# NICOMEKL RIVERFRONT PARK

## ENVIRONMENTAL ASSESSMENT REPORT 2018

SURREY PARKS
Connecting through nature + play

Prepared by
Diamond Head Consulting
*Environmental Consultant*

IN PARTNERSHIP WITH:
PFS STUDIO

# Nicomekl Riverfront Environmental Assessment Report

November 2018

Submitted to:

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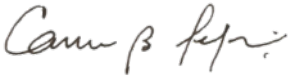

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**Insurance Information**

| | |
|---|---|
| WCB: | # 657906 AQ (003) |
| General Liability: | Northbridge General Insurance Corporation - Policy #CBC1935506, $5,000,000 (Mar 2018) |
| Errors & Omissions: | Lloyds Underwriters – Policy #1010615D, $1,000,000 (June 2018) |

# 1.0 Introduction

The Nicomekl River is an iconic natural feature and one of three significant fish bearing river systems within the City of Surrey. It is intended to be a major recreational "blueway" for the city, providing a pathway for non-motorized boat use. It is currently highly constricted for flood control and runs through farm land and the Agricultural Land Reserve until crossing 40th Avenue, where the southern bank is bounded primarily by parkland and private property (Figure 1). A series of properties that extend along the south shore of this River were purchased by the City of Surrey with the intention of flood control management and creating protected riverfront parkland. This area has been identified as a wildlife movement corridor as part of the City's Green Infrastructure Network and supports both unique natural areas as well as disturbed areas that provide opportunities for ecological restoration and habitat enhancement.

This environmental overview assessment identifies existing natural values, opportunities for enhancement, and constraints associated with the site. The intent of this report is to inform the planning and design phase for this park.

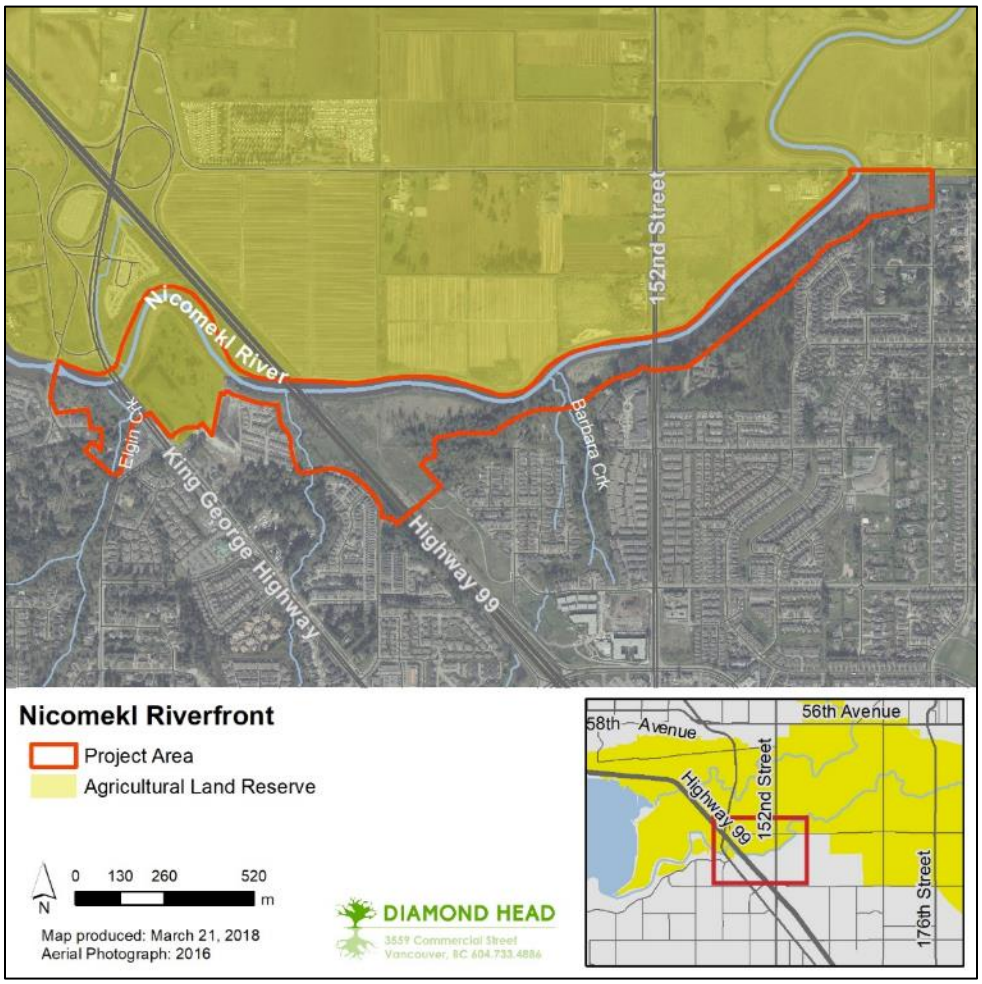


**Figure 1: Site location, south of the Nicomekl River**

# 2.0 Existing Conditions

The study area extends along the south shore of the Nicomekl River from the Sea Dam crossing at Elgin Road to 156 St and 40th Avenue. It includes disturbed sites such as former residential properties and an old driving range and golf course at the west end, areas dominated by invasive plant species, as well as some areas of natural forest and floodplains that are highly diverse and ecologically significant in the region. The lands on the north shore of the River are privately owned agricultural lands; therefore, they are outside of the scope of this project.

## 2.1 Topography

The study area includes a variety of landscape forms from low and flat floodplains adjacent to the Nicomekl River to steep embankments and some upland areas. The terrain is highly variable from flat to very steep (~100%). Ground elevation ranges from sea level at the Nicomekl River to 40 m ASL under the utility lines along Highway 99. Portions of the river bank have engineered flood control, influencing the topography of the shoreline[1][2].

## 2.2 Biogeoclimatic Classification

The project site is located in the Very Dry Maritime Coastal Western Hemlock (CWHxm) Subzone, as defined by the Biogeoclimatic Ecosystem Classification (BEC) system of BC. This zone experiences warm, dry summers and moist, mild winters with relatively little snowfall. It is, however, very close to where this zone transitions to the milder and drier Moist Maritime Coastal Douglas-fir (CDFmm) Subzone to the south and west. As such it shares some ecological characteristics of both subzones.

Site level classification (Site Series) is defined by soil moisture and nutrient availability and describes the late seral or climax plant community that will develop through natural succession. The terrain that is lower in elevation and includes most of the floodplain habitat have soils with high clay content which originated mostly from marine deposits as well as mixed layers of sand from fluvial deposits. These areas are very rich in nutrients and wet. Most are classified as the low and medium bench floodplain site series (09 and 10). Above the floodplains the sites are also high in moisture regime and nutrient-rich and are primarily classified as site series 07. Some areas near the upper portions of the steep slopes have sandier soils with mixed coarse fragments and were likely formed by morainal deposits. These areas are also rich in nutrients but slightly drier. These are classified as site series 05.

## 2.3 Plant Communities

The project site has been divided into polygons with similar plant communities. These are mapped and described in more detail in Appendix 1, with summary disturbance maps provided below (Figures 2-4). Much of the original forest that would have been native to this area was previously cleared for

[1] http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/bc-floodplain-maps/Serpentine_Nicomekl_Rivers/2-91-5-2.pdf

[2] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/as-built-dike-drawings-and-reports/dike-inventory/s_surrey_colebrook_mudbay_9.pdf

development or agriculture in the early 20th century. In many areas, it has been cleared again for development and infrastructure. The plant communities that exist range from young regenerating pioneer forests to some well-established and diverse older mature forests. Some trees in remote areas that would have been difficult to clear are estimated to range from 150-250 years old.

**Figure 2: Level of disturbance on west end of site.**

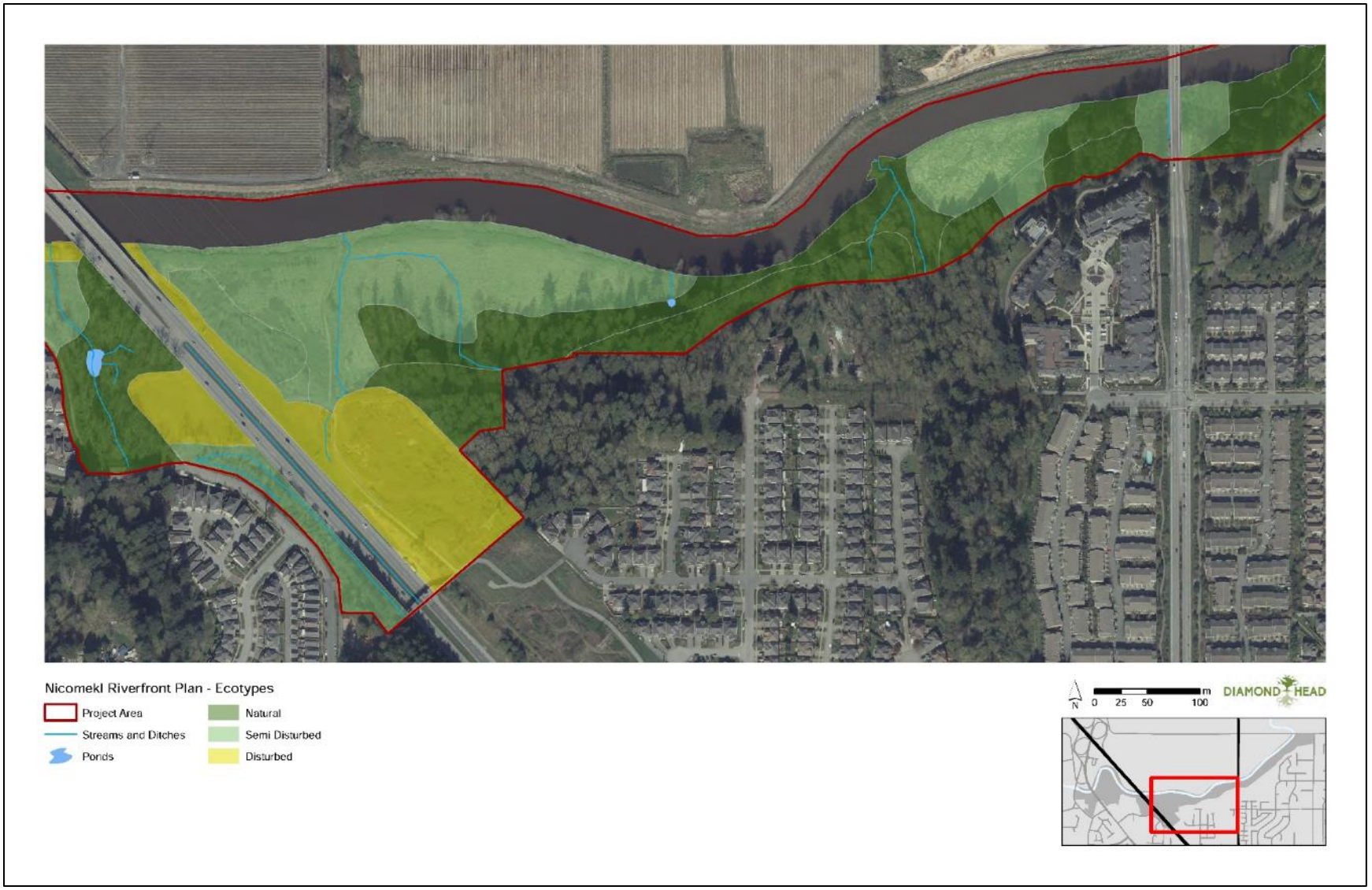


**Figure 3: Level of disturbance on centre of site.**

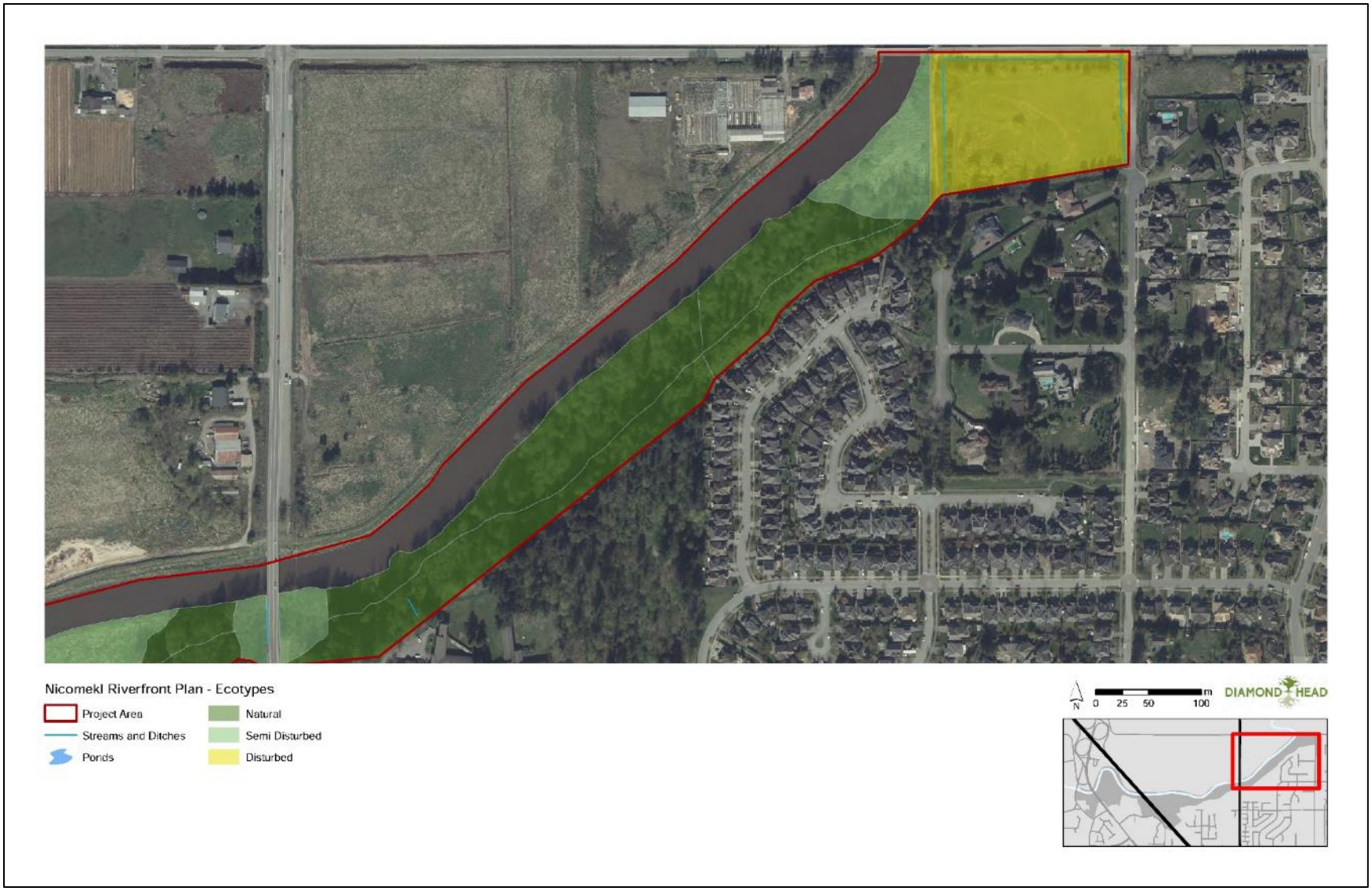


**Figure 4: Level of disturbance on east end of site.**

### 2.3.1 West of Highway 99

To the young regenerating pioneer forests to some well-established and diverse older mature forests. This area contains many engineered flood control measures including constructed dykes. There are small pockets of young to mature second growth forest. There are some older conifers that remain on the residence at 14391 Crescent Road, including several large Western redcedar trees. Some of these trees have diameters of greater than 1m. The stands adjacent to Elgin and Anderson Creeks are generally dominated by younger deciduous species. There are rows of mature conifers as well as some large open grown native and non-native trees on the golf course. Previous flood control measures on the course such as pumping out water have been discontinued, and the area has since begun to retain water. Understory vegetation varies across this area but is generally discontinuous. Many developed areas are dominated by turf grass. The areas that are more natural generally include high components of invasive plant species.

View of south bank of Nicomekl from Elgin Rd bridge

Japanese Butterbur is a species of concern found spreading into the riparian area of the Nicomekl

Large pond on the property adjacent to Elgin Creek.

Channel connecting the pond to Elgin Creek.

Elgin Creek.

View of mature conifer trees along the edge of what was previously a driving range.

Nicomekl River at the edge of the former golfing area.

View of the former driving range from Crescent Road, facing north.

Himalayan blackberry along the Dyke west of Anderson Creek.

Anderson Creek, view facing south.

### 2.3.2 Hwy 99 east to 152nd

Directly east of Hwy 99 there is a BC Hydro right of way that excludes the establishment of mature trees. This area is now dominated by a dense shrub layer with a high component of invasive plants, mainly Himalayan blackberry and reed canary grass. There is also a large patch of Japanese knotweed. In the northern part of this right of way there is a thicket which is providing high value for wildlife and consists of dense shrubs with willow and cottonwood sprouting from old cut stumps.

To the east of this Hydro right of way there is a steep embankment above a wide floodplain. The floodplain area is dominated by reed canary grass and pockets of Himalayan blackberry with scattered trees. This area is under restoration with a newly created stream, planted wildlife trees, and native species plantings. The constructed dykes stop at the east end of the restoration area where a stormwater outlet drains into the Nicomekl.

To the south there is a steep embankment where there is an active development project. The lower slopes that are not being developed support a mature stand of conifers and deciduous trees. There are some Douglas-fir trees in these stands that extend well above the main canopy and are large in diameter (>80cm). There are also some western redcedar of significance with diameters reaching 150cm. The understory in these areas is dense with mostly native species. Invasive species include scattered pockets of Himalayan blackberry and some large areas that have been invaded by Himalayan Balsam (Policeman's helmet).

The forested areas east of Barbara creek have few anthropogenic modifications. There are no constructed dykes as the landform provides natural flood control. Development exists well above the embankment. There is one very large area on the floodplain east of Barbara creek that is dominated by reed canary grass.

Invasive Japanese knotweed and Himalayan blackberry under the hydro transmission lines.

Floodplain with newly constructed watercourse.

Recently installed access road and wildlife trees.

Newly constructed watercourse on Nicomekl floodplain.

Large diameter Douglas-fir trees.

Large diameter cedar tree.

Upland forest above Barbara Creek.

Floodplain adjacent to Barbara Creek.

Barbara Creek streambed

Barbara creek where it drains into the Nicomekl

View of reed canary grass field

View from above of new development above the Nicomekl floodplain

### 2.3.3 East of 152nd

The steep embankment and distinct slope break between the floodplain and the developed lands above continues east from 152nd St to 155th St. This area is the most naturalized section of the study area. There is a distinct floodplain that extends adjacent to the River. The slope to the south is generally very steep extending up to a slope break. Above this there is an active development site.

The floodplain adjacent to the river is active with signs of regular flooding. The trees range in age from young to mature but consist of mainly deciduous tree species. Many have defects or are leaning. Signs of windthrow are evident throughout this floodplain area. There are several mature Sitka Spruce of significant size growing here. These are not as common in the region due to extensive development of lowland areas. The understory vegetation is generally dense and diverse. Invasive species exist but are isolated to some pockets of reed canary grass and Himalayan blackberry.

The steep slopes and upland above the floodplain support a mixed mature stand of conifers and deciduous species. The understory vegetation is generally dense and healthy. The invasive species that were found are limited to the interfaces with adjacent development. Several trees of significance were identified. These include some dominant Douglas-fir trees that are very tall and extend above the main

canopy. There is one area with several older western redcedars and Douglas-firs that are estimated to be 150-250 years old, with diameters of up to 150cm. These are east of 152nd street and are considered significant at a regional level.

Some trees have characteristics that make them interesting. For example, we found bigleaf maples covered in licorice fern, or trees that are heavily leaning or have partially failed. A number of heritage stumps with signs of wildfire and spring board notches were also identified.

The eastern end of the site consists of a recently acquired property that is to be redeveloped. It contains an open field with minimal tree and understory coverage. There is a thick area of Himalayan blackberry (~5m wide) along the outside edges of the property, particularly along 156 St and 40th Avenue.

Large heritage stump.

One of several large (DBH > 1m) Douglas-fir.

View of the eatern property to be redevleoped, from the southwest corner.

View of reed canary grass field and floodplain from north across the Nicomekl.

Bigleaf maple covered in licorice fern.

Tree with nest box and short wildlife tree with cavities near a new residential neighbourhood.

View of floodplain.

Corner of 40 Ave and 156 Street. Himalayan blackberry surrounds the eastern end of the site.

### 2.3.4 Invasive plant species

In general, invasive species are found adjacent to the areas that have been historically developed as well as along waterways (Figures 5-7). These include Himalayan blackberry (*Rubus armeniacus*), Scotch broom (*Cytisus scoparius*), English ivy (*Hedera helix*), Common periwinkle (*Vinca minor*), Lamium/Yellow archangel (*Lamiastrum galeobdolon*), Policeman's helmet (*Impatiens glandulifera*), Common tansy (*Tanacetum vulgare*), English holly (*Ilex aquifolium*), Japanese knotweed (*Fallopia japonica*), and Cherry laurel (*Prunus laurocerasus*). Many of the knotweed pockets appear to have been treated historically or to be currently undergoing chemical treatment by the City of Surrey. There is one patch of an emerging species of concern called Japanese butterbur (*Petasites japonicus*) just east of Elgin rd.

The area under the Hydro transmission lines is almost exclusively dominated by invasive species. Several large patches were documented of Reed canary grass, Himalayan blackberry, and one large patch of Japanese knotweed. A significant area at the top of the slope is dominated by Common tansy.

Several large areas on the floodplain of the Nicomekl are dominated by Reed canary grass. This species forms thick monocultural mats in low lying areas throughout the site, crowding out and preventing the establishment of native species. It also poses a significant challenge for management, often requiring an extensive and integrated suite of control actions to reduce populations. Areas with significant canopy cover appear to be less at risk for reed canary grass establishment.

Invasive species that have been previously identified by the Conservation Data Centre along the highway within 500 m of the site includes: Scotch broom, English ivy, English holly, Yellow archangel, Himalayan blackberry, Cutleaf blackberry, Common periwinkle, Japanese knotweed, and Scentless chamomile (*Matricaria perforata*).

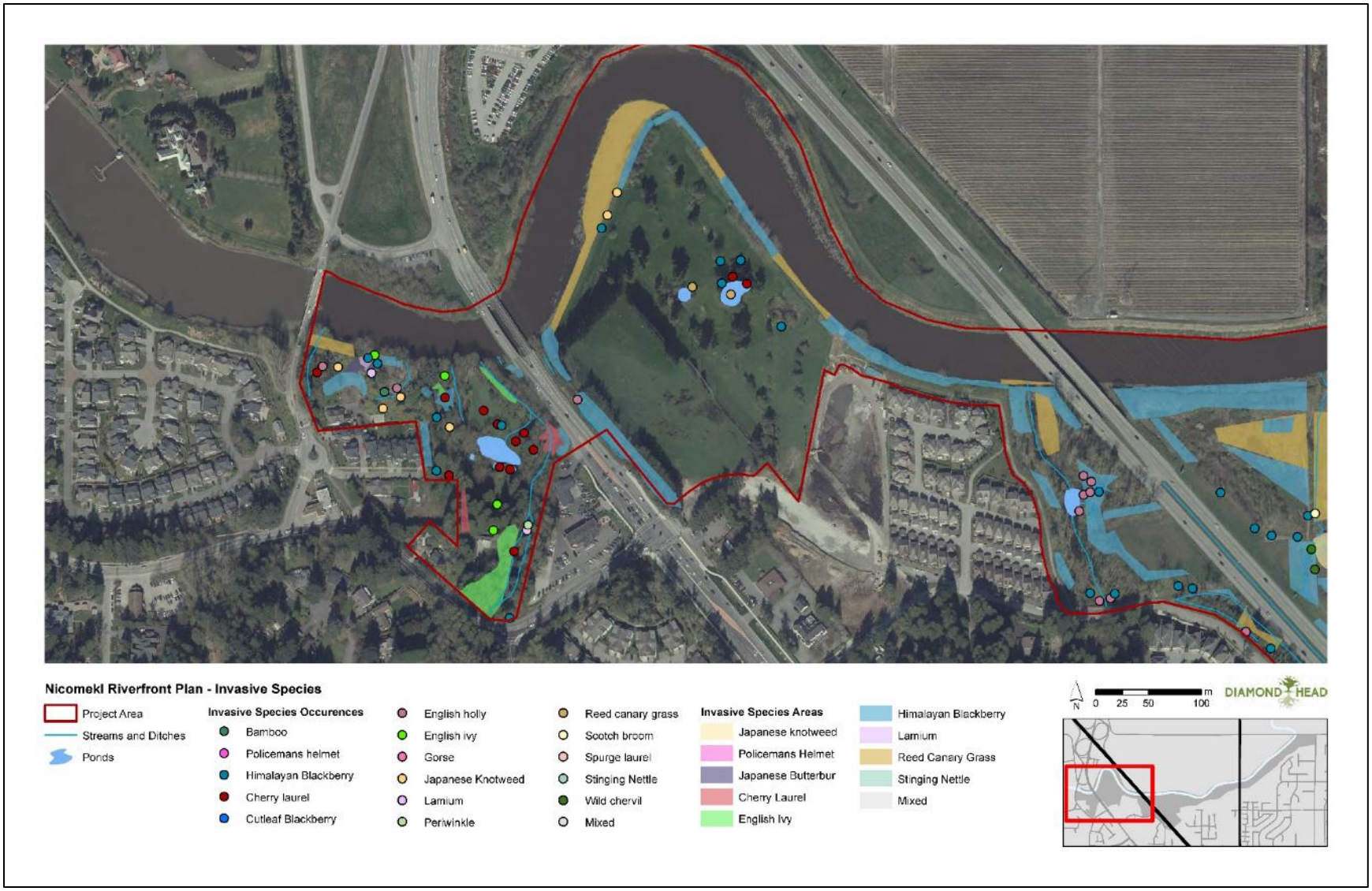


**Figure 5: Invasive species found on the west end of site.**

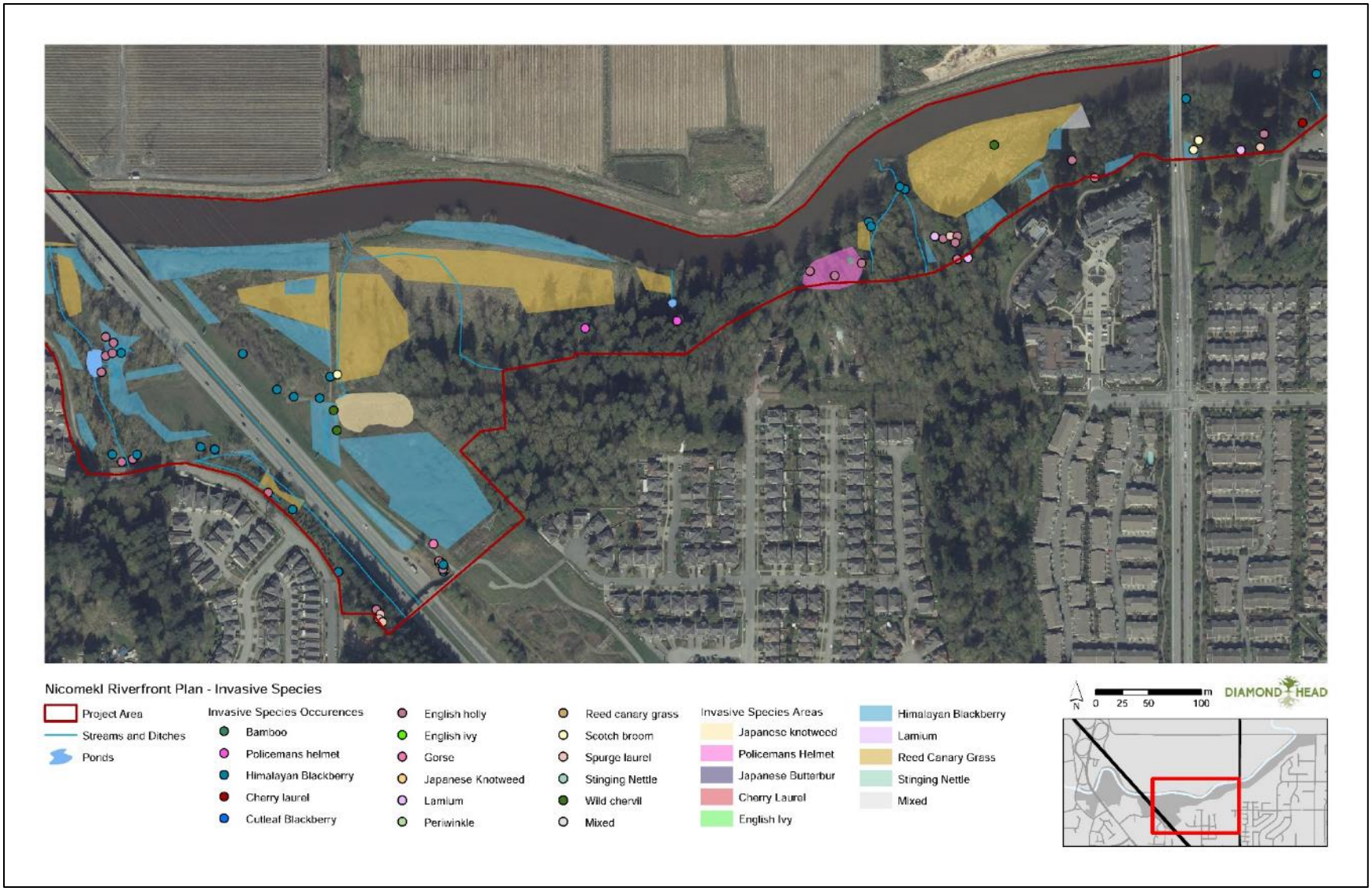


**Figure 6: Invasive species found in the centre of the site.**

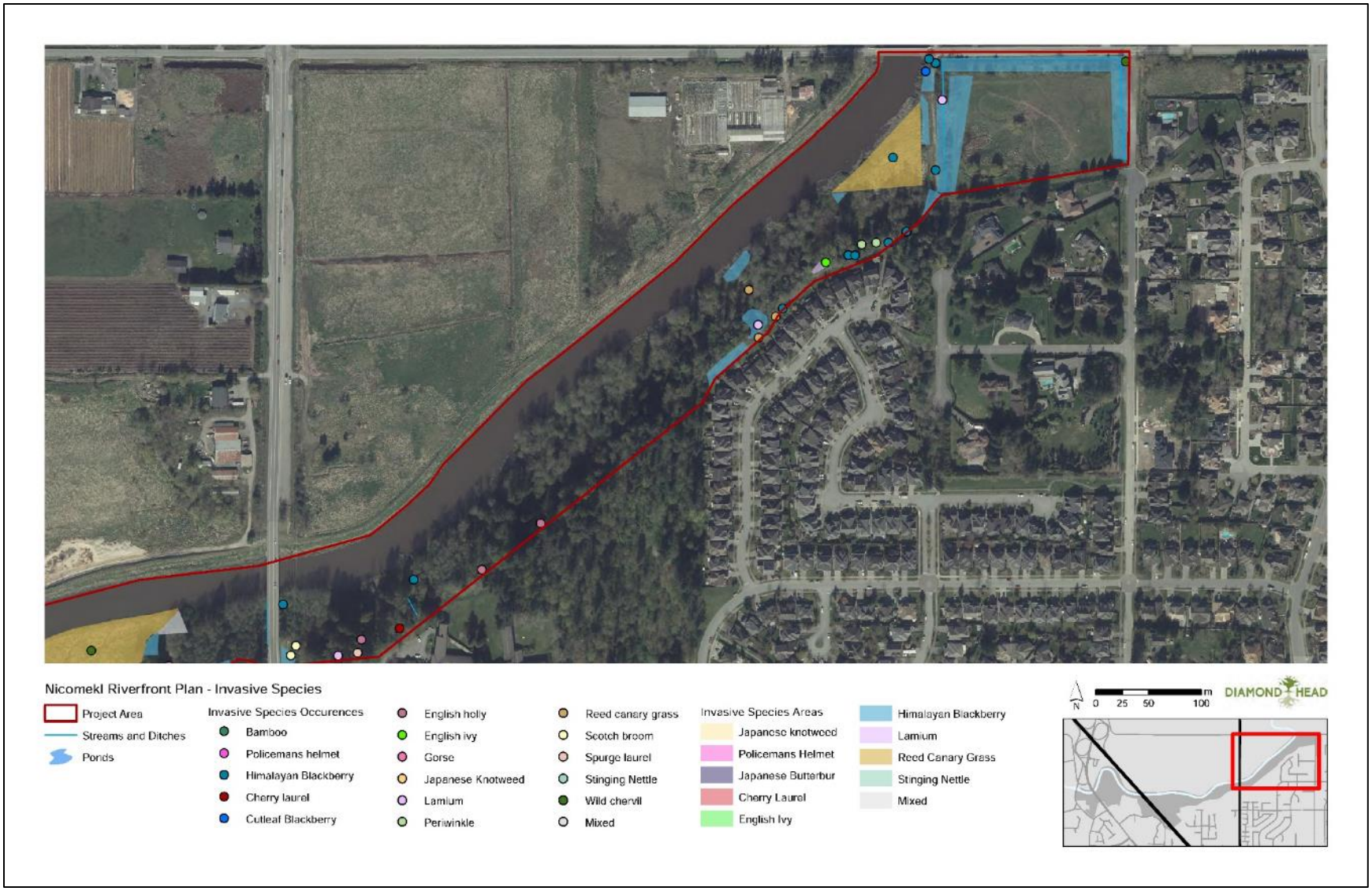


**Figure 7: Invasive species found on the eastern end of the site.**

Patch of English Ivy.

Emerging Himalayan Balsam (Policeman's helmet).

- Large field of Himalayan blackberry.

English holly tree near the new development.

Common periwinkle found in open patches in the understory.

Field of reed canary grass

## 2.4 Watercourses and drainages

### 2.4.1 Water Quality

The City of Surrey Engineering Department has been conducting water quality sampling of the Nicomekl River (Table 1 & Table 2). This data has been collected at 2 locations downstream of the study site since 2009. The site closest to the new Nicomekl waterfront park is located just downstream of the Sea Dam at the crossing of Elgin Road. Bacteriology (*E. coli*, fecal coliforms and *Enterococci*) is collected, as well as the following water quality parameters:

- Nutrients
- Temperature
- Dissolved Oxygen (DO)
- Conductivity
- Turbidity
- Chlorophyll A
- Total metals (>30 metals)

Samples were collected once a week for approximately 5 weeks, once in the dry season (July-August), and once in the wet season (October to November). Biological parameters were averaged using a 30-day geometric mean, as is the standard for bacterial indicators. Water quality chemical parameters were an average of ~5 samples. All of the above parameters, except for total metals, are discussed in the following sections.

**Microbiological Parameters**

Recommended guidelines from "Guidelines for Canadian Recreational Water Quality – 3rd Edition" for primary contact recreational activities (e.g. swimming) is a geometric mean of less than 200 *E. coli*/100 mL and a single sample maximum of 400 *E. coli*/100 mL. Secondary contact recreational activities (e.g. kayaking, paddle boarding, etc.) suggest a factor of 5 be applied to primary contact recommendations. Therefore, secondary contact guidelines for *E.coli* is a geometric mean of <1000 *E. coli*/100 mL[3]. Previous studies found that as of 2002, *E. coli* concentrations exceeded primary contact requirements and met secondary contact guidelines[4].

[3] Health Canada. 2012. Guidelines for Canadian Recreational Water Quality, Third Edition. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. Catalogue No H129-15/2012E.*Retrieved from*: https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition.html

[4] BC Environment. 2003. Water quality in British Columbia: Objectives attainment in 2002. *Retrieved from*: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/wq-attainment-report-archive/wq_amb_wq_objectives_2002.pdf

**Table 1: Average dry (July-August) and wet (October-November) season microbiological parameters from the Nicomekl River. Averages were calculated using a geometric mean. Samples were collected just downstream of the sea dam.**

| Year | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wet/Dry** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** |
| E. coli (CFU/100mL) | 44 | 120 | 18 | 636 | 8* | 25* | 90* | 698* | 5 | 450 | 29 | 184 | 9 | 122 |
| Enterococcus spp. (CFU/100mL) | 53 | 136 | 16 | 1017 | 5* | 13* | 178* | 520* | 7 | 416 | 83 | 186 | 166 | 413 |
| Fecal Coliforms (CFU/100mL) | 118 | 150 | 56 | 1234 | 39* | 35* | 109* | 1961* | 15 | 734 | 58 | 351 | 15 | 122 |

**Table 2: Average dry (July-August) and wet (October-November) season water quality parameters from the Nicomekl River. Samples were collected just downstream of the sea dam.**

| Year | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wet/Dry** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** |
| Field Conductivity (µS/cm) | 12256 | 31105 | 12144 | 6943 | 9472* | 20845* | 12690* | 12461* | 27439 | 13552 | 26228 | 4655 | 12000 | 21530 |
| DO - Field Dissolved Oxygen (mg/L) | 4.68 | 8.87 | 7.78 | 8.38 | 7.01* | 6.67* | 5.03* | 8.47* | 5.40 | 5.93 | 6.45 | 6.77 | 6.22 | 2.79* |
| Field pH | 7.58 | 6.75 | 7.07 | 7.64 | 7.62* | 7.00* | 7.31* | 6.95* | 8.32 | 7.32 | 7.67 | 6.86 | 7.92 | 6.83* |
| Field Temperature (°C) | 20.40 | 6.35 | 21.83 | 10.09 | 25.07* | 10.41* | 21.94* | 7.55* | 24.10 | 10.61 | 23.02 | 10.00 | 19.63 | 10.31* |
| Field Turbidity (NTU) | 5.4 | 138.1 | 5.0 | 15.6 | 4.9* | 4.0* | 4.63* | 10.2* | 8.9 | 11.7 | 10.4 | 9.0 | 9.3 | 7.1* |
| Chlorophyll a (µg/L) | 32.20 | 1.89 | 46.93 | 1.76 | 19.17* | 1.99* | 36.23* | 3.70* | 27.11 | 4.33 | 23.24 | 5.04 | 33.04 | 2.01 |
| Total Nitrogen – TN (mg/L) | 1.300 | 1.781 | 0.684 | 3.320 | 1.068* | 1.500* | 0.983* | 2.593* | 0.690 | 3.122 | 0.695 | 3.499 | 0.890 | 2.332 |
| Total Phosphorous - TP (mg/L) | 0.123 | 0.147 | 0.140 | 0.399 | 0.191* | 0.152* | 0.199* | 0.270* | 0.204 | 0.212 | 0.282 | 0.291 | 0.205 | 0.180 |

*Less than 5 samples were collected for this average.

Data collected by the City between July 2011 and November 2017 found a similar pattern. In all 6 summers, geometric mean *E. coli* concentrations and single samples all met the primary and secondary guidelines. However, in the wet seasons, primary contact guidelines are regularly exceeded either by single point samples or the geometric mean *E.coli* concentration. The geometric mean primary recreation guidelines were exceeded in 2012, 2014 and 2015, with every wet season after 2011 containing at least one sample point that exceeded maximum primary recreation guidelines. Geometric mean *E.coli* concentrations met secondary contact guidelines; however, point samples occasionally exceeded them in 2012 and 2015.

*Enterococci* primary contact guidelines suggest that the geometric mean should not exceed 35 *Enterococci*/100 mL, with a single sample maximum of 70 *Enterococci*/100 mL[1]. Both the geometric mean and single sample primary contact guidelines are regularly exceeded. The dry season in 2012, 2013 and 2015 met both single point and geometric mean guidelines. Only one wet season (2013) met requirements; however, there were not 5 samples completed, which is the minimum required for an accurate geometric mean.

Secondary contact guidelines suggest the geometric mean should not exceed 175 *Enterococci*/100 mL, with point samples not exceeding 350 *Enterococci*/100 mL. Geometric means typically met secondary contact guidelines in the dry season, but rarely met the guidelines in the wet season. All wet seasons and most dry seasons contained single point samples that exceeded the secondary contact guidelines.

**Conductivity**

Field conductivity was quite variable, ranging from a low of 31 to a high of 42,330 µS/cm. This suggests that the level of seawater entering the Nicomekl River up to the sea dam is also quite variable and likely fluctuated with tides and groundwater levels.

**Oxygen**

While Coho salmon can survive periods of hypoxic conditions, dissolved oxygen (DO) levels should ideally be 7.75 mg/L or higher, and, at a minimum, above 5 mg/L. Average DO levels range from 2.8 to 8.9 mg/L. Generally, oxygen levels deplete by the end of August, but are replenished in the fall with an increase in precipitation. Oxygen levels are occasionally too low to adequately support Coho in the Nicomekl.

**pH**

pH values are circumneutral, with average pH ranging from 6.75 to 8.32. pH had a low of 5.7 and a high of 9.0. The average values are within the ideal pH range for fish growth and survivability.

**Temperature**

The wet season average temperatures ranged from 6.4°C to 10.6°C, which are normal for winter habitat for cold-water fish in B.C. Summer water temperatures averaged in the early to mid 20's, reaching a maximum of 27°C. Summer water temperatures are high enough they would likely cause stress on Coho

salmon. Restoring the native riparian vegetation along the Nicomekl would help increase shade and reduce water temperature.

**Turbidity**

In both wet and dry seasons, turbidity levels were low enough that they should not affect fish survivability (averaging 4.0 to 15.6 NTU, excluding the wet season of 2011). There was a large spike in turbidity in November 2011 (395 NTU), suggesting there was a large input of sediment. High turbidity levels can clog fish gills and have a detrimental effect on salmon growth and survivability.

**Chlorophyll a**

BC guidelines suggest that Chlorophyll a should generally be under 50 $mg/m^2$ in streams used for recreation, or 100 $mg/m^2$ for non-recreational streams[5]. Average Chlorophyll a values range from 1.76 to 46.9, which is within the recreational guidelines. Chlorophyll a concentrations are higher in the warmer, dryer summer months than in the wet fall months. Concentrations generally are high enough to support zooplankton populations, which in turn support salmon populations.

**Nutrients (Total Phosphorus and Total Nitrogen)**

Total Nitrogen (TN) concentrations are fairly high, and Total Phosphorous (TP) concentrations are very high in the Nicomekl River. While sources of phosphorous and nitrogen to the Nicomekl River are not known, it is likely that phosphorous and nitrogen inputs are coming from nearby farming activities. This is further supported by the high concentrations of *E. coli* and *Enterococci*, suggesting nutrient inputs are likely coming from a combination of animal waste and fertilizer. Nutrient concentrations are generally higher during the wet season, suggesting nutrient inputs are entering the river through run off.

In highly phosphorous enriched watercourses, nitrogen can become the limiting nutrient. Total nitrogen (TN) is an aggregate amount of nitrogen in the water, made up primarily of nitrate, nitrite, and ammonia. These different forms are useful in different quantities, having deleterious effects on fish survival at high concentrations. Most lakes, rivers and ponds in B.C. are not limited by nitrogen concentrations; however, due to the high concentration of phosphorus in the Nicomekl River, it is possible that it is currently nitrogen limited.

**Water Levels**

The city also has a series of water level gauges along the river which monitor water levels. This data will be useful for determining the potential impacts of climate change and periodic flooding and to inform plant species selection for restoration plans.

[5] British Columbia Ministry of Environment and Climate Change Strategy. 2017. B.C. Recreational Water Quality guidelines: Guideline Summary. Water Quality Guideline Series No. WQG-02. *Retrieved* October 29th 2018 *from* https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/recreational_water_quality_guidelines_bcenv.pdf

### 2.4.2 The Nicomekl River

The Nicomekl River itself has been highly confined to manage flood risk to agricultural developments. The northern banks are dyked for flood control for the agricultural land found north of the River, while the southern edge consists of old dykes from the sea dam to west of about 150 Street. The south banks east of 150 Street are more naturalized as the existing embankment manages the risk of flooding. The previous dyking on the western half of the site has limited the extent of the estuarine marsh and wetlands that once existed. There is tidal influence on the lower reaches of this river, especially below the sea dams on Highway 99.

The Nicomekl river ranges from 40 to 45 m wide at the west end, and 35 to 40 m wide at the east end of the site. The gradient is very low. The instream complexity and cover habitat has been compromised by the engineering required for flood control. The south banks of the river east of Barbara creek have not been built up or dyked and in most areas support tree cover. These are the most valuable areas for riparian and instream habitat.

Despite the challenges associated with existing dykes, including flood control measures and poor instream habitat, there are extensive salmon migrations up the Nicomekl River. Fish species that have been observed in the Nicomekl River over the last 20 years include: Coho Salmon (*Oncorhynchus kisutch*), Brassy Minnow (*Hybognathus hankinsoni*), Fathead Minnow (*Pimephales promelas*), Brown Catfish (*Ameiurus nebulosus*), Rainbow Trout (*Oncorhynchus mykiss*), Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*), Prickly Sculpin (*Cottus asper*), Pumpkinseed (*Lepomis gibbosus*), Redside Shiner (*Richardsonius sp.*), Threespine Stickleback (*Gasterosteus aculeatus*), and Western Brook Lamprey (*Lampetra richardsoni*). Invasive Goldfish (*Carassius auratus*) have also been observed in the river. The Nicomekl River has also been stocked at various locations and multiple times over the 20th century and into the early 2000s, historically with Rainbow Trout, and more recently also with Cutthroat Trout.

View of Nicomekl from the former driving range, facing west.

View of Nicomekl from the former driving range, facing east.

View west towards Elgin Rd bridge.

View of Nicomekl River and Highway 99 bridge, facing west.

View of Nicomekl River from Elgin Rd bridge.

View of Nicomekl River at Highway 99.

## 2.5 Riparian Setback Areas

The riparian areas of streams are protected by the City through Development Permit Areas, and guidelines in the OCP and setback regulations within the Zoning Bylaw (
Table 3). All measurements are measured back from the top of bank, where present. Riparian setback areas are illustrated in figures 8-10. The top of bank has been approximated using topographical data for Elgin creek. The riparian setback for the Nicomekl River varies depending on the condition of the adjacent topography (ie. if there is a distinct top of bank present), and if there is an associated floodplain. The area west of Highway 99 has been modified by dykes and is not associated with an active floodplain. In these areas the 30m setback is measured back from the top of bank of the Dyke or the high water mark. The area between Highway 99 east to 152nd street floods on a regular basis. The slopes to the south generally extends up to development often with no distinct top of bank. In these areas the 30m setback is measured back from the edge of the floodplain.

The area east of 152nd to about 155th is associated with an active floodplain which abuts to a steep slope. This slope extends up to a distinct slope break. This break is considered the top of bank. In these areas the 30m setback is measured back from this top of bank.

**Table 3: Riparian setback requirements by stream type and class**

| **Minimum Distance From *Top of Bank*** | | |
|---|---|---|
| | ***Stream* Classifications** | |
| ***Stream* Types** | **A or A/O** | **B** |
| All *Stream* Types (except as shown below) | 30 metres* | 20 metres* |
| Channelized<br>*Stream* that has been dyked, diverted or straightened carrying drainage flows from headwaters or significant sources of groundwater, and can include channels that divert irrigation from a *stream* and send overflow water back to a *stream*. | 25 metres* | 15 metres* |
| Ditches<br>*Stream* that is a constructed drainage channel, carrying water that does not originate from a headwater or significant source of groundwater. | 10 metres** | 7 metres |
| Natural<br>*Stream* predominantly in its natural state that is not significantly altered by human activity. | 30 metres* | 15 metres* |
| Large Ravines<br>*Stream* with a narrow, steep-sided valley with a minimum of 60 metres between the top of bank from either side of the *stream*. | 15 metres* | 15 metres* |

Some important definitions associated with this policy include the following:

**Top of Bank**
means

(a) the point closest to the boundary of the *active floodplain* of a *stream* where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1, at any point, for a minimum distance of 15 metres, measured perpendicularly from the break; and

**Active Floodplain**
means an area of land that supports *floodplain plant species* and is:

(a) adjacent to a stream that may be subject to temporary, frequent or seasonal inundation; or
(b) within a boundary that is indicated by the visible *high water mark*.

The City's riparian setback policy must meet or exceed the Provincial Riparian Areas Regulation (RAR). RAR however applies to development, which is defined as projects that require local government regulation or approval for residential, commercial, or institutional activities. It is not designed to regulate institutional projects that do not require formal approval from the municipality. Development in parks by a municipality are not regulated by the Regulation. Planned works within these riparian areas can be approved at the City's discretion.

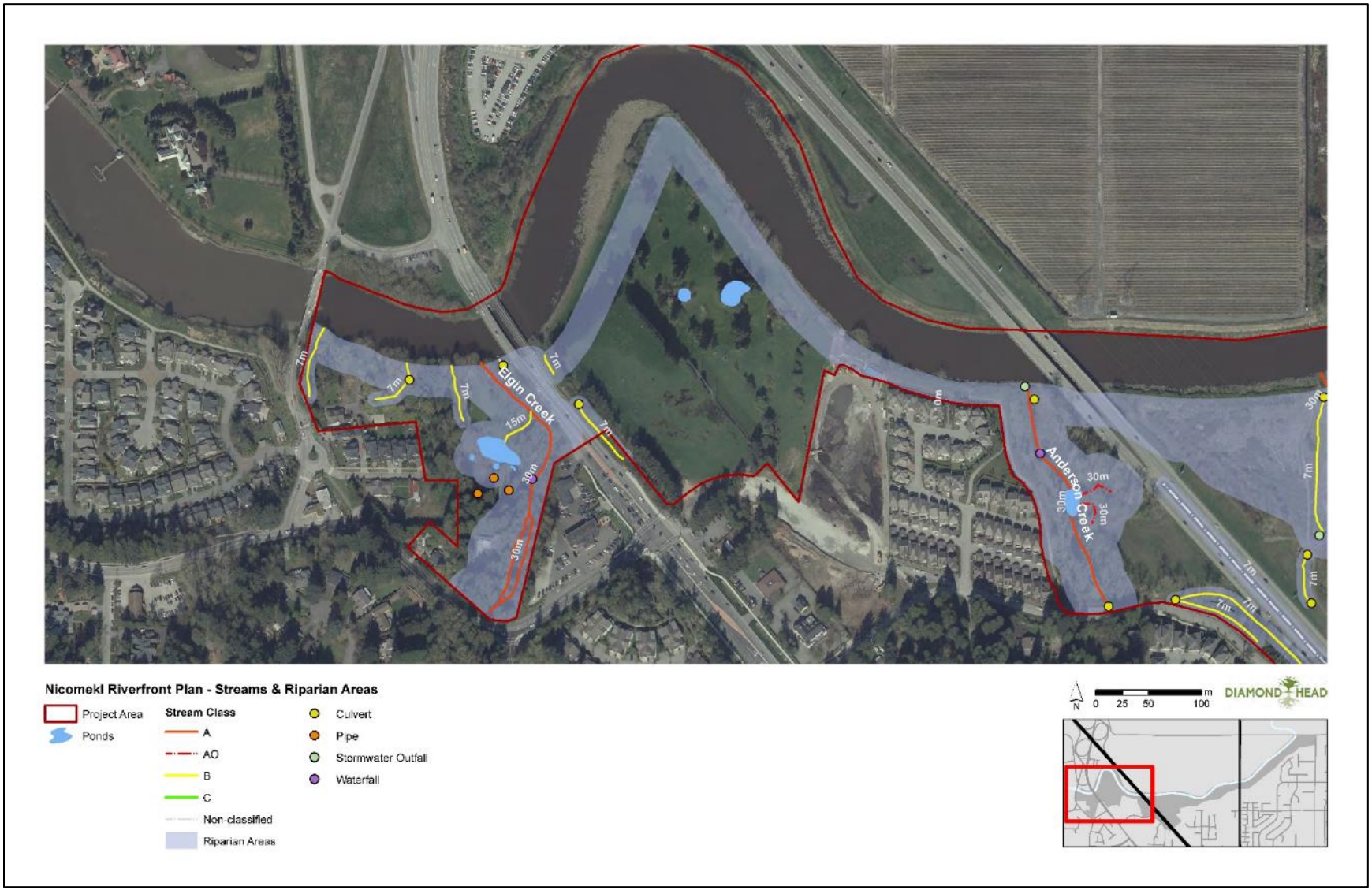


Figure 8: Watercourses and stormwater features located on the western end of the site.

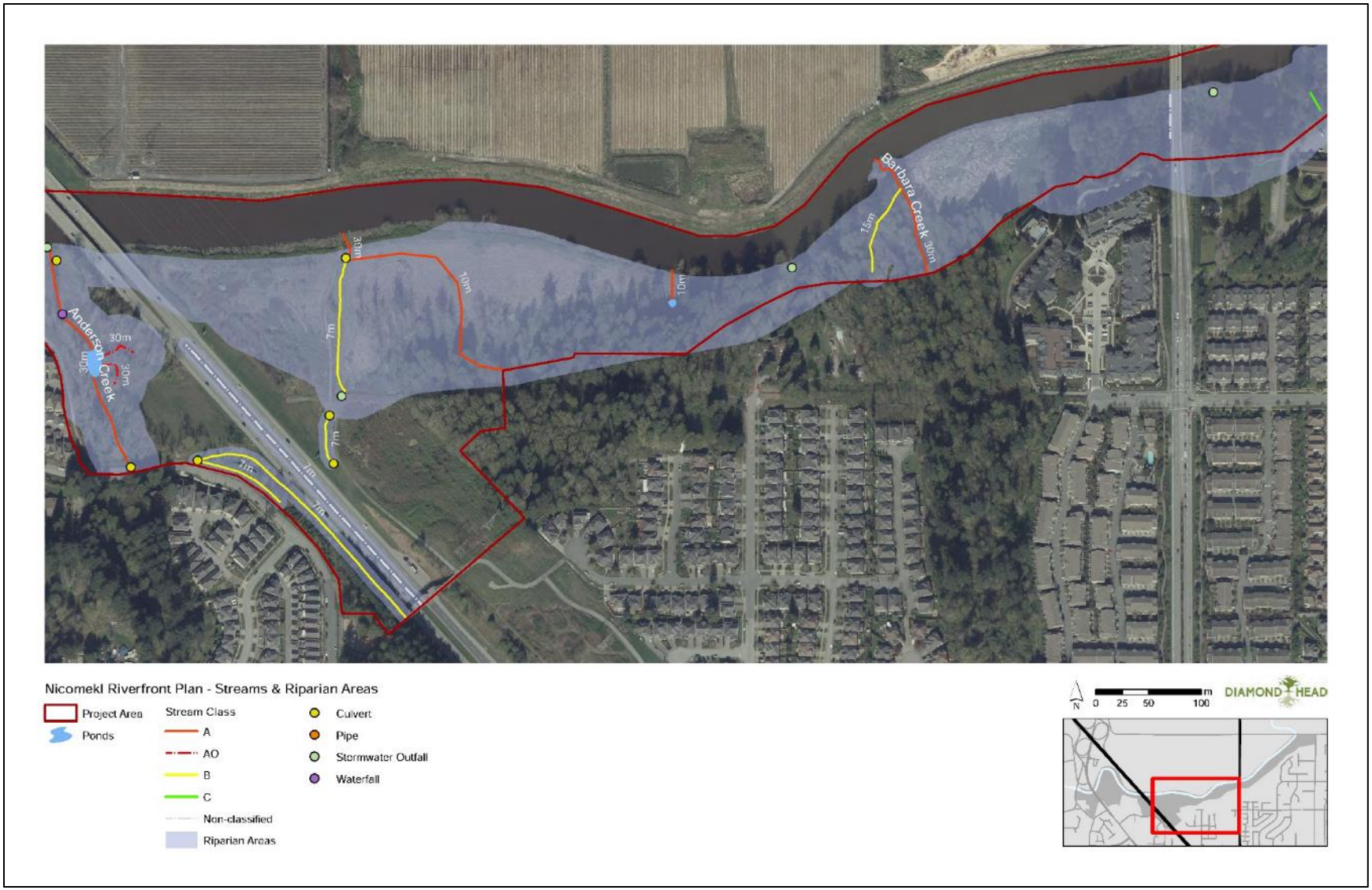


**Figure 9: Watercourses and stormwater features located in the centre of the site.**

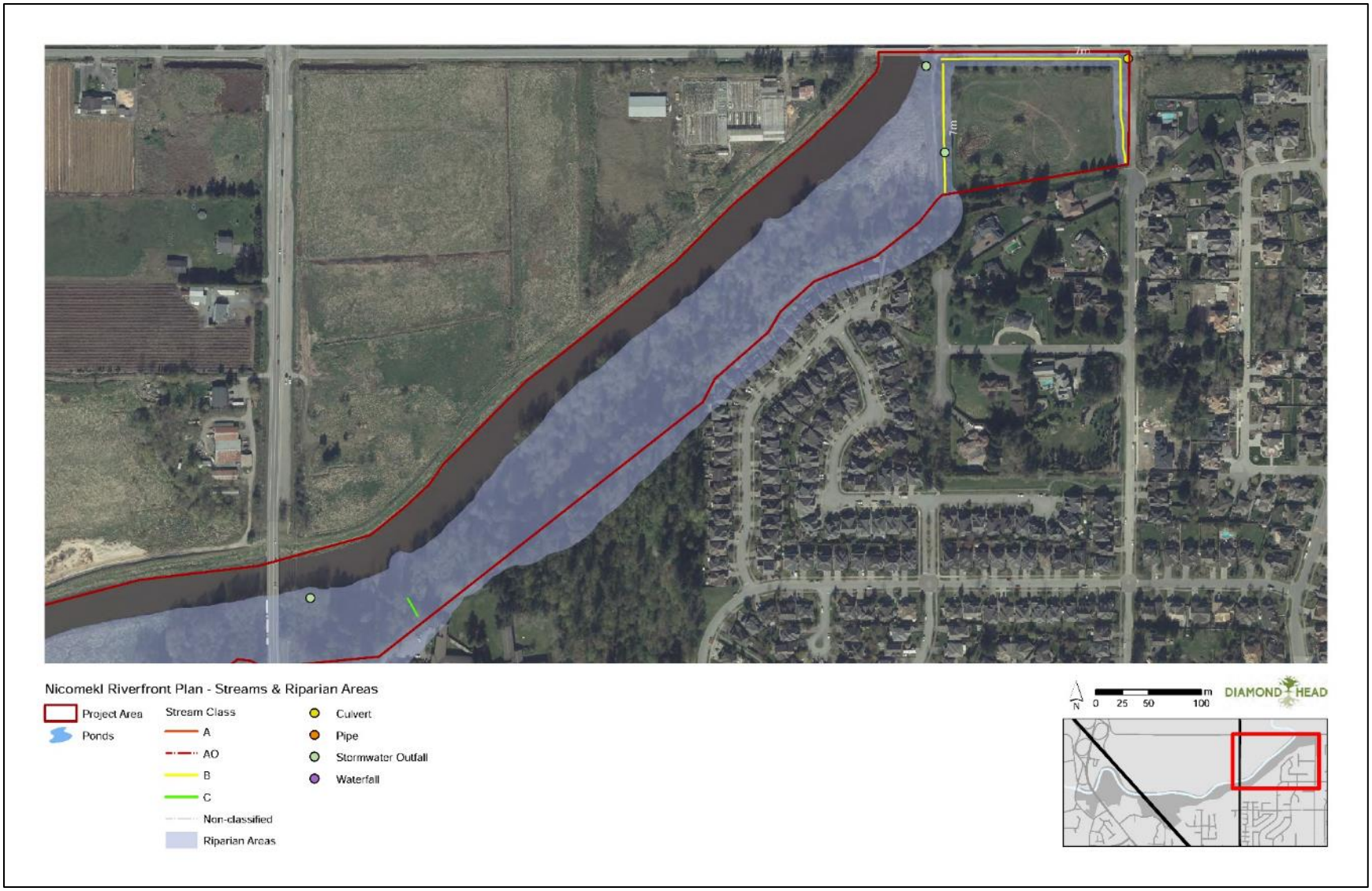


**Figure 10: Watercourses and stormwater features located on the eastern end of the site.**

### 2.5.1 Elgin creek

Elgin Creek is a natural creek that flows north east then curves north west and drains into the Nicomekl River. It is classified as a Class A fish bearing stream. Elgin Creek is a relatively flat, channelized stream that averages 2.5m wide with areas as wide as 6m and an average depth of 0.3m. The creek streambed consists of sand and organic material (80%), boulders (15%) and cobble (5%). The bank slopes range with an average slope of 80% on the left and 30% on the right. The left bank is generally higher than the right with an average of 1.5m and 1.0m respectively. The banks and riparian vegetation at the south of the site have extensive English ivy growing and would benefit from its removal.

Elgin Creek flows into the Nicomekl River west of King George Boulevard. Fish species observed in recent years include the Coho Salmon, Coastal Cutthroat Trout, Rainbow Trout, and Threespine Stickleback. At present time, Elgin Creek is fish passable throughout the site. Base flows of the creek are maintained by the City to ensure fish access. There are a few noted obstructions further upstream and south of the site including falls from the culvert that may block the salmonid migration. There is an existing fish-passable culvert under Crescent Road which occasionally exceeds capacity. Plans to replace it in the future include making it larger and more fish friendly.

Small waterfall near middle of the section of Elgin Creek found on site.

Elgin Creek turns briefly west at the north end of the site. Vegetation here is minimal and soils are exposed.

View of the northern end of Elgin Creek.

Connection between the on-site pond and Elgin Creek.

View of the mouth of Elgin Creek, facing north.

Understory vegetation is highly modified in places, with minimal vegetation cover and extensive invasive species (ex. English ivy).

Elgin Creek, further upstream.

Elgin Creek and southern edge of property. Thick English ivy is found on several of the trees.

### 2.5.2 Anderson creek

Anderson creek is a naturally occurring watercourse the mouth of which is located just east of highway 99. It flows north at a gradual incline and drains into the Nicomekl River. It is defined as a Class A fish bearing stream with an average width ranging from 3 to 5 m and depth of 0.5m. Near the middle section, the creek widens up to 20m and has multiple areas prone to flooding. The streambed is composed of sand and organic matter (90%) and gravel (10%). Further upstream, the creek contains a large amount of wood debris.

Anderson creek is home to several fish species. Fish species observed in recent years include Coho Salmon, Cutthroat Trout, Minnow, and Steelhead Trout. Past culverts which restricted fish movement on Anderson Creek have since been upgraded. There was a culvert under King George Boulevard that was replaced with a bridge structure in 2014/2015. There is also a culvert where Anderson drains into Nicomekl River which was recently replaced and is believed to be fish passable.

View of Anderson Creek, facing south.

View of Anderson Creek with minimal native riparian vegetation, and thick Himalayan blackberry covering its left bank.

View of Anderson Creek, before it flows under the berm through a culvert. Facing north.

View of upper reaches of Anderson creek

Culvert where Anderson Creek flows into Nicomekl River. This has recently been replaced.

### 2.5.3 Barbara Creek

Barbara Creek is a naturally occurring channel that is a Class A fish bearing stream. It has an average width of 2.8m and depth of 0.3-0.6m. The creek's streambed is composed of gravel (30%), cobble (20%), sand (20%) and boulders (5%). The creek's banks are quite vertical. The right bank is generally higher and steeper, with its average height at 0.8m and slope of 100% compared to the left bank height at 0.6m and slope of 80%. Signs of bank erosion are noticeable. There are some leaning trees along the bank as well as some large woody debris. The channel gradient is gradual at ~2%.

Barbara Creek is a tributary of the Nicomekl River, located between Highway 99 and 152nd Street in the project area. Coho Salmon, Cutthroat Trout, Sculpin, and Steelhead//Rainbow Trout have been observed in this creek. Woody, concrete, and asphalt debris as well as a dam upstream from the project area have been recorded as possible obstructions for fish passage.

Barbara Creek, upstream of Nicomekl.

Photo of Barbara Creek showing the creek bed and some large woody debris (LWD).

View of Barbara Creek from the Nicomekl

Barbara Creek draining into Nicomekl River

### 2.5.4 Additional natural and constructed watercourses and stormwater features.

There are a number of additional natural and constructed watercourses, ponds and stormwater features throughout the site. These are generally smaller in size, but crucial for water and nutrient supply to the larger creeks and Nicomekl River, additional habitat, and stormwater management.

Eastern end of the pond on the 14391 Crescent Road property.

Example of series of smaller ponds on the 14391 Crescent Road property.

Constructed ditch east of Highway 99, directing stormwater out of the new development and into the Nicomekl River.

Constructed watercourse east of Highway 99 under a newly built access road, draining into the Nicomekl River.

Stormwater outfall west of Barbara Creek.

Small creek outfall on the eastern end of the Elgin St. property with a fish gate blocking the end.

Stormwater outfall.

Constructed ditch, partially consisting of rusty metal half pipe.

## 2.6 Wildlife

The study area provides a wide range of habitat for wildlife, from dense shrub and grass communities to forests of varying ages, floodplains, open water features, and wetlands. The naturalized areas east of 150 Street, which includes Barbara creek, provides relatively isolated and naturalized habitat areas away from roads and urban areas. These areas provide protected interior habitat and are used as refuge by many species. The steep banks, wet floodplains, and the River have kept humans away from these areas, thereby increasing their value for wildlife.

There are natural areas east of 152nd and adjacent to the south park that provide connected high value forest habitat. This area is under development which is expected to negatively impact the wildlife that inhabit it.

Modified and developed areas through the western portion of the project are likely inhabited by a high proportion of scavengers, mostly birds and small mammals, that are more tolerant of urban disturbance. In general, the diversity of species is expected to decrease with proximity to roads and development. The golf course is occupied by turf grass and landscaped areas that provide limited habitat.

The park area on the south bank of the Nicomekl will provide high value to local wildlife species, partly due to its connectivity with adjacent natural habitat areas. The entire park area has been identified as an important wildlife movement corridor in the Green Infrastructure Network (GIN) for the City of Surrey's Biodiversity Conservation Strategy (Figure 11). There are extensive signs of wildlife traveling east to west across the study area.

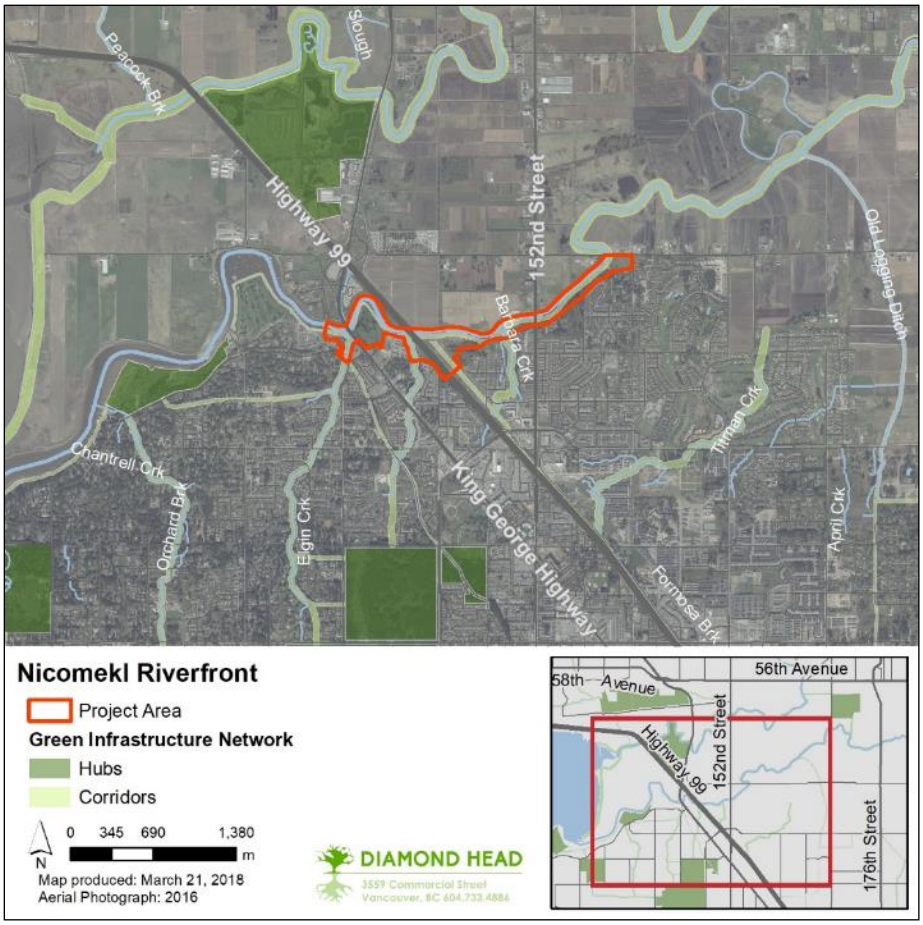


**Figure 11: Location of this park in the City of Surrey's Green Infrastructure Network (GIN).**

A detailed wildlife survey was not completed for this site. The following is a general account of what species may be expected to be present for some or all of the year based on existing habitat and habitat condition. This was further refined based on the level of disturbance, size, and connectivity of habitat. Any habitat features, manmade features, and signs of wildlife were also recorded in the field (Figures 12-14).

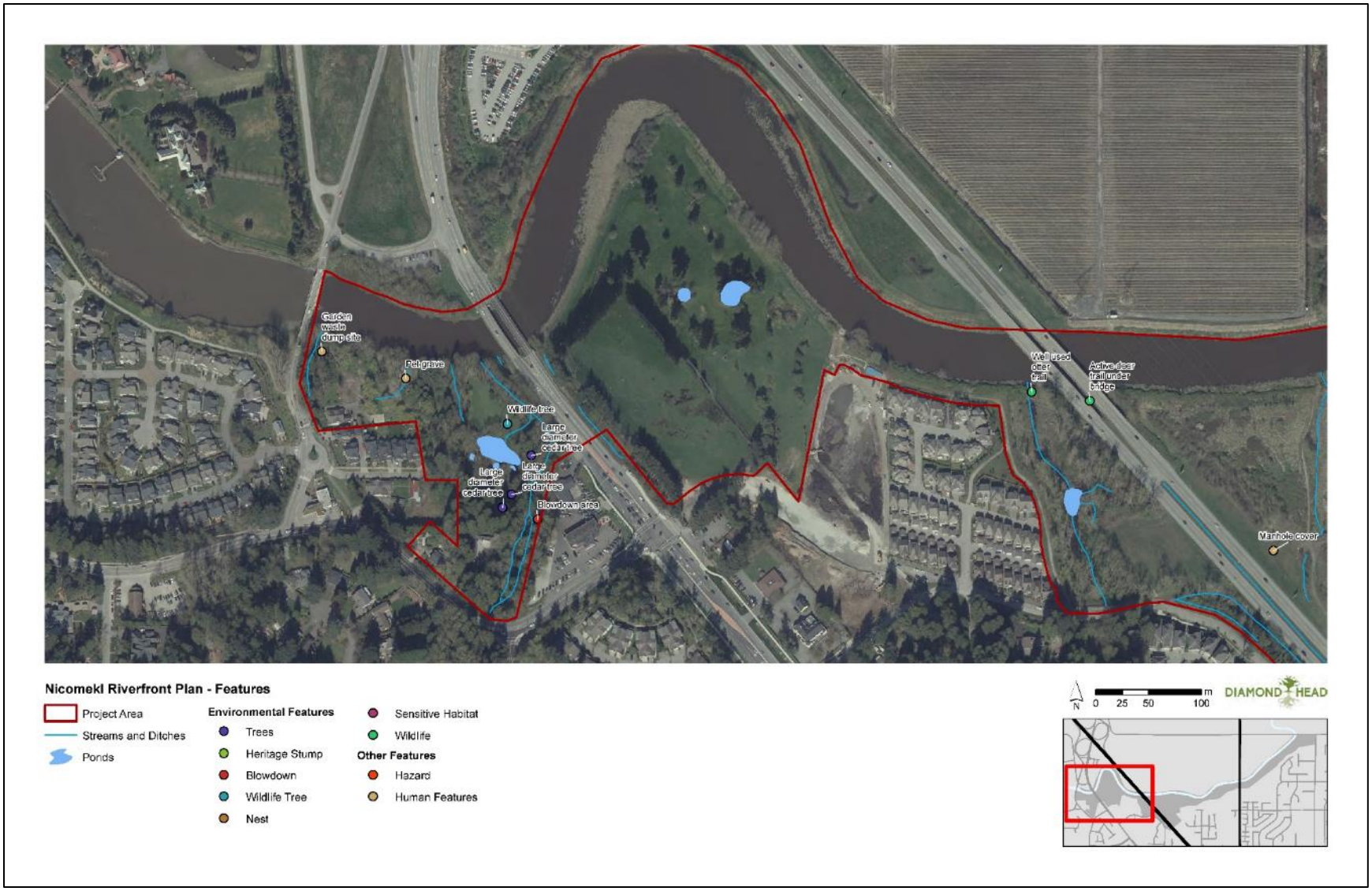


**Figure 12: Ecological features and signs of wildlife on the western end of the site.**

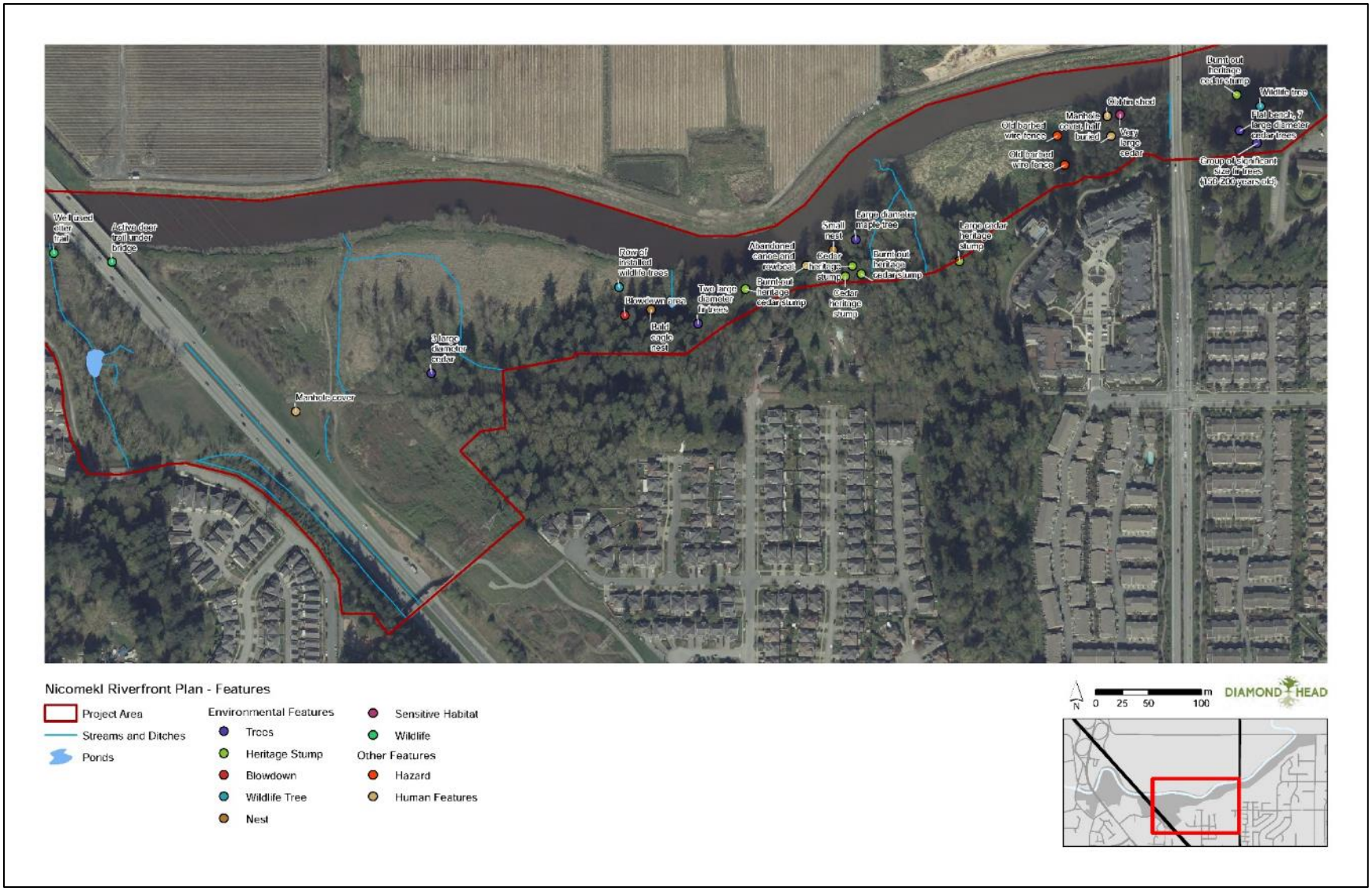


**Figure 13: Ecological features and signs of wildlife on the centre of the site.**

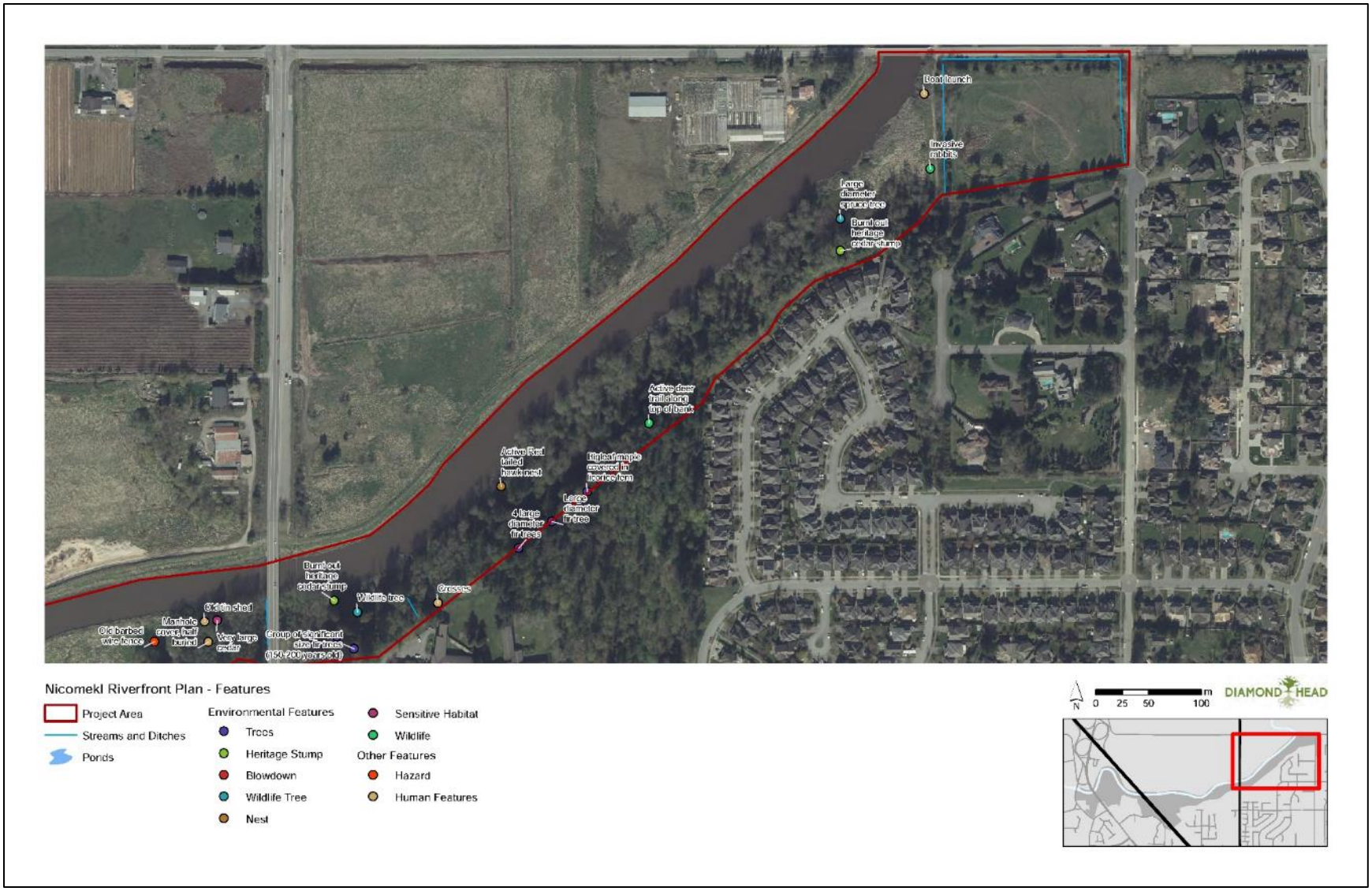


**Figure 14: Ecological features and signs of wildlife on the eastern end of the site.**

Wildlife tree, with nest in cavity.

Large Douglas Fir trees, ~150+ years old.

Burnt out cedar heritage stump.

Otter trail from Nicomekl River to Anderson Creek.

Heritage cedar stump.

### 2.6.1 Fish and Wildlife

**Birds**

The Mud Bay intertidal zones form part of the Pacific Flyway, which is a bird migration route along the west coast between wintering areas and nesting habitat. The mud flats of Boundary Bay are critical areas where large migrating flocks stop, rest, and feed to ensure they have enough energy for the rest of their migration.

Birds that inhabit this area are likely diverse, with a number of species that seasonally feed and nest in the project area. The combination of streams, forest, shrub communities, and agricultural fields provide habitat for resident and migratory bird families including raptors, doves, kingfishers, swallows, hummingbirds, woodpeckers, great blue herons, flycatchers, wrens, jays, crows, chickadees, nuthatches, thrushes, vireos, warblers, sparrows, and finches.

Red tailed hawks and bald eagles were seen using the larger trees on site for roosting, and the adjacent fields, and estuary areas for hunting. One red tailed hawk nest was identified and is active in a large Sitka spruce tree growing on the floodplain east of 152nd street. Bald Eagles were observed mating in a mature Douglas-fir tree close to Barbara creek on March 6th. An active Bald Eagle nest exists within a spruce tree at the east end of the park being developed east of highway 99. A pair of breeding eagles has historically been observed in this area as of 2016[6]. When construction for a nearby development began, the nest tree was more exposed after tree falling. A platform was installed in an alternate nest tree to provide additional nest options post development. It is expected that the identified nest was constructed by the same pair.

Active Bald eagle nest in spruce tree

[6] Arbortech Consulting. 2016. Provisional Eagle Nest Tree Modification Project.

Eagle perched next to the active nest

Active red-tailed hawks nest

Numerous old cup and cavity nests were found

### Mammals

No formal survey for mammals was conducted, however the natural forest areas in this park provide habitat to support a diversity of mammals. Larger mammals that inhabit this area include coyote and black tailed deer. Extensive evidence (trails and scat) was found on site for both species. There is a well used deer trail that extends along the top of bank from 152nd to 154th. Extensive tracks under Highway 99 suggest that this is an important movement corroder and deer often travel east to west through this area. The bridge under Hwy 99 provides the only safe passage in the area for deer to avoid this high traffic road.

Tracks showing deer movement under the highway 99 bridge

Deer scat

Coyote scat

A wide range of medium and small mammals likely inhabit this area, including beaver, skunk, marten, mink, racoon, and weasels. Signs of beaver were observed at the base of Anderson Creek. There is also a well-used connecting trail for otters that connects Anderson Creek to the Nicomekl River.

Beaver damage for birch tree

Otter trail at Anderson creek

Smaller mammals include a variety of rodents, hares, and shrews. A variety of bats likely inhabit this area.

Species of smaller mammals expected to inhabit the study area include:

- Mouse family (*Muridae*) including a variety of mice rats and voles
- Jumping Mouse family (*Zapodidae*)
- Squirrel family (*Sciuridae*) including chipmunks and the ground and flying squirrels
- Mole family (*Talpidae*) including the coast mole
- Shrew family (*Soricidae*)
- Eastern Cottontail (*Sylvilagus floridanus*), a non-native species originally introduced to Washington
- Snowshoe Hare (*Lepus americanus*)

Medium sized mammals likely to inhabit this area (as part of a larger range) include:

- Short-tailed weasil (*Mustela erminea*)
- Long-tailed weasil (*Mustela frenata*)
- Western spotted skunk (*Spilogale gracilis*)
- Striped skunk (*Mephitis mephitis*)
- Common racoon (*Procyon lotor*)
- Beaver (*Castor canadensis*)

There are a number of bats that could potentially inhabit the park including:

- Big Brown bat *(Eptesicus* fuscus)
- Townsend's Big-eared bat (*Plecotus townsendii*)
- Little brown myotis (*Myotis lucifugus*)

#### Herpetofauna

No formal survey for reptiles and amphibians was conducted; however, some are expected to inhabit this area based on the habitat present. There are several permanent waterbodies present which can permit breeding for some species. Also, there are numerous natural areas adjacent to wetlands and open water that provide high value habitat for amphibians.

Species that may be present for part or all of the year include those associated with terrestrial habitats for some of their life cycle; these include the Red-legged Frog (*Rana aurora*), Pacific Treefrog (*Pseudacris regilla*), Northwestern Salamander (*Ambystoma gracile*), Long Toed Salamander (*Ambystoma macrodactylum*), Ensinata salamander (*Ensanita eschscholtzii*), and Common Garter Snake (*Thamnophis sirtalis*).

#### Fish

Nicomekl river drains into Mud bay immediately downstream of the study area. Tidal influences are managed by sea dams at Hwy 99. Despite the impacts of dykes and development, there is a migration of salmon up the river. Fish species that have been found to be present in Nicomekl River include:

- Coho Salmon (*Oncorhynchus kisutch*)
- Brassy Minnow (*Hybognathus hankinsoni*)
- Fathead Minnow (*Pimephales promelas*)
- Brown Catfish (*Ameiurus nebulosus*)
- Rainbow Trout (*Oncorhynchus mykiss*)
- Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*)
- Prickly Sculpin (*Cottus asper*)
- Pumpkinseed (*Lepomis gibbosus*)
- Redside Shiner (*Richardsonius sp.*)
- Threespine Stickleback (*Gasterosteus aculeatus*)
- Western Brook Lamprey (*Lampetra richardsoni*)
- Invasive Goldfish (*Carassius auratus*)

### 2.6.2 Species and Ecological Communities at Risk

The BC Conservation Data Centre (CDC) records BC's most vulnerable vertebrate animals and vascular plants, each of which is assigned to a provincial Red or Blue list according to their provincial conservation status rank. Species or populations at high risk of extinction or extirpation are placed on the Red list and are candidates for formal endangered species status. Blue-listed species are considered vulnerable to human activity and natural events.

### Species at Risk

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No species at risk were identified at the site during the field visit. The Great Blue Heron (*Ardea Herodias fannini*) is the only species previously identified by the Conservation Data Centre close to the study area. They had a colony on the north bank of the Nicomekl River, directly north of the study site, from 1984 to 2014 with as many as 128 active nests in 2011. However, the main nesting trees were cut down in 2012, and the CDC does not have any records of Great Blue Herons there since 2014. Wildlife species at risk that could potentially inhabit the study area or the adjacent natural area are listed in Table 4.

**Table 4: Species at Risk that could potentially inhabit the areas in and adjacent to the study area**

| Common Name | Scientific Name | B.C. Status |
|---|---|---|
| Long-tailed weasel | *Mustela frenata altifrontalis* | Red |
| Southern Red-backed Vole | *Clethrionomys gapperi occidentalis* | Red |
| Keen's Long-eared Myotis | *Myotis keenii* | Blue |
| Pacific Water Shrew | *Sorex bendirii* | Red |
| Great blue heron | *Ardea herodias* | Blue |
| Townsend's Big-eared Bat | *Corynorhinus townsendii* | Blue |
| Red-legged Frog | *Rana aurora* | Blue |
| Olive-sided Flycatcher | *Contopus cooperi* | Blue |
| Barn Swallow | *Hirundo rustica* | Blue |
| Western Screech-Owl, kennicottii subspecies | *Megascops kennicottii kennicottii* | Blue |
| Band-tailed Pigeon | *Patagioenas fasciata* | Blue |
| Trowbridge's Shrew | *Sorex trowbridgii* | Blue |

### Plant Communities at Risk

All rare and endangered plant communities are mapped based on data retrieved from the Conservation Data Centre (CDC). Rare and endangered plant communities that occur within the study area are identified in Table 5.

**Table 5: Conservation Data Centre ranked plant communities located within the study area.**

| Common Name | Scientific Name | BEC Unit | BC Status |
|---|---|---|---|
| Populus trichocarpa / Salix sitchensis | black cottonwood / Sitka willow | CWHxm/10 (Low bench floodplain) | Red |
| Populus trichocarpa - Alnus rubra / Rubus spectabilis | black cottonwood - red alder / salmonberry | CWHxm/09 (Medium bench floodplain) | Blue |
| Picea sitchensis / Rubus spectabilis Very Dry Maritime | Sitka spruce / salmonberry Very Dry Maritime | CWHxm/08 (High bench floodplain) | Red |
| Thuja plicata / Polystichum munitum Very Dry Maritime | western redcedar / sword fern Very Dry Maritime | CWHxm/05 | Blue |
| Thuja plicata / Tiarella trifoliata very Dry Maritime | western redcedar / three-leaved foamflower very Dry Maritime | CWHxm/07 | Blue |

## 3.0 Opportunities for Enhancement

This park provides a unique and significant opportunity to protect a highly diverse natural area. This area is large in size, is continuous and connected to adjacent natural or semi natural areas, and provides a wide range of habitat features. There are some opportunities to enhance these areas , restore previous disturbance, and protect them from the influences of human development. The following sections include a number of recommendations that should be considered during the design phase of the park. More detail will be provided in the later stages of planning.

**Figure 15: Opportunities for habitat enhancement on the west end of the site.**

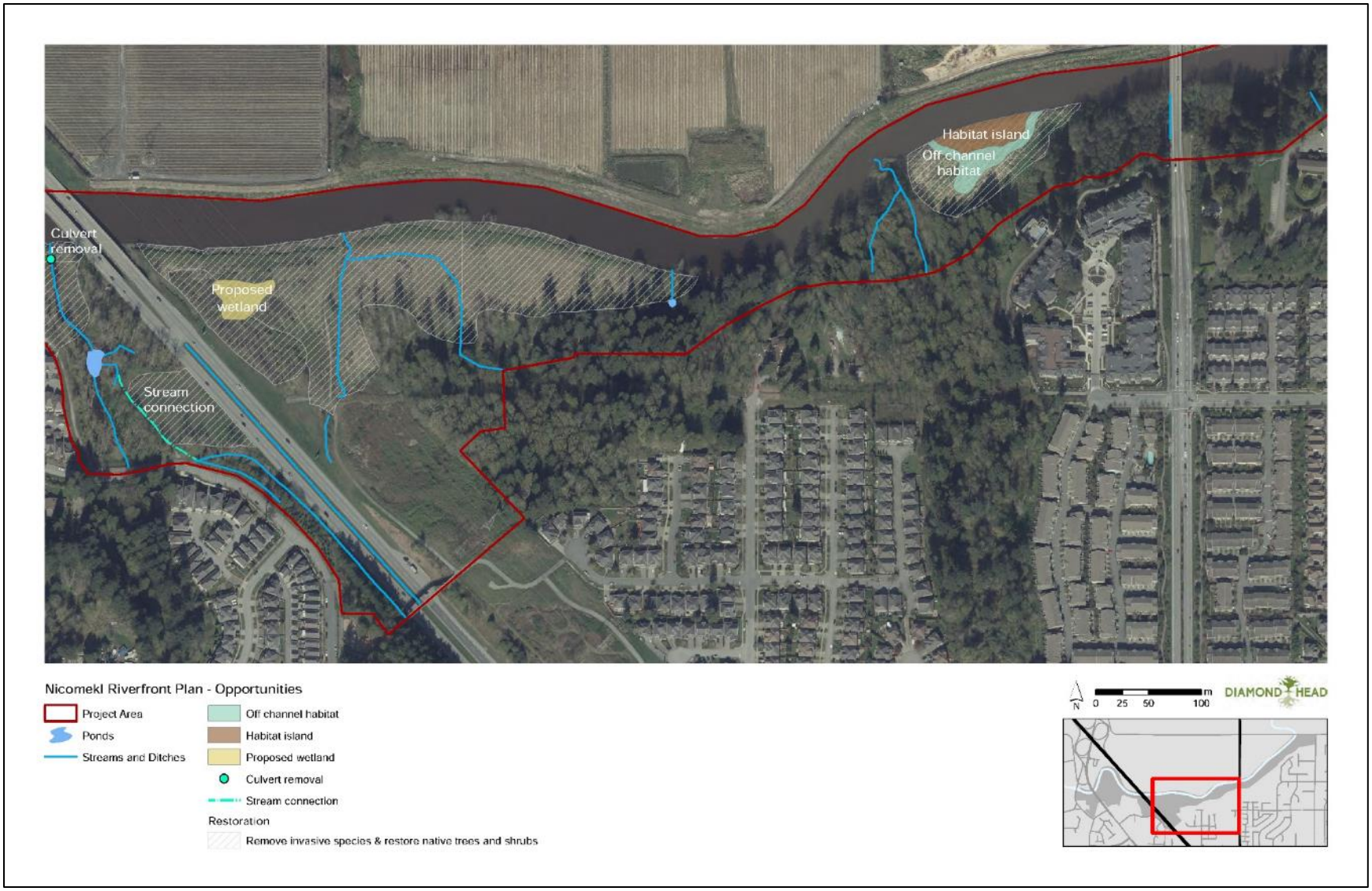


**Figure 16: Opportunities for habitat enhancement in the centre of the site.**

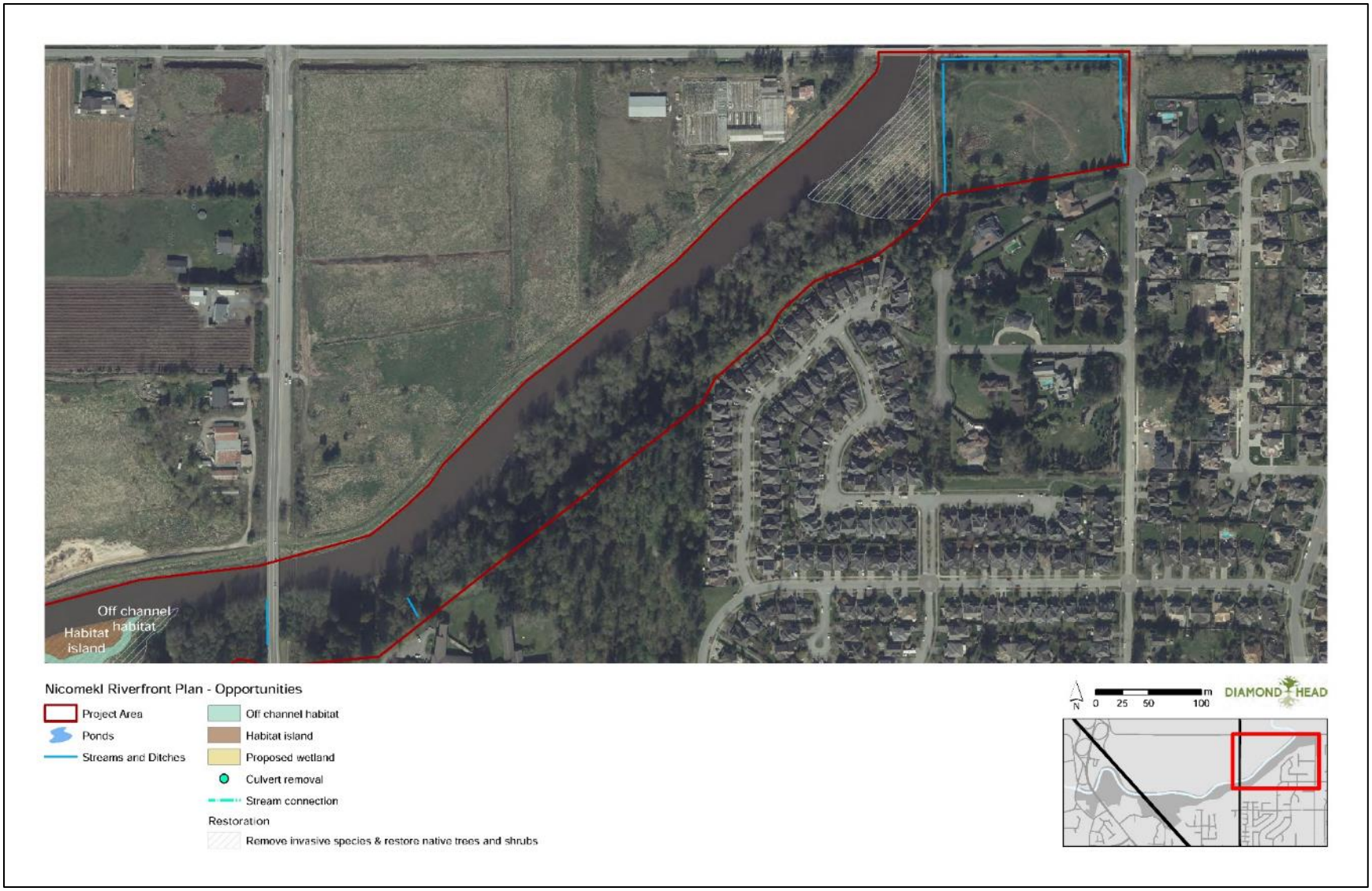


**Figure 17: Opportunities for habitat enhancement on the east end of the site.**

### 3.1 Enhance tree and shrub cover along the Nicomekl river

Tree cover along the south side of the Nicomekl river is critical for shading, stabilizing banks, and providing leaf litter input. The areas east of Barbara creek generally provide good riparian vegetation with the exception of two large areas dominated by reed canary grass. The areas west of Barbara creek have generally been disturbed. Many areas where previous dykes were constructed have little tree cover or bank complexity. Where these dykes are not subject to the Dike Maintenance Act and required to be maintained, they should be replanted with native trees and shrubs. The area between Barbara creek and highway 99 is currently under restoration with a commitment in place through a P-15 agreement. There is great opportunity to restore riparian plant cover at the golf course site and east to Highway 99. Restoration of native plant communities can provide important habitat for animal species, increase biodiversity, and create the conditions for a more resilient and ecological system. Climate change should be considered during replanting and species integrated that are more adaptable to slightly direr climates found west on the gulf islands and the Victoria area.

The existing dykes are drier than the undisturbed areas. If left in place, recommended species to be considered for planting are summarized in Table 6. It is expected that pioneer species such as Red alder and Black cottonwood will established naturally in these areas. Access for watering and maintenance must be a consideration when planning these restoration areas.

**Table 6: Native tree and shrub species recommended for replanting the berm along Nicomekl River to enhance riparian areas.**

| Botanical Name | Common Name |
|---|---|
| **Trees** | |
| *Pseudotsuga menziesii* | Douglas-Fir |
| *Acer macrophyllum* | Broadleaf Maple |
| *Abies grandis* | Grand Fir |
| *Rhamnus purshiana* | Cascara |
| *Thuja plicata* | Western Red Cedar |
| **Shrubs** | |
| *Acer circinatum* | Vine Maple |
| *Symphocarpos albus* | Snowberry |
| *Philadelphus lewisii* | Mock-orange |
| *Corylus cornuta* | Beaked Hazelnut |
| *Gaultheria shallon* | Salal |
| *Ribes sanguineum* | Red Flowering Currant |
| *Polystichum munitum* | Sword Fern |
| *Oemleria cerasiformis* | Indian Plum |
| *Amelanchier alnifolia* | Saskatoon |
| *Mahonia nervosa* | dull Oregon-grape |
| *Holodiscus discolor* | Ocean Spray |
| *Rosa gymnocarpa* | Baldhip Rose |

In areas where there are generally no dykes restricting water flow, the moisture regime is classified as wet. Recommended species for these areas are summarized in Table 7.

**Table 7: Native tree and shrub species recommended for replanting in wetter sites.**

| Botanical Name | Common Name |
|---|---|
| **Trees** | |
| *Alnus rubra* | Red Alder |
| *Populus trichocarpa* | Back Cottonwood |
| *Rhamnus purshiana* | Cascara |
| *Picea sitchensis* | Sitka Spruce |
| *Thuja plicata* | Western Red Cedar |
| **Shrubs** | |
| *Lonicera involucrata* | Black Twinberry |
| *Rubus spectabilis* | Salmonberry |
| *Crataegus douglasii* | Black hawthorn |
| *Ribes bracteosum* | Stink currant |
| *Cornus stolonifera* | Red-osier Dogwood |
| *Oplopanax horridus* | Devil's club |
| *Oemleria cerasiformis* | Indian Plum |
| *Sambucus racemosa* | Red elderberry |
| *Salix Sp* | Willow (Pacific, Scouler,Sitka) |
| *Spiraea douglasii* | Hardhack |
| *Physocarpus capitatus* | Pacific Ninebark |

## 3.2 Wildlife Habitat Features

Areas that have previously been disturbed or are dominated by invasive species provide a limited diversity of habitat features. Creation of additional artificial and natural habitat features wherever possible will improve overall biodiversity in the park. Habitat enhancement recommendations are discussed below and conceptually illustrated in Figure 18.

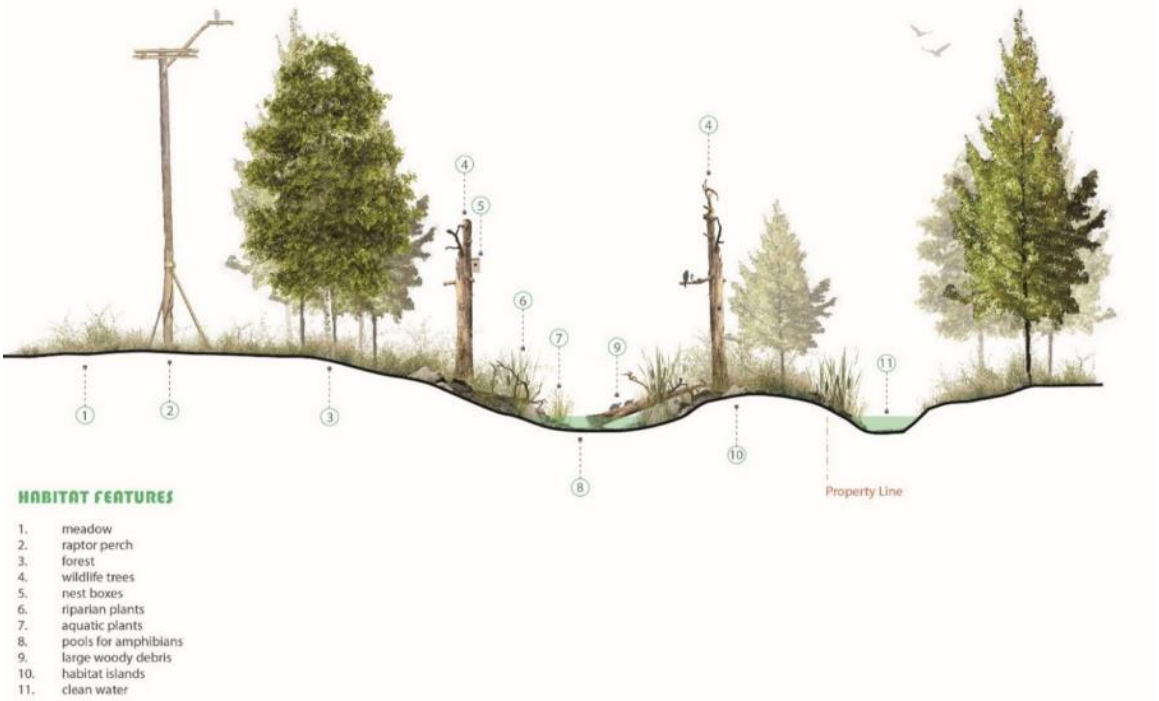


**Figure 18: Habitat Features to be Incorporated into the Environmental Program.**

### Large Woody Debris

Larger tree trunks that have fallen are often called downed wood, large woody debris (LWD) or coarse woody debris (CWD). These features provide shelter, feeding sites, and movement pathways for wildlife. They also act as nurse logs for plants, add organic matter and nutrients to the soil, and help to stabilize slopes, reduce erosion, and control sediment runoff. As a critical restoration substrate, large wood should be retained and reintroduced wherever possible.

- Generally speaking, more wood is preferable to less; target density should be a minimum of 200 pieces per hectare (two per 100 $m^2$);
- Preferred sources are native conifer species. The amount of western redcedar placed near water sources should be minimal due to the levels of auxins (plant hormone) present in the wood;
- Large stumps or logs should be used. Logs should be a minimum of 30 centimetres diameter and four (4) metres long;
- Large woody debris should be strategically interconnected, with some extending into the water; single pieces, including stumps, can also be placed in the water to provide cover habitat.

The City of Surrey has a natural areas management strategy with the explicit purpose to maximize the ecological and human benefits of enhanced CWD in natural areas[7]. This document should be used to guide the CWD strategy on site.

[7] Parks, Recreation and Culture Department, City of Surrey. N.D. Natural Areas: Coarse Woody Debris Management Strategy.

Examples of CWD placement on restoration sites at KM4 in the Lower Seymour Conservation Reserve and in Tynehead Regional Park (photo: Diamond Head Consulting).

### Standing Wildlife Trees

Dead standing trees or 'planted wildlife trees' are important habitat features for birds, mammals, amphibians and other organisms. They provide forage, roosting and nesting sites for a diversity of bird species. They are also a source of organic nutrient inputs. If at any point an excavator is being used on site, it could be used to install wildlife trees.

- Wildlife tree density should target 25 stems/ha;
- Logs should be native conifer species;
- One third to one half the length of a wildlife tree should be buried to ensure stability;
- Trees should be placed leaning away from structures and people;
- Logs should be a minimum of 40 cm in diameter and 6 m long; and
- Wildlife trees should be installed at variable spacing (single trees no closer than 10 metres apart) and in clusters (several trees grouped together).

Standing wildlife trees.

### Raptor Perches and Nests

Raptors have a preference for perching above hunting areas. The playing field, meadow habitat and wetland areas should provide good habitat for prey. Raptors perches should be installed along the forest edge and in the habitat islands. These should be a height that exceeds the natural canopy height (30-40m). Perches can be metal or wood poles with a perch/nesting structure at the top.

### Nest Boxes

Raised nest boxes located on artificial posts or pilings provide secure habitat protected from terrestrial predators and human disturbance. Nest boxes should be designed for local cavity nesting birds. There are over 30 bird species that are known to use nest boxes, including raptors, waterfowl, and songbirds. These features require maintenance to be successful. Installation and maintenance of nest boxes should be coordinated with local stewardship groups.

A barn owl box was installed nearby in Elgin Heritage Park to the west. This has been successful in supporting breeding pairs. A similar installation should be considered within Nicomekl park.

### Bat Boxes

Natural bat roosts are declining, particularly in urban areas. Building bat boxes as part of a restoration project can be successful as there are usually numerous insects for feeding. Boxes should be installed high up on a wildlife tree or artificial post and be located near a water source in an area that receives ample sunshine.

### Mason Bee Nesting Features

Nesting features for native mason bees should be considered at various areas of the park. Surrey Nature Centre includes a large mason bee nest installation that has been very successful. These do require maintenance which could be coordinated with local stewardship groups.

## 3.3 Creation of habitat islands

Habitat areas that are isolated from humans and pets are extremely valuable especially for nesting birds. The golf course could be fragmented by a channel to create an island that could be naturalized for wildlife. This would provide a highly valuable natural area for wildlife that are more sensitive to human presence. A second area to consider is east of Barbara creek which is dominated by reed canary grass. This area is large enough that an off channel could be created to isolate a small island. These features will also increase the capacity of the park to handle flooding events which are expected to increase with climate change and rising sea levels.

## 3.4 Creation of off channel ponds and wetlands

The influence of tides and the extent of estuarine habitat areas is limited by the Sea dam and dykes. This lower reach of the river is critical for adult and juvenile salmon for forage, cover from prey and to provide a zone for adaptation to the transition from salt to fresh water during migration. The creation of protected intertidal or wetland/pond complexes in the lower reaches of the river would greatly benefit a diversity of wildlife species. The lowland areas that are disturbed or dominated by invasive species provide an excellent opportunity to create some permanently wetter ponds and wetland features.

An off-channel pond could be constructed in the naturally flooding area in the golf course site.

Large reed canary fields provide an opportunity to create off channel ponds or wetlands

## 3.5 Daylight streams

There are two constructed streams the run south along the west side of Highway 99 into a culvert which drains into Anderson creek. There is a large turf field between Anderson creek and these creeks that could be used to connect these reaches. This land is owned by the Ministry of Transportation, not the City of Surrey and is outside the scope of this project.

Turf field adjacent to Highway 99 could be used to daylight the upper Anderson creek

## 3.6 Invasive Species Management

Invasive species should be managed to protect natural biodiversity and prevent further spread and encroachment to and from adjacent areas. These should be treated using the current best management practices for each species. Manual removal is recommended wherever possible in order to minimize the introduction of chemical herbicides into sensitive environmental areas. Some species, such as Japanese knotweed, do not respond to manual control methods and chemical control methods such as foliar Glyphosate application should be considered. Large areas of Reed Canary grass can be dug up using an excavator or overplanted with large stock black cottonwood and red alder; increasing canopy cover has been found to be one of the most effective methods to shade out reed canary grass over time. English ivy should be manually removed from the base of all trees, with roots severed at breast height. Exact treatment and control methods are dependent on site conditions and the species encountered and may require adapted and site-specific control plans.

Invasive species control and removal should always be considered a first step in a more holistic process of ecological restoration. Areas with extensive invasive species removal should be replanted as soon as feasible with native plant communities. Invasive species are quick to colonize disturbed areas. Areas with extensive removal or control are often very susceptible to reinvasion by the same or other species if not replanted with native species.

## 3.7 Connection and enhancement of the Elgin creek ponds

The ponds that have been constructed adjacent to Elgin creek provide an excellent opportunity to provide overwintering habitat for young Coho salmon. According to City staff, these ponds were previously used for rearing young salmon. The channel of Elgin Creek is very close to the central pond. Connecting it would require some hydrological analysis and control measures to ensure water flow is suitable for both the pond and Elgin Creek, while creating improved access for Coho salmon. This work would require an approval from the Provincial Government under the Water Sustainability Act.

The edges of these ponds should be planted with native trees and shrubs. Habitat features such as woody debris and wildlife trees should be established around the edges, improving the function of the ponds for a variety of species.

View of ~10m possible connection point between Elgin creek and the pond.

Outlet channel from the pond could be restored to facilitate fish passage.

## 3.8 Removal of culverts to improve fish passage

Anderson Creek presently flows through a culvert before draining into Nicomekl River. Culverts can create natural barriers to fish passage. It is recommended that the culvert is removed and the connection between Anderson and Nicomekl is naturalized. This will improve fish access to Anderson Creek and provide additional freshwater habitat. This would assist in meeting one of the goals of the Nicomekl park, which is to ensure continued fish passage into Elgin, Barbara, and Anderson Creeks. This culvert was recently replaced with one that is free flowing. The City requires a culvert or bridge in this area for the recreation trail that goes across it.

Culvert from Anderson creek. This has recently been replaced with one that is free flowing.

# Appendix A - Ecological Data Forms

**Figure 19: Ecotype Polygons – western end of the site.**

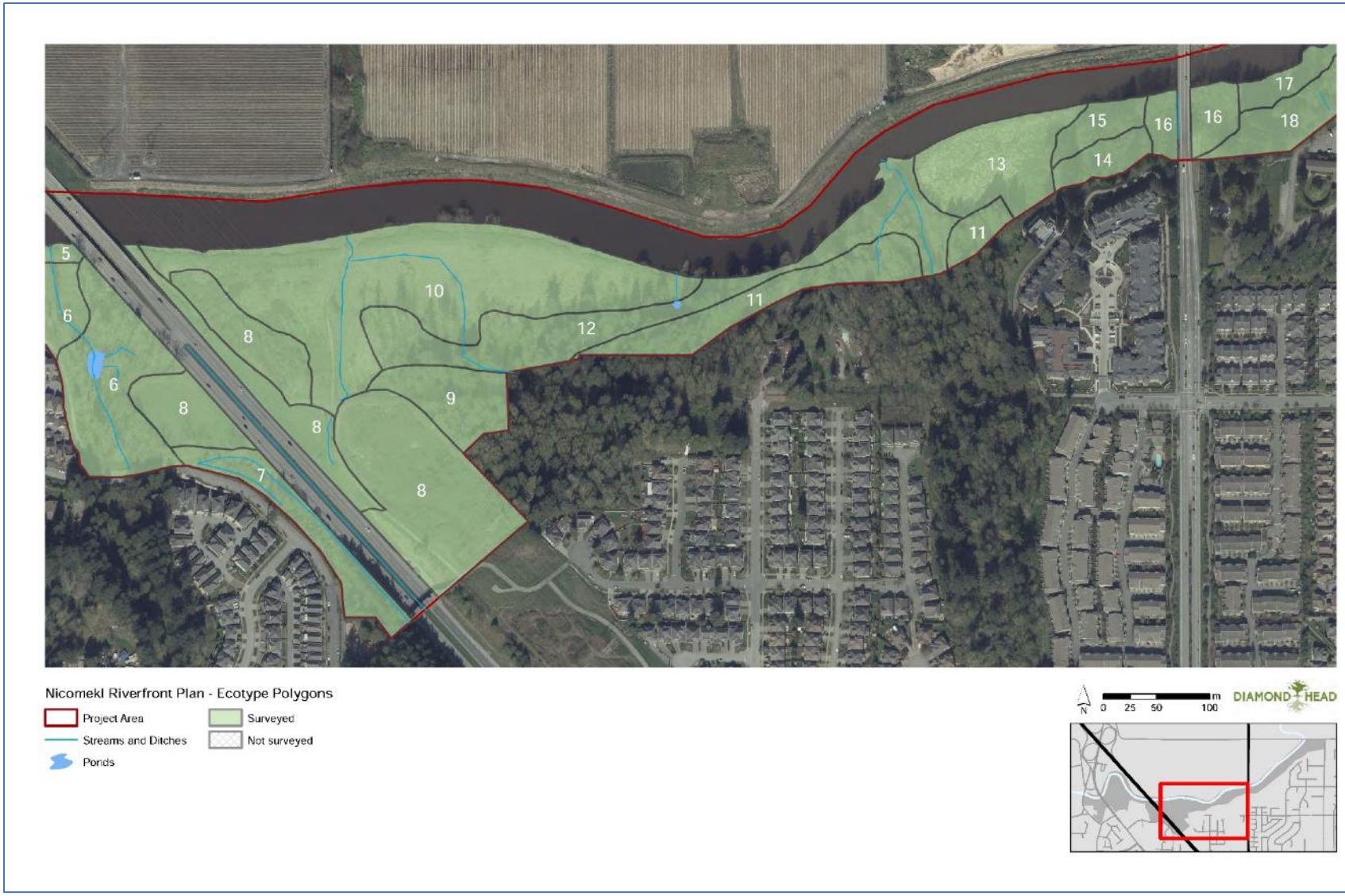


**Figure 20: Ecotype Polygons – central part of the site.**

**Figure 21: Ecotype Polygons – eastern part of the site.**

## Polygon # 1

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0-15 | Variable | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Fill in many areas. Sandy loam to clay loam | D/5-6 | Moder - 3 | 07 on fill, floodplain on lower flats (08 or 09) |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | $Act_5Fd_5$ | $W_2Dr_2Mb_3Cw_1S_1\ Ep_1$ | $Bg_1Mb_4Cw_3S_4Ep_4$ | $Bg_3Cw_4S_3$ | - |
| Density (stems/ha) | 10 | 250 | 50 | 50 | - |
| Tree diameter at breast height (cm) | 80 | 40 | 15 | 8 | |
| Tree height (m) | 37 | 25 | 15 | 6 | |
| Live crown ratio | 60 | 70 | 80 | 80 | |
| Crown closure (%) | 35 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (spruce)

### Observations:

- Some old fruit trees
- Some spruce are planted (non-native species)
- One area used for landscape dumping

| UNDERSTORY VEGETATION – Total Cover – 70-80% | | |
|---|---|---|
| Species | | Avg % Cover |
| Buttercup | *Ranunculus sp.* | *8-10* |
| Grasses | | *10* |
| Hardhack | *Spiraea douglasii* | *5* |
| Hazelnut | *Corylus cornuta* | *2* |
| Herb Roberts | *Geranium robertianum* | *2-5* |
| Horsetail | *Equisetum sp.* | *5-10* |
| Indian plum | *Oemleria cerasiformis* | *5* |
| Nootka rose | *Rosa nutkana* | *2* |
| Red elderberry | *Sambucus racemosa* | *2* |
| Salmonberry | *Rubus spectabilis* | *10* |
| Snowberry | *Symphoricarpos albus* | *8* |
| Sweetscented bedstraw | *Galium odoratum* | *1* |
| Sumac | *Sumac sp.* | *+* |
| sword fern | *Polystichum munitum* | *2-3* |
| Trailing blackberry | *Rubus ursinus* | *3* |
| Vine maple | *Acer circinatum* | *8* |

**Invasive Plants:**

Cherry laurel (*Prunus laurocerasus*) – 3%
Cutleaf blackberry (*Rubus laciniatus*) – 2%
English holly (*Ilex aquifolium*) – 2%
Himalayan blackberry (*Rubus armeniacus*) – 3%
Japanese butterbur (*Petasites japonicus*) – 5%
Japanese knotweed (*Fallopia japonica*) – +
Lamium (*Lamiastrum galeobdolon*) – 5%
Stinging nettle (*Urtica dioica*) – 1-2%

View of forest from Elgin Rd Bridge

View of plant community and stream at west edge of polygon

**Polygon # 2**

This area is a previous large residential lot. The previous owners constructed and maintained ponds for the purpose of raising salmon. Most of the lot consists of turf grass with rows and groups of young to mature trees. There is a mix of tree species and ages on the site. Native species include Douglas-fir, Western redcedar, birch and alder. There are scattered large mature western redcedar trees some of which are significant size based on their diameters. Younger planted trees scattered around the site include bigleaf maple, western redcedar and spruce trees. There are scattered no native willow and spruce. There are also scattered shrubs including rhododendron, Indian plum, sword fern and foxglove. Invasive species are found mostly around the perimeter of this polygon and include English Ivy, Japanese knotweed and blackberry. There is one wildlife tree adjacent to the pond and evidence of beaver damage to many of the riparian trees.

View of turf area

View south towards residence

Existing pond structure.

Connection between Elgin Creek and pond

**Polygon #3**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 5-60 variable | Variable | Lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/35 | D/6-(7) | Moder/2 | 07(12) |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | $Cw_7Mb_3$ | $Cw_2Dr_6Mb_2$ | $Dr_2Mb_3Cw_5Pr_+$ | $Cw_8Bg_2$ | Cw |
| Density (stems/ha) | 25 | 200 | 25 | 100 | 10 |
| Tree diameter at breast height (cm) | 65 | 40 | 15 | 8 | |
| Tree height (m) | 35 | 30 | 18 | 6 | |
| Live crown ratio | 80 | 70 | 70 | 60 | |
| Crown closure (%) | 40 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (spruce)

**Observations:**

- Forest is variable with canopy gaps
- Largest trees include western red cedar and bigleaf maple
- High cover of English ivy
- Scattered cherry laurel and English holly
- Some pipes in Elgin creek need cleaning out
- Stream enhancement works completed in upper reach

| UNDERSTORY VEGETATION – Total Cover - 50% | | |
|---|---|---|
| Species | | Avg % Cover |
| Bracken fern | *Pterdium aquilinum* | *+* |
| Buttercup | *Ranunculus sp.* | *5* |
| Forsynthia | *Forsynthia sp.* | *+* |
| Hazelnut | *Corylus cornuta* | *1-2* |
| Indian plum | *Oemleria cerasiformis* | *5* |
| Lady fern | *Athyrium felix-femina* | *1-2* |
| Salmonberry | *Rubus spectabilis* | *15* |
| Skunk cabbage | *Lysichiton americanus* | *2* |
| sword fern | *Polystichum munitum* | *5-10* |
| Vine maple | *Acer circinatum* | *10-15* |

**Invasive Plants:**

Cherry laurel – 3
English ivy (*Hedera helix*) – 25
English holly – 1-2
Lamium – 3-5
Common periwinkle (*Vinca minor*) – 2-3
Japanese kerria (*Kerria japonica*) – +

Lower Elgin Creek just above confluence with Nicomekl

Elgin Creek with stream enhancement works

**Polygon # 4**

This area was previously used as a golf driving range and 9 hole golf course. It has been left unmanaged since acquisition and now consists of regenerating grass with trees in rows, small groups and open grown individuals. Mature Douglas-fir are growing in in rows along the edges of the range site. On the course there is mostly a mix of non-native pine trees as well as a number of mature willow and naturally regenerated alder and birch. Some cedar trees are dying along the eastern edge, possible from the change in hydrology on site since pumping has stopped.

Understory vegetation is found in groups mostly associated with small ponds and wetlands and includes:

- Dogwood (*Cornus stolonifera*)
- Hardhack (*Spiraea douglasii*)
- Indian plum (*Oemleria cerasiformis*)
- Red elderberry (*Sambucus racemose*)
- Salmonberry (*Rubus spectabilis*)
- Tall Oregon grape (*Mahonia aquifolium*)
- Honeysuckle (*Lonicera involucrata*).

Invasive species include reed canary grass (*Phalaris arundinacea*) and blackberry around the edges of the dykes.

View of driving range

Open grown pine trees

Small wetland area

**Polygon # 5**

This areas includes the dyke north of existing and development that is under construction. Most of this area is dominated by invasive blackberry. One area about 40m long has been restored. Blackberry has been removed and replanted with a direr riparian mix of species which includes: Red flowering currant (*Ribes sanguineum*), Snowberry, Hawthorn (*Crataegus*), Nootka rose, horsetail, and Baldhip rose (*Rosa gymnocarpa*). Regenerating (planted) tree species includes: Douglas-fir, Bigleaf maple, and Western red cedar. Invasive species includes remnant Himalayan blackberry and common tansy.

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Pr_3Dr_3W_3S_1$ | $Dr_9Act_1$ | | |
| Density (stems/ha) | | 50 | 100 | | |
| Tree diameter at breast height (cm) | | 40 | 10 | | |
| Tree height (m) | | 19 | 9 | | |
| Live crown ratio | | | | | |
| Crown closure (%) | 25 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Pocket of alder at eastern end
- High concentrations of non-native and invasive understory species

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Red elderberry | *Sambucus racemosa* | *3-5* |
| Salmonberry | *Rubus spectabilis* | *10-15* |
| Western honeysuckle | *Lonicera ciliosa* | *1-2* |
| Witch-hazel (non-native) | *Hamamelis* | *1-2* |

**Invasive Plants:**

Himalayan blackberry – scattered 15-20%
English ivy – 3%
Common Tansy (*Tanacetum vulgare*) – 1-2%
Wisteria sp climbing trees +%

Restoration area along dyke

Regenerating alder with blackberry understory

Reed Canary Grass bordering the Nicomekl River

Culvert output to Nicomekl River

## Polygon #6

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0-15 | Variable | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/35 | 6-7/D | Moder/5 | 07/12 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Act_7Dr_3$ | $Pr_+Ma_+Dr_7Fd_+Cw_3W_+$ | $Dr_4Fd_+Cw_6S_+$ | $S_4Cw_6$ (planted) |
| Density (stems/ha) | | 250 | 300 | 150 | 50 |
| Tree diameter at breast height (cm) | | 40 | 10 | 5 | |
| Tree height (m) | | 35 | 11 | 5 | |
| Live crown ratio | | 80 | 70 | | |
| Crown closure (%) | 25 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce), Ma (Mountain Ash)

**Observations:**

- Cottonwood trees mostly along highway 99
- Young alder regenerating along west side of creek
- Planted young cedar and spruce in eastern area of Reed Canary Grass
- Restoration area between pedestrian path and Anderson creek replanted with native species

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Dogwood | *Cornus stolonifera* | *2* |
| Grass sp. | | *5* |
| Hardhack | *Spiraea douglasii* | *+* |
| Horsetail | *Equisetum sp.* | *2* |
| Indian plum | *Oemleria cerasiformis* | *10-lots on R bank* |
| Nootka rose | *Rosa nutkana* | *5* |
| Oceanspray | *Holodiscus discolor* | *+* |
| Red elderberry | *Sambucus racemosa* | *2-3* |
| Red flowering currant | *Ribes sanguineum* | *1-2* |
| Salmonberry | *Rubus spectabilis* | *3-5* |
| Snowberry | *Symphoricarpos albus* | *2-3* |
| Sword fern | *Polystichum munitum* | *2* |
| Twinberry | *Lonicera involucrata* | *3-5* |

**Invasive Plants:**

Himalayan blackberry 10%
Reed canary grass – 20%

View of Anderson creek

Conifers planted in reed canary grass

Reed Canary Grass bordering Anderson Creek

Cottonwood along Hwy 99

**Polygon #7**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 15 | N | Mid | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/35% | 4/D | Moder 3 | 05 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | $Act_5Fd_5$ | $Mb_+Dr_7Cw_2Fd_2$ | $Mb_1Dr_6Cw_2Fd_1$ | $Cw_9Fd_1$ | |
| Density (stems/ha) | 25 | 1500 | 300 | 200 | |
| Tree diameter at breast height (cm) | 60 | 18 | 10 | 5 | |
| Tree height (m) | 35 | 12 | 6 | 8 | |
| Live crown ratio | 80 | 40 | | 70 | |
| Crown closure (%) | 60 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Opportunity to daylight short section between creek and Anderson creek through grass field
- Southern end of this polygon is all coniferous with cedar and fir 5-8m tall

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Baldhip Rose | (*Rosa gymnocarpa*) | *+* |
| Bracken fern | *Pterdium aquilinum* | *5* |
| Indian plum | *Oemleria cerasiformis* | *5-10* |
| Salmonberry | *Rubus spectabilis* | *5-10* |
| Snowberry | *Symphoricarpos albus* | *1-2* |
| Sword fern | *Polystichum munitum* | *3-5* |
| Trailing blackberry | *Rubus ursinus* | *3-5* |
| Vine maple | *Acer circinatum* | *2* |

**Invasive Plants:**

Himalayan blackberry - 3
English holly – 1
Reed Canary Grass – 3-5
Foxglove - presence

Ditches bordering Hwy. 99

Reed Canary Grass along ditch

Mix of deciduous overstory with conifers below

View of constructed stream

**Polygon #8**

This polygon is located under the powerlines east of Highway 99, with a small area west of the highway. This area mainly consists of invasive species include: Himalayan blackberry, Scotch broom, Reed canary grass, Common tansy, Gorse, Japanese knotweed and English holly. The rest of the area consists of grasses and scattered native regenerating trees and shrubs including Willow, Red alder, Bitter cherry, and Bigleaf maple, Black cottonwood, hardhack, salmonberry, snowberry, trailing blackberry, twinberry, and horsetail.

Himalayan Blackberry bordering Hwy. 99

Himalayan Blackberry beneath Hydro lines

Japanese knotweed and blackberry

Himalayan Blackberry, grass and regenerating alder adjacent to Hwy. 99

**Polygon #9**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 5-25 | N | lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Loam/25% | 6-10 | Moder/4 | 07 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | Cw | $Cw_3Hw_2Dr_3Mb_1S_1$ | $Dr_7Cw_3$ | Cw | |
| Density (stems/ha) | 50 | 150 | 50 | 10 | |
| Tree diameter at breast height (cm) | 90 | 50 | 35 | 10 | |
| Tree height (m) | 38 | 32 | 22 | 7 | |
| Live crown ratio | 70 | 80 | 70 | 80 | |
| Crown closure (%) | 40 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Pocket of mature trees at base of slope
- 3 large diameter Cw trees >1m (130-160 DBH)

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Bracken fern | *Pterdium aquilinum* | *2* |
| Hardhack | *Spiraea douglasii* | *3* |
| Horsetail | *Equisetum sp.* | *1-2* |
| Indian plum | *Oemleria cerasiformis* | *10-15* |
| Lady fern | *Athyrium felix-femina* | *2-3* |
| Salmonberry | *Rubus spectabilis* | *15-20* |
| Sword fern | *Polystichum munitum* | *5* |
| Trailing blackberry | *Rubus ursinus* | *2* |
| Vine maple | *Acer circinatum* | *3* |

**Invasive Plants:**

English holly – 1%

Large diameter cedar trees

**Polygon #10**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0 | N/A | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Clay loam/15 | 7/D | 3 moder | 08/09 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Cw_2Dr_5S_3$ | $Dr_8S_1Cw_1$ | Cw | |
| Density (stems/ha) | | 10 | 20 | 5 | |
| Tree diameter at breast height (cm) | | 65 | 25 | 15 | |
| Tree height (m) | | 35 | 18 | 8 | |
| Live crown ratio | | 80 | 80 | 90 | |
| Crown closure (%) | 5 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

A large part of this area has is undergoing restoration. A new creek has been constructed, shrubs and tree planted and wildlife trees placed. Trees scattered at low density. Most of this area consists of grasses and scattered native regenerating trees and shrubs including Willow, Red alder, Bitter cherry, and Bigleaf maple, Black cottonwood, hardhack, salmonberry, snowberry, trailing blackberry, twinberry, and horsetail.

| UNDERSTORY VEGETATION – Total Cover 80 % | | |
|---|---|---|
| Species | | Avg % Cover |
| Bracken fern | *Pterdium aquilinum* | *3* |
| Bulrush | *Scirpus sp.* | *2-3* |
| False lily-of-the-valley | *Maianthemum diletatum* | *5* |
| Indian plum | *Oemleria cerasiformis* | *5* |
| Lady fern (Planted) | *Athyrium felix-femina* | *2-3* |
| Licorice Fern | *Polypodium glycyrrhiza* | *1* |
| Pacific bleeding heart | *Dicentra formosa* | *2-3* |
| Salmonberry | *Rubus spectabilis* | *30* |
| Skunk cabbage | *Lysichiton americanus* | *2* |
| Sword fern | *Polystichum munitum* | *5* |

**Invasive Plants:**

Reed canary grass – 5
Stinging nettle - 1
Policeman's helmet – 3

View of open floodplain

Recent trail construction adjacent to restoration area

Pathway

Pathway and constructed stream

**Polygon #11**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 35 | N | lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/25% | 4-D(C) | Moder/8 | 05(07) |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | Fd | $Cw_6Dr_1Mb_2Fd_1$ | Cw | Cw | Cw |
| Density (stems/ha) | 10 | 150 | 50 | 50 | 25 |
| Tree diameter at breast height (cm) | 120 | 70 | 30 | 10 | |
| Tree height (m) | 48 | 35 | 15 | 5 | |
| Live crown ratio | 70 | 70 | 50 | 80 | |
| Crown closure (%) | 70 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Some large diameter Fd trees
- Heritage stumps remain

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Bracken fern | *Pterdium aquilinum* | *2-3* |
| Indian plum | *Oemleria cerasiformis* | *30* |
| Licorice fern | *Polypodium glycyrrhiza* | *1-2* |
| Pacific bleeding heart | *Dicentra formosa* | *2* |
| Red elderberry | *Sambucus racemosa* | *1-2* |
| Red huckleberry | *Vaccinium parvifolium* | *1-2* |
| Salmonberry | *Rubus spectabilis* | *15* |
| Skunk cabbage | *Lysichiton americanus* | *1* |
| Spiny wood fern | *Dryopteris expansa* | *1-2* |
| sword fern | *Polystichum munitum* | *5* |
| Trailing blackberry | *Rubus ursinus* | *1-2* |
| Vine maple | *Acer circinatum* | *3* |

**Invasive Plants:**

Himalayan blackberry – along development edge, 1-2%
English holly – +
Policeman's helmet – 20%
Stinging Nettle – 1-2%
Foxglove - presence

Large diameter Douglas-fir

Plant community above Barbara creek

Large heritage stump

## Polygon #12

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0 | N/A | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Silt loam under 30cm organic | 6-7/E | Moder/2-3 | 08/09 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | $Cw_3S_7$ | $Cw_1Dr_9$ | $Cw_4Dr_5Mb_1$ | $Cw_5Mb_5$ | |
| Density (stems/ha) | 50 | 200 | 50 | 10 | |
| Tree diameter at breast height (cm) | 80 | 45 | 25 | 10 | |
| Tree height (m) | 40 | 30 | 15 | 7 | |
| Live crown ratio | 60 | 70 | 70 | 65 | |
| Crown closure (%) | 45 | | | | |

**Observations:**

- Pacific side band snail (blue-listed)
- Eagles nest, with two Bald eagles

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Bracken fern | *Pterdium aquilinum* | *1* |
| Hazelnut | *Corylus cornuta* | *+* |
| Horsetail | *Equisetum sp.* | *1* |
| Indian plum | *Oemleria cerasiformis* | *30* |
| Lady fern | *Athyrium felix-femina* | *3* |
| Pacific bleeding heart | *Dicentra formosa* | *1* |
| Salmonberry | *Rubus spectabilis* | *20* |
| Skunk cabbage | *Lysichiton americanus* | *1* |
| Sword fern | *Polystichum munitum* | *2-3* |

**Invasive Plants:**

Policeman's Helmet – 5-10%
Reed canary grass – 5%

Eagles nest

Invasive Policeman's helmet emerging

Floodplain plant community

Tributary of Barbara creek

**Polygon #13**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0 | N/A | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| N/A - Organic | 7/D | N/A - Organic | 08/09 |

**Observations:**

- No mature trees
- Reed Canary Grass wetland

**Invasive Plants:**

Himalayan blackberry – along eastern trail
Reed Canary Grass – covers most open non-forested areas, 90% coverage

Large area dominated by Reed Canary Grass

Slope leading up to amenity building at top of slope

## Polygon #14

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 65 | North | Lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/30 | 5/D | Moder/8 | 05 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | Fd | $Fd_3$ $Cw_3$ $Dr_2$ $Mb_2$ | $Mb_5$ $Cw_3$ $Dr_2$ | Cw | |
| Density (stems/ha) | 150 | 150 | 200 | 25 | |
| Tree diameter at breast height (cm) | 70 | 50 | 25 | 15 | |
| Tree height (m) | 40 | 32 | 18 | 8 | |
| Live crown ratio | 70 | 60 | 50 | 70 | |
| Crown closure (%) | 50 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Indian plum | *Oemleria cerasiformis* | *25* |
| Red huckleberry | *Vaccinium parvifolium* | *5* |
| sword fern | *Polystichum munitum* | *10* |

Himalayan Blackberry bordering walking path at top of slope

Mixed mature forest on slope

**Polygon #15**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 15 | North | Lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/25 | 5(6)/D | Moder/6 | 07 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Dr_8$ $Mb_2$ | $Dr_9$ $Cw_1$ | Cw | Cw |
| Density (stems/ha) | | 500 | 200 | 10 | 10 |
| Tree diameter at breast height (cm) | | 40 | | 5 | |
| Tree height (m) | | 25 | | 6 | |
| Live crown ratio | | 60 | | 90 | |
| Crown closure (%) | 60 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Mature Alder on lower slope

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Indian plum | *Oemleria cerasiformis* | *40* |
| Red elderberry | *Sambucus racemosa* | *5* |
| Salmonberry | *Rubus spectabilis* | *20 - lower slope* |
| sword fern | *Polystichum munitum* | *10* |
| Vine maple | *Acer circinatum* | *2* |

View of lower slope alder stand

View of understory

## Polygon #16

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 50-60 | North | Lower | |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Dr_9Mb_1$ | $Dr_8\ Mb_2Fd_+$ | Cw | |
| Density (stems/ha) | | 1000 | 600 | 5 | |
| Tree diameter at breast height (cm) | | 20 | 10 | 5 | |
| Tree height (m) | | 18 | 12 | 4 | |
| Live crown ratio | | 60 | 40 | 90 | |
| Crown closure (%) | 70 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

### Observations:

- More recently disturbed on both sides of bridge
- Dense young deciduous stand
- Power lines run on east side of bridge- trees topped under the lines

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Grasses | | *50* |
| Hawthorn | *Crataegus* | *+* |
| Indian plum | *Oemleria cerasiformis* | *40* |
| Salmonberry | *Rubus spectabilis* | *5 – at rivers edge* |
| sword fern | *Polystichum munitum* | *10* |
| Trailing blackberry | *Rubus ursinus* | *5* |
| Twinberry | *Lonicera involucrata* | *3 – at rivers edge* |

### Invasive Plants:

Himalayan blackberry – On edges by wood
Scotch broom – 2 plants up top by wood

Dense young alder

Culvert stream output into Nicomekl River

## Polygon #17

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0 | N/A | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Clay loam/40 or organic | 7/D | 3 moder | 08/09 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | S | $Dr_8\ Cw_2\ S+$ | $Dr_7\ S_1\ Cw_2\ Hw_+$ | $Cw_8\ Hw_2$ | |
| Density (stems/ha) | 10 | 100 | 50 | 25 | |
| Tree diameter at breast height (cm) | 60 | 50 | 30 | 8 | |
| Tree height (m) | 38 | 30 | 20 | 5 | |
| Live crown ratio | 70 | 70 | 50 | 90 | |
| Crown closure (%) | 30 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Windthrow on floodplain
- Many Alder have dead tops or are decayed creating short lived wildlife trees
- Signs of windthrow
- One huge Sitka Spruce tree ~120 cm
- Rich and diverse structure – high value for wildlife
- Very dense shrub layer

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Hazelnut | *Corylus cornuta* | *5* |
| Horsetail | *Equisetum sp.* | *5* |
| Bracken fern | *Pterdium aquilinum* | *10* |
| Dogwood | *Cornus stolonifera* | *5* |
| Indian plum | *Oemleria cerasiformis* | *15* |
| Licorice fern | *Polypodium glycyrrhiza* | *1* |
| Salmonberry | *Rubus spectabilis* | *60* |
| Skunk cabbage | *Lysichiton americanus* | *4* |
| Spiny wood fern | *Dryopteris expansa* | *5* |
| Sword fern | *Polystichum munitum* | *2* |
| Twinberry | *Lonicera involucrata* | *3* |

**Invasive Plants:**

Himalayan blackberry 3%

Reed Canary Grass – 10% in patches along rivers edge mostly

View of dense shrub community

View of Reed canary grass pocket

View of floodplain

View from above

## Polygon #18

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 80-100 | North | lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Sandy Loam/25% | 4(5)/D | Moder/7 | 05(07) |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | Fd | $Mb_6$ $Cw_3$ $Fd_1$ | Cw Mb | Cw | |
| Density (stems/ha) | 20 | 150 | 50 | 50 | |
| Tree diameter at breast height (cm) | 70 | 60 | 25 | 8 | |
| Tree height (m) | 45 | 35 | 19 | 8 | |
| Live crown ratio | 70 | 80 | 50 | | |
| Crown closure (%) | 25 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- Dominant Douglas fir just above top of bank
- Could build trail along top of bank
- Great views

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| dull Oregon grape | *Mahonia nervosa* | *2* |
| Indian plum | *Oemleria cerasiformis* | *30* |
| Licorice fern | *Polypodium glycyrrhiza* | *2* |
| Red elderberry | *Sambucus racemosa* | *4* |
| Red huckleberry | *Vaccinium parvifolium* | *5* |
| Salmonberry | *Rubus spectabilis* | *5* |
| Snowberry | *Symphoricarpos albus* | *3* |
| sword fern | *Polystichum munitum* | *5* |
| Tall Oregon grape | *Mahonia aquifolium* | *1* |
| Thimbleberry | *Rubus parviflorus* | *5* |
| Vine maple | *Acer circinatum* | *5* |
| Yew | *Taxus sp.* | *+* |

Large diameter Douglas-fir tree

Large diameter Douglas-fir trees

Mixed mature forest at top of slope

Mid slope stand with mature Douglas-fir

**Polygon #19**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 70-110 | North | Lower | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| Clay Loam/30 | 6/D | Moder -5 | 07 |

| STAND CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| Canopy Layer | Dominant Trees | Co-Dominant Trees | Intermediate Trees | Suppressed Trees | Regeneration |
| Species[1] (% by volume; + denotes <10%) | | $Mb_6$ $Cw_3$ $Dr_1$ | $Mb_5$ $Cw_3$ $Dr_2$ | Mb Fd Bg | Cw |
| Density (stems/ha) | | 200 | 100 | 40 | 10 |
| Tree diameter at breast height (cm) | | 60 | 25 | 5 | |
| Tree height (m) | | 28 | 15 | 4 | |
| Live crown ratio | | 70 | 50 | 70 | |
| Crown closure (%) | 35 | | | | |

[1] Species codes: Fd (Douglas-fir), Hw (western hemlock), Cw (western redcedar), Act (black cottonwood), Mb (bigleaf maple), Dr (red alder), Pr (bitter cherry), Ep (Paper birch), W (willow), Bg (Grand fir), S (Spruce)

**Observations:**

- A to top of slope – moles, coyote scat, dear pellets
- Upper slope recently planted
- 1 garden waste dump site
- Some remains of old metal fence along top of slope to remove

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Indian plum | *Oemleria cerasiformis* | *25* |
| Salmonberry | *Rubus spectabilis* | *5* |
| sword fern | *Polystichum munitum* | *10* |
| Trailing blackberry | *Rubus ursinus* | *5* |
| Vine maple | *Acer circinatum* | *3* |

**Invasive Plants:**

Himalayan blackberry – 10% upper edge mostly
English ivy – One patch
Lamium – upper fringe 3%
Periwinkle – One patch

Himalayan Blackberry bordering forest edge

Periwinkle bordering walking trail

Wildlife trees

Mixed mature stand at top of slope

**Polygon #20**

| SITE CHARACTERISTICS | | | |
|---|---|---|---|
| Slope | Aspect | Slope position | |
| 0 | N/A | Flat | |

| ECOLOGICAL CHARACTERISTICS | | | |
|---|---|---|---|
| Soil Texture/Coarse Fragment Content | Soil Moisture/ Soil Nutrient | Humus Type/ Depth (cm) | BEC Site Series |
| N/A - Organic | 7/D | N/A - Organic | 08/09 |

**Observations:**

- No mature trees
- Reed Canary Grass wetland area
- Young alder along eastern edge by trail

| UNDERSTORY VEGETATION – Total Cover - % | | |
|---|---|---|
| Species | | Avg % Cover |
| Crab apple | *Malus sylvestris* | *3* |
| Dogwood | *Cornus stolonifera* | *10* |
| Hazelnut | *Corylus cornuta* | *3* |
| Horsetail | *Equisetum sp.* | *3* |
| Nootka rose | *Rosa nutkana* | *3* |
| salal | *Gaultheria shallon* | *5* |
| Twinberry | *Lonicera involucrata* | *3* |

**Invasive Plants:**

Himalayan blackberry – along eastern trail
Reed Canary Grass – covers most open non-forested areas, 90% coverage

Himalayan Blackberry mounds in wetland

Reed Canary Grass in wetland