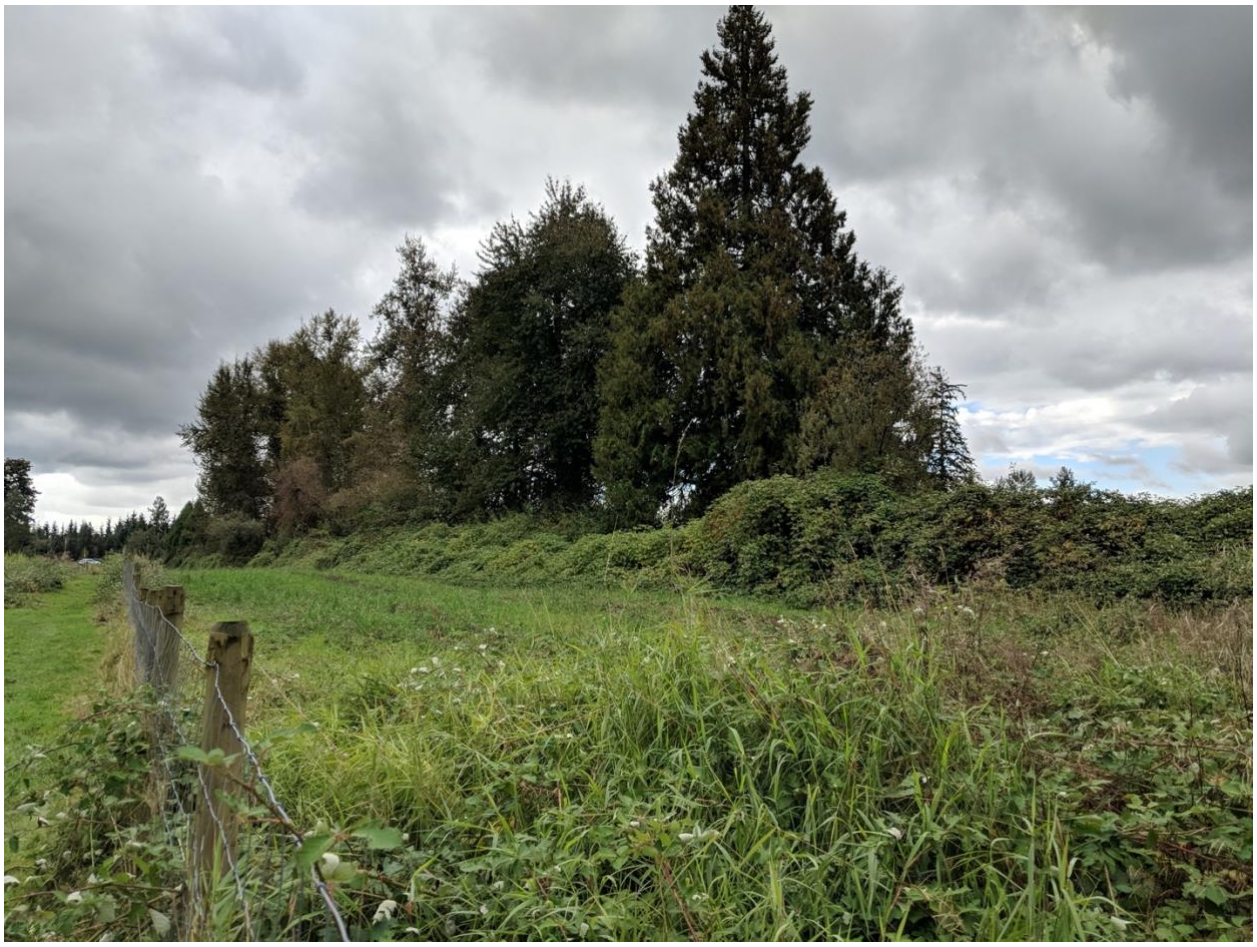
ER 390 PROJECT:
CHEMICAL REMOVAL OF HIMALAYAN BLACKBERRY (*RUBUS ARMENIACUS*)
IN DERBY REACH REGIONAL PARK, LANGLEY, BC



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Abstract

Invasive species are recognized globally as the second greatest threat to biodiversity after direct habitat loss (British Columbia Ministry of Environment, 2018). Throughout Metro Vancouver, many restoration projects are being implemented to control invasive species and restoring the natural vegetation that were once there. Sierra Harvey and I partnered with Metro Vancouver Regional Parks to provide recommendations regarding the removal of Himalayan blackberry (Rubus armeniacus) at Derby Reach Regional Park in Langley, British Columbia. The goal is to remove the Himalayan blackberry and plant native species to encourage the return of overwintering birds and pollinators. Sierra and I conducted multiple field visits to create a biophysical inventory of the site. This project, we outlined two types of removal techniques for Himalayan blackberry and have divided the work in such a way. I will be focusing on the chemical removal method and will provide recommendations for this method as well as on timing and methods of application to minimize environmental impacts. Sierra Harvey's project will focus on the mechanical techniques and provide recommendations for this technique at the site. As well, follow up restoration activities such as a list of native species to be planted, a monitoring and maintenance plan, is provided.

1.0 Introduction

Derby Reach Regional Park is located along the banks of the Fraser River and encompasses a variety of habitats such as old and second growth forests, riparian areas and a bog (see **fig. 1**) (Metro Vancouver, 1999). Derby Reach is one of Metro Vancouver's regional parks that protects diverse natural habitat throughout British Columbia's largest metropolitan areas, while allowing access to enjoy these areas without harming them. In 2017, the park has over 817,000 annual visitors, making it the third most visited in the region. (Metro Vancouver, 2017). Located in the township of Langley, Derby Reach is surrounded by residential developments and agricultural activities that includes a cranberry farm. The park is heavily influenced by the anthropogenic activities the surround the park, making it particularly vulnerable for invasive species to establish, especially Himalayan blackberry. The site is located within the traditional territory of the Kwikiwetlem First Nation as well as the original site of the Fort Langley settlement, which poses a challenge in regard to how restoration can be done. As outlined in the *Derby Reach Regional Park Management Plan*, protecting and maintaining cultural heritage are key for park planning. This poses numerous challenges for restoration as it limits the type of activity that can be done at the site.

Himalayan blackberry (Rubus armeniacus) is an invasive weed that is particularly problematic in southwestern British Columbia as grows vigorously in temperate, moist environments and outcompetes native plant species by shading (Gaire et al., 2015). Once it establishes, it forms dense thickets of live and dead canes and extensive root systems that presents a challenge for restorationists in the region. The dense blackberry patches can prevent establishment of native vegetation, limit the movement of people and large animals and obstruct sight lines (Metro Vancouver, 2018). While Himalayan blackberry does provide some habitat values, such as food and cover, the overall plant and animal diversity is likely to be lower than in areas that have a more diverse native vegetation community (Bennett, 2007). Throughout the lower mainland of British Columbia, there has been efforts to manage and remove this invasive species. The plot of interest for this project is a large non-forested grassy disturbed area within Derby Reach Regional Park in Langley, British Columbia (see **fig. 1**). The plot has been maintained by park staff to control the growth of blackberry but much more needs to be done to fully remove it from the site. There is considerable community interest as it is situated just south of the Fraser River as well as a popular dog off-leash area. The purpose of the project will be to remove the growth of blackberry and re-establish habitat for overwintering birds and pollinators, as well as creating a buffer between the dog off leash area and the park boundary.

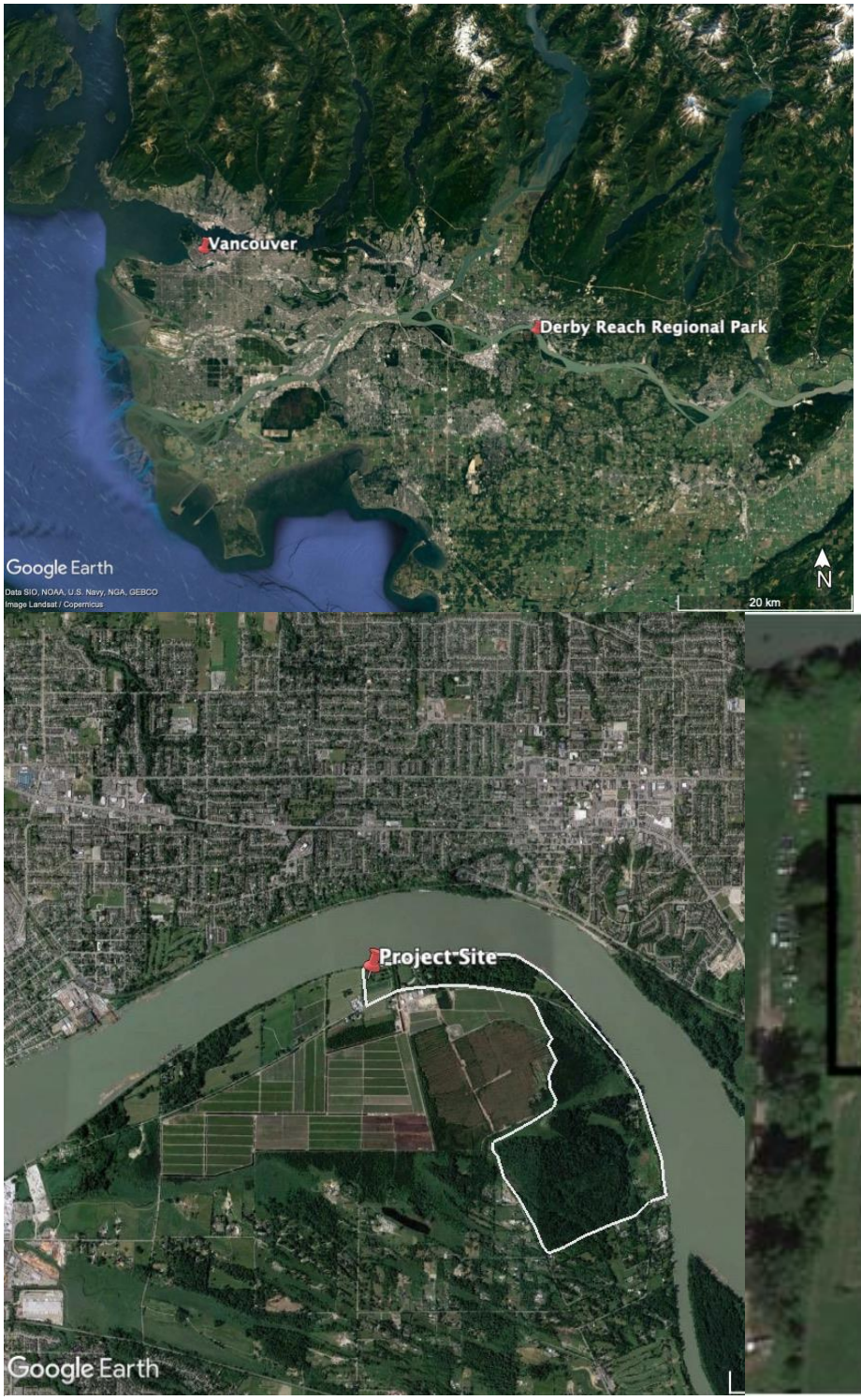

Figure 1: Location of Derby Reach Regional Park in Metro Vancouver, BC

1.2 COMMUNITY PARTNERS

Sierra Harvey and I have partnered with Janice Jarvis, one of Metro Vancouver's Natural Resource Management Specialists for Regional Parks. We decided to go with Metro Vancouver as a partner and I am an employee of Metro Vancouver Regional Parks and have worked at Derby Reach for the past couple of years. The familiarity with both the park and park operation and staff provided us with a unique opportunity to partner with the agency to further understand how restoration works with a government agency. The project will focus on removal of the Himalayan blackberry currently present and re-establish habitat for pollinators and overwintering birds as well as creating a buffer between the dog off leash area and the boundary of the park. Considering the challenges surrounding the cultural heritage of the park, Janice suggested that we create a restoration plan that provides two common removal techniques for Himalayan blackberry – chemical and mechanical. The challenge that surrounds all operations in the park is digging as it triggers archaeological surveying to identify if (and any) cultural significant items are located at the site of interest. As this will likely create time constraints, this limits the type of 6 restoration that could occur at the site. Following Janice's suggestions, Sierra and I decided to each take on developing on restoration plan for each technique (Alison: Chemical/Sierra: Mechanical) for the site. Janice suggested that the creation of a restoration plan for both techniques will provide her with options for the type of restoration that can be completed at the site. As well, the restoration plans can be used to help implement similar restoration project in other parks in Metro Vancouver's regional park system. The implementation of either restoration plans will be based on Metro Vancouver's schedule (specifically in relation to interagency permitting) and budget. The project has been slated to be implemented in the next year or two.

2.0 Goals & Objectives

The goals of the project were developed by Sierra and I following our site visits and discussions with Janice to design a project will that remove Himalayan blackberry (Rubus armeniacus) from a section of field at the park and re-establish natural habitat for overwintering birds and pollinators. Once the blackberry is removed, the area will be revegetated with native plants in soil beds that will allow for continuous and easy maintenance. The project will launch a multi-year restoration plan to maintain the habitat through continuous maintenance and monitoring. As well, the project will aim to involve the community whenever it is possible. The project focuses on increasing functional natural habitat and increasing biodiversity through re-establishing critical habitats for birds and pollinators.

Goal 1: Eliminate Himalayan blackberry from the Project Site by December 2020. Objective 1.1: Mow project site prior to herbicide application by end of August 2020.
Objective 1.2: Reduce Himalayan blackberry through chemical removal at the site by 90% by October 2020.
Objective 1.3: Maintain the treated area to monitor new growth over the winter of 2020/2021.

Goal 2: Improve habitat for pollinators and overwintering birds by Spring 2021.
Objective 2.1: Create native plant beds and plant native species such as snowberry (*Symphoricarpos*), oceanspray (*Holodiscus discolor*) and salal (*Gaultheria shallon*) by May 2021.
Objective 2.2: Cover any exposed soil between the native plant beds with mulch by May 2021.
Objective 2.3: Continuous monitoring of bird and pollinator populations for at least five years following restoration treatment.

Goal 3: Monitor and mitigate growth of Himalayan blackberry for at least five years.
Objective 3.1: Continuous maintenance of project site to mitigate re-establishment of Himalayan blackberry for at least five years.
Objective 3.2: Develop community engagement program that involves invasive species removal to maintain the project site for at least five years.

3.0 SITE DESCRIPTION

3.1 SITE CONDITIONS

Derby Reach Regional Park is found within the Coastal Western Hemlock (CWH) biogeoclimatic zone. This zone has a cool mesothermal climate that is characterized by cool summers and wet winters. The topography of the park is the product of two highly influential natural forces, glaciation and the potent force of the Fraser River (Township of Langley (TOL), 2017). Located in the Fraser Lowland, the soil is made up of rich alluvial material and is quite fertile as the Fraser River deposits sediment from its headwaters in the Rocky Mountains. Human use and invasive plant species have greatly impacted the natural areas within the park. The project site is located between the Dog off Leash area of the park and a farmer's field and has been infested with Himalayan blackberry (*Rubus armeniacus*).

3.2 HISTORICAL CONDITIONS

One of the unique aspects of the park is the history that is within its boundaries. It is located on the traditional territory of the Coast Salish First Nation, specifically the Katzie and Kwantlen First Nation, who occupied the land for over 12,000 years (TOL, 2017). First contact with European explorers occurred in the 1770s and this contact significantly altered the way of the life for the First Nations. The first European fort in Coast Salish Territory was constructed by the Hudson's Bay Company (HBC) in 1827 (TOL, 2017) and is located within the park boundaries. At first, there was a close working relationship between HBC and the local indigenous community, but these relations quickly deteriorated due the spread of disease and the Europeans' interest in maximizing profits from the area's natural resources. The fort was relocated downstream in 1839, as it was recognized that the site was vulnerable to flooding and too far from the new farmland (TOL, 2017).

As farming expanded from the banks of the Fraser River inland, other permanent posts were established. The township of Derby, located where the old HBC fort was, resulted in the re- settlement of the local First Nations, increasing their dependency on European goods as their access to their resources diminished. With the growth of European colonies throughout the region, they were formally united as the Crown colony of British Columbia in 1866 and soon joined Confederation in 1871 (TOL, 2017). With this, the new province passed the Municipalities Act and many Fraser Valley communities, including Langley, petitioned for municipal incorporation in 1873.

As the province continued to grow, the region developed multiple essential services to support the growing population. In 1886, the Vancouver and Coquitlam Waterworks was founded, which signifies the beginning of cooperation in the development of essential services within the region (Metro Vancouver, 2016). In 1965, the province legislation the creation of regional districts, which led to the creation of the Regional District of Fraser-Burrard in 1967. Soon to be renamed to the Greater Vancouver Regional District (GVRD), the regional government began to develop regional parks within the area in 1972 (Metro Vancouver, 1999). As a part of the Lower Mainland Parks Plan, the GVRD began to acquire the land for the proposed Derby Reach Regional Park in 1972 and it opened in 1976.

3.3 CURRENT CONDITIONS

The recreation role of Derby Reach is considered "the western anchor of an outdoor recreation system of nodes connected by trails along the south shore of the Fraser River" (Metro Vancouver, 1999). It is an open space for passive recreation and river edge activities such as walking, picnicking, camping, and an

equestrian trail. The 297 hectares park encompasses a variety of ecosystems such as farm meadows, upland forest and a peat bog. The diversity of habitat within the park has become increasingly important to wildlife as urbanization and agriculture continue to expand around the park (Metro Vancouver, 1999). The project site is located in one of the farm meadows close to the Fraser River and dog off leash area of the park. The farm meadows have a variety of plants and progression from grasses to shrubs, providing excellent habitat for songbirds, raptors and small mammals (Metro Vancouver, 1999). Birds such as Sandhill cranes (*Antigone canadensis*) and Great blue heron (*Ardea herodias*) can be found in the area and are known to nest near the farm meadows.

3.4 CHALLENGES

Human activity and invasive species are the biggest challenges to restoring the site. The Himalayan blackberry (*Rubus armeniacus*) is already established at the site, which will be the main challenge that the restoration project will focus on. As well, proximity to the dog off leash area may pose a challenge when re-establishing the bird population. The extensive history of the site must also be considered. Ground disturbance in regional parks with high archaeological or cultural values is of heightened concern and requires further guidance on activities such as digging, as an archaeological investigation may be necessary (Metro Vancouver, 2018). This limits restoration methods that can be used because digging and disturbing the ground too much may not occur. Due to this limitation, the use of herbicide to stop the growth of the Himalayan blackberry (*Rubus armeniacus*) from the site will likely be used for this project.

Glyphosate is the herbicide of choice if the chemical removal method is selected for the site. Glyphosate is a broad-spectrum, post-emergent, non-selective and synthetic herbicide (Agostini et al., 2019) that is considered to be most applied herbicide in Canada (Carex Canada, 2019). It is typically applied pre-harvest, post-planting and pre-emergence for plant grow control in both agricultural and non-agricultural application (Agostini et al., 2019). The chemical and its metabolites are known to persist in the soil, air, water and groundwater following the application, which is a serious concern in regard to both ecological and human health. The herbicide has had a reputation for low toxicity to mammals, fish, birds and insects and for a low impact on nontarget vegetation for many years (Cornish & Burgin, 2005) but it is becoming evident that it perishes in the environment and poses a potential threat. Application method is critical in reducing the risk of unintentional contamination of both the environment and humans. The contact between non-target plants and herbicides occurs through off-target spray drift and overspray. It has been proven that off-target drift can cause mortality and suppression of growth of sensitive plant species (Florencia et al., 2017). In vascular plants, it has been proven that glyphosate active ingredients are

rapidly throughout all of the plant and can have long-term negative impacts on the plant. As well, it can have an impact on the plant community structure and diversity as it can exert a selection pressure, which can persist over time and promote the selection of new weeds (Florencia et al., 2017). Shifts in plant communities caused by herbicide treatment will likely affect habitat conditions for wildlife and can result in the decrease of small mammals (Ortega, 2008).There is also sufficient evidence that this herbicide may be carcinogenic to humans as well. The short-term side effects vary depending on contact method. Irritation of the eyes and/or skin can occur if it comes in contact with either (Carex Canada, 2019). Inhaling spray mist may cause oral and/or nasal discomfort, tingling and throat irritation. Ingesting a large amount of glyphosate can corrode the gastrointestinal system and can impair the heart, kidneys and liver (Carex Canada, 2019**)**.

It is critical that we select an application method that will reduce the side effects to not only the park users but also those doing the application. During and following the herbicide application, proper safety protocols and personal protective equipment will be important. The project site is directly beside the dog off leash area, a field that the regularly hayed by a local farmer and blackberry that park users will pick while in season. As well, the area is not too far from the Fraser River. Application method is critical to reduce the risk of unintentional contamination of both park users and the environment. Glyphosate is a commonly used herbicide in restoration activities as it is low cost and easy to apply (Cornish & Burgin, 2005). Typically, restoration work uses unregulated spraying equipment, such as backpack sprayers, where herbicide concentrations are controlled but spray volumes are not. This may lead to both excessive herbicide application and run-off from leaves to soil (Cornish & Burgin, 2005). To reduce this risk, application needs to be injected rather than spraying it.

It cannot be assumed that this practice will improve conditions on the land. It is critical to understand that herbicide is only a temporary solution (Ortega, 2008) and follow-up and/or continuous maintenance is crucial for the success of the project. As the use of glyphosate and other herbicides may have an impact on the general public, it is important that the concerns of local stakeholders, including the Kwikwetlem First Nations, must be considered.

4.0 SAFETY AND LEGAL OBLIGATIONS

4.1 SAFETY CONSIDERATIONS

The use of herbicide poses the greatest safety concern. Action should be taken to reduce the risk for those participating in the restoration and the park users that may be present in the dog off leash area. Proper personal protective equipment will be necessary for those working when the herbicide is applied. The weather of the day of application should be considered as the herbicide can be carried by the wind and/or rain, which may intentionally expose park users.

4.2 REGULATORY STANDARDS & SUPPORT DOCUMENTS

The project will follow *Best Management Practices for Himalayan Blackberry in the Metro Vancouver Region*. Under Section 2(1)(b)(iii) of the "Community Charter Spheres of Concurrent Jurisdiction - Environment and Wildlife Regulation" states that "municipalities may regulate, prohibit and impose requirements in relation to control and eradication of alien invasive species," which includes Himalayan blackberry (*Rubus armeniacus*) (Metro Vancouver, 2018). The document outlines different restoration methods for the removal of blackberry in Metro Vancouver regional parks, including chemical and physical methods, which we will be following throughout the project.

Pesticides are regulated by the federal and provincial governments, and municipal governments often have their own pesticide bylaws. The *BC Integrated Pest Management Act* sets out the requirements for the use of pesticides in BC (Metro Vancouver, 2018). A valid pesticide license is required when application occurs on public land, including local government lands. This project will require a license and will be required to follow local government, both Metro Vancouver and the Township of Langley's, pesticide bylaws.

5.0 SITE INVENTORY

5.1 GROUND INSPECTION FORM

Sierra and I conducted a ground inspection form for the site, which can be found in the appendix (**Appendices 3** and **4**). As well, **Appendices 1** and **2** describe the symbols and codes that are used in the ground inspection form. As previously mentioned, the site is located in the Coastal Western Hemlock biogeoclimatic zone, or CWH, and the Fraser Lowland, or FRL, ecosection. The hummus layer at the site is **moder** with a **loam sandy** texture. We determined that the soil moisture regime is **5**$_2$ and the soil nutrient regime is **M**. The site classification is **CWHdm** with a site series of **HwCw**.

5.1 PLANT INVENTORY

Table 1 illustrates the plant inventory we took during our visit on June 15th, 2019. While the Himalayan blackberry is not dominant and does not cover a large area, regrowth is present. It is likely that without any treatment, the blackberry will re-establish in the area. The site is dominated by a variety of grasses and the herb layer.

Table 1: Plant Inventory from June 15th, 2019 at Derby Reach Regional Park, Langley, BC

Latin Name	Common Name	Vegetation Layer	Percent Cover (%)
Poa palustris	Fowl bluegrass	Herb	15
Poa pratensis	Kentucky bluegrass	Herb	30
Festuca occidentalis	Western fescue	Herb	25
Cynosurus echinatus	Hedgehog dogtail	Herb	40
Phleum pratense	Timothy-grass	Herb	5
Ranunculus repens	Creeping buttercup	Herb	5
Rubus armeniacus	Himalayan blackberry	Herb	2

5.3 BIRD INVENTORY

We completed two bird point surveys at the site, once in the morning and once in early afternoon. The first visit was on January 31st and we only observed an American robin (*Turdus migratorius*). During our second site visit on June 15th, we conducted a second bird survey and observed a Black-headed grosbeak (*Pheucticus melanocephalus*) and a Willow flycatcher (*Empidonax trailii*). As we did not observe many birds during our visits, we compiled a list of birds that have been observed within the park from the website *ebird*. This website is citizen science site that allows birdwatchers to upload their bird sightings. As well, habitat description of their typical habitat to provide an idea of what kind of vegetation should be planted at the project site. **Table 2** demonstrates the birds that are most frequently observed and are most likely to be found in the project site.

Table 2: Bird observation at Derby Reach Regional Park from *ebird* and habitat data from *All About Birds*		
Common name	**Scientific name**	**Habitat Description**
Northern flicker	*Colaptes auratus*	Open habitat near trees (woodlands, parks)
Black-capped chickadee	*Pocile atricapillus*	Mixed forests, open woods, parks
Chestbut-backed chickadee	*Poecile rufescens*	Mainly in coniferous forest but also found in urban areas when trees and shrubs are present
Red-breasted nuthatch	*Sitta canadensi*	Mainly in coniferous forest and will use habitat in parks in winter
Pacific wren	*Troglodytes pacificus*	Lives in forested habitats with a thick understory of mosses and ferns
American robin	*Turdus migratorius*	Found almost everywhere but will move to woods with berry-producing shrubs in winter
Varied thrush	*Ixoreus naevius*	Mainly in dark, wet forests but will migrate to parks in winter if berries are abundant
Cedar Waxwing	*Bombycillia cedrorum*	Found in forest but are most abundant around fruiting plants in parks during winter
Spotted towhee	*Pipilo maculatus*	Found along forest edges and places with dense shrub cover and leaf litter
Purple finch	*Haemorhous purpureus*	Found in evergreen forests but can be found in shrubby areas and weedy fields in winter
House finch	*Haemorhouse mexicanus*	Found in human-created habitats, including small conifers and urban centres
American goldfinch	*Spinus tristis*	Found in weedy fields and common in parks.
Steller's jay	*Cyanocitta stelleri*	Common in forest wilderness but also parklands.
Rufous hummingbird	*Selasphorus rufus*	Mainly in open or shrubby areas (parks, yards)
White-crowned sparrow	*Zonotrichia leucophrys*	During winter, these birds frequent thickets, weedy fields, backyards, parks
Dark-eyed junco	*Junco hyemalis*	During winter, they use a wide variety of habitat that include open woodlands, fields, parks

5.4 POLLINATOR SURVEY

Table 3 lists the species of pollinators that are native to the site and a description of their behaviour. We did not conduct a pollinator survey, so we utilized the information from *Border Free Bees & Environmental Youth Alliance*.

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Table 3: Pollinators and their descriptions from *Border Free Bees & Environmental Youth Alliance*		
Common Name	**Scientific Name**	**Description**
Bumble Bees	*Apidae Bombus*	They are social with queens and workers that are ground-nesters who find existing holes to nest in. They are active in the spring summer and early fall.
Hover Fly	*Syrphidae*	These flies look like bees but have four wings. They are good pollinators of open-faced flowers and dominate pollination in high altitudes.
Hair-Belly Bees	*Megachilidae*	These bees nest in tunnel-shaped cavities and re-purpose materials from nature. Mason bees, leafcutter bees, and resin bees are all part of this category.
Mining Bees	*Andrenidae, Halictidae, Colletidae*	Includes all ground nesting bees (miners, sweat beas, and plasterer bees). They are solitary and are active mostly in the spring.
Honey Bees	*Apis mellifera*	Plays an important role in the economics of agricultural crop pollination and the only bee in North America that makes honey for winter food source.
Butterfly	*Lepidoptera*	Only a handful are common in urban centres and tend to thrive in grassland and coastal meadows in BC. They typically pollinate and feed on nectar from daytime-blooming flowers.
Wasp	*Vespidae*	Vespid wasps are the most common family in BC and feed on nectar, which pollinates the plants in the process.

6.0 RESTORATION TREATMENT: CHEMICAL

6.1 CONSIDERATIONS

The use of herbicides is a relatively effective and inexpensive method but must be used with caution. Always read and follow the directions on the label and proper personal protective equipment must be used during and after application. Proper cleaning of equipment that is used is critical to reduce unintentional contamination. Treatment with herbicides should be conducted cautiously for three reasons (Soll, 2018):

1. Himalayan blackberry often grows in riparian areas
2. Some herbicides promote vegetation growth from lateral roots
3. When used incorrectly, the herbicide will only top kill the blackberry

Timing of application is crucial for the success of the herbicide. It is best to spray in summer and/or fall as the herbicide should be applied only when the plants are in full leaf (Soll, 2018). Weather must be considered as well, because the effectiveness of foliar application is significantly reduced if the plants are badly moisture-stressed and should not be applied when it is rainy, windy and/or rain is forecasted (Whatcom County Noxious Weed Board, 2018). Proximity to human-use activities and bodies of water must be considered to reduce unintentional contamination of park users and habitat. This project is in close proximity to the dog off leash area and park users may pick the berries from the bushes. Signs should be posted prior to the application to make the public aware of what will be occurring, and the area should be closed to the public during and following the application.

6.2 HERBICIDE APPLICATION METHOD

We will be using the herbicide glyphosate", which is a non-selective herbicide that prevents the plants from making certain proteins that are needed for plant growth (Henderson, M.,Gervais, Luukinen, Buhl, Stone, Strid, Cross, & Jenkins, 2010). Glyphosate is absorbed across the leaves and stems of plants and is translocated throughout the plant. Plants that have been exposed will display stunted growth, loss of green colouration, leaf wrinkling and will die 4 to 20 days after application (Henderson et al., 2010). **Table 4** demonstrates the different methods that can be used to apply the herbicide.

Table 4: Application Methods	
Method	**Description**
Broadcast application	Spreading of the herbicide over an entire area Most effective where the weed infestation is very dense Consider a 'quick fix' to eradicating plants Does not distinguish between plants May create long-term problems due to the vegetation becoming resistant (Soll, 2018)
Foliar application	Use of backpack and/or handheld sprayer to completely cover the plant parts, including suckers (Metro Vancouver, 2018)
Basal bark spray	High concentrations of herbicides in oil or other penetrating carriers are applied to the basal portion of stems Effectively kills roots, especially in the fall when vascular fluids are moving towards the roots (Soll, 2018)
Cut stump	Directly applied to the cambial area around the edges of freshly cut stumps (Soll, 2018) Involves cutting the stems near the ground followed by applying the herbicide (Must be done within minutes) Best applied in the late summer and/or fall (Metro Vancouver, 2018)
Stem injection	Injected into wounds and/or cuts in the stems/trunks of plants to be killed Herbicide must penetrate to the cambial tissue and be water-soluble to be effective Chemical is translocated throughout the plant and can provide good root kill (Soll, 2018)

As previously mentioned, there are numerous concerns surrounding the use of Glyphosate this environment. With this in mind, we want to select the application methods that will minimize risk to both the natural environment and park users. We also need to consider the effectiveness of the application method so that we do not need to apply the herbicide more than once, in an effort to reduce the risk. The site is not covered with blackberry as a result of regular mowing but there is still growth from the extensive root system that exists. The basal bark spray application method effectively kills roots and is applied directly to the basal portion of the stem. This application method reduces the risk of unintentional glyphosate contamination while being effective enough to removing the roots that exist. Following application, mowing and/or cutting of the canes should be completed for a week to limit and control any new growth.

6.3 NATIVE PLANT BEDS

Following herbicide treatment, native plant beds will be installed to create bird and pollinator habitat, as well as a visual barrier. Native vegetation and soil may not be available in the quantities that are required so a special order from a nursery may be necessary, which may take time. We will need to bring soil to create the beds for the plants, as we restricted because we cannot dig. The beds should be varied in size and be at least 5cm deep and should be large enough to comfortably fit trees and shrubs with approximately 2 m between them. Most of the beds should have about 72 inches between each other to allow for routine maintenance to continue to occur. The placement of plants can be done once the soil beds are created and the plants have been delivered. Plant placement is important to create a visual barrier between the dog off leash area and the park boundary (see **fig. 2** below). Shrub and herb species will be planted in beds closer to the dog-off leash area (the green-yellow area in **fig. 2**) with shrub and tree species being planted closer to the park boundary (blue and teal area in **fig. 2**). The light white area in **fig. 2** represents the buffer zone between the dense thicket of blackberry that lines the park boundary and the planting area. This is will help reduce the likelihood that the blackberry will re-establish in the area.

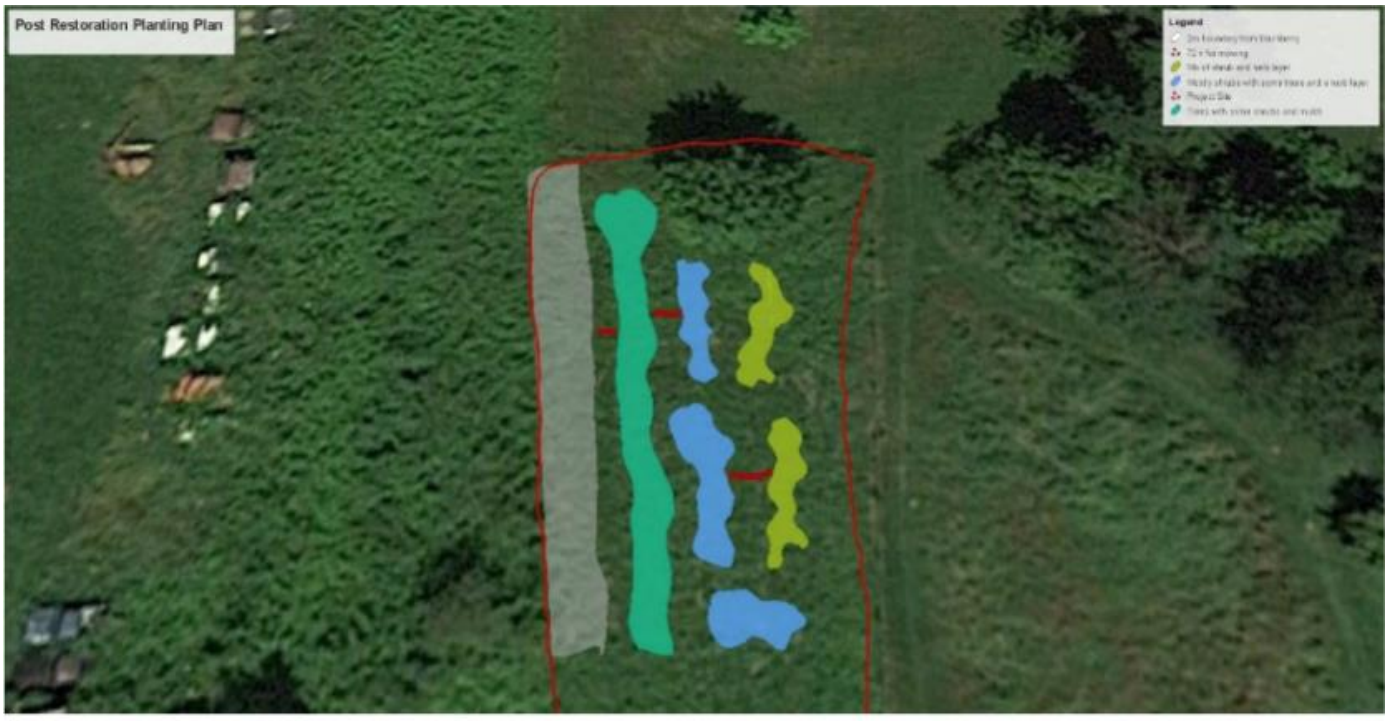

Figure 2: Native Plant Bed Placement Plan

Native species should be selected based on their ability to provide the necessary habitat and food source for both pollinator and over-wintering birds as well as their resistance to invasive species (ability to shade out encroaching blackberry and heartiness). As well, tree and shrub species should be planted to re-

establish a closed canopy to inhibit the any further growth of the blackberry (Gaire et al., 2015). **Table 5** indicates the native plant species that have been set out by *Best Management Practices for Himalayan Blackberry in the Metro Vancouver Region* and the Simon Fraser University's *Pollination Ecology Lab.* Planting should occur as soon as possible following the herbicide treatment to prevent any re-establishment of the blackberry, specifically two or three weeks afterwards. Following the planting, the plant beds should be covered with mulch and compost to retain moisture and limit the any new growth of blackberry in the plant beds.

Table 5: List of the native species that can be used (Metro Vancouver, 2018 & Elle, & Wray, n.d.)

Common name	**Scientific name**	**Type**	**Type of Bloom**	**Berries**
Douglas-fir	*Pseudotsuga menziesii*	Tree	n/a	n/a
Red alder	*Alnus rubra*	Tree	n/a	n/a
Thimbleberry	*Rubus parviflorus*	Shrub	May-July	Ripens in July to September
Nootka rose	*Rosa nutkana*	Shrub	May-July	Ripens in early fall and persists over winter
Red flowering currant	*Ribes sanguineum*	Shrub	February-April	Ripens in August to September
Snowberry	*Symphoricarpos*	Shrub	May-August	Ripens in September to October and persists over winter
Tall Oregon grape	*Mahonia aquifolium*	Shrub	March-May	Ripens in September to October
Oceanspray	*Holodiscus discolor*	Shrub	June-August	Ripens in late summer
Black twinberry	*Lonicera involucrata*	Shrub	April-August	Ripens in September
Red oiser dogwood	*Cornus sericea*	Shrub	May-July	Ripens in late summer
Arctic lupine	*Lupinus arcticus*	Herb	June-July	n/a
Fireweed	*Chamaenerion angustifolium*	Herb	June-September	n/a
Salal	*Gaultheria shallon*	Herb	May-July	Ripens in July to September

6.4 SCHEDULE

Table 6 demonstrates a potential schedule for the project. Following the *Best Management Practices for Himalayan Blackberry in the Metro Vancouver Region*, the herbicide should be applied when the blackberry is in full leaf. Glyphosate is most effective when sprayed in September and October while the canes are actively growing and the berries have been formed (Fraser Valley Invasive Species Society, 2019). It is important to consider timing to avoid unintentional contamination to the public as people may pick the berries. As well, a nest activity search should be conducted prior to application (Metro Vancouver, 2018). Following application, the dead canes and grubbing out the roots might be considered to prevent re-infestation (Jackson Soil & Water Conservation District (JSWCD), 2018). The new native plant beds should be installed following the treatment in the early fall. Mulch and/or cardboard can be placed on the exposed grass to prevent further growth of the blackberry. Removal of any new growth should continue into the spring and should be maintained for a year and a half following the restoration (JSWCD, 2018).

Table 6: Potential schedule for restoration

Time	**Description**
September	Mow of the area Herbicide treatment
October	Volunteer event: Planting of native species in soil beds Cover exposed areas with mulch and/or cardboard
October - March	Little growth through winter but area should be monitored to detect any growth
March and onward	Removal of any new growth by volunteers Monitoring of birds and pollinators by volunteers Biweekly-weekly mowing around plant beds

6.5 BUDGET

Much of the work such as mowing, can be done by the park staff as a part of their regular maintenance duties. Some of their time will need to be dedicated to mowing the area prior to spraying the herbicide. Cost of the glyphosate as well as the application of it must be considered in the budget. The soil and plants must also be considered in the budget but planting of those plants can be done through a volunteer event. Monitoring and follow-up maintenance can be done by the park staff and/or volunteers.

7.0 POST RESTORATION TREATMENTS

7.1 COMMUNITY ENGAGEMENT

Throughout the project, community engagement will be an important aspect. There is a strong community that visits the park, especially in the dog off leash and campground. The project can be used to get those who visit the park regularly to get involved. Since treatment requires the use of herbicide and heavy equipment, volunteer opportunities will arise in the latter half of the project. The first opportunity will be planting native species into the soil beds that can be done as a volunteer event. Park interpreters can teach the volunteers about the native species they are planting and the importance of pollinator and bird habitat.

Following the planting event, volunteers can be involved with the maintenance and monitoring the site. Regular maintenance will be required for the success of the project. While most of the maintenance can be done with a mower, there will likely be some blackberry shots that the mower cannot reach, specifically those that grow in the plant bed. Volunteers can be brought in to pull the blackberry by hand and do other maintenance on the site that might be required. As hand pulling requires little to no equipment, the volunteers will need to be prepared by ensuring they have property shoes and gloves.

A volunteer monitoring group can also be established to monitor the site following the completion of the project. This group can focus on conducting bird and pollinator surveys on a regular basis to properly track the success of the project. As well, they can keep track of any new blackberry growth so that it can be removed before it re-establishes. The group could consist of university students and other community members who are interested in gaining experience in the field. Monitoring will allow us to determine what is occurring the site and whether management should be adapted for the project to be successful.

7.2 MAINTENANCE

Without continuous maintenance, the initial treatment is rarely successful as resprouting and new germination from the seed bank will likely occur. As well, it is quite common for an effectively controlled blackberry patch to be re-invaded by surrounding patches (Metro Vancouver, 2018). Most invasive plants are persistent and take several years of control and monitoring to ensure the restoration is successful (Page & Lilley, 2008). Annual follow-up monitoring is important to track any undesirable growth and to monitor the effectiveness of the control methods. Planting of native vegetation, re-seeding grass species and mulching the area will help prevent regrowth of the blackberry in the area. As well, follow-up maintenance of the area should not be difficult for the park staff to maintain the site to prevent further growth of the blackberry.

The design of the planting beds will be critical as it should allow for easy maintenance of the area so that it can easily be maintained by those who work at the park. Ideally, the beds should be at least **72 inches** to allow for the ride-on mower to maneuver around the site with ease to control any new growth in the grass surrounding the beds. The dog-off leash area and the surrounding fields are currently mowed on a weekly basis from March to the end of October. If necessary, the spots that the mower cannot reach can easily be weedeated and/or pulled by hand. By doing so, the roots of the blackberry should become exhausted and stop growing. Due to the size of the area, the maintenance should not add too much time to what is already being maintained in that section of the park. For the long-term success of the project, it is critical that maintenance to continue to prevent the re-infestation of the area.

8.0 RECOMMENDATIONS

CONDUCT MORE BIRD SURVEYS, ONCE IN THE WINTER AND ONE PRIOR TO WORK.

At least two more bird surveys should be conducted to get a better picture of what species are present on the site. These surveys should occur in the morning and once in the summer and winter. As well, a survey for bird nests should done prior to the initial mowing.

USE THE BASAL BARK SPRAY METHOD THAT WILL REDUCE UNINTENTIONL CONTAMINATION.

The application method should reduce the risk of unintentional contamination. The site is in close proximity to a popular area of the park as well as the Fraser River so the method should reduce spray and run-off. As the existing blackberry growth is project site, the basal bark spray application method will likely be the most successful at eliminating the plant from the site.

LEAVE A TWO METRE BUFFER BETWEEN THE THICKET OF HIMALAYAN BLACKBERRY AND NEW NATIVE PLANT BEDS.

To reduce the growth of the Himalayan blackberry that remains along the park boundary, there should be at least a two-metre buffer between the new plant beds and the blackberry.

PLANT SPECIES THAT WILL PROVIDE FOOD AND HABITAT FOR BIRDS OVER THE WINTER.

Plant species that produce berries throughout the winter should be planted at this site to increase bird visitation. Species such as Thimbleberry and Nootka rose should be planted to support the overwintering bird species.

CONTINUOUS MAINTENANCE OF THE SITE

Mowing and pulling of any new growth must be done to exhaust the roots so that the site does not get re-infested.

9.0 CONCLUSION

The project site within Derby Reach Regional Park has been influenced by anthropogenic impacts and invasive species for a number of years, which has altered the natural state of the ecosystem. This project is aiming to increase the natural habitat of the bird and pollinators, while creating a visual barrier. Restoration work must be done to control the growth of the Himalayan blackberry in this area. Follow-up maintenance will be crucial in this project to prevent any re- establishment of the blackberry. The success of the project will be based on the continuous maintenance until the blackberry roots to be exhausted. By conducting this project, the park will gain new natural habitat that will hopefully support important pollinator species and birds.

Both chemical and mechanical removal techniques should be considered for this project as each have their own strengths and weakness that need to be considered at the time of restoration. My report has outlined the chemical removal approach, but the mechanical approach also should be considered. Sierra and mine reports will provide Metro Vancouver with two viable options for this site as well as for other parks that are facing similar restoration issues.

10.0 REFERENCES

Agostini, L., Dettogni, R., dos Reis, R., Stur, E., dos Santos, E., Ventorim, D., Garcia, F., Cadoso, R., Graceli, J., & Louro, I. (2020). Effects of glyphosate exposure on human health: Insights from epidemiological and in vitro studies. *Science of the Total Environment, 705*.

All About Birds [Website]. (2019 September 20). Retrieved from https://www.allaboutbirds.org/.

Border Free Bees & Environmental Youth Alliance. (2017). *Common Pollinators of British Columbia: A Visual Identification Guide*. Retrieved from http://borderfreebees.com/wp-content/uploads/2017/11/Common-Pollinators-of-British-Columbia-2nd-Edition.pdf.

British Columbia Ministry of Environment. (2016). *Integrated Pest Management Act and Regulation Summary*.

British Columbia Ministry of Environment. (2018). *Invasive Species.* Retrieved from https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species.

Carex Canada (2019). Glyphosate Profile. Retrieved from https://www.carexcanada.ca/profile/glyphosate/.

Cornish, P.S. & Burgin, S. (2005). Residual Effects of Glyphosate Herbicide in Ecological Restoration. *Restoration Ecology, 13*(4), 695-702.

ebird [Website]. (2019 September 17). Retrieved from https://ebird.org/home.

Elle, E., & Wray, J. (n.d.). *Wild and Managed Pollinators: Current Status and Strategies to increase diversity*. Simon Fraser University. Retrieved from https://www.sfu.ca/people/eelle/bee_info.html.

Fraser Valley Invasive Species Society. (2019). *Himalayan Blackberry Chemical Control Prescription.*

Florencia, F., Carolina, T., Enzo, B., & Leonardo, G. (2017). Effects of the herbicide glyphosate on non-target plant native species from Chaco forest (Argentina). *Ecotoxicology and Environmental Safety, 144,* 360-368.

Gaire, R., Astley, C., Upadhyaya, M.K., Clements, D.R., & Bargen, M. (2015). The Biology of Canadian Weeds. *Canadian Journal of Plant Species, 95*, 557-570.

Henderson, A. M.,Gervais, J. A., Luukinen, B., Buhl, K., Stone, D., Strid, A., Cross, A., & Jenkins, J. (2010). *Glyphosate Technical Fact Sheet*. National Pesticide Information Center, Oregon State University. Retrieved from http://npic.orst.edu/factsheets/archive/glyphotech.html.

Invasive Plant Council of BC. (2007). *A Legislative Guidebook to Invasive Plant Management in BC*.

Jackson Soil & Water Conservation District (2018). *AHHH!! Blackberries: Removing and Managing the Himalayan Blackberry.*

Metro Vancouver. (1999). *Derby Reach Regional Park Management Plan*.

Metro Vancouver. (2016). *Regional Parks Plan.*

Metro Vancouver. (2018). *Best Management Practices for Himalayan Blackberry in the Metro Vancouver Region.*

Ortega, Y.(2008). The Tao of Treating Weeds: Reaching for Restoration in the Northern Rocky Mountains. *Fire Science Brief, 18*, 1-6.

Page, N. & Lilley, P. (2008). *City of Coquitlam Invasive Plant Management Strategy.*

Soll, J. (2018). Controlling Himalayan Blackberry in the Pacific Northwest. *The Nature Conservancy.*

Township of Langley. (2017). Our Shared History: Historic Context Statement and Thematic Framework. Retrieved from https://www.tol.ca/your-township/about-the-township/heritage-conservation/our-shared-history/.

Whatcom County Noxious Weed Board. (2018). *Control Options for Himalayan Blackberry.*

11.0 APPENDIX

Appendices 1: Terrain Classification System Legend		
Terrain Texture		
Code	**Name**	**Description**
s	sand	Particle size between 0.062-2
Surficial Materials		
F	fluvial	River deposits
Surface Expression		
m	rolling	Unidirectional surface; up to 3_o
Geological Processes		
I	Irregular channel	A single, clearly defined main channel displaying irregular turns and bends
Appendices 2: Ground Inspection Legend		
Site Series		
Code	**Ecosystem Units**	**Definitions**
RR	Rural	Any area in which residences and other human development are scattered and intermingled with forest, range, farmland, and native vegetation or cultivated crops.

Appendices 3: Ground Inspection Form from January 31st, 2019 field visit

BRITISH COLUMBIA — GROUND INSPECTION FORM

G ☒ vs V ☐	PHOTO	X:	Y:	DATE
PROJECT ID.		SURV. Alison + Sierra		
MAP SHEET		PLOT #		POLY. #
UTM ZONE 10U	LAT. / NORTH 49		LONG. / EAST	
ASPECT °		ELEVATION m		
SLOPE 3 %	SMR 5L²		SNR M	

MESO SLOPE POSTION	☐ Crest	☐ Upper slope	☐ Mid slope	☐ Lower slope
	☐ Toe	☐ Depression	☐ Level	
DRAINAGE - MINERAL SOILS	☐ Very rapidly	☐ Rapidly	☐ Well	☐ Mod. well
	☐ Imperfectly	☐ Poorly	☐ Very poorly	
MOISTURE SUBCLASSES - ORGANIC SOILS	☐ Aqueous	☐ Peraquic	☐ Aquic	☐ Subaquic
	☐ Perhumid	☐ Humid		
MINERAL SOIL TEXTURE	☐ Sandy (LS,S)	☐ Loamy (SL,L,SCL,FSL)	☐ Silty (SiL,Si)	☒ Clayey (SiCL,CL,SC,SiC,C)
ORGANIC SOIL TEXTURE n/a	☐ Fibric	☐ Mesic	☐ Humic	
SURF. ORGANIC HORIZON THICKNESS	☒ 0–40 cm	☐ > 40 cm		
HUMUS FORM	☐ Mor	☒ Moder	☐ Mull	
ROOT RESTRICTING LAYER	Depth 0 cm	Type n/a		
COARSE FRAGMENT CONTENT	☒ < 20%	☐ 20–35%	☐ 35–70%	☐ > 70%
	n/a			

TERRAIN

COMPONENT: TC1 ☒ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1 ~~S~~	1 F	1 m	1 I
2	2	2	2

ECOSYSTEM

COMPONENT: EC1 ☒ EC2 ☐ EC3 ☐

BGC UNIT CWH	ECOSECTION FRL
SITE SERIES ~~02~~ ~~01~~ RR	SITE MODIFIERS ~~3~~ ~~c~~ n/a
STRUCTURAL STAGE ~~5~~ n/a	CROWN CLOSURE 0 %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

Appendices 4: Ground Inspection Form from January 31st, 2019 field visit

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	A: 0 %	B: 0 %	C: 95 %	D: 0 %

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%
C	Fowl bluegrass	15		Poa palustris				
C	Himayalan blackberry	30%		Rubus armeniacus				
C	Kentucky bluegrass	25 %		Poa pratensis				
C	Western fescue	40%		Festuca occidentalis				
C	Hedgehog dogtail	5%		Cynosurus echinatus				
C	Timothy-grass	5%		Phleum pratense				
C	Creeping buttercup	2%		Ranunculus repens				

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH						Ht. to DBH	Total HT	BH Age	Path Y/N
		Top	Bot	SD	SL	HD	HT				

NOTES (site diagram, exposure, gleying, etc.)