-stemmed and bushy instead of a single stem). Smaller diameter broom plants not of seed producing age can be left until they flower (2 to 4 years old) or pulled during wet months when soil is moist to minimize soil disturbance. Scotch broom is adapted to growing in disturbed soil and will easily out-compete native species.
- Where possible plant native species such as red alder (fills a similar ecological niche as broom – association with nitrogen fixing bacteria on its roots that enhances the plants ability to grow in disturbed soils) or native conifers after removing broom. This will help to speed up the development of a tree canopy that will eventually create enough shade to inhibit further growth of broom and blackberry.

Himalayan blackberry control:

- Himalayan blackberry generally grows on richer disturbed sites, often on berms around landings or staging areas where top soil has been pushed and piled. The best strategy for controlling blackberry is to stop patches from spreading until they are shaded out by native trees and shrubs. Most blackberry patches on the property are located within pole forests – these areas will likely get shaded out naturally over the next decade.
- Cutting canes will not kill blackberry plants (this will only control the spread).
- The best strategy for removal is to dig up the root nodules of Himalayan blackberry in winter

when canes have died back and soil is moister.

- A good strategy for control of large patches of blackberry over the long-term is to create small “gaps” in the blackberry patch and plant native trees. Prune any new growth to maintain the “gaps” over time and to stop the patch from expanding until the trees are established and large enough to begin shading out the blackberry plants.

The general strategy for control of invasive exotic vegetation is to first eliminate the outliers – individual plants or small patches scattered around the property, which have the potential to become seed producing hubs that further the spread of these species. Once outliers have been eliminated work back along the pathways of spread – usually old logging roads – to the major hubs or centres (usually old landings or staging areas or utility corridors).

An annual work party in late May or early June is recommended. Have one or two participants walk the ridge top trails and cut all flowering broom plants and dig up blackberry root nodules in Polygons 1, 1a, 19, 20 and 21. The rest of the participants can focus on the major roads and landings (Polygons 11 and 6a).

6.4.2 Landings and Staging Areas

Restoration is recommended on landing sites and staging areas that are not proposed for siting of future buildings or infrastructure. Sites recommended for restoration include Polygons 6a, 17a, 17b and 18a. The following are specific recommendations for each Polygon:

- Polygon 6a: Removal of scotch broom, tansy ragwort and thistles followed by planting of native species including but not limited to Douglas-fir, western redcedar, grand fir (*Abies grandis*), red alder (*Alnus rubra*), evergreen huckleberry (*Vaccinium ovatum*), and red elderberry (*Sambucus racemosa*). De-compact soil around planting sites and protect species susceptible to deer browse.
- Polygons 17a and 17b: Recommend removal of any Scotch broom or Himalayan blackberry and spot planting of red alder, western redcedar, big-leaf maple (*Acer macrophyllum*) and grand fir throughout the polygons to hasten the formation of a tree canopy. Plant trees on raised micro-sites in areas near the wetland or stream where temporary flooding or saturated soils may occur. De-compact soil around planting sites to provide a more favorable growing condition for the planted tree. Protect western redcedar from deer browse and red alder from beaver damage by establishing fencing around planted trees.
- Polygon 18a: Recommend spot planting of Douglas-fir, grand fir and sword fern to hasten the formation of a tree canopy – de-compact soil around planting sites to provide a more favorable growing condition for the planted tree.

6.4.3 Forest Restoration

There are a number of polygons within the properties where well planned forest restoration treatments would help to enhance biological diversity while addressing a number of additional goals such as reducing wildfire risk, increasing resilience to climate change and providing wood products for Crystal Mountain's use. Recommended treatments include restoration thinning, planting native vegetation and dispersal of slash piles. Recommendations are focused on Crystal Mountain's young and pole forests currently recovering from the clearcut(s) that took place in the 1990's. Forest restoration treatments always have benefits to the ecology as their focus with other objectives such as the harvest of wood or reduction of fuel load as secondary or complimentary outcomes. Recommendations include:

- Polygon 2: Minor thinning of Douglas-fir over the next 20 years could maintain or increase diversity in the stand while providing small diameter poles for use. None of the older seed trees should be removed.
- Polygon 14 : Recommend planting red alder and western redcedar in appropriate raised (dryer) micro-sites within the more heavily disturbed (no red alder canopy) areas.
- Polygon 15: Recommend targeted thinning of red alder to encourage the growth of western redcedar and grand fir saplings. Thinning should be completed in dry summer months without the use of any machinery.
- Polygon 16a: Recommend planting western redcedar and red alder where soils have been disturbed.
- Polygon 17 Recommend pulling apart and spreading remaining slash piles to create a more natural distribution of coarse woody debris and to reduce the risk of high intensity fire getting into adjacent conifer dominated stands.
- Polygon 18: Thinning of Douglas-fir and some grand fir will increase species diversity and growth rates of remaining trees. Targeted trees could be removed through multiple entries over the next 30 to 40 years. Limited removal of Douglas-fir and grand fir stems from the site for firewood or construction is possible while still achieving restoration goals.
- Polygon 21: Thinning of Douglas-fir in high density patches (scattered throughout polygon) will increase the growth rate of remaining trees and will improve or maintain species diversity. A portion of the thinned stems could be removed from the site for firewood or construction products.
- Polygon 22: Thinning of red alder to increase species diversity and promote succession to a conifer dominated forest. Thinning should select for conifer release and maintenance of understory diversity but could also compliment the objective of providing light for triad meditation huts.
- Polygon 24: Light thinning of Douglas-fir and grand fir poles to increase growth in remaining trees and to maintain diversity in the stand. Leave thinned stems on the site as additions to coarse woody debris.

Polygon 29: Thinning Douglas-fir to maintain and enhance biological diversity in the polygon. Individuals and clusters of Douglas-fir should be removed as they begin to shade out other tree species and understory vegetation over the next 10 to 20 years. Restorative thinning could in this area could provide an ongoing sustainable supply of timber as the stand ages.

The completion of restoration thinning treatments will require ground level decision making based on details that are beyond the scope of this document. It is recommended that a biologist or forester with forest restoration experience be consulted to determine the number of trees, the timing of treatments and the individual selection of trees for thinning. The following are a number of general considerations for ground level restoration thinning prescriptions:

- Leave trees that are growing next to old stumps or large diameter woody debris where soil biology may have been preserved or protected from past logging operations. These areas likely contain remnant nutrient sources and potential mycorrhizal associations that will increase the health of nearby trees.
- Thin to promote diversity - remove trees that are overcrowding or beginning to shade out less dominant tree species and/or patches of understory vegetation.
- Leave larger or dominant trees – these trees have likely found the best micro-sites for growing and may have a better chance for long-term success.
- Also select for phenotypic diversity – leave some ‘funky’ and/or smaller trees – with a goal of retaining as much genetic diversity on the site as possible to increase the stand’s resilience to disease and changes in climate.
- When thinning, create gaps or holes in the canopy by removing clusters of trees rather than creating evenly spaced rows.
- Create gaps of a variety of sizes that together form a non-uniform mosaic or patchy appearance to the forest canopy.
- Consider thinning intensively on steep or upper slope areas in order to mitigate possible moisture deficits that may result from high densities of trees during long drought periods.
- Leave at least double the stands natural historic density of dominant trees (often 100 to 200 stems per hectare of dominant old-growth Douglas-fir) to accommodate natural mortality from disease and other environmental factors over time.
- Always leave a portion of the thinned stems on the site to provide coarse woody debris and nutrient inputs for the soil.
- Top some trees to create snags.

6.4.4 Additional Restoration Recommendations

Polygons 25 and 26: Remove the deteriorating hut structures, unused shed structures and old building materials from these polygons.

Spotlight Creek: Remove the black ABS pipe and the weir from the lower portion of the creek. Verify that the downstream landowner who has rights to extract water from the creek no longer requires the infrastructure prior to removal.

6.5 Pesticides and Fertilizers

No chemical pesticides or fertilizers should be used or applied within the properties.

6.6 Fire

There is a high risk of fire during months of low precipitation and warm temperatures. The risk is at its greatest in late July, August, and early September, before the autumn rains. Fuel loads within densely regenerating pole forest areas of the properties are high and are susceptible to high intensity wildfire conditions. Similar conditions exist on adjacent properties.

Emergency response to any fire is within the jurisdiction of the North Galiano Volunteer Fire Department. The BC Forest Service Fire Protection Branch should be alerted to any potential forest fire threat. Recommendations to reduce the risk of wildfire include:

1. The North Galiano Volunteer Fire Department should be notified of any controlled burning.
2. Adhere to a general policy of no open fires between June and October.
3. All participants in retreats during times of high or extreme fire risk should be notified that open fires are prohibited.
4. Emergency access roads within the properties should be maintained in order to allow fire department vehicles to access the properties.
5. Conduct forest restoration thinning treatments within dense conifer dominated stands. Treatments will create gaps resulting in a patchy forest canopy where tree crowns are not interwoven - much more resistant to the spread of catastrophic wildfire. Thinning will also promote the growth of more fire resistant trees such as red alder and other broadleaf species as well as shrubby vegetation such as salal.
6. Prune dead lower limbs of conifer trees to remove 'fire ladders' and reduce the ability of fire to move from the ground into the tree canopy.

Ecosystem 1

Description: Mature Douglas-fir (*Pseudotsuga menziesii*), Arbutus (*Arbutus menziesii*) – salal (*Gaultheria shallon*) (CDFmm/02) vegetation community along major ridgeline. The ecosystem is characterized by very shallow, rapidly drained, dry soils with a high coarse fragment content and poor to medium soil nutrient regime. The dominant Douglas-fir trees are generally between 80 and 150 years old with older veterans scattered throughout.

Polygon ID:	1	Slope:	convex	Aspect:	230°
Structural Stage:	MFm	Mesoslope Position:	crest	Site Series:	CDFmm/02
Soil Nutri. Regime:	VP - P	Soil Moisture Regime:	1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	20	30	10	2	2			B1 is higher (20%) in poly 1a
<i>Arbutus menziesii</i>		10	10					Southwest side of crest
<i>Thuja plicata</i>		2	2					
<i>Acer macrophyllum</i>			T					
<i>Gaultheria shallon</i>					70			
<i>Mahonia nervosa</i>					3			
<i>Rosa gymnocarpa</i>					T			
<i>Lonicera ciliosa</i>				T				
<i>Lonicera hispidula</i>					T			
<i>Symphoricarpos alba</i>					T			
<i>Pachistima myrsinites</i>					T			
<i>Cornus nuttalli</i>				T				
<i>Goodyera oblongifolia</i>						T		
<i>Kindbergia oregana</i>							T	
<i>Dicranum scoparium</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Timmia austriaca</i>							T	
<i>Racomitrium</i>							T	
Cover by Layer (%)	Tree:	70	Shrub:	75	Herb:	2	Moss:	2

Soils:

Soils range in depth from exposed bedrock to 50cm. Well defined L and F layers with a thin H and thin Ae and occasionally Ah in patches. High in coarse fragments (50-60%), rapidly drained, and light in colour. Abundant mycelia and fauna found in soil where decay class 5 cwd is present.

Wildlife and Wildlife Habitat:

Observed during data collection: bald eagle (heard in tree top) and seen flying,

Habitat: snags are rare but extensively used by woodpeckers, cwd is scattered throughout and includes a variety of diameters and decay classes.

Disturbance History:

Evidence of selective logging with single stem selection occurring during clearcutting of adjacent forest on northeast facing slope. In Polygon 1a logging has been more extensive resulting in ‘dog-hair’ like Douglas-fir regeneration on the northeast side of the crest. Polygon 1b has also been selectively logged but is adjacent to intact mature forest on the northeast and southwest facing slopes.

Both polygon 1, 1a and 1b have structures and clearing associated with meditation retreat activities – a recently cleared site with a pieced together platform (approx. 100 sqft) at the southwest edge of the ridge in Polygon 1; an established well constructed teaching platform (approx. 1200 sqft) in the transition area between the crest/ridge and northeast facing upper slope in Polygon 1a, and; a frequently visited pagoda (monument) in Polygon 1b.

Succession:

These mature forest sites will continue to move towards climax without too much variation in tree composition and cover. As ecosystems on the northeast facing slopes adjacent to Polygons 1 and 1a develop into young and mature forests, light in these ridge polygons will decrease slightly possibly resulting in a reduction of shrubby salal cover and an increase in moss ground cover.

Restoration Recommendations:

Restoration is not required.

Ecosystem 2

Description: Douglas-fir, western redcedar (*Thuja plicata*) naturally regenerating pole forest (CDFmm/01 – 90%, CDFmm/04 – 10%) approximately 15 years in age with scattered young 50 to 60 year old seed trees. The polygon includes a number of microsites of varying slope, aspect and mesoslope character ranging from moister micro depressions to dryer rock outcrops. Soils are generally well drained silty loams with moderate coarse fragment content and moder humus forms and vary in depth between 30 centimeters to greater than 80 cm.

Polygon ID:	2	Slope:	Variable, generally 5%		Aspect:	Concave - southwest to northeast
Structural Stage:	PSc	Mesoslope Position:	Flat		Site Series:	CDFmm/01 (90%) CDFmm/04 (10%)
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	2-4		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5		20	10	T		T	
<i>Thuja plicata</i>	2		10	5	2		T	
<i>Alnus rubra</i>				3				On moister micro-sites
<i>Salix scouleriana</i>				5				On moister micro-sites
<i>Arbutus menziesii</i>			2					On drier micro-sites

<i>Gaultheria shallon</i>					60				
<i>Polystichum munitum</i>						5			
<i>Pteridium aquilinum</i>						1			
<i>Abies grandis</i>				1					On richer micro-sites
<i>Acer macrophyllum</i>				T					
<i>Kindbergia oregana</i>							10		On richer micro-sites
<i>Achlys triphylla</i>						T			On richer micro-sites
<i>Cornus nuttallii</i>				T					On moister micro-sites
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10	

Soils:

Silty loam with 25-50% coarse fragment content, well drained to moderately well drained. Moder humus form. Soil depth varies from 30 to greater than 80cm.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, hairy or downy woodpecker, piliated woodpecker heard.

Habitat: mixed species, mixed aged forest with gaps and scattered snags is excellent habitat for birds, small mammals etc. Moist areas support amphibians.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. Char marks on cwd and stumps indicates low intensity slash burn after logging.

Landing area (Polygon 2a) has been cleared to support meditation retreat activities and currently includes an outhouse. Two trails leading from the road to the ridge have been established.

Succession:

Stand will develop into uneven aged, multi-storied young forest over the next 15 to 20 years with canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

Minor thinning over the next 20 years could maintain or increase diversity in the stand while providing small diameter poles for use. None of the older seed trees should be removed.

Ecosystem 3

Description: Small cliff and talus slope characterized by bedrock outcrops, exposed boulders, and pockets of shallow soil. The ecosystem is characterized by open, patchy Douglas-fir – oceanspray (*Holodiscus discolor*) (CDFmm/02 – 80%) plant community with a minor component of Douglas-fir – salal (CDFmm/01 - 20%) and approximately 30% exposed rock. A number of young Douglas-fir seed trees are scattered amongst regenerating Douglas-fir poles.

Polygon ID:	3	Slope:	80%	Aspect:	225°
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Structural Stage:	PSc	Mesoslope Position:	Upper Slope	Site Series:	CDFmm/01 (20%) CDFmm/02 (80%)
Soil Nutri. Regime:	VP – P	Soil Moisture Regime:	0-1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	15			40	T			
<i>Thuja plicata</i>				T				
<i>Acer macrophyllum</i>		2		T				
<i>Mahonia nervosa</i>					10			
<i>Holodiscus discolor</i>				10				
<i>Lonicera hispidula</i>				T	T			
<i>Lonicera ciliosa</i>				T	T			
<i>Rhamnus purshiana</i>				T				
<i>Rosa gymnocarpa</i>					T			
<i>Gaultheria shallon</i>					50			
<i>Linnaea borealis</i>					2			
<i>Taxus brevifolia</i>				T				
Cover by Layer (%)	Tree:	15	Shrub:	90	Herb:	5	Moss:	2

Soils:

Pockets of soil are rapidly drained, generally shallow and light in colour with a sandy loam texture and between 35 and 70% coarse fragment content. They are characterized by a mor humus form and have a high content of semi decomposed wood and a deep litter layer.

Wildlife and Wildlife Habitat:

Habitat: exposed rock and cliff is good habitat for northern alligator lizard

Disturbance History:

Any trees of merchantable size were harvested 15 to 20 years ago at the time of the clearcut in Polygon 2. Young seed trees were left.

Succession:

A main canopy of Douglas-fir will slowly develop on this naturally regenerating site over the next several decades eventually leading to a closed canopy with very little exposed cliff face and sparse understorey cover.

Restoration Recommendations:

None recommended.

Ecosystem 4

Description: Douglas-fir – salal (CDFmm/01- 02) dominated regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees on a convex ridgeline. Soils are very well drained, shallow with silty-loam texture and high (50-70%) coarse fragment content.

Polygon ID:	4	Slope:	Variable - convex	Aspect:	Southwest to northeast
Structural Stage:	PSc	Mesoslope Position:	Crest	Site Series:	CDFmm/01 - 02
Soil Nutrient Reg.:	VP-P	Soil Moisture Regime:	1-2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	3		5	35				
<i>Thuja plicata</i>	5		5	5				
<i>Arbutus menziesii</i>			5					
<i>Gaultheria shallon</i>					60			
<i>Mahonia nervosa</i>					15			
<i>Kindbergia oregana</i>							10	
Cover by Layer (%)	Tree:	25	Shrub:	90	Herb:	T	Moss:	10

Soils:

Silty loam with 50-70% coarse fragment content, very well drained. Mor humus form. Soils are shallow.

Wildlife and Wildlife Habitat:

Observed during data collection: pacific tree frog, raven

Habitat: several snags along the ridge with evidence of woodpecker use.

Disturbance History:

Logging 15 to 20 years ago left a high concentration of western redcedar and Douglas-fir seed trees along the ridgeline.

Succession:

Stand will develop into uneven aged, multi-storied young Douglas-fir dominated forest over the next 20 to 30 years with a reduction in shrub / understorey cover due to canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

No restoration required – allow natural processes to continue.

Ecosystem 5

Description: Northeast facing, mid to upper slope, zonal Douglas-fir – salal (CDFmm/01) regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees. Soils

are well drained and shallow with sandy loam texture and high (50%) coarse fragment content.

Polygon ID:	5	Slope:	35%	Aspect:	60°
Structural Stage:	PSc	Mesoslope Position:	Mid to upper slope	Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	2		1	30	1			
<i>Thuja plicata</i>	5		2	5	1			
<i>Arbutus menziesii</i>	1		1					
<i>Gaultheria shallon</i>					75			
<i>Mahonia nervosa</i>					1			
<i>Rosa gymnocarpa</i>					1			
<i>Polystichum munitum</i>						3		
<i>Pteridium aquilinum</i>						10		
<i>Kindbergia oregana</i>							20	
<i>Holodiscus discolor</i>				T				
<i>Vaccinium ovatum</i>				T				
<i>Cytisus scoparius</i>				T	T			Along old road
Cover by Layer (%)	Tree:	12	Shrub:	95	Herb:	15	Moss:	20

Soils:

Silty loam with 50% coarse fragment content, well drained. Moder humus form.

Wildlife and Wildlife Habitat:

Habitat: abundant coarse woody debris scattered throughout.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. No evidence of burn after logging – slash remains on site.

Landing area (Polygon 2a) has been cleared to support meditation retreat activities and currently includes an outhouse.

Succession:

Stand will develop into uneven aged, multi-storied young Douglas-fir dominated forest over the next 20 to 30 years with a reduction in shrub / understory cover due to canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

There is an opportunity for restoration thinning treatments over the next 20 years with a goal of maintaining and enhancing structural and compositional diversity while removing a small portion

of the stems for use.

Ecosystem 6

Description: Northeast facing, mid to lower slope, Douglas-fir, western redcedar – salal (CDFmm/05) regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees. Soils are moderately well drained and with silty loam texture and moderate (25-35%) coarse fragment content.

Polygon ID:	6	Slope:	5-15% (concave)	Aspect:	60°
Structural Stage:	PSc	Mesoslope Position:	Mid to lower slope	Site Series:	CDFmm/05
Soil Nutrient Reg.:	M	Soil Moisture Regime:	5	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5		T	30				
<i>Thuja plicata</i>	30		5					
<i>Alnus rubra</i>				1				On edge of landing
<i>Gaultheria shallon</i>					65			
<i>Holodiscus discolor</i>				T				
<i>Pteridium aquilinum</i>						5		
<i>Hylocomnium splendens</i>							8	
<i>Kindvergia oregano</i>							10	
<i>Rhytidiadelphus loreus</i>							1	
<i>Lonicera hispidula</i>					2			
<i>Polystichum munitum</i>						1		
<i>Trientalis latifolia</i>						1		
<i>Vaccinium ovatum</i>					1			
<i>Linnaea borealis</i>					1			
<i>Achlys triphylla</i>						T		
<i>Lonicera ciliosa</i>				1				
<i>Cytisus scoparius</i>				T	T			On landing – poly 6a
<i>Cirsium spp.</i>						T		On landing – poly 6a
<i>Senecio jacobaeae</i>						T		On landing – poly 6a
<i>Grass spp.</i>						2		On landing – poly 6a
<i>Juncus effusus</i>						T		On landing – poly 6a
<i>Carex spp.</i>						T		On landing – poly 6a
Cover by Layer (%)	Tree:	40	Shrub:	90	Herb:	10	Moss:	20

Soils:

Silty loam with 25-35% coarse fragment content, moderately well drained. Moder humus form.

Wildlife and Wildlife Habitat:

Observed during data collection: tree frog, squirrel nut cache, deer scat, red legged frog, dragonfly.

Habitat: Snags and large diameter coarse woody debris observed.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. No evidence of burn after logging – slash remains on site.

Landing area (Polygon 6a) was cleared and served as a staging area during past logging. Soils have been heavily disturbed and compacted and are now dominated by invasive grasses, thistles, scotch broom and tansy ragwort. Due to moist soils and timing of logging, deep ruts were left from machinery and are now compacted micro-depression sites where sedges and rushes are growing.

Succession:

Stand will develop into uneven aged, multi-storied young forest over the next 15 to 20 years with canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

There is an opportunity for restoration thinning treatments over the next 20 years with a goal of maintaining and enhancing structural and compositional diversity while removing a small portion of the stems for use.

Landing site: removal of scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobaeae*) and thistles (*Cirsium spp.*) followed by planting of native species including but not limited to Douglas-fir, western redcedar, grand fir (*Abies grandis*), red alder (*Alnus rubra*), evergreen huckleberry (*Vaccinium ovatum*), and red elderberry (*Sambucus racemosa*). De-compact soil around planting sites and protect species susceptible to deer browse.

Ecosystem 7

Description: Seasonally flooded wet bench dominated by Pacific willow (*Salix lucida ssp. laciandra*) nootka rose (*Rosa nootkensis*), and slough sedge (*Carex obnupta*) (CDFmm/09). This polygon is a moisture receiving site with soils that are very rich but poorly drained due to a clay mineral soil layer and is flooded during winter storm events.

Polygon ID:	7	Slope:	<1%	Aspect:	250°
Structural Stage:	PSb	Mesoslope Position:	Flat	Site Series:	CDFmm/09
Soil Nutrient Reg.:	VR	Soil Moisture Regime:	05-07	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Salix lucida ssp laciandra</i>				15				
<i>Salix scouleriana</i>				10				

<i>Equisitum arvense</i>						10			
<i>Carex obnupta</i>						40			
<i>Rubus ursinus</i>						3			
<i>Elymus hirsutus</i>						5			
<i>Rosa nootkensis</i>				25	5				
<i>Alnus rubra</i>				20					
<i>Rubus discolor</i>				2	2				
<i>Kinbergia praelonga</i>								15	
<i>Menthe arvensis</i>						T			
<i>Rosa gymnocarpa</i>						T			
<i>Rubus spectabilis</i>						2			
<i>Gaultheria shalon</i>						T			On raised micro-sites
<i>Polystichum munitum</i>						T			On raised micro-sites
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10	

Soils:

Silty loam over top of heavy clay approximately 50 cm deep. Thick H and Ah horizons, dark coloured. Low coarse fragment content (10 – 15%) characterized by a few platy sandstone cobbles. Poorly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: heard lots of unidentified frog calls.

Habitat: Moist area supports amphibians and shrubby thicket like riparian provides high quality bird habitat.

Disturbance History:

The area appears to have been logged and is located next to the Crystal Mountain driveway – the ditch along the driveway provides significant water additions during storm events.

Succession:

Seasonal flooding will maintain willow and red alder in this ecosystem with possible infill of western redcedar as raised micro-sites develop over time. No cedar seedlings were observed.

Restoration Recommendations:

More in-depth investigation into hydrological alterations caused by the ditch and driveway should occur to determine whether restoration is required.

Ecosystem 8

Description: Red alder / bitter cherry (*Prunus emargenata*) – oceanspray (*Holodiscus discolor*) (CDFmm/01 – 40%) (CDFmm/06 – 60%) disturbed pole-sapling, lower/tow slope. The polygon is a transition zone from flat seasonally flooded Polygon 7 to a drier southwest facing upper slope characterized by Polygon 9.

Polygon ID:	8	Slope:	Concave, 25-60%	Aspect:	250°
Structural Stage:	PSm	Mesoslope Position:	Flat	Site Series:	CDFmm/01 (40%) CDFmm/06 (60%)
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	4-5	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Prunus emarginata</i>			15					
<i>Alnus rubra</i>		60	10					
<i>Salix scouleriana</i>			2					
<i>Pteridium aquilinum</i>						15		
<i>Gaultheria shallon</i>				10				
<i>Holodiscus discolor</i>				20				
<i>Rubus discolor</i>				40				
<i>Rubus parviflorus</i>				T				
<i>Acer macrophyllum</i>				T				
<i>Elymus glaucus</i>						1		
<i>Urtica dioica</i>						1		
<i>Rubus ursinus</i>					1			
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						1		
<i>Kinderbergia oregana</i>							5	
<i>Pseudotsuga menziesii</i>				2				
<i>Abies grandis</i>				1	1			
<i>Lonicera ciliosa</i>				1				
Cover by Layer (%)	Tree:	75	S`hrub:	70	Herb:	15	Moss:	5

Soils:

Silty loam with moderate coarse fragment content between 35 and 50%. Patchy deeper soil pockets interspersed with exposed boulder talus from ridge crest above. Moderately well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: heard lots of unidentified frog calls.

Habitat: Moist area supports amphibians and shrubby thicket like riparian provides high quality bird habitat.

Disturbance History:

Logged in mid 1990's. Logging likely contributed to slope instability leading to movement of boulders and soil from the cliff/ridge above.

Succession:

Red alder canopy will eventually be overtaken by Douglas-fir and grand fir that have established on drier, deeper soil micro-sites eventually leading to a conifer dominated mature forest.

Restoration Recommendations:

None recommended.

Ecosystem 9

Description: Douglas-fir / Arbutus (*Arbutus menziesii*) naturally regenerating pole forest (CDFmm/02) with scattered young seed trees. The polygon includes the upper slope and crest areas with an aspect that shifts from southwest to northeast. Soils are very shallow and very well drained with a high coarse fragment content and loamy textured mineral soil.

Polygon ID:	9	Slope:	Convex 0 - 90%		Aspect:	southwest to northeast
Structural Stage:	PSm	Mesoslope Position:	Crest – upper slope		Site Series:	CDFmm/02
Soil Nutrient Reg.:	P-M	Soil Moisture Regime:	1		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>			5	50				
<i>Arbutus menziesii</i>			10	2				
<i>Salix scouleriana</i>				1				
<i>Abies grandis</i>				1	2			
<i>Thuja plicata</i>				2				8% on northeast side of ridge
<i>Holodiscus discolor</i>				10				
<i>Mahonia nervosa</i>					5			
<i>Gaultheria shallon</i>					10			
<i>Lonicera hispidula</i>					10			
<i>Polystichum munitum</i>						T		
<i>Amelanchier alnifolia</i>						T		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Cytisus scoparius</i>					T	5		
<i>Racomitrium spp.</i>							30	
<i>Prunus emarginata</i>				15				
<i>Kindbergia oregana</i>							20	
<i>Rhytidiadelphus triquetrus</i>							5	On northeast side of ridge
Cover by Layer (%)	Tree:	15	Shrub:	65	Herb:	25	Moss:	50

Soils:

Very shallow, characterized by cracks and crevices with deeper soils between exposed boulders and bedrock. Loam with high coarse fragment (50-60%) and very well drained. Some of the deeper soil pockets have a small Ah and darker soils indicating scattered richer micro-sites.

Wildlife and Wildlife Habitat:

Observed during data collection: evidence of intense deer browse on Saskatoon (*Amelanchier alnifolia*), red huckleberry (*Vaccinium parvaflorum*) and scotch broom.

Disturbance History:

Polygon was logged resulting in increased exposure to winds. Loose rock and soil also suggests susceptibility to mass wasting – also increased from logging. Intense deer browse was also noted to the extent where the establishment of preferred species such as Saskatoon is severely impeded.

Succession:

Stand will develop into a Douglas-fir dominated site with scattered Arbutus – species like bitter cherry (*Prunus emarginata*) will die off over the next 20 years.

Restoration Recommendations:

Remove scotch broom by cutting during flowering season. Pulling will damage shallow, loose soils.

Ecosystem 12

Description: Mature to Old-growth Douglas-fir – Arbutus (CDFmm/02) southwest facing steep slope with exposed bedrock and boulder cliff micro-sites scattered throughout. Soils are generally less than 30cm in depth except on flatter “shelf” micro-sites also scattered throughout the polygon where deeper soil have been able to accumulate. In the smaller Polygon 12b along Porlier Pass road, there is a 25% component of Douglas-fir – salal (CDFmm/01) on a slightly shallower slope (50 – 60%).

Polygon ID:	12	Slope:	80%		Aspect:	250°	
Structural Stage:	MF m	Mesoslope Position:	Mid to upper slope		Site Series:	CDFmm/02	
Soil Nutrient Reg.:	M	Soil Moisture Regime:	0-1		Photo Points:		

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5	40	5	1	T		T	
<i>Arbutus menziesii</i>		15	15					
<i>Acer macrophyllum</i>		10	5					Mainly on mid slope
<i>Thuja plicata</i>				T	T			In CDFmm/01 Poly 12b
<i>Holodiscus discolor</i>				1				
<i>Gaultheria shallon</i>					10			Mainly on mid slope
<i>Mahonia nervosa</i>					20			Mainly on mid slope
<i>Linnaea borealis</i>					T			
<i>Vaccinium ovatum</i>					1			
<i>Lonicera hispidula</i>					25			Mainly on upper slope
<i>Polystichum munitum</i>						1		

<i>Lactuca muralis</i>						T		
<i>Kinbergia praelonga</i>							5	On rocks
<i>Kinbergia oregana</i>							5	On rocks
<i>Lonicera ciliosa</i>				T				In CDFmm/01 Poly 12b
<i>Grass spp.</i>							15	
Cover by Layer (%)	Tree:	75	Shrub:	55	Herb:	15	Moss:	5

Soils:

Silty loam with medium coarse fragment content (30-50%), a medium to dark color, a mor humus form and very shallow. Exposed soil (no veg) and rock accounts for approximately 35% of the polygon.

Wildlife and Wildlife Habitat:

Observed during data collection: Bald eagles and Turkey vultures observed flying over steep slope / cliff.

Habitat: Large diameter snags and coarse woody debris and living veteran Douglas-firs are scattered throughout the polygon and all show signs of woodpecker use. A few scattered old-growth Douglas-fir trees provide rare canopy and below ground habitat associations.

Disturbance History:

Lower portion of the polygon has been selectively logged for Douglas-fir. Old-growth Douglas-fir trees show fire scars while mature trees do not indicating that the area was burned during or after the original logging entry in the early 1900's.

Succession:

Stand will continue to mature with a relatively stable species composition.

Restoration Recommendations:

None recommended.

Ecosystem 13

Description: Young Douglas-fir / western redcedar / big-leaf maple (*Acer macrophyllum*) (CDFmm/01) mixed forest characterized by large exposed boulders and soil deposited from the steep slope/cliff area above in Polygon 12. Exposed rock and boulder account for between 60% of surface cover at the bottom of the slope to 30% in the upper portion of the polygon.

Polygon ID:	13	Slope:	Concave 15 - 55%		Aspect:	250°
Structural Stage:	YFm	Mesoslope Position:	Mid to lower slope		Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	3		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		15	5	10	T		T	

<i>Thuja plicata</i>		25	10	5	T		T	
<i>Arbutus menziesii</i>			T					
<i>Acer macrophyllum</i>		15	10	1	T		T	
<i>Gaultheria shallon</i>					15			
<i>Mahonia nervosa</i>					3			
<i>Holodiscus discolor</i>				1				
<i>Polystichum munitum</i>						10		
<i>Kinbergia oregana</i>						15		
<i>Alnus rubra</i>				5				
<i>Lonicera hispidula</i>					5			
<i>Lactuca muralis</i>						T		
<i>Gallium aparine</i>						T		
<i>Racomitrium spp.</i>							15	Lower slope on talus
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10

Soils:

Very well drained silty loam with medium coarse fragment content (30-50%), a medium to dark color, a mor humus form and generally shallow.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven

Habitat: Lots of potential hiding and den sites in cracks and fissures created by boulders.

Abundant coarse woody debris.

Disturbance History:

The polygon was logged in the early 1900's and was high-graded again in the 1990's when the major clearcut on the property occurred. The major natural disturbance is from mass wastage with large gaps within the polygon formed due to high boulder content and very few soil pockets suitable for tree growth.

The major disturbance to Polygon 13b is from Porlier Pass road with permanently altered light conditions along with consistent disturbance from traffic. Also, polygon 13b was not high-graded.

Succession:

Lower boulder dominated area will slowly develop canopy cover as existing trees grow and more regen is recruited. The upper "less bouldery" area will continue to develop mature forest characteristics. The soil communities on in the talus dominated area where high-grade logging occurred will take many decades or even centuries to re-establish and support tree growth.

Restoration Recommendations:

None recommended.

Ecosystem 14

Description: Western redcedar – sword fern (*Polystichum munitum*) – skunk cabbage (*Lysichiton americanum*) swamp (Ws53 – 80%). The seasonally flooded wetland depression is recovering from logging related disturbance and is currently characterized by regenerating red alder pole forest mixed with graminoid dominated open patches. Raised micro-sites are scattered throughout the swamp area and transition into a CDFmm/06 (20%) moist forest along the edges of the polygon. A seasonal stream channel is braided through the wetland area and varies in width to from concentrated (1m width) to dispersed (no defined channel).

Polygon ID:	14	Slope:	Less than 1%		Aspect:	Depression (160°)
Structural Stage:	PSb	Mesoslope Position:	Depression		Site Series:	CDFmm/11 (80%) CDFmm/06 (20%)
Soil Nutrient Reg.:	R-VR	Soil Moisture Regime:	6-7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes	
<i>Alnus rubra</i>				65					
<i>Abies grandis</i>				T	T			On raised micro-sites	
<i>Thuja plicata</i>	2			T	T			On raised micro-sites	
<i>Acer macrophyllum</i>	T							On raised micro-sites	
<i>Rubus spectabilis</i>				1	1				
<i>Gaultheria shallon</i>					1			On raised micro-sites	
<i>Polystichum munitum</i>						55		On raised micro-sites	
<i>Urtica dioica</i>						3			
<i>Juncos effusus</i>						T			
<i>Lysichiton americanum</i>						5			
<i>Scirpus microcarpus</i>						5			
<i>Equisetum arvense</i>						25			
<i>Achlys triphylla</i>						2			
<i>Elymus glaucus</i>						5			
<i>Kindbergia praelonga</i>							2		
Cover by Layer (%)	Tree:	2	Shrub:	70	Herb:	95	Moss:	2	

Soils:

Soils range from wet year round in the centre to seasonally wet on the fringes. Characterized by deep organic horizon with underlying heavy clay.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog and active beaver damming (freshly cut small diameter red alder stumps and downed stems with beaver tooth patterns)

Habitat: mixed species, mixed aged forest with gaps and open water for the majority of the year is excellent habitat for birds, amphibians and mammals.

Disturbance History:

The polygon was clearcut logged around 16 years ago with varying degrees of disturbance to soils – indicated by variation in regenerating vegetation communities.

Freshly felled red alder is being used by beaver to create a new dam which is increasing the size of the flooded wetland area.

Succession:

Swamp area will continue to develop forest canopy transitioning from a red alder dominated community into a western redcedar dominated community. Red alder will remain as a long-term component of the stand. Succession will depend on degree of soil disturbance with high impact areas taking longer to develop forest canopy. If beaver persist with the development of new dams the water table may be raised in affected areas creating pockets of year round marsh habitat – trees and shrubby vegetation in the flooded area will likely die and marsh vegetation adapted to year round flooding will increase.

Restoration Recommendations:

Recommend planting red alder and western redcedar in appropriate raised (dryer) micro-sites within the more heavily disturbed (no red alder canopy) areas.

Ecosystem 15

Description: Young red alder (*Alnus rubra*) / western redcedar – sword fern (*Polystichum munitum*) / salmonberry (*Rubus spectabilis*) swamp (Ws53 - 50%) in depression areas transitioning into sword fern dominated lower slope with scattered young big-leaf maple and western redcedar (CDFmm/06 - 50%) left after logging. The polygon also includes a seasonal stream channel that varies in width to from concentrated (1m width) to dispersed (no defined channel) to subsurface flow.

Polygon ID:	15	Slope:	1 - 5%		Aspect:	45°
Structural Stage:	PSb	Mesoslope Position:	Depression – lower slope		Site Series:	Ws53 (50%) CDFmm/06 (50%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	5-7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>			65					
<i>Abies grandis</i>				1	1			Raised micro-sites
<i>Thuja plicata</i>	5		5	T	T			
<i>Acer macrophyllum</i>			15					
<i>Rubus spectabilis</i>				15	1			
<i>Polystichum munitum</i>						60		
<i>Climacium dendroides</i>							T	
<i>Plagiomnium insigne</i>							5	

<i>Kindbergia oregana</i>							10		
<i>Kindbergia praelonga</i>							5		
<i>Rhytididiadelphus triquetrus</i>							T		
<i>Achlys triphylla</i>						5			
<i>Elymus glaucus</i>						5			
<i>Carex sp.</i>						10			
<i>Gaultheria shallon</i>					1				Raised micro-sites
<i>Salix scouleriana</i>				T					
<i>Rubus ursinus</i>					1				
Cover by Layer (%)	Tree:	80	Shrub:	20	Herb:	80	Moss:	20	

Soils:

Dark silty loam with high organic content, thick Ah and low coarse fragment content (10%).
Seasonally saturated with standing water during winter months.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.
Habitat: multi-layered vegetation with broadleaf canopy, salmonberry and water source
extremely valuable for wildlife.

Disturbance History:

Soils have been heavily impacted from machinery during logging 15 to 20 years ago. Old stumps indicate a mature forest community dominated by large western redcedar with the odd Douglas-fir and grand fir scattered on micro-sites. Red alder is very spindly and dense due to soil disturbance and fluctuating water table.

Succession:

Western redcedar will gradually grow up and replace the red alder as the dominant cover with grand fir and Douglas-fir taking hold on appropriate microsites over the next 50 or 60 years. Micro-sites will continue to develop creating a more patchy swamp/dry site mosaic.

Restoration Recommendations:

Recommend targeted thinning of red alder to encourage the growth of western redcedar and grand fir saplings. Thinning should be completed in dry summer months without the use of any machinery.

Ecosystem 16

Description: Riparian forest characterized by young red alder - sword fern community (CDFmm/06 – 90%) on a lower slope mixed with red alder / black cottonwood (*Populus balsamifera spp. trichocarpa*) – salmonberry community (CDFmm/07) in small depression areas along the edge of the seasonal creek where flooding occurs. In polygon 16a, patches of young forest are mixed with open shrub and pole/sapling dominated areas where soils were more heavily impacted during logging and regeneration is hindered.

Polygon ID:	16	Slope:	2-30% - concave		Aspect:	variable
Structural Stage:	PSb	Mesoslope Position:	Lower slope		Site Series:	CDFmm/06 (90%) CDFmm/07 (10%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		2	T	T	T			No A2/A3 in disturbed areas
<i>Thuja plicata</i>		1	2	5	T			No A2/A3 in disturbed areas
<i>Alnus rubra</i>		25	20	5				No A2/A3 in disturbed areas
<i>Abies grandis</i>		T	T	1	T			No A2/A3 in disturbed areas
<i>Arbutus menziesii</i>				T				On raised micro-site
<i>Gaultheria shallon</i>					5			
<i>Polystichum munitum</i>						50		Less in flooded areas
<i>Pteridium aquilinum</i>						T		
<i>Acer macrophyllum</i>		3	T	T				
<i>Kindbergia oregana</i>							1	
<i>Achlys triphylla</i>						3		
<i>Equisetum arvense</i>						3		
<i>Rubus discolor</i>				1	1			In flooded area by road
<i>Vaccinium parvaflorum</i>				T				
<i>Populus balsamifera trichocarpa</i>				T				In flooded areas
<i>Sambucus racemosa</i>				T				In flooded areas
<i>Rubus spectabilis</i>				3	2			In flooded areas
<i>Carex spp.</i>						2		In flooded areas
<i>Grass spp.</i>						2		More in disturbed areas
<i>Urtica dioica</i>						1		
<i>Rubus ursinus</i>					T			
<i>Kindbergia praelonga</i>							2	more in flooded areas
<i>Climacium dendroides</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Plagiomnium insigne</i>							T	
<i>Holodiscus discolor</i>				T				In disturbed areas
<i>Gallium aparine</i>						T		In disturbed areas
<i>Crataegus monogyna</i>					T			In disturbed areas
<i>Mahonia nervosa</i>					T			In disturbed areas
<i>Cirsium spp.</i>						T		In disturbed areas
<i>Symphoricarpos albus</i>					T			In disturbed areas
<i>Salix scouleriana</i>			1					In disturbed areas

<i>Tellima grandiflora</i>					T		In disturbed areas		
Cover by Layer (%)	Tree:	60	Shrub:	30	Herb:	65	Moss:	5	

Soils:

Imperfectly drained silty clay loam with low coarse fragment content (10%) and thick H and Ah horizons. Moder humus form. Mottles are present in clay layer approximately 50 cm deep indicating a slightly fluctuating water table and /or saturation during winter months.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, tree frog, red squirrel

Habitat: multi species, riparian forest with gaps, floodplains and scattered snags is excellent habitat for birds, small mammals, amphibians etc. Freshwater available in winter, fall and spring.

Disturbance History:

The area was clearcut 15 to 20 years ago. Machine use has damaged and compacted soils and is more pronounced in areas used for repeated access (polygon 16a). Regeneration has been compromised in these areas and they remain in the shrub/herb successional phase.

Succession:

Red alder will continue to dominate the polygon for several decades with western redcedar and grand fir slowly emerging as the red alder dies off. Areas of heavier soil disturbance will continue to develop very slowly with a mixed tree canopy forming over the next 20 – 30 years.

Restoration Recommendations:

Recommend planting western redcedar and red alder in polygon 16a where soils have been disturbed.

Recommend the removal of the black ABS pipe and the weir from the lower portion of the creek.

Ecosystem 17

Description: Moist, red alder dominated pole forest with a sword fern and grass dominated understory (CDFmm/06). The ecosystem is recovering from heavy soil disturbance and compaction that occurred during logging approximately 15 years ago. Polygons 17a and 17b were likely old road and staging areas during logging and have been significantly impacted by extensive soil compaction and disturbance. As a result, these areas have not been able to develop a tree canopy and have a dominant vegetation cover of grasses and sword fern.

Polygon ID:	17	Slope:	5-10% - concave	Aspect:	variable
Structural Stage:	PSb	Mesoslope Position:	Lower slope	Site Series:	CDFmm/06
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes	
<i>Pseudotsuga menziesii</i>				5	1			1% in 17a/b	
<i>Thuja plicata</i>				T				1% in 17a/b	
<i>Alnus rubra</i>				60				5% in 17a/b	
<i>Abies grandis</i>				1	3			1% in 17a/b	
<i>Prunus emarginata</i>				10					
<i>Gaultheria shallon</i>					2				
<i>Polystichum munitum</i>						50		20% in polygons 17a/b	
<i>Pteridium aquilinum</i>						T		5% in 17a/b	
<i>Acer macrophyllum</i>				2					
<i>Kindbergia oregana</i>							2		
<i>Achlys triphylla</i>						T			
<i>Equisetum arvense</i>						3			
<i>Rubus discolor</i>				2					
<i>Scirpus microcarpus</i>						T		In 17b	
<i>Sambucus racemosa</i>				1					
<i>Rubus spectabilis</i>				2	2				
<i>Carex spp.</i>						T			
<i>Grass spp.</i>						25		60% in Polygons 17a/b	
<i>Urtica dioica</i>						5			
<i>Rubus ursinus</i>						T			
<i>Kindbergia praelonga</i>							2		
<i>Elymus hirsutus</i>						10			
<i>Rhytidiadelphus triquetrus</i>							T		
<i>Plagiomnium insigne</i>							4		
<i>Polytrichum juniperinum</i>							T		
<i>Gallium aparine</i>						T			
<i>Cirsium spp.</i>							T	5% in 17a/b	
<i>Dactylis glomerata</i>						3			
<i>Agropyron repens</i>							T		
<i>Tellima grandiflora</i>						T			
Cover by Layer (%)	Tree:		Shrub:	80	Herb:	95	Moss:	10	

Soils:

Modor humus form with 15 – 25% coarse fragments, a deep Ah layer and a silty clay loam mineral horizon texture. There are signs of compaction between 10 and 30 cm and a clay layer at approximately 40 cm.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, tree frog, raven

Disturbance History:

The area was very heavily impacted by machinery during logging. There is evidence slash pile burning after logging with large deposits of charred wood/ash in soils. Soil compaction is

evident as well as soil mixing from bulldozers. Stumps remaining on the site are dominated by western redcedar (75%) and Douglas-fir (25%)

Succession:

Red alder will continue to dominate the polygon for several decades with western redcedar and grand fir slowly emerging as the red alder dies off. Areas of heavier soil disturbance will continue to develop very slowly with a mixed tree canopy forming over the next 20 – 30 years.

Restoration Recommendations:

Recommend pulling apart and spreading remaining slash piles to create a more natural distribution of coarse woody debris and to reduce the risk of high intensity fire getting into adjacent conifer dominated stands.

Recommend spot planting of red alder, western redcedar and grand fir in polygons 17a and 17b to hasten the formation of a tree canopy – de-compact soil around planting sites to provide a more favorable growing condition for the planted tree.

Ecosystem 18

Description: Dense Douglas-fir / grand fir (*Abies grandis*) dominated pole forest with sparse Oregon grape (*Mahonia nervosa*) / sword fern understory (CDFmm/04). The Polygon is characterized by dense conifer areas mixed with patches of red alder. Polygon 18a was likely an old road and staging area during logging and has been significantly impacted by extensive soil compaction and disturbance. As a result, this area has not been able to develop a tree canopy and has a dominant vegetation cover of grasses and sword fern.

Polygon ID:	18	Slope:	5-15% - concave	Aspect:	NE to E
Structural Stage:	PSb	Mesoslope Position:	Mid Slope	Site Series:	CDFmm/04
Soil Nutrient Reg.:	R	Soil Moisture Regime:	2-3	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>				40	1			
<i>Thuja plicata</i>				T	T			
<i>Alnus rubra</i>				10				
<i>Abies grandis</i>				40	1			
<i>Prunus emarginata</i>				T				
<i>Gaultheria shallon</i>					5			
<i>Polystichum munitum</i>						2		
<i>Mahonia nervosa</i>					10			
<i>Kindbergia oregana</i>							2	
<i>Rubus discolor</i>				2				
<i>Dicranum spp.</i>							2	
<i>Lonicera ciliosa</i>				T				

Cover by Layer (%)	Tree:		Shrub:	95	Herb:	2	Moss:	4
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Soils:

Moderately well drained silty clay loam with 25% coarse fragments and moder humus form. Observed a distinct mushroom smell and an abundance of fungal mycelia.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed

Disturbance History:

Logged approximately 15 years ago, with very dense natural regeneration taking place resulting in a barren forest floor and relatively low diversity.

Succession:

The stand will continue as a very dense Douglas-fir, grand fir dominated young forest with very barren understory and poor species diversity for the next 80 to 100 years while natural stem exclusion takes place.

Restoration Recommendations:

Recommend well planned thinning treatments with a goal to increase species diversity and general tree growth - possibly making multiple entries over the next 30 to 40 years. Limited removal of Douglas-fir and grand fir stems from the site is possible while still achieving restoration goals.

Recommend spot planting of Douglas-fir, western redcedar and grand fir in polygon 18a to hasten the formation of a tree canopy – de-compact soil around planting sites to provide a more favorable growing condition for the planted tree.

Ecosystem 19

Description: Douglas-fir – Arbutus (CDFmm/01-02) pole forest on a small ridge and associated southwest facing steep slope. Dominated by pole trees with scattered young and mature trees throughout, characterized by exposed bedrock and very shallow soils on the crest with slightly deeper soil pockets on the southwest facing steep slope.

Polygon ID:	19	Slope:	Variable, 5-30%	Aspect:	S – SW, convex
Structural Stage:	PSc	Mesoslope Position:	Crest / upper slope	Site Series:	CDFmm/01-02
Soil Nutrient Reg.:	P - M	Soil Moisture Regime:	1-2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	1			40				
<i>Thuja plicata</i>	1			5				
<i>Alnus rubra</i>				1				

<i>Abies grandis</i>				T				
<i>Arbutus menziesii</i>				10				
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				5	T			
<i>Mahonia nervosa</i>					5			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							1	
<i>Pteridium aquilinum</i>						2		
<i>Polytrichum juniperinum</i>							T	
<i>Lonicera hispidula</i>					2			
<i>Lonicera ciliosa</i>					1			
<i>Rubus discolor</i>				2				
<i>Cytisus scoparius</i>					1			
Cover by Layer (%)	Tree:	2	Shrub:	80	Herb:	5	Moss:	2

Soils:

Silty loam with 50% coarse fragment content, well drained. Mor humus form with an Ae horizon.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed

Habitat: Scattered medium diameter snags well used by woodpeckers.

Disturbance History:

Logged approximately 15 years ago with evidence of soil disturbance from heavy machinery scattered throughout in patches – often coinciding with Scotch broom (*Cytisus scoparius*) and Himilayan blackberry (*Rubus discolor*) cover. Scattered charred areas suggest spot slash burns after logging or a patchy broadcast burn.

Succession:

Stand will continue to develop into a Douglas-fir / Arbutus dominated young forest with a diverse canopy and understory.

Restoration Recommendations:

Recommend removal of Scotch broom and Himilayan blackberry.

Ecosystem 20

Description: Douglas-fir – Arbutus (CDFmm/02) / Oregon beaked moss mature forest ridge mixed with patches of regenerating pole forest clearcut 15 years ago. Polygon is characterized by very shallow soils with significant patches of moss covered exposed boulders and bedrock.

Polygon ID:	20	Slope:	Variable, 5-20%	Aspect:	SW - NE, convex
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Structural Stage:	MFm / PSm	Mesoslope Position:	Crest	Site Series:	CDFmm/02
Soil Nutrient Reg.:	P	Soil Moisture Regime:	0-1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		10	5	5	2		T	
<i>Thuja plicata</i>				5	2		T	Mainly on NE aspect
<i>Acer macrophyllum</i>		5						
<i>Abies grandis</i>		T	T	T				
<i>Arbutus menziesii</i>		20	5				T	
<i>Gaultheria shallon</i>					35			Increases on NE aspect
<i>Polystichum munitum</i>						T		
<i>Mahonia nervosa</i>					15			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							30	
<i>Rhytidadelphus lorus</i>							T	
<i>Hylocomnium splendens</i>							1	
<i>Lonicera hispidula</i>					3			
<i>Lonicera ciliosa</i>				T				
<i>Trientalis latifolia</i>						T		
<i>Gallium aparine</i>						T		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Dicranum spp.</i>							T	
Cover by Layer (%)	Tree:	45	Shrub:	60	Herb:	2	Moss:	35

Soils:

Mor humus form with a thin Ae horizon. Soil has a silty loam texture with a very high coarse fragment content (50-70%) mostly consisting of flat platy sandstone cobbles. Well to rapidly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven, bald eagle, seagull

Habitat: Scattered snags well used by woodpeckers and coarse woody debris of varying decay class scattered around the polygon.

Disturbance History:

Logging encroached up into slightly deeper soiled portions of the ridge creating a wavy border along the northeast side of the ridge between the mature forest and regenerating clearcut.

Succession:

Developing into a mixed species, multi-layered canopy young/mature forest with a diverse moss dominated understory. Regen in clearcut areas is thick and healthy and will begin to self thin over the next several decades.

Restoration Recommendations:

None recommended.

Ecosystem 21

Description: Patches of Douglas-fir dominated pole forest (CDFmm/01 – 75%) mixed with very shallow soiled, open areas dominated by exposed boulders and bedrock (CDFmm/02 – 25%). The northeast facing area spans from an upper slope to a lower slope and is characterized by appropriate variation in moisture and nutrient regimes with soils that are slightly drier and poorer at the top and slightly moister and richer at the bottom.

Polygon ID:	21	Slope:	20-30%	Aspect:	50°
Structural Stage:	PSc	Mesoslope Position:	Mid slope	Site Series:	CDFmm/01 – 75% CDFmm/02 – 25%
Soil Nutrient Reg.:	P - R	Soil Moisture Regime:	1-3	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>				60	2		T	
<i>Thuja plicata</i>				4	1		T	
<i>Alnus rubra</i>				5				
<i>Abies grandis</i>				T	T			
<i>Arbutus menziesii</i>				8				
<i>Acer macrophyllum</i>				5				
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				5				
<i>Mahonia nervosa</i>					30			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							5	
<i>Pteridium aquilinum</i>						T		
<i>Polytrichum juniperinum</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Dicranum spp.</i>							T	
<i>Rubus discolor</i>				2	2			
<i>Hylocomnium splendens</i>							T	
<i>Gallium aparine</i>						T		
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						5		Lower slope
<i>Symphoricarpus albus</i>					1			
<i>Vaccinium parviflorum</i>					T			
<i>Grass spp.</i>						5		
<i>Cytisus scoparius</i>				T				

<i>Lychnis coronaria</i>						T		
<i>Rubus ursinus</i>						T		
Cover by Layer (%)	Tree:		Shrub:	95	Herb:	15	Moss:	10

Soils:

Silty loam with 30 – 50% coarse fragments increasing to over 50% similar to polygon 20 in upper areas. Moder humus form with a thin Ah, very well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven, bald eagle

Disturbance History:

Logged approximately 15 years ago - thin soils are sensitive to compaction.

Succession:

The patchy appearance with dense stands of regenerating Douglas-fir and open rocky outcrops will continue for several decades until the canopies of large maturing trees begin to close in over rocky outcrop gaps. Dense regen areas will begin to lose diversity over the next 10 to 15 years and the dominant Douglas-fir canopies shade everything else out.

Restoration Recommendations:

Recommend removal of Scotch broom and Himalayan blackberry.

Recommend thinning of Douglas-fir in dense areas to increase tree growth and improve or maintain species diversity.

Ecosystem 22

Description: Young Red alder – salal dominated gently sloping south facing moisture receiving area. The polygon includes old logging access routes on its eastern and western edges and is characterized by relatively heavy disturbance and soil compaction with a central core of less disturbed young mixed red alder, Douglas-fir and western redcedar forest.

Polygon ID:	22	Slope:	5 - 10%	Aspect:	180°
Structural Stage:	SH	Mesoslope Position:	Mid slope	Site Series:	CDFmm/01-04
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	4	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>	5	50						
<i>Abies grandis</i>				5				
<i>Thuja plicata</i>	5	5		2				
<i>Acer macrophyllum</i>		2						
<i>Psuedotsuga menziesii</i>		2		10				

<i>Gaultheria shallon</i>					45			
<i>Rubus spectabilis</i>					2			
<i>Polystichum munitum</i>						15		
<i>Mahonia nervosa</i>					5			
<i>Rubus parvaflorus</i>					T			
<i>Kindbergia oregana</i>							2	
<i>Kindbergia praelonga</i>							T	
<i>Achlys triphylla</i>						T		
<i>Urtica dioica</i>						3		
<i>Salix scouleriana</i>				T				
<i>Lonicera ciliosa</i>				T				
Cover by Layer (%)	Tree:	70	Shrub:	65	Herb:	20	Moss:	5

Soils:

Moder humus form with an Ah layer of variable thickness (0-5cm). Mineral soil has 20 to 35% coarse fragments, a sandy loam texture and a dark reddish brown hue. Soil is moderately to well drained and is moisture receiving from adjacent cliff/ridge areas.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

A wide strip (10 – 15m) area running down the northeastern side of the polygon was used as a skid road to access the creek area – deep ruts were observed. There is also an old logging road located on the southwestern edge of the polygon. Disturbance from logging and log hauling has likely resulted in the red alder dominance.

Succession:

Heavily disturbed road areas will remain dominated by red alder for 40 to 50 years – as the alder start to die and fall over, the Douglas-fir, grand fir and western redcedar waiting in the sub canopy will be released and gradually take over. The less disturbed central portion of the polygon will continue to grow into a multi-stories, mixed species young forest.

Restoration Recommendations:

None recommended.

Ecosystem 23

Description: Red alder – sword fern / salmonberry (CDFmm/12 – 80%) dominated pole forest with scattered young western redcedar and bigleaf maple. The site has a strongly fluctuating water table due to flat topography, dense relatively fine soils, and receiving moisture from adjacent cliff / ridge sites. The polygon is characterized by raised micro-sites scattered within and around its edges where there is less water table fluctuation in the rooting zone and the ecosystem more closely resembles a CDFmm/06 site series (20%) with no salmonberry and more salal.

Polygon ID:	23	Slope:	2 - 5%		Aspect:	320°	
Structural Stage:	PSb	Mesoslope Position:	Flat		Site Series:	CDFmm/12 (80%) CDFmm/06 (20%)	
Soil Nutrient Reg.:	VR	Soil Moisture Regime:	5f		Photo Points:		

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes	
<i>Alnus rubra</i>				40					
<i>Abies grandis</i>				T	T				
<i>Thuja plicata</i>	5		5	5					
<i>Acer macrophyllum</i>	5		5						
<i>Psuedotsuga menziesii</i>				1	T				
<i>Salix scouleriana</i>				20					
<i>Gaultheria shallon</i>					5				
<i>Rubus spectabilis</i>				20					
<i>Polystichum munitum</i>						50			
<i>Cornus stolonifera</i>				T					
<i>Plagiomnium insigne</i>							T		
<i>Kindbergia oregana</i>							3		
<i>Kindbergia praelonga</i>							3		
<i>Achlys triphylla</i>						3			
<i>Urtica dioica</i>						T			
<i>Carex opnupta</i>						1			
<i>Equisetum arvense</i>									
<i>Pteridium aquilinum</i>						2			
<i>Vaccinium parvaflorum</i>					T				
<i>Rubus ursinus</i>					T				
<i>Rubus discolor</i>				8	2				
<i>Sambucus racemosa</i>				2					
<i>Grass spp.</i>						6			
<i>Rubus parvaflorum</i>				T					
<i>Dicranum spp.</i>							T		
<i>Rhytidiadelphus loreus</i>							T		
<i>Gallium aparine</i>						T			
<i>Gallium trifidum</i>						T			
<i>Rubus laciniatus</i>				T	T				
Cover by Layer (%)	Tree:	20	Shrub:	90		Herb:	60	Moss:	10

Soils:

An underlying layer of moderately well drained sandy loam with a layer of sandy clay loam above with 10 to 15% coarse fragments. Very thick H and Ah layers combining to a depth of approximately 15cm. Moder humus form.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Habitat: Moist area supports amphibians and shrubby thicket like salmonberry in fluctuating water table provides high quality bird habitat..

Disturbance History:

Logged approximately 15 years ago. Small areas where machinery was used extensively and possibly where logs were decked are scattered throughout this polygon – this has resulted in soil compaction and inhibited growth of native plants. These more heavily disturbed areas are often dominated by exotic grasses and blackberry thickets.

Succession:

Moving towards a young red alder dominated site with scattered individual large western redcedar and bigleaf maple trees. Western redcedar will gradually take over to form the dominant tree canopy with scattered Douglas-fir occurring on dryer micro-sites.

Restoration Recommendations:

None recommended.

Ecosystem 24

Description: Douglas-fir / grand fir / red alder - sword fern (CDFmm/06 – 60%) dominated gently sloped, moisture receiving pole forest site with a slightly drier soil area more characteristic of a CDFmm/04 site series (40%) mostly on the northwest side of the road that bisects the polygon. There are scattered young western redcedar and bigleaf maple trees scattered throughout the polygon.

Polygon ID:	24	Slope:	10%	Aspect:	320°
Structural Stage:	PSm	Mesoslope Position:	Mid slope	Site Series:	CDFmm/06 – 60% CDFmm/04 – 40%
Soil Nutrient Reg.:	R	Soil Moisture Regime:	4-5	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	2			30				
<i>Thuja plicata</i>	8			2				
<i>Alnus rubra</i>				15				
<i>Abies grandis</i>				25				
<i>Arbutus menziesii</i>				T				
<i>Acer macrophyllum</i>	5							
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				10				
<i>Mahonia nervosa</i>					5			

<i>Rosa nootkensis</i>				T				
<i>Kindberia praelonga</i>							T	
<i>Pteridium aquilinum</i>						1		
<i>Rubus spectabilis</i>				5	1			
<i>Rhamnus purshiana</i>				T				
<i>Lonicera ciliosa</i>				T				
<i>Rubus discolor</i>				2	2			
<i>Salix scouleriana</i>				3				
<i>Achlys triphylla</i>							T	
<i>Lactuca muralis</i>							T	
<i>Polystichum munitum</i>							20	
<i>Symphoricarpos albus</i>						T		
<i>Rubus ursinus</i>						T		
Cover by Layer (%)	Tree:	15	Shrub:	85	Herb:	20	Moss:	1

Soils:

Silty clay loam overtop of a clay loam beginning at 30cm with 25 – 35% coarse fragments and a reddish hue. Mottling was observed below 30cm. The soils are characterized by a moder humus form and are moderately well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

Logged approximately 15 years ago. Small areas where machinery was used extensively and possibly where logs were decked are scattered throughout this polygon – this has resulted in soil compaction and inhibited growth of native plants. There is a noticeable lack of coarse woody debris in this polygon.

Succession:

The ecosystem is moving towards a Douglas-fir – grand fir dominated young forest with scattered western redcedar and bigleaf maples and a very sparse understory due to shading from a dense canopy. The naturally regenerating stand will self thin over the next 70 to 100 years.

Restoration Recommendations:

Recommend a light thinning of Douglas-fir and grand fir poles to increase growth in remaining trees and to maintain diversity in the stand. Leave stems as additions to coarse woody debris on the site.

Ecosystem 25

Description: Western redcedar / bigleaf maple – sword fern (CDFmm/06) dominated mature forest mixed with disturbed areas including old logging roads and selectively logged patches where western redcedar, grand fir and western hemlock saplings are the dominant tree regeneration with a sword fern dominated understory.

Polygon ID:	25	Slope:	20% (concave)		Aspect:	55°
Structural Stage:	MFm	Mesoslope Position:	Lower slope		Site Series:	CDFmm/06
Soil Nutrient Reg.:	R - VR	Soil Moisture Regime:	6		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5	10						
<i>Thuja plicata</i>		25		5	T			
<i>Alnus rubra</i>			5					
<i>Abies grandis</i>		2	2	5	T			
<i>Tsuga heterophylla</i>				T				
<i>Acer macrophyllum</i>		20	2				T	
<i>Gaultheria shallon</i>					1			
<i>Trientalis latifolia</i>						T		
<i>Mahonia nervosa</i>					10			
<i>Kindbergia oregana</i>							3	
<i>Kindbergia praelonga</i>							2	
<i>Pteridium aquilinum</i>						T		
<i>Rubus spectabilis</i>				1	T			
<i>Climacium dendroides</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Plagiomnium insigne</i>							1	
<i>Neckera Douglasii</i>							T	
<i>Achlys triphylla</i>						2		
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						60		
<i>Vaccinium parvaflorum</i>					T			
<i>Rubus ursinus</i>					T			
<i>Isothecium myosuroides</i>								
<i>Metaneckera menziesii</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Equisetum arvense</i>						T		
<i>Carex spp.</i>						1		
<i>Grass spp.</i>						1		
<i>Galium trifidum</i>						T		
Cover by Layer (%)	Tree:	65	Shrub:	25	Herb:	70	Moss:	10

Soils:

Moder humus form with small patchy Ae and thick Ah layers. Moderately well to imperfectly drained silty clay loam with a silty clay layer appearing roughly at 60 cm in depth where mottling is evident. Coarse fragment content is approximately 15 to 20%.

Wildlife and Wildlife Habitat:

Observed during data collection: Red-legged frog, raven, bard owl.

Habitat: Variety of large diameter coarse woody debris of varying decay class – excellent for amphibians breeding in nearby flooded areas.

Disturbance History:

Selective logging over the past 60 to 80 years along with a number of small clearings associated with meditation huts and other associated infrastructure as well as old logging roads and trails.

Succession:

The mixed species canopy will continue to mature and maintain a similar composition. The currently broadleaf dominated areas on the fringe of the lower slope bordering with the wetland will slowly transition towards a greater percentage of grand fir and western redcedar in the canopy.

Restoration Recommendations:

Recommend removal of the deteriorating hut structures and old building materials.

Ecosystem 26

Description: Maturing western redcedar / Douglas-fir – sword fern / Oregon beaked moss (CDFmm/04 – 80%) dominated forest characterized by sword fern dominated canopy gaps (often associated with laminated root rot (*Phelinus wierii*) scattered throughout the polygon’s dense conifer canopy and relatively barren forest floor. The polygon transitions to a Douglas-fir dominated canopy as it moves into a slightly shallower and coarser soiled upper slope CDFmm/01 (20%) ecosystem. The area is just beginning to develop mature forest characteristics as it transitions from a young forest.

Polygon ID:	26	Slope:	30%		Aspect:	65°
Structural Stage:	MFc	Mesoslope Position:	Mid slope		Site Series:	CDFmm/04 - 80% CDFmm/01 – 20%
Soil Nutrient Reg.:	R - M	Soil Moisture Regime:	2-3		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		20	T					
<i>Thuja plicata</i>		50	5	1	T			
<i>Alnus rubra</i>			1					
<i>Abies grandis</i>		2		T				
<i>Acer macrophyllum</i>		4	T					
<i>Gaultheria shallon</i>					3			
<i>Trientalis latifolia</i>					T			
<i>Mahonia nervosa</i>					5			

<i>Kindbergia oregana</i>							25		
<i>Kindbergia praelonga</i>							1		
<i>Rhizomnium glabrescens</i>							T		
<i>Pseudotaxiphyllum elegans</i>							T		
<i>Achlys triphylla</i>							1		
<i>Lactuca muralis</i>							T		
<i>Polystichum munitum</i>							20		
<i>Vaccinium parvaflorum</i>					1				
Cover by Layer (%)	Tree:	80	Shrub:	10	Herb:	25	Moss:	30	

Soils:

Moder humus form with Ah layers. Moderately to well drained silty loam with a silty clay layer appearing roughly at 50 cm in depth along the lower slope edge of Polygon 25. Coarse fragment content is approximately 25 to 35% increasing to 35 – 50% towards the upper slope edge.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

The area was clearcut approximately 70 years ago – the stumps are low and almost all Douglas-fir. Prior to the clearcut, Douglas-fir would have occupied a much greater percentage of the canopy cover. The polygon appears to have naturally regenerated. Areas are scattered throughout where there appears to have been heavy soil disturbance from machinery.

Windthrow in areas affected by laminated root rot is the primary natural disturbance – the root rot gaps appear to be growing as die back in surrounding Douglas-fir canopies was observed.

Several meditation huts, sheds and trails are also located within the polygon.

Succession:

The stand is at the end of its young forest successional stage and is beginning to show mature forest characteristics resulting from root rot gap creation and the formation of a multi-storied canopy. The polygon will continue towards a mature forest as gaps and resulting understory diversity increase. The canopy will gradually move to a Douglas-fir dominated over the next century.

Restoration Recommendations:

Recommend removal of the deteriorating hut structures and unused shed structures.

Ecosystem 27

Description: Red alder – salmonberry dominated young forest characteristic of a seasonally flooded (WS53 – 45%) swamp interspersed with western redcedar / big-leaf maple areas occurring on very moist (CDFmm/11 – 40%) forest, and transitioning into a slightly drier (CDFmm/06 – 15%) lower slope ecosystem in a broad band along the gently sloping southern

edge and a narrow band along the toe of the adjacent cliff to the north.

Polygon ID:	27	Slope:	0-1%		Aspect:	160°
Structural Stage:	YFb	Mesoslope Position:	Depressio n		Site Series:	WS53 – (45%) CDFmm/11 (40%) CDFmm/06 (15%)
Soil Nutrient Reg.:	R-VR	Soil Moisture Regime:	7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>		10	20					
<i>Abies grandis</i>							T	Drier CDFmm06 sites
<i>Thuja plicata</i>		5	5	2	1			
<i>Acer macrophyllum</i>		10						
<i>Psuedotsuga menziesii</i>	2							On raised micro-sites
<i>Gaultheria shallon</i>					5			On raised micro-sites
<i>Rubus spectabilis</i>				35				
<i>Polystichum munitum</i>						20		
<i>Stachys spp.</i>						T		
<i>Plagiomnium insigne</i>							2	
<i>Kindbergia oregana</i>							2	
<i>Kindbergia praelonga</i>							5	
<i>Achlys triphylla</i>								
<i>Urtica dioica</i>						2		
<i>Carex opnupta</i>						2		
<i>Equisetum arvense</i>						8		
<i>Atherium felix-femina</i>						1		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Rubus ursinus</i>					T			
<i>Carex spp.</i>						8		
<i>Sambucus racemosa</i>				T				
<i>Oenanthe sarmentosa</i>						1		Flooded area
<i>Lactuca muralis</i>						T		
<i>Tellima grandiflora</i>						T		
<i>Porella navicularis</i>							2	On salmonberry branches
<i>Rhyzomnium glabrescens</i>							T	
<i>Climacium dendroides</i>							T	
<i>Rhytidiadelphus loreus</i>							1	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Isothecium myosuroides</i>							2	
<i>Hylocomnium splendens</i>							T	

Cover by Layer (%)	Tree:	10	Shrub:	10	Herb:	95	Moss:	2
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Soils:

Clay with high organic content in the flooded areas transitioning to slightly raised where red alder are growing which have an upper silty clay horizon. Moder humus form with very low coarse fragment content (0-5%), imperfectly to poorly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.

Habitat: Salmonberry and water source extremely valuable for wildlife. Active beaver damming occurring above culvert on Lot 10.

Disturbance History:

The area was logged in the early to mid 20th century. The soil has been severely compacted where road access has occurred resulting in water collection and channelization in the old ruts. There are patches scattered throughout with evidence of heavier disturbance including a staging area where an old Douglas-fir snag with a 50 to 60 foot high burn scar may be evidence of an intense slashpile burn.

Succession:

Red alder is commonly the dominant tree species that regenerates after logging in wet soils – the alder will slowly be taken over by a higher percentage of western redcedar and big-leaf maple as the soils continue to recover. Red alder will persist on the sites in gaps and openings. The percentage of the area characterized by raised micro-sites will also increase allowing for slight increases in Douglas-fir and grand fir cover over time. This area may also move towards a flooded marsh ecosystem if beaver continue to expand their territory and construct more damns in this area (this seems unlikely due to the the broad, gradual slope of in this polygon with no easily dammable ‘bottlenecks’ observed).

Restoration Recommendations:

None recommended.

Ecosystem 28

Description: Sword fern dominated and scattered young western redcedar, big-leaf maple and red alder (CDFmm/06 – 90%) open recently logged lower slope with small patches of seasonally open salmonberry – slough sedge (carex obnupta) flooded wet soils (CDFmm/11 – 10%). There is no defined seasonal stream channel in this polygon with flow likely occurring below the surface.

Polygon ID:	28	Slope:	2 - 10%	Aspect:	160°
Structural Stage:	SH	Mesoslope Position:	Lower slope	Site Series:	CDFmm/11 (10%) CDFmm/06 (90%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6-7	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes		
<i>Alnus rubra</i>			2	1						
<i>Abies grandis</i>				T	T					
<i>Thuja plicata</i>	2		3	T	T					
<i>Acer macrophyllum</i>	5									
<i>Psuedotsuga menziesii</i>				T						
<i>Gaultheria shallon</i>					2					
<i>Rubus spectabilis</i>					5					
<i>Polystichum munitum</i>						80				
<i>Cornus stolonifera</i>				T						
<i>Plagiomnium insigne</i>							T			
<i>Kindbergia oregana</i>							T			
<i>Kindbergia praelonga</i>							T			
<i>Achlys triphylla</i>						T				
<i>Urtica dioica</i>						2				
<i>Carex opnupta</i>						5				
<i>Equisetum arvense</i>						5				
<i>Pteridium aquilinum</i>						T				
<i>Vaccinium parvaflorum</i>				T						
<i>Rubus ursinus</i>					T					
Cover by Layer (%)	Tree:	10	Shrub:	10	Herb:	95	Moss:	2		

Soils:

Dark silty loam with high organic content, thick Ah and low coarse fragment content (10%).
Seasonally moist.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.
Habitat: Salmonberry and water source extremely valuable for wildlife.

Disturbance History:

Soils have been heavily impacted from machinery during logging 15 to 20 years ago. Old stumps indicate a mature forest community dominated by large western redcedar with the odd Douglas-fir and grand fir scattered on micro-sites.

Succession:

Western redcedar will gradually increase in density and become the dominant cover with grand fir and Douglas-fir taking hold on appropriate microsites and maple remaining a minor component over the next 50 or 60 years. Sword fern will remain a dominant understorey cover though species diversity should increase as the tree canopy develops

Restoration Recommendations:

None recommended.

Ecosystem 29

Description: Douglas-fir / Arbutus – salal (CDFmm/01) regenerating pole forest with scattered patches of heavily disturbed soils near roads characterized by a higher percent cover of Himalayan blackberry (*Rubus discolor*), red alder and bitter cherry.

Polygon ID:	29	Slope:	10-20%	Aspect:	180-210°
Structural Stage:	PSm	Mesoslope Position:	Mid to upper slope	Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	2-4	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>				25				
<i>Thuja plicata</i>				2	T		T	
<i>Alnus rubra</i>				7				
<i>Abies grandis</i>				5	T			
<i>Arbutus menziesii</i>			1	25				
<i>Acer macrophyllum</i>			1	T				
<i>Prunus emarginata</i>				2				
<i>Gaultheria shallon</i>					25			
<i>Mahonia nervosa</i>					10			
<i>Galium trifidum</i>						T		
<i>Kindberia oregona</i>							3	
<i>Pteridium aquilinum</i>						5		
<i>Grass spp.</i>						T		
<i>Lonicera hispidula</i>					2			
<i>Lonicera ciliosa</i>				T				
<i>Rubus discolor</i>				5	3			
<i>Cytisus scoparius</i>				T	T			
<i>Achlys triphylla</i>						T		
<i>Polystichum munitum</i>						1		
<i>Rubus ursinus</i>					T			
Cover by Layer (%)	Tree:	2	Shrub:	90	Herb:	7	Moss:	5

Soils:

Mor humus form with a charred layer in patches where slash piles were burnt after logging. Silty loam over top of a silty clay loam with approximately 25 to 35% coarse fragment content. Some orange/red mottles observed between 30 and 40 cm deep. Coarse fragments increase towards the upper slope areas. Well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

Clearcut approximately 16 years ago in 1993 or 94. Slash burn is indicated by scattered patches of charred material in soils and remaining coarse woody debris on site is charred. The site appears to have been left to naturally regenerate. Machine use on the site has disturbed the soils in general and has left scattered areas of higher disturbance where staging areas or access routes were located.

Succession:

Patches of dense Douglas-fir and grand fir are mixed with well spaced Douglas-fir, Arbutus and red alder dominated areas. Diversity will decrease over the next several decades with Douglas-fir emerging as the sole dominant tree species and forming a continuous canopy over a large portion of the area with very little understory cover. Self thinning will begin in 15 to 20 years and continue for another 40 to 50 years when mature forest characteristics such as canopy gaps, a diverse understory and a multi-layered, multi-species canopy will begin to emerge.

Restoration Recommendations:

Recommend thinning treatments over time to maintain tree diversity in the stand. Remove individual and clusters of Douglas-fir as they begin to shade out other trees and understory vegetation over the next 10 to 20 years. This area could provide an ongoing sustainable supply of timber as the forest ages.

Ecosystem 30

Description: Douglas-fir / salal (CDFmm/01) mature forest on a northeast facing moderately sloped site. Douglas-fir trees in the main canopy are approximately 150 years old and the ecosystem exhibits the structural characteristics of a maturing to old-growth forest.

Polygon ID:	30	Slope:	38%	Aspect:	45°
Structural Stage:	MFc	Mesoslope Position:	Mid to upper slope	Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	2-3	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>								
<i>Thuja plicata</i>								
<i>Arbutus menziesii</i>								
<i>Acer macrophyllum</i>								
<i>Gaultheria shallon</i>								
<i>Mahonia nervosa</i>								
<i>Lonicera hispidula</i>								
<i>Lonicera ciliosa</i>								
<i>Symphoricarpos alba</i>								
<i>Polystichum munitum</i>								

<i>Kindberia oregona</i>								
<i>Dicranum scoparium</i>								
<i>Rhytidiadelphus triquetrus</i>								
<i>Kinbergia praelonga</i>								
<i>Hylocomnium splendens</i>								
<i>Isothecium myosuroides</i>								
Cover by Layer (%)	Tree:		Shrub:		Herb:		Moss:	

Soils:

Range from approximately 60cm in depth to over 75cm in depth before hitting a shattered bedrock horizon. The depth of the soil corresponds generally to the position on the slope with the shallower areas occurring closer to the ridge top. High coarse fragment content (45% near the surface to over 70% at 70cm in depth). Rapidly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

Evidence of single tree selection (Douglas-fir) logging and trail up to the pagoda were observed. Wind is the most prevalent natural disturbance on the site. Relatively recent (last 10 to 20 years) windthrow was observed in the area. Fallen trees were generally perpendicular to the slope pointing downhill, indicating that winds blowing from the west are primarily responsible for the disturbance. Broken tops were observed on the upper slope area near the ridge top.

Succession:

This site will continue to develop structural and functional complexity as it moves towards an old-growth climax forest.

Restoration Recommendations:

No recommendations.

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**GROUNDWATER ASSESSMENT REPORT FOR
CRYSTAL MOUNTAIN RETREAT CENTRE,
GALIANO ISLAND**

Lot A, District Lots 88 and 89, Plan VIP68079 and
Lot 9, District Lot 90, Plan 31200
Galiano Island, Cowichan District

Prepared for:

CRYSTAL MOUNTAIN SOCIETY
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Victoria, British Columbia

November 2, 2015

EXECUTIVE SUMMARY

This report assesses the overall groundwater supply requirements for the Crystal Mountain Retreat Centre and provides an opinion on meeting the water demands from an existing well on the property. The maximum daily requirements or maximum day demand (MDD) that would likely occur at the retreat centre is estimated at 2839 liters/day or 625 Imperial gallons day which would serve a maximum of 30 persons accommodated on site. An existing well at the centre, designated the central well, was pump tested in October 2015 for a minimum period of 12 hours at a constant rate of 8.07 L/min and evaluated to have a long term yield of 2.826 L/min (4069 L/day) with a 70% safety factor. This calculated yield is 43% more than the estimated water supply requirements of 2839 L/day and would amount to a total potential supply of 1.49 million litres/year. Testing was conducted at the optimal time of the year when water levels are at their seasonal lowest.

No discernable pumping effects were observed in two observation wells at the centre that were monitored during the October testing. Based on these monitoring results, use of the central well at a rate of 1.972 L/min (2839 L/day) would have no measureable effect on any of the neighbouring wells or surface water sources in the region.

Water quality testing of the central well (*WID 23227*) indicates that the water meets or exceeds *Guidelines for Canadian Drinking Water* (Federal-Provincial-Territorial Committee on Drinking Water, 2015) for all parameters tested except for total coliforms. Total coliforms of 3 and 1 CFU/100mL were reported for two samples taken after chlorination of the well. No *E.coli* was detected. The source of the coliforms is not known and could be due to grey water discharge in the vicinity of the well and /or natural sources such as decaying vegetation in nearby wetland areas. Previous occurrences of coliform bacteria have been effectively reduced by well chlorination. As a precautionary measure against any future potential sources of coliform bacteria, water from the existing well source should be treated with an appropriately designed and maintained ultraviolet irradiation (UV) or chlorination treatment system.

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GROUNDWATER ASSESSMENT REPORT FOR CRYSTAL MOUNTAIN RETREAT CENTRE, GALIANO ISLAND

INTRODUCTION

Hy-Geo Consulting was retained by the Crystal Mountain Society (CMS) in August 2015, to provide hydrogeological engineering services to assess the quantity and quality of available groundwater for all proposed uses at their retreat centre on Galiano Island and to identify any potential risks to groundwater or surface waters.

The Crystal Mountain Retreat Centre (CMRC) is located adjacent to and east of Porlier Pass Road at the north end of the island near Spotlight Cove (Figure 1). The retreat centre encompasses Lot A, District Lots 88 and 89, Plan VIP68079 and Lot 9, District Lot 90, Plan 31200, Galiano Island, Cowichan District. Lot A is zoned Forrest 1 (F1) and Lot 9 is zoned Rural 2 (R2) in the *Galiano Land Use Bylaw* (Islands Trust Staff Report, 2015). The society has submitted an application to rezone the two lots to permit a year-round forest retreat centre on both lots. The Crystal Mountain Retreat Centre property is situated directly upslope of several waterfront properties near Spotlight Cove (Figure 1) where residential wells are reported. Three wells are located on the Crystal Mountain property, with the central well currently serving the water requirements of the retreat centre.

This report assesses the overall groundwater supply requirements for the Crystal Mountain Retreat Centre and provides an opinion on meeting the water demands from an existing well on the property. An assessment is also provided on the potential effects of the proposed groundwater use at the CMRC on neighbouring wells and overall groundwater quantity and quality in the region.

Scope of Work

Scope of the work carried out by Hy-Geo-Consulting included:

- (a) reviewing and examining existing hydrogeologic data and reports for the property and adjoining region including topography, geology, climatic and well record information;
- (b) conducting one or more site visits to examine local geology, topography, drainage, surface water sources, existing well conditions, water supply infrastructure, neighbouring wells and land use;
- (c) determining the water uses and total estimated water demands for the retreat centre;

- (d) assessing the quantity and quality of the existing water sources on the property and their uses and determining whether any additional water quantity or water quality testing or monitoring may be required;
- (e) undertaking a minimum 12-hour constant rate pumping test of the central well on the property to determine its long-term capacity to meet the estimated total water demand, including sampling of water quality; This work was planned and completed in conjunction with a qualified pump testing contractor, Red Williams of Red Williams Well Drilling Ltd.
- (f) identifying any potential impacts arising from the proposed use and development of the property on groundwater and surface water;
- (g) reviewing and analyzing the results of the above investigations; and
- (h) preparing a final report suitable for submission to the Local Islands Trust Committee, Vancouver Island Health Authority (VIHA) and Capital Regional District.

Topography and Drainage

The retreat property is situated along an irregular southwest facing slope (Figure 1), comprised of a series of bedrock ridges trending northwest to southeast with elevations rising from 20 metres above sea along Porlier Pass Road to just over 120 metres above sea level at the eastern end of the property. The central portion of the property lies between elevations 40 to 60 m. Towards the east, elevations rise abruptly along an escarpment to above 120 m. Spotlight Creek, appears to originate along the base of the escarpment and is the main drainage feature on the property flowing southeasterly towards the southeast boundary of the property and then southwesterly towards Spotlight Cove. Erickson (2014) reports that Spotlight Creek is intermittent and runs only during peak rainfall months from November through to the spring. No water flow was observed in the creek during the period of field investigations carried out in August, September and early October 2015. An existing surface water licence (No. C058557) for domestic use of 2273 L/day (Figure 1) is registered on Spotlight Creek. An examination of the intake in October 2015 indicated that it does not appear to have been active for some time. Another licence (No. C106042) for domestic use of 682 L/day exists on Stemo Spring. An examination of this source in October 2015 did not show any apparent water flow.

Climate

The climate of Galiano Island is characterized by cool dry summers and humid mild winters. Based on records from 1951 to 1980 (Environment Canada, 198_) the average annual precipitation for a station on Galiano Island was 33.7 inches

(856 mm). Over 90 % of this total annual amount fell as rain with over 60% of the total falling during the period from November to February. Newer data for the 1981-2010 normal period reported by Environment Canada (2015) for Mayne Island and Saturna Island weather stations indicates annual mean precipitation of 842.0 and 812.2 mm., respectively. With the absence of a current climate station on Galiano Island, the Saturna Campon climate station may be considered representative of the general longer-term (monthly) precipitation patterns on Galiano (Figure 2). Global climate models (Allen *et al.*, 2008) suggest precipitation may increase slightly in the future, particularly during the winter months. Table 1 indicates that the cumulative precipitation for the Saturna Campon CS climate station was 90.9 percent of normal from January to end of September 2015. The months of April to July 2015 were particularly dry and well below normal while September 2015 was relatively wet and well above normal.

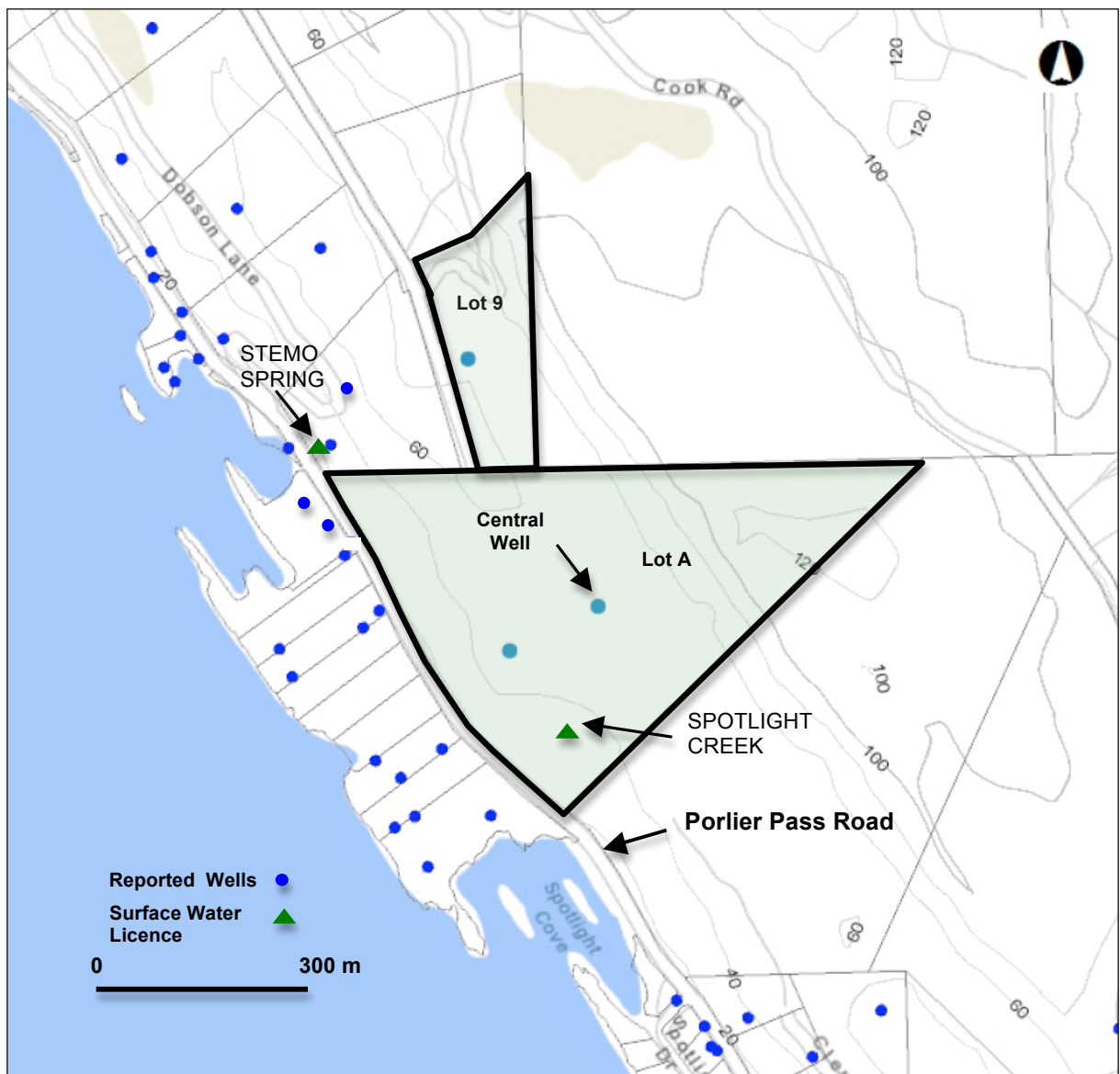


Figure 1. Location of Crystal Mountain properties, wells and water licences. Basemap and from Ministry of Environment (2015a).

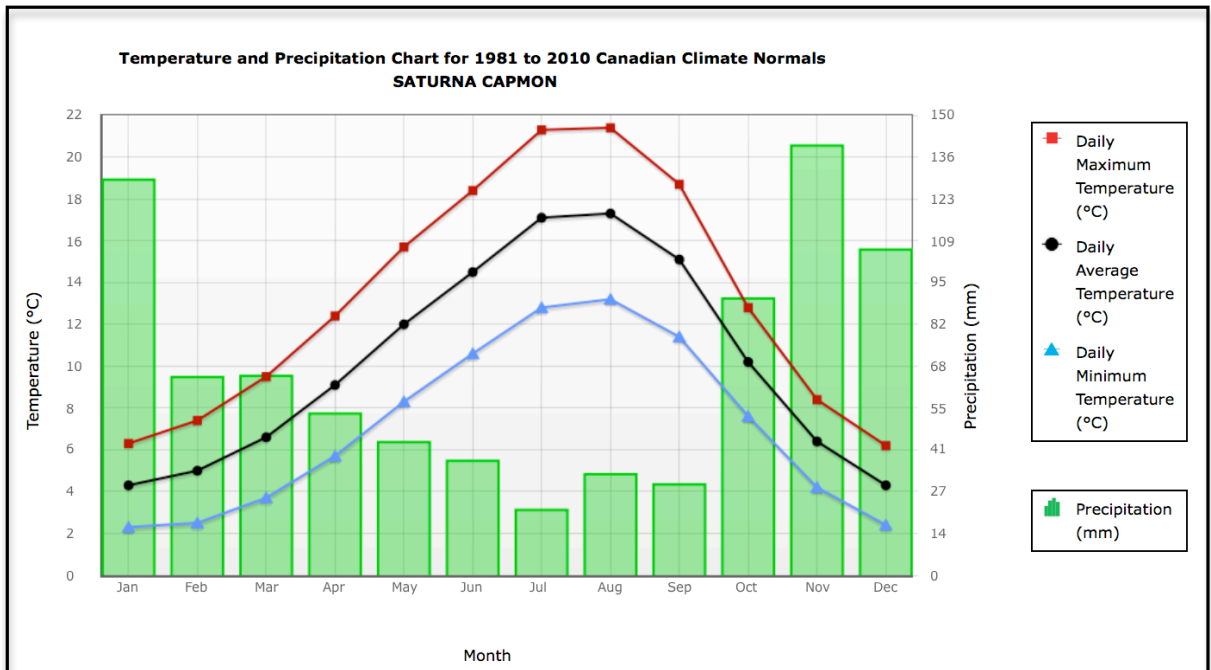


Figure 2. Graph of monthly normal monthly precipitation for Saturna Island Campon station (Climate ID. 1017098). Graph from Government of Canada (2015a).

Table 1. Monthly precipitation data for Saturna Campon CS climate station (Climate ID. 1017098) in 2015 compared to 1981-2010 normals

Month	Precipitation in 2015 (mm)	Precipitation Normal (mm)	Percent of Normal	Cumulative Percent of Normal
January	115.4	129.0	89.5	89.5
February	72.5*	64.6	112.2	97.1
March	107.5	65.0	165.4	114.2
April	16.2*	52.7	30.7	100.1
May	2.6	43.4	6.0	88.6
June	4.8*	37.3	12.9	81.4
July	7.5	21.3	35.2	79.0
August	27.8	32.9	84.5	79.4
September	78.4	29.6	264.9	90.9

* Incomplete data.

Data from Government of Canada (2015b).

Hydrogeologic Conditions

The general groundwater conditions of Galiano Island have been reported by several authors including Harrison (1994), Kohut and Johanson (1998) and Waterline Resources Inc. (2011). Galiano is comprised of sedimentary clastic rocks belonging to the Nanaimo Group of Late Cretaceous age (Muller and Jeletzky, 1970). These consist of alternating interbeds of sandstone, mudstone,

siltstone, shale and some conglomerate. The retreat centre property and surrounding region is principally underlain by the Gabriola Formation that is dominantly sandstone with some shale (mudstone) interbeds.

Groundwater on the island is found primarily in open fractures in the bedrock formations as they are encountered during drilling of water wells. These fractures constitute the major zones for groundwater storage and movement. The retreat centre property lies entirely within the North Trincomali groundwater region as outlined by Kohut and Johanson (1998). In 1998, Kohut and Johanson estimated the demand to groundwater in storage ratio in this region to be relatively low at 0.11. Existing well density at that time was also determined to be low to medium at 0.077 wells/acre. The current well density based on the number of wells reported in the Ministry of Environment WELL database (Ministry of Environment, 2015) is 0.086 wells/acre. Higher well densities also occur locally along the coastline.

From historic observation well data in the Gulf Islands, groundwater levels in bedrock wells generally rise and fall with the seasons, in response to available precipitation, becoming highest during the late fall and winter months. Water levels then normally decline during the dry summer months reaching seasonal lows in the late fall months (Kohut *et al.*, 1984). Figure 3 shows the groundwater level trend for 2015 falling below historic mean levels from May to September as shown in the graph of provincial observation well 258.

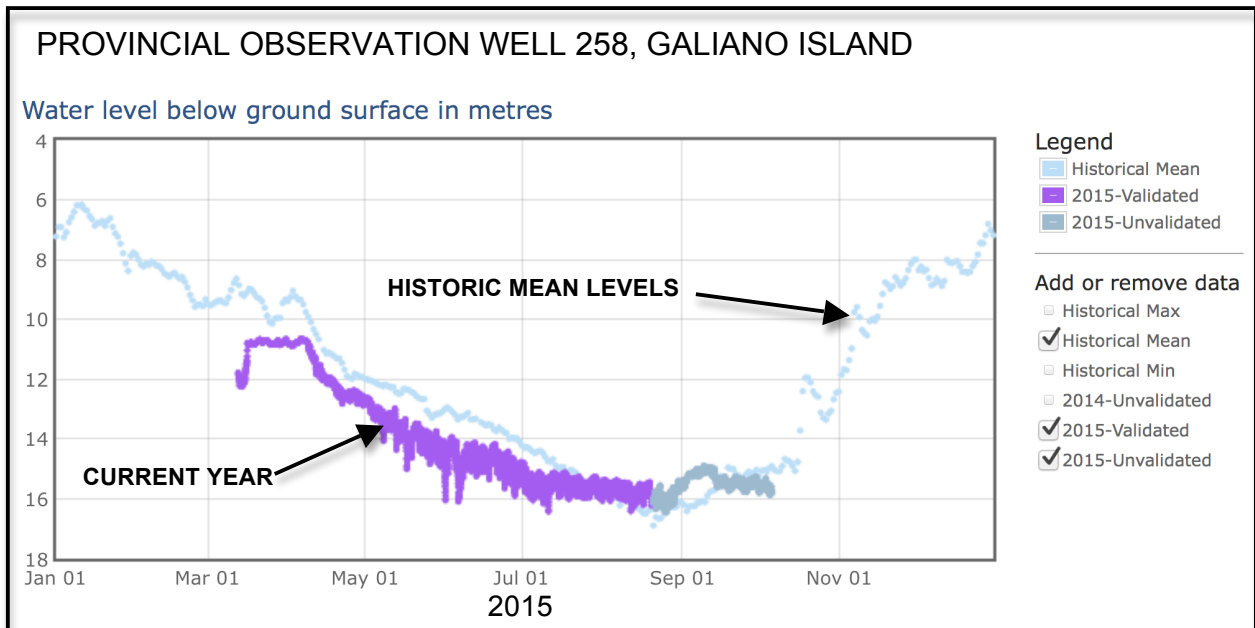


Figure 3. Groundwater level trend in 2015 compared to historic mean data for Observation Well 258. From Ministry of Environment (2015b).

EXISTING WELLS

Figure 4 shows the location of 30 known and reported water wells and springs within 0.64 km. of the central well on the Crystal Mountain property. It should be noted that all well locations have not been verified in the field. Table 2 provides a brief description of the wells within the 0.64 km radius of the central well. Wells currently within the Ministry of Environment's database are identified in Table 2 with a Ministry well tag number (WTN) that is a unique computer generated identification number. In recent years, the Ministry has also provided well identification plate (WID) numbers to well drillers for attaching to the casing of new wells for their identification in the field.

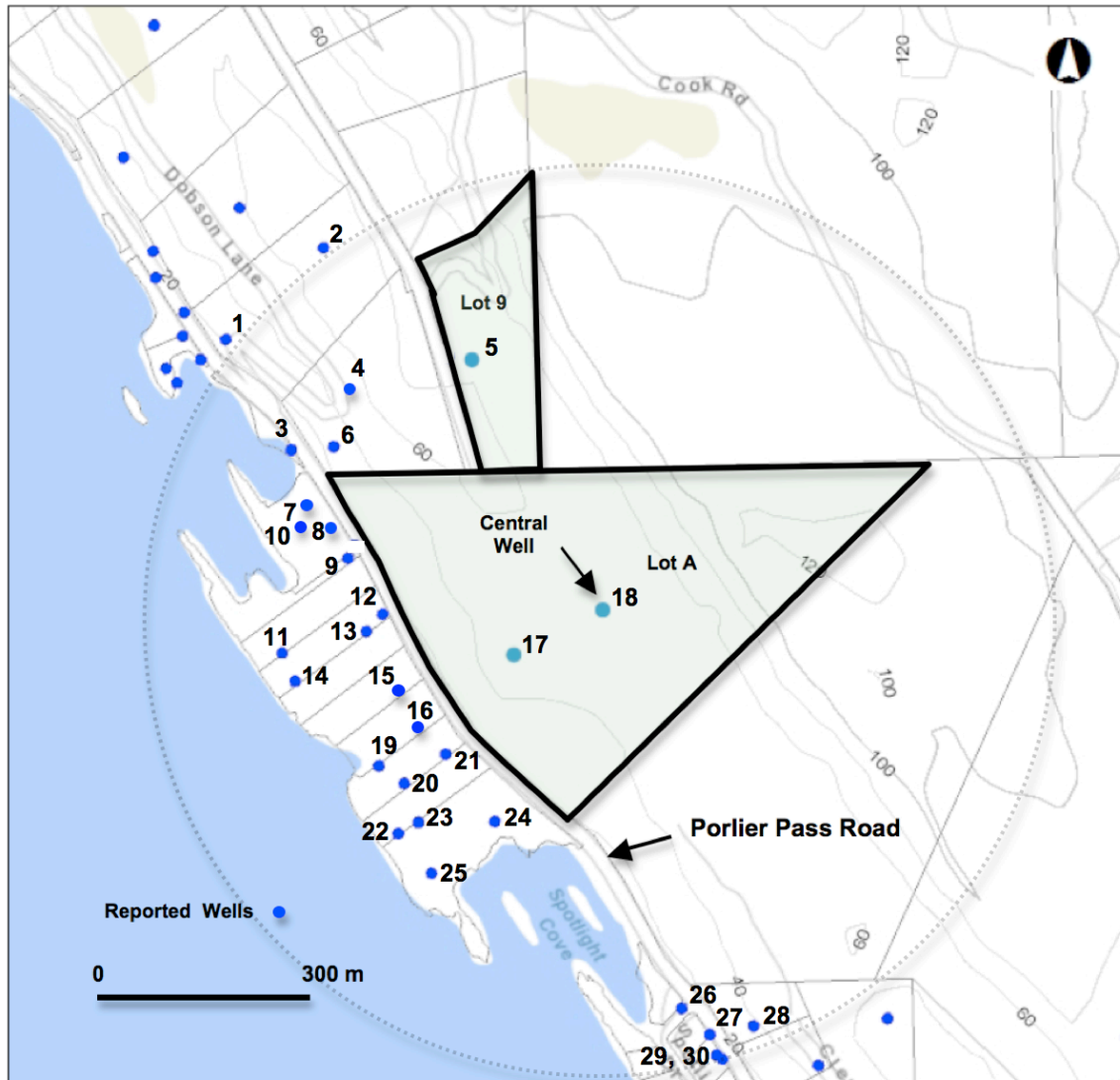


Figure 4. Existing wells and springs within 0.64 km of the central well on Crystal Mountain property.

Table 2. Summary of reported water wells and springs at and in vicinity of Crystal Mountain Retreat Centre.

Site Number on Map	Well Tag No. (WTN)	Well Identification No. (WID)	Address	Depth Drilled/ Dug (feet)	Depth Well Drilled/ Dug (m)	Diameter (in)	Diameter (cm)	Driller's Estimated Yield Value	Yield Unit Description	Water Depth (feet)	Water Depth (m)	Depth to Bedrock (feet)	Depth to Bedrock (m)	Construction Start Date	General Remarks	Legal District Lot	Legal Plan	Lot No.	Owner When Constructed	Well Use
1	49351			172	52.43	6	15.24	4	GPM			14	4.27	14-Oct-81	4 gpm at 158-164 feet	90	31200	7	Brian Preston	Private Domestic
2	97038			400	121.92			6	GPM			6	1.83	04/15/(2008)	0.5 gpm at 95 feet, 1.5 gpm at 345 feet, 4 gpm at 375	90	31200	7	Harding & Nation	Private Domestic
3	13409			50	15.24			8 ?	GPM	45	13.72			01/01/1950*		90	4164	5	Halling	Unknown Well Use
4		26548				6	15.24													
5	56583	23228		280	85.34	6	15.24	6	GPM	55	16.76	9	2.74	30-Sep-86		90	31200	9	Crystal Mountain Retreat Centre	Private Domestic
6	13368							150	GPD	0				01/01/1950*	spring, from crack in sandstone beside road, east side, Licence C.L. 24457	90			Stafford	Drinking Water
7	13358		21035 Porlier Pass Road	14	4.27									01/01/1950*		89	12139	A	W.J. Stafford	Garden
8	18719		21035 Porlier Pass Road	80	24.38	5	12.70	5	GPM	8	2.44	20	6.10	01-Jun-64		89	12139	A	W.J. Stafford	Private Domestic
9	105861		20925 Porlier Pass Road	100	30.48			5	GPM			13	3.96	05/14/(2009)					Gray	Private Domestic
10	96239			84	25.60	6	15.24	2	GPM	11	3.35			04-Dec-92	well unstable, requires well liner, pitless unit welded	89	12139	A	Grey	Water Supply System
11	27570			97	29.57	6	15.24	5	GPM	11	3.35	15	4.57	24-Jan-73	15 gph at 35 feet, 5 gpm at 89 feet	89	22608	1	Stewart	Private Domestic
12	42140			146	44.50	6	15.24	5	GPM	10	3.05	13	3.96	20-Apr-79		89	22608	2	E. Scott	Unknown Well Use
13	40306			115	35.05	6	15.24	0.66	GPM	7	2.13	12	3.66	09-Aug-78	20 gph at 58, 20 gph at 75 and 6 gph at 106 ft	89	22608	2	E. Scott	Unknown Well Use
14	31547			110	33.53	6	15.24	4	GPM	18	5.49	12	3.66	09-Oct-74		89	22608	2	E. Scott	Unknown Well Use
15			20775 Porlier Pass Road			6	15.24													
16			20705 Porlier Pass Road			6	15.24													
17		23229		183	55.78	6	15.24	7	GPM	68	20.73	24	7.32	25-Nov-94	7 gpm at 177 feet				Fibermax	Private Domestic
18		23227		125	38.10	6	15.24	5	GPM	60	18.29	4	1.22	19-Aug-94	Well # 2, 1 gpm at 100 feet and 5 gpm at 120 feet				Fibermax	Private Domestic
19	32075			80	24.38	6	15.24	3	GPM	11	3.35	15	4.57	07-Feb-75	1 gpm at 22 ft, 2 gpm at 36 feet	89	22608	5	John Innes	Unknown Well Use
20	37329			70	21.34	6	15.24	2	GPM	19	5.79	12	3.66	22-Jun-77	1 gpm at 58 ft, 2 gpm at 63 feet	89	22608	6	N. Ritchie	Unknown Well Use
21	52553			182	55.47	6	15.24	2	GPM	10	3.05	10	3.05	03-Aug-83	80 gph at 82 ft, 40 gph at 175 feet	89	22608	6	Alice Alexander & Nora Ritchie	Private Domestic
22	35507			55	16.76	6	15.24	0.33	GPM			1	0.30	19-Aug-76	10 gph at 40 ft, 10 gph at 55 feet, salt water well	89	22608	7	Alistair F. Ross	Unknown Well Use
23	35516			80	24.38	6	15.24	3	GPM	16	4.88	19	5.79	22-Aug-76	15 gph at 30 ft, 45 gph at 48 feet and 2 gpm at 73 feet	89	22608	7	Alistair F. Ross	Unknown Well Use
24	39464		20445 Porlier Pass Road	166	50.60	6	15.24	4	GPM	14	4.27	22	6.71	17-Apr-78	5 gph at 37 ft, 35 gph at 85 feet, 20 gph at 120 ft, 1 gpm at 135 feet and 2 gpm at	89	22608	8	P.N. Thornsteinsson	Unknown Well Use
25	23428			60	18.29	6	15.24	2	GPM			8	2.44	03-Apr-70	well reported not in use in 1996	89	22608	8	Whittale	Unknown Well Use
26	45829			92	28.04	6	15.24	4	GPM	14	4.27	20	6.10	15-Aug-80	1 gpm at 60 feet, 3 gpm at 65 feet	89	22690	1	Lee Kolosoff	Private Domestic
27	50413			82	24.99	6	15.24	12	GPM	25	7.62	7	2.13	09-Jun-82	4 gpm at 55 feet, 8 gpm at 72 feet	89	20266	7	Bill Patey	Private Domestic
28	58986			180	54.86	6	15.24	4	GPM	70	21.34	0	0	27-Jul-89	4 gpm at 165 feet	89	21465	1	John Ince	Private Domestic
29	59848			164	49.99	6	15.24	4	GPM	25	7.62	9	2.74	25-Sep-91	2 gpm at 55 feet, 1 gpm at 75 feet and 1gpm at 110 feet, deepened in 1998	89	20266	8	Spotlight Cove Community Well	Water Supply System
30	43162			75	22.86	6	15.24	3	GPM	17	5.18	19	5.79	16-Aug-79	1.5 gpm at 35 and 58 feet	89	20266	8	A. Haksi	Unknown Well Use

Data from BC Water Resources Atlas (Ministry of Environment, 2015), copies of original well records filed with Ministry of Environment, Victoria, Crystal Mountain Retreat Centre and field checking.

Note that data has not been field verified in all instances.

* Ministry assumed construction date for computer database.

ESTIMATED WATER SUPPLY DEMAND

The proposed retreat centre development is to be comprised of the following units connected to a small water supply system served by the central well:

1 single detached residence (caretakers dwelling) to be occupied year-round for up to 2 persons;

1 main kitchen facility serving up to 30 persons including drinking water and hand washing needs;

1 utility building with 4 shower units, 4 toilets, sinks and limited laundry facilities to serve short-term and long-term visitors.

In addition, water would also be provided in containers (e.g. 20 to 40 liters) for drinking water and hand washing needs for up to 15 forestry hut sites, accommodating up to 28 persons at any one time.

It is anticipated that the maximum number of persons to be accommodated at the centre over any long-term intervals of one to two months duration would not exceed 30 persons. Occasionally for some weekend day events (e.g. 1 to 3 per year) up to 60 persons may be in attendance at the centre.

Table 3 outlines the estimated maximum daily water demand anticipated for the retreat centre based on a number of assumptions. Maximum Day Demand (MDD) is the single highest total 24-hour daily water consumption occurring over a one-year period. MDD for a water system is generally comprised of a number of subcomponents including indoor usage, a water loss allowance and irrigation demand. In the case of the retreat centre, potential water losses and irrigation demands would be insignificant given the small size of the water system. There are also no plans to include watering of lawns or gardens on the property.

Indoor water use for conventional water systems, based on the *Design Guidelines for Rural Residential Community Systems* (Ministry of Forests, Lands & Natural Resource Operations, 2012) suggests that a minimum of 230 L/capita/day or 50.6 Imperial gallons/capita/day would need to be considered for a water system design. Environment Canada (2015) reports a similar water use figure of 251 L/day per capita for metered urban household water systems monitored across Canada in 2011. Using a per capita demand figure of 230 L/day suggests 30 persons could possibly require up to maximum of 6900 L/day or 1518 Imperial gallons per day (IGPD).

Apart from water use at the one, year-round caretaker dwelling, it is unlikely, however, that visitors to the retreat centre would be using water at a rate as high as 230 L/day/person for all their needs. It is anticipated that visitors would follow water conservation practices. In addition, the water system will incorporate water-saving appliances such as dual-flush toilets, coin-metered showers, high efficiency washing machines, low flow fixtures, and faucet aerators to reduce

water consumption. Water use would also be metered to monitor water use. Table 3 outlines a more detailed estimate of the anticipated maximum day demand (2839 liters/day or 625 IGPD) that may likely occur at the centre. This estimate is regarded as conservative. Actual reported water use during the period July 4 to August 2, 2015, for example, ranged from 75 to 225 US gals/day (284 to 852 liters/day) to provide water for 12 to 22 persons on the property for kitchen, hand washing and drinking water purposes (pers. comm., K. Lenglet, August 2015). During special event days (2 to 3 per year) when up to 60 persons maybe in attendance at the centre, kitchen and bathroom water use could approach 720 liters/day based on 12 liters/day/person. During these days, however, the maximum day demand of (2839 liters/day or 625 IGPD) would remain unchanged as it unlikely that there would be any significant shower or laundry use on these days.

Table 3. Estimates of maximum day demands (MDD) for retreat centre.

Number of Persons Served	Facilities Used	Period	Estimated MDD (liters/day)	Comments
2	caretaker dwelling septic system	year-round	460	residential use
28	15 forestry hut sites compost toilets	July-August	560 700 84	washing ¹ showers ² drinking water ³
30	main kitchen, 3 meals/day/person septic system	July-August	360	food preparation, dish washing and limited toilet use ⁴
30	laundry septic system	July-August	675	periodic use ⁵
Total:			2839	

¹ based on 20 liters/day/person

² based on 50 liters/person and 50 % of guests with alternate day use

³ based on 3 liters/day/person

⁴ based on 12 liters/day/person

⁵ based on 45 liters/load and 50 % alternate day use

The largest potential use of water on any day would be for laundry and shower facilities. Overall water demands could be readily reduced, if necessary by utilizing off site laundry facilities and limiting shower use to less than half of the guests, every other day.

WATER SUPPLY SOURCES

There are three wells at the centre which could conceivably provide water for the facility. These are indicated as well site numbers 5, 17 and 18 in Figure 4 and Table 2. A brief description of these wells is outlined below and copies of the available well records are provided in Appendix A.

Well Site 5, (WTN 56583/WID 23228)

This is a 6 inch (15.24 cm) diameter bedrock well, that was drilled to a depth of 280 feet (85.34 m) in 1986. It was reported to yield 6 gpm at the time of drilling with a non-pumping water level of 55 feet (16.76 m). The well has been used to supply the retreat centre in the past and reported to provide adequate quantities, although it produced water with elevated turbidity (pers. comm., S. Foster, August 2015). Depth to bedrock was reported at 9 feet (2.74 m). Currently, the well is not being used.

Well Site 17, (WID 23229)

This is a 6 inch (15.24 cm) diameter bedrock well, that was drilled in 1994 to a depth of 183 feet (55.78 m) and completed in grey sandstone. It was reported to yield 7 gpm from a depth of 177 feet (53.95 m) at the time of drilling with a non-pumping water level of 68 feet (20.73 m). Depth to bedrock was reported at 24 feet (7.32 m) with the well completed with 28 feet (8.53 m) of surface casing. Currently, the well is not being used.

Well Site 18, Central Well (WID 23227)

This is a 6 inch (15.24 cm) diameter bedrock well, that was drilled in 1994 to a depth of 125 feet (38.10 m) and completed in shaley and grey sandstone. It was reported to yield 5 gpm from a depth of 120 feet (36.58 m) at the time of drilling with a non-pumping water level of 60 feet (18.29 m). Depth to bedrock was reported at 4 feet (1.22 m) with the well completed with 20 feet (6.10 m) of surface casing and 125 feet (38.10 m) of 4-inch (10.2 cm) diameter PVC well liner.

This central well located on the property near the outdoor kitchen, is currently being used to supply water for the retreat centre. Water is pumped to a small 1137 L (300 USgal) storage tank (cistern) situated about 65 m northwest of the well. Grey water from the kitchen and outdoor shower is currently discharged to a drainage pit situated 20 to 25 m from the central well. An outhouse (pit latrine) serving the kitchen also exists 30.5 m south of the central well.

Since the central well was equipped with a pump and already serving the retreat centre, it was decided to carry out a constant rate pumping test on this well for a minimum period of 12 hours duration to assess its capacity for meeting the projected water demands of the retreat centre. The methodology employed and results of the testing are provided in the next sections.

PUMP TESTING METHODOGY FOR THE CENTRAL WELL

Given the relatively low water demands of the retreat centre, a constant rate pumping test of 12 hours duration was considered sufficient for determining the yield of the central well as the well driller's record had indicated a potential yield of 0.315 L/s (5 USgpm). Testing was conducted at the optimal time of the year when water levels are at their seasonal lowest (Figure 3). Only 0.2 mm of precipitation was recorded at the Saturna Campon CS climate station during the 10 days prior to the testing. Initially the well was tested on October 5, 2015 (Test 1) at a rate of 0.285 L/s (4.52 USgpm) but it soon became apparent within 2 hours that the well was being over-pumped at that rate since excessive drawdown was occurring. A second test (Test 2) was therefore started on the well on October 6, 2015 at a reduced rate of 0.135 L/s (2.14 USgpm). Water levels were monitored in the pumped well with a pressure transducer at one minute intervals prior to testing, during the testing and for 16.7 hours after pumping. Manual water level readings were also taken in the pumped well during the testing at frequent intervals following general standards for pump testing. Pumped water was discharged down slope 75 m away from the wellhead towards the east. Water level dataloggers were also employed at *Well Site 5, (WTN 56583/WID 23228)* and *Well Site 17, (WID 23229)* which were used as observation wells to record any well interference effects during the testing.

Pumped water samples were taken from the central well after 7.5 hours of pumping and delivered with cooler packs to the Maxxam Analytics laboratory in Saanich for analysis of chemical and bacteriological parameters. All samples were unadulterated and delivered to the laboratory within 24 hours of sampling.

PUMP TESTING RESULTS

Pumping test data for the second test including drawdown and recovery plots are provided in Appendix B. The drawdown plot is also shown in Figure 5. A copy of the analytical laboratory report from Maxxam Analytics is provided in Appendix C and Table 4 provides a summary of the water quality results. Figures 6 and 7 show the water levels in the two observation wells, *Well Site 5, (WTN 56583/WID 23228)* and *Well Site 17, (WID 23229)* which were monitored prior to, during and after the pumping tests.

During the pumping test (Test 2) drawdown in the pumped well (Figure 5) reached a level of 20.505 m below the pre-pumping level of 13.290 m, utilizing 86.7 percent of the available drawdown of 23.65 m to the major water-bearing fracture at a depth of 36.58 m (120 feet). Specific capacity at the end of the test of was 0.3936 L/min per meter. As the drawdown showed no evidence of stabilization at the pumping rate of 8.07 L/min it is evident that the well would not be able to sustain this rate for a period of 100 days without recharge. Reducing the pumping rate by 50% to 4.035 L/min as shown in Figure 5 would result in the drawdown reaching the main water-producing fracture after 100 days of pumping. Applying a 70% safety factor (i.e. utilizing only 70 percent of the

available drawdown in the well) would indicate a potential long-term well yield of 2.826 L/min (4069 L/day). This calculated yield is 43% more than the estimated water supply requirements of 2839 L/day and would amount to a total potential supply of 1.49 million litres/year. Water level in the well recovered to within 95% of the pre-pumping level after 1000 minutes following pump shutdown. The recovery graph (Figure 2, Appendix B) indicates that the well would fully recover within a reasonable time.

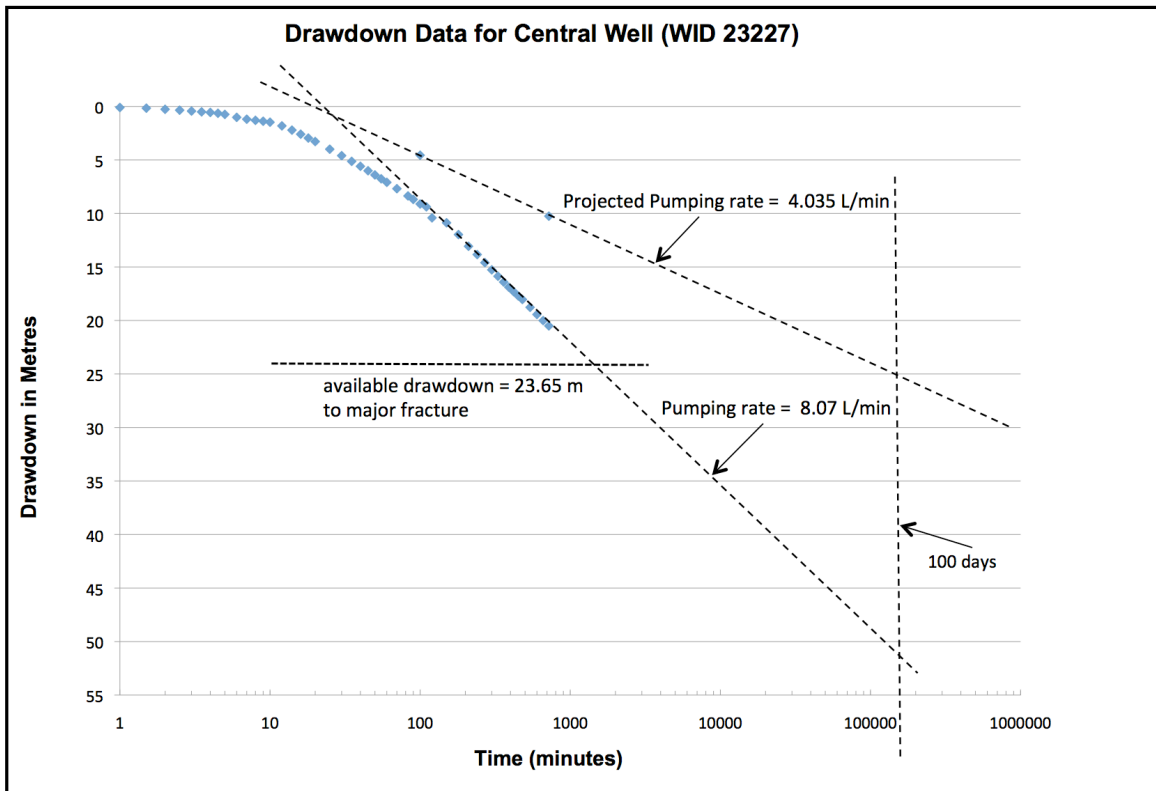


Figure 5. Drawdown in the central well observed during pumping at 8.07 L/min and projected drawdown at a pumping rate of 4.035 L/min.

No discernable pumping effects were observed in the two observation wells monitored during the October 5 pumping test as water levels were rising slightly in these wells at the time (Figures 6 and 7). Similarly, well site 17 showed a rising trend during the October 6 pumping test while well site 5 showed a slight declining trend, dropping less than 5 cm during the test. This minor decline was likely due mainly to tidal effects. Both wells show daily water level changes that range from 3 to 7 cm due to tidal effects. During the period September 23 to October 7, the water level in well site 17 showed an overall downward trend falling about 15 cm. During the same period the water level in well site 5 showed an initial rising trend over 3 days, followed by a declining trend for 6 days and then rising again for 5 days before declining again. Total water level variation was about 20 cm. The longer term variations shown at well site 5 suggest some pumping effects of a nearby well, likely down-slope, but these effects are not due to any pumping of the central well. The above data indicates that pumping the central well at a rate of 1.972 L/min (2839 L/day) would have no measureable effect on any of the neighbouring wells or surface water sources in the region.

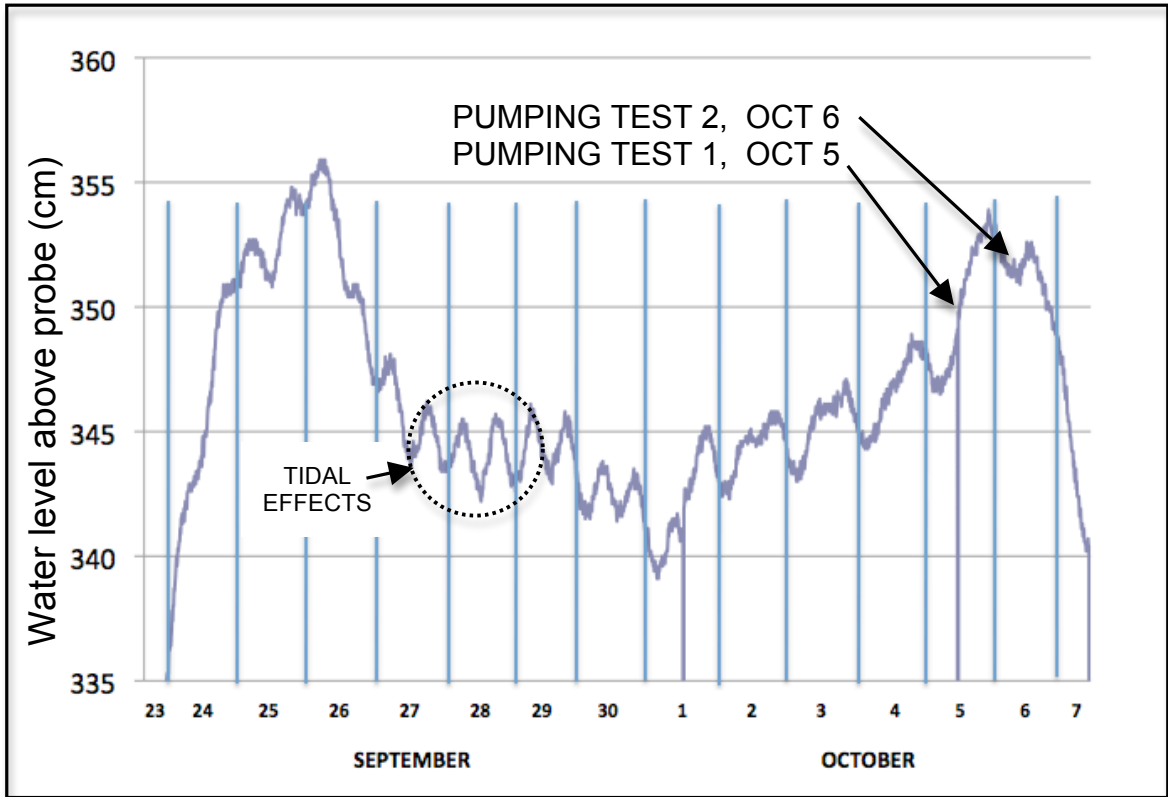


Figure 6. Water levels in observation well site 5, (WTN 56583/WID 23228).

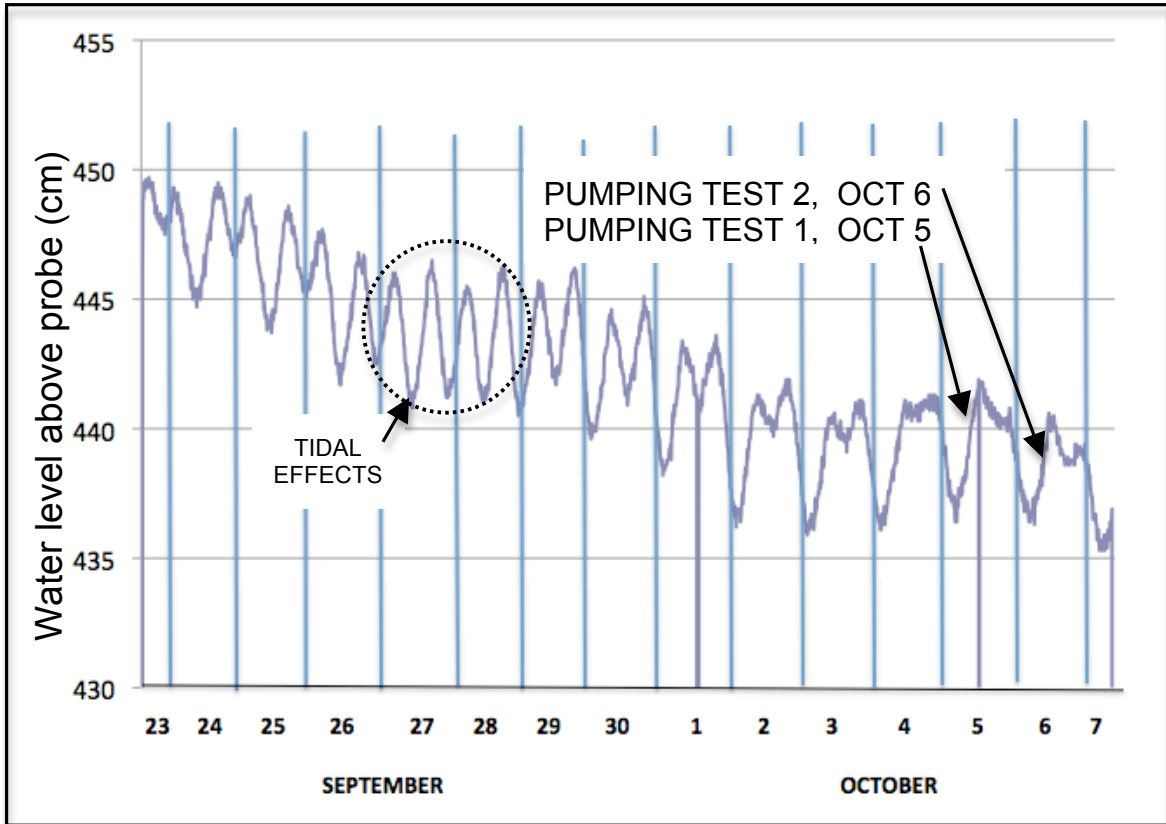


Figure 7. Water levels in observation well site 17, (WID 23229).

WATER QUALITY RESULTS

Based on the laboratory results of the October 6, 2015 samples (Table 4) the water quality of the central well (WID 23227) met or exceeded the *Guidelines for Canadian Drinking Water* (Federal-Provincial-Territorial Committee on Drinking Water, 2015) for all parameters tested except for total coliforms at 11 CFU/100mL. No E.coli was detected. Previous bacteriological reports for samples taken from a tap at the kitchen showed elevated coliforms of 142, 23 and 4.8 MPN/100mL in September 2015, June and August 2014 respectively, indicating that presence of coliforms may be problematic.

Red Williams subsequently acidized and chlorinated the well on October 26 and 27, 2015. The well was then pumped to remove several well volumes and resampled on October 28, 2015 for bacteriological analysis. Two samples were delivered to Maxxam Analytics laboratory in Saanich within 24 hours of sampling. Results of this last sampling showed totals coliforms of 3 and 1 CFU/100ml with E. Coli in both samples at <1 CFU/ml. A copy of the analytical laboratory report from Maxxam Analytics is provided in Appendix C. Table 5 summarizes the results of the recent bacteriological testing for the central well (WID 23227). The periodic source of the coliforms is not known and could be due to grey water discharge in the vicinity of the well and/or natural sources such as decaying vegetation in nearby wetland areas.

Based on the most recent chemical and physical tests (Table 4), the groundwater accessed by the central well can be classified as a calcium-magnesium-bicarbonate type, low in overall mineralization with total dissolved solids of 265 mg/L. Low mineralization may indicate that the well is situated close to a local groundwater recharge area. A previous analysis in May 2001, showed elevated iron and manganese levels above the *Guidelines for Canadian Drinking Water*. These elevated levels for these parameters do not appear in the most recent testing.

Table 4. Summary of water quality analyses.									
Parameters/Site and Sampling Date	WID 23277 pumped well sample	WID 23277 pumped well sample	WID 23277 (tap sample)	WID 23277 (tap sample)	WID 23277 (tap sample)	WID 23277 (tap sample)	WID 23277 (tap sample)	Canadian DW Guideline 2014	Units
	Oct 6/15	Oct 28/15	Sept 26/15	Jul 09/13	Jun 08/14	Aug 04/14	May 13/01		
PHYSICAL TESTS									
True Colour	<5.0						5	15	TCU
Conductivity	420						304		µS/cm
Total Hardness (CaCO ₃)	131						51		mg/L
pH	8.23						6.91	6.5-8.5	pH units
Total Dissolved solids (TDS)	265						209	500	mg/L
Turbidity	1.7						52.0		
DISSOLVED ANIONS									
Alkalinity (Total as CaCO ₃)	198						154		mg/L
Alkalinity (PP as CaCO ₃)	<0.50								
Bicarbonate	241								mg/L
Carbonate	<0.50								mg/L
Hydroxide	<0.50								mg/L
Chloride	12.1						7.8	250	mg/L
Fluoride	0.193						0.22	1.5	mg/L
Nitrate (N)	<0.010						0.33	10	mg/L
Nitrite (N)	<0.010						0.005	1	mg/L
Sulphate	14.7						11.3	500	mg/L
TOTAL METALS									
Aluminum	55.5							100	µg/L
Antimony	<0.50							6	µg/L
Arsenic	3.04							10	µg/L
Barium	2.9							1000	µg/L
Beryllium	<0.10								
Bismuth	<1.0								
Boron	84							5000	µg/L
Cadmium	<0.010							5	µg/L
Chromium	<1.0							50	µg/L
Cobalt	<0.50								µg/L
Copper	9.16							1000	µg/L
Iron	79.3						4140	300	µg/L
Lead	0.6							10	µg/L
Manganese	14.2						93	50	µg/L
Mercury	<0.010							1	µg/L
Molybdenum	<1.0								µg/L
Nickel	<1.0								µg/L
Selenium	<0.10							50	µg/L
Silicon	12400						15800		µg/L
Silver	<0.020								µg/L
Strontium	109								µg/L
Thallium	<0.050								µg/L
Tin	<5.0								µg/L
Titanium	<5.0								
Uranium	0.29							20	µg/L
Vanadium	<5.0								µg/L
Zinc	9.1							5000	µg/L
Zirconium	<0.50								
Calcium	29.2						16.2		mg/L
Magnesium	14.0						5.72		mg/L
Potassium	0.310						1.47		mg/L
Sodium	43.4						47.4	200	mg/L
Sulphur	4.0								mg/L
MICROBIOLOGICAL									
Total Coliforms	11	3, 1	142*, <1	0	23	4.8	<1	<1	CFU/100 mL
Escherichia Coli (E.Coli)	<1	<1, <1	<1		<1	<1		<1	CFU/100 mL
Fecal Coliforms			<1	0			<1	<1	CFU/100 mL

Red font indicates exceedances.
* before chlorinating well

Table 5. Summary of bacteriological sampling of central well (WID 23227).

Sampling Date	E. coli (CPU/100ml)	Total Coliforms (CPU/100ml)	Comments
September 26, 2015	<1	142	kitchen tap before chlorination
September 26, 2015	<1	<1	kitchen tap after well chlorination
October 6, 2015	<1	11	after pumping
October 28, 2015	<1, <1	3, 1	after well acidizing, chlorination and pumping

CONCLUSIONS

1. The maximum daily requirements or maximum day demand (MDD) that would likely occur at the retreat centre is estimated at 2839 liters/day or 625 Imperial gallons day which would serve a maximum of 30 persons accommodated on site.
2. There are three bedrock wells on the retreat centre properties. Two of the wells are not currently being used. A central well, designated (WID 23227) that currently supplies the retreat centre was pump tested on October 6, 2015 for 12 hours at a constant rate of 8.07 L/min. The other wells on the property were used as observation wells during the test. Based on the results of this testing the potential long-term well yield of the well is estimated at 2.826 L/min (4069 L/day) with a 70% safety factor. This calculated yield exceeds the estimated water supply requirements of 2839 L/day by 43%.
3. No discernable pumping effects were observed in the two observation wells monitored during the October testing. Based on these monitoring results use of the central well at a rate of 1.972 L/min (2839 L/day) would have no measureable effect on any of the neighbouring wells or surface water sources in the region.
4. Water quality testing of the central well (WID 23227) indicates that the water meets or exceeds *Guidelines for Canadian Drinking Water* (Federal-Provincial-Territorial Committee on Drinking Water, 2015) for all parameters tested except for total coliforms. Total coliforms of 3 and 1 CFU/100mL were reported for two samples after chlorination of the well. No E.coli was detected. The source of the coliforms is not known and could be due to grey water discharge in the vicinity of the well and /or natural sources such as decaying vegetation in nearby wetland areas. Previous occurrences of coliform bacteria have been effectively reduced by well chlorination.

5. Based on the most recent chemical and physical testing, the groundwater accessed by the central well can be classified as a calcium-magnesium-bicarbonate type, low in overall mineralization with total dissolved solids of 265 mg/L. Low mineralization may indicate that the well is situated close to a local groundwater recharge area.

RECOMMENDATIONS

The following recommendations are provided for consideration.

1. All potential sources of contamination in the vicinity of the central well such as grey water discharge from the kitchen, the existing outdoor shower and the outhouse (pit latrine) should be removed and any remaining excavation filled in with clean fill, such as sand and gravel, glacial till or clay, with no boulders.
2. When put into operation for the new facilities, the central well (*WID 23227*) should be equipped with a totalizing flow meter and records should be kept of the total amount of water produced each month. These records should also be reviewed on an annual basis to ensure that no excessive water demands are being placed on the well.
3. The other two wells at the centre should be retained as observation wells and water levels in these wells taken and compiled on a minimum monthly basis. Wells that are no longer being used, for example, would need to be deactivated or closed in compliance with the *Ground Water Protection Regulation* (Ministry of Environment, 2015c). This would require filling the well with clean materials such as sand, clay and an effective sealant.
4. As a precautionary measure against any future potential sources of coliform bacteria, water from the existing well source should be treated with an appropriately designed and maintained ultraviolet irradiation (UV) or chlorination treatment system.
5. Water quality from the well should be monitored for bacteria and chemical quality on a regular basis (minimum of once a year) and as directed by the local health authority to detect any changes that might occur with time that may require additional treatment.

CLOSURE

This report was prepared in accordance with generally accepted engineering, hydrogeological and consulting practices. It is intended for the prime use of Crystal Mountain Society, in connection with its purpose as outlined under the scope of work for this project. This report is based on data and information available to the author from various sources at the time of its preparation and the

findings of this report may therefore be subject to revision. Data and information supplied by others has not been independently confirmed or verified to be correct or accurate in all cases. Any errors, omissions or issues requiring clarification should be brought to the attention of the author. The author retains full copyright of the material contained in the report. The author and Hy-Geo Consulting accepts no responsibility for damages suffered by any third party as a result of any unauthorized use of this report.

Respectfully submitted:




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Hy-Geo Consulting

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APPENDIX A

**Water Well Records,
Crystal Mountain Properties**

Well Site 18, Central Well (WID 23227)

11/20/98 15:30 FAX 1 250 539 2097

WINDERMERE GALIA

005

08/25 '98 14:24

ID:LANIERFAX3800

FAX:

PAGE 1



Province of British Columbia

BC
Environment

Water Management Division

FIBERMAX

WATER WELL RECORD

Date 19/11/98

N.T.S. MAP [] WELL No. [] ELEV [] Location Accuracy []

Owners Name & Address SOUTH LAND CORP. c/o W.H. Stobart, P.O. Box 219, Station "E"
 Legal Description & Address District Lot 29, Galiano Island Victoria, BC, V8M 2M4

Descriptive Location Polier Pass Rd.

TYPE OF WORK: New Well Reconditioned Deepened Abandoned

WORK METHOD: Cable tool Rotary Other Mired Mud Jetted Air Reverse

WATER WELL USE: Domestic Comm. & Ind. Municipal Irrigation Other

DRILLING ADDITIVES

MEASUREMENTS from Around level Top of casing casing height above ground level [] ft.

FROM	TO	6. WELL LOG DESCRIPTION	SWL
0	24	Brown Gravelly soil	
24	95	Grey Sandstone	
95	123	Laminated lenses	
Water source			
7gpm @ 177 ft			
Static level			
63 ft - 12 hours later			

9. CASING Materials		1 <input checked="" type="checkbox"/> Steel		2 <input type="checkbox"/> Galvanized		3 <input type="checkbox"/> Wood		4 <input type="checkbox"/> Plastic		5 <input type="checkbox"/> Concrete		6 <input type="checkbox"/> Other	
Major Diameter													units
Diameter from													ins
to													ft
Thickness													ins
Weight													lb/ft

Pipes unit [] ft above below ground level
 1 Welded Cemented Threaded New Used

Open hole, from 27 to 123 ft Diameter 6 in
 Grout []

10. SCREEN: Nominal (Telescope) Pipe Size
 Type: Continuous Slot Perforated Louvre
 Material: Stainless Steel Plastic Other
 Set from [] to [] ft below ground level

RISER, SCREEN & BLANKS		units	
Length			ft
Diem. I.D.			ins
Slot Size			ins
from			ft
to			ft

11. DEVELOPED BY: Surging Jetting Air Boring Pumping Other

12. TEST: Pump Ball Air Other
 Rate, [] USgpm Temp. [] °C SWL before test [] ft
 Water Level [] ft after test of [] hrs

DRAWDOWN in ft				RECOVERY in ft			
mins	WL	mins	WL	mins	WL	mins	WL

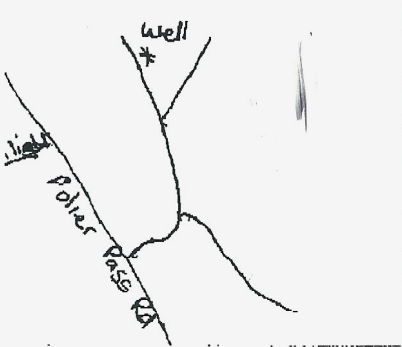
13. RECOMMENDED PUMP TYPE: [] Recommended PUMP SIZE AND RECOMMENDED PUMPING RATE: []

14. WATER TYPE: Fresh Salty Clear Cloudy
 colour [] ; gas yes no

15. WATER ANALYSIS: 1 Hardness [] mg/L
 2 Iron [] mg/L 3 Chloride [] mg/L
 4 pH [] Field Date [] Lab Date []

7. CONSULTANT Address []

8. WELL LOCATION SKETCH



SITE ID No []

16. FINAL WELL COMPLETION DATA
 Well Depth 118.3 ft Well Yield 7 USgpm
 Static Water Level [] ft Annular Space [] USgpm
 Back filled Rock chip slurry
 Well Head Completion **PERM**

17. DRILLER: NEGGEN SIGNATURE: IANDY

18. CONTRACTOR: RED WILLIAMS WELL DRILLING LTD
 Address: 539-5339 980 PRATT ROAD
QUALICUM BEACH, BC, V8K 1W5
 Member, BCWDA yes no



Report 1 - Detailed Well Record

<p>Well Tag Number: 56583</p> <p>Owner: CRYSTAL MOUNTAIN ENT</p> <p>Address: DIVINA DRIVE</p> <p>Area:</p> <p>WELL LOCATION:</p> <p>COWICHAN Land District</p> <p>District Lot: 90 Plan: 31200 Lot: 9</p> <p>Township: Section: Range:</p> <p>Indian Reserve: Meridian: Block:</p> <p>Quarter:</p> <p>Island: GALIANO</p> <p>BCGS Number (NAD 83): 092B093332 Well: 20</p> <p>Class of Well:</p> <p>Subclass of Well:</p> <p>Orientation of Well:</p> <p>Status of Well: New</p> <p>Licence General Status: UNLICENSED</p> <p>Well Use: Private Domestic</p> <p>Observation Well Number:</p> <p>Observation Well Status:</p> <p>Construction Method: Drilled</p> <p>Diameter: 6.0 inches</p> <p>Casing drive shoe:</p> <p>Well Depth: 280 feet</p> <p>Elevation: 0 feet (ASL)</p> <p>Final Casing Stick Up: inches</p> <p>Well Cap Type:</p> <p>Bedrock Depth: 9 feet</p>	<p>Construction Date: 1986-09-30 00:00:00</p> <p>Driller: Island Well Drilling</p> <p>Well Identification Plate Number:</p> <p>Plate Attached By:</p> <p>Where Plate Attached:</p> <p>PRODUCTION DATA AT TIME OF DRILLING:</p> <p>Well Yield: 6 (Driller's Estimate) Gallons per Minute (U.S./Imperial)</p> <p>Development Method:</p> <p>Pump Test Info Flag:</p> <p>Artesian Flow:</p> <p>Artesian Pressure (ft):</p> <p>Static Level: 55 feet</p> <p>WATER QUALITY:</p> <p>Character:</p> <p>Colour:</p> <p>Odour:</p> <p>Well Disinfected: N</p> <p>EMS ID:</p> <p>Water Chemistry Info Flag:</p> <p>Field Chemistry Info Flag:</p> <p>Site Info (SEAM):</p> <p>Water Utility:</p> <p>Water Supply System Name:</p> <p>Water Supply System Well Name:</p> <p>SURFACE SEAL:</p> <p>Flag:</p> <p>Material:</p> <p>Method:</p> <p>Depth (ft):</p>
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Lithology Info Flag:	Thickness (in):
File Info Flag:	
Sieve Info Flag:	WELL CLOSURE INFORMATION:
Screen Info Flag:	Reason For Closure:
	Method of Closure:
Site Info Details:	Closure Sealant Material:
Other Info Flag:	Closure Backfill Material:
Other Info Details:	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS:				
LITHOLOGY INFORMATION:				
From	0 to	9 Ft.	STONEY BROWN CLAY	
From	9 to	11 Ft.	BROWN SANDSTONE	
From	11 to	28 Ft.	GRAY SANDSTONE WITH BROWN SANDSTONE LENS	
From	28 to	36 Ft.	GRAY SANDSTONE	
From	36 to	48 Ft.	SHALEY SANDSTONE	
From	48 to	125 Ft.	GRAY SANDSTONE WITH SHALEY SANDSTONE LEN	
From	125 to	130 Ft.	SHALEY SANDSTONE	
From	130 to	136 Ft.	VERY SHALEY SANDSTONE	
From	136 to	142 Ft.	GRAY SANDSTONE	
From	142 to	200 Ft.	GREY SANDSTONE WITH SHALEY SANDSTONE LEN	
From	200 to	245 Ft.	GREY SANDSTONE	
From	245 to	280 Ft.	GRAY SANDSTONE WITH SHALEY SANDSTONE LEN	

Information Disclaimer

The Province disclaims all responsibility for the accuracy of information provided. Information provided should not be used as a basis for making financial or any other commitments.

APPENDIX B

PUMPING TEST RESULTS

Pumping Test Data for Central Well (WID 23227)

Project: Crystal Mountain Retreat Centre
Client: as above]
Location: Galiano Island
Date of Test: 06-Oct-15
Test Conducted by: Red Williams Well Drilling
Pumped Well: WID 23277
Pumping Rate: 8.07 L/min (0.135L/s)
Static Water Level: 13.290 m.

Reference: all readings from top of sounding tube
Stick up: 36 cm
Observation Wells: WID 23228 and WID 23229
Pump Start Time: 9:00 AM
Pump End Time: 9:00 PM
Analysis by: A. Kohut, P.Eng.

Drawdown Data:

Recovery Data:

Time (minutes)	Water Level (metres)	Drawdown (metres)	Time t (minutes)	Time t' (minutes)	Water Level (metres)	t/t'	Residual Drawdown (metres)
0.5	13.34	0.05	720.5	0.5	33.560	1441.0	20.27
1	13.39	0.1	721	1	33.349	721.0	20.06
1.5	13.453	0.163	721.5	1.5	33.130	481.0	19.84
2	13.558	0.268	722	2	32.914	361.0	19.62
2.5	13.641	0.351	722.5	2.5	32.720	289.0	19.43
3	13.726	0.436	723	3	32.520	241.0	19.23
3.5	13.798	0.508	723.5	3.5	32.320	206.7	19.03
4	13.852	0.562	724	4	32.160	181.0	18.87
4.5	13.93	0.64	724.5	4.5	31.920	161.0	18.63
5	14.036	0.746	725	5	31.740	145.0	18.45
6	14.31	1.02	726	6	31.380	121.0	18.09
7	14.485	1.195	727	7	31.050	103.9	17.76
8	14.59	1.3	728	8	30.720	91.0	17.43
9	14.675	1.385	729	9	30.403	81.0	17.11
10	14.763	1.473	730	10	30.098	73.0	16.81
12	15.108	1.818	732	12	29.506	61.0	16.22
14	15.503	2.213	734	14	28.960	52.4	15.67
16	15.884	2.594	736	16	28.452	46.0	15.16
18	16.245	2.955	738	18	27.967	41.0	14.68
20	16.57	3.28	740	20	27.518	37.0	14.23
25	17.287	3.997	745	25	26.448	29.8	13.16
30	17.89	4.6	750	30	25.783	25.0	12.49
35	18.422	5.132	755	35	24.622	21.6	11.33
40	18.884	5.594	760	40	23.878	19.0	10.59
45	19.3	6.01	765	45	23.317	17.0	10.03
50	19.69	6.4	770	50	22.670	15.4	9.38
55	20.051	6.761	775	55	22.235	14.1	8.94
60	20.383	7.093	780	60	21.776	13.0	8.49
70	20.977	7.687	790	70	21.045	11.3	7.75
83	21.652	8.362	800	80	20.467	10.0	7.18
90	21.979	8.689	810	90	19.985	9.0	6.69
100	22.405	9.115	820	100	19.57	8.2	6.28
110	22.673	9.383	830	110	19.21	7.5	5.92
120	23.7	10.41	840	120	18.895	7.0	5.60
150	24.164	10.874	870	150	18.113	5.8	4.82
180	25.262	11.972	900	180	17.526	5.0	4.24

Time (minutes)	Water Level (metres)	Drawdown (metres)	Time t (minutes)	Time t' (minutes)	Water Level (metres)	t/t'	Residual Drawdown (metres)
210	26.357	13.067	950	230	16.749	4.1	3.46
240	27.133	13.843	1000	280	16.204	3.6	2.91
270	27.885	14.595	1050	330	15.784	3.2	2.49
300	28.56	15.27	1100	380	15.444	2.9	2.15
330	29.158	15.868	1200	480	14.96	2.5	1.67
360	29.697	16.407	1300	580	14.664	2.2	1.37
390	30.182	16.892	1400	680	14.442	2.1	1.15
420	30.603	17.313	1500	780	14.217	1.9	0.93
450	30.99	17.7	1600	880	14.085	1.8	0.79
480	31.328	18.038	1670	950	14.006	1.8	0.72
540	32.063	18.773	1720	1000	13.958	1.7	0.67
600	32.73	19.44					
660	33.299	20.009					
720	33.795	20.505					

Note: Data in red font from transducer.

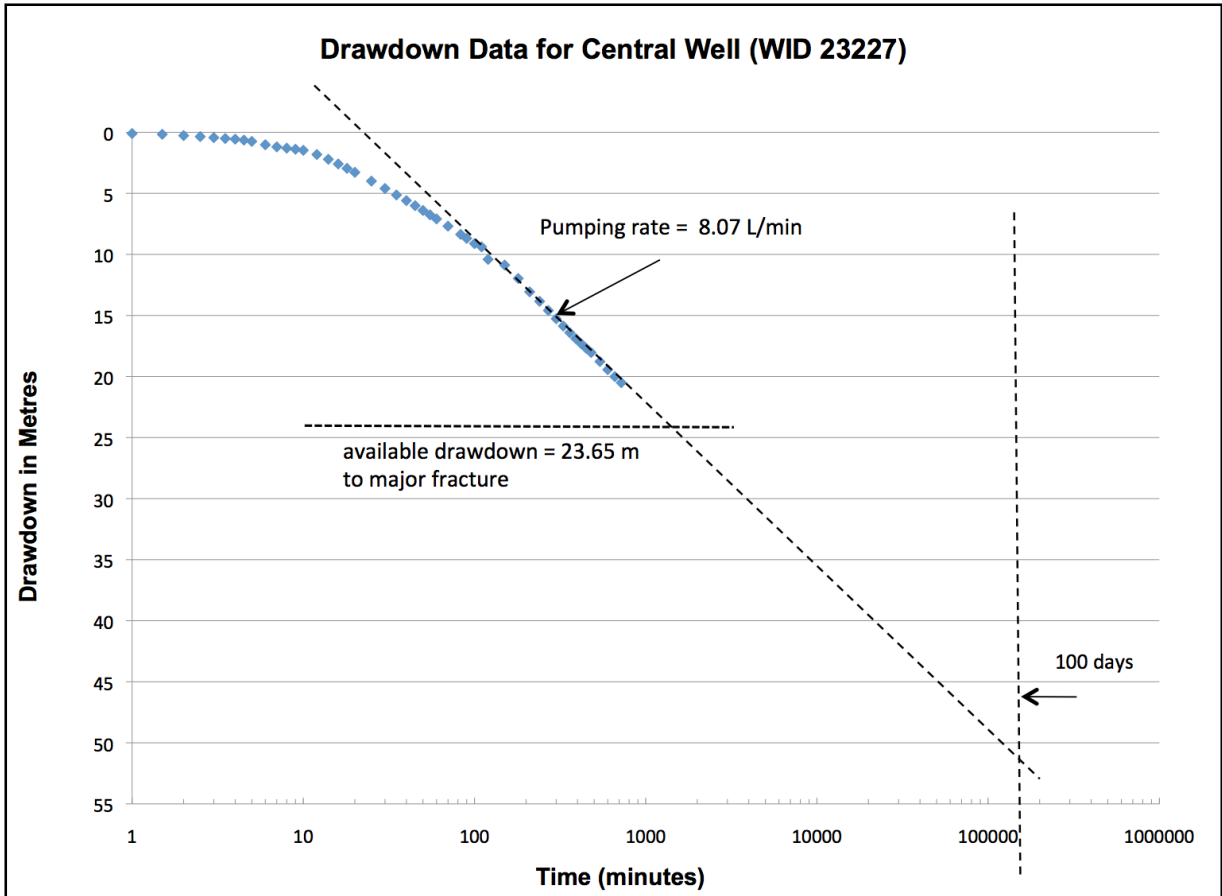


Figure 1. Drawdown graph for central well, pumped October 6, 2015.

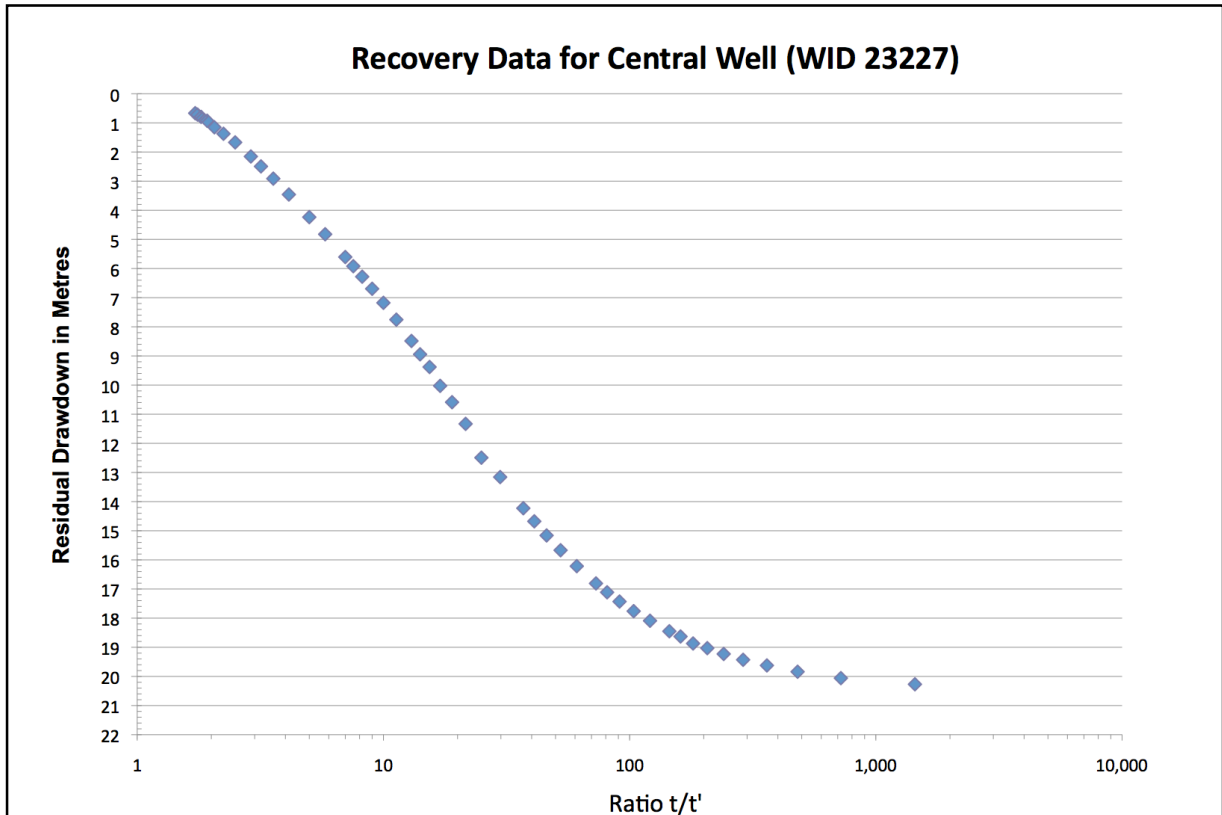


Figure 2. Recovery graph for central well, pumped October 6, 2015.

APPENDIX C

Water Quality Analyses

Your C.O.C. #: WI000401

Attention: Al Kohut

Hy-Geo Consulting
1041 Laburnum Rd
Victoria, BC
Canada V8Z 2M9

Report Date: 2015/10/20

Report #: R2061237

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B588378

Received: 2015/10/07, 11:06

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date		Laboratory Method	Analytical Method
		Extracted	Analyzed		
Alkalinity - Water	1	2015/10/17	2015/10/17	BBY6SOP-00026	SM 22 2320 B m
Anions in Water by Ion Chromatography (1, 2)	1	N/A	2015/10/07	VIC SOP-00020	Based on SM-4110B
True Colour (Single Wavelength) (1)	1	N/A	2015/10/09	VIC SOP-00010	Based on SM-2120 C
Conductance - water	1	N/A	2015/10/17	BBY6SOP-00026	SM 22 2510 B m
Hardness Total (calculated as CaCO3)	1	N/A	2015/10/20	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Total) by CVAf	1	2015/10/16	2015/10/18	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	1	N/A	2015/10/20	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (total)	1	N/A	2015/10/20	BBY7SOP-00002	EPA 6020A R1 m
Nitrate + Nitrite (N) (calculated) (1)	1	N/A	2015/10/16	VIC-SOP-00005	Based SM-4500 NO2 E
pH Water (3)	1	N/A	2015/10/17	BBY6SOP-00026	SM 22 4500-H+ B m
Total Dissolved Solids (Filt. Residue) (1)	1	N/A	2015/10/15	VIC SOP-00008	Based on SM 2540C
Total coliform and E. by MF (Chromocult) (1)	1	N/A	2015/10/07	VIC SOP 00112	Based on SM-9222
Turbidity (1)	1	N/A	2015/10/09	VIC SOP-00011	Based on SM - 2130

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Victoria

(2) Anions in Water by Ion Chromatography: The samples were received and analyzed in Maxxam Victoria. The data was processed and approved in Maxxam Burnaby.

(3) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Debbie Nordbruget, Project Manager

Email: DNordbruget@maxxam.ca

Phone# (250)385-6112

=====
This report has been generated and distributed using a secure automated process.

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID					NI0755		
Sampling Date					2015/10/06 16:25		
COC Number					WI000401		
	UNITS	MAC	AO	OG	WID 23227	RDL	QC Batch
CONVENTIONALS							
Dissolved Nitrate (N)	mg/L	10	-	-	<0.010	0.010	8065824
Dissolved Nitrite (N)	mg/L	1	-	-	<0.010	0.010	8065824
Misc. Inorganics							
Dissolved Chloride (Cl)	mg/L	-	250	-	12.1	0.50	8065824
Dissolved Fluoride (F)	mg/L	1.5	-	-	0.193	0.010	8065824
Dissolved Sulphate (SO4)	mg/L	-	500	-	14.7	0.50	8065824
Alkalinity (Total as CaCO3)	mg/L	-	-	-	198	0.50	8078038
Alkalinity (PP as CaCO3)	mg/L	-	-	-	<0.50	0.50	8078038
Bicarbonate (HCO3)	mg/L	-	-	-	241	0.50	8078038
Carbonate (CO3)	mg/L	-	-	-	<0.50	0.50	8078038
Hydroxide (OH)	mg/L	-	-	-	<0.50	0.50	8078038
MISCELLANEOUS							
True Colour	Col. Unit	-	15	-	<5	5	8073503
Nutrients							
Nitrate plus Nitrite (N)	mg/L	-	-	-	<0.010	0.010	8069236
Physical Properties							
Conductivity	uS/cm	-	-	-	420	1.0	8078041
pH	pH	-	6.5:8.5	-	8.23	N/A	8078042
Physical Properties							
Total Dissolved Solids	mg/L	-	500	-	265	10	8075415
Turbidity	NTU	see remark	see remark	see remark	1.7	0.1	8072031
RDL = Reportable Detection Limit N/A = Not Applicable							

Maxxam Job #: B588378
Report Date: 2015/10/20

Hy-Geo Consulting

MICROBIOLOGY (WATER)

Maxxam ID			NI0755		
Sampling Date			2015/10/06 16:25		
COC Number			WI000401		
	UNITS	MAC	WID 23227	RDL	QC Batch
Microbiological Param.					
Total Coliforms	CFU/100mL	1	11	1	8073379
E. coli	CFU/100mL	1	<1	1	8073379
RDL = Reportable Detection Limit					

TOT. METALS W/ CV HG FOR DRINKING WATER (WATER)

Maxxam ID					NI0755		
Sampling Date					2015/10/06 16:25		
COC Number					WI000401		
	UNITS	MAC	AO	OG	WID 23227	RDL	QC Batch
Calculated Parameters							
Total Hardness (CaCO3)	mg/L	-	-	-	131	0.50	8068356
Elements							
Total Mercury (Hg)	ug/L	1	-	-	<0.010	0.010	8076829
Total Metals by ICPMS							
Total Aluminum (Al)	ug/L	-	-	100	55.5	3.0	8080659
Total Antimony (Sb)	ug/L	6	-	-	<0.50	0.50	8080659
Total Arsenic (As)	ug/L	10	-	-	3.04	0.10	8080659
Total Barium (Ba)	ug/L	1000	-	-	2.9	1.0	8080659
Total Beryllium (Be)	ug/L	-	-	-	<0.10	0.10	8080659
Total Bismuth (Bi)	ug/L	-	-	-	<1.0	1.0	8080659
Total Boron (B)	ug/L	5000	-	-	84	50	8080659
Total Cadmium (Cd)	ug/L	5	-	-	<0.010	0.010	8080659
Total Chromium (Cr)	ug/L	50	-	-	<1.0	1.0	8080659
Total Cobalt (Co)	ug/L	-	-	-	<0.50	0.50	8080659
Total Copper (Cu)	ug/L	-	1000	-	9.16	0.20	8080659
Total Iron (Fe)	ug/L	-	300	-	79.3	5.0	8080659
Total Lead (Pb)	ug/L	10	-	-	0.60	0.20	8080659
Total Manganese (Mn)	ug/L	-	50	-	14.2	1.0	8080659
Total Molybdenum (Mo)	ug/L	-	-	-	<1.0	1.0	8080659
Total Nickel (Ni)	ug/L	-	-	-	<1.0	1.0	8080659
Total Selenium (Se)	ug/L	50	-	-	<0.10	0.10	8080659
Total Silicon (Si)	ug/L	-	-	-	12400	100	8080659
Total Silver (Ag)	ug/L	-	-	-	<0.020	0.020	8080659
Total Strontium (Sr)	ug/L	-	-	-	109	1.0	8080659
Total Thallium (Tl)	ug/L	-	-	-	<0.050	0.050	8080659
Total Tin (Sn)	ug/L	-	-	-	<5.0	5.0	8080659
Total Titanium (Ti)	ug/L	-	-	-	<5.0	5.0	8080659
Total Uranium (U)	ug/L	20	-	-	0.29	0.10	8080659
Total Vanadium (V)	ug/L	-	-	-	<5.0	5.0	8080659
Total Zinc (Zn)	ug/L	-	5000	-	9.1	5.0	8080659
Total Zirconium (Zr)	ug/L	-	-	-	<0.50	0.50	8080659
Total Calcium (Ca)	mg/L	-	-	-	29.2	0.050	8069234
Total Magnesium (Mg)	mg/L	-	-	-	14.0	0.050	8069234
Total Potassium (K)	mg/L	-	-	-	0.310	0.050	8069234
Total Sodium (Na)	mg/L	-	200	-	43.4	0.050	8069234
Total Sulphur (S)	mg/L	-	-	-	4.0	3.0	8069234
RDL = Reportable Detection Limit							

Maxxam Job #: B588378
Report Date: 2015/10/20

Hy-Geo Consulting

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	8.3°C
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MAC,AO,OG: The guidelines that have been included in this report have been taken from the Canadian Drinking Water Quality Summary Table, October 2014.

Criteria A = Maximum Acceptable Concentration (MAC) / Criteria B = Aesthetic Objectives (AO) / Criteria C = Operational Guidance Values (OG)
It is recommended to consult these guidelines when interpreting your data since there are non-numerical guidelines that are not included on this report.

Turbidity Guidelines:

1. Chemically assisted filtration: less than or equal to 0.3 NTU in 95% of the measurements or 95% of the time each month. Shall not exceed 1.0 NTU at any time.
2. Slow sand / diatomaceous earth filtration: less than or equal to 1.0 NTU in 95% of the measurements or 95% of the time each month. Shall not exceed 3.0 NTU at any time.
3. Membrane filtration: less than or equal to 0.1 NTU in 99% of the measurements made or at least 99% of the time each calendar month. Shall not exceed 0.3 NTU at any time.

Results relate only to the items tested.

Maxxam Job #: B588378
Report Date: 2015/10/20

QUALITY ASSURANCE REPORT

Hy-Geo Consulting

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8065824	Dissolved Chloride (Cl)	2015/10/07	NC	80 - 120	106	80 - 120	<0.50	mg/L		
8065824	Dissolved Fluoride (F)	2015/10/07	109	80 - 120	109	80 - 120	<0.010	mg/L	NC	20
8065824	Dissolved Nitrate (N)	2015/10/07	99	80 - 120	109	80 - 120	<0.010	mg/L		
8065824	Dissolved Nitrite (N)	2015/10/07	102	80 - 120	107	80 - 120	<0.010	mg/L		
8065824	Dissolved Sulphate (SO4)	2015/10/07	106	80 - 120	107	80 - 120	<0.50	mg/L		
8072031	Turbidity	2015/10/09			99	80 - 120	<0.1	NTU	0	20
8073503	True Colour	2015/10/09			100	80 - 120	<5	Col. Unit	NC	10
8075415	Total Dissolved Solids	2015/10/15			113	80 - 120	15, RDL=10	mg/L	7.8	20
8076829	Total Mercury (Hg)	2015/10/18	90	80 - 120	93	80 - 120	<0.010	ug/L	NC	20
8078038	Alkalinity (PP as CaCO3)	2015/10/17					<0.50	mg/L	NC	20
8078038	Alkalinity (Total as CaCO3)	2015/10/17	NC	80 - 120	97	80 - 120	<0.50	mg/L	0.58	20
8078038	Bicarbonate (HCO3)	2015/10/17					<0.50	mg/L	0.58	20
8078038	Carbonate (CO3)	2015/10/17					<0.50	mg/L	NC	20
8078038	Hydroxide (OH)	2015/10/17					<0.50	mg/L	NC	20
8078041	Conductivity	2015/10/17			99	80 - 120	<1.0	uS/cm	0.083	20
8078042	pH	2015/10/17			101	97 - 103			0.13	N/A
8080659	Total Aluminum (Al)	2015/10/20	NC	80 - 120	102	80 - 120	<3.0	ug/L		
8080659	Total Antimony (Sb)	2015/10/20	104	80 - 120	98	80 - 120	<0.50	ug/L		
8080659	Total Arsenic (As)	2015/10/20	98	80 - 120	101	80 - 120	<0.10	ug/L		
8080659	Total Barium (Ba)	2015/10/20	98	80 - 120	97	80 - 120	<1.0	ug/L		
8080659	Total Beryllium (Be)	2015/10/20	98	80 - 120	91	80 - 120	<0.10	ug/L		
8080659	Total Bismuth (Bi)	2015/10/20	103	80 - 120	96	80 - 120	<1.0	ug/L		
8080659	Total Boron (B)	2015/10/20					<50	ug/L		
8080659	Total Cadmium (Cd)	2015/10/20	98	80 - 120	94	80 - 120	<0.010	ug/L		
8080659	Total Chromium (Cr)	2015/10/20	95	80 - 120	101	80 - 120	<1.0	ug/L		
8080659	Total Cobalt (Co)	2015/10/20	94	80 - 120	101	80 - 120	<0.50	ug/L		
8080659	Total Copper (Cu)	2015/10/20	NC	80 - 120	102	80 - 120	<0.20	ug/L		
8080659	Total Iron (Fe)	2015/10/20	NC	80 - 120	113	80 - 120	<5.0	ug/L		
8080659	Total Lead (Pb)	2015/10/20	100	80 - 120	96	80 - 120	<0.20	ug/L		
8080659	Total Manganese (Mn)	2015/10/20	NC	80 - 120	102	80 - 120	<1.0	ug/L		
8080659	Total Molybdenum (Mo)	2015/10/20	101	80 - 120	97	80 - 120	<1.0	ug/L		
8080659	Total Nickel (Ni)	2015/10/20	95	80 - 120	102	80 - 120	<1.0	ug/L		

Maxxam Job #: B588378
Report Date: 2015/10/20

QUALITY ASSURANCE REPORT(CONT'D)

Hy-Geo Consulting

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8080659	Total Selenium (Se)	2015/10/20	97	80 - 120	99	80 - 120	<0.10	ug/L		
8080659	Total Silicon (Si)	2015/10/20					<100	ug/L		
8080659	Total Silver (Ag)	2015/10/20	101	80 - 120	97	80 - 120	<0.020	ug/L		
8080659	Total Strontium (Sr)	2015/10/20	NC	80 - 120	94	80 - 120	<1.0	ug/L		
8080659	Total Thallium (Tl)	2015/10/20	91	80 - 120	89	80 - 120	<0.050	ug/L		
8080659	Total Tin (Sn)	2015/10/20	104	80 - 120	94	80 - 120	<5.0	ug/L		
8080659	Total Titanium (Ti)	2015/10/20	87	80 - 120	109	80 - 120	<5.0	ug/L		
8080659	Total Uranium (U)	2015/10/20	104	80 - 120	97	80 - 120	<0.10	ug/L		
8080659	Total Vanadium (V)	2015/10/20	99	80 - 120	98	80 - 120	<5.0	ug/L		
8080659	Total Zinc (Zn)	2015/10/20	NC	80 - 120	106	80 - 120	<5.0	ug/L		
8080659	Total Zirconium (Zr)	2015/10/20					<0.50	ug/L		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B588378
Report Date: 2015/10/20

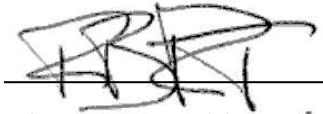
Hy-Geo Consulting

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



David Nadler, AASc, Victoria Operations Manager



Rob Reinert, Data Validation Coordinator

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Your C.O.C. #: V014603

Attention: EILEEN JENNETT

RED WILLIAMS WELL DRILLING LTD.
980 PRATT RD
QUALICUM BEACH, BC
CANADA V9K 1W5

Report Date: 2015/10/30

Report #: R2068261

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B596362

Received: 2015/10/29, 08:00

Sample Matrix: DRINKING WATER
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Total coliform and E. by MF (Chromocult) (1)	2	N/A	2015/10/29	VIC SOP 00112	Based on SM-9222

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Victoria

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Debbie Nordbruket, Project Manager

Email: DNordbruket@maxxam.ca

Phone# (250)385-6112

=====
This report has been generated and distributed using a secure automated process.

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Maxxam Job #: B596362
Report Date: 2015/10/30

RED WILLIAMS WELL DRILLING LTD.

MICROBIOLOGY (DRINKING WATER)

Maxxam ID			NN0484	NN0485		
Sampling Date			2015/10/28 18:35	2015/10/28 18:40		
COC Number			V014603	V014603		
	UNITS	MAC	CRYSTAL MNT. #1	NEW WELL #2	RDL	QC Batch
Microbiological Param.						
Total Coliforms	CFU/100mL	<1	3	1	1	8095999
E. coli	CFU/100mL	<1	<1	<1	1	8095999
RDL = Reportable Detection Limit						

GENERAL COMMENTS

MAC: The guidelines that have been included in this report have been taken from the Canadian Drinking Water Quality Summary Table, October 2014.

Criteria A = Maximum Acceptable Concentration (MAC) / Criteria B = Aesthetic Objectives (AO) / Criteria C = Operational Guidance Values (OG)
It is recommended to consult these guidelines when interpreting your data since there are non-numerical guidelines that are not included on this report.

Turbidity Guidelines:

1. Chemically assisted filtration: less than or equal to 0.3 NTU in 95% of the measurements or 95% of the time each month. Shall not exceed 1.0 NTU at any time.
2. Slow sand / diatomaceous earth filtration: less than or equal to 1.0 NTU in 95% of the measurements or 95% of the time each month. Shall not exceed 3.0 NTU at any time.
3. Membrane filtration: less than or equal to 0.1 NTU in 99% of the measurements made or at least 99% of the time each calendar month. Shall not exceed 0.3 NTU at any time.

Results relate only to the items tested.

Maxxam Job #: B596362
Report Date: 2015/10/30

QUALITY ASSURANCE REPORT

RED WILLIAMS WELL DRILLING LTD.

QC Batch	Parameter	Date	RPD	
			Value (%)	QC Limits
8095999	E. coli	2015/10/29	NC	N/A
8095999	Total Coliforms	2015/10/29	NC	N/A

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B596362
Report Date: 2015/10/30

RED WILLIAMS WELL DRILLING LTD.

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Ecological Assessment

Parcel A of DL88 and DL89, Plan 27287 & Lot 9, Plan 31200
DL90, Galiano Island, BC

March, 2021

-
- Summary of changes and updates to ecological condition since the 2009 baseline documentation included with the Crystal Mountain Ecosystem-based Land-use Plan (Erickson, 2010)
 - Summary of the distribution of Sensitive Ecosystems and Habitat Types according to proposed Crystal Mountain and Islands Trust Conservancy lot configuration
 - Ecological Considerations for the proposed Crystal Mountain Site Plan and location of structures.
-

Prepared for Crystal Mountain Society
c/o Libby McClelland, Board Member

Keith Erickson R.P.Bio.
kericksongaliano@gmail.com

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Introduction

This report provides a summary of the observed changes in ecological character and describes new disturbances that have taken place since the detailed ecological assessment was completed in 2009 as part of the '*Crystal Mountain Ecosystem-based Land-use Plan for Parcel A of DL89 except part in plan 27287 and Lot 9 Plan 31200 D190, Galiano Island, BC*'. The report also updates and improves the accuracy of ecological classifications and map unit boundaries.

Updates are based on field observations that took place during three site visits on November 3rd, November 20th and December 10th, 2020. GPS was used to aid mapping updates along with detailed review of current aerial photography. All ecological communities documented in the 2009 assessment were visited. The review assessed the general character of the ecosystems and dominant species, noting only the most significant and obvious changes. This review did not include a detailed species inventory and did not verify species by species coverage estimates.

Observations and updates are listed for each ecological community (EC). If a community is not listed, there were no significant changes observed.

Map 1 shows the revised ecological community boundaries.

This report is a companion document to the original 2009 ecological assessment. The 2009 report is included as Appendix 1.

In addition to updating the baseline documentation, this report addresses requested information (items 2 and 3 below) from Islands Trust Planner, Brad Smith, communicated verbally in a meeting with Crystal Mountain representatives and Keith Erickson and outlined in his October 5th, 2020 Staff Report to the Galiano Island Local Trust Committee (File No: GL-RZ-2014.1).

1. *Conduct a site visit to confirm if site conditions remain the same or have changed (e.g. increased beaver activity may have shifted hydrology in low lying areas).*
2. *Compare proposed location of CMS structures on site plan with ecological data to identify any areas of significant concern or potential impact.*
3. *Provide a summary of habitat features/types on the 25% portion retained by CMS versus the 75% proposed for transfer to ITC (% wetland habitat).*

The report identifies ecological communities considered as 'sensitive ecosystems' and locates them in relation to the proposed subdivision lot configuration (Shown on Map 2 – Sensitive Ecosystem Distribution). The report also summarizes the distribution of ecological communities, or, habitat types according to the proposed subdivision lot configuration, in Figure 1. In addition, the report discusses the criteria used to determine the proposed lot configuration and siting plan and provides further recommendations for final siting of structures.

General Trends and Observations of Forest Succession on the Properties

Mature Forest Communities

Areas characterized by mature forest appeared substantively unchanged in structural, compositional, and functional aspects.

Pole Sapling or Immature Forest Communities

These stands were logged in 1993 or 1994 and do not appear to have been planted. Natural regeneration would have taken a year or two to respond making the age of the dominant tree canopy roughly 15 years old in 2009 and 26 years old in 2020. The stand is now cusp on becoming a young forest where a dense conifer dominated canopy is forming and the natural stem exclusion process is beginning to ramp up. General shifts between 2009 and 2020 include:

- Increased canopy closure.
- Increased dominance of conifer species, particularly Douglas-fir.
- Marginal decrease in broadleaf tree cover.
- Marginal decrease in shrub (salal) cover.
- Marginal decrease in cover of moss and herbaceous species.
- Evidence of the initiation of stem exclusion in very dense Douglas-fir patches.
- Slightly older trees that were already established as saplings or poles in the sub-canopy prior to logging are emerging as dominant structures in the stands.

Ecological Communities

Crystal Mountain Properties
December 2020 Update

Scale: 1 : 3,500

Projection: UTM Zone 10 NAD83

Map Rotation: 46 degrees West of North

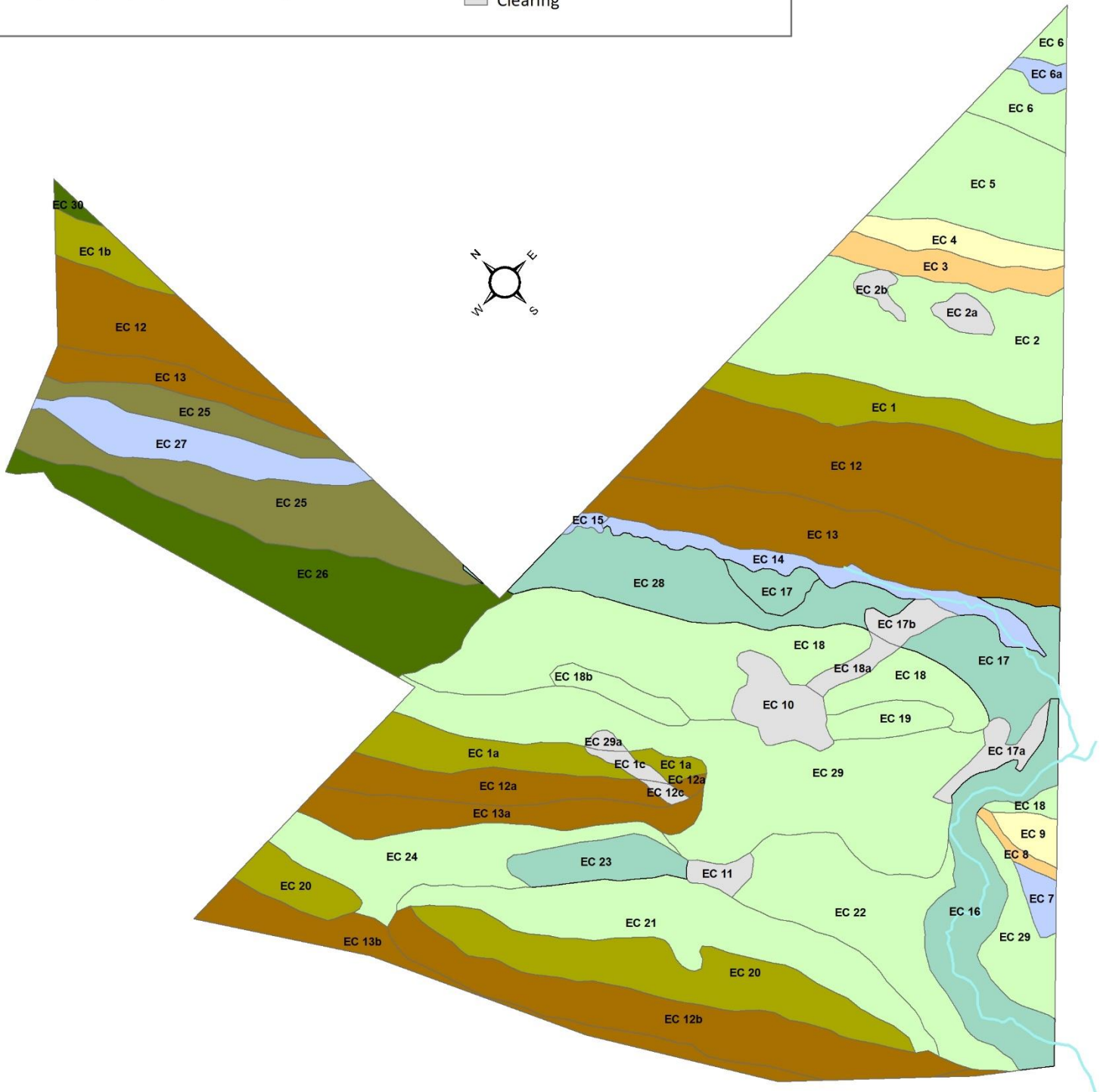
Map Date - Feb 3, 2021

Produced by: Keith Erickson



- Creek
- Mature Forest - Moist Soil
- Mature Forest
- Mature Forest - Steep SW Slope
- Mature Forest - Ridge
- Immature Forest - Moist Soil
- Immature Forest
- Immature Forest - Steep SW Slope
- Immature Forest - Ridge
- Wetland
- Clearing

MAP 1



Ecological Communities (EC): Changes and Updates

EC 01

A meditation platform was removed from southwest edge of ridge in Polygon 1 in 2016. This site is now designated for day use meditation which does not require infrastructure.

2013 – Platform in active use.



December 2020 – site recovering.



In Polygon 01a, a patch of forest extending south from the meditation platform has been logged to create an unobstructed view to the Trincomali Channel. The cutting extends down through Polygon 12a and into Polygon 29. The platform and clearing are shown on the accompanying map and labeled as Polygons 01c, 12c and 29a.



EC 02

A sleeping hut and related clearing have been established in this polygon. The clearing is shown on the revised Ecological Communities Map and is shown as Polygon 2b. Access to the hut is from the established easement road through EC02.



EC 03

Includes small patches of Provincially red listed CDFmm/01 Douglas-fir – dull Oregon grape in deeper soiled pocket sites on the steep slope between rock outcrops.

EC 05

Taking on young forest character with Douglas-fir and Western redcedar seed trees taking on more of a dominant forest canopy structure and salal dominated patchy gaps beginning to fill in with Douglas-fir poles.

EC 06

This community is characterized by CDFmm/01 – 70%, CDFmm/05 – 30%.

Polygon 06a is an old landing or log sorting area with compacted, seasonally flooded soils. The ecosystem on this disturbed, moisture receiving site is difficult to classify though the amount of standing water in the winter would suggest that it would have wetland characteristics of a Western redcedar - salmonberry – skunk cabbage (CDFmm/11) community in its natural state.

EC 07

This community more closely resembles a seasonally flooded, Sitka willow-Pacific willow-skunk cabbage swamp (Ws51) ecosystem. It is not a CDFmm/09 low bank floodplain ecosystem as previously identified.

EC 12

A portion of polygon 12a was logged to provide a view from the meditation platform. This area has been delineated on the ecosystem map and is now labeled as EC12c. While the trees have been removed, the area retains its shrub and herbaceous cover, though these layers were temporarily disturbed from the tree falling.

EC 14

Boundaries have been adjusted to include the seasonally flooded wetland area that runs along the base of the primary ridge/cliff ecosystem according to 2020 field reconnaissance.

EC 15

This ecological community, as described in the original report has been absorbed into adjacent, but similar communities and the map has been adjusted accordingly.

The wetland depression portions have been merged with EC14 and the lower slope CDFmm/06 portions have been merged with EC28 and EC17 according to their dominant tree and understory cover.

The map label EC15 now refers to a small, previously unmapped wetland that was discovered at the toe of the major cliff line along the norther boundary of Lot A. The wetland is dominated by slough sedge (*Carex obnupta*) mixed with patches of hardhack (*Spirea douglasii*) along with scattered willow (*Salix sitchensis?*), Pacific ninebark (*Physocarpus capitatus*) and black hawthorn (*Crataegus douglasii*) in the shrub layer. The margins of the wetland are lined with red alder, Western redcedar, and grand fir along with a dense sword fern and salal patches characteristic of a CDFmm/06 ecosystem as it transitions into EC28 to the west and EC13 to the east.



EC 16

This community has been incorporated into EC17 in areas where they shared a boundary to more accurately reflect the ecological continuity observed during the 2020 site visit. Polygon 16a is now part of 17a. As a result of this change, the new description is as follows:

EC16 is a riparian forest (CDFmm/06) characterized by scattered Douglas-fir, bigleaf maple and Western redcedar dominant trees in a matrix of young red alder in the sub-canopy and a sword fern dominated understory with scattered salmonberry throughout. There are moister areas in small depressions along the creek where red alder is mixed with black cottonwood and a higher concentration of salmonberry occurs.

The ecosystem begins to transition to a young Douglas-fir / Western redcedar dominated forest with scattered red alder, grand fir and salmonberry towards the southern corner of the property.

Additional species were observed in December 2020 include cascara, pacific willow, and snowberry.

EC 17

Boundaries have been adjusted according to 2020 field reconnaissance (see EC15 and EC16).

17a and 17b have started to regenerate to red alder except where the road is still used. These areas would benefit from a 'rough and loose' decompaction treatment.

Sleeping huts have been established in both Polygon 17a and 17b. The sleeping huts were established on the edges of the polygons and included some tree and vegetation clearing. Crystal Mountain has indicated that the sleeping huts will be moved from these locations.

After the huts are removed from these areas, the compacted, grass dominated clearings and old roadbeds are slated for 'rough and loose' decompaction treatment to restore a natural ecosystem.

EC 18

Average diameter main canopy Douglas-fir tree was cored and is estimated to be 24 years old.

A new polygon labeled 18b was delineated within EC18. It is a long, narrow band running parallel to a portion of the main driveway access from Devina. Excess soil and rock produced during the construction of Devina Dr. was piled in this area and left for decades. A young bigleaf maple stand has now grown up on the fill. The understory includes scattered, suppressed grand fir and Douglas-fir saplings growing and a thick layer of moss connecting a few scattered patches of sword fern.

EC 19

EC19 is mostly comprised of a Douglas-fir dominated CDFmm/01 ecosystem on a moderately sloped 'knoll' with small pockets of steeper southwest facing slope. The understory is mostly salal with pockets of dull Oregon grape. Arbutus will likely be surpassed by Douglas-fir and be shaded out of this stand.

EC 20

Pole/sapling areas are mainly located along the northeastern boundary of the polygon. There are a few old Douglas-fir trees that should be considered dominant (A1) accounting for roughly 8% cover.

EC 21

There are young, dominant Douglas-fir (20% cover) and arbutus (5% cover) trees throughout the matrix of smaller pole-sapling Douglas-fir canopy. There are also a couple of larger Western redcedar trees scattered throughout.

This community is roughly 80% pole-sapling and 20% young forest. The density of older, larger trees increases towards the upper slope position along the border with EC20.

EC 22

Scattered Douglas-fir trees beginning to emerge as co-dominant with red alder. A small, slough sedge dominated pocket wetland (too small to map) was discovered at the end of the old logging road in the southern 'panhandle' of this polygon. The seepage drains down to Porlier Pass Road. Spurge Laurel was also observed here.

EC 23

Red alder dominated CDFmm/06 (70%) transitions to a Pacific willow (*Salix lucida*) - slough sedge (*Carex obnupta*) dominated wetland, possibly a CDFmm/14 (30%) site with a fluctuating water table. Compaction related to machine use during logging was observed in the wet depression portion of the polygon making it difficult to determine the ecosystem classification. Black cottonwood (*Populus trichocarpa*), and Cascara (*Rhamnus purshiana*) were also observed along the margins of the wet depression, in the dominant tree layer and tall shrub layer respectively.

EC 24

This stand is transitioning from a pole/sapling to a young forest with Douglas-fir beginning to form a main canopy (A2) layer. The ecosystem is a CDFmm/01-04 (90%) with a slightly moister, depression area running roughly north/south along the old road and where this 'valley' opens up to the west with moisture running down towards the ocean through a gap in the ridge line (EC20).

EC 25/26

Meditation huts have been carefully deconstructed and removed. There is 1 outhouse and 1 storage shed remaining in this area. These structures are slated to be removed prior to transfer of the land.

Dec. 2020: Site of former meditation hut.



Shed to be removed.



EC 28

Observation in December 2020 clearly identifies a stream and wetland complex similar to that described in Ecosystem 15 (see description in original report and updates in this document) along the narrow depression at the base of the slope (with southwest facing EC13 on the other side). This area has been removed from EC28 and the map has been adjusted accordingly.

A small area was cleared of shrubs and a couple of trees were cut to accommodate a tent platform in this polygon. The platform will be removed, and the site will be restored prior to transfer. This area is shown on the updated map.



Disassembled platform shown in background. Stump of cut tree just to right of platform.

EC 29

Dense Douglas-fir dominated stand transitioning to a young forest. This ecosystem has a significantly higher percent cover of Douglas-fir than observed in the original report – approaching 50% now. Arbutus, red alder, and bitter cherry remain in the stand (though will be shaded out over the next few decades). The ecosystem includes the occasional larger diameter,

dominant bigleaf maple and remnant Douglas-fir. There is a higher concentration of larger diameter trees in the upper slope portions along the boundary with EC01a. Soils are also drier and slightly poorer in nutrients in this upper slope area.

A small chunk of this ecosystem has been cleared around the meditation platform and has been labeled EC29a on the map. The area has been cleared of trees but retains a partial shrub – salal – layer.

Summary of Sensitive Ecosystems and Habitat Types

Crystal Mountain is proposing a rezoning that requires the subdivision of Lot A to create two parcels, one retained by Crystal Mountain and one transferred to the Islands Trust Conservancy along with the entirety of Lot 9, for conservation purposes. Crystal Mountain will retain 25% of the total area (Lot 9 and Lot A) or 6.14 hectares and the Islands Trust Conservancy (ITC) will receive 75% of the total area or 18.41 hectares.

Ecological communities designated as sensitive include:

- Wetlands
- Riparian forest including all areas within 30m of the stream channel
- Forests with moist to wet soils (CDFmm/06, CDFmm/11, CDFmm/14)
- Mature Forest
- Rare and endangered ecological communities
- Steep slopes and cliffs with shallow soils in all forest structural stages

Based on the updated ecological community classification and mapping completed in December 2020 and the proposed subdivision lot configuration dated March, 2021, sensitive ecological communities are distributed as follows (see Map 2):

- Total area of sensitive ecological communities on the properties: 15.53 hectares
- Total area of sensitive ecosystem in proposed CM Portion: 1.04 hectares (6.7%)
- Total area of sensitive ecosystem in proposed ITC Portion: 14.49 hectares (93.3%)

The following table provides a summary of how the full range of mapped and described ecological communities (in this report) are distributed across the proposed properties.

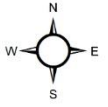
FIGURE 1: Ecosystem Types by Proposed Lot

Ecological Community Type	Sensitive	Total Area (ha)	Crystal Mountain		Islands Trust Conservancy	
			Area (ha)	% of Ecosystem	Area (ha)	% of Ecosystem
Clearing		0.84	0.60	71%	0.24	29%
Immature Forest		9.08	4.61	51%	4.46	49%
Immature Forest - Moist Soil	yes	1.36	0.12	9%	1.24	91%
Immature Forest - Ridge	yes	0.33		0%	0.33	100%
Immature Forest - Steep SW Slope	yes	0.30		0%	0.30	100%
Mature Forest	yes	1.34		0%	1.34	100%
Mature Forest - Moist Soil	yes	2.30		0%	2.30	100%
Mature Forest - Ridge	yes	2.20	0.49	22%	1.71	78%
Mature Forest - Steep SW Slope	yes	5.87	0.31	5%	5.55	95%
Wetland	yes	0.94		0%	0.94	100%
Total		24.55	6.14	25%	18.41	75%

MAP 2

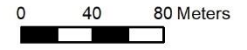
Sensitive Ecosystem Distribution

Crystal Mountain Society Proposed
Subdivision Lot Configuration, March 2021

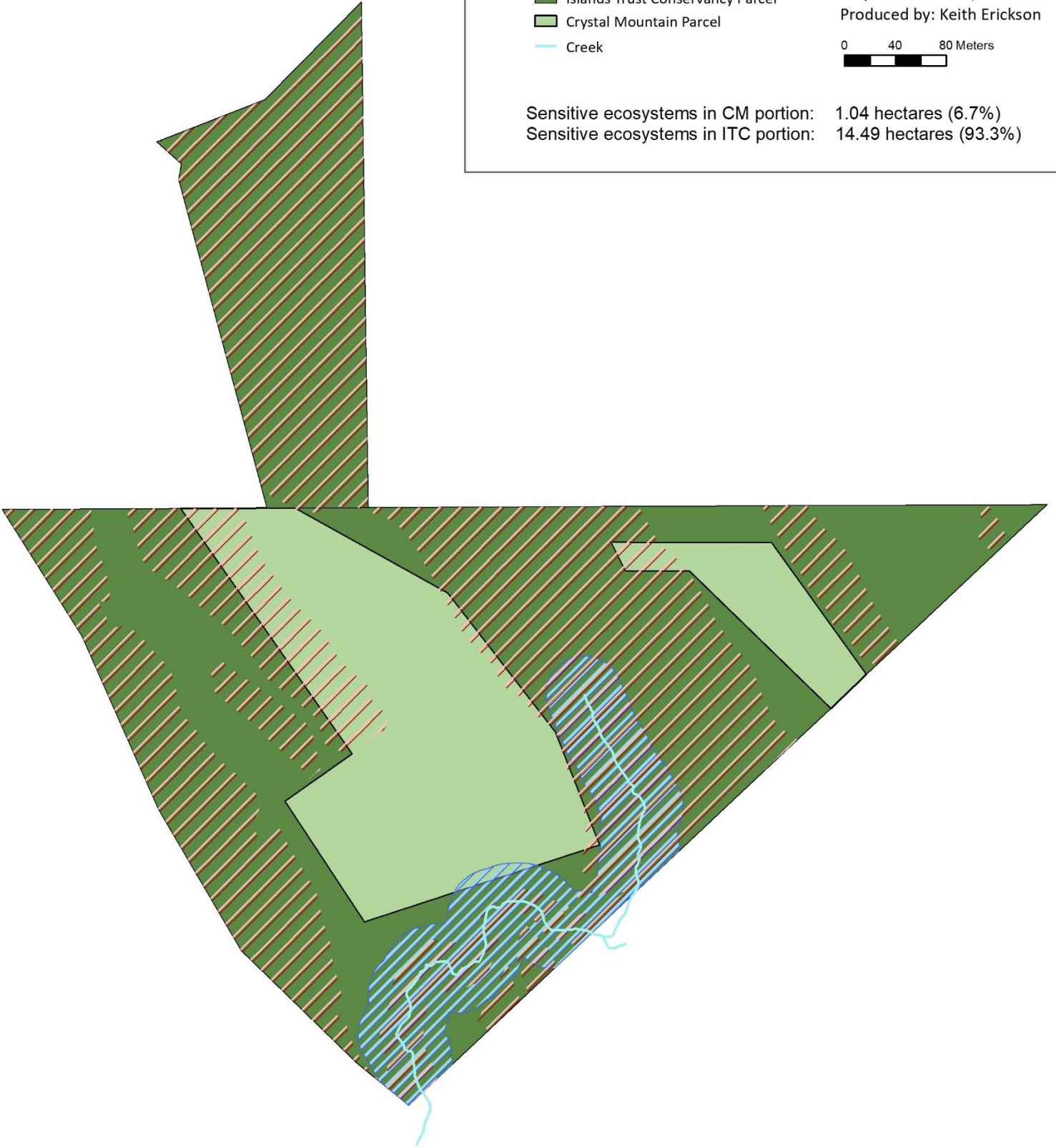


- Sensitive Ecosystem
- Riparian Buffer (30m)
- Islands Trust Conservancy Parcel
- Crystal Mountain Parcel
- Creek

Scale: 1 : 4,000
UTM Zone 10 NAD83
Map Date - March, 2021
Produced by: Keith Erickson



Sensitive ecosystems in CM portion: 1.04 hectares (6.7%)
Sensitive ecosystems in ITC portion: 14.49 hectares (93.3%)



Ecological Considerations of Crystal Mountain Site Plan and Proposed Location of Structures

Crystal Mountain has prepared a site plan that considers maximum protection and minimum impact to ecological values on the land given the following critical development criteria to achieve the Society's spiritual education goals:

1. Ensure limited, long-term spiritual education use in the upper ridge location where the elements of privacy required for this use can be adequately achieved.
2. Ensure facilities to accommodate multi-day, overnight, spiritual education use for up to 28 participants. Accommodations, as much as possible, should be arranged in manner that provides visual and auditory solitude / privacy for participants.
3. Ensure access to viewpoints and view corridors for spiritual education participants.
4. Provide facilities to accommodate a caretaker of the land and administrative management of Crystal Mountain Society programs.
5. Ensure access to spiritual education use areas from public roads.
6. Ensure Emergency Access across Lot A that serves to connect Devina Drive with Porlier Pass Road.
7. Utilize 'buildable' areas specified by the Geotechnical survey completed for Lot A.

Given these development parameters, Crystal Mountain Society has developed a subdivision lot configuration using the following ecological criteria:

- Protect a minimum 30m riparian buffer either side of the seasonal stream channel except for where the requested Emergency Access necessarily crosses the stream.
- Protect all wetlands.
- Protect moist forest areas including all CDFmm/06 ecological communities.
- Protect shallow soiled, ridge, cliff and steep southwest facing slope that include Provincially red listed CDFmm/02 Douglas-fir / Arbutus and CDFmm/01 Douglas-fir – dull Oregon grape ecological communities.
- Protect areas characterized by mature forest (80+ years of age)
- Focus development in areas where ecological values have been compromised due to historical land-use and of higher resilience to disturbance:
 - Areas that were clear-cut in in the mid-1990's
 - Logging roads and compacted landings
 - Areas impacted from the construction of Devina Drive (spoil areas).
 - Ecosystems that are common and well represented locally and Provincially.
 - Areas characterized by soils that are well drained and are less susceptible to compaction from disturbance (drier, deeper, sands and gravels)

Further, Crystal Mountain has developed a site plan for the layout of buildings and structures within the proposed subdivision lot created for Spiritual Education use (see Map 3: Crystal Mountain Society (CMS) Site Plan Proposal -- 75% Land Transfer). The site plan shows the broad areas, within which, various proposed structures and facilities will be located along with

the approximate locations of structures. The certainty of building site locations varies and is reflected through the ‘broadness’ of the areas. Locations for the kitchen and washroom facilities, meditation hall, caretaker cottage, service buildings and water related infrastructure are narrowly defined. Locations for future meditation huts and camping sites are more broadly defined. “Infrastructure Areas” and their related structures and services are shown in the table below. Their locations are shown on Map 3.

FIGURE 2: Development Footprint Table

Infrastructure Area	Size (ha.)	Infrastructure Included	Actual Lot Coverage (m ²)
Kitchen / Washroom Area (Area A – lower)	0.2	Kitchen (125m ²) Bath/Laundry (70m ²) Septic Tank	195 m ²
Kitchen / Washroom Area (Area B– Upper Ridge)	0.1	Kitchen/Bath/Laundry (36m ²) Storage Bldg. (10m ²) Water Storage Tank	46 m ²
Service Building Area	0.1	Office (70m ²) Storage/Workshop (80m ²) Water Storage Tanks	144 m ²
Caretaker Building Area	0.1	Caretaker Bldg (80m ²) Septic Tank	80 m ²
Meditation Hall Area	0.05	Meditation hall (125m ²)	125 m ²
Septic Field Area	0.1	Primary field (80m ²) Upper ridge field (32m ²)	112 m ²
Parking Area	0.1	9 spaces (Devina) (284m ²) 1 space (caretaker) (44m ²) 1 space (upper ridge) (44m ²)	372 m ²
Meditation Hut Area 1	1.15	14 x med hut (15m ²) 2 x long-term med hut (21m ²)	252 m ²
Meditation Hut Area 2	0.25	3 x med hut (15m ²)	45 m ²
Meditation Hut Area 3	0.20	2 x long-term med hut (21m ²)	42 m ²
Meditation Hut Area 4	0.7	1 x long-term med hut (21m ²)	21 m ²
Camping Area	1.0	6 x seasonal tent sites (14m ²)	84 m ²
TOTAL	3.05	30 x buildings 6 x tent sites 2 x septic fields 11 x parking spaces TOTAL LOT COVERAGE	911 m ² 84 m ² 112 m ² 372 m ² 1,479 m ²
		LOT COVERAGE % (includes septic and parking)	2.4%

Final siting of all buildings, structures, utilities, and services will be guided by the following criteria:

1. No structures are permitted in sensitive ecosystems (as defined and shown in this report).
 - a. The existing meditation platform is located on the boundary of an area characterized by a mature forest ridge ecosystem (sensitive). When this existing structure is replaced by the proposed Meditation Hall, siting of the hall will utilize existing footings or be moved away from the ridge (to the northeast).
 - b. Two existing meditation huts on the property are in areas characterized by moist soils and are outside of the proposed Crystal Mountain parcel boundaries. These huts will be removed, and their current sites will be remediated (rough and loose decompaction and planting) prior to rezoning.
2. Minimize hydrological impacts by utilizing existing roads, created by historical logging activities that pre-date Crystal Mountains ownership, for access.
3. Locate utility corridors (power and water lines) along existing roads that are also used as access routes, whenever possible.
4. Protect remnant old forest structures that were not degraded or removed during the most recent clear-cut. At a minimum, establish critical root protection zones (RPZ) around trees where no buildings may be located, or soil disturbance may occur. The RPZ radius can be calculated using the 'tree diameter method' employing a 12 to 1 ratio – 12 units in radius for every 1 unit in tree diameter at breast height, or, as otherwise advised by an arborist. Significant structures to be protected include:
 - Mature or old-growth trees and any remnant young trees (taller and larger than main forest canopy) that survived the clearcut.
 - Large diameter snags or "wildlife trees" (greater than 50cm in diameter).
5. Generally, cluster structures together as much as possible and minimize the 'spread' of development into the forest. It is recognized that this criterion will be weighed against development criteria #2 above.
6. Utilize existing compacted soil areas for siting structures whenever possible.



Existing Easement across Lot 9 in favour of neighbouring Lots 10 to 14.

LOT 10

LOT 9
DL90, Plan 31200

DeVina Drive

DL 87

Proposed Lot Boundaries

- Islands Trust Conservancy
- Crystal Mountain
- Property Line Setbacks

Water System

- Observation Well
- Primary Well
- Proposed Ridge Well
- Potable Storage Tank
- Septic Tank

Access Routes

- Primary Access Road
- Access Road
- Trail
- Easement To Lands Beyond
- Emergency Access SROw

Buildings

- Caretaker Building
- Bath / Laundry
- Kitchen / Dining
- Meditation Hall
- Office
- Kitchen / Bath / Laundry
- Service Building
- Med Hut
- Long-term Med Hut
- Tent Pad
- Parking Spaces/Aisle
- Septic Field

Infrastructure Areas

- Parking Area
- Meditation Hut Area
- Camping Area
- Kitchen / Washroom Area
- Meditation Hall Area
- Service Building Area
- Caretaker Building Area
- Septic Field Area

Sensitive Ecosystems

- Old Forest, Moist Forest, Wetlands, Ridges, Cliffs
- 30m Stream Buffer
- stream

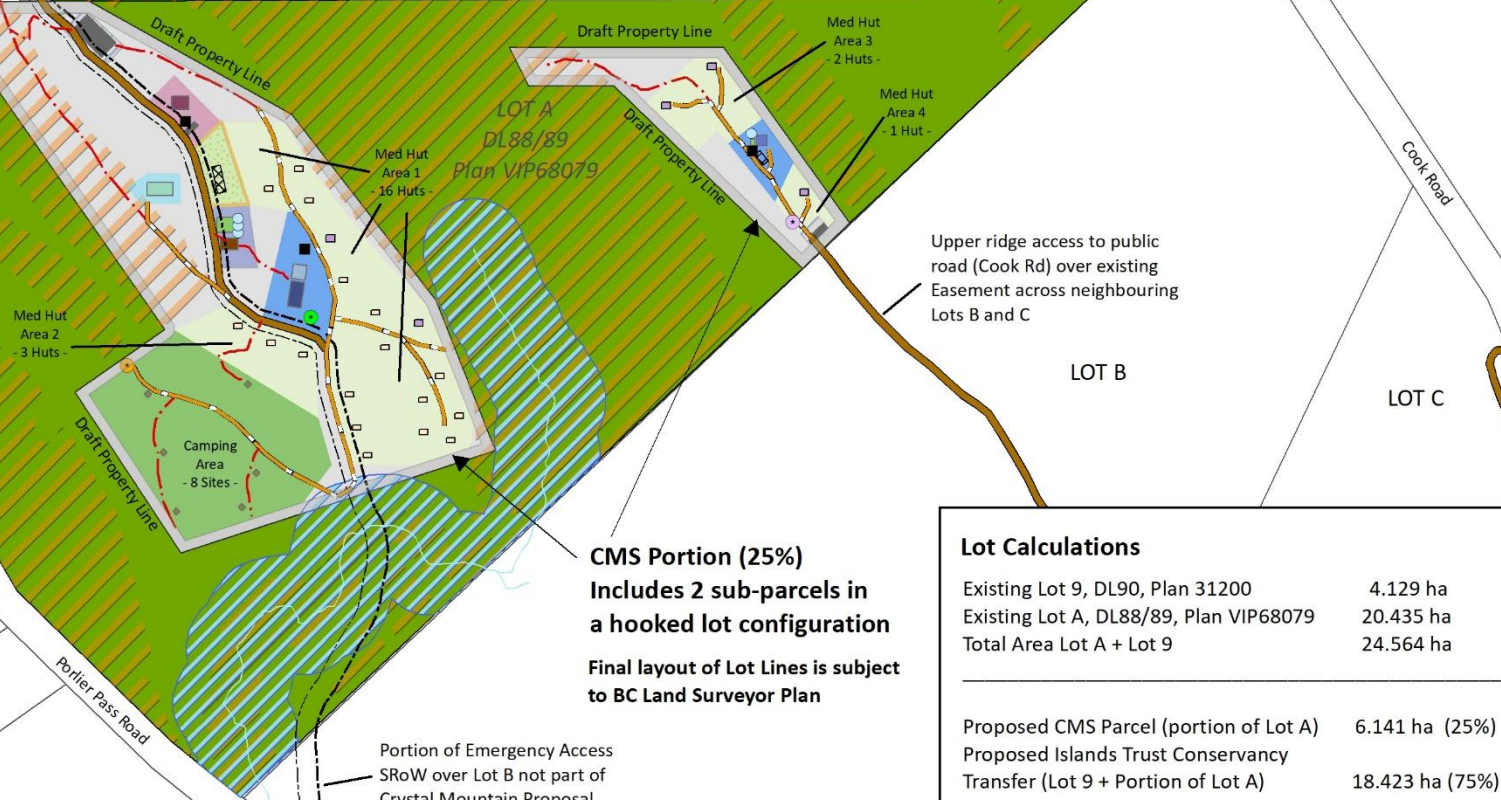
0 25 50 100 Meters



Map Date: March 13, 2021

Scale: 1 : 4,200

Projection: UTM Zone 10 NAD83



CMS Portion (25%)
Includes 2 sub-parcels in a hooked lot configuration
Final layout of Lot Lines is subject to BC Land Surveyor Plan

Portion of Emergency Access SROw over Lot B not part of Crystal Mountain Proposal

Lot Calculations

Existing Lot 9, DL90, Plan 31200	4.129 ha
Existing Lot A, DL88/89, Plan VIP68079	20.435 ha
Total Area Lot A + Lot 9	24.564 ha
<hr/>	
Proposed CMS Parcel (portion of Lot A)	6.141 ha (25%)
Proposed Islands Trust Conservancy Transfer (Lot 9 + Portion of Lot A)	18.423 ha (75%)

APPENDIX 1 – 2009 Ecological Assessment

Excerpt from:

Crystal Mountain Ecosystem-based Land-use Plan

Parcel A of D189 except part in plan 27287 & Lot 9 Plan 31200 D190, Galiano Island, BC

Keith Erickson, January 2010, Revised April 2014

3.1 Biological and Geographical Inventory

3.1.1 Climate¹

The rainshadow effect of the Olympic and Vancouver Island mountains and the moderating effects of the ocean are the dominant influences on the climate of Galiano Island. Kerr (1951) describes the Island as having a “Transitional, Cool Mediterranean Climate”. Galiano exhibits a pattern of warm, dry summers and mild, wet winters with an average of approximately 1,900 to 2,000 hours of sunshine (Renneseth and Barr, 1982) and 254 frost free days (Agriculture Canada, 1989) per annum. The average annual rainfall recorded at the North Galiano Atmospheric Environment Service station is 920 mm (from 1977 to 1988). Annual rainfall ranges from 597.3 mm to 1152.6 mm (Harrison, 1994). Over 75% of the total annual precipitation falls during the winter months (Nov. to Feb.), with less than 10% falling as snow.

The months of January and February produce the coldest mean temperatures of 4° to 5° Celsius, while July and August are the warmest months with mean temperatures of 17° to 19° Celsius. The combined effects of low precipitation, warm temperatures, and high number of sunshine hours often result in an annual moisture deficit on Galiano Island from mid-June to early October (Harrison, 1994). This deficit can often reach drought conditions in areas of recent clearcuts, such as those found on Lot A, and can result in an extreme forest fire hazard.

3.1.2 Topography

The properties exhibit a complex topography through a series of 4 major southeast to northwest running ridges with their associated steep southwest facing slopes and cliffs, gentle northeast facing slopes and wet depressions or flat benches. The elevation ranges from approximately 10 meters at the lowest point along Porlier Pass road to 125 meters at the highest point near the northeastern corner of Lot A. All areas of the property are below 140 meters in elevation and are not part of “Development Permit Area 4: Elevated Groundwater Catchment Areas” described in the Galiano Island Official Community Plan (Consolidated October 30, 2013).

3.1.3 Hydrology

The properties fall within the North Trincomali Groundwater Region, with a surface flow that empties into the Trincomali Channel. Approximately 10 hectares or just over 40% of the properties are designated as Groundwater Recharge Areas. Recharge areas generally incorporate the higher elevation portions of the properties including the teaching platform ridge and its associated steep southwest facing slope and gentle northeast facing slope and the area including

¹ Excerpt from: *Erickson, Keith. 2008. Heritage Forest Management Plan. Galiano Conservancy Association. Galiano Island.*

and above the major cliff/ridge that bisects the properties. The moist forest, wetland and creek areas in the depressions are considered to be part of the groundwater discharge zone. Elevated water recharge areas such as those found on the property are considered of great value to the maintenance of water quality in aquifers, of special significance for wells drilled at lower elevations along the shoreline with regard to salt water intrusion.

Spotlight Creek is the major drainage system associated with the properties running roughly from northwest to southeast through the lower portion of the properties. The creek originates from the large wetland complex adjacent to Devina Drive flowing under the main driveway access to Lot 10. The Spotlight Creek watershed is relatively small, even by Galiano standards, totaling approximately 60 hectares in size. The creek is intermittent and runs only during peak rainfall months from November through to the spring. In accordance with the BC Riparian Areas Regulation assessment methodology, Spotlight Creek is considered a non-fish bearing system and does not support salmonids, game fish or regionally significant fish. Fish absence was determined based on stream gradient and the presence of a human made permanent impassible barrier as the creek enters Spotlight Cove. The impassible barrier is a 20 meter long culvert at a 10% slope with a measured 2cm maximum stream depth at high flow (December 30, 2009). The creek gradient increases to 30% for a 15 meter stretch just upstream from the culvert and then flattens back down to 10% for close to 300 meters. The stream is completely dry over the summer months, eliminating the possibility for presence of any resident fish species.

The upper portion of the properties located roughly above 100 meters in elevation are a part of the Jack Creek Watershed, however, stream channels or any above ground flow associated with the Jack Creek were not observed on the properties.

3.1.4 Soil

According to the Agriculture Canada report, *Soils of the Gulf Islands of British Columbia Volume 3*, the Properties are characterized by three different soil types:

1. **Saturna:** Saturna is the dominant soil type on the properties covering the majority of the gently to moderately sloping areas over roughly 55% of the property. Saturna soils are well-drained and droughty during the summer. They have developed on shallow deposits of channery, sandy loam to channery, loamy sand textured, colluvial and glacial drift materials over sandstone bedrock within 100cm of the surface. Areas of the property are characterized by very shallow lithic Saturna soils often associated with bedrock exposures or very thin mineral soil layers less than 50 cm deep. Coarse fragment content varies between 20 and 50%.
2. **Rock-Saturna:** Rock-Saturna soils are found along the ridges and associated steep southwest facing slopes on the properties and account for roughly 30% of the area. They are characterized by patches of exposed sandstone bedrock often covered with moss, mixed with

areas covered with a shallow well drained Saturna mineral soil layer. Mineral soils are either colluvial or glacial drift derived, generally between 10 and 50cm thick and have a coarse fragment content that varies between 20 and 50%.

3. Parksville: Parksville soils are a minor component of the properties accounting for roughly 15% of the area. They occur on nearly level to very gently sloping (0.5 – 5%) topography in depressional areas, swales and drainageways between bedrock ridges. Parksville soils are poorly drained with a layer of sandy or silty loam of fluvial origin overlying deep silty clay loam to silty clay textured marine deposits that are virtually stone free. Distinct mottles are often present within 50 centimeters of the surface. They are saturated with water to within 30cm of the surface from late fall to spring. During summer, the water table drops to below 60cm, allowing the surface horizons to become dry. Soil receives seepage and runoff water from surrounding slopes, which tends to keep the soil moist during dry periods.

3.1.5 Wildlife

The diversity of ecosystems on the properties supports many species of animals. Fauna observed while surveying the lot are listed below. Surveys took place between September 2009 and December 2009.

List of bird species observed:

Turkey Vulture	Northern Flicker	Winter Wren
Red-tailed Hawk	Pileated Woodpecker	Varied Thrush
Bald Eagle	Common Raven	American Robin
Barred Owl	Northwestern Crow	Dark-eyed Junco
Rufous Hummingbird	Chestnut-backed Chickadee	Pine Siskin
Downy Woodpecker	Common Bushtit	
Hairy Woodpecker	Brown Creeper	

Other fauna observed include:

<u>Mammals</u>	<u>Amphibians</u>	<u>Reptiles</u>
Red Squirrel	Red-legged Frog (blue-listed)	Northwestern Garter Snake
Raccoon	Pacific Tree Frog	
Black-tailed Deer	Rough-skinned Newt	
Deer Mouse		

3.1.6 Ecosystem Types

The Crystal Mountain Lands are characterized by a wide range of ecological conditions due to their topographic complexity and past logging activities. Ecosystem types are determined by two primary factors – the site characteristics (such as soil, slope and aspect) and the disturbance

history (the type of disturbance and time since it occurred). The soils and the topography determine the various species and assemblages of plants that will grow on a site and the disturbance history determines the present condition of the plant communities and their successional status (eg. plant communities that form immediately after a disturbance such as a regenerating clearcut vs. plant communities that form 300 years after disturbance - an old-growth forest).

Soil conditions generally follow topographic trends with deeper, moister, nutrient rich soils occurring in the depressions and shallow, dry, nutrient poor soils occurring on the ridge tops. The general pattern of vegetation from a wet depression to a dry ridge top is as follows:

- Depressions are often dominated by broadleaf trees with scattered large diameter conifers growing on rich raised mounds. The understory is diverse and lush in appearance, often characterized by a mix of shrubs, ferns, sedges, rushes, grasses and mosses.
- Moist depression areas generally transition to conifer dominated lower to mid-slopes with patchy but robust shrub and fern dominated understories that generally coincide with canopy gaps. The composition of the trees and understory varies depending on the aspect (the direction that the slope faces) and how steep or gentle the slope is.
- Upper slope and ridge-top areas are generally comprised of a mix of conifer and broadleaf (primarily *Arbutus* (*Arbutus menziesii*)) with a more consistent cover of understory shrubs and mosses with fewer ferns. The shallow and poor soils on the ridge-tops generally produce smaller diameter trees that are gnarly or weathered in appearance.

Succession ranges from undisturbed mature climax forest on some of the very steep southwest facing slopes to highly disturbed, non-vegetated sites where the soil disturbance from logging related activities was so severe that pioneering vegetation has not yet been able to establish. The general pattern of vegetation development after a clearcut is as follows – a flush of herbaceous and shrubby vegetation emerges as tree seedlings begin to establish about 3 years after the disturbance leading to a diverse mixed pole/sapling forest with a robust, diverse understory for about 20 years. The pole/sapling forest then moves into the young forest phase characterized by a very dense conifer dominated tree canopy with a sparse understory and general loss of diversity. The young phase lasts for roughly 40 to 50 years as the forest slowly thins itself out through natural competition and the onset of various root diseases and other pathogens. These natural processes lead to the young forest's transition into a more complex, multi-layered, mixed species mature and eventually old-growth forest diverse in composition (the parts), structure (the arrangement of the parts) and function (how the parts work).

The majority of Lot A is recovering from an intense clearcut which took place in 1993. The land is currently in the pioneering seral stage characterized by patchy and diverse pole / sapling forest of varied vegetative composition depending on slope position, aspect, slope and soil depth. The moist depression sites are generally dominated by red alder (*Alnus rubra*) with sword fern

(*Polystichum munitum*) and patches of salmonberry (*Rubus spectabilis*) in the understory. The drier, gently sloping logged areas are characterized by dense patches of Douglas-fir (*Pseudotsuga menziesii*) and grand fir (*Abies grandis*) poles with very little understory vegetation scattered within a more open mix of Douglas-fir, red alder, bitter cherry (*Prunus emarginata*), big-leaf maple (*Acer macrophyllum*), grand fir and arbutus with salal (*Gaultheria shallon*), Oregon-grape (*Mahonia nervosa*) and sword fern dominant in the understory.

Remnant patches of healthy mature forest are located in thin strips along the ridge tops and down the associated southwest facing steep slopes where logging was not practical. The majority of Lot 9 is also characterized by mature forest growing under a variety of ecological conditions. Ecosystem types range from western redcedar (*Thuja plicata*), Douglas-fir, big-leaf maple dominated northeast facing, moderate slopes to red alder, salmonberry dominated seasonally flooded wetland depression to Douglas-fir, arbutus dry rocky ridge top.

Each of the 30 ecosystem types identified on the Crystal Mountain Lands has been listed and described according to its site characteristics, vegetation, and soils as well as its related disturbance history, successional trajectory and restoration issues. Ecosystem types have been identified through field work conducted between September 2009 and December 2009. The detailed ecosystem type descriptions have been included as Appendix 1 of this document. MAP 2 shows the locations of the various ecosystem types.

3.2 Disturbance History

The primary disturbance on the properties over the past century has been logging. Lot A has been logged at least twice and Lot 9 once. MacMillan Bloedel records suggest that the upper portion of Lot A was cut in the late 1870's while the lower portion was cut in the early 1920's. Timbermarks suggest that Lot A was clearcut by the owner previous to Crystal Mountain between 1993 and 1996. It appears that the property was not planted and is regenerating naturally. The clearcut was intensive and appears to have been completed with excavators and skidders resulting in significant impacts to the soils, especially in moist and seasonally flooded areas.

3.3 Conservation Significance

The Crystal Mountain lands are located within the Coastal Douglas-fir Biogeoclimatic Zone (CDF), an ecological classification that has recently been identified as imperiled (a high risk of extinction) both Provincially and globally in Biodiversity BC's "Taking Natures Pulse: The Status of Biodiversity in British Columbia". The fact that the Crystal Mountain lands have not

Crystal Mountain Ecosystem-based Plan

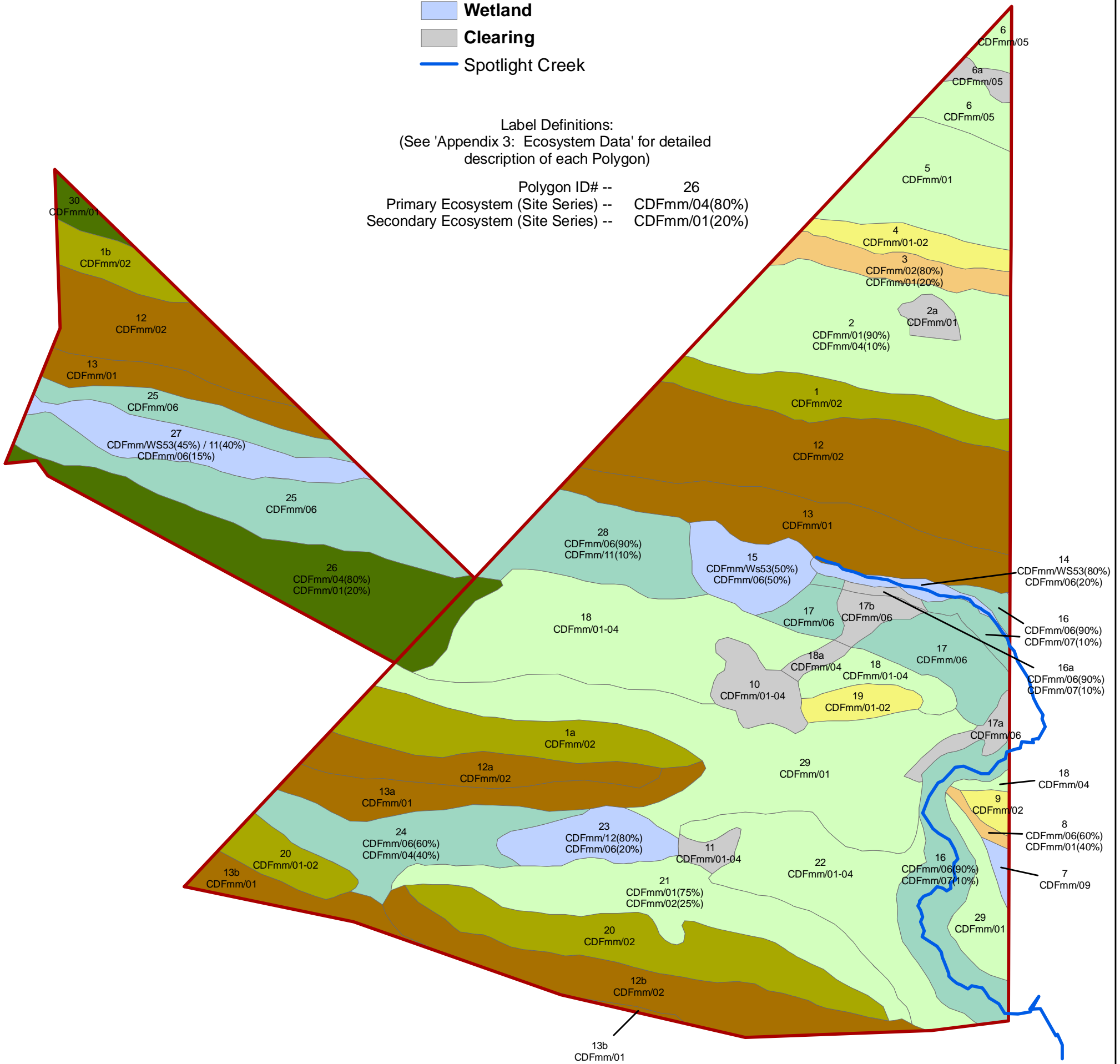
-- Ecosystem Types --

2

- Property Boundary
- Mature Forest
- Mature Forest Ridge
- Mature Forest Steep Slope / Cliff
- Pole Forest
- Pole Forest Ridge
- Pole Forest Steep Slope / Cliff
- Moist Soil / Riparian Forest
- Wetland
- Clearing
- Spotlight Creek

Label Definitions:
(See 'Appendix 3: Ecosystem Data' for detailed description of each Polygon)

Polygon ID# --	26
Primary Ecosystem (Site Series) --	CDFmm/04(80%)
Secondary Ecosystem (Site Series) --	CDFmm/01(20%)



Produced by: Keith Erickson (R.P.Bio.)
 Map Date: December 2009
 Scale: 1 : 2,850
 Projection: UTM Zone 10 NAD83
 Rotation: 46.5 degrees W of N



been developed or permanently altered is a significant conservation achievement within the most densely populated region of the Province. Despite the industrial scale logging that has occurred on the lands in the past, there are a number of remnant patches of healthy mature and old-growth forest that have been identified along the steep slopes and ridge-tops of Lot A and over most of Lot 9. These areas are of significant conservation importance. In addition, a seasonal stream, a variety of small wetlands and the associated riparian ecosystems provide important habitat for wildlife. The diversity of ecological conditions and associated vegetation communities and wildlife resulting from the remarkable topographic complexity of the properties is also of high conservation significance – and is of particular importance when considering adaptation to climate change and migration routes of flora and fauna from drier to wetter sites or vice versa.

3.3.1 Ecosystems and Species at Risk

The properties include intact mature examples of two provincially red-listed ecological communities recognized by the British Columbia Conservation Data Centre:

- Community: Douglas-fir - arbutus (*Pseudotsuga menziesii* - *Arbutus menziesii*)
Global Rank: Not Ranked
Provincial Rank: Red (S2) – Imperiled
Site Series: CDFmm/02
Location (MAP2): Polygons 1, 12 and 20
- Community: Douglas-fir / dull Oregon-grape (*Pseudotsuga menziesii* / *Mahonia nervosa*)
Global Rank: G2 – Imperiled
Provincial Rank: Red (S2) – Imperiled
Site Series: CDFmm/01
Location (MAP2): Polygons 1, 12 and 20

The properties also include a young early successional example of the following listed ecological community:

- Community: red alder / skunk cabbage (*Alnus rubra* / *Lysichiton americanus*)
Global Rank: Not Ranked
Provincial Rank: Blue (S2S3) – special concern, vulnerable to extirpation or extinction
Site Series: CDFmm/11
Location (MAP2): Polygon 14

The properties are also home to a robust population of the provincially blue-listed (species of special concern, vulnerable to extirpation or extinction) red-legged frog (*Rana Aurora*). Red-legged frogs were observed in, but are not limited to, the following locations on MAP 2: Polygons 2, 6, 7, 8, 14, 15, 16, 17, 25, 27 and 28.

3.3.2 Landscape Connections

Ecosystems located on the Crystal Mountain properties are part of a larger generally southeast to northwest running ridge and valley system that includes several significant wetland complexes and mature forest stands. Large portions of the system have been protected within Dionisio Provincial Park to the northwest, the Provincial Ecological Reserve #128 to the southeast and most recently within District Lot 87, immediately adjacent and wedged between the Crystal Mountain properties (See MAP3: Landscape Connections). District Lot 87 was acquired by the Provincial Government and is intended to become a BC Park’s managed protected area, but has not been officially transferred or designated at this time. Its transfer to BC Parks management may be contingent on additional rezoning and development of privately held lands linking District Lot 87 with Dionisio Park.

Protection of ecosystems on the Crystal Mountain lands will directly contribute to overarching goals for landscape connectivity on the northern portion of Galiano Island. It will specifically conserve portions of the Spotlight Creek watershed and will preserve ecosystem integrity along north/south and cross-island landscape level corridors.

3.4 Identified Threats to Ecosystem Values

Threats to ecosystem values are determined by identifying and assessing all current and potential uses or activities associated with the Crystal Mountain properties and surrounding areas. Threats have been identified and classified using criteria developed by the International Union for Conservation of Nature (IUCN) – a now generally accepted standard methodology. Threats and associated impacts will be addressed through the development of management zones and through the strategies and recommendations outlined in the remainder of this document.

IUCN Threat Category	Specific Threat	Associated Impacts
Residential and Commercial Development – Tourism and Recreation Areas	Development of retreat huts, service buildings, managers cottage, septic system	Habitat loss Habitat fragmentation Encroachment on sensitive ecosystems
Human Intrusions and Disturbance – Recreational Activities	Meditation sites - clearing for light or view sites on ridges	Habitat loss Soil erosion and compaction
	Walking / Hiking - trail network	Minor habitat fragmentation Soil erosion and compaction
Transportation and Service Corridors	Access roads and parking lot(s)	Habitat loss Habitat fragmentation Soil erosion and compaction
	Utility and Service Lines – hydro lines, water lines	Habitat loss Habitat fragmentation

Natural System Modifications – Fire Suppression	Fire suppression – general fire suppression and fuel load buildup	Habitat loss from catastrophic fire Alteration of natural disturbance regimes
Natural System Modifications – Water Management / Use	Damming of creek and use of water (for neighbouring water license)	Downstream habitat loss
	Excessive use of groundwater (wells) by Crystal Mountain and on surrounding properties within the groundwater region	Degraded groundwater quality
Invasive Species – Non-native Species	Scotch broom, Himalayan / Evergreen blackberry	Habitat loss
Pollution – Household Sewage	Leaking septic systems	Degraded stream water quality Degraded groundwater quality
	Seepage from Outhouses	Degraded stream water quality Degraded groundwater quality
Biological Resource Use – Gathering Terrestrial Plants	Uncontrolled harvest of native plants / fungi	Species loss Habitat loss
Biological Resource Use – Logging / Wood Harvesting	Unsustainable harvest of timber	Habitat loss Habitat fragmentation Degraded stream water quality Degraded groundwater quality Soil erosion and compaction
Climate Change	Droughts	Species loss Decrease in groundwater recharge
	Storms and Flooding	Species loss
	Habitat shifting	Species loss

Ecosystem 1

Description: Mature Douglas-fir (*Pseudotsuga menziesii*), Arbutus (*Arbutus menziesii*) – salal (*Gaultheria shallon*) (CDFmm/02) vegetation community along major ridgeline. The ecosystem is characterized by very shallow, rapidly drained, dry soils with a high coarse fragment content and poor to medium soil nutrient regime. The dominant Douglas-fir trees are generally between 80 and 150 years old with older veterans scattered throughout.

Polygon ID:	1	Slope:	convex	Aspect:	230°
Structural Stage:	MFm	Mesoslope Position:	crest	Site Series:	CDFmm/02
Soil Nutri. Regime:	VP - P	Soil Moisture Regime:	1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	20	30	10	2	2			B1 is higher (20%) in poly 1a
<i>Arbutus menziesii</i>		10	10					Southwest side of crest
<i>Thuja plicata</i>		2	2					
<i>Acer macrophyllum</i>			T					
<i>Gaultheria shallon</i>					70			
<i>Mahonia nervosa</i>					3			
<i>Rosa gymnocarpa</i>					T			
<i>Lonicera ciliosa</i>				T				
<i>Lonicera hispidula</i>					T			
<i>Symphoricarpos alba</i>					T			
<i>Pachistima myrsinites</i>					T			
<i>Cornus nuttalli</i>				T				
<i>Goodyera oblongifolia</i>						T		
<i>Kindbergia oregana</i>							T	
<i>Dicranum scoparium</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Timmia austriaca</i>							T	
<i>Racomitrium</i>							T	
Cover by Layer (%)	Tree:	70	Shrub:	75	Herb:	2	Moss:	2

Soils:

Soils range in depth from exposed bedrock to 50cm. Well defined L and F layers with a thin H and thin Ae and occasionally Ah in patches. High in coarse fragments (50-60%), rapidly drained, and light in colour. Abundant mycelia and fauna found in soil where decay class 5 cwd is present.

Wildlife and Wildlife Habitat:

Observed during data collection: bald eagle (heard in tree top) and seen flying,

Habitat: snags are rare but extensively used by woodpeckers, cwd is scattered throughout and includes a variety of diameters and decay classes.

Disturbance History:

Evidence of selective logging with single stem selection occurring during clearcutting of adjacent forest on northeast facing slope. In Polygon 1a logging has been more extensive resulting in ‘dog-hair’ like Douglas-fir regeneration on the northeast side of the crest. Polygon 1b has also been selectively logged but is adjacent to intact mature forest on the northeast and southwest facing slopes.

Both polygon 1, 1a and 1b have structures and clearing associated with meditation retreat activities – a recently cleared site with a pieced together platform (approx. 100 sqft) at the southwest edge of the ridge in Polygon 1; an established well constructed teaching platform (approx. 1200 sqft) in the transition area between the crest/ridge and northeast facing upper slope in Polygon 1a, and; a frequently visited pagoda (monument) in Polygon 1b.

Succession:

These mature forest sites will continue to move towards climax without too much variation in tree composition and cover. As ecosystems on the northeast facing slopes adjacent to Polygons 1 and 1a develop into young and mature forests, light in these ridge polygons will decrease slightly possibly resulting in a reduction of shrubby salal cover and an increase in moss ground cover.

Restoration Recommendations:

Restoration is not required.

Ecosystem 2

Description: Douglas-fir, western redcedar (*Thuja plicata*) naturally regenerating pole forest (CDFmm/01 – 90%, CDFmm/04 – 10%) approximately 15 years in age with scattered young 50 to 60 year old seed trees. The polygon includes a number of microsites of varying slope, aspect and mesoslope character ranging from moister micro depressions to dryer rock outcrops. Soils are generally well drained silty loams with moderate coarse fragment content and moder humus forms and vary in depth between 30 centimeters to greater than 80 cm.

Polygon ID:	2	Slope:	Variable, generally 5%		Aspect:	Concave - southwest to northeast
Structural Stage:	PSc	Mesoslope Position:	Flat		Site Series:	CDFmm/01 (90%) CDFmm/04 (10%)
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	2-4		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5		20	10	T		T	
<i>Thuja plicata</i>	2		10	5	2		T	
<i>Alnus rubra</i>				3				On moister micro-sites
<i>Salix scouleriana</i>				5				On moister micro-sites
<i>Arbutus menziesii</i>			2					On drier micro-sites

<i>Gaultheria shallon</i>					60				
<i>Polystichum munitum</i>						5			
<i>Pteridium aquilinum</i>						1			
<i>Abies grandis</i>				1					On richer micro-sites
<i>Acer macrophyllum</i>				T					
<i>Kindbergia oregana</i>							10		On richer micro-sites
<i>Achlys triphylla</i>						T			On richer micro-sites
<i>Cornus nuttallii</i>				T					On moister micro-sites
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10	

Soils:

Silty loam with 25-50% coarse fragment content, well drained to moderately well drained. Moder humus form. Soil depth varies from 30 to greater than 80cm.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, hairy or downy woodpecker, piliated woodpecker heard.

Habitat: mixed species, mixed aged forest with gaps and scattered snags is excellent habitat for birds, small mammals etc. Moist areas support amphibians.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. Char marks on cwd and stumps indicates low intensity slash burn after logging.

Landing area (Polygon 2a) has been cleared to support meditation retreat activities and currently includes an outhouse. Two trails leading from the road to the ridge have been established.

Succession:

Stand will develop into uneven aged, multi-storied young forest over the next 15 to 20 years with canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

Minor thinning over the next 20 years could maintain or increase diversity in the stand while providing small diameter poles for use. None of the older seed trees should be removed.

Ecosystem 3

Description: Small cliff and talus slope characterized by bedrock outcrops, exposed boulders, and pockets of shallow soil. The ecosystem is characterized by open, patchy Douglas-fir – oceanspray (*Holodiscus discolor*) (CDFmm/02 – 80%) plant community with a minor component of Douglas-fir – salal (CDFmm/01 - 20%) and approximately 30% exposed rock. A number of young Douglas-fir seed trees are scattered amongst regenerating Douglas-fir poles.

Polygon ID:	3	Slope:	80%	Aspect:	225°
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Structural Stage:	PSc	Mesoslope Position:	Upper Slope	Site Series:	CDFmm/01 (20%) CDFmm/02 (80%)
Soil Nutri. Regime:	VP – P	Soil Moisture Regime:	0-1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	15			40	T			
<i>Thuja plicata</i>				T				
<i>Acer macrophyllum</i>		2		T				
<i>Mahonia nervosa</i>					10			
<i>Holodiscus discolor</i>				10				
<i>Lonicera hispidula</i>				T	T			
<i>Lonicera ciliosa</i>				T	T			
<i>Rhamnus purshiana</i>				T				
<i>Rosa gymnocarpa</i>					T			
<i>Gaultheria shallon</i>					50			
<i>Linnaea borealis</i>					2			
<i>Taxus brevifolia</i>				T				
Cover by Layer (%)	Tree:	15	Shrub:	90	Herb:	5	Moss:	2

Soils:

Pockets of soil are rapidly drained, generally shallow and light in colour with a sandy loam texture and between 35 and 70% coarse fragment content. They are characterized by a mor humus form and have a high content of semi decomposed wood and a deep litter layer.

Wildlife and Wildlife Habitat:

Habitat: exposed rock and cliff is good habitat for northern alligator lizard

Disturbance History:

Any trees of merchantable size were harvested 15 to 20 years ago at the time of the clearcut in Polygon 2. Young seed trees were left.

Succession:

A main canopy of Douglas-fir will slowly develop on this naturally regenerating site over the next several decades eventually leading to a closed canopy with very little exposed cliff face and sparse understorey cover.

Restoration Recommendations:

None recommended.

Ecosystem 4

Description: Douglas-fir – salal (CDFmm/01- 02) dominated regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees on a convex ridgeline. Soils are very well drained, shallow with silty-loam texture and high (50-70%) coarse fragment content.

Polygon ID:	4	Slope:	Variable - convex	Aspect:	Southwest to northeast
Structural Stage:	PSc	Mesoslope Position:	Crest	Site Series:	CDFmm/01 - 02
Soil Nutrient Reg.:	VP-P	Soil Moisture Regime:	1-2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	3		5	35				
<i>Thuja plicata</i>	5		5	5				
<i>Arbutus menziesii</i>			5					
<i>Gaultheria shallon</i>					60			
<i>Mahonia nervosa</i>					15			
<i>Kindbergia oregana</i>							10	
Cover by Layer (%)	Tree:	25	Shrub:	90	Herb:	T	Moss:	10

Soils:

Silty loam with 50-70% coarse fragment content, very well drained. Mor humus form. Soils are shallow.

Wildlife and Wildlife Habitat:

Observed during data collection: pacific tree frog, raven

Habitat: several snags along the ridge with evidence of woodpecker use.

Disturbance History:

Logging 15 to 20 years ago left a high concentration of western redcedar and Douglas-fir seed trees along the ridgeline.

Succession:

Stand will develop into uneven aged, multi-storied young Douglas-fir dominated forest over the next 20 to 30 years with a reduction in shrub / understorey cover due to canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

No restoration required – allow natural processes to continue.

Ecosystem 5

Description: Northeast facing, mid to upper slope, zonal Douglas-fir – salal (CDFmm/01) regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees. Soils

are well drained and shallow with sandy loam texture and high (50%) coarse fragment content.

Polygon ID:	5	Slope:	35%	Aspect:	60°
Structural Stage:	PSc	Mesoslope Position:	Mid to upper slope	Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	2		1	30	1			
<i>Thuja plicata</i>	5		2	5	1			
<i>Arbutus menziesii</i>	1		1					
<i>Gaultheria shallon</i>					75			
<i>Mahonia nervosa</i>					1			
<i>Rosa gymnocarpa</i>					1			
<i>Polystichum munitum</i>						3		
<i>Pteridium aquilinum</i>						10		
<i>Kindbergia oregana</i>							20	
<i>Holodiscus discolor</i>				T				
<i>Vaccinium ovatum</i>				T				
<i>Cytisus scoparius</i>				T	T			Along old road
Cover by Layer (%)	Tree:	12	Shrub:	95	Herb:	15	Moss:	20

Soils:

Silty loam with 50% coarse fragment content, well drained. Moder humus form.

Wildlife and Wildlife Habitat:

Habitat: abundant coarse woody debris scattered throughout.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. No evidence of burn after logging – slash remains on site.

Landing area (Polygon 2a) has been cleared to support meditation retreat activities and currently includes an outhouse.

Succession:

Stand will develop into uneven aged, multi-storied young Douglas-fir dominated forest over the next 20 to 30 years with a reduction in shrub / understory cover due to canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

There is an opportunity for restoration thinning treatments over the next 20 years with a goal of maintaining and enhancing structural and compositional diversity while removing a small portion

of the stems for use.

Ecosystem 6

Description: Northeast facing, mid to lower slope, Douglas-fir, western redcedar – salal (CDFmm/05) regenerating pole forest with scattered young Douglas-fir and western redcedar seed trees. Soils are moderately well drained and with silty loam texture and moderate (25-35%) coarse fragment content.

Polygon ID:	6	Slope:	5-15% (concave)	Aspect:	60°
Structural Stage:	PSc	Mesoslope Position:	Mid to lower slope	Site Series:	CDFmm/05
Soil Nutrient Reg.:	M	Soil Moisture Regime:	5	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5		T	30				
<i>Thuja plicata</i>	30		5					
<i>Alnus rubra</i>				1				On edge of landing
<i>Gaultheria shallon</i>					65			
<i>Holodiscus discolor</i>				T				
<i>Pteridium aquilinum</i>						5		
<i>Hylocomnium splendens</i>							8	
<i>Kindvergia oregano</i>							10	
<i>Rhytidiadelphus loreus</i>							1	
<i>Lonicera hispidula</i>					2			
<i>Polystichum munitum</i>						1		
<i>Trientalis latifolia</i>						1		
<i>Vaccinium ovatum</i>					1			
<i>Linnaea borealis</i>					1			
<i>Achlys triphylla</i>						T		
<i>Lonicera ciliosa</i>				1				
<i>Cytisus scoparius</i>				T	T			On landing – poly 6a
<i>Cirsium spp.</i>						T		On landing – poly 6a
<i>Senecio jacobaeae</i>						T		On landing – poly 6a
<i>Grass spp.</i>						2		On landing – poly 6a
<i>Juncus effusus</i>						T		On landing – poly 6a
<i>Carex spp.</i>						T		On landing – poly 6a
Cover by Layer (%)	Tree:	40	Shrub:	90	Herb:	10	Moss:	20

Soils:

Silty loam with 25-35% coarse fragment content, moderately well drained. Moder humus form.

Wildlife and Wildlife Habitat:

Observed during data collection: tree frog, squirrel nut cache, deer scat, red legged frog, dragonfly.

Habitat: Snags and large diameter coarse woody debris observed.

Disturbance History:

The area was logged 15 to 20 years ago leaving a variety of scattered young seed trees that were not worth removing at the time of logging. Area is regenerating naturally. No evidence of burn after logging – slash remains on site.

Landing area (Polygon 6a) was cleared and served as a staging area during past logging. Soils have been heavily disturbed and compacted and are now dominated by invasive grasses, thistles, scotch broom and tansy ragwort. Due to moist soils and timing of logging, deep ruts were left from machinery and are now compacted micro-depression sites where sedges and rushes are growing.

Succession:

Stand will develop into uneven aged, multi-storied young forest over the next 15 to 20 years with canopy closure increasing and stem exclusion occurring for several decades there after.

Restoration Recommendations:

There is an opportunity for restoration thinning treatments over the next 20 years with a goal of maintaining and enhancing structural and compositional diversity while removing a small portion of the stems for use.

Landing site: removal of scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobaeae*) and thistles (*Cirsium spp.*) followed by planting of native species including but not limited to Douglas-fir, western redcedar, grand fir (*Abies grandis*), red alder (*Alnus rubra*), evergreen huckleberry (*Vaccinium ovatum*), and red elderberry (*Sambucus racemosa*). De-compact soil around planting sites and protect species susceptible to deer browse.

Ecosystem 7

Description: Seasonally flooded wet bench dominated by Pacific willow (*Salix lucida ssp. laciandra*) nootka rose (*Rosa nootkensis*), and slough sedge (*Carex obnupta*) (CDFmm/09). This polygon is a moisture receiving site with soils that are very rich but poorly drained due to a clay mineral soil layer and is flooded during winter storm events.

Polygon ID:	7	Slope:	<1%	Aspect:	250°
Structural Stage:	PSb	Mesoslope Position:	Flat	Site Series:	CDFmm/09
Soil Nutrient Reg.:	VR	Soil Moisture Regime:	05-07	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Salix lucida ssp laciandra</i>				15				
<i>Salix scouleriana</i>				10				

<i>Equisitum arvense</i>						10			
<i>Carex obnupta</i>						40			
<i>Rubus ursinus</i>						3			
<i>Elymus hirsutus</i>						5			
<i>Rosa nootkensis</i>				25	5				
<i>Alnus rubra</i>				20					
<i>Rubus discolor</i>				2	2				
<i>Kinbergia praelonga</i>								15	
<i>Menthe arvensis</i>						T			
<i>Rosa gymnocarpa</i>						T			
<i>Rubus spectabilis</i>						2			
<i>Gaultheria shalon</i>						T			On raised micro-sites
<i>Polystichum munitum</i>						T			On raised micro-sites
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10	

Soils:

Silty loam over top of heavy clay approximately 50 cm deep. Thick H and Ah horizons, dark coloured. Low coarse fragment content (10 – 15%) characterized by a few platy sandstone cobbles. Poorly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: heard lots of unidentified frog calls.

Habitat: Moist area supports amphibians and shrubby thicket like riparian provides high quality bird habitat.

Disturbance History:

The area appears to have been logged and is located next to the Crystal Mountain driveway – the ditch along the driveway provides significant water additions during storm events.

Succession:

Seasonal flooding will maintain willow and red alder in this ecosystem with possible infill of western redcedar as raised micro-sites develop over time. No cedar seedlings were observed.

Restoration Recommendations:

More in-depth investigation into hydrological alterations caused by the ditch and driveway should occur to determine whether restoration is required.

Ecosystem 8

Description: Red alder / bitter cherry (*Prunus emargenata*) – oceanspray (*Holodiscus discolor*) (CDFmm/01 – 40%) (CDFmm/06 – 60%) disturbed pole-sapling, lower/tow slope. The polygon is a transition zone from flat seasonally flooded Polygon 7 to a drier southwest facing upper slope characterized by Polygon 9.

Polygon ID:	8	Slope:	Concave, 25-60%		Aspect:	250°
Structural Stage:	PSm	Mesoslope Position:	Flat		Site Series:	CDFmm/01 (40%) CDFmm/06 (60%)
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	4-5		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Prunus emarginata</i>			15					
<i>Alnus rubra</i>		60	10					
<i>Salix scouleriana</i>			2					
<i>Pteridium aquilinum</i>						15		
<i>Gaultheria shallon</i>				10				
<i>Holodiscus discolor</i>				20				
<i>Rubus discolor</i>				40				
<i>Rubus parviflorus</i>				T				
<i>Acer macrophyllum</i>				T				
<i>Elymus glaucus</i>						1		
<i>Urtica dioica</i>						1		
<i>Rubus ursinus</i>					1			
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						1		
<i>Kinderbergia oregana</i>							5	
<i>Pseudotsuga menziesii</i>				2				
<i>Abies grandis</i>				1	1			
<i>Lonicera ciliosa</i>				1				
Cover by Layer (%)	Tree:	75	S`hrub:	70	Herb:	15	Moss:	5

Soils:

Silty loam with moderate coarse fragment content between 35 and 50%. Patchy deeper soil pockets interspersed with exposed boulder talus from ridge crest above. Moderately well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: heard lots of unidentified frog calls.

Habitat: Moist area supports amphibians and shrubby thicket like riparian provides high quality bird habitat.

Disturbance History:

Logged in mid 1990's. Logging likely contributed to slope instability leading to movement of boulders and soil from the cliff/ridge above.

Succession:

Red alder canopy will eventually be overtaken by Douglas-fir and grand fir that have established on drier, deeper soil micro-sites eventually leading to a conifer dominated mature forest.

Restoration Recommendations:

None recommended.

Ecosystem 9

Description: Douglas-fir / Arbutus (*Arbutus menziesii*) naturally regenerating pole forest (CDFmm/02) with scattered young seed trees. The polygon includes the upper slope and crest areas with an aspect that shifts from southwest to northeast. Soils are very shallow and very well drained with a high coarse fragment content and loamy textured mineral soil.

Polygon ID:	9	Slope:	Convex 0 - 90%		Aspect:	southwest to northeast
Structural Stage:	PSm	Mesoslope Position:	Crest – upper slope		Site Series:	CDFmm/02
Soil Nutrient Reg.:	P-M	Soil Moisture Regime:	1		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>			5	50				
<i>Arbutus menziesii</i>			10	2				
<i>Salix scouleriana</i>				1				
<i>Abies grandis</i>				1	2			
<i>Thuja plicata</i>				2				8% on northeast side of ridge
<i>Holodiscus discolor</i>				10				
<i>Mahonia nervosa</i>					5			
<i>Gaultheria shallon</i>					10			
<i>Lonicera hispidula</i>					10			
<i>Polystichum munitum</i>						T		
<i>Amelanchier alnifolia</i>						T		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Cytisus scoparius</i>					T	5		
<i>Racomitrium spp.</i>							30	
<i>Prunus emarginata</i>				15				
<i>Kindbergia oregana</i>							20	
<i>Rhytidiadelphus triquetrus</i>							5	On northeast side of ridge
Cover by Layer (%)	Tree:	15	Shrub:	65	Herb:	25	Moss:	50

Soils:

Very shallow, characterized by cracks and crevices with deeper soils between exposed boulders and bedrock. Loam with high coarse fragment (50-60%) and very well drained. Some of the deeper soil pockets have a small Ah and darker soils indicating scattered richer micro-sites.

Wildlife and Wildlife Habitat:

Observed during data collection: evidence of intense deer browse on Saskatoon (*Amelanchier alnifolia*), red huckleberry (*Vaccinium parvaflorum*) and scotch broom.

Disturbance History:

Polygon was logged resulting in increased exposure to winds. Loose rock and soil also suggests susceptibility to mass wasting – also increased from logging. Intense deer browse was also noted to the extent where the establishment of preferred species such as Saskatoon is severely impeded.

Succession:

Stand will develop into a Douglas-fir dominated site with scattered Arbutus – species like bitter cherry (*Prunus emarginata*) will die off over the next 20 years.

Restoration Recommendations:

Remove scotch broom by cutting during flowering season. Pulling will damage shallow, loose soils.

Ecosystem 12

Description: Mature to Old-growth Douglas-fir – Arbutus (CDFmm/02) southwest facing steep slope with exposed bedrock and boulder cliff micro-sites scattered throughout. Soils are generally less than 30cm in depth except on flatter “shelf” micro-sites also scattered throughout the polygon where deeper soil have been able to accumulate. In the smaller Polygon 12b along Porlier Pass road, there is a 25% component of Douglas-fir – salal (CDFmm/01) on a slightly shallower slope (50 – 60%).

Polygon ID:	12	Slope:	80%	Aspect:	250°
Structural Stage:	MF m	Mesoslope Position:	Mid to upper slope	Site Series:	CDFmm/02
Soil Nutrient Reg.:	M	Soil Moisture Regime:	0-1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5	40	5	1	T		T	
<i>Arbutus menziesii</i>		15	15					
<i>Acer macrophyllum</i>		10	5					Mainly on mid slope
<i>Thuja plicata</i>				T	T			In CDFmm/01 Poly 12b
<i>Holodiscus discolor</i>				1				
<i>Gaultheria shallon</i>					10			Mainly on mid slope
<i>Mahonia nervosa</i>					20			Mainly on mid slope
<i>Linnaea borealis</i>					T			
<i>Vaccinium ovatum</i>					1			
<i>Lonicera hispidula</i>					25			Mainly on upper slope
<i>Polystichum munitum</i>						1		

<i>Lactuca muralis</i>						T		
<i>Kinbergia praelonga</i>							5	On rocks
<i>Kinbergia oregana</i>							5	On rocks
<i>Lonicera ciliosa</i>				T				In CDFmm/01 Poly 12b
<i>Grass spp.</i>							15	
Cover by Layer (%)	Tree:	75	Shrub:	55	Herb:	15	Moss:	5

Soils:

Silty loam with medium coarse fragment content (30-50%), a medium to dark color, a mor humus form and very shallow. Exposed soil (no veg) and rock accounts for approximately 35% of the polygon.

Wildlife and Wildlife Habitat:

Observed during data collection: Bald eagles and Turkey vultures observed flying over steep slope / cliff.

Habitat: Large diameter snags and coarse woody debris and living veteran Douglas-firs are scattered throughout the polygon and all show signs of woodpecker use. A few scattered old-growth Douglas-fir trees provide rare canopy and below ground habitat associations.

Disturbance History:

Lower portion of the polygon has been selectively logged for Douglas-fir. Old-growth Douglas-fir trees show fire scars while mature trees do not indicating that the area was burned during or after the original logging entry in the early 1900's.

Succession:

Stand will continue to mature with a relatively stable species composition.

Restoration Recommendations:

None recommended.

Ecosystem 13

Description: Young Douglas-fir / western redcedar / big-leaf maple (*Acer macrophyllum*) (CDFmm/01) mixed forest characterized by large exposed boulders and soil deposited from the steep slope/cliff area above in Polygon 12. Exposed rock and boulder account for between 60% of surface cover at the bottom of the slope to 30% in the upper portion of the polygon.

Polygon ID:	13	Slope:	Concave 15 - 55%		Aspect:	250°
Structural Stage:	YFm	Mesoslope Position:	Mid to lower slope		Site Series:	CDFmm/01
Soil Nutrient Reg.:	M	Soil Moisture Regime:	3		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		15	5	10	T		T	

<i>Thuja plicata</i>		25	10	5	T		T	
<i>Arbutus menziesii</i>			T					
<i>Acer macrophyllum</i>		15	10	1	T		T	
<i>Gaultheria shallon</i>					15			
<i>Mahonia nervosa</i>					3			
<i>Holodiscus discolor</i>				1				
<i>Polystichum munitum</i>						10		
<i>Kinbergia oregana</i>						15		
<i>Alnus rubra</i>				5				
<i>Lonicera hispidula</i>					5			
<i>Lactuca muralis</i>						T		
<i>Gallium aparine</i>						T		
<i>Racomitrium spp.</i>							15	Lower slope on talus
Cover by Layer (%)	Tree:	35	Shrub:	85	Herb:	10	Moss:	10

Soils:

Very well drained silty loam with medium coarse fragment content (30-50%), a medium to dark color, a mor humus form and generally shallow.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven

Habitat: Lots of potential hiding and den sites in cracks and fissures created by boulders.

Abundant coarse woody debris.

Disturbance History:

The polygon was logged in the early 1900's and was high-graded again in the 1990's when the major clearcut on the property occurred. The major natural disturbance is from mass wastage with large gaps within the polygon formed due to high boulder content and very few soil pockets suitable for tree growth.

The major disturbance to Polygon 13b is from Porlier Pass road with permanently altered light conditions along with consistent disturbance from traffic. Also, polygon 13b was not high-graded.

Succession:

Lower boulder dominated area will slowly develop canopy cover as existing trees grow and more regen is recruited. The upper "less bouldery" area will continue to develop mature forest characteristics. The soil communities on in the talus dominated area where high-grade logging occurred will take many decades or even centuries to re-establish and support tree growth.

Restoration Recommendations:

None recommended.

Ecosystem 14

Description: Western redcedar – sword fern (*Polystichum munitum*) – skunk cabbage (*Lysichiton americanum*) swamp (Ws53 – 80%). The seasonally flooded wetland depression is recovering from logging related disturbance and is currently characterized by regenerating red alder pole forest mixed with graminoid dominated open patches. Raised micro-sites are scattered throughout the swamp area and transition into a CDFmm/06 (20%) moist forest along the edges of the polygon. A seasonal stream channel is braided through the wetland area and varies in width to from concentrated (1m width) to dispersed (no defined channel).

Polygon ID:	14	Slope:	Less than 1%		Aspect:	Depression (160°)
Structural Stage:	PSb	Mesoslope Position:	Depression		Site Series:	CDFmm/11 (80%) CDFmm/06 (20%)
Soil Nutrient Reg.:	R-VR	Soil Moisture Regime:	6-7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes	
<i>Alnus rubra</i>				65					
<i>Abies grandis</i>				T	T			On raised micro-sites	
<i>Thuja plicata</i>	2			T	T			On raised micro-sites	
<i>Acer macrophyllum</i>	T							On raised micro-sites	
<i>Rubus spectabilis</i>				1	1				
<i>Gaultheria shallon</i>					1			On raised micro-sites	
<i>Polystichum munitum</i>						55		On raised micro-sites	
<i>Urtica dioica</i>						3			
<i>Juncos effusus</i>						T			
<i>Lysichiton americanum</i>						5			
<i>Scirpus microcarpus</i>						5			
<i>Equisetum arvense</i>						25			
<i>Achlys triphylla</i>						2			
<i>Elymus glaucus</i>						5			
<i>Kindbergia praelonga</i>							2		
Cover by Layer (%)	Tree:	2	Shrub:	70	Herb:	95	Moss:	2	

Soils:

Soils range from wet year round in the centre to seasonally wet on the fringes. Characterized by deep organic horizon with underlying heavy clay.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog and active beaver damming (freshly cut small diameter red alder stumps and downed stems with beaver tooth patterns)

Habitat: mixed species, mixed aged forest with gaps and open water for the majority of the year is excellent habitat for birds, amphibians and mammals.

Disturbance History:

The polygon was clearcut logged around 16 years ago with varying degrees of disturbance to soils – indicated by variation in regenerating vegetation communities.

Freshly felled red alder is being used by beaver to create a new dam which is increasing the size of the flooded wetland area.

Succession:

Swamp area will continue to develop forest canopy transitioning from a red alder dominated community into a western redcedar dominated community. Red alder will remain as a long-term component of the stand. Succession will depend on degree of soil disturbance with high impact areas taking longer to develop forest canopy. If beaver persist with the development of new dams the water table may be raised in affected areas creating pockets of year round marsh habitat – trees and shrubby vegetation in the flooded area will likely die and marsh vegetation adapted to year round flooding will increase.

Restoration Recommendations:

Recommend planting red alder and western redcedar in appropriate raised (dryer) micro-sites within the more heavily disturbed (no red alder canopy) areas.

Ecosystem 15

Description: Young red alder (*Alnus rubra*) / western redcedar – sword fern (*Polystichum munitum*) / salmonberry (*Rubus spectabilis*) swamp (Ws53 - 50%) in depression areas transitioning into sword fern dominated lower slope with scattered young big-leaf maple and western redcedar (CDFmm/06 - 50%) left after logging. The polygon also includes a seasonal stream channel that varies in width to from concentrated (1m width) to dispersed (no defined channel) to subsurface flow.

Polygon ID:	15	Slope:	1 - 5%		Aspect:	45°
Structural Stage:	PSb	Mesoslope Position:	Depression – lower slope		Site Series:	Ws53 (50%) CDFmm/06 (50%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	5-7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>			65					
<i>Abies grandis</i>				1	1			Raised micro-sites
<i>Thuja plicata</i>	5		5	T	T			
<i>Acer macrophyllum</i>			15					
<i>Rubus spectabilis</i>				15	1			
<i>Polystichum munitum</i>						60		
<i>Climacium dendroides</i>							T	
<i>Plagiomnium insigne</i>							5	

<i>Kindbergia oregana</i>							10		
<i>Kindbergia praelonga</i>							5		
<i>Rhytididiadelphus triquetrus</i>							T		
<i>Achlys triphylla</i>						5			
<i>Elymus glaucus</i>						5			
<i>Carex sp.</i>						10			
<i>Gaultheria shallon</i>					1				Raised micro-sites
<i>Salix scouleriana</i>				T					
<i>Rubus ursinus</i>					1				
Cover by Layer (%)	Tree:	80	Shrub:	20	Herb:	80	Moss:	20	

Soils:

Dark silty loam with high organic content, thick Ah and low coarse fragment content (10%).
Seasonally saturated with standing water during winter months.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.

Habitat: multi-layered vegetation with broadleaf canopy, salmonberry and water source extremely valuable for wildlife.

Disturbance History:

Soils have been heavily impacted from machinery during logging 15 to 20 years ago. Old stumps indicate a mature forest community dominated by large western redcedar with the odd Douglas-fir and grand fir scattered on micro-sites. Red alder is very spindly and dense due to soil disturbance and fluctuating water table.

Succession:

Western redcedar will gradually grow up and replace the red alder as the dominant cover with grand fir and Douglas-fir taking hold on appropriate microsites over the next 50 or 60 years. Micro-sites will continue to develop creating a more patchy swamp/dry site mosaic.

Restoration Recommendations:

Recommend targeted thinning of red alder to encourage the growth of western redcedar and grand fir saplings. Thinning should be completed in dry summer months without the use of any machinery.

Ecosystem 16

Description: Riparian forest characterized by young red alder - sword fern community (CDFmm/06 – 90%) on a lower slope mixed with red alder / black cottonwood (*Populus balsamifera spp. trichocarpa*) – salmonberry community (CDFmm/07) in small depression areas along the edge of the seasonal creek where flooding occurs. In polygon 16a, patches of young forest are mixed with open shrub and pole/sapling dominated areas where soils were more heavily impacted during logging and regeneration is hindered.

Polygon ID:	16	Slope:	2-30% - concave		Aspect:	variable
Structural Stage:	PSb	Mesoslope Position:	Lower slope		Site Series:	CDFmm/06 (90%) CDFmm/07 (10%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		2	T	T	T			No A2/A3 in disturbed areas
<i>Thuja plicata</i>		1	2	5	T			No A2/A3 in disturbed areas
<i>Alnus rubra</i>		25	20	5				No A2/A3 in disturbed areas
<i>Abies grandis</i>		T	T	1	T			No A2/A3 in disturbed areas
<i>Arbutus menziesii</i>				T				On raised micro-site
<i>Gaultheria shallon</i>					5			
<i>Polystichum munitum</i>						50		Less in flooded areas
<i>Pteridium aquilinum</i>						T		
<i>Acer macrophyllum</i>		3	T	T				
<i>Kindbergia oregana</i>							1	
<i>Achlys triphylla</i>						3		
<i>Equisetum arvense</i>						3		
<i>Rubus discolor</i>				1	1			In flooded area by road
<i>Vaccinium parvaflorum</i>				T				
<i>Populus balsamifera trichocarpa</i>				T				In flooded areas
<i>Sambucus racemosa</i>				T				In flooded areas
<i>Rubus spectabilis</i>				3	2			In flooded areas
<i>Carex spp.</i>						2		In flooded areas
<i>Grass spp.</i>						2		More in disturbed areas
<i>Urtica dioica</i>						1		
<i>Rubus ursinus</i>					T			
<i>Kindbergia praelonga</i>							2	more in flooded areas
<i>Climacium dendroides</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Plagiomnium insigne</i>							T	
<i>Holodiscus discolor</i>				T				In disturbed areas
<i>Gallium aparine</i>						T		In disturbed areas
<i>Crataegus monogyna</i>					T			In disturbed areas
<i>Mahonia nervosa</i>					T			In disturbed areas
<i>Cirsium spp.</i>						T		In disturbed areas
<i>Symphoricarpos albus</i>					T			In disturbed areas
<i>Salix scouleriana</i>			1					In disturbed areas

<i>Tellima grandiflora</i>					T		In disturbed areas		
Cover by Layer (%)	Tree:	60	Shrub:	30	Herb:	65	Moss:	5	

Soils:

Imperfectly drained silty clay loam with low coarse fragment content (10%) and thick H and Ah horizons. Moder humus form. Mottles are present in clay layer approximately 50 cm deep indicating a slightly fluctuating water table and /or saturation during winter months.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, tree frog, red squirrel

Habitat: multi species, riparian forest with gaps, floodplains and scattered snags is excellent habitat for birds, small mammals, amphibians etc. Freshwater available in winter, fall and spring.

Disturbance History:

The area was clearcut 15 to 20 years ago. Machine use has damaged and compacted soils and is more pronounced in areas used for repeated access (polygon 16a). Regeneration has been compromised in these areas and they remain in the shrub/herb successional phase.

Succession:

Red alder will continue to dominate the polygon for several decades with western redcedar and grand fir slowly emerging as the red alder dies off. Areas of heavier soil disturbance will continue to develop very slowly with a mixed tree canopy forming over the next 20 – 30 years.

Restoration Recommendations:

Recommend planting western redcedar and red alder in polygon 16a where soils have been disturbed.

Recommend the removal of the black ABS pipe and the weir from the lower portion of the creek.

Ecosystem 17

Description: Moist, red alder dominated pole forest with a sword fern and grass dominated understory (CDFmm/06). The ecosystem is recovering from heavy soil disturbance and compaction that occurred during logging approximately 15 years ago. Polygons 17a and 17b were likely old road and staging areas during logging and have been significantly impacted by extensive soil compaction and disturbance. As a result, these areas have not been able to develop a tree canopy and have a dominant vegetation cover of grasses and sword fern.

Polygon ID:	17	Slope:	5-10% - concave	Aspect:	variable
Structural Stage:	PSb	Mesoslope Position:	Lower slope	Site Series:	CDFmm/06
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes	
<i>Pseudotsuga menziesii</i>				5	1			1% in 17a/b	
<i>Thuja plicata</i>				T				1% in 17a/b	
<i>Alnus rubra</i>				60				5% in 17a/b	
<i>Abies grandis</i>				1	3			1% in 17a/b	
<i>Prunus emarginata</i>				10					
<i>Gaultheria shallon</i>					2				
<i>Polystichum munitum</i>						50		20% in polygons 17a/b	
<i>Pteridium aquilinum</i>						T		5% in 17a/b	
<i>Acer macrophyllum</i>				2					
<i>Kindbergia oregana</i>							2		
<i>Achlys triphylla</i>						T			
<i>Equisetum arvense</i>						3			
<i>Rubus discolor</i>				2					
<i>Scirpus microcarpus</i>						T		In 17b	
<i>Sambucus racemosa</i>				1					
<i>Rubus spectabilis</i>				2	2				
<i>Carex spp.</i>						T			
<i>Grass spp.</i>						25		60% in Polygons 17a/b	
<i>Urtica dioica</i>						5			
<i>Rubus ursinus</i>						T			
<i>Kindbergia praelonga</i>							2		
<i>Elymus hirsutus</i>						10			
<i>Rhytidiadelphus triquetrus</i>							T		
<i>Plagiomnium insigne</i>							4		
<i>Polytrichum juniperinum</i>							T		
<i>Gallium aparine</i>						T			
<i>Cirsium spp.</i>							T	5% in 17a/b	
<i>Dactylis glomerata</i>						3			
<i>Agropyron repens</i>							T		
<i>Tellima grandiflora</i>						T			
Cover by Layer (%)	Tree:		Shrub:	80	Herb:	95	Moss:	10	

Soils:

Modor humus form with 15 – 25% coarse fragments, a deep Ah layer and a silty clay loam mineral horizon texture. There are signs of compaction between 10 and 30 cm and a clay layer at approximately 40 cm.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, tree frog, raven

Disturbance History:

The area was very heavily impacted by machinery during logging. There is evidence slash pile burning after logging with large deposits of charred wood/ash in soils. Soil compaction is

evident as well as soil mixing from bulldozers. Stumps remaining on the site are dominated by western redcedar (75%) and Douglas-fir (25%)

Succession:

Red alder will continue to dominate the polygon for several decades with western redcedar and grand fir slowly emerging as the red alder dies off. Areas of heavier soil disturbance will continue to develop very slowly with a mixed tree canopy forming over the next 20 – 30 years.

Restoration Recommendations:

Recommend pulling apart and spreading remaining slash piles to create a more natural distribution of coarse woody debris and to reduce the risk of high intensity fire getting into adjacent conifer dominated stands.

Recommend spot planting of red alder, western redcedar and grand fir in polygons 17a and 17b to hasten the formation of a tree canopy – de-compact soil around planting sites to provide a more favorable growing condition for the planted tree.

Ecosystem 18

Description: Dense Douglas-fir / grand fir (*Abies grandis*) dominated pole forest with sparse Oregon grape (*Mahonia nervosa*) / sword fern understory (CDFmm/04). The Polygon is characterized by dense conifer areas mixed with patches of red alder. Polygon 18a was likely an old road and staging area during logging and has been significantly impacted by extensive soil compaction and disturbance. As a result, this area has not been able to develop a tree canopy and has a dominant vegetation cover of grasses and sword fern.

Polygon ID:	18	Slope:	5-15% - concave	Aspect:	NE to E
Structural Stage:	PSb	Mesoslope Position:	Mid Slope	Site Series:	CDFmm/04
Soil Nutrient Reg.:	R	Soil Moisture Regime:	2-3	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>				40	1			
<i>Thuja plicata</i>				T	T			
<i>Alnus rubra</i>				10				
<i>Abies grandis</i>				40	1			
<i>Prunus emarginata</i>				T				
<i>Gaultheria shallon</i>					5			
<i>Polystichum munitum</i>						2		
<i>Mahonia nervosa</i>					10			
<i>Kindbergia oregana</i>							2	
<i>Rubus discolor</i>				2				
<i>Dicranum spp.</i>							2	
<i>Lonicera ciliosa</i>				T				

Cover by Layer (%)	Tree:		Shrub:	95	Herb:	2	Moss:	4
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Soils:

Moderately well drained silty clay loam with 25% coarse fragments and moder humus form. Observed a distinct mushroom smell and an abundance of fungal mycelia.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed

Disturbance History:

Logged approximately 15 years ago, with very dense natural regeneration taking place resulting in a barren forest floor and relatively low diversity.

Succession:

The stand will continue as a very dense Douglas-fir, grand fir dominated young forest with very barren understory and poor species diversity for the next 80 to 100 years while natural stem exclusion takes place.

Restoration Recommendations:

Recommend well planned thinning treatments with a goal to increase species diversity and general tree growth - possibly making multiple entries over the next 30 to 40 years. Limited removal of Douglas-fir and grand fir stems from the site is possible while still achieving restoration goals.

Recommend spot planting of Douglas-fir, western redcedar and grand fir in polygon 18a to hasten the formation of a tree canopy – de-compact soil around planting sites to provide a more favorable growing condition for the planted tree.

Ecosystem 19

Description: Douglas-fir – Arbutus (CDFmm/01-02) pole forest on a small ridge and associated southwest facing steep slope. Dominated by pole trees with scattered young and mature trees throughout, characterized by exposed bedrock and very shallow soils on the crest with slightly deeper soil pockets on the southwest facing steep slope.

Polygon ID:	19	Slope:	Variable, 5-30%	Aspect:	S – SW, convex
Structural Stage:	PSc	Mesoslope Position:	Crest / upper slope	Site Series:	CDFmm/01-02
Soil Nutrient Reg.:	P - M	Soil Moisture Regime:	1-2	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	1			40				
<i>Thuja plicata</i>	1			5				
<i>Alnus rubra</i>				1				

<i>Abies grandis</i>				T				
<i>Arbutus menziesii</i>				10				
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				5	T			
<i>Mahonia nervosa</i>					5			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							1	
<i>Pteridium aquilinum</i>						2		
<i>Polytrichum juniperinum</i>							T	
<i>Lonicera hispidula</i>					2			
<i>Lonicera ciliosa</i>					1			
<i>Rubus discolor</i>				2				
<i>Cytisus scoparius</i>					1			
Cover by Layer (%)	Tree:	2	Shrub:	80	Herb:	5	Moss:	2

Soils:

Silty loam with 50% coarse fragment content, well drained. Mor humus form with an Ae horizon.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed

Habitat: Scattered medium diameter snags well used by woodpeckers.

Disturbance History:

Logged approximately 15 years ago with evidence of soil disturbance from heavy machinery scattered throughout in patches – often coinciding with Scotch broom (*Cytisus scoparius*) and Himilayan blackberry (*Rubus discolor*) cover. Scattered charred areas suggest spot slash burns after logging or a patchy broadcast burn.

Succession:

Stand will continue to develop into a Douglas-fir / Arbutus dominated young forest with a diverse canopy and understory.

Restoration Recommendations:

Recommend removal of Scotch broom and Himilayan blackberry.

Ecosystem 20

Description: Douglas-fir – Arbutus (CDFmm/02) / Oregon beaked moss mature forest ridge mixed with patches of regenerating pole forest clearcut 15 years ago. Polygon is characterized by very shallow soils with significant patches of moss covered exposed boulders and bedrock.

Polygon ID:	20	Slope:	Variable, 5-20%	Aspect:	SW - NE, convex
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Structural Stage:	MFm / PSm	Mesoslope Position:	Crest	Site Series:	CDFmm/02
Soil Nutrient Reg.:	P	Soil Moisture Regime:	0-1	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		10	5	5	2		T	
<i>Thuja plicata</i>				5	2		T	Mainly on NE aspect
<i>Acer macrophyllum</i>		5						
<i>Abies grandis</i>		T	T	T				
<i>Arbutus menziesii</i>		20	5				T	
<i>Gaultheria shallon</i>					35			Increases on NE aspect
<i>Polystichum munitum</i>						T		
<i>Mahonia nervosa</i>					15			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							30	
<i>Rhytidadelphus lorus</i>							T	
<i>Hylocomnium splendens</i>							1	
<i>Lonicera hispidula</i>					3			
<i>Lonicera ciliosa</i>				T				
<i>Trientalis latifolia</i>						T		
<i>Gallium aparine</i>						T		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Dicranum spp.</i>							T	
Cover by Layer (%)	Tree:	45	Shrub:	60	Herb:	2	Moss:	35

Soils:

Mor humus form with a thin Ae horizon. Soil has a silty loam texture with a very high coarse fragment content (50-70%) mostly consisting of flat platy sandstone cobbles. Well to rapidly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven, bald eagle, seagull

Habitat: Scattered snags well used by woodpeckers and coarse woody debris of varying decay class scattered around the polygon.

Disturbance History:

Logging encroached up into slightly deeper soiled portions of the ridge creating a wavy border along the northeast side of the ridge between the mature forest and regenerating clearcut.

Succession:

Developing into a mixed species, multi-layered canopy young/mature forest with a diverse moss dominated understory. Regen in clearcut areas is thick and healthy and will begin to self thin over the next several decades.

Restoration Recommendations:

None recommended.

Ecosystem 21

Description: Patches of Douglas-fir dominated pole forest (CDFmm/01 – 75%) mixed with very shallow soiled, open areas dominated by exposed boulders and bedrock (CDFmm/02 – 25%). The northeast facing area spans from an upper slope to a lower slope and is characterized by appropriate variation in moisture and nutrient regimes with soils that are slightly drier and poorer at the top and slightly moister and richer at the bottom.

Polygon ID:	21	Slope:	20-30%	Aspect:	50°
Structural Stage:	PSc	Mesoslope Position:	Mid slope	Site Series:	CDFmm/01 – 75% CDFmm/02 – 25%
Soil Nutrient Reg.:	P - R	Soil Moisture Regime:	1-3	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>				60	2		T	
<i>Thuja plicata</i>				4	1		T	
<i>Alnus rubra</i>				5				
<i>Abies grandis</i>				T	T			
<i>Arbutus menziesii</i>				8				
<i>Acer macrophyllum</i>				5				
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				5				
<i>Mahonia nervosa</i>					30			
<i>Rosa gymnocarpa</i>					T			
<i>Kindberia oregana</i>							5	
<i>Pteridium aquilinum</i>						T		
<i>Polytrichum juniperinum</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Dicranum spp.</i>							T	
<i>Rubus discolor</i>				2	2			
<i>Hylocomnium splendens</i>							T	
<i>Gallium aparine</i>						T		
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						5		Lower slope
<i>Symphoricarpus albus</i>					1			
<i>Vaccinium parviflorum</i>					T			
<i>Grass spp.</i>						5		
<i>Cytisus scoparius</i>				T				

<i>Lychnis coronaria</i>						T		
<i>Rubus ursinus</i>						T		
Cover by Layer (%)	Tree:		Shrub:	95	Herb:	15	Moss:	10

Soils:

Silty loam with 30 – 50% coarse fragments increasing to over 50% similar to polygon 20 in upper areas. Moder humus form with a thin Ah, very well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: Raven, bald eagle

Disturbance History:

Logged approximately 15 years ago - thin soils are sensitive to compaction.

Succession:

The patchy appearance with dense stands of regenerating Douglas-fir and open rocky outcrops will continue for several decades until the canopies of large maturing trees begin to close in over rocky outcrop gaps. Dense regen areas will begin to lose diversity over the next 10 to 15 years and the dominant Douglas-fir canopies shade everything else out.

Restoration Recommendations:

Recommend removal of Scotch broom and Himalayan blackberry.

Recommend thinning of Douglas-fir in dense areas to increase tree growth and improve or maintain species diversity.

Ecosystem 22

Description: Young Red alder – salal dominated gently sloping south facing moisture receiving area. The polygon includes old logging access routes on its eastern and western edges and is characterized by relatively heavy disturbance and soil compaction with a central core of less disturbed young mixed red alder, Douglas-fir and western redcedar forest.

Polygon ID:	22	Slope:	5 - 10%	Aspect:	180°
Structural Stage:	SH	Mesoslope Position:	Mid slope	Site Series:	CDFmm/01-04
Soil Nutrient Reg.:	M-R	Soil Moisture Regime:	4	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>	5	50						
<i>Abies grandis</i>				5				
<i>Thuja plicata</i>	5	5		2				
<i>Acer macrophyllum</i>		2						
<i>Psuedotsuga menziesii</i>		2		10				

<i>Gaultheria shallon</i>					45			
<i>Rubus spectabilis</i>					2			
<i>Polystichum munitum</i>						15		
<i>Mahonia nervosa</i>					5			
<i>Rubus parvaflorus</i>					T			
<i>Kindbergia oregana</i>							2	
<i>Kindbergia praelonga</i>							T	
<i>Achlys triphylla</i>						T		
<i>Urtica dioica</i>						3		
<i>Salix scouleriana</i>				T				
<i>Lonicera ciliosa</i>				T				
Cover by Layer (%)	Tree:	70	Shrub:	65	Herb:	20	Moss:	5

Soils:

Moder humus form with an Ah layer of variable thickness (0-5cm). Mineral soil has 20 to 35% coarse fragments, a sandy loam texture and a dark reddish brown hue. Soil is moderately to well drained and is moisture receiving from adjacent cliff/ridge areas.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

A wide strip (10 – 15m) area running down the northeastern side of the polygon was used as a skid road to access the creek area – deep ruts were observed. There is also an old logging road located on the southwestern edge of the polygon. Disturbance from logging and log hauling has likely resulted in the red alder dominance.

Succession:

Heavily disturbed road areas will remain dominated by red alder for 40 to 50 years – as the alder start to die and fall over, the Douglas-fir, grand fir and western redcedar waiting in the sub canopy will be released and gradually take over. The less disturbed central portion of the polygon will continue to grow into a multi-stories, mixed species young forest.

Restoration Recommendations:

None recommended.

Ecosystem 23

Description: Red alder – sword fern / salmonberry (CDFmm/12 – 80%) dominated pole forest with scattered young western redcedar and bigleaf maple. The site has a strongly fluctuating water table due to flat topography, dense relatively fine soils, and receiving moisture from adjacent cliff / ridge sites. The polygon is characterized by raised micro-sites scattered within and around its edges where there is less water table fluctuation in the rooting zone and the ecosystem more closely resembles a CDFmm/06 site series (20%) with no salmonberry and more salal.

Polygon ID:	23	Slope:	2 - 5%		Aspect:	320°	
Structural Stage:	PSb	Mesoslope Position:	Flat		Site Series:	CDFmm/12 (80%) CDFmm/06 (20%)	
Soil Nutrient Reg.:	VR	Soil Moisture Regime:	5f		Photo Points:		

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>				40				
<i>Abies grandis</i>				T	T			
<i>Thuja plicata</i>	5		5	5				
<i>Acer macrophyllum</i>	5		5					
<i>Psuedotsuga menziesii</i>				1	T			
<i>Salix scouleriana</i>				20				
<i>Gaultheria shallon</i>					5			
<i>Rubus spectabilis</i>				20				
<i>Polystichum munitum</i>						50		
<i>Cornus stolonifera</i>				T				
<i>Plagiomnium insigne</i>							T	
<i>Kindbergia oregana</i>							3	
<i>Kindbergia praelonga</i>							3	
<i>Achlys triphylla</i>						3		
<i>Urtica dioica</i>						T		
<i>Carex opnupta</i>						1		
<i>Equisetum arvense</i>								
<i>Pteridium aquilinum</i>						2		
<i>Vaccinium parvaflorum</i>					T			
<i>Rubus ursinus</i>					T			
<i>Rubus discolor</i>				8	2			
<i>Sambucus racemosa</i>				2				
<i>Grass spp.</i>						6		
<i>Rubus parvaflorum</i>				T				
<i>Dicranum spp.</i>							T	
<i>Rhytidiadelphus loreus</i>							T	
<i>Gallium aparine</i>						T		
<i>Gallium trifidum</i>						T		
<i>Rubus laciniatus</i>				T	T			
Cover by Layer (%)	Tree:	20	Shrub:	90	Herb:	60	Moss:	10

Soils:

An underlying layer of moderately well drained sandy loam with a layer of sandy clay loam above with 10 to 15% coarse fragments. Very thick H and Ah layers combining to a depth of approximately 15cm. Moder humus form.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Habitat: Moist area supports amphibians and shrubby thicket like salmonberry in fluctuating water table provides high quality bird habitat..

Disturbance History:

Logged approximately 15 years ago. Small areas where machinery was used extensively and possibly where logs were decked are scattered throughout this polygon – this has resulted in soil compaction and inhibited growth of native plants. These more heavily disturbed areas are often dominated by exotic grasses and blackberry thickets.

Succession:

Moving towards a young red alder dominated site with scattered individual large western redcedar and bigleaf maple trees. Western redcedar will gradually take over to form the dominant tree canopy with scattered Douglas-fir occurring on dryer micro-sites.

Restoration Recommendations:

None recommended.

Ecosystem 24

Description: Douglas-fir / grand fir / red alder - sword fern (CDFmm/06 – 60%) dominated gently sloped, moisture receiving pole forest site with a slightly drier soil area more characteristic of a CDFmm/04 site series (40%) mostly on the northwest side of the road that bisects the polygon. There are scattered young western redcedar and bigleaf maple trees scattered throughout the polygon.

Polygon ID:	24	Slope:	10%	Aspect:	320°
Structural Stage:	PSm	Mesoslope Position:	Mid slope	Site Series:	CDFmm/06 – 60% CDFmm/04 – 40%
Soil Nutrient Reg.:	R	Soil Moisture Regime:	4-5	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	2			30				
<i>Thuja plicata</i>	8			2				
<i>Alnus rubra</i>				15				
<i>Abies grandis</i>				25				
<i>Arbutus menziesii</i>				T				
<i>Acer macrophyllum</i>	5							
<i>Gaultheria shallon</i>					30			
<i>Holodiscus discolor</i>				10				
<i>Mahonia nervosa</i>					5			

<i>Rosa nootkensis</i>				T				
<i>Kindberia praelonga</i>							T	
<i>Pteridium aquilinum</i>						1		
<i>Rubus spectabilis</i>				5	1			
<i>Rhamnus purshiana</i>				T				
<i>Lonicera ciliosa</i>				T				
<i>Rubus discolor</i>				2	2			
<i>Salix scouleriana</i>				3				
<i>Achlys triphylla</i>							T	
<i>Lactuca muralis</i>							T	
<i>Polystichum munitum</i>							20	
<i>Symphoricarpos albus</i>						T		
<i>Rubus ursinus</i>						T		
Cover by Layer (%)	Tree:	15	Shrub:	85	Herb:	20	Moss:	1

Soils:

Silty clay loam overtop of a clay loam beginning at 30cm with 25 – 35% coarse fragments and a reddish hue. Mottling was observed below 30cm. The soils are characterized by a moder humus form and are moderately well drained.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

Logged approximately 15 years ago. Small areas where machinery was used extensively and possibly where logs were decked are scattered throughout this polygon – this has resulted in soil compaction and inhibited growth of native plants. There is a noticeable lack of coarse woody debris in this polygon.

Succession:

The ecosystem is moving towards a Douglas-fir – grand fir dominated young forest with scattered western redcedar and bigleaf maples and a very sparse understory due to shading from a dense canopy. The naturally regenerating stand will self thin over the next 70 to 100 years.

Restoration Recommendations:

Recommend a light thinning of Douglas-fir and grand fir poles to increase growth in remaining trees and to maintain diversity in the stand. Leave stems as additions to coarse woody debris on the site.

Ecosystem 25

Description: Western redcedar / bigleaf maple – sword fern (CDFmm/06) dominated mature forest mixed with disturbed areas including old logging roads and selectively logged patches where western redcedar, grand fir and western hemlock saplings are the dominant tree regeneration with a sword fern dominated understory.

Polygon ID:	25	Slope:	20% (concave)		Aspect:	55°
Structural Stage:	MFm	Mesoslope Position:	Lower slope		Site Series:	CDFmm/06
Soil Nutrient Reg.:	R - VR	Soil Moisture Regime:	6		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>	5	10						
<i>Thuja plicata</i>		25		5	T			
<i>Alnus rubra</i>			5					
<i>Abies grandis</i>		2	2	5	T			
<i>Tsuga heterophylla</i>				T				
<i>Acer macrophyllum</i>		20	2				T	
<i>Gaultheria shallon</i>					1			
<i>Trientalis latifolia</i>						T		
<i>Mahonia nervosa</i>					10			
<i>Kindbergia oregana</i>							3	
<i>Kindbergia praelonga</i>							2	
<i>Pteridium aquilinum</i>						T		
<i>Rubus spectabilis</i>				1	T			
<i>Climacium dendroides</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Plagiomnium insigne</i>							1	
<i>Neckera Douglasii</i>							T	
<i>Achlys triphylla</i>						2		
<i>Lactuca muralis</i>						T		
<i>Polystichum munitum</i>						60		
<i>Vaccinium parvaflorum</i>					T			
<i>Rubus ursinus</i>					T			
<i>Isothecium myosuroides</i>								
<i>Metaneckera menziesii</i>							T	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Equisetum arvense</i>						T		
<i>Carex spp.</i>						1		
<i>Grass spp.</i>						1		
<i>Galium trifidum</i>						T		
Cover by Layer (%)	Tree:	65	Shrub:	25	Herb:	70	Moss:	10

Soils:

Moder humus form with small patchy Ae and thick Ah layers. Moderately well to imperfectly drained silty clay loam with a silty clay layer appearing roughly at 60 cm in depth where mottling is evident. Coarse fragment content is approximately 15 to 20%.

Wildlife and Wildlife Habitat:

Observed during data collection: Red-legged frog, raven, bard owl.

Habitat: Variety of large diameter coarse woody debris of varying decay class – excellent for amphibians breeding in nearby flooded areas.

Disturbance History:

Selective logging over the past 60 to 80 years along with a number of small clearings associated with meditation huts and other associated infrastructure as well as old logging roads and trails.

Succession:

The mixed species canopy will continue to mature and maintain a similar composition. The currently broadleaf dominated areas on the fringe of the lower slope bordering with the wetland will slowly transition towards a greater percentage of grand fir and western redcedar in the canopy.

Restoration Recommendations:

Recommend removal of the deteriorating hut structures and old building materials.

Ecosystem 26

Description: Maturing western redcedar / Douglas-fir – sword fern / Oregon beaked moss (CDFmm/04 – 80%) dominated forest characterized by sword fern dominated canopy gaps (often associated with laminated root rot (*Phelinus wierii*) scattered throughout the polygon’s dense conifer canopy and relatively barren forest floor. The polygon transitions to a Douglas-fir dominated canopy as it moves into a slightly shallower and coarser soiled upper slope CDFmm/01 (20%) ecosystem. The area is just beginning to develop mature forest characteristics as it transitions from a young forest.

Polygon ID:	26	Slope:	30%		Aspect:	65°
Structural Stage:	MFc	Mesoslope Position:	Mid slope		Site Series:	CDFmm/04 - 80% CDFmm/01 – 20%
Soil Nutrient Reg.:	R - M	Soil Moisture Regime:	2-3		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Pseudotsuga menziesii</i>		20	T					
<i>Thuja plicata</i>		50	5	1	T			
<i>Alnus rubra</i>			1					
<i>Abies grandis</i>		2		T				
<i>Acer macrophyllum</i>		4	T					
<i>Gaultheria shallon</i>					3			
<i>Trientalis latifolia</i>					T			
<i>Mahonia nervosa</i>					5			

<i>Kindbergia oregana</i>							25		
<i>Kindbergia praelonga</i>							1		
<i>Rhizomnium glabrescens</i>							T		
<i>Pseudotaxiphyllum elegans</i>							T		
<i>Achlys triphylla</i>							1		
<i>Lactuca muralis</i>							T		
<i>Polystichum munitum</i>							20		
<i>Vaccinium parviflorum</i>					1				
Cover by Layer (%)	Tree:	80	Shrub:	10	Herb:	25	Moss:	30	

Soils:

Moder humus form with Ah layers. Moderately to well drained silty loam with a silty clay layer appearing roughly at 50 cm in depth along the lower slope edge of Polygon 25. Coarse fragment content is approximately 25 to 35% increasing to 35 – 50% towards the upper slope edge.

Wildlife and Wildlife Habitat:

Observed during data collection: none observed.

Disturbance History:

The area was clearcut approximately 70 years ago – the stumps are low and almost all Douglas-fir. Prior to the clearcut, Douglas-fir would have occupied a much greater percentage of the canopy cover. The polygon appears to have naturally regenerated. Areas are scattered throughout where there appears to have been heavy soil disturbance from machinery.

Windthrow in areas affected by laminated root rot is the primary natural disturbance – the root rot gaps appear to be growing as die back in surrounding Douglas-fir canopies was observed.

Several meditation huts, sheds and trails are also located within the polygon.

Succession:

The stand is at the end of its young forest successional stage and is beginning to show mature forest characteristics resulting from root rot gap creation and the formation of a multi-storied canopy. The polygon will continue towards a mature forest as gaps and resulting understory diversity increase. The canopy will gradually move to a Douglas-fir dominated over the next century.

Restoration Recommendations:

Recommend removal of the deteriorating hut structures and unused shed structures.

Ecosystem 27

Description: Red alder – salmonberry dominated young forest characteristic of a seasonally flooded (WS53 – 45%) swamp interspersed with western redcedar / big-leaf maple areas occurring on very moist (CDFmm/11 – 40%) forest, and transitioning into a slightly drier (CDFmm/06 – 15%) lower slope ecosystem in a broad band along the gently sloping southern

edge and a narrow band along the toe of the adjacent cliff to the north.

Polygon ID:	27	Slope:	0-1%		Aspect:	160°
Structural Stage:	YFb	Mesoslope Position:	Depressio n		Site Series:	WS53 – (45%) CDFmm/11 (40%) CDFmm/06 (15%)
Soil Nutrient Reg.:	R-VR	Soil Moisture Regime:	7		Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes
<i>Alnus rubra</i>		10	20					
<i>Abies grandis</i>							T	Drier CDFmm06 sites
<i>Thuja plicata</i>		5	5	2	1			
<i>Acer macrophyllum</i>		10						
<i>Psuedotsuga menziesii</i>	2							On raised micro-sites
<i>Gaultheria shallon</i>					5			On raised micro-sites
<i>Rubus spectabilis</i>				35				
<i>Polystichum munitum</i>						20		
<i>Stachys spp.</i>						T		
<i>Plagiomnium insigne</i>							2	
<i>Kindbergia oregana</i>							2	
<i>Kindbergia praelonga</i>							5	
<i>Achlys triphylla</i>								
<i>Urtica dioica</i>						2		
<i>Carex opnupta</i>						2		
<i>Equisetum arvense</i>						8		
<i>Atherium felix-femina</i>						1		
<i>Vaccinium parvaflorum</i>				T	T			
<i>Rubus ursinus</i>					T			
<i>Carex spp.</i>						8		
<i>Sambucus racemosa</i>				T				
<i>Oenanthe sarmentosa</i>						1		Flooded area
<i>Lactuca muralis</i>						T		
<i>Tellima grandiflora</i>						T		
<i>Porella navicularis</i>							2	On salmonberry branches
<i>Rhyzomnium glabrescens</i>							T	
<i>Climacium dendroides</i>							T	
<i>Rhytidiadelphus loreus</i>							1	
<i>Rhytidiadelphus triquetrus</i>							T	
<i>Plagiothecium undulatum</i>							T	
<i>Isothecium myosuroides</i>							2	
<i>Hylocomnium splendens</i>							T	

Cover by Layer (%)	Tree:	10	Shrub:	10	Herb:	95	Moss:	2
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Soils:

Clay with high organic content in the flooded areas transitioning to slightly raised where red alder are growing which have an upper silty clay horizon. Moder humus form with very low coarse fragment content (0-5%), imperfectly to poorly drained.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.

Habitat: Salmonberry and water source extremely valuable for wildlife. Active beaver damming occurring above culvert on Lot 10.

Disturbance History:

The area was logged in the early to mid 20th century. The soil has been severely compacted where road access has occurred resulting in water collection and channelization in the old ruts. There are patches scattered throughout with evidence of heavier disturbance including a staging area where an old Douglas-fir snag with a 50 to 60 foot high burn scar may be evidence of an intense slashpile burn.

Succession:

Red alder is commonly the dominant tree species that regenerates after logging in wet soils – the alder will slowly be taken over by a higher percentage of western redcedar and big-leaf maple as the soils continue to recover. Red alder will persist on the sites in gaps and openings. The percentage of the area characterized by raised micro-sites will also increase allowing for slight increases in Douglas-fir and grand fir cover over time. This area may also move towards a flooded marsh ecosystem if beaver continue to expand their territory and construct more damns in this area (this seems unlikely due to the the broad, gradual slope of in this polygon with no easily dammable ‘bottlenecks’ observed).

Restoration Recommendations:

None recommended.

Ecosystem 28

Description: Sword fern dominated and scattered young western redcedar, big-leaf maple and red alder (CDFmm/06 – 90%) open recently logged lower slope with small patches of seasonally open salmonberry – slough sedge (carex obnupta) flooded wet soils (CDFmm/11 – 10%). There is no defined seasonal stream channel in this polygon with flow likely occurring below the surface.

Polygon ID:	28	Slope:	2 - 10%	Aspect:	160°
Structural Stage:	SH	Mesoslope Position:	Lower slope	Site Series:	CDFmm/11 (10%) CDFmm/06 (90%)
Soil Nutrient Reg.:	R	Soil Moisture Regime:	6-7	Photo Points:	

Vegetation Species	A1	A2	A3	B1	B2	C	D	Distribution Notes		
<i>Alnus rubra</i>			2	1						
<i>Abies grandis</i>				T	T					
<i>Thuja plicata</i>	2		3	T	T					
<i>Acer macrophyllum</i>	5									
<i>Psuedotsuga menziesii</i>				T						
<i>Gaultheria shallon</i>					2					
<i>Rubus spectabilis</i>					5					
<i>Polystichum munitum</i>						80				
<i>Cornus stolonifera</i>				T						
<i>Plagiomnium insigne</i>							T			
<i>Kindbergia oregana</i>							T			
<i>Kindbergia praelonga</i>							T			
<i>Achlys triphylla</i>						T				
<i>Urtica dioica</i>						2				
<i>Carex opnupta</i>						5				
<i>Equisetum arvense</i>						5				
<i>Pteridium aquilinum</i>						T				
<i>Vaccinium parvaflorum</i>				T						
<i>Rubus ursinus</i>					T					
Cover by Layer (%)	Tree:	10	Shrub:	10	Herb:	95	Moss:	2		

Soils:

Dark silty loam with high organic content, thick Ah and low coarse fragment content (10%).
Seasonally moist.

Wildlife and Wildlife Habitat:

Observed during data collection: red legged frog, piliated woodpecker heard.
Habitat: Salmonberry and water source extremely valuable for wildlife.

Disturbance History:

Soils have been heavily impacted from machinery during logging 15 to 20 years ago. Old stumps indicate a mature forest community dominated by large western redcedar with the odd Douglas-fir and grand fir scattered on micro-sites.

Succession:

Western redcedar will gradually increase in density and become the dominant cover with grand fir and Douglas-fir taking hold on appropriate microsites and maple remaining a minor component over the next 50 or 60 years. Sword fern will remain a dominant understorey cover though species diversity should increase as the tree canopy develops

Restoration Recommendations:

None recommended.