Appendix 6. Wilder Creek Management Plan 2025 Update

SITE C CLEAN ENERGY PROJECT

WILDER CREEK PROPERTY MANAGEMENT PLAN V2.0

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TABLE OF CONTENTS

1.0 Introduction 4
1.1 Plan objectives 7
1.2 Ungulate Winter Range Biological Justification / Supporting Rationale 7
1.2.1 Biological Justification / Supporting Rationale 7
1.2.2 Conservation Status / Priority 8
1.2.3 Expected Conservation Achievements /Outcome 8
2.0 Consultation on plan 8
3.0 Property Background 9
3.1 Agriculture 9
3.1.1 Soils 9
3.1.2 Climate Capability for Agriculture 10
3.1.3 Land Capability for Agriculture 10
3.1.4 Crop Suitability 10
3.1.5 Summary of past use 11
3.1.6 Noxious Weeds 11
3.2 Infrastructure on site 11
3.2.1 Access 11
3.2.2 Water 12
3.2.3 Fencing 12
3.3 Baseline Vegetation Resources on the Property 14
3.3.1 Ecosystems Present 14
3.3.2 Rare Plants 14
3.4 Vegetation Management 17
3.4.1 Protection of south-facing grassland and forested slopes 17
3.4.2 Creation of Old field habitats 17
3.4.3 Riparian vegetation plantings 17
4.0 Wildlife Objectives 18
4.1 Target species 18
4.2 Management Activities 21
4.2.1 Ungulate Winter Range - Winter Ecology and Habitat Requirements – Biological Rationale 22
4.3 Ungulate Winter Range Objectives 24
5.0 Management Objectives: Agriculture 24
5.1 Field Management 25
5.2 Grazing Rotation 25
6.0 Detailed Management Plan 26
6.1 Priority Site Works 26
6.1.1 Access 26

6.1.2 Fencing....26
6.1.3 Cattle Watering....26
6.2 Field Improvements....26
6.2.1 Field Management....26
6.2.2 Weed management plan....27
7.0 Additional Requirements and/or recommendations....27
8.0 Monitoring and Follow-up management of the property....28
8.1 Leaseholder record-keeping requirements....28
8.2 Monitoring by BCH....28
8.3 Annual meetings to discuss/update management plans....28
9.0 Summary of Ungulate Winter Range Management....28
10.0 References....29

List of Tables

Table 1. Legal descriptions of Wilder Creek Properties. 5
Table 2. Habitats mapped within the Wilder Creek Properties (Hilton *et al*. 2013). 14
Table 3. Rare plants potentially occurring on the Wilder Creek Property. 16
Table 4. Wildlife species expected to occur on the Wilder Creek lands (M=migrant breeder, R=resident, F=feeding). 19
Table 5 – Ungulate Winter Range Objectives for elk, mule deer and moose[3] 24

List of Figures

Figure 1. Wilder Creek Lands.... 6
Figure 2. Wilder Creek Property field numbers and ungulate winter range locations 13
Figure 3. Habitats on the Wilder Creek Property. 15

Wilder Creek Property Wildlife and Agricultural Management Plan

1.0 INTRODUCTION

BC Hydro owns 7 land Parcels (48, 50, 52, 53, 54, 55, 56 and 57) totalling 423.2 ha, lying between the confluences of Cache Creek and Wilder Creek (Figure 1). Collectively these properties are referred to as the Wilder Creek Properties (the Property). The legal descriptions of the 7 parcels comprising the Property are summarized in Table 1.

The Property, purchased by BC Hydro in 1977, was part of a historic Peace River ranch, encompassing both native rangeland and cultivated lands used for the production of forage, oilseed and grains. The lands are located along the north bank of the Peace River and comprise gently sloping river terraces which back onto steep, warm (south) aspect valley wall slopes. Once the reservoir is filled, 40.4 ha of the lower terrace (Figure 2) will be flooded creating a shallow area of water < 3m deep (Klohn 2009). The cultivated terraces are within the Provincial Agricultural Land Reserve (ALR). The un-cultivated slopes are not in the ALR but have been identified as providing ungulate winter range by the Ministry of Environment although they have not been officially designated as Ungulate Winter Range (UWR) under the Forest and Range Practices Act. This plan has been prepared to add these areas as UWR's based upon the reduction in ungulate winter habitat resulting from filling the Site C reservoir.

The Property has been identified as a location where retention and management by BC Hydro, for the life of the Project, will be used to mitigate the loss of vegetation and ecological resources and their associated values as wildlife habitat.

The current and potential value of the Property as wildlife habitat is a reflection of past agricultural management practices. An understanding of this past use is summarized below and will be used to guide the development of the long-term Property management plan.

Table 1. Legal descriptions of Wilder Creek Properties.

Parcel No.	Legal description	Area (ha)
48	Parcel A (25107M) of the northeast 1/4 of Section 28, Township 83, Range 20, west of the 6th meridian Peace River District	61.14
50	Part of the northwest 1/4 of Section 28, Township 83, Range 20, west of the 6th meridian Peace River District lying north of the left bank of the Peace River	39.76
52	Southeast 1/4 of Section 33, Township 83, Range 20, west of the 6th meridian Peace River District	64.86
53	Southwest 1/4 of Section 33, Township 83, Range 20, west of the 6th meridian Peace River District	64.89
54	Fractional Legal Subdivision 16 of Section 29, Township 83, Range 20, west of the 6th meridian Peace River District	5.94
55	Northeast 1/4 of Section 32, Township 83, Range 20, west of the 6th meridian Peace River District	64.91
56	Fractional southeast 1/4 of Section 32, Township 83, Range 20, west of the 6th meridian Peace River District	58.78
57	Fractional northwest 1/4 of Section 32, Township 83, Range 20, west of the 6th meridian Peace River District	62.91

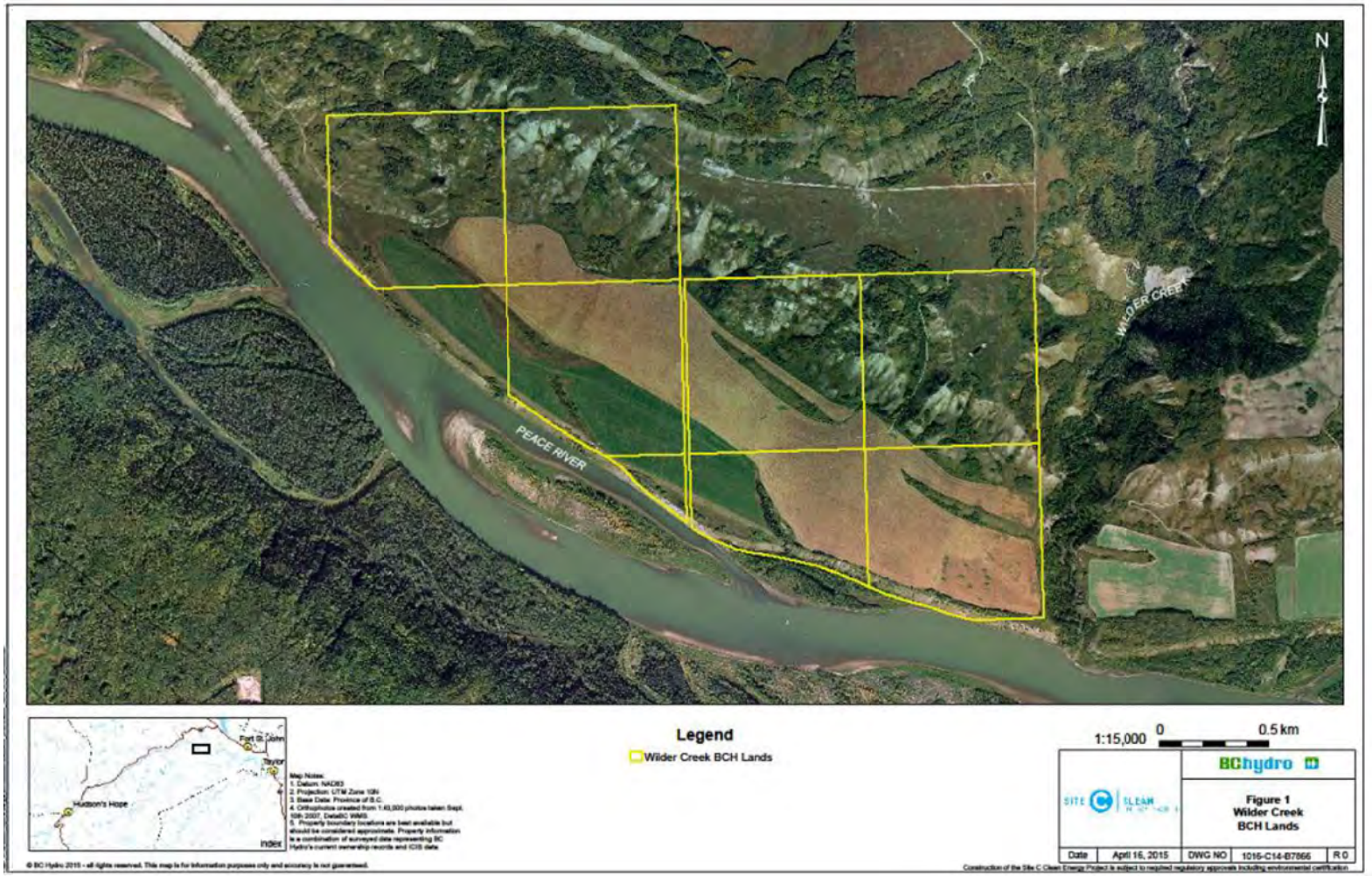

Figure 1. Wilder Creek Lands

This document outlines how the Property will be managed to maintain current agricultural production, protect and enhance sensitive ecosystems, maximize the value of habitats for non-wetland migratory birds and species at risk on the upland and riparian slopes, protect and enhance the shoreline and maximize the habitat value of the shallow, flooded area. This document is intended to be a high-level guidance document that will be amended as needed based on monitoring of the effects of agricultural activities on the Property, further studies on the use of the Property by non-wetland migratory birds and species at risk. Management objectives and results will be reviewed annually with the leaseholder and refined as and when needed.

1.1 Plan objectives

This document outlines how the Property will be managed to protect the ungulate winter range on the steep, south-facing native grassland slopes, maintain and enhance values for non-wetland migratory birds, species at risk and maintain agricultural production on the lower terraces adjacent to the reservoir.

Management of the Property will aid in fulfilling various conditions attached to the Project's environmental certification as stated in the Federal Decision Statement (FDS) and provincial Environmental Assessment Certificate (EAC; Schedule B). These include:

- **FDS Condition 10.1 and 10.2**: addressing potential effects of the Project on non-wetland migratory bird habitat
- **FDS Condition16.1 and 16.2**: addressing potential effects of the Project on species at risk, at-risk and sensitive ecological communities and rare plants
- **EAC Condition 4**: addressing provision of riparian habitat and bank stabilization
- **EAC Condition 16**: Implement various mitigation and compensation measures and describe in the Vegetation and Wildlife Mitigation and Monitoring Plan.
- **EAC Condition 24**: The EAC Holder must identify and maintain suitable lands for ungulate winter range on BC Hydro-owned lands.

This management plan is a living document which will be amended as needed based on Property monitoring, further studies, and refinement of management objectives.

1.2 Ungulate Winter Range Biological Justification / Supporting Rationale

The term ungulate winter range means an area that is identified as being necessary for the winter survival of an ungulate species. UWR objectives need to consider key life requisites including thermal cover, security cover and forage sources as well as potential risk factors such as road access, and conflicts with other user groups (e.g., range management).

1.2.1 Biological Justification / Supporting Rationale

The Peace River valley supports healthy populations of moose, elk, mule deer and white-tailed deer that have value to Indigenous people for cultural uses, spirituality and sustenance harvest, to resident hunters and Guide Outfitters for harvest and for the tourism value of their presence on the landscape. These ungulates are considered a high priority for conservation management. The current UWR's in the Peace River Valley will be partly inundated by the flooding of the Site C Clean Energy Project's reservoir, reducing the availability of winter range for these species.

Therefore, the protection of new UWR's helps to uphold Provincial condition 24 to ensure there is adequate winter range for these species and their winter survival. While the provincial management goal for these species is to ensure Indigenous harvest first, resident harvest second and to maintain viable populations, the setting aside of land as UWR that already has high ungulate value helps to attain this goal. The biological criteria that was applied in the selection of this UWR includes snow interception (thermal cover of forested habitat and south-facing slopes), security cover (screening/protection from predators/hunters) and forage production (quality and quantity).

1.2.2 Conservation Status / Priority

Moose (*Alces alces americanus*), elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*) are provincially yellow-listed and are not ranked under the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC). None of these species are listed under the federal *Species at Risk Act* (Canada 2024).

1.2.3 Expected Conservation Achievements /Outcome

Currently UWR U-9-007 (NPL-026) is managed for elk, mule deer, and moose and overlaps Wilder Creek and the south-facing Peace slopes to Bear Flats and also overlaps into the Wilder Property. This 1980 hectare (ha) UWR will be impacted by inundation of the reservoir along Wilder Creek and 40.4 ha of the lower flats, so the protection of this property will act as an offset of 423.2 ha for winter range lost through reservoir filling.

This document will provide General Wildlife Measures (GWMs) that specify how the property can be managed to maintain value to ungulates (largely tied to its use as agricultural land) by providing monitoring measures over time. These measures will be consistent with the recommendations in the *Compendium of Wildlife Guidelines for Industrial Operation Projects in the North Area, British Columbia* (MFLNRO 2014). As per Section 9 of the Government Action Regulation of the *Forest and Range Practices Act* the minister responsible for the *Wildlife Act* may by order establish the GWMs for this UWR. It is expected that the agricultural use of the Property will be maintained as it provides intrinsic winter range value for ungulates using this area.

2.0 CONSULTATION ON PLAN

Consultation with agencies regarding the development and implementation of this plan is outlined below:

- July 30, 2015 draft plan sent to Environment Canada (Christie and McIntosh 2015)
- September 10, 2015 draft plan sent to and Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) (Christie and McIntosh 2015)
- September 21, 2015 tour of property and review of management plan with Environment Canada, Canadian Wildlife Service and MFLNRO
- October 28, 2015 comments on plan received from MFLNRO
- January 2024 – March 2025 draft plan reviewed by Dan Webster with Eco-Web Ecological Consulting Ltd. to update for resubmittal.

3.0 PROPERTY BACKGROUND

3.1 Agriculture

3.1.1 Soils

The Wilder Creek property lies between the confluences of Cache Creek and Wilder Creek with the Peace River, southeast of Bear Flats, at an elevation between 419-785m above sea level (asl).

Attachie (AH) soils occupy the northerly portion of the Property along the steep, actively eroding, south-facing valley slopes, above the floodplain of the Peace River (BC Soil Survey 1986). Attachie soils have developed on undifferentiated colluvial materials, including loamy tills mixed with shale and sandstone, and may also have a thin covering of glaciofluvial gravels, sands and silts, as well as loess. Attachie soils are classified as Regosols (young, poorly developed soils) and lithic (shallow to bedrock) Chernozemic soils developed under native grass and shrub vegetation. Due to instability and steep irregular topography, agricultural and forestry uses are severely limited on the AH unit. In some areas, the open slopes have the capacity to support limited domestic grazing.

Taylor (TY) soils occur over the southerly portion of the Property, along the gently to moderately sloping terraces of the north bank of the Peace River at elevations between 400 and 500 m. Taylor soils are classified as Rego Black Chernozems developed on clay textured colluvial (fan) deposits, underlain by variable glaciofluvial deposits. Taylor soils are moderately well to well drained, slowly pervious, and have a subhumid moisture regime. In their native condition, the soils generally have a well developed Ah horizon that overlies clay loam C horizons and usually one or more buried Ah horizon(s). Taylor soils are often associated with Branham soils, classified as Orthic Eutric Brunisols developed on sandy and silty, calcareous, colluvial fan and glaciofluvial terrace materials. Inclusions of Regosols and Rego Dark Gray Chernozems commonly occur with Taylor and Branham map units.

A detailed soil survey has not been carried out as part of the current work on the Property and the following notes are based on limited field observations to date (refer to Figure 2):

- Soils in the southwestern field (Field 1) have a shallow (15-20 cm) cultivated (Ap) layer of dark brown loam overlying very gravelly and stony, rounded glaciofluvial deposits. This unit is rapidly drained, with low moisture holding capacity. Several large rock piles occur along the inner margin of the field.
- The soils of the middle fields (Fields 2a and 2b) have a clay loam Ap horizon (surface plough layer), generally without gravel but likely including sparse rocks in the top 50 cm. There are several large rock piles in the southeast corner that presumably came from previous landowners picking rocks in this field to improve the agricultural capability.

3.1.2 Climate Capability for Agriculture

The lower terraces of the Property, including all of Fields 1, 2a and 2b, are mapped within unimproved (non-irrigated) Climate Capability for Agriculture Class 3A, with the "A" limitation denoting a climatic moisture deficit of about 132 mm/year (BC Hydro 2012a and 2013). May to September precipitation is about 230 mm. With irrigation the climatic capability rating improves to Class 2G, with the "G" limitation denoting growing degree-days (GDD) of about 1,241. The freeze-free period (FFP) averages 91 days.

3.1.3 Land Capability for Agriculture

The Attachie map units, occupying the escarpment slopes, have very low agricultural capability (Class 6 and 7) due to steep irregular slopes and instability, which limit agricultural use to non-intensive grazing (BC Hydro 2011).

The Taylor soil map units, occupying the river terraces where Fields 1, 2a and 2b are located, have high capability for agriculture and are capable of supporting a fairly wide range of crops. The detailed Land Capability for Agriculture mapping compiled by BC Hydro (2012b) rates Field 1 as 60% Class 3 with topography and/or stoniness limitations, and 40% Class 2 with stoniness limitations. The Class 3 areas improve with irrigation to Class 2, with ongoing stoniness limitations while the Class 2 areas would not improve with irrigation due to the on-going GDD climatic limitation (Figure 3). Fields 2a and 2b are rated as dominantly Class 2, with soil structure (D) or aridity (A) limitations and would not improve to Class 1with irrigation due to the on-going GDD climatic limitation (BC Hydro 2012a). The agricultural capability maps prepared for the EIS show these fields as improved Class 1. This classification is not supported by the updated climatic data and capability classification which reflects improved Class 2 due to growing degree days of 1241 in the Bear Flats area.

Based on the July 2015 site visit, Field 1 is dominantly Class 4 with on-going stoniness and low moisture-holding capacity. This rating will not improve with irrigation due to the shallow depth to excessive gravels and stones, although forage production would benefit from irrigation. Fields 2a and 2b are dominantly Class 2, with soil structure limitations due to the fine (clay) textures.

3.1.4 Crop Suitability

Fields 2a and 2b are suitable for all the hay and grain crops grown in the Peace Region, with the Class 3A climate limiting the range of other crops, such as vegetables, that could be commercially grown without irrigation. The climatic moisture deficit (~132 mm at Bear Flats) limits the amount of forage that could be produced (i.e., cut hay would be limited to one or possibly two crops per year, with the potential for additional aftermath grazing). The fine textured soils of Fields 2a and 2b mitigate the climatic soil moisture deficit to some extent, and both the range of cropping alternatives and production levels should be better on the fine textured areas of these fields, compared to the coarser textured Field 1 which would require irrigation to achieve higher production levels.

Soil and moisture conditions observed during the July 2015 site visit, indicate that a single cut of hay can be taken from the fields in most years. Fields 2a and 2b may yield a second cut in some

years due to inherently higher moisture holding capacity and higher fertility. Actual harvested hay yields are unknown but likely in the 3-4 tonne/ha (1.5 – 2 t/ac) range based on production estimates for Class 2-3 lands in a Class 3A climate area. Forage yields would improve with irrigation, and it is possible that three cuts of hay could be harvested in some years by doing this.

3.1.5 Summary of past use

The subject lands have historically been used for forage and grain production including cut hay and canola, as well as periodically oats and/or wheat. Alfalfa seed has also been produced on Fields 2a and 2b. Historically, operators have raised cattle and horses, with the hayfields grazed by cattle following forage harvesting. Livestock have been placed on the fields and the adjacent hillside from about mid-September to mid-November. In 2014, Field 2 was treated for noxious weeds, cultivated and left fallow in preparation for planning canola in the spring of 2015.

Field 1 appears to be a relatively recently created field that has been planted to a grass/legume (clover) hay crop.

The upper, rough pasture area has been grazed by domestic bison in the past.

3.1.6 Noxious Weeds

The leaseholder has been managing noxious weeds in the cultivated portions of the property. Minor infestations of thistle and dandelion were observed in Fields 1, 2a and 2b during the field reconnaissance. In 2008, night-flowering catchfly (*Silene noctiflora*) was documented on the property. Night-flowering catchfly is a Category B - Medium Priority for Eradication and Containment rated weed by the Peace River Regional District and can be controlled by persistent shallow cultivation and spraying with herbicides (PRRD 2016). Night-flowering catchfly is an annual herb 75 or 80 cm in height, sticky in texture with nocturnally blooming white flowers, that form into yellowish-brown fruit capsules (PRRD 2016). A noxious weed inventory was conducted in 2015 and the results will be provided to the leaseholder for incorporation into their weed management program.

3.2 Infrastructure on site

3.2.1 Access

The Property is located about 7 km southeast of Bear Flats, on the north bank of the Peace River. Access is via an all-weather gravel road travelling southeast from Highway 29, through the Shaman Buffalo Ranch, then a poorly-graded bare soil track cutting through an escarpment gully to the metal gate located along the north side of Field 2. The track through the gully has slumped (at UTM Z10 618260E, 6234211N) and given the conditions will continue to erode if no corrective measures are taken. Access around and through Fields 1, 2a and 2b is via poorly-graded farm tracks.

3.2.2 Water

There are two water sources for livestock on the property:

- A dugout located in the pasture, upland area of Parcel 523 near the eastern Property boundary (see Figure 3).
- A small wetland located mid-escarpment within Parcel 57 near the western boundary of the Property.

There are no known excavated or drilled wells on the Property.

3.2.3 Fencing

The Property fields are fenced and cross-fenced with 4-strand barbed wire on split-fence posts. Much of the fencing is in disrepair and requires replacement. The main access gate along the northern edge of Field 2 is metal and field gates are barbed slip wire.

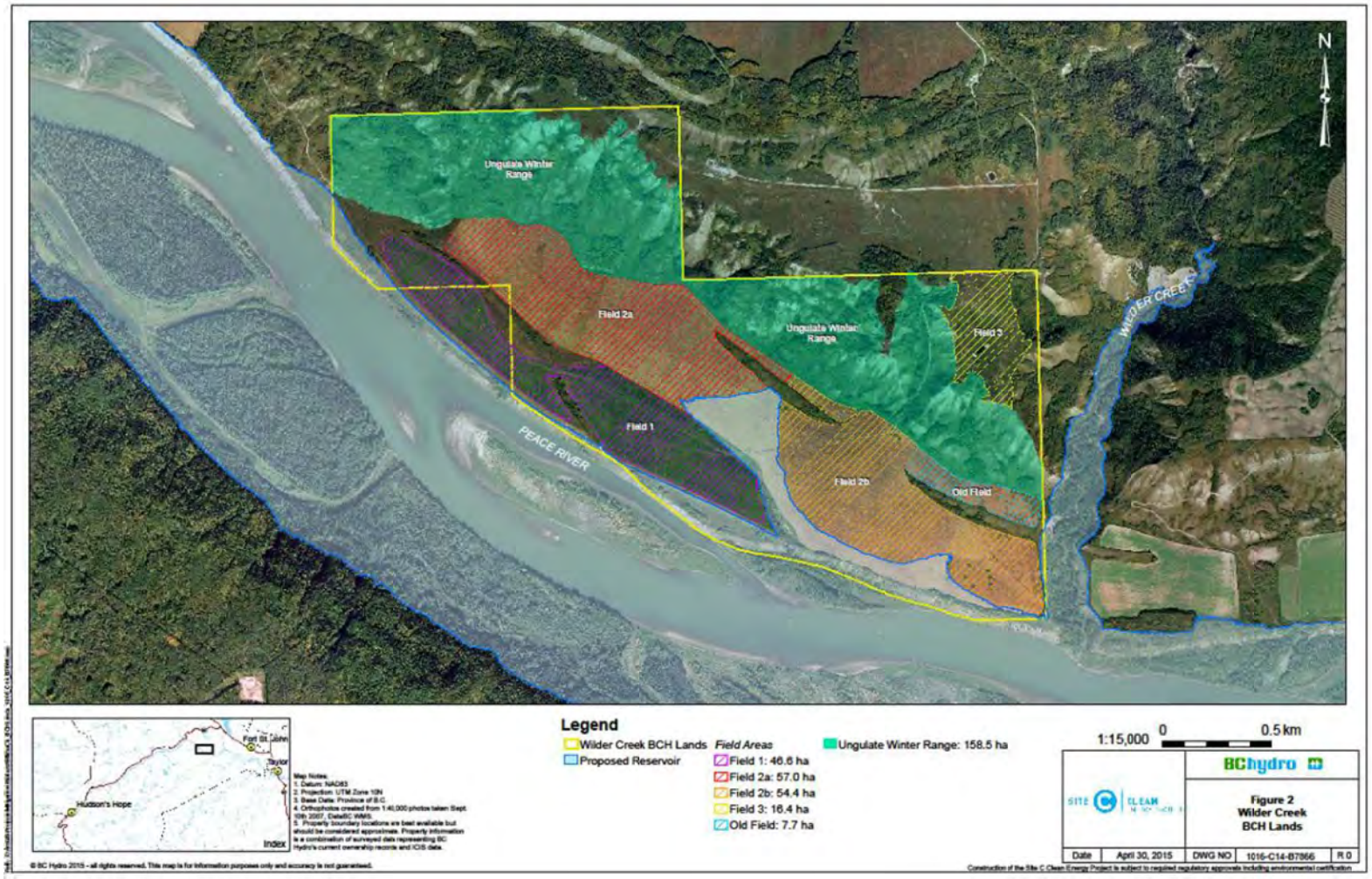

Figure 2. Wilder Creek Property field numbers and ungulate winter range locations

3.3 Baseline Vegetation Resources on the Property

3.3.1 Ecosystems Present

Terrestrial Ecosystem Mapping was completed for the Property as part of the Site C Environmental Assessment (Hilton *et al.* 2013a). Seven ecosystems (habitats) were mapped on the Property (Figure 3). Table 2 summarizes the amount of each ecosystem mapped within the Property. The grasslands mapped as Fuzzy-spiked Wildrye-Wolf Willow (WW) are classified as a sensitive ecological community (Hilton *et al.* 2013). None-of the ecosystems on the Property are classified as at risk (Hilton *et al.* 2013).

Table 2. Habitats mapped within the Wilder Creek Properties (Hilton *et al*. 2013).

Habitat	TEM Code	Structural Stage	Area (ha)
Trembling Aspen-Creamy Peavine	AM:ap	3	3.69
Trembling Aspen-Creamy Peavine	AM:ap	4	9.02
Trembling Aspen-Creamy Peavine	AM:ap	5	6.39
White Spruce-Aspen-Step moss	AM	4	3.09
White Spruce-Trembling Aspen Soopolallie	AS	2	1.90
White Spruce-Trembling Aspen Soopolallie	AS	3	61.55
Cut bank	CB	1	16.00
Cultivated Field	CF	2	225.83
White Spruce-Wildrye-Peavine	SW	4	4.98
White Spruce-Wildrye-Peavine	SW	5	5.06
Fuzzy-spiked wildrye-Wolf Willow	WW	2	76.93
Fuzzy-spiked wildrye-Wolf Willow	WW	3	8.66

3.3.2 Rare Plants

Inventories for rare plants were not conducted in this area during baseline surveys. Habitats within the Wilder Creek properties have the potential to support 23 species of rare plants documented during baseline surveys (Table 3) (Hilton *et al.* 2013a). A rare plants survey will be conducted in non-cultivated parts of the property during the Project construction phase to determine which if any rare plants are present within the Property.

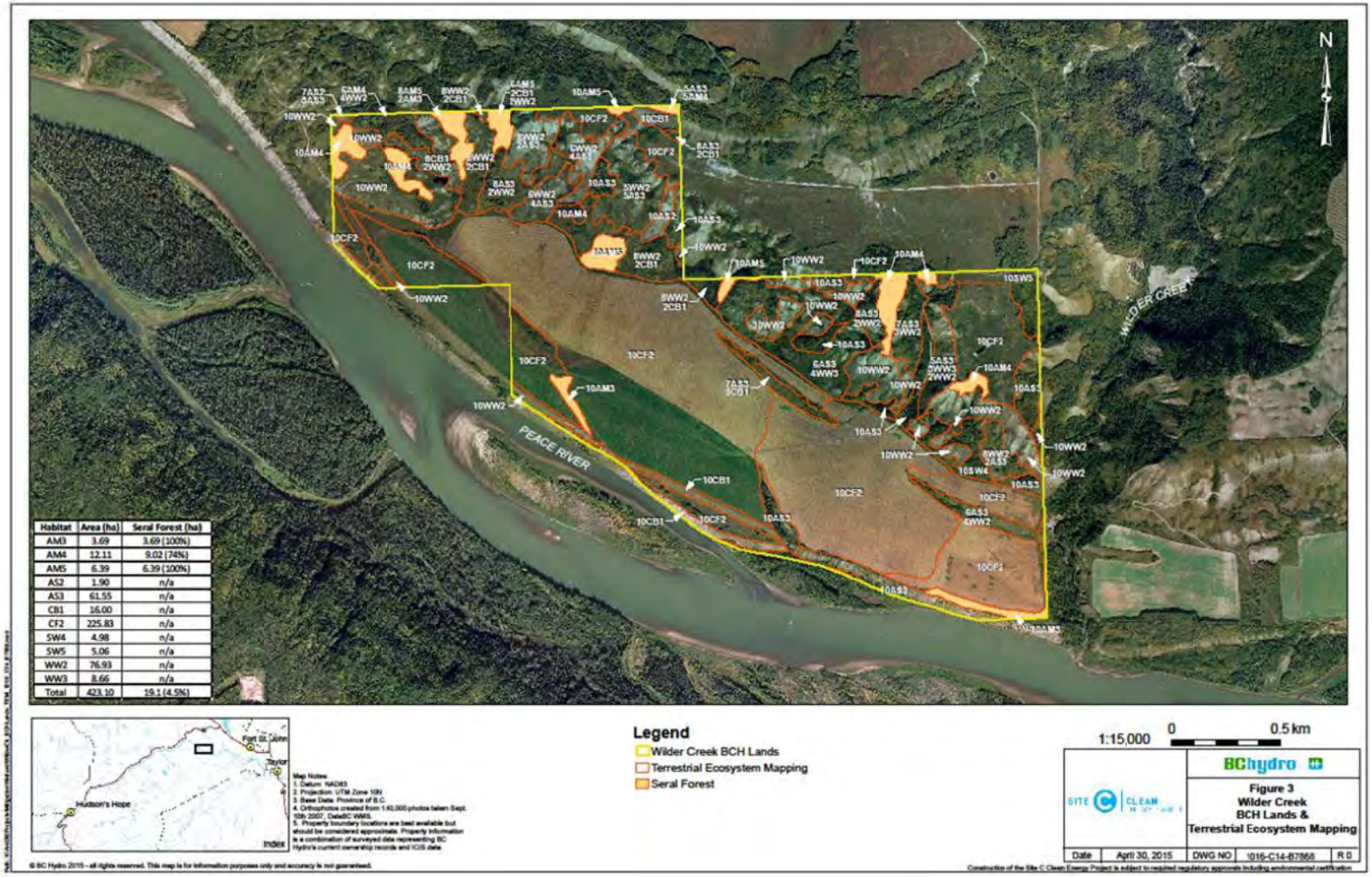

Figure 3. Habitats on the Wilder Creek Property.

Table 3. Rare plants potentially occurring on the Wilder Creek Property.

Species	Expected habitat
Riverbank anemone (*Anemone virginiana* var. *cylindroidea*)	Upland areas in understory of open aspen forest or in mixed woodlands of aspen, balsam poplar and white spruce and occasionally in full sun with grasses and low shrubs, near fence lines and road shoulders.
Herriot's sage (*Artemisia herriotii*)	River shores, cut banks, slopes; areas of loosely-consolidated soils; moist to dry.
Gardner's saltbrush (*Atriplex gardneri* var. *gardneri*)	Dry grassy slopes; saline clay slopes
Plains reedgrass (*Calamagrostis montanensis*)	Dry grassland slopes, shrub flats, and in open forests
Tawny paintbrush (*Castilleja miniata* var. *fulva*)	Mesic open forests; bluffs
Tender sedge (*Carex tenera*)	Mesic to dry meadows, shorelines, and open forests
Torrey's sedge (*Carex torreyi*)	Grassland; mesic to moist meadows and shrubland; moist woods
Dry-land sedge (*Carex xerantica*)	Dry grasslands and hillsides, open forests, and rock outcrops
Drummond's thistle *(Cirsium drummondii*)	Dry to moist soils of pastures, meadows, forest openings, prairies, and roadsides
Peace daisy (*Erigeron pacalis*)	Grassland opening near low shrubs and mixed woodland.
Old-man's whiskers (*Geum triflorum* var. *triflorum*)	Dry to mesic grasslands, meadows, rocky slopes and open forests
Spike-oat (*Avenula hookeri*)	Mesic to dry open slopes, meadows, and forest clearings
Colorado rush (*Juncus confusus*)	Moist steppe and montane habitats such as open grasslands, meadows, stream banks, and woods
Fennel-leaved desert-parsley (*Lomatium foeniculaceum* var. *foeniculaceum*)	Dry slopes, prairies, and grasslands
Davis' oxytrope (*Oxytropis campestris* var. *davisii*)	River shores, mesic to dry meadows, gravel bars, forest openings
Slender penstemon (*Penstemon gracilis*)	Mesic to dry plains and grasslands
persistent-sepal yellow-cress (*Rorippa calycina*)	River shorelines
Arkansas rose (*Rosa arkansana*)	Prairies and grasslands, thickets, and woodlands
Little bluestem (*Schizachyrium scoparium*)	Mesic to dry grasslands, shrublands, open woods, rocky slopes, and canyons
Rock selaginella (*Selaginella rupestris*)	Rock outcrops and grassy ridges

Species	Expected habitat
Drummond's campion (*Silene drummondii* var. *drummondii*)	Dry shrubland, meadows, and woodland openings
Slender wedgegrass (*Sphenopholis intermedia*)	Moist habitats such as shorelines, streambanks, meadows, ponds, etc.
Purple-stemmed aster (*Symphyotrichum puniceum* var. *puniceum*)	Various wetlands; shoreline

3.4 Vegetation Management

3.4.1 Protection of south-facing grassland and forested slopes

Management of agricultural lands on the lower terrace will retain the suitability and availability of the adjacent steep south-facing grassland slopes for ungulate use in winter, late fall and early spring. No livestock grazing will be permitted in grassland or forested habitats. Fences will be installed around the fields to contain any livestock grazing within the cultivated areas.

Prescribed burns are used in the Peace Region to rejuvenate the grasslands and increase their value and suitability for ungulates. BC Hydro will work with the Ministry of Forests to determine if prescribed burns under appropriate conditions are a suitable management tool for the south-facing grassland slopes on the Property. From there a prescribed fire burn plan could be developed, which can take up to two years to put in place (see https://prescribedfire.ca/plan-a-burn/).

3.4.2 Creation of Old field habitats

The old field habitats on the plateau and lower terrace (Parcel 52 uplands and old field; Figure 2) will be fenced off from Fields 2a and 2b to provide old field-grassland habitat. Vegetation within the old field areas will be maintained through periodic mowing, outside of the breeding bird window, on a rotational basis such that at least one area is maintained in old field status within the Property at all times (i.e., one old field mowed every four years). BC Hydro will ensure that the mowing activity is supervised by qualified professionals to ensure the protection of bird nesting, small mammal dens and other animals using the habitat.

3.4.3 Riparian vegetation plantings

A 15-metre riparian vegetation zone will be established along the edge of the reservoir in parcels 57, 54, 50 and 48 though planting of native shrubs and trees outside the five-year beach line. The five-year beach line is the predicted extent of shoreline retreat at the maximum normal reservoir level five years after impoundment (EIS, Volume 2 Appendix B, Part 2).

The objective of establishing a 15 m riparian vegetation zone is to replace deciduous and coniferous riparian vegetation lost due to reservoir creation. A mix of live staked Balsam poplar (60%), willow (30%) and red-osier dogwood (10%) will be planted at densities of 2,500 stems/ha.

In the long term, the vegetation within this zone is expected provide protection against additional shoreline erosion and provide riparian habitat with the attributes needed to support rare plants, non-wetland migratory birds and species at risk.

4.0 WILDLIFE OBJECTIVES

Except for butterfly surveys, baseline wildlife surveys were not conducted at Wilder Creek. Baseline data were consulted to determine which species would be expected to use the Property based on the habitats present.

Management of the Property will aid in fulfilling the conditions outlined in Section 1.1 above.

4.1 Target species

Management of the Property will target maintaining, creating and managing habitat (breeding, feeding, migration and winter) for:

- non-wetland migratory birds identified as species of conservation concern for Bird Conservation Region 6 by Environment Canada (2013)
- species at risk documented in similar habitats in the project area
- ungulate winter range for elk, deer and moose

Should additional species of conservation concern for Bird Conservation Region 6 or species at risk be documented on the property during monitoring surveys the management plan will be reviewed and revised as required.

Table 4 below summarizes the species expected to occur on the Wilder Creek lands based on their habitat preferences and occurrences documented in the baseline data (Hilton *et al*. 2013b, 2013c, 2013d and Hilton and Simpson 2013).

Table 4. Wildlife species expected to occur on the Wilder Creek lands (M=migrant breeder, R=resident, F=feeding).

Hilton *et al*. 2013b, 2013c, 2013d and Hilton and Simpson 2013

Species	BCCF Priority	Habitat										
		AM3	AM4	AM5	AS2	AS3	CB	CF	SW4	SW5	WW2	WW3
Non-wetland migratory birds of Conservation Concern Region 6												
American Kestrel	2							M			M	
American Three-toed Woodpecker	6			R								
Baltimore Oriole	2		M	M								
Bank Swallow	5						M					
Black-billed Magpie	6					R		R			R	R
Blackpoll Warbler	5		M	M								
Bohemian Waxwing	6			R						R		
Boreal Chickadee	5			R								
Boreal Owl				R						R		
Clay-colored sparrow	4				M	M		M			M	M
Eastern Phoebe	4							M			M	M
Great Gray Owl				R						R		
Killdeer	2							M				
Least Flycatcher	6		M	M								
Mourning Warbler	2	M	M						M			
Northern Flicker	6			M						M		
Northern Goshawk	3			M						M		
Northern Harrier	2							M			M	
Northern Shrike	4				R	R		R				
Pileated Woodpecker				R								
Sharp-tailed Grouse	2	R	R	R				R	R	R	R	R
Western Tanager	6			M						M		
Western Wood-Pewee	2			M						M		
White-throated Sparrow	5				M	M		M			M	M
White-winged Crossbill	5			R						R		
Yellow-bellied Sapsucker	6		R	R					R	R		
Other non-wetland migratory birds												
American Redstart	6		M	M					M	M		
American Robin	6	M	M	M		M		M	M	M		
Black capped Chickadee	6			R		R				R		
Cedar Waxwing	6	M	M	M		M			M	M		
Chipping Sparrow	5	M	M	M		M		M	M	M		M
Common Yellowthroat	5							M				

Species	BCCF Priority	Habitat										
		AM3	AM4	AM5	AS2	AS3	CB	CF	SW4	SW5	WW2	WW3
Dark-eyed Junco	5	R	R	R		R			R	R		R
Golden-crowned Kinglet	5								M	M		
Great Horned Owl				R						R		
Least Flycatcher	6	M	M	M		M			M	M		M
Northern Saw-whet Owl				R						R		
Purple Finch	2			M						M		
Red-breasted Nuthatch	5		M	M					M	M		
Red-eyed Vireo	2	M	M	M		M			M	M		
Ruby-crowned Kinglet	6			M						M		
Tennessee Warbler	5	M				M			M		M	M
Warbling Vireo	6	M	M	M		M			M	M		
White-throated Sparrow	5	M	M	M		M			M	M		
Yellow-rumped Warbler	5	M	M	M		M			M	M		
Yellow Warbler	2	M	M	M		M		M	M	M		
Species at Risk												
Alberta Arctic											M	M
Aphrodite Fritillary		M	M	M		M					M	M
Arctic Blue					M	M					M	M
Arctic Skipper		M	M	M				M	M	M	M	M
Assiniboine Skipper		M	M	M	M	M		M			M	M
Common Ringlet					M	M		M			M	M
Common Woodnymph		M	M	M	M	M		M	M	M	M	M
Coral Hairstreak								M				
Great Spangled Fritillary		M	M	M	M	M					M	M
Old World Swallowtail											M	M
Striped Hairstreak											M	M
Tawny Crescent		M	M	M	M	M			M	M	M	M
Uhler's Arctic					M	M					M	M
Black-throated Green Warbler	1			M								
Broad-winged Hawk	4			M						M		
Canada Warbler	2		M	M					M	M		
Cape-may Warbler*												
Cackling Goose	4							M				
Common Nighthawk	2										M	M
Connecticut Warbler	2			M						M		
Le Conte's Sparrow	4							M			M	M
Olive-sided Flycatcher*												
Rusty Blackbird*												

Species	BCCF Priority	Habitat										
		AM3	AM4	AM5	AS2	AS3	CB	CF	SW4	SW5	WW2	WW3
Short-eared Owl	2							R			R	R
Upland Sandpiper	1							M			M	
Winter Wren				M					M	M		
Eastern red bat		F	F	F	F	F	F	F	F	F	F	F
Northern long-eared myotis	2	F	F	F	F	F	F	F	F	F	F	F
Ungulates												
Elk	5	R	R	R	R	R	R	R	R	R	R	R
Mule deer	6	R	R	R	R	R	R	R	R	R	R	R
Moose		R	R	R	R	R	R	R	R	R	R	R

*Expected to occur after reservoir inundation and establishment of old forests within the Property

4.2 Management Activities

Management for non-wetland migratory birds, species at risk and ungulates will be achieved through:

- Installing fencing around the perimeter of Fields 1, 2a and 2b. The objective of the fencing is to contain any livestock grazing within the cultivated field areas and allow wildlife access to the hills.
    - The inside fence configuration will be 5-strand wire. The top and bottom wires will be smooth. The middle three wires will be barbed. The lower and top smooth wires will be raised to facilitate ungulate passage (the proposed fencing is described in the BC Agricultural Fencing Handbook (Ministry of Agriculture Food and Fisheries 2002).
    - Existing fencing will be removed in conjunction with installation of the new fencing.
- Installing split rail fencing along the northern Property boundary of Parcel 52 to demark the beginning of the old field habitat (former rough pasture) area.
- Establishing and maintaining old field habitats on the plateau and lower terrace (Parcel 52 uplands and old field; Figure 2).
- Establishing large trees along the edge of fields and within current forested areas.
- Enhancing values of the steep riparian ravine and gully slopes to non-wetland migratory birds by planting native, woody species (trees and shrubs).
- Installing posts and nest boxes suitable for American Kestrel, swallows, waterfowl and other cavity-nesting species along fence lines at the edge of cultivated fields and within the 15 m riparian vegetation zone.
- Conducting prescribed burns of grassland habitats (steep south-facing slopes) to rejuvenate native grassland and early seral habitats and maintain and enhance their value as ungulate winter range

4.2.1 Ungulate Winter Range - Winter Ecology and Habitat Requirements – Biological Rationale

The biological rationale provided for below is intended to cover elk, mule deer and moose, the species currently protected by UWR U-9-007. The components of winter ecology and habitat requirements include thermal cover, winter forage, interspersion of thermal cover and foraging areas, and access management and human disturbance, as outlined in the document "Establishing Ungulate Winter Range Objectives – Omineca Region" (Triton 2002).

Thermal Cover

The forested portions of the Property have the capacity to intercept snow and provide both thermal cover and accessible forage, which are the primary habitat variables influencing ungulate winter habitat selection in this part of northern British Columbia (Triton 2002). Snow depth greatly influences elk distribution with a large selection to open south-facing slopes and forested habitats with good snow interception. Elk movements can be restricted by snow depths of 40-50 cm (Triton 2002). Along the Peace reach elk use open shrub/grassland communities and deciduous/mixed stands, along with south-facing slopes and cultivated fields such as those represented on the Property (Bachmeyer 1994). Snow depths >40 cm restrict deer movement and bury shrub forage, so having the forested portion and the south-facing slopes on the Property are important aspects to elk and deer survival during the winter months. Moose are physically adapted to the deeper snow conditions but are known to select for areas under 40 cm and will move out of an area when depths exceed 70-90 cm. Moose will spend most of their time feeding in open areas such as the agricultural fields, south-facing slopes and old fields, but if snow depths increase the forest cover is an important part of this Property. The forested areas have a crown closure of 60-65% which will help maintain this snow interception and not clearing these areas is an important part of this management plan.

Winter Forage

Elk are primarily grazers with 90% of their diet coming from grass species (Triton 2002). In the winter they tend to shift to mixed grasses and shrubs such as those found on the south-facing slopes, old fields, and forested habitat on the Property. Mule deer browse a wider array of habitats from forested areas, agricultural fields and during the later winter, south-facing slopes. Maintaining this diversity of habitats on the Property through active burning of the south-facing slopes, creation and maintenance of old field habitat and preventing logging of the forested habitat builds durability of this winter range for deer.

The availability of forage is an important component of moose winter habitat selection as they need to consume large quantities of high-quality browse for their survival. Moose will therefore select foraging areas high in shrub species (willow, aspen, Balsam poplar, red osier-dogwood, Saskatoon, highbush cranberry, prickly rose and gooseberry. These species are well-represented on the Property on the south-facing slopes, forested areas, and old field habitat.

Interspersion of Thermal Cover and Foraging Areas

For elk and mule deer the interspersion of forest cover and openings is a desirable management objective for a UWR. Elk and deer require a minimum of 20% forest retention in age class ≥ 80 years with a minimum forage requirement of 15% or ≤20 years old (Mowat 2002). Crown closure in the retained forested areas should be maintained at ≥50%. Elk prefer to stay close to escape/thermal cover at the forest edges so most of their foraging typically occurs within 200 m of available cover. The Property has fields 1, 2a and 2b as primarily agriculturally cultivated fields, but will also have fields 3 and the old field habitat. The old fields and much of the main cultivated fields have some adjacent forest cover in the slope ravines that will meet these conditions.

Moose winter range objectives will require up to 10% of the area left in forest cover >60 years old and at least 10% of the area available for forage (i.e., early seral shrub habitat <20 years old). The creation and maintenance of the old fields will provide the <20-year-old habitat and retention of the existing intermediate (80-100 years old) forest will provide the cover.

Access Management and Human Disturbance

For all the species involved, roads decrease the value of the habitat in a zone up to 100 m from the road. There are no main roads into this Property, just two old farm trails used to access the agricultural fields. The one trail comes down from the Shaman Bison Farm to the north. The other old farm trail was historically part of the old Hope Road to Hudson's Hope but is not longer accessible to the public. It is therefore recommended that no new roads be incorporated into the Property for the existing agricultural uses or potential future industrial use. Since the Property is private land, this can be managed by BC Hydro within the UWR. Currently there are some low-grade agricultural farm trails from the top side to the dry south-facing slopes. Increased road access can increase hunter success, and reduce ungulate densities, so the Property should be posted for no hunting and enforced by BC Hydro and/or the leaseholder.

4.3 Ungulate Winter Range Objectives

Based on the above suitable characteristics of the proposed UWR area, the objectives in Table 5 are proposed to manage elk, mule deer, and moose winter range.

Table 5 – Ungulate Winter Range Objectives for elk, mule deer and moose[Error! Bookmark not defined.]

Objectives	Assumptions	Measures
Maintaining 10-40% shrub cover of preferred deciduous forage species.	• Provides winter forage for elk, deer and moose.	• Create and maintain old field habitats.
Maintaining at least 15% of the area in high suitability foraging habitat - grazing/ browsing habitat (grasses and shrubs)	• Elk and deer require a higher quantity of early seral habitat for winter forage. • Elk and deer will supplement agricultural species for winter grazing.	• Enhance forage productivity through prescribed burns. • Creation and maintenance of old field habitat. • Continued use and maintenance of the agricultural fields.
Maintain the intermediate age class (80-100 years) forest within the Property for thermal cover.	• Maintains available thermal cover by having a diversity of forest cover habitat.	• No logging or clearing in forested areas of the Property.
No new road or access development and no recreational use of the Property.	• Roads and human disturbance and noise reduce habitat effectiveness. • Road activity will displace animals and result in increase vehicle mortality.	• No hunting or other recreational uses of the property permitted. • No new road development for agriculture or industry will be allowed on the property.

5.0 MANAGEMENT OBJECTIVES: AGRICULTURE

The objectives of field management are to maintain agricultural production within the areas of cultivated field habitat on the lower terrace adjacent to the reservoir, create additional wildlife habitat within cultivated fields, and protect and maintain wildlife habitats within the Property. This will be achieved through a program of field management that will include:

- Retain and improve existing grain and oilseed production on Fields 2a and 2b;
- Retain and improve existing forage production on Field 1 and 3;
- Establish and maintain areas of old field habitat on the plateau (formerly rough pasture) and terrace (old field)
- Allow current level of livestock grazing in cultivated areas until reservoir filling completes;
- After reservoir fill and fencing is installed, allow pasture use and aftermath grazing of crop residue by livestock only on the actively cultivated areas of Fields 2a and 2b.
- Encourage more intensive agricultural crop production (e.g., alfalfa seed, vegetables) post--reservoir fill, particularly if irrigation water becomes available.

5.1 Field Management

Typically, Peace River hayfields and pastures require renovation every 5-8 years to maintain optimal forage production levels. Field 1 has been recently cultivated and seeded and should not require renovation for a few years, but would benefit from regular fertilizing, addition of organic matter (manure or green maturing) and perhaps scarification and over-seeding.

Field 2 is being alternately cropped for forage and oil seed production by the previous leaseholder. In 2014 it was prepared for planting to a canola crop in 2015. In 2022 a wheat crop was documented in Field 2 (Eco-Web 2022).

The proposed cultivation, weed treatment, fertilizing, and seeding specifications will be reviewed for each field with the leaseholder annually.

5.2 Grazing Rotation

The primary use of the main fields will be crop production, with grazing of crop residue following crop removal and rotational grazing of the old field areas. Continuous grazing can lead to overgrazing resulting in increased weed growth and soil damage, while rotational grazing, helps to maintain the quality and longevity of the forage stand. Rotational grazing entails more intensive field management where the field is rested for several weeks or months, following a period of grazing for several days or weeks. The optimal number of livestock is placed in the field and distributed evenly throughout the field by salting and water placement to ensure even grazing pressure over the entire field. The management decision on when to start grazing, end grazing, and then re-graze a field, is based on several factors, including the density and height of the grass/legume cover and ground (soil) conditions.

Rotational grazing is used to manage both native (natural) forested and grassland ranges and improved fields such as occur within the Property. For native ranges, the period of use is generally rotated annually between the earlier and later grazing season to achieve optimal forage health and production levels. Early spring grazing by cattle increases the palatability of the forage for ungulates, while the later fall grazing helps to rejuvenate the forage yield the following year.

Two general rotation patterns are proposed for management of cultivated fields on the Property:

Old Field (Fields 1 and 3): For “old field habitats” a simple rotation of predominantly light, later season grazing (August to mid-September – 1.5 months) in one year, will be followed by earlier, light spring (late-May to end of June – 1 month) grazing the following year if growing conditions are conducive to this. In years with limited spring growth, grazing would be held off to late season grazing. The interval (e.g., every second or third year) with which the fields would be grazed in the spring would be based on actual field conditions. Grazing of the hillside and forested areas will not be permitted.

Crop fields (Fields 2a and 2b): A post crop residue grazing rotation from September to mid-October will be followed for the intensively managed crop fields. This will generally entail a period of short-term intensive grazing following crop removal. The timing of the start of the grazing period

will be dependent on crop removal timing and adequate soil and grass conditions to support grazing. This will be determined annually by the leaseholder.

The exact rotation schedule will be based on seasonal monitoring. Individual field specific rotations will be determined in consultation with the Property leaseholder on an annual basis. Implementation of this rotational system will require intensive management during the grazing season, including regular field maintenance (e.g., rejuvenation) and timely movement of cattle between fields, by the leaseholder.

6.0 DETAILED MANAGEMENT PLAN

6.1 Priority Site Works

6.1.1 Access

The access road entering the Property through Field 3 requires improvement. Stabilizing works are required where the track is slumping in the gully. Additional site visits may be required to develop a strategy to restore the road with the leaseholder.

6.1.2 Fencing

Ungulate-friendly fencing will be installed along the perimeter of Field 1, 2a and 2b as described in Section 3.2 to restrict livestock use to the cultivated fields. Once reservoir filling completes, split-rail fencing should be installed along the northern boundary of Parcel 52 at the entrance to the Property.

6.1.3 Cattle Watering

The dugout located in Parcel 52 will no longer be available for livestock watering. If livestock use is to continue on Fields 1, 2a and 2b, options for providing water will need to be developed. Livestock may be able to access the reservoir or new dugouts may be required. Discussions should be held with the leaseholder to determine the necessity of and possible locations for livestock watering facilities within the Property.

6.2 Field Improvements

6.2.1 Field Management

Field 1 (46.6 ha) adjacent to the Peace River is currently only used for forage crops because the soils are coarse (sandy) textured and shallow, overlying gravels and stones (Figure 2). Field 2 (57 ha) is used to produce forage and oilseed (canola) crops.

Two management regimes will be implemented in these fields:

- Maintain long term forage production in Field 1
- Maintain intensive crop production on Field 2 (and post-flooding, Fields 2a and 2b)
- Margins of Fields 1 and 2, where appropriate, will be managed to provide old field-grassland habitat. Vegetation height within these areas will be 0.3 to 2.1 meters with the

objective of providing breeding habitat for Short-eared Owl (*Asio flammeus*), Northern Harrier (*Circus hudsonius*), Sharp-tailed Grouse (*Tympanuchus phasianellus*) and Common Nighthawk (*Chordeiles minor*).

- Old field habitats will have a simple rotation of predominantly light, later season grazing (August to mid-September – 1.5 months) in one year, will be followed by earlier, light spring (late-May to end of June – 1 month) grazing the following year if growing conditions are conducive to this.
- A post crop residue grazing rotation from September to mid-October will be followed for the intensively managed crop fields. This will generally entail a period of short-term intensive grazing following crop removal. The timing of the start of the grazing period will be dependent on crop removal timing and adequate soil and grass conditions to support grazing. This will be determined annually by the leaseholder.

6.2.2 Weed management plan

- Minor infestations of thistle and dandelion were recorded during the brief Property visit in 2014 (Christie and McIntosh 2015);
- A weed survey was conducted in 2015. Results will be provided to the leaseholder for inclusion in their weed management plan. BC Hydro will assist the leaseholder in the development of a weed management plan through its Agricultural Leaseholder Noxious Weed Treatment Program. Through this program, leaseholders can access expert advice from a noxious weed control specialist in planning and implementing noxious weed control. After an audit by the weed control specialist, of the efficacy of any chemical treatments, BC Hydro reimburses the leaseholder the cost of chemicals used.

7.0 ADDITIONAL REQUIREMENTS AND/OR RECOMMENDATIONS

- Create and maintain old field habitats.
- Enhance forage productivity through prescribed burns.
- No logging or clearing in forested areas of the Property.
- No polypropylene twine or wire is to be used for any hay brought on site. Only biodegradable twine should be used.
- Hunting will not be permitted on the property during the winter months, other than predator control.
- No recreational use of the property will be allowed in the winter months.
- No access development other than that required to manage the cultivated fields will be allowed
- Honeybees will be allowed

8.0 MONITORING AND FOLLOW-UP MANAGEMENT OF THE PROPERTY

8.1 Leaseholder record-keeping requirements

At a minimum the leaseholder will keep records of the following:

- Crops grown including date of planting and harvest
- Weed treatment(s) including: area treated, date of treatment, chemicals applied, rate of application, treatment efficacy and plans for the following year's treatment
- Wildlife observations, including any issues with wildlife;
- Fencing requiring repairs (dates, locations, particularly if likely caused by wildlife)
- Wildlife carcasses including locations and dates
- Active raptor nests
- Carnivore (bear, coyote, fisher) dens

8.2 Monitoring by BCH

BC Hydro will conduct the following surveys and monitoring observations on the Property:

- Breeding bird surveys (see Sections 7.1.1.2-A and 7.2.7 of the *Vegetation and Wildlife Mitigation and Monitoring Plan*)
- Bird nest monitoring plan (see Section 7.1.1.2-B of the *Vegetation and Wildlife Mitigation and Monitoring Plan*)
- Ground nesting raptor surveys (see Section 78.9.5.1 of the *Vegetation and Wildlife Mitigation and Monitoring Plan*)
- Monitoring of general property conditions (TBD).

8.3 Annual meetings to discuss/update management plans

To be determined in consultation with leaseholder. BC Hydro suggests having these annual meetings in April each year, with potential follow up meetings in October if required.

9.0 SUMMARY OF UNGULATE WINTER RANGE MANAGEMENT

The Property has excellent historical winter range use by elk, deer and moose. The agricultural activity has enhanced forage opportunities for wildlife in this area and the maintenance of this agricultural use is important to this value. Ungulate winter range values are enhanced by maintaining 10-40% shrub cover of preferred deciduous forage species in the old fields and surrounding hillsides, at least 15% of the area in high suitability foraging habitat - grazing/browsing habitat (grasses and shrubs) and the intermediate age class (80-100 years) forest within the Property for thermal cover. Grazing will be managed to short term rotational grazing in the old field and post harvest residue grazing on the crop fields to ensure forage levels will be maintained for ungulate winter use. To further prevent winter disturbance to ungulates, no new road or access development and no recreational use of the Property in the winter months will ensure its suitability as winter range.

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Appendix 7. 2024 Rare Plant Surveys Annual Report

EAGLE CAP CONSULTING
environmental consulting services

2024 Annual Report
Preconstruction Rare Plant Surveys
Site C Clean Energy Project

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April 2, 2025

Contents

1. Introduction **3**

1.1. Background 3

1.2. Scope 4

1.3. Study Area 5

2. Methods **5**

2.1. Pre-field Review 5

2.2. Field Survey 7

2.3. Mitigation Planning and Implementation Assistance 10

2.4. Analysis 10

3. Results **13**

3.1. Pre-field Review 13

3.2. Field Survey 13

3.3. Mitigation Planning and Implementation 17

4. Discussion **20**

4.1. Coverage 20

4.2. Seasonal Timing 20

4.3. Ongoing Work 21

5. Closure **22**

6. References **23**

7. Appendices **27**

7.1. Appendix 1: Rare plant taxa with potential for occurrence in the Site C Project area 28

7.2. Appendix 2: Plant and lichen species recorded during the 2015–2024 surveys 31

7.3. Appendix 3: Species accounts for rare plant taxa found during preconstruction surveys 40

7.3.1. Atriplex gardneri var. gardneri (Gardner's sagebrush) 41

7.3.2. Carex sprengelii (Sprengel's sedge) 42

7.3.3. Carex torreyi (Torrey's sedge) 43

7.3.4. Carex xerantica (dry-land sedge) 44

7.3.5. Drymocallis arguta (tall wood beauty) 45

7.3.6. Lomatium foeniculaceum var. foeniculaceum (fennel-leaved desert-parsley) 47

7.3.7. Penstemon gracilis (slender penstemon) 48

7.3.8. Piptatheropsis canadensis (Canada ricegrass) 49

7.3.9. Polygala senega (Seneca snakeroot) 51

7.3.10. Ranunculus rhomboideus (prairie buttercup) 51

7.3.11. Salix petiolaris (meadow willow) 53

7.3.12. Selaginella rupestris (rock selaginella) 54

7.4. Appendix 4: Memo Evaluating Site C EIS Rare Plant Predictions 56

1. INTRODUCTION

1.1. Background

The Environmental Assessment Certificate (EAC #E14-02) for the Site C Clean Energy Project (the Project) sets out the conditions that BC Hydro must comply with during construction and operation of the Project (BC Environmental Assessment Office 2014). Condition 9 states in part:

- *The EAC Holder must, with the use of a QEP [Qualified Environmental Professional], complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission lines. These preconstruction surveys must target rare plants as defined in Section 13.2.2 of the EIS [Environmental Impact Statement] —including vascular plants, mosses, and lichens.*
- *The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE [Ministry of Environment] using provincial data collection standards.*

In addition, the Federal Decision Statement (FDS) issued under the Canadian Environmental Assessment Act sets out conditions relating to rare plants (Canadian Environmental Assessment Agency 2014). Condition 16 states in part:

- *16.1 The Proponent shall ensure that potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants are addressed and monitored.*
- *16.2. The Proponent shall develop, in consultation with Environment Canada, a plan setting out measures to address potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants.*
- *16.3. The plan shall include:*
    - *16.3.3. measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;*
    - *16.3.4. conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation;*
    - *16.3.6. an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and*
    - *16.3.7. an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in*

> *accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the Designated Project.*

To partially fulfill EAC condition 9 and FDS conditions 16.1, 16.2, 16.3.3, 16.3.4, 16.3.6 and 16.3.7, BC Hydro is conducting rare plant surveys in previously unsurveyed areas of the proposed transmission line, access roads, and other construction corridors. By documenting additional occurrences of rare plants within the Project footprint, measures to mitigate effects to these occurrences—including seed recovery and translocation—can be identified.

Data collected during these preconstruction rare plant surveys are added to the Project's environmental features spatial database. These spatial data are used during detailed design and construction to identify opportunities for avoidance, areas where extra care is needed, and areas where losses will occur. The first season of preconstruction surveys was completed in the summer and fall of 2015, and the work has been proceeding every year since. This interim report documents the methods and results of the 2024 surveys, and includes summaries of the work completed since 2015 for context.

In addition, to fulfill other requirements of FDS condition 16.3.6, an analysis was conducted to assess the accuracy of the rare plant predictions contained in the Site C EIS, based on data collected during the past 10 years of rare plant and vegetation work. The results of this analysis are presented in a memo report attached as an appendix (Section 7.4) to this interim report.

1.2. Scope

The goals of the study are:

- to develop, maintain, and update a spatial database of rare plant occurrences in the vicinity of Project facilities;
- to determine the location of rare plant occurrences in previously unsurveyed areas that are proposed for ground or vegetation disturbance during construction and operation of the Project;
- to determine the location of rare plant occurrences within two mitigation parcels that will be used to compensate for project effects;
- to record detailed occurrence data in the master rare plant spatial database for all rare plant populations found, and submit these data to the B.C. (British Columbia) Conservation Data Centre (BCCDC) and—for taxa of federal concern—to Environment and Climate Change Canada (ECCC);
- to develop occurrence-specific mitigation measures to eliminate or reduce adverse effects to rare plant populations resulting from the Project;
- to assist construction teams in implementing the ongoing rare plant mitigation measures; and
- to monitor and evaluate the effectiveness of direct mitigation measures implemented to protect Project-area rare plant populations.

1.3. Study Area

Rare plant surveys were conducted in:

- the Highway 29 realignment corridors;
- the transmission line corridor;
- the new or upgraded transmission line access road corridors;
- the new or upgraded access road corridors into the reservoir clearing zone—excluding the reservoir footprint;
- the aggregate extraction areas;
- the haul road running along Ice Bridge and Septimus Roads from Area E to the Dam Site;
- the Project Access Road corridor running from Jackfish Road to the Dam Site;
- the access road extension at the Portage Mountain site;
- the 85th Avenue industrial site;
- the conveyor corridor from the 85th Avenue industrial site to the dam site;
- the 204 hectare Rutledge mitigation parcel along Highway 29 at Dry Creek; and
- the 423 hectare Wilder Creek mitigation parcel located along the Peace River approximately six kilometres (km) downstream from Bear Flat.

Preconstruction rare plant surveys were completed for many of these areas during the 2015 through 2023 field seasons. The 2024 work focussed on areas along the Highway 29 realignment corridors north of the Peace River, and on the Area E aggregate extraction site.

2. Methods

2.1. Pre-field Review

Each year in the spring the investigation began with a pre-field review designed to collect and analyze existing data. This information was used to create a field study plan and to identify data gaps in order to direct further research.

For the purpose of the investigation, “rare plants” were defined as the following vascular plants, mosses, and lichens:

- species listed on Schedule 1 of the Canadian Species at Risk Act (SARA) as amended (Government of Canada 2002);
- species assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2023); and

- species on the BCCDC's provincial Red or Blue lists (Red = Endangered, Threatened, or Extirpated; Blue = Special Concern)(BCCDC 2024a) .

Scientific and common plant names in this document follow the BCCDC's online Species and Ecosystem Explorer (BCCDC 2024a), which also serves as the authority for the Provincial rare plant status determinations and rankings.

Since 2005, BC Hydro has been conducting rare plant surveys in the Project's Regional Assessment Area (RAA)—as defined in the Site C Environmental Impact Statement (Hilton et al. 2013). As such, much is known about the rare flora of the area, and the pre-field review was based heavily on rare plant occurrence data collected over the last 20 years. Currently, 21 different rare plant taxa are reported to occur in the Project area. Consequently, these 16 vascular plants, four lichens, and one moss formed the basis of the target species list for the work, comprising the rare species with the highest likelihood of occurrence.

Since 2011 all rare plant data for the Project have been managed in a master rare plant spatial database. This database contains occurrence information for all known rare plant occurrences in the RAA, as well as rare plant survey tracks, field notes, species information, and other collected data relevant to the rare plant work. Collected field data are added to the database as needed over the course of the year. Periodically, the master rare plant spatial database has been queried, and the information supplied to BC Hydro, to update the Project's environmental features database. This environmental features database has been made available to Project engineers for use in mitigation planning.

In order to identify additional rare plant species that could potentially occur in the Project area, each year the dataset of all B.C. vascular plants, mosses, and lichens was downloaded from the BCCDC's Species and Ecosystem Explorer (BCCDC 2024a). Queries were run on the dataset to extract a list of the rare plant species that the BCCDC associates with the Peace River Regional District and the Boreal Black and White Spruce Biogeoclimatic Zone. Each species on this list was further reviewed to determine its potential for occurrence within the areas targeted for survey.

In addition, the BCCDC occurrence dataset of all species and ecosystems at risk (BCCDC 2024b) was periodically downloaded from the B.C. Data Warehouse and added to the master rare plant spatial database. The dataset was queried to investigate historic and verified extant rare plant occurrences within the Project area.

All the above information was compiled to produce a list of target rare plant species potentially occurring within the Project area. This target list included the 21 rare plant taxa currently reported to occur in the Project area, as well as numerous other possible Peace Region species uncovered during the pre-field review of data and literature. The target list was used as a working guideline and was not considered to be an exhaustive list of all potential rare plants in the Project area. For this reason, the botanists considered all described plant taxa while conducting surveys.

Aerial imagery, digital elevation data, and project maps were reviewed to predict the habitat types present in the survey corridors. General plant communities were determined, and the locations of possible high-suitability rare plant habitat were noted.

To refine their search images for the target taxa, the surveyors studied photographs, herbarium specimens, and species descriptions in various published references (Hitchcock et al. 1955; Flora of North America Editorial Committee 1993; Goward et al. 1994; McCune et al. 1995; Douglas et al. 1998; Goward 1999; Brodo et al. 2001; Welsh 2001; Cronquist et al. 2013; Brodo 2016) and online databases (CNALH 2021; Klinkenberg 2024; NatureServe 2024). In addition, they reviewed similar data for species that might be confused with the target taxa. Tables of summary identification characteristics were prepared for field use. The goals were to maximize detectability of the target species and to reduce surveyor bias during the field work.

The final field plan each year was designed to guide the methods, coverage, and timing of the rare plant surveys. Seasonal timing was based on the predicted phenologies of the target species.

2.2. Field Survey

The preconstruction surveys began in June of 2015 and have taken place every year since. Over the ten field seasons, 389 surveyor-days have been spent surveying a total transect distance of 2,171.5 km (Table 1 and Figure 1).

Table 1: Rare Plant Survey Effort

Year	Start Date	End Date	Surveyor-Days	Total Survey Km
2015	June 30	September 7	42	209.8
2016	June 20	August 23	41	191.8
2017	June 23	August 12	12	51.7
2018	June 13	August 29	56	409.3
2019	May 31	August 15	46	250.7
2020	June 4	October 9	56	322.3
2021	June 8	September 4	44	318.3
2022	June 6	August 23	40	156.6
2023	June 5	September 13	32	154.8
2024	June 5	August 3	20	106.2
Totals			**389**	**2,171.5**

Table notes:

- *Surveyor-Days = days spent surveying x number of botanists*
- *Total Survey Km = total survey transect distance*

For all ten years, the surveys were performed by two senior-level rare plant botanists, both of whom have been working with the rare flora of the Project area for the past 14 years. The surveyors primarily used a habitat-directed meander search protocol to cover the areas surveyed. This survey technique is based on floristic, intuitive-controlled meander search types outlined in various rare plant survey guidelines (Whiteaker et al. 1998; ANPC 2000; ANPC 2012; Penny & Klinkenberg 2012; MOECCS Ecosystems Branch 2018). The surveyors, working together or separately, walked the length of the linear corridors, zig-zagging back and forth from one edge of the proposed disturbance area to the other. For non-linear survey areas such as the Industrial 85th Avenue or Portage Mountain sites, the surveyors conducted meander transects to cover the entire area.

When using the habitat-directed meander search protocol:

- surveyors walk variable-width transects that are spaced relatively close together (typically so that the edge of the transect just surveyed is still visible to the surveyor or their partner—this distance varies based on the habitat surveyed and the detectability of the target species);
- surveyors attempt to locate all rare plant occurrences and high-suitability rare plant habitat within a defined unit in a systematic way (e.g., by walking in a zig-zag pattern along linear features, or in a contour pattern when surveying non-linear features); and
- surveyors attempt to traverse a representative cross-section of all low-suitability rare plant habitat within the unit.

The habitat-directed meander search preferentially covers high-suitability ecosystems over the more common low-suitability habitats (MacDougall & Loo 2002). The survey method is floristic in nature, meaning that all plant taxa encountered are recorded and identified to a level necessary to determine their rarity (ANPC 2012). Furthermore, the habitat-directed meander search pattern is of variable intensity, such that when a rare plant occurrence or high-suitability rare plant habitat is located, the surveyors increase the intensity of their survey by narrowing the spacing of the transect pattern they are walking. Depending on the kind of habitat being surveyed and the detectability of the target rare species, this can require very close, hands-and-knees survey work in some areas.

For certain linear corridors that traverse habitat with a low potential for rare plant occurrence, the botanists drove slowly along the corridor in a Utility Terrain Vehicle (UTV) or truck, scanning both sides for rare plants and pockets of high-suitability rare plant habitat. This procedure was only conducted in corridors where the majority of habitat was low-probability rare plant habitat, and at a speed of approximately five kilometres per hour. When high-potential rare plant habitat was encountered—such as wetlands or rock outcrops—the surveyors exited the vehicle and surveyed the habitat on foot. Over the course of the ten field seasons, 85.9 km out of the total 2,171 km covered (4.0%) were surveyed in this manner.

In 2016, surveys were conducted within the Rutledge and Wilder Creek mitigation parcels. These surveys were designed to provide a general overview of the rare plant populations present within the parcels, in order to inform mitigation planning. As such, these areas were surveyed at a lower intensity level,

covering a smaller percentage of the suitable habitats than in the areas proposed for disturbance. Although the habitat-directed meander survey technique described above was used in the mitigation parcels, certain areas of suitable habitat were not covered.

During the fieldwork, the surveyors constantly monitored all areas traversed for changes in habitat and plant association, as well as for previously unrecorded plant species (common and rare). Lists were kept of all plants and plant communities observed; unknown species were collected for later identification in the lab; Global Positioning System (GPS) units were used to mark location points as appropriate; and notes and photographs were taken to record plants of interest, landforms and unique features, habitat quality and disturbance, and areas requiring further survey.

When target rare plants were found during the fieldwork, occurrence information was entered into custom-built digital forms or recorded on printed BCCDC rare plant survey forms (BCCDC 2012). Where paper forms were used, the information was later transcribed into digital format to facilitate analysis of the occurrences. Photographs were taken of both the individual plants and the surrounding habitat. Consistent with the B.C. Resource Information Standards Committee guidelines and the rare plant survey guidelines on the B.C. E-Flora website, a voucher specimen was collected where permitted by the landowner, and when doing so did not compromise the viability of the population (RIC 1999; Penny & Klinkenberg 2012; MOECCS Ecosystems Branch 2018). At each vascular rare plant occurrence, GPS units were used to record the boundary of the occurrence to facilitate mitigation planning.

Delimitation of occurrences is based on *A Habitat-Based Strategy for Delimiting Plant Element Occurrences* (NatureServe 2004). The Element Occurrence (EO) is a fundamental unit of information in the Conservation Data Centre system, and is defined as "an area of land and/or water in which a species or natural community is, or was present." (NatureServe 2002). Based on the NatureServe guidance, rare plants for the Project were typically grouped into a single occurrence when they were located closer than one kilometre from another individual of the same species. In some cases, occurrences were composed of two or more discrete patches within a larger area. These patches were mapped separately to facilitate mitigation planning, but were recorded as a single occurrence when the patches were closer than one kilometre to each other.

Accordingly for the Site C Project, the following definitions were used for rare plant groupings:

- **Occurrence:** an area of land occupied by one or more rare plant individuals of the same species; each individual in an occurrence is located less than one kilometre from its nearest neighbour (if the occurrence contains more than one individual).

- **Patch:** a sub-group within an occurrence, used when two or more discrete clusters of the same rare plant are separated by unoccupied habitat, but are less than one kilometre from the nearest neighbouring cluster.

The botanists conducting the 2019 through 2024 preconstruction surveys were also working on the Site C Experimental Rare Plant Translocation program at the time, selecting and documenting potential recipient sites for translocation outplanting. When new rare plant occurrences were found during potential recipient site selection work, they were documented using the same methods as described

above. All of the new rare plant occurrences found during the survey work for either program are reported here to provide a single document that contains all the new rare plant occurrences.

2.3. Mitigation Planning and Implementation Assistance

In order to assist with mitigation efforts and determine Project effects to rare plant species, certain known rare plant occurrences within the project activity zone were revisited during the course of the survey work. The botanists noted any impacts to these occurrences, predicted upcoming threats, and looked for mitigation opportunities to ameliorate adverse effects to the rare plants. This information was used to update the records in the Project rare plant database, assist with on-the-ground mitigation efforts, and provide decision makers with the information necessary to evaluate the threat statuses of the Project-area rare plants.

In certain priority cases, where rare plant occurrences were situated in or near Project construction zones, the botanists worked with BC Hydro planning teams and contractors to develop mitigation measures designed to reduce or eliminate impacts to the occurrences. This took place on an as-needed basis in situations where a species was difficult to identify in the field, or the layout of the occurrence was complex and difficult to map on the ground. The mitigation measures developed were focussed on avoidance or impact reduction, and included flagging occurrences in the field, coordinating with on-site construction personnel, and assisting rare plant salvage operations.

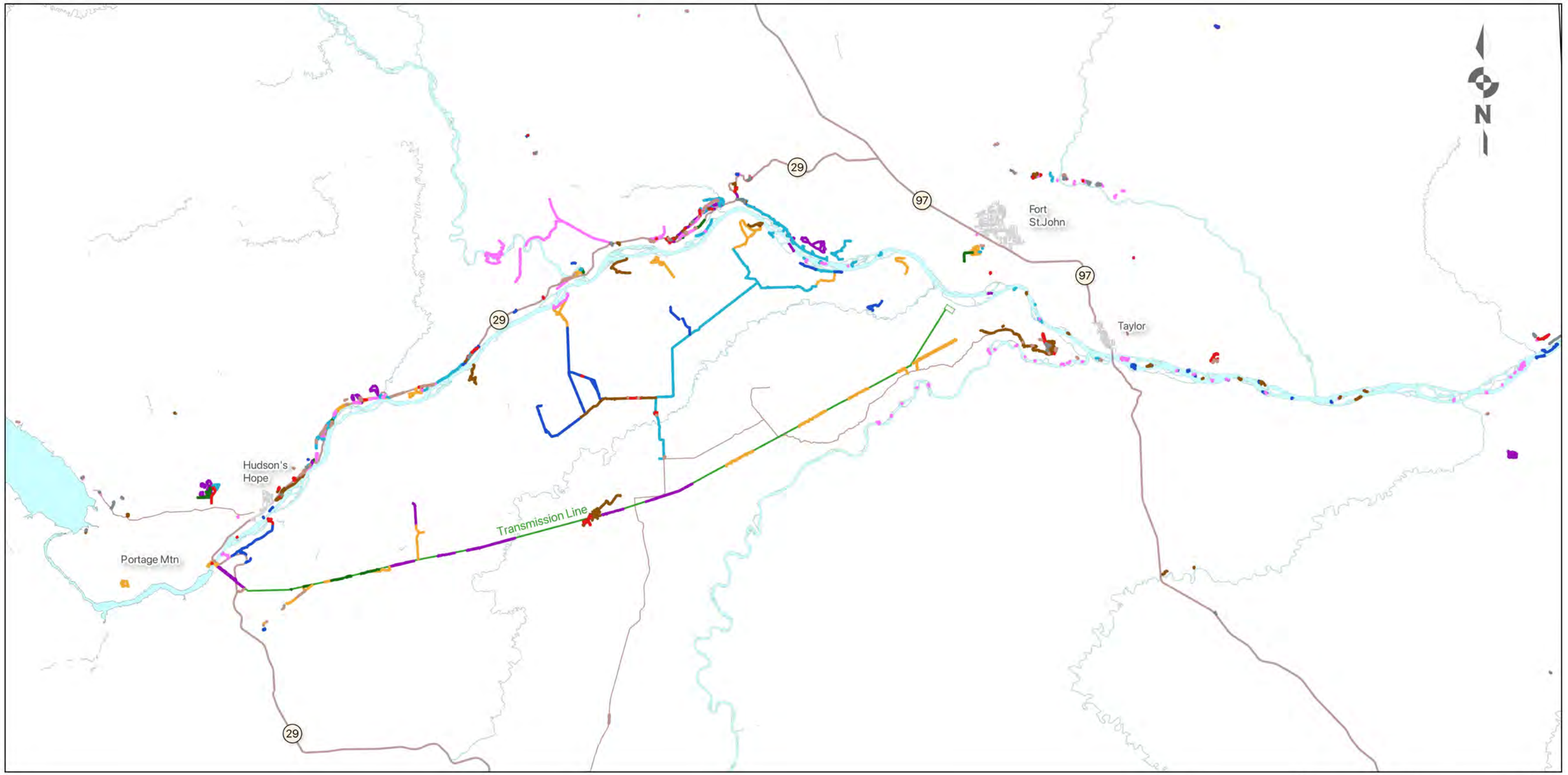
In addition, for one Red-listed species confirmed for the project area in 2018—*Selaginella rupestris* (rock selaginella)—a set of mitigation options was developed for all known occurrences in the RAA.

2.4. Analysis

As field data were collected, they were imported into the master rare plant spatial database. This included rare plant occurrence information, survey transect routes, and field notes. Collected data were encrypted and secured with multi-factor authentication protocols. The information and field photos were backed up to secure off-site servers.

Following the field season, the collected rare plant information was compiled and analyzed in the Project rare plant Geographic Information System (GIS). Voucher specimens were examined and sent to outside experts when additional verification was required. New rare plant locations were compared with BCCDC data to determine if the newly discovered patches could be combined as extensions of previously recorded occurrences.

Once the data had been compiled, verified, and cleaned, a submission package was prepared for the BCCDC. This dataset contained all the new rare plant occurrences found during the previous field season, as well as any updates and extensions to previously reported occurrences. The data were provided in a spatial format compatible with BCCDC submission requirements. Voucher specimens were prepared based on Ministry of Environment and Climate Change Strategy guidelines (MOECCS 2018) and submitted to the appropriate herbarium (typically UBC).



Map Notes:

1. Based on surveys completed through August 2024.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

Survey Transects

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024

Roads

- Highway
- Secondary
- Urban

Map Scale 1:350000

0 10 20 30 km

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Figure 1
Rare Plant Survey Transects
2015 to 2024

Date	November 26, 2024	DWG NO	2024-11-26-001	Revision 0

The following quality assurance and quality control measures were applied to promote accurate data collection and analysis:

- The master rare plant spatial database, which contains all rare plant data for the project, is a custom-built spatial database (PostgreSQL 16.3 spatially enabled with PostGIS 3.4). The database server software was regularly updated to the latest stable versions and all security patches were applied soon after issue.
- The tables in the database were normalized to reduce data redundancy and improve integrity.
- Primary key constraints were enforced for all relational tables to improve database integrity and allow complex queries to be run.
- Fields were constrained at the database level to ensure type-consistency. Electronic input forms also constrained entered data to provide front-end validation and user guidance.
- Regular updates were pulled from the BCCDC's Ecosystem Explorer and added to the master database to ensure that analyses were performed using the latest BCCDC rare plant statuses and nomenclature.
- The data fields *UTM northing*, *UTM easting*, *lat_long,* and *occurrence area* were calculated programmatically from the rare plant polygons, for accuracy of the derived fields. Point data were also derived programmatically from the rare plant polygons for locational consistency between the spatial fields.
- Multipolygons—a GIS feature class that allows one or more closed plane figures to be recorded for each occurrence—were used as the basic spatial descriptor for the rare plant occurrences recorded after 2008. This allowed for more precise avoidance mitigation than would be possible using single polygons or points.
- Custom-built electronic forms were used by the botanists to enter rare plant data in the field while at the occurrence. Paper versions of the forms were also used in cases where there were difficulties with the electronic entry devices. In these cases, the paper forms were transcribed onto the electronic forms as soon as possible to allow for data validation.
- Every record was reviewed for typographical and transcription errors at the end of the field season.
- Associated species lists were reviewed by a second botanist to ensure identification accuracy.
- Rare plant polygons were reviewed on aerial imagery and ecosystem layers in the GIS to check boundary accuracy by the botanist(s) who recorded the occurrence.
- Voucher specimens were collected where appropriate and verified in the lab and herbarium, or sent to species experts for further verification when taxonomic questions still existed.

3. RESULTS

3.1. Pre-field Review

The 2024 pre-field review identified 71 rare plant taxa with potential for occurrence in the overall Project area (Appendix 1). The list comprises 35 vascular plant species, 19 bryophytes, and 17 lichens. As noted previously, this list was used for planning purposes and was not considered to be an exhaustive listing of all possible rare plant taxa in the project area. The surveyors considered all rare taxa during the surveys, whether they were on the target list or not.

It should also be noted that the BCCDC regularly reviews the statuses of the plant taxa in the province to determine if new information warrants a change in the rarity rankings. As the Site C rare plant work proceeded, the numerous new occurrences that have been found during the surveys have allowed the BCCDC to reassess many of the plant taxa in the RAA. Prior to 2019, these reassessments were typically published by the BCCDC in the spring of each year, allowing Project botanists time to incorporate the updates into the field plan for the upcoming season.

However, starting in 2019 the BCCDC began publishing status updates in mid-summer, halfway through the field survey season. Particularly in 2019 and 2022, the status updates had considerable effect on the number of rare plant occurrences within the RAA. In 2019, 10 RAA plant taxa were removed from the Red or Blue lists, meaning that they no longer met the definition of "rare plants" for the Project (see Section 2.1), thus reducing the number of rare plant occurrences in the RAA by more than half. In 2022 one Project area species was removed from the Blue list mid-season, and another species found in the Site C area—*Drymocallis arguta* (tall wood beauty)—was added to the BC Flora on the Blue list, indicating that the taxon was of conservation concern and therefore met the Project definition of a "rare plant" (BCCDC 2024a). These mid-season status changes frequently necessitated a change in the field plans for the remainder of each survey season.

3.2. Field Survey

The 2024 field surveys discovered or updated 13 occurrences (comprising 29 separate patches) of five different rare vascular plant taxa: two B.C. Red-listed taxa, and three B.C. Blue-listed taxa. None of the five species are listed on Schedule 1 of the Species at Risk Act or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2023).

In total, 219 occurrences containing 509 patches of 31 currently or formerly listed rare plant taxa have been discovered during the preconstruction surveys since 2015 (Table 2 and Figure 2). Over the course of the ten survey years, the investigators have recorded 707 vascular plant, bryophyte, and lichen taxa (Appendix 2).

Table 2: Rare plants found during the Site C Preconstruction surveys; 2015 through 2024

Taxon	Common Name	Current BC List	Occurrences	Patches
Vascular Plants				
Artemisia longifolia	long-leaved sage	Yellow	7	24
Atriplex gardneri var. gardneri	Gardner's sagebrush	Red	2	3
Calamagrostis montanensis	plains reedgrass	Yellow	5	14
Carex backii	Back's sedge	Yellow	4	11
Carex sprengelii	Sprengel's sedge	Blue	4	8
Carex torreyi	Torrey's sedge	Blue	8	14
Carex xerantica	dry-land sedge	Blue	16	39
Castilleja miniata var. fulva	tawny paintbrush	Yellow	1	1
Cirsium drummondii	Drummond's thistle	Yellow	4	13
Drymocallis arguta	tall wood beauty	Blue	38	116
Geum triflorum var. triflorum	old man's whiskers	Yellow	7	28
Helictochloa hookeri	spike-oat	Yellow	1	1
Juncus stygius var. americanus	bog rush	Yellow	1	1
Lomatium foeniculaceum var. foeniculaceum	fennel-leaved desert-parsley	Blue	2	2
Oxytropis campestris var. davisii	Davis' locoweed	Yellow	21	33
Pedicularis parviflora	small-flowered lousewort	Yellow	1	2
Penstemon gracilis	slender penstemon	Blue	13	42
Piptatheropsis canadensis	Canada ricegrass	Red	7	22
Polygala senega	Seneca-snakeroot	Red	1	1
Polypodium sibiricum	Siberian polypody	Yellow	1	12
Potentilla pulcherrima	pretty cinquefoil	Yellow	4	9
Ranunculus rhomboideus	prairie buttercup	Blue	10	16
Salix petiolaris	meadow willow	Blue	2	2
Selaginella rupestris	rock selaginella	Red	3	4
Silene drummondii var. drummondii	Drummond's campion	Yellow	3	3

Taxon	Common Name	Current BC List	Occurrences	Patches
Sphenopholis intermedia	slender wedgegrass	Yellow	7	13
Symphyotrichum puniceum var. puniceum	purple-stemmed aster	Yellow	7	7
Lichens				
Physcia biziana	frosted rosette	Yellow	16	28
Physcia stellaris	immaculate rosette	Yellow	8	11
Ramalina sinensis	threadbare ribbon	Yellow	14	25
Usnea cavernosa	pitted beard	Yellow	1	4

Table notes:

- *B.C. List (BCCDC): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern; Yellow = Apparently Secure (had been on the Red or Blue list previously)*
- *Occurrences: Includes newly discovered occurrences as well as occurrences expanded during the preconstruction surveys*

Many of the rare plant taxa found during the preconstruction surveys had been documented previously in other occurrences during the baseline surveys performed for the Project environmental impact assessment. Species descriptions for the 12 taxa that held rare status during the 2024 field season are presented in Appendix 3. Each section also contains an overview of any new occurrences documented in 2024, and up-to-date summary information on all reported occurrences for each of these taxa in the RAA.

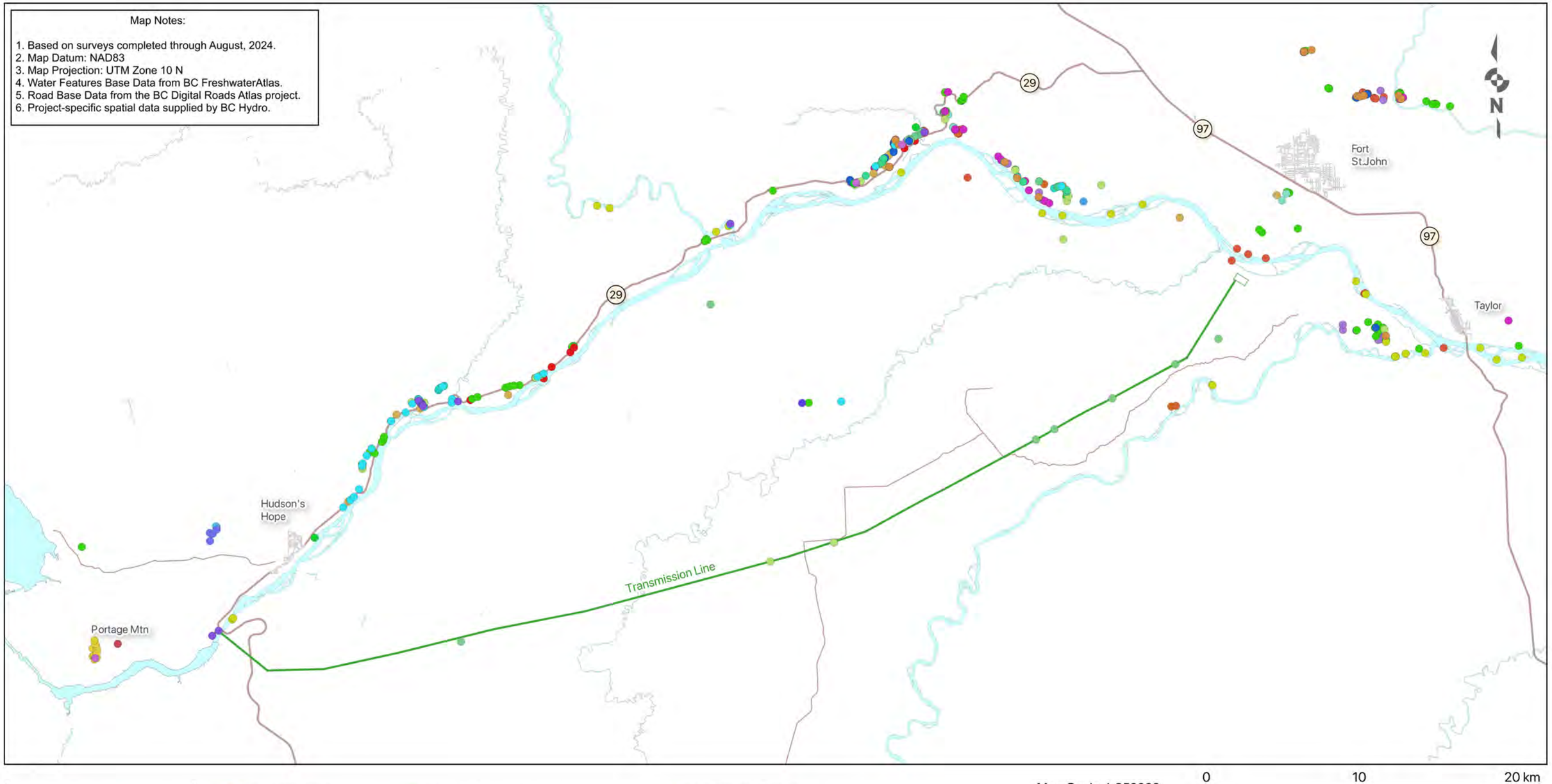
In this report all of the rare plant taxa discussed in Appendix 3 were Red- or Blue-listed by the BCCDC for at least part of the 2024 survey season. For clarity, rare species found in previous years that have subsequently been removed from the Red or Blue lists are not included. Although not currently of conservation concern, the occurrence data for these taxa have been retained in the master rare plant spatial database for future reference if needed.

Information on additional taxa and occurrences documented in the RAA prior to 2015 can be found in the following references:

- Site C Project Environmental Impact Statement, Volume 2, Appendix R, Part 1 (Hilton et al. 2013);
- Report: Site C Clean Energy Project: Pre-disturbance Rare Plant Assessment #1: Rolling Work Plan 10 (Eagle Cap Consulting Ltd 2014);
- Report: Site C Clean Energy Project: Wildlife, Vegetation and Mapping Inventory for the Marl Fen Property (Simpson et al. 2014); and
- B.C. Ecosystem Explorer website (BCCDC 2024a).

Map Notes:

1. Based on surveys completed through August, 2024.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.



- *Artemisia herriotii*
- *Atriplex gardneri var.gardneri*
- *Avenula hookeri*
- *Calamagrostis montanensis*
- *Carex backii*
- *Carex sprengelii*
- *Carex torreyi*
- *Carex xerantica*
- *Castilleja miniata var.fulva*
- *Cirsium drummondii*
- *Drymocallis arguta*
- *Geum triflorum var.triflorum*
- *Juncus stygius var.americanus*
- *Lomatium foeniculaceum var.foeniculaceum*
- *Oxytropis campestris var.davisii*
- *Pedicularis parviflora*
- *Penstemon gracilis*
- *Physcia biziana*
- *Physcia stellaris*
- *Piptatheropsis canadensis*
- *Polypodium sibiricum*
- *Potentilla pulcherrima*
- *Ramalina sinensis*
- *Ranunculus rhomboideus*
- *Salix petiolaris*
- *Selaginella rupestris*
- *Silene drummondii var.drummondii*
- *Sphenopholis intermedia*
- *Symphyotrichum puniceum var.puniceum*
- *Usnea cavernosa*

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

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Figure 2
Rare Plant Sites Found in Project Vicinity (2015-2024)

Date	November 27, 2024	DWG NO	2024-11-26-0002	Revision 2

3.3. Mitigation Planning and Implementation

Twenty-eight previously known rare plant occurrences were revisited during the 2024 survey work to verify identification, continued survival, document potential threats, and develop potential mitigation strategies to ameliorate effects. All were found to be still extant, and no more plants were found to be impacted than had been on the most recent previous visit.

To-date, eight priority rare plant occurrences have required mitigation assistance from the preconstruction rare plant survey team. In 2018, two occurrences of Red-listed species—*Piptatheropsis canadensis* (Canada ricegrass) and *Atriplex gardneri* var. *gardneri* (Gardner's sagebrush)—adjacent to access roads in the Wilder Creek area were flagged, mapped, and photographed to assist the road crews. The forestry contractor responsible for the area was contacted so that crews understood how the occurrences were flagged and the importance of avoiding them in the field. Monitoring surveys conducted in 2019 found that both occurrences had been substantially avoided during the road work and the viability of the occurrences had not been threatened by the activity. The Canada ricegrass occurrence had been completely avoided, and the Gardner's sagebrush occurrence had had only a few individuals destroyed, leaving the majority (an estimated 150 plants) untouched.

In 2019, two priority rare plant occurrences growing together on the same hillside in the Farrell Creek East Highway 29 realignment clearing zone were identified as requiring additional mitigation assistance. The two rare plant occurrences—*Selaginella rupestris* (rock selaginella) and *Penstemon gracilis* (slender penstemon)—had the potential to be extirpated by clearing activities. Due to access restrictions, propagule salvage operations could not occur at this location until BC Hydro acquired rights to the land. In cooperation with the Project environmental team, a mitigation plan was developed delaying clearing activities until 2021, allowing for propagule salvage after land acquisition.

In 2021 the preconstruction botany team assisted the Experimental Rare Plant Translocation program team in salvaging a representative sample of the rock selaginella and slender penstemon individuals at this location, before the area was cleared for aggregate extraction. The location was revisited in 2022 to assess impacts, as the aggregate extraction work had apparently been completed and the equipment removed. The rock selaginella and slender penstemon occurrences had been significantly reduced in extent and number of individuals: the entire main patch of the rock selaginella had been destroyed (thousands of clumps), and an estimated 75% of the main patch of slender penstemon had been destroyed (hundreds of plants). However, both occurrences were found to extend beyond the area of construction disturbance and may persist if further construction disturbance is avoided. The 2023 revisit to this location confirmed that both the rock selaginella and slender penstemon occurrences are still extant. The 2024 revisit to this location verified that the slender penstemon plants are persisting, but the identification of the selaginella species at the site was revised to the very similar cliff selaginella *(S. scopulorum)* (see Appendix 3 summary for rock selaginella).

In 2020, preconstruction rare plant surveys discovered an occurrence of *Carex sprengelii* (Sprengel's sedge) in an area at Dry Creek that had been recently cleared. The overstory trees and shrubs had been cut and removed, and some ground disturbance had taken place. In the opening, four Sprengel's sedge

plants were found, all of which were in late fruit. The remaining undispersed Sprengel's sedge achenes were collected and sent to NATS Nursery in Langley, B.C. to be incorporated into the Project's Experimental Rare Plant Translocation program. The four plants were left in place (no flagging or buffers were established as no active construction activities were planned for the cleared area). In 2021 the occurrence was revisited and all four plants were extant. In addition, a fifth plant was found. The occurrence was revisited in 2022, 2023, and 2024, and all the plants were present. The surrounding vegetation had become quite dense and was potentially negatively affecting the viability of the occurrence. It remains to be seen if the Sprengel's sedge plants at this occurrence can persist through the successional stages as the surrounding vegetation regrows.

Also in 2020, late season field work within the Cache Creek Highway Realignment construction corridor discovered a new occurrence of Canada ricegrass. Nine patches were found in and adjacent to the Leave to Construct (LTC) corridor. Clearing in this area was scheduled for the fall of 2020, so the rare plant botanists returned to the occurrence to implement and facilitate mitigation measures for the occurrence.

One of the nine patches was in an area that had been cleared. Twelve Canada ricegrass plants were still present along the edges of the former patch—some stems were broken but the remaining base and root portions of the plants were intact. Several of the stem heads contained undispersed fruit and 27 seeds were collected. After microscopic examination, nine of the seeds were found to be apparently viable, and these were sent to NATS Nursery for storage and propagation as part of the Project's Experimental Rare Plant Translocation program. The 12 plants were salvaged and directly replanted at two suitable recipient sites outside of the LTC zone.

The remaining eight patches had not been affected by project activities. Two of these patches were over 300 m from the LTC zone and were not expected to be affected by the Project. The other six were in areas of the LTC zone where construction activities may have been able to avoid disturbing the patches. These six were clearly flagged and staked in the field to facilitate avoidance. Personnel from the construction firms were contacted so that they were aware of the rare plant occurrences and understood how the patches were flagged in the field. In addition, the botanists met with a representative from the Site C environmental team and visited each of the flagged patches.

In 2021, this Canada ricegrass occurrence at Cache Creek was revisited to determine its status. As expected, the patch that had been cleared in 2020 was extirpated under the newly built highway (although as noted above, some of the individuals had been translocated previously). The area adjacent to one other patch straddling the edge of the right-of-way (ROW) fence had been cleared by highway construction, however, no Canada ricegrass plants had been destroyed. The remaining seven patches had not been directly impacted by highway construction.

The Canada ricegrass occurrence at Cache Creek was checked again during the 2022 field work. No construction effects were observed in seven of the nine original patches. In addition to the patch which was extirpated in 2020, the patch straddling the ROW fence had been completely cleared within the ROW with the result that one plant had been destroyed. However, the estimated 10 remaining plants on the other side of the fence outside of the ROW appeared unaffected. As well, a tenth small patch

containing two plants was found further west within the ROW. It is not known if this tenth patch will persist given the high levels of ground and vegetation disturbance that take place within highway ROWs. At this point, the individuals are not being translocated, as it is felt that their chance for survival in-place is greater than if they are moved to another location.

During the 2023 field season, an additional visit was made to the Cache Creek Canada ricegrass occurrence: of the 10 patches, seven were not checked due to access restrictions. Of the three patches rechecked, one was confirmed extirpated as previously observed, one partially affected (the loss of a single plant in the ROW corridor, as previously documented), and one extant but with new construction disturbance evident: a ditch had been dug and a power pole had been installed. In spite of this ground disturbance, both the original two Canada ricegrass plants remained unaffected, and four new plants were documented. The August 2024 revisit to this latter patch found no new disturbance.

Another Canada ricegrass occurrence near the proposed Area E aggregate extraction site was staked and flagged in 2021 to facilitate contractor avoidance. This occurrence is located approximately 60 metres outside of the extraction site boundary, and was not expected to be affected by construction activities. The occurrence was flagged as a precautionary measure to reduce the chance of unintentional impacts. This occurrence was revisited in early summer of 2022 after extraction activities had begun, and although it was too early in the season to locate individual Canada ricegrass plants, the occurrence appeared to be undisturbed by construction activities and the stakes and flagging were still in place. In June of 2023 the occurrence was again revisited and the area remained undisturbed. The August 2024 revisit to this occurrence found the Canada ricegrass plants in fruit with no disturbance to the site.

In 2022, the *Ranunculus rhomboideus* (prairie buttercup) occurrence at Watson Slough was salvaged and transplanted to a site outside the project activity zone in anticipation of clearing activities scheduled for the winter of 2022/2023. Project botanists removed the majority of the occurrence (16 plants in nine clumps) and directly transplanted the individuals to a site near a wetland along Upper Cache Road.

The prairie buttercup salvage site was revisited in June 2023. While the translocated plants were found to be surviving and many fruiting, the site (a Crown parcel) had been recently fenced and stocked with grazing cattle. Disturbance from cattle as well as human and beaver activity was observed in most portions of the salvage transects. In particular, many of the prairie buttercup fruiting heads had been cropped off.

The June 2024 revisit to the prairie buttercup salvage site found additional disturbance to half of the area, where it appeared shrubs had been cut back to allow for vehicle access at the end of the 2023 grazing season. However, it appeared that no new disturbance had yet occurred in 2024: the cattle fence and gate were in disuse, there was no new cattle sign, and no sign of new human disturbance. Ongoing beaver activity (tree gnawing and felling) was observed in one small portion of the transects. The translocated prairie buttercup plants were found to be surviving in spite of the loss of shrub cover, but fewer of the plants had flowered and set fruit. It is unknown to what extent these various disturbances will affect the success of the translocated plants.

4. Discussion

4.1. Coverage

Survey coverage of the areas proposed for construction disturbance—both the linear corridors and non-linear areas—was considered sufficient to locate the majority of identifiable target rare plant species. The field crew used a habitat-directed search protocol, employing a variable-intensity survey pattern that focussed time and effort on the habitats most likely to contain rare plant occurrences. Transects were spaced so that the majority of rare plant occurrences and high-suitability rare plant habitat would have been visible during the surveys. See Section 2.2 above for a complete description of the survey methods.

For the mitigation parcels—where the goal was to provide only a general overview of the rare plant populations present—the lower intensity meander surveys sampled most of the important habitats at both parcels. Although there are likely additional rare plant occurrences to be found at the mitigation parcels, the surveys provided a general picture of the rare plant resources present.

The logistics of performing rare plant surveys in the project area present certain challenges for coverage and timing. Several of the target rare plant species have extremely limited seasonal identification periods and can only be optimally found during a four-week window that changes slightly from year to year depending on the weather. In addition, access is often unsafe or impossible during substantial periods of the growing season due to severe weather events, flooding, road wash-outs, and impassable wetland conditions. These physical access limitations are particularly constraining on the plateau south of the Peace River, but can also be challenging on the north side of the river. Furthermore, landowner restrictions prevent surveyors' access to certain areas until BC Hydro is able to acquire access rights to the specific survey parcels (and often the roads that lead up to them).

All these factors—target species identification periods, favourable weather and road conditions, legally granted access permission—must coincide for a successful survey visit. Often, repeated attempts are necessary. In a limited number of cases (less than 5% of the affected hectares) it was not possible to access certain planned construction corridors at the appropriate time of year prior to clearing. Nevertheless, these areas were surveyed using the standard methods described in Section 2.2 when rare plant habitat persisted following the clearing.

4.2. Seasonal Timing

Based on the observed phenology of the plants in the areas surveyed and data gathered during previous years' survey work, the seasonal timing of the surveys was sufficient to identify most of the target rare plants. The June and early July work typically focussed on areas north of the Peace River, where floodplain and grassland habitats make up the majority of the high-potential rare plant habitats present. Target species in these habitats often bloom early in the season, and then wither by later in the summer (although some notable exceptions have been observed, such as Canada ricegrass, which is not clearly

identifiable until later in the season). The late summer and early fall surveys mainly focussed on areas south of the Peace River, where wetlands are the primary high-potential rare plant habitats. Many of these wetland-associated target rare plants bloom later in the season, and persist longer into the fall than those found in the upland areas.

4.3. Ongoing Work

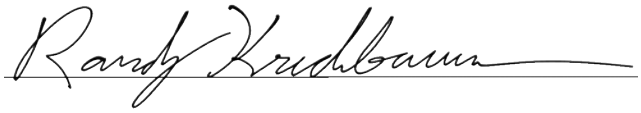
Construction of the Site C Project is essentially complete. The reservoir was filled in the fall of 2024 and the Project has begun to generate electricity. Highway 29 has been realigned, and traffic is flowing along the new alignment.

As such, no additional preconstruction rare plant surveys are planned for the 2025 field season. The spatial database of Project-area rare plant occurrences will be archived once the relevant data has been transmitted to the BCCDC. Any remaining voucher specimens will be submitted to the UBC herbarium.

If unforeseen conditions necessitate additional Site C construction activities, the Project rare plant spatial database can be restored, and additional rare plant surveys can be conducted if needed.

5. CLOSURE

Reviewed and approved:



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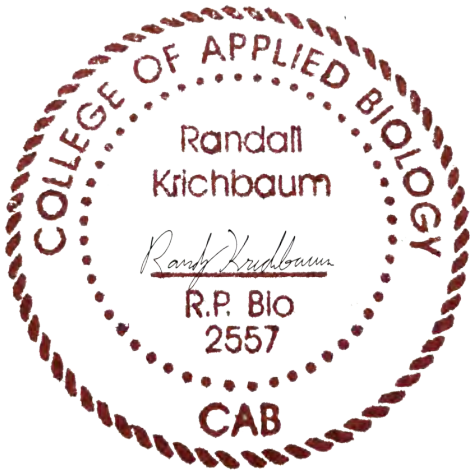
<Original signed and sealed April 2, 2025 at Calgary, Alberta>



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7. APPENDICES

7.1. Appendix 1: Rare plant taxa with potential for occurrence in the Site C Project area

Scientific Name	Common Name	BC List	COSEWIC	SARA
VASCULAR PLANTS				
Acorus americanus	American sweet-flag	Blue	-	-
Arctophila fulva	pendantgrass	Blue	-	-
Artemisia alaskana	Alaskan sagebrush	Blue	-	-
Atriplex gardneri var. gardneri	Gardner's sagebrush	Red	-	-
Botrychium montanum	mountain moonwort	Blue	-	-
Botrychium paradoxum	two-spiked moonwort	Blue	-	-
Carex bicolor	two-coloured sedge	Blue	-	-
Carex lapponica	Lapland sedge	Blue	-	-
Carex sprengelii	Sprengel's sedge	Blue	-	-
Carex torreyi	Torrey's sedge	Blue	-	-
Carex xerantica	dry-land sedge	Blue	-	-
Drosera linearis	slender-leaf sundew	Blue	-	-
Drymocallis arguta	tall wood beauty	Blue	-	-
Epilobium saximontanum	Rocky Mountain willowherb	Red	-	-
Hesperostipa spartea	porcupinegrass	Blue	-	-
Lomatium foeniculaceum var. foeniculaceum	fennel-leaved desert-parsley	Blue	-	-
Nabalus racemosus	purple rattlesnake-root	Red	-	-
Packera ogotorukensis	Ogotoruk Creek butterweed	Red	-	-
Penstemon gormanii	Gorman's penstemon	Blue	-	-
Penstemon gracilis	slender penstemon	Blue	-	-
Piptatheropsis canadensis	Canada ricegrass	Red	-	-
Polygala senega	Seneca-snakeroot	Red	-	-
Polygonum ramosissimum ssp. prolificum	proliferous knotweed	Red	-	-
Potentilla furcata	forked cinquefoil	Red	-	-
Ranunculus cardiophyllus	heart-leaved buttercup	Red	-	-
Ranunculus rhomboideus	prairie buttercup	Blue	-	-
Salix petiolaris	meadow willow	Blue	-	-

Scientific Name	Common Name	BC List	COSEWIC	SARA
Sarracenia purpurea ssp. purpurea	common pitcher-plant	Red	-	-
Saussurea angustifolia var. angustifolia	northern sawwort	Red	-	-
Selaginella rupestris	rock selaginella	Red	-	-
Silene repens	pink campion	Blue	-	-
Symphyotrichum falcatum var. commutatum	white prairie aster	Red	-	-
Tephroseris palustris	marsh fleabane	Blue	-	-
Thalictrum dasycarpum	purple meadowrue	Blue	-	-
Utricularia ochroleuca	ochroleucous bladderwort	Blue	-	-
LICHENS				
Anaptychia crinalis	electrified millepede	Red		
Anaptychia ulotrichoides	amputated millepede	Blue	-	-
Cladonia parasitica	fence-rail pixie	Red	-	-
Collema bachmanianum	Caesar's tarpaper	Blue	-	-
Collema coniophilum	crumpled tarpaper	Red	Threatened	Threatened
Fulgensia desertorum	desert sulphur	Blue	-	-
Fulgensia subbracteata	creeping sulphur	Blue	-	-
Heterodermia speciosa	smiling centipede	Red	-	-
Phaeophyscia adiastola	granulating shadow	Blue	-	-
Phaeophyscia hispidula	whiskered shadow	Red	-	-
Physcia dimidiata	exuberant rosette	Blue	-	-
Physcia tribacia	beaded rosette	Red	-	-
Physciella chloantha	downside shade	Blue	-	-
Squamarina cartilaginea	pea-green dimple	Red	-	-
Squamarina lentigera	snow-white dimple	Red	-	-
Thyrea confusa	candied gummybear	Blue	-	-
Xanthoparmelia camtschadalis	rockfrog	Red	-	-
BRYOPHYTES				
Acaulon muticum	[no common name]	Blue	-	-
Amblyodon dealbatus	[no common name]	Blue	-	-
Atrichum tenellum	[no common name]	Blue	-	-
Aulacomnium acuminatum	[no common name]	Blue	-	-
Bartramia halleriana	Haller's apple moss	Blue	Threatened	Threatened

Scientific Name	Common Name	BC List	COSEWIC	SARA
Blindiadelphus subimmersus	[no common name]	Blue	-	-
Cnestrum glaucescens	[no common name]	Blue	-	-
Dicranum majus var. orthophyllum	[no common name]	Blue	-	-
Encalypta mutica	[no common name]	Blue	-	-
Haplodontium macrocarpum	Porsild's bryum	Blue	Threatened	Threatened
Orthothecium strictum	[no common name]	Blue	-	-
Plagiobryum demissum	[no common name]	Blue	-	-
Pohlia bulbifera	[no common name]	Blue	-	-
Schistidium confertum	[no common name]	Blue	-	-
Schistidium robustum	[no common name]	Blue	-	-
Seligeria tristichoides	[no common name]	Blue	-	-
Tayloria splachnoides	[no common name]	Red	-	-
Timmia sibirica	[no common name]	Blue	-	-
Weissia brachycarpa	[no common name]	Blue	-	-

Table notes:

- *B.C. List (BCCDC): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern*
- *COSEWIC (Committee on the Status of Endangered Wildlife in Canada): E = Endangered; T = Threatened; SC = Special Concern; DD = Data Deficient*
- *SARA (Species at Risk Act): 1-E = Schedule 1 Endangered; 1-T = Schedule 1 Threatened; 1-SC = Schedule 1 Special Concern*

7.2. Appendix 2: Plant and lichen species recorded during the 2015–2024 surveys

Vascular Plants

Acer glabrum var. douglasii
Acer negundo
Achillea alpina
Achillea borealis
Achillea millefolium var. lanulosa
Achnatherum nelsonii ssp. dorei
Achnatherum richardsonii
Aconitum delphiniifolium
Actaea rubra
Agropyron cristatum ssp. pectinatum
Agrostis capillaris
Agrostis exarata
Agrostis gigantea
Agrostis scabra
Alisma triviale
Allium cernuum
Allium cernuum var. cernuum
Allium schoenoprasum var. sibiricum
Alnus incana ssp. tenuifolia
Alnus viridis ssp. crispa
Alnus viridis ssp. sinuata
Alopecurus aequalis
Alopecurus pratensis
Amelanchier alnifolia
Amerorchis rotundifolia
Anaphalis margaritacea
Androsace septentrionalis
Anemone cylindrica
Anemone multifida var. multifida
Anemone patens ssp. multifida
Anemone virginiana var. cylindroidea
Angelica genuflexa
Antennaria howellii ssp. canadensis
Antennaria howellii ssp. petaloidea
Antennaria microphylla
Antennaria neglecta
Antennaria parvifolia
Antennaria pulcherrima ssp. pulcherrima
Antennaria racemosa
Antennaria rosea
Anthoxanthum hirtum
Apocynum androsaemifolium
Apocynum androsaemifolium var. androsaemifolium
Aquilegia brevistyla
Aralia nudicaulis
Arctium minus
Arctium sp.
Arctostaphylos uva-ursi
Arnica chamissonis
Arnica cordifolia
Artemisia biennis
Artemisia campestris ssp. pacifica
Artemisia dracunculus
Artemisia frigida
Artemisia herriotii
Askellia elegans
Asparagus officinalis
Astragalus agrestis
Astragalus alpinus var. alpinus
Astragalus americanus
Astragalus australis
Astragalus canadensis
Astragalus cicer
Astragalus eucosmus
Astragalus laxmannii var. robustior
Astragalus tenellus
Athyrium filix-femina ssp. cyclosorum
Atriplex gardneri var. gardneri
Avena sativa
Avenula hookeri
Axyris amaranthoides
Beckmannia syzigachne
Betula neoalaskana
Betula papyrifera
Betula pumila
Betula pumila var. glandulifera
Bidens cernua
Blitum capitatum
Boechera divaricarpa
Boechera grahamii
Boechera pendulocarpa
Boechera retrofracta
Boechera stricta
Botrypus virginianus
Brassica rapa var. rapa
Bromus ciliatus
Bromus inermis
Bromus pumpellianus ssp. pumpellianus
Calamagrostis canadensis
Calamagrostis canadensis var. langsdorfii
Calamagrostis montanensis
Calamagrostis purpurascens var. purpurascens

Calamagrostis stricta ssp. inexpansa
Calla palustris
Callitriche palustris
Caltha natans
Campanula rotundifolia
Canadanthus modestus
Capsella bursa-pastoris
Caragana arborescens
Cardamine oligosperma var. oligosperma
Carex aquatilis
Carex aquatilis var. aquatilis
Carex arcta
Carex atherodes
Carex atratiformis
Carex aurea
Carex backii
Carex bebbii
Carex brunnescens
Carex brunnescens ssp. brunnescens
Carex canescens ssp. canescens
Carex capillaris
Carex chordorrhiza
Carex concinna
Carex crawfordii
Carex cusickii
Carex deweyana var. deweyana
Carex diandra
Carex disperma
Carex duriuscula
Carex eburnea
Carex filifolia
Carex foenea
Carex gynocrates
Carex inops ssp. heliophila
Carex interior
Carex lasiocarpa
Carex leptalea
Carex limosa
Carex livida var. radicaulis
Carex magellanica ssp. irrigua
Carex microptera
Carex obtusata
Carex peckii
Carex pellita
Carex praegracilis
Carex praticola
Carex retrorsa
Carex richardsonii
Carex rossii
Carex sartwellii
Carex siccata
Carex sprengelii
Carex tenera
Carex tenuiflora
Carex torreyi
Carex utriculata
Carex vaginata
Carex viridula ssp. viridula
Carex xerantica
Castilleja miniata
Castilleja miniata var. fulva
Centaurea stoebe ssp. micranthos
Cerastium arvense
Cerastium fontanum
Cerastium nutans
Chamerion angustifolium
Chenopodiastrum simplex
Chenopodium album
Chenopodium album ssp. album
Chenopodium album ssp. striatum
Chenopodium desiccatum
Chenopodium pratericola
Chrysosplenium tetrandrum
Cicuta bulbifera
Cicuta douglasii
Cicuta virosa
Cinna latifolia
Circaea alpina ssp. alpina
Cirsium arvense
Cirsium drummondii
Cirsium foliosum
Cirsium vulgare
Clematis occidentalis ssp. grosseserrata
Clematis tangutica var. tangutica
Coeloglossum viride var. virescens
Collomia linearis
Comandra umbellata
Comandra umbellata var. pallida
Comarum palustre
Conyza canadensis
Corallorhiza maculata
Corallorhiza striata var. striata
Corallorhiza trifida
Cornus canadensis

Cornus stolonifera
Corydalis aurea ssp. aurea
Corylus cornuta
Crepis tectorum
Cypripedium passerinum
Cystopteris fragilis
Dactylis glomerata
Dactylorhiza viridis
Danthonia intermedia ssp. intermedia
Danthonia spicata
Dasiphora fruticosa
Delphinium glaucum
Deschampsia cespitosa ssp. cespitosa
Descurainia sophia
Diphasiastrum complanatum
Dracocephalum parviflorum
Drosera linearis
Drosera rotundifolia
Drosera rotundifolia var. rotundifolia
Dryas drummondii
Drymocallis arguta
Dryopteris carthusiana
Dryopteris expansa
Elaeagnus commutata
Eleocharis mamillata ssp. mamillata
Eleocharis palustris
Elymus albicans
Elymus canadensis
Elymus glaucus
Elymus glaucus ssp. glaucus
Elymus lanceolatus ssp. lanceolatus
Elymus repens
Elymus trachycaulus
Elymus trachycaulus ssp. subsecundus
Elymus trachycaulus ssp. trachycaulus
Epilobium angustifolium
Epilobium ciliatum
Epilobium ciliatum ssp. ciliatum
Epilobium ciliatum ssp. glandulosum
Epilobium halleanum
Epilobium hornemannii ssp. hornemannii
Epilobium palustre
Equisetum arvense
Equisetum fluviatile
Equisetum hyemale
Equisetum hyemale ssp. affine
Equisetum laevigatum
Equisetum palustre
Equisetum pratense
Equisetum scirpoides
Equisetum sylvaticum
Equisetum variegatum ssp. variegatum
Erigeron caespitosus
Erigeron glabellus var. pubescens
Erigeron philadelphicus
Erigeron philadelphicus var. philadelphicus
Eriophorum angustifolium
Eriophorum chamissonis
Eriophorum gracile
Eriophorum sp.
Eriophorum viridicarinatum
Erysimum cheiranthoides
Euphrasia nemorosa
Eurybia conspicua
Eurybia sibirica
Fallopia convolvulus
Festuca rubra ssp. rubra
Festuca saximontana
Festuca trachyphylla
Fragaria vesca var. bracteata
Fragaria virginiana
Fragaria virginiana var. platypetala
Galearis rotundifolia
Galeopsis bifida
Galium boreale
Galium labradoricum
Galium trifidum
Galium trifidum ssp. trifidum
Galium triflorum
Gentianella amarella ssp. acuta
Geocaulon lividum
Geranium bicknellii
Geum aleppicum
Geum macrophyllum
Geum macrophyllum ssp. macrophyllum
Geum macrophyllum var. perincisum
Geum triflorum
Geum triflorum var. triflorum
Glyceria borealis
Glyceria grandis var. grandis
Glyceria striata
Gnaphalium uliginosum
Goodyera repens
Grindelia squarrosa var. quasiperennis

Gymnocarpium dryopteris
Halenia deflexa ssp. deflexa
Halerpestes cymbalaria
Hedysarum alpinum
Hedysarum boreale
Helictochloa hookeri
Heracleum maximum
Hesperostipa comata ssp. comata
Hesperostipa curtiseta
Heuchera richardsonii
Hieracium aurantiacum
Hieracium canadense
Hieracium umbellatum ssp. umbellatum
Hierochloë hirta ssp. arctica
Hippuris vulgaris
Hordeum jubatum ssp. jubatum
Hypopitys monotropa
Impatiens noli-tangere
Juncus alpinoarticulatus ssp. americanus
Juncus balticus ssp. ater
Juncus bufonius
Juncus dudleyi
Juncus nodosus
Juncus stygius ssp. americanus
Juncus vaseyi
Juniperus communis
Koeleria macrantha
Lactuca serriola
Lappula occidentalis var. occidentalis
Lappula squarrosa
Larix laricina
Lathyrus ochroleucus
Lemna minor
Lepidium densiflorum
Leucanthemum vulgare
Leymus innovatus ssp. innovatus
Limosella aquatica
Linaria genistifolia ssp. dalmatica
Linaria vulgaris
Linnaea borealis
Linum lewisii ssp. lewisii
Listera borealis
Listera cordata
Lithospermum incisum
Lomatium foeniculaceum var. foeniculaceum
Lonicera dioica var. glaucescens
Lonicera involucrata
Lotus corniculatus
Lycopodium annotinum
Lycopodium clavatum
Lycopodium dendroideum
Madia glomerata
Maianthemum canadense
Maianthemum racemosum ssp. amplexicaule
Maianthemum stellatum
Maianthemum trifolium
Matricaria discoidea
Medicago lupulina
Medicago sativa
Medicago sativa ssp. falcata
Melampyrum lineare var. lineare
Melica smithii
Melilotus albus
Melilotus officinalis
Mentha arvensis
Menyanthes trifoliata
Mertensia paniculata var. paniculata
Mitella nuda
Moehringia lateriflora
Monarda fistulosa var. menthaefolia
Moneses uniflora
Monotropa uniflora
Muhlenbergia glomerata
Mulgedium pulchellum
Myriophyllum sibiricum
Nassella viridula
Neslia paniculata
Nuphar sp.
Oplopanax horridus
Opuntia fragilis
Orobanche fasciculata
Orthilia secunda
Orthilia secunda var. secunda
Orthocarpus luteus
Oryzopsis asperifolia
Osmorhiza berteroi
Osmorhiza sp.
Oxybasis glauca
Oxytropis campestris var. davisii
Oxytropis deflexa
Oxytropis sericea var. speciosa
Oxytropis splendens
Packera paupercula
Packera plattensis

Packera streptanthifolia
Parnassia palustris
Pascopyrum smithii
Pedicularis groenlandica
Pedicularis labradorica
Pedicularis parviflora
Penstemon gracilis
Penstemon procerus var. procerus
Persicaria amphibia
Persicaria amphibia var. emersa
Persicaria amphibia var. stipulacea
Persicaria hydropiper
Persicaria lapathifolia
Persicaria sp.
Petasites frigidus var. palmatus
Petasites frigidus var. sagittatus
Phalaris arundinacea var. arundinacea
Phleum pratense ssp. pratense
Picea glauca
Picea mariana
Pinus contorta var. latifolia
Piptatheropsis canadensis
Piptatheropsis pungens
Plantago major
Platanthera aquilonis
Platanthera huronensis
Platanthera obtusata ssp. obtusata
Platanthera orbiculata
Platanthera sp.
Poa alpina ssp. alpina
Poa annua
Poa compressa
Poa glauca
Poa glauca ssp. glauca
Poa nemoralis ssp. interior
Poa palustris
Poa pratensis
Poa pratensis ssp. pratensis
Poa secunda
Polygala senega
Polygonum achoreum
Polygonum aviculare
Polygonum douglasii
Polygonum fowleri
Polygonum ramosissimum
Polypodium sibiricum
Populus balsamifera
Populus tremuloides
Potamogeton alpinus
Potamogeton gramineus
Potamogeton pusillus ssp. tenuissimus
Potentilla anserina
Potentilla gracilis var. fastigiata
Potentilla hippiana
Potentilla norvegica
Potentilla pensylvanica
Potentilla pensylvanica var. pensylvanica
Potentilla pulcherrima
Primula incana
Prosartes trachycarpa
Prunus pensylvanica
Prunus virginiana ssp. melanocarpa
Prunus virginiana var. demissa
Pseudoroegneria spicata
Puccinellia distans
Puccinellia nuttalliana
Pulsatilla nuttalliana
Pyrola asarifolia
Pyrola chlorantha
Pyrola minor
Ranunculus acris
Ranunculus aquatilis var. aquatilis
Ranunculus aquatilis var. diffusus
Ranunculus cymbalaria
Ranunculus gmelinii
Ranunculus macounii
Ranunculus rhomboideus
Ranunculus sceleratus
Ranunculus sceleratus var. multifidus
Rhinanthus minor
Rhododendron groenlandicum
Ribes hudsonianum var. hudsonianum
Ribes lacustre
Ribes oxyacanthoides ssp. oxyacanthoides
Rorippa palustris
Rorippa palustris ssp. palustris
Rosa acicularis ssp. sayi
Rosa woodsii ssp. woodsii
Rubus arcticus ssp. acaulis
Rubus chamaemorus
Rubus idaeus ssp. strigosus
Rubus parviflorus var. parviflorus
Rubus pedatus
Rubus pubescens

Rumex britannica
Rumex crispus
Rumex fueginus
Rumex occidentalis
Rumex triangulivalvis
Salix arbusculoides
Salix bebbiana
Salix candida
Salix discolor
Salix drummondiana
Salix interior
Salix lasiandra var. lasiandra
Salix maccalliana
Salix myrtillifolia
Salix pedicellaris
Salix petiolaris
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix pseudomyrsinites
Salix pyrifolia
Salix scouleriana
Salix serissima
Salsola tragus
Sanicula marilandica
Saxifraga tricuspidata
Schedonorus arundinaceus
Schizachne purpurascens
Schoenoplectus tabernaemontani
Scirpus atrocinctus
Scirpus microcarpus
Scutellaria galericulata
Secale cereale
Selaginella rupestris
Senecio eremophilus var. eremophilus
Senecio vulgaris
Shepherdia canadensis
Silene drummondii var. drummondii
Silene latifolia
Sisymbrium altissimum
Sisyrinchium montanum var. montanum
Sium suave
Solidago altissima ssp. gilvocanescens
Solidago bellidifolia
Solidago glutinosa
Solidago lepida var. lepida
Solidago lepida var. salebrosa
Solidago missouriensis
Solidago multiradiata
Solidago simplex var. simplex
Sonchus arvensis
Sonchus arvensis ssp. uliginosus
Sorbus scopulina var. scopulina
Sparganium emersum
Sparganium natans
Sparganium sp.
Sphenopholis intermedia
Spiraea betulifolia ssp. lucida
Spiraea lucida
Spiranthes romanzoffiana
Sporobolus cryptandrus
Stachys palustris ssp. pilosa
Stellaria borealis
Stellaria borealis ssp. borealis
Stellaria longifolia
Stellaria longipes var. longipes
Stellaria media
Stuckenia pectinata
Symphoricarpos albus
Symphoricarpos occidentalis
Symphyotrichum boreale
Symphyotrichum ciliolatum
Symphyotrichum ericoides var. pansum
Symphyotrichum laeve var. geyeri
Symphyotrichum lanceolatum var. hesperium
Symphyotrichum puniceum var. puniceum
Tanacetum vulgare
Taraxacum officinale
Thalictrum venulosum
Thinopyrum intermedium
Thlaspi arvense
Tofieldia pusilla
Tragopogon dubius
Triantha glutinosa
Trifolium hybridum
Trifolium pratense
Trifolium repens
Triglochin maritima
Triglochin palustris
Tripleurospermum inodorum
Triticum aestivum
Turritis glabra
Typha latifolia
Urtica dioica ssp. gracilis

Utricularia intermedia
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium myrtilloides
Vaccinium oxycoccos
Vaccinium vitis-idaea ssp. minus
Valeriana dioica ssp. sylvatica
Verbascum thapsus
Veronica americana
Veronica beccabunga ssp. americana
Veronica peregrina var. xalapensis
Veronica scutellata
Viburnum edule
Vicia americana
Viola adunca var. adunca
Viola canadensis var. rugulosa
Woodsia scopulina
Zizia aptera

Bryophytes

Abietinella abietina
Antitrichia curtipendula
Aulacomnium palustre
Barbula convoluta var. convoluta
Brachythecium salebrosum
Brachythecium sp.
Bryum argenteum
Ceratodon purpureus
Climacium dendroides
Dicranum polysetum
Dicranum undulatum
Didymodon fallax
Didymodon ferrugineus
Distichium capillaceum
Ditrichum flexicaule
Drepanocladus aduncus
Encalypta rhaptocarpa
Funaria hygrometrica
Hamatocaulis vernicosus
Hedwigia ciliata
Hylocomium splendens
Hymenostylium recurvirostre var. recurvirostre
Leptobryum pyriforme
Marchantia polymorpha
Marchantia quadrata
Mnium thomsonii
Orthotrichum anomalum
Orthotrichum obtusifolium
Orthotrichum speciosum
Philonotis fontana var. fontana
Plagiomnium cuspidatum
Plagiomnium ellipticum
Plagiomnium sp.
Pleurozium schreberi
Pohlia nutans
Polytrichum commune
Polytrichum juniperinum
Ptilium crista-castrensis
Pylaisiella polyantha
Sanionia uncinata
Sphagnum capillifolium
Sphagnum magellanicum
Sphagnum sp.
Syntrichia norvegica
Syntrichia ruralis
Tomentypnum nitens
Tortula mucronifolia

Lichens

Bryoria capillaris
Bryoria fuscescens
Bryoria lanestris
Bryoria sp.
Buellia elegans
Caloplaca cerina
Caloplaca holocarpa
Cetraria ericetorum
Cladina rangiferina
Cladina sp.
Cladonia carneola
Cladonia pocillum
Cladonia sp.
Collema furfuraceum
Diploschistes muscorum
Enchylium tenax
Endocarpon pusillum
Evernia mesomorpha
Flavocetraria cucullata
Hypogymnia occidentalis
Hypogymnia physodes
Icmadophila ericetorum
Lathagrium undulatum var. granulosum
Lecanora impudens
Leptogium saturninum
Leptogium teretiusculum
Lobaria pulmonaria

Melanelixia subaurifera
Melanohalea exasperatula
Melanohalea septentrionalis
Melanohalea subolivacea
Nephroma resupinatum
Parmelia fraudans
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera aphthosa
Peltigera britannica
Peltigera didactyla
Peltigera elisabethae
Peltigera extenuata
Peltigera lepidophora
Peltigera leucophlebia
Peltigera malacea
Peltigera neckeri
Peltigera sp.
Phaeophyscia orbicularis
Phaeophyscia sciastra
Phaeophyscia sp.
Physcia adscendens
Physcia aipolia
Physcia alnophila
Physcia biziana
Physcia caesia
Physcia phaea
Physcia stellaris
Physcia tenella
Physconia muscigena
Physconia perisidiosa
Platismatia glauca
Ramalina dilacerata
Ramalina obtusata
Ramalina sinensis
Rinodina sp.
Stereocaulon tomentosum
Tuckermannopsis americana
Tuckermannopsis sp.
Umbilicaria americana
Usnea cavernosa
Usnea filipendula
Usnea lapponica
Usnea scabrata
Usnea sp.
Usnea substerilis
Vulpicida pinastri
Xanthomendoza fallax
Xanthoparmelia wyomingica
Xanthoria candelaria
Xanthoparmelia wyomingica
Xanthoria candelaria

7.3. Appendix 3: Species accounts for rare plant taxa found during preconstruction surveys

7.3.1. Atriplex gardneri var. *gardneri* (Gardner's sagebrush)

Gardner's sagebrush (Figure 3), a small perennial sub-shrub with a woody base, is a member of the Chenopodiaceae (goosefoot family). Variety *gardneri* is found on fine-textured saline soils and dry grassy slopes in the Great Plains and Intermountain regions of central North America (Douglas et al. 1998; Welsh 2003). In B.C., Gardner's sagebrush is known only from the Peace River region (BCCDC 2024a).

Gardner's sagebrush has a rank of S2 (Imperilled) in B.C. and is on the province's Red list (BCCDC 2024a). The taxon has a global classification of G5 (Secure) (NatureServe 2024).

Figure 3: *Atriplex gardneri* var. *gardneri* (Gardner's sagebrush)

No new occurrences of Gardner's sagebrush were reported in the Site C Regional Assessment Area (RAA) in 2024.

There are a total of four known occurrences (comprising five patches) of Gardner's sagebrush in the RAA. Three of these occurrences (comprising four patches) are situated north of the Peace River near the Alberta border, and, excluding the patch located in 2020, are older records without information on the number of individuals or areal coverage. The patch found in 2020 contained an estimated 50 male and female plants over an approximate area of 50 square metres (m^2). The fourth occurrence of Gardner's sagebrush, discovered in 2018 during Site C survey work, is some 60 km to the west near Wilder Creek. Here, an estimated 150 male plants were found scattered over an area of 618 m^2; no female plants were observed at this occurrence.

All four of the Gardner's sagebrush occurrences are situated on open, dry, south-facing grassland slopes. The dominant associated species include native grasses such as various wildryes (*Elymus* spp.), junegrass (*Koeleria macrantha*), and green needlegrass (*Nassella viridula*), and native forbs such as prairie sagewort (*Artemisia frigida*) and asters (*Symphyotrichum* spp.).

7.3.2. Carex sprengelii (Sprengel's sedge)

Sprengel's sedge (Figure 4) is a perennial herb belonging to the Cyperaceae (sedge family); plants have tall stems with fibrous bases and bear achenes in drooping heads. The species forms loose clumps in a variety of dry to wet habitats, including openings, slopes, and alluvial woodlands, often on calcareous substrates (Douglas et al. 1998; Ball & Reznicek 2002). Sprengel's sedge was only known from three locations in B.C. prior to the Site C rare plant survey work: two near Williams Lake, and one in the Peace River region (BCCDC 2024a).

Figure 4: *Carex sprengelii* (Sprengel's sedge)

Sprengel's sedge has a rank of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2024a). Globally, the taxon is classed G5 (Secure) (NatureServe 2024).

No new occurrences of Sprengel's sedge were reported in the Site C RAA in 2024, however one occurrence at Dry Creek was revisited. Prior to its discovery in 2020 the overstory of trees and shrubs had been removed from this area; in subsequent years the regenerating woodland vegetation was found to be quite dense. During the 2024 revisit, all Sprengel's sedge plants were found alive and with no new disturbance. All four patches had produced multiple fruiting stems.

In total, there are six known occurrences (comprising 11 patches) of Sprengel's sedge in the RAA. Four of these occurrences (comprising eight patches)—found during survey work for the Site C project—are situated between Dry Creek and Wilder Creek, on flat to south-facing slopes north of the Peace River. An estimated 38 plants have been observed growing in a total approximate area of 17 m^2, in various shrub and woodland habitats. All of these locations are moist to mesic, and the Sprengel's sedge plants are generally found in relatively shaded microhabitats. Associated species are similar, including prairie saskatoon (*Amelanchier alnifolia*), prickly rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), aspen (*Populus tremuloides*), and native and weedy herbs such as smooth brome (*Bromus inermis*), northern bedstraw (*Galium boreale*), and American vetch (*Vicia americana*).

The remaining two occurrences of Sprengel's sedge in the RAA are derived from BCCDC records that lack certain population data. An occurrence of 20 plants in two patches was discovered between a hay field and a shrubby south-facing escarpment above the Pine River in 2016; areal extent, associated species, and other details of this occurrence were not documented. Additionally, a sixth occurrence of Sprengel's sedge, first observed in 2010, is reported approximately 80 km southwest, in moist balsam poplar (*Populus balsamifera*) woods north of the Moberly River. No clear information is available on the number of individuals or areal coverage (BCCDC 2024a).

7.3.3. Carex torreyi (Torrey's sedge)

Torrey's sedge (Figure 5) is a soft-hairy perennial in the Cyperaceae (sedge family) found growing in montane meadows, shrublands, and moist woods across central North America (Douglas et al. 1998; Ball & Reznicek 2002). In B.C. the species is found only in the Peace River region (BCCDC 2024a). Torrey's sedge is ranked S3? (Vulnerable?) in B.C. and is on the province's Blue list (BCCDC 2024a). The species is ranked G4G5 (Apparently Secure or Secure) globally (NatureServe 2024).

No new occurrences of Torrey's sedge were reported in the Site C RAA in 2024.

There are a total of 13 occurrences (comprising 21 patches) of Torrey's sedge reported in the RAA. An estimated 562 plants have been observed growing in a total area of approximately 446 m^2. Twelve of the occurrences are situated north of the Peace River; the 13th occurrence (not reconfirmed since the 1960 report) is located more than 45 km south, near Dawson Creek, B.C. All of the occurrences were found on mesic to xeric south-facing slopes in open shrub grassland complexes. Associated species are similar at the occurrences and include native shrubs such as prickly rose, prairie saskatoon, and snowberry (*Symphoricarpos* spp.); native and non-native graminoids such as smooth brome, bluegrasses (*Poa* spp.), and sedges (*Carex* spp.); and a diverse mix of native and weedy forbs.

Figure 5: *Carex torreyi* (Torrey's sedge)

7.3.4. Carex xerantica (dry-land sedge)

Dry-land sedge (Figure 6), a perennial herb with silvery-gold heads of the Cyperaceae (sedge family), is found across central North America in xeric steppe and montane habitats such as dry grasslands and hillsides, open forests, and rock outcrops (Douglas et al. 1998; Ball & Reznicek 2002). In B.C., dry-land sedge has been collected in the Peace River area as well as scattered locations in the central interior and central Rocky Mountains (BCCDC 2024a; Klinkenberg 2024).

Dry-land sedge is classed as S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2024a). The species has a global rank of G5 (Secure) (NatureServe 2024).

One new occurrence of dry-land sedge was recorded, and one previously-known occurrence was expanded, in the Site C RAA in June 2024. The new occurrence was located in a narrow low-shrub grassland opening in mixed woodland north of Chetwynd, B.C. An estimated 30 plants in flower were found scattered in an area of approximately 2,822 m^2. The expansion documented for the previously-known dry-land sedge occurrence consisted of one small new patch at Clayhurst near the Alberta border, east of the main patch which was first reported in 2019.

Figure 6: *Carex xerantica* (dry-land sedge)

In total, there are 23 known occurrences of dry-land sedge (comprising 60 patches) in or near the RAA. An estimated 14,363 plants have been observed growing in an approximate total area of 15.6 ha. Eighteen of the occurrences were found on south-facing slopes north of the Peace River from Bear Flat east to the Alberta border, and two occurrences were reported from a large bench and adjacent south-facing slopes on the south side of the Peace River. Additionally, dry-land sedge has been collected on a slope above the Pouce Coupe River, over 25 km south of the Peace River, and has been documented at two locations on steep hillsides near Chetwynd, approximately 75 and 80 km southwest of Fort St. John.

The dry-land sedge occurrences are invariably located in xeric grassland habitat, generally in the vicinity of low shrub thickets. The dominant associated species include native shrubs such as prairie saskatoon, prickly rose, and snowberry; native dryland sedges such as hay sedge (*Carex siccata*); and native grasses such as junegrass, short-awned porcupinegrass (*Hesperostipa curtiseta*), spike-oat (*Helictochloa hookeri*), wildryes, and needlegrasses (*Achnatherum* spp. and *Nassella viridula*). A diverse mix of native and non-native forbs are also present at dry-land sedge occurrences.

7.3.5. Drymocallis arguta (tall wood beauty)

Tall wood beauty (Figure 7) is a glandular hairy perennial in the Rosaceae (rose family). The species grows in a wide variety of open, mesic habitats across North America east of the Rocky Mountains (Ertter et al. 2014). The taxonomy of tall wood beauty was clarified by the 2014 publication of Flora of North

America, but its presence in B.C. has not been well documented and the species was only added to the B.C. flora in July of 2022 (Ertter et al. 2014; BCCDC 2024a). Records and collections of tall wood beauty from B.C. require review to determine those that represent *D. convallaria* (white cinquefoil), a similar-looking plant that is common west of the continental divide (Ertter et al. 2014; Beaty Biodiversity Museum 2023; Klinkenberg 2024). Two new occurrences of tall wood beauty were reported in June 2024 from Prince George, B.C. by a biologist working with the Site C Experimental Rare Plant Translocation program.

Figure 7: *Drymocallis arguta* (tall wood beauty)

Tall wood beauty is classified as S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2024a). Globally the taxon is considered Secure (G5) (NatureServe 2024).

Four new occurrences of tall wood beauty were documented, and two previously-known occurrences were expanded, in the study area in June 2024, and the size of one previously-known occurrence was clarified in August. The 2024 survey work for tall wood beauty deliberately targeted search areas at the edge of or outside of the Site C RAA, in order to document a larger range for the species in northeast B.C.

Two new occurrences were found near the Pouce Coupe River close to the Alberta border. The first consisted of a patch of 50 plants in a disturbed field on the south edge of the town of Pouce Coupe, B.C. Areal coverage at this occurrence was approximately 1,000 m^2 and while most of the plants were not yet in bloom, many still had flowering stalks from the previous year attached. The second occurrence, over a

total area of approximately 117 m^2, contained 40 plants scattered in a shrubby clearing along Landry Road, northeast of Dawson Creek, B.C.

A third new occurrence was recorded along the Cameron River at Upper Halfway Road, where an estimated 200 tall wood beauty plants were observed over an approximate area of 4,247 m^2 on a disturbed flat between the river and the road. The fourth new occurrence was located in a narrow low-shrub grassland opening in mixed woodland north of Chetwynd, B.C. An estimated 150 tall wood beauty plants in bud were found scattered in an area of approximately 1,416 m^2.

The first previously-known occurrence of tall wood beauty that was revisited and expanded in June is located north of Cecil Lake Road, northeast of Fort St. John. Three new patches, east of the original patch first documented in 2022, were added to the occurrence, for a current total of four patches. The second previously-known occurrence revisited and expanded in June is along Clayhurst Road, near the Alberta border. Two new patches of tall wood beauty were added, for a current total of five patches.

The previously-known occurrence that was revisited in August is situated on a bench west of the confluence of the Pine and Peace Rivers. This occurrence was first documented in 2023, and consists of several patches of tall wood beauty each containing hundreds or thousands of individuals. The 2024 revisit clarified the size of certain patches of this occurrence where the area had been impacted by aggregate extraction for the Site C project.

Of note for 2024, two of the four new occurrences were in degraded plant communities that consisted of predominantly non-native species such as smooth brome and dandelion *(Taraxacum officinale)*. This is in contrast to the generally good condition native plant assemblages associated with most other known occurrences of tall wood beauty in B.C.

In total, 38 tall wood beauty occurrences (comprising 116 patches) are known in or near the RAA, ranging from near the Williston Reservoir in the west to the Alberta border in the east, and extending north and south as described for the 2024 occurrences above. An estimated 15,513 plants have been documented growing in an approximate total area of 12.9 hectares. The plants are usually found on open slopes, but occasionally occur on level ground; in a few instances the substrate is quite rocky. Tall wood beauty generally grows in association with low to mid-height native shrubs, usually species such as prairie saskatoon, prickly rose, and snowberry. A diverse mix of native and non-native graminoids are also found at the occurrences: dominant taxa include bluegrasses, wildryes, needlegrasses, smooth brome, junegrass, short-awned porcupinegrass, and sedges. Associated forb species include northern bedstraw, asters, and woolly yarrow (*Achillea borealis*).

7.3.6. Lomatium foeniculaceum var. *foeniculaceum* (fennel-leaved desert-parsley)

Fennel-leaved desert-parsley (Figure 8), a low perennial herb with a long taproot, is a member of the Apiaceae (carrot family) (Douglas et al. 1998). The taxon is found on dry, open slopes across much of central North America (Hitchcock et al. 1961; NatureServe 2024). Fennel-leaved desert parsley var. *foeniculaceum* is restricted to the Peace River region in B.C. (BCCDC 2024a).

Figure 8: *Lomatium foeniculaceum* var. *foeniculaceum* (fennel-leaved desert-parsley)

In B.C., fennel-leaved desert-parsley var. *foeniculaceum* carries a rank of S3 (Vulnerable) and is on the province's Blue list (BCCDC 2024a). The taxon's global classification is G5T5 (Secure for both the species and the variety) (NatureServe 2024).

No new occurrences of fennel-leaved desert-parsley were reported in the Site C RAA in 2024.

A total of seven occurrences (comprising 12 patches) of fennel-leaved desert-parsley are known from the RAA, ranging in the Peace River corridor from the Cache Creek area east to near the mouth of the Kiskatinaw River. An estimated 980 plants have been documented in an approximate total area of 8,626 m^2. All fennel-leaved desert-parsley occurrences occur on dry, south-facing grassland slopes. Associated species include low shrubs such as prairie saskatoon and snowberry, and herbs such as thick-spike wildrye (*Elymus lanceolatus* ssp. *lanceolatus*), short-awned porcupinegrass, green needlegrass, and pale comandra (*Comandra umbellata* ssp. *pallida)*.

7.3.7. Penstemon gracilis (slender penstemon)

Slender penstemon (Figure 9) is a perennial herb of the Plantaginaceae (plantain family)—formerly of the Scrophulariaceae (figwort family)—that inhabits mesic to dry plains and grasslands (Hitchcock et al. 1959; Douglas et al. 1998; Freeman & Rabeler 2016). The species is commonly found throughout much of central North America, but in B.C. is restricted to the Peace River area (Hitchcock et al. 1959; BCCDC 2024a; NatureServe 2024).

Figure 9: *Penstemon gracilis* (slender penstemon)

Slender penstemon is ranked S3 (Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2024a). The species' global status is G5 (Secure) (NatureServe 2024).

No new occurrences of slender penstemon were found in the Site C RAA in 2024, however one occurrence on the north side of Highway 29 east of Farrell Creek was revisited in August. Prior to aggregate extraction at the site in 2021, this occurrence was a large population of slender penstemon containing hundreds of plants. During the 2024 revisit, it was observed that some tens of plants are persisting and flowering in a small area of undamaged habitat, between the aggregate pit and the overburden pile.

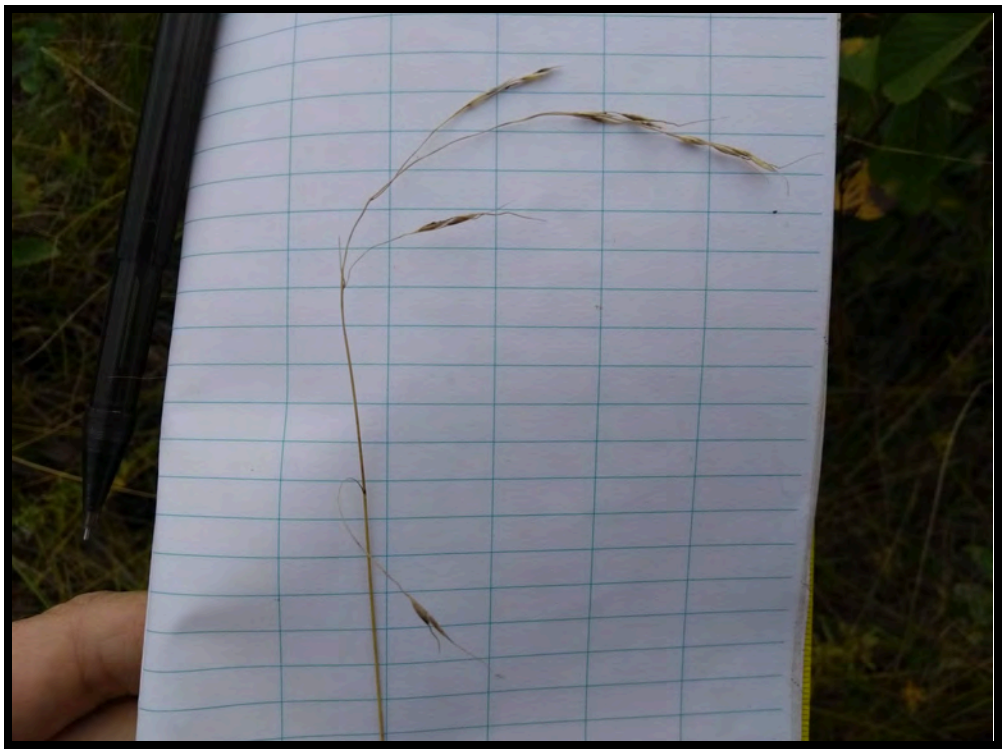
In total, there are 28 occurrences of slender penstemon (comprising 63 patches) reported in the RAA. All of the occurrences are situated north of the Peace River, from the Farrell Creek area east to the Alberta border. An estimated 3,905 plants have been documented in an approximate total area of 6.52 hectares. All of the occurrences were found on south-facing slopes in xeric grassland habitat, often in the vicinity of low shrub thickets. Dominant associated species include the native shrubs prairie saskatoon, kinnikinnick, and common snowberry (*Symphoricarpos albus*), native graminoids such as junegrass, wildryes, and dryland sedges, and a diverse mix of native and non-native forbs.

7.3.8. Piptatheropsis canadensis (Canada ricegrass)

Canada ricegrass (Figure 10) is a delicate perennial bunchgrass of the Poaceae (grass family). The species grows in grasslands and open woods. In eastern North America, the taxon is specifically reported from

dry, sparsely-vegetated soils which are usually sandy or rocky, as well as moist peaty barrens. Prior to the 2018 Site C rare plant survey work, no verified extant occurrences of Canada ricegrass were known from B.C. (BCCDC 2024a). Of note: the genus *Piptatheropsis* was only recently described (Romaschenko et al. 2011), therefore Canada ricegrass is still referred to by the name *Piptatherum canadense* in some literature (Lapin 2004; Barkworth 2007; NatureServe 2024).

Figure 10: *Piptatheropsis canadensis* (Canada ricegrass)



Canada ricegrass is ranked S1 (Critically Imperilled) in B.C., and is on the province's Red list (BCCDC 2024a). The taxon's global classification is G4G5 (Apparently Secure or Secure) (NatureServe 2024).

No new occurrences of Canada ricegrass were documented in the Site C RAA in 2024.

There are a total of seven known occurrences of Canada ricegrass (comprising 22 patches) in the RAA. The occurrences are located from the Cache Creek area east to near the Beatton River. An estimated total of 311 plants have been documented in an approximate total area of 1,407 m^2. All of the Canada ricegrass occurrences are situated on level to gently sloped, open, good quality native shrub-grassland or remnants of such, usually in close proximity to aspen woodlands. Soils at the occurrences can be moist to dry. The Canada ricegrass plants grow scattered in dense vegetation consisting of a diverse assemblage of low shrubs and herbs. Dominant associated species are native plants and include the shrubs prairie saskatoon, prickly rose, and chokecherry; graminoids such as spreading needlegrass (*Achnatherum richardsonii*), slender wheatgrass (*Elymus trachycaulus* ssp. *subsecundus*), false melic (*Schizachne purpurascens*), and hay sedge; and forbs such as northern bedstraw and anemones (*Anemone* spp.). A few non-native species are also present, particularly Kentucky bluegrass.

7.3.9. Polygala senega (Seneca snakeroot)

Polygala senega (Figure 11) (syn. *Senega officinalis*) is a small, multi-stemmed perennial herb of the Polygalaceae (milkwort family). The species grows in open woods, prairies, and other mesic habitats across much of central and eastern North America (Abbott 2021; Pastore et al. 2023). In B.C., prior to survey work in 2024, Seneca snakeroot was only known from an historic collection from the B.C.-Alberta border near Clayhurst (BCCDC 2024a).

Figure 11: *Polygala senega* (Seneca snakeroot)

Seneca snakeroot is currently ranked SH (Historical/Possibly Extirpated) in B.C., and is on the province's Red list (BCCDC). The taxon's global status is G4/G5 (Apparently Secure/Secure), although there is some concern that harvest of the root for the medicinal trade may be negatively affecting the taxon's viability (NatureServe 2024) .

One occurrence of Seneca snakeroot was documented in the study area in June 2024. Hundreds of plants were found in early bloom in open woods east of Hudson's Hope. Associated species included white spruce, trembling aspen, kinnikinnick, Richardson's sedge *(Carex richardsonii)*, and a mix of native forbs such as woolly yarrow and northern bedstraw.

7.3.10. Ranunculus rhomboideus (prairie buttercup)

Prairie buttercup (Figure 12) is a soft-hairy perennial of the Ranunculaceae (buttercup family). The species grows in grasslands, prairies, open woods and thickets across north-central North America

(Whittemore & Parfitt 1997; Douglas et al. 1998). In B.C., prairie buttercup is only known from the Peace River region (BCCDC 2024a).

Figure 12: *Ranunculus rhomboideus* (prairie buttercup)

Prairie buttercup has a ranking of S2S3 (Imperilled and Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2024a). Globally, the taxon is ranked G5 (Secure) (NatureServe 2024).

No new occurrences of prairie buttercup were reported from the Site C RAA in 2024.

In total, 13 occurrences of prairie buttercup (comprising 19 patches) have been reported in the RAA. Ten of the occurrences (comprising 16 patches)—discovered during the Site C rare plant survey work—are situated north of the Peace River from the Cache Creek area east to the Beatton River, and contain an estimated 227 plants in an approximate total area of 465 m^2.

One other occurrence of one plant, observed west of the confluence of the Peace and Pine Rivers in 2018, was also found during Site C-related work. The remaining occurrences are historical records not recently verified and with no information available on precise location, number of individuals or areal coverage. The habitat for prairie buttercup is somewhat variable: soils can range from moist to dry, shrub cover can be dense to sparse, and occurrence microsites can be flat to sloped. Dominant associated species include a wide variety of native forbs such as northern bedstraw and American vetch as well as weedy grasses such as smooth brome and Kentucky bluegrass. Native shrub species are also present, the most commonly reported being rose (*Rosa* spp.) and prairie saskatoon.

7.3.11. Salix petiolaris (meadow willow)

Meadow willow (Figure 13), a shrub or small tree of the Salicaceae (willow family), has long, slender leaves and is found in moist to wet habitats across north-central North America (Douglas et al. 1998; Argus 2010). In B.C., the species has only been collected in the northeast part of the province (BCCDC 2024a; Klinkenberg 2024).

Figure 13: *Salix petiolaris* (meadow willow)

Meadow willow is ranked S3 (Vulnerable) in B.C. and is on the Blue list for the province (BCCDC 2024a); the species is classed as G5 (Secure) globally (NatureServe 2024).

One new occurrence of meadow willow was documented in the study area in June 2024. Eight plants in flower were found near the Cameron River, in a ditch between Upper Halfway Road and a disturbed flat. The meadow willow plants were growing with other willows in an area of approximately 220 m^2.

There are a total of seven reported occurrences of meadow willow in or near the RAA, of which only two—both found during the Site C survey work—are recent records. In addition to the new occurrence described above, there is also an occurrence of 22 meadow willow shrubs in an approximately 160 m^2 patch on the southern edge of a large wetland on the plateau between the Peace and Moberly Rivers. In both cases, the meadow willow habitat consists of level, moist to wet ground along roadways, and the associated species include predominantly other willow species such as *Salix discolor* (pussy willow), *Salix*

lasiandra var. *lasiandra* (Pacific willow), and *Salix bebbiana* (Bebb's willow), along with a mix of native and non-native herbs.

The remaining five occurrences of meadow willow reported from the RAA have not been recently field verified. Four records date from 1967 to 1976 and provide little or no information besides a collection point: two are east of Fort St. John, and two are located to the south near Dawson Creek, B.C. The fifth occurrence was reported in 2008 from along a forest road south of Hudson's Hope, B.C., but subsequent attempts to relocate this occurrence have not been successful and it is presumed that either the location data or the identification are incorrect.

7.3.12. Selaginella rupestris (rock selaginella)

Rock selaginella (Figure 14) is a small, mat-forming evergreen perennial in the Selaginellaceae (spike-moss family). The taxon is found in a variety of open, dry, rocky or gravelly habitats in eastern and central North America (Valdespino 1993; Douglas et al. 1998). In B.C., rock selaginella is known only from the Peace River region (BCCDC 2024a; Klinkenberg 2024).

Figure 14: *Selaginella rupestris* (rock selaginella)

Rock selaginella is ranked S2 (Imperilled) in B.C., and is on the Red list for the province (BCCDC 2024a). The taxon is classed as G5 (Secure) globally (NatureServe 2024).

One occurrence of rock selaginella was substantially expanded in the Site C RAA in 2024. A revisit to the occurrence at Clayhurst near the Alberta border found many more clumps over a much larger area than previously reported, either in 2000 at the time of the original discovery or on the revisit by the Site C botanical team in 2020.

Of note, nine of the eleven rock selaginella occurrences reported in or near the RAA for Site C work were revisited in June for field verification, in support of a review of the *Selaginella* documentation for the Site C Project. The project botanists, working together with the botanist who originally documented rock selaginella in B.C. in 2000, have revised the identifications of most of the voucher specimens, with the result that only four of the occurrences are now considered to be rock selaginella. The remaining seven are now considered to be cliff selaginella *(Selaginella scopulorum)*, a very similar plant with a status in B.C. of S5 (Secure) (BCCDC 2024a).

All four verified occurrences of rock selaginella (comprising five patches) in the Site C RAA are located north of the Peace River, from Hudson Hope east to the Alberta border, and contain an estimated 1,850 clumps in an approximate total area of 2,963 m^2. Of the four occurrences, three remain undisturbed by Site C project construction, and one has been completely extirpated.

The rock selaginella occurrences are found on dry, rocky, open shrub-grassland habitat on south-facing hillsides or hillcrests. Dominant associated species include the shrubs prairie saskatoon, kinnikinnick, and common juniper (*Juniperus communis*); graminoids such as junegrass, thickspike wildrye, and various dryland sedge species; and forbs such as prairie sagewort, northern bedstraw, and woolly yarrow.

7.4. Appendix 4: Memo Evaluating Site C EIS Rare Plant Predictions

EAGLE CAP CONSULTING
environmental consulting services

MEMO

Date: April 1, 2025

To: Brent Matsuda (BC Hydro)

From: Randy Krichbaum (Eagle Cap)

Subject: Evaluation of Site C EIS Rare Plant Predictions

INTRODUCTION

BC Hydro and Power Authority (BC Hydro) is in the final stages of commissioning the Site C Clean Energy Project (the Project) on the Peace River near Fort St. John in northeastern British Columbia. The Project consists of a 1,050-metre-long earthfill dam, a 1,100-megawatt generating station, transmission lines, and associated facilities. The Project was approved with conditions in late 2014 by the BC Provincial Government (BC Environmental Assessment Office 2014) and the Federal Government (Canadian Environmental Assessment Agency 2014) after a joint review of the amended Environmental Impact Statement (EIS) submitted by BC Hydro in 2013 (BC Hydro 2013).

Condition 16 of the Federal Decision Statement for the Project addresses "*Species at risk, at-risk and sensitive ecological communities and rare plants"* and, in part, directs BC Hydro to develop a plan to address potential Project effects on species at risk and rare plants. Condition 16.3.6. further specifies that the plan shall include, "*an approach to…verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants" (Canadian Environmental Assessment Agency 2014).*

In fulfilling the various provincial and federal conditions since 2014, BC Hydro has undertaken extensive studies on the rare plants in the Project area. Due to this work, much more is known about the distribution, habitat requirements, and disturbance response of the rare plants in the study area than was known when the EIS was prepared over 12 years ago. As such, BC Hydro is now in a better position to evaluate the actual and potential Project effects to rare plants and ecological communities than when the EIS was written, and is in a position to assess the accuracy of the assumptions and predictions made in the EIS. This memo describes the analysis conducted to assess the accuracy of the rare plant predictions contained in the EIS, based on data collected during the past 10 years of rare plant and vegetation work.

ASSUMPTIONS AND PREDICTIONS IN THE SITE C EIS

For the Site C EIS, BC Hydro defined a Project Activity Zone (PAZ), which represented the footprint required to construct and operate the Project (BC Hydro 2013). Because construction planning had not been finalized at the time, it was assumed that ground and vegetation disturbance could take place anywhere within the PAZ. For the assessment of likely rare plant impacts, the PAZ and Peace River downstream reach were buffered by 50 or 100 metres (depending on the facility) to create a direct-effects polygon. Within this direct-effects polygon it was assumed that all rare plant occurrences and high-suitability rare plant ecosystem units would be lost (for the

downstream reach, these effects were only predicted to occur once the Project was in operation, not during the construction phase). It was understood at the time that not all the ground within the direct-effects polygon would be disturbed, but because detailed construction plans had not yet been formulated, a precautionary approach was taken by assuming adverse rare plant effects within the entire direct-effects polygon.

At the time of the EIS, field studies had identified 39 provincially rare vascular plant species within the Project's Local Analysis Area (LAA), in a total of 242 separate occurrences (Hilton et al. 2013). Of these, 142 occurrences (of 30 rare taxa) were located within the direct-effects polygon described above, and the majority of these (122 occurrences) were predicted to be extirpated during construction of the Project, while the remainder were predicted to be lost during the operations phase of the Project. This represented a loss of approximately 50% of the known rare plant occurrences in the LAA, and was therefore judged to be a significant residual effect on the rare plant key indicator (contributing to the determination of significance for the overall Vegetation and Ecological Communities Valued Component) (BC Hydro 2013).

In order to make the above effects predictions and determination of significance, several key assumptions were made:

1. all rare plant occurrences within the direct-effects polygon (excluding the downstream reach) would be lost during construction of the Project;
2. rare plants in the additional buffered areas would receive the same level of direct effects as they would if they had been located within the footprint of a facility; and
3. the 100 known rare plant occurrences located outside the direct-effects polygon (but within the LAA) would not be directly affected by the Project.

Current Conditions

The uncertainties regarding Site C rare plant impacts have been greatly clarified since the EIS was issued, due to ongoing Project-related rare plant work conducted since 2014. This has included yearly preconstruction rare plant surveys (2015-present), experimental rare plant translocation work, regional rare plant surveys conducted to clarify species distribution questions, and various other work related to rare plant mitigation.

These surveys have documented numerous additional rare plant occurrences within the Project area and region, which has led the BC Conservation Data Centre (CDC) to remove the rare status designation for many of the local taxa (*i.e.* moving them from the provincial *Red* or *Blue* lists, to the *Yellow* list). As a result, currently only 14 rare vascular taxa in 83 occurrences are known to occur in the LAA despite considerable additional survey effort conducted since baseline surveys were completed in support of the EIS; whereas at the time the EIS was issued, 39 rare vascular plant taxa in 242 occurrences were known.

Likewise, as Project construction has progressed, a clearer picture of the actual disturbance footprint has been gained. Based on the latest spatial data supplied by BC Hydro of actual construction disturbance, as well as on-the-ground observations, a revised direct-effects polygon was created to better reflect actual construction disturbance.

Thus, as a combined result of the refinement of the direct-effects polygon and the rare status changes by the CDC over the years, the current direct-effects polygon now contains nine rare vascular plant taxa in 25 occurrences (as opposed to the 30 taxa in 142 occurrences reported in the EIS).

As Project construction nears completion, the disturbance to rare plant occurrences can also be evaluated to a greater extent. Of the 25 known rare vascular plant occurrences in the current direct-effects polygon,

- 5 occurrences (20%) are still extant;
- 5 occurrences (20%) have been completely extirpated by Project activities; and
- 15 occurrences (60%) have been partially extirpated by Project activities.

Mitigation

Due to the uncertainties regarding the effectiveness of the proposed mitigation measures, the EIS assumed that only minimal direct impact reductions would be achieved from the proposed avoidance and reduction mitigation efforts. However, substantial indirect benefits were expected from the experimental rare plant translocation program and the habitat compensation program. As the Project has progressed, some initial conclusions about the effectiveness of the rare plant mitigation programs can be gained.

Avoidance and impact reduction mitigation measures have been effective in several situations where rare plant occurrences were located close to Project facilities. In some cases, the occurrence boundaries have been staked and flagged in the field by Project botanists who have then coordinated avoidance and reduction measures with the construction crews. In one case, construction activities were delayed until a botanical salvage crew could translocate representative specimens from two rare plant occurrences at the site (BC Hydro 2022).

The Site C Experimental Rare Plant Translocation (ERPT) program has also established several new rare plant occurrences using propagules collected from the PAZ and nearby areas. In addition, several other previously known rare plant occurrences located outside of the PAZ have been augmented using translocated specimens. Although it is still early in the establishment process, some of the translocated plants show good vigour and appear to be establishing themselves on a more permanent basis. Even though several of the species translocated as part of the ERPT program were subsequently taken off the rare list by the CDC, the knowledge gained during the process can help with future translocation projects involving the same, or similar, species (BC Hydro 2022).

Finally, various habitat compensation projects are ongoing to preserve and enhance desirable native habitats affected by the Project. Several of these have direct benefits to the rare plants in the Peace Region. For example, both the Marl Fen and Wilder Creek Mitigation Lands contain known rare plant occurrences that are presumably benefitting from protection measures implemented at these sites (BC Hydro 2016).

Validation of Predictions and Assumptions

It is impossible to directly compare the EIS-predicted rare plant effects of the Project to those actually occurring presently. Most of the 39 rare vascular taxa that were known to occur in the LAA at the time of the EIS have since been removed from rare classification by the CDC. Furthermore, additional rare plant species and

occurrences have been discovered in the Project area. The current complement of rare species and occurrences in the LAA is much different than it was when the EIS was issued.

However, some indirect comparisons are still possible. The determination of significance for the rare plant key indicator in the EIS was based on the number of rare vascular plant occurrences predicted to be lost (122 occurrences) as a percentage of the total number that were known in the LAA (242 occurrences), which means approximately 50% of the known occurrences were predicted to be lost. That can be compared to the present situation where 25 rare vascular plant occurrences are known in the current direct-effects polygon out of a total of 83 known in the LAA, which is approximately 30%, a reduction in the magnitude of effect from that predicted in the EIS.

The predicted area of direct rare plant effects can also be compared. The EIS used a direct-effects polygon of 19,836 hectares to calculate construction effects to rare plants. The current direct-effects polygon is 36% smaller at 12,776 hectares. This also suggests a reduction in the magnitude and extent of the predicted rare plant impacts from the Project.

It is also now possible to reexamine the three key assumptions used in the EIS to calculate rare plant effects:

Assumption 1: All rare plant occurrences within the direct-effects polygon (excluding the downstream reach) would be lost during construction of the Project: As expected, this conservative assumption appears to overstate the Project rare plant effects. Eighty percent of the known rare plant occurrences in the current direct-effects polygon have not been completely extirpated by the Project (60% partially extirpated, and 20% not impacted). It is clear that not all the rare plant occurrences in the direct-effects polygon will be adversely affected.

Assumption 2: Rare plants in the additional buffered areas would receive the same level of direct effects as they would if they had been located within the footprint of a facility: Again, this assumption overstates the direct Project effects to rare plants. Within the buffered areas around the facilities, several rare plant occurrences have been monitored which appear to have received no direct effects from the Project. These are most often associated with the 50-metre-wide buffer along the new and upgraded access roads and Highway 29 realignments, where Project activities are largely confined to the roadway and adjacent verge.

Assumption 3: The known rare plant occurrences located outside the direct-effects polygon (but within the LAA) would not be directly affected by the Project: This assumption appears to be valid for the rare plant occurrences being monitored outside of the current direct-effects polygon. No evidence of direct Project impacts to these occurrences has been observed.

In addition to revisiting the assumptions made in the EIS, with the additional data gained through the subsequent rare plant work it is also possible to reevaluate the level of confidence in the assessment of impacts to rare plants. The EIS states that the confidence in the characterization of the residual Project effect to rare plants was considered low for a number of reasons including:

1. *the specific disturbance responses for the rare plants in the LAA are unknown;*
2. *the prediction of important habitats for rare plant occurrence is subject to limitations; and*
3. *distribution data within B.C. are incomplete for many of the affected rare plant taxa* (BC Hydro 2013).

All three of these uncertainties have been greatly clarified through the extensive rare plant surveys that have been conducted in the Project area and Peace Region since the EIS was prepared. The disturbance responses of selected Project area rare plants have been monitored to determine which species are surviving in, or adjacent to, disturbed conditions. Furthermore, by documenting hundreds of additional rare plant occurrences in the region, Project botanists now better understand which habitats are critical for rare plant occurrence and survival. Additionally, the many hours of rare plant surveys conducted in both the Project area and Peace Region have clarified the distribution and abundance of certain B.C. rare plants, in many cases leading to rare status removal for species that have been found to be more abundant or more widely distributed than previously thought.

Discussion

Although direct comparison of EIS-predicted versus actual Site C rare plant effects is impossible due to a number of factors, it is reasonable to form some conclusions regarding the validity of the predictions made in the Site C EIS with respect to rare plant impacts. Construction disturbance is essentially complete and the reservoir has been filled.

The key assumptions used in the EIS to predict Project rare plant impacts appear to be conservative, as they were intended to be, with actual impacts less than were predicted using the assumptions. Not all rare plant occurrences in the direct-effects polygon have been extirpated, with many still surviving. Rare plant occurrences adjacent to Project facilities are persisting with no direct Project effects occurring. No evidence has been found of direct adverse Project effects to rare plant occurrences located outside of the current direct-effects polygon (although indirect effects were not investigated).

The direct-effects polygon used to predict impacts in the EIS was deliberately large to include all potential direct Project disturbance, using wide buffers around the proposed Project facilities. It appears that this polygon was indeed sufficient to capture the vast majority of the Project disturbance footprint, and was also conservative in that it overestimated the footprint area. The current direct-effects polygon, representing the best current estimate of the actual Project construction disturbance area, is 36% smaller than the direct-effects polygon used in the EIS. Furthermore the original direct-effects polygon contains more than 99% of the current direct-effects polygon, with only 111 hectares (out of 12,776 hectares) outside the original area.

The confidence in the rare plant predictions has also increased substantially since the publication of the EIS, due to the subsequent rare plant work that has been conducted in the Project area. Project botanists are now able to predict with much greater certainty which habitats are capable of supporting which rare plants, where these habitats occur, and where else in the region these rare plants may be located.

It appears that mitigation efforts have been successful at reducing Project impacts to rare plant occurrences, and providing compensatory value for certain unavoidable impacts. Direct avoidance and reduction of impacts to rare plant occurrences has been facilitated in some cases, and plants have been salvaged and translocated in other cases. The experimental translocation program continues to make progress establishing new rare plant occurrences, and augmenting existing occurrences of priority rare plant species. As well, the compensation

program has protected and enhanced several parcels containing high-quality rare plant occurrences and suitable habitat.

Conclusion

The rare plant impact predictions contained in the Site C EIS were deliberately conservative and used assumptions designed to take in worst case scenarios. Overall, the current observed Project rare plant impacts are less in magnitude and extent than those predicted in the EIS. The actual loss of rare plant occurrences and habitat due to the Project, as well as the number of rare plant species affected, are all less than predicted in the EIS. The level of confidence in the predictions has substantially increased due primarily to extensive rare plant work conducted in the Project area and region since EIS issuance. Therefore, it can be concluded that the rare plant predictions contained in the EIS were appropriately conservative, and that actual Project impacts on rare plants will be less than those predicted in the EIS.

Closure

Reviewed and approved:

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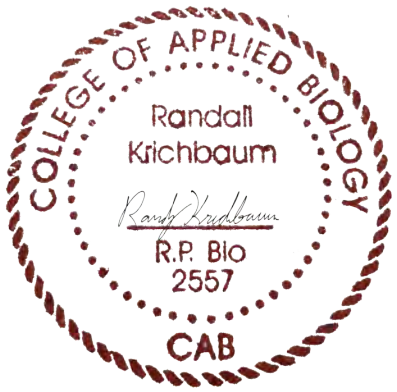

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Appendix 8. 2024 Experimental Rare Plant Translocation Program Annual Report

Experimental Rare Plant Translocation Program
2024 Annual Report

Date: April 2, 2025

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TABLE OF CONTENTS

Table of Contents i

Acronyms & Abbreviations ix

1. Introduction 1
   1.1 Plant Species included in the Program and their Conservation Ranks 1
      1.1.1 Listing under the Species at Risk Act 2
      1.1.2 NatureServe Conservation Priority Global Rank 2
      1.1.3 B.C. Conservation Data Centre Priority Rank 3
      1.1.4 Plant Species included in the ERPT Program 4
2. General Methods 5
   2.1 Phase 1. Propagule Collection 5
      2.1.1 *In-situ* Seed Collection 5
      2.1.2 *Ex-situ* Seed Collection 5
   2.2 Phase 2. *Ex-situ* Propagation 5
   2.3 Phase 3. Translocation 6
      2.3.1 Recipient Site Selection 6
      2.3.2 Transport and Plant Preparation 8
      2.3.3 Selection of Planting Locations within the Habitat Matrix 9
      2.3.4 Translocation at Recipient Sites 10
   2.4 Phase 4. Monitoring 11
   2.5 Data Analysis 12
   2.6 Quality Assurance and Control 13
3. Results 14
   3.1 Phase 1. Propagule Collection 14
   3.2 Phase 2. *Ex-situ* Propagation 17
   3.3 Phase 3. Translocation Implementation 17
      3.3.1 Sprengel's Sedge (*Carex sprengelii*) 20
      3.3.2 Torrey's Sedge (*Carex torreyi*) 20
      3.3.3 Prairie buttercup *(Ranunculus rhomboideus)* 22

3.3.4 Canada mountain-ricegrass (*Piptatheropsis canadensis*) 25
3.4 Monitoring 32
3.4.1 Population Monitoring 40
3.4.2 Canada mountain-ricegrass (*Piptatheropsis canadensis)* 42
3.4.3 Davis' locoweed (*Oxytropis campestris var. davisii*) 44
3.4.4 Dryland sedge (*Carex xerantica*) 50
3.4.5 Prairie buttercup (*Ranunculus rhomboideus*) 51
3.4.6 Slender penstemon (*Penstemon gracilis*) 58
3.4.7 Rock selaginella (*Selaginella rupestris*) 61
3.4.8 Torrey's sedge (*Carex torreyii*) 62
3.4.9 Sprengel's sedge (*Carex sprengelii*) 64
3.5 Preliminary Data Analysis 68
3.5.1 Sprengel's sedge 68
3.5.2 Dryland sedge 70
3.5.3 Davis' locoweed 72
3.5.4 Slender penstemon 74
3.6 Year in Review Summary 76
3.7 Discussion 77

References 79

List of Figures

Figure 3.1-1. Experimental Rare Plant Translocation Propagule Collection Locations 16

Figure 3.3-1. Experimental Rare Plant Translocation Recipient Site Locations 18

Figure 3.3-2. Experimental Rare Plant Translocation Recipient Site Locations 19

Figure 3.3-3. Torrey's sedge planting diagram at Beatton Valley Trails site ID: CARETOR-2023-C-1A 21

Figure 3.3-4. Torrey's sedge planting diagram at Beatton Valley Trails site ID: CARETOR-2024-D 22

Figure 3.3-5. Prairie buttercup planting diagram at Beatton Valley Trails site ID: RANURHO-2023-E 24

Figure 3.3-6. Prairie buttercup planting diagram at Beatton Valley Trails site ID: RANURHO-2024-F 25

Figure 3.3-7. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 1-4) 26

Figure 3.3-8. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 5-7) 27

Figure 3.3-9. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 8-9) 28

Figure 3.3-10. Canada mountain-ricegrass planting diagram at Beatton Valley Trails site ID: PIPTCAN-2023-C-Cohort 2 30

Figure 3.3-11. Canada mountain-ricegrass planting diagram at Beatton Valley Trails site ID: PIPTCAN-2024-E 31

Figure 3.4-1. Experimental Rare Plant Monitoring Site Locations 34

Figure 3.4-2. Experimental Rare Plant Monitoring Site Locations 35

Figure 3.5-1. Patterns of survivorship, flowering, reproduction, and recruitment over time for Sprengel's sedge at site ID: CARESPR-2020-B and CARESPR-2021-C (Sites B and C). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites 69

Figure 3.5-2. Patterns of survivorship, flowering, and reproduction over time for dryland sedge at site IDs: CAREXER-2020-D and CAREXER-2020-E (Sites D and E). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites 71

Figure 3.5-3. Patterns of survivorship, flowering, reproduction, and recruitment over time for Davis' locoweed at site IDs: OXYTCAM3-2020-C and OXYTCAM3-2022-C (Sites C and E). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites 73

Figure 3.5-4. Patterns of survivorship, flowering, reproduction, and recruitment for slender penstemon at Sites A, B, and C. The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites 75

List of Tables

Table 1.1-1 NatureServe Global Conservation Status Ranks and Definitions 2

Table 1.1-2. NatureServe Subnational and B.C. CDC Conservation Status Ranks and Definitions 3

Table 1.1-3. Species included in the Experimental Rare Plant Translocation Program 4

Table 3.1-1. Summary of Successful 2024 Propagule Collection Efforts 15

Table 3.3-1. Summary of Individuals Translocated by Species and Site ID in 2024 17

Table 3.4-1. 2024 Translocated Rare Plant Species and Monitoring Sites 32

Table 3.4-2. Summary of Recipient Sites and Current Status 36

Table 3.4-3. Summary of Population Monitoring Results for 2024 40

Table 3.5-1. Summary statistics for Sprengel's sedge based on monitoring data collected between 2020 and 2024 69

Table 3.5-2. Summary statistics for dryland sedge based on monitoring data collected between 2020 and 2024 71

Table 3.5-3. Summary statistics for Davis' locoweed based on monitoring data collected between 2020 and 2024 73

Table 3.5-4. Summary statistics for slender penstemon based on monitoring data collected between 2020 and 2024 75

Table 3.6-1. Summary of goals achieved in 2024 76

List of Plates

Plate 2.3-1. Canada mountain-ricegrass arrived in excellent condition. Prairie buttercup exhibited signs of frost damage, which occurred during transport in the refrigerator truck. 9

Plate 3.3-1. Rootbound Sprengel's sedge 20

Plate 3.3-1. Sample of Sprengel's sedge recovering in Prince George, BC 20

Plate 3.3-3. Example of Torrey's sedge tag 012 (site ID: CARETOR-2023-C-1A; June 10, 2024) 21

Plate 3.3-4. Example of Torrey's sedge tag 081 (site ID: CARETOR-2024-D; June 14, 2024) 21

Plate 3.3-5. Prairie buttercup planting site ID: RANURHO-2023-E-1A cohort 2 (June 10, 2024) 23

Plate 3.3-6. Prairie buttercup planting site ID: RANURHO-2024-F (June 14, 2024) 23

Plate 3.3-7. Example of frost-damaged prairie buttercup tag #005 (site ID: RANURHO-2023-E-1A; June 10, 2024) 24

Plate 3.3-8. Example of frost-damaged prairie buttercup tag #088 (site ID: RANURHO-2024-F; June 14, 2024) 24

Plate 3.3-9. General site photo (site ID: PIPTCAN-2024-D) showing matrix of grass and small shrubs bordered by larger snowberry and young aspen 28

Plate 3.3-10. Example of a subplot (site ID: PIPTCAN-2024-D subplot 5) with Canada mountain-ricegrass plantings (tall, light-coloured grasses in the photo) 29

Plate 3.3-11. Example of planted Canada mountain rice-grass with ziptie ring at the base (tag 368)..... 29

Plate 3.3-12. Example of a natural population of Torrey' sedge found near Canada mountain rice-grass planting site..... 29

Plate 3.3-13. Canada mountain-ricegrass planted at site ID: PIPTCAN-2023-C-Cohort 2 (June 13, 2024). 31

Plate 3.3-14. Canada mountain-ricegrass (along edges of shrubs) planted at site ID: PIPTCAN-2024-E (June 14, 2024)..... 32

Plate 3.4-1. Sample of Canada mountain-ricegrass (tag 084) that was monitored at site ID: PIPTCAN-2020-B (August 2, 2024; photo taken by Eagle Cap) 42

Plate 3.4-2. Close up of Canada mountain-ricegrass (tag 084) seed head that was monitored at site ID: PIPTCAN-2020-B (August 2, 2024; photo taken by Eagle Cap) 42

Plate 3.4-3. Example close up of Canada mountain-ricegrass (tag 396) seed head that was monitored at site ID: PIPTCAN-2024-C-Cohort 1 (August 2, 2024; photo taken by Eagle Cap)..... 43

Plate 3.4-4. Disturbance observed at site ID: PIPTCAN-2024-C-Cohort 2 (August 2, 2024; photo taken by Eagle Cap)..... 43

Plate 3.4-5. Sample of Canada mountain-ricegrass observed at site ID: PIPTCAN-2024-D (September 6, 2024) 43

Plate 3.4-6. Sample of Davis' locoweed parent plant (tag 062) and recruit (at the end of pencil tip) observed at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024) 45

Plate 3.4-7. Example of large Davis' locoweed recruit (foreground) located 60 cm from parent plant (background; tag 063) site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)..... 45

Plate 3.4-8. Example of cow dung smothering several plants at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)..... 45

Plate 3.4-9. Alfalfa growing with Davis' locoweed at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024) 45

Plate 3.4-10. Example of Davis' locoweed planting within the understory edge subplot BB – site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024) 46

Plate 3.4-11. Example of Davis' locoweed recruit within subplot FF - site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)..... 46

Plate 3.4-12. Sandy and gravelly plot NN site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)..... 47

Plate 3.4-13. Example of Davis' locoweed seeds and pods where jumping spiders were observed site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024) 47

Plate 3.4-14. One of a few jumping spiders found inside Davis' locoweed seed pod site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024) 47

Plate 3.4-15. Example of size 50P Davis' locoweed growing in subplot 22 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024) 48

Plate 3.4-16. Example of Davis' locoweed with seedheads in subplot 19 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024) 48

Plate 3.4-17. Example of Davis' locoweed and recruit (near top of measuring tape) growing in subplot 16 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024) 49

Plate 3.4-18. Example of Davis' locoweed with insect damage on seedpod (tag 125, subplot 15); site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024) 49

Plate 3.4-19. Davis' locoweed subplot XX; site ID: OXYTCAM3-2020-C-Cohort 4 (August 30, 2024) 49

Plate 3.4-20. Example of Davis' locoweed with seedpod and in poor condition (tag 159, subplot AAA); site ID: OXYTCAM3-2020-C-Cohort 4 (August 30, 2024) 49

Plate 3.4-21. Example of Davis' locoweed planting area with an abundant moss and lichen ground cover; site ID: OXYTCAM3-2022-E (August 31, 2024) 50

Plate 3.4-22. Example of natural population of Davis' locoweed near site ID: OXYTCAM3-2022-E (August 31, 2024) 50

Plate 3.4-23. Example of dryland sedge (tag 060) monitored at site ID: CAREXER-2020-D – August 2, 2024 51

Plate 3.4-24. Example of dryland sedge monitored (tag 009) with no seed heads at site ID: CAREXER-2020-E – August 3, 2024 51

Plate 3.4-25. Example of prairie buttercup seedhead (site ID: RANURHO-2021-A; tag 049) observed during monitoring June 13, 2024 52

Plate 3.4-26. Example of prairie buttercup recruit near tag 059 (site ID: RANURHO-2021-A) observed during monitoring June 13, 2024 52

Plate 3.4-27. Example of crushed wire cage that was later replaced June 10, 2024 52

Plate 3.4-28. Example of a new rose collar barrier installed on June 10, 2024 52

Plate 3.4-29. Sample of prairie buttercup (tag 394) on June 10, 2024 (site ID: RANURHO-2021-B) 53

Plate 3.4-30. Seeds observed at the base of parent plant 393 observed on June 10, 2024, (site ID: RANURHO-2021-B) 53

Plate 3.4-31. Flowering recruit from parent plant tag 393 observed on June 10, 2024 (site ID: RANURHO-2021-B; tag 001). 53

Plate 3.4-32. Sample of surviving prairie buttercup with seed heads (tag 401) on June 13, 2024 (site ID: RANURHO-2023-D-1A) 54

Plate 3.4-33. Sample of surviving prairie buttercup with insect damage on leaves (tag 416) on June 13, 2024 (site ID: RANURHO-2023-D-2A) 54

Plate 3.4-34. Grasshopper nymph observed on the inside of a rose collar on June 13, 2024 (site ID: RANURHO-2023-D-2A) 55

Plate 3.4-35. Example of individual (tag 445) with high seedhead production on June 12, 2024 (site ID: RANURHO-2023-E-2A) 56

Plate 3.4-36. Seeds observed to be sticking to the edges of the rose collar and presence of aphids (small dark spots in the photo; site ID: RANURHO-2023-E-2A; tag 447) 56

Plate 3.4-37. Example of browning seeds on July 6, 2024, (site ID: RANURHO-2023-E-1A; tag 431) 56

Plate 3.4-38. Example of recruit with seedhead on June 10, 2024, (site ID: RANURHO-2023-E-1A; tag 435) 56

Plate 3.4-39. Example of recovering prairie buttercup tag #005 observed during interim monitoring (site ID: RANURHO-2023-E-1A; July 6, 2024) 57

Plate 3.4-40. Example of recovering prairie buttercup tag #088 observed during interim monitoring (site ID: RANURHO-2024-F; July 6, 2024) 57

Plate 3.4-41. Beaver activity and loss of shrub cover at site ID: RANURHO-2022-C (June 11, 2024) 58

Plate 3.4-42. Developing seedheads on a monitored adult prairie buttercup at site ID: RANURHO-2022-C (June 11, 2024) 58

Plate 3.4-43. Sample of slender penstemon with inflorescences and developing seed pods at site ID: PENSGRA-2020-A (August 3, 2024) 59

Plate 3.4-44. Sample of slender penstemon developing seed heads at site ID: PENSGRA-2020-B (August 2, 2024) 59

Plate 3.4-45. Example of an adult slender penstemon (tag 056) with flower heads developing (June 9, 2024; site ID: PENSGRA-2021-C-Cohort 2) 60

Plate 3.4-46. Example of an adult slender penstemon (tag 056) with flower heads developing into seedheads (July 6, 2024; site ID: PENSGRA-2021-C-Cohort 2) 60

Plate 3.4-47. Example of an adult slender penstemon (tag 056) with seedheads (August 28, 2024; site ID: PENSGRA-2021-C-Cohort 2) 60

Plate 3.4-48. Example of rock selaginella tag 096 with dormant foliage on June 9, 2024 (site ID: SELARUP-2021-A-Cohort 2) 61

Plate 3.4-49. Example of rock selaginella tag 065 with dormant foliage on June 9, 2024 (site ID: SELARUP-2021-A-Cohort 2) 61

Plate 3.4-50. Example of rock selaginella tag 096 with greening leaves and developing spike-like reproductive structures on July 6, 2024 (site ID: SELRAUP-2021-A-Cohort 2) 62

Plate 3.4-51. Example of rock selaginella tag 096 with greening leaves and developing spike-like reproductive structures on July 6, 2024 (site ID: SELRAUP-2021-A-Cohort 2) 62

Plate 3.4-52. Example of adult Torrey's sedge (size 1G; tag 086) at site CARETOR-2021-A on June 13, 2024 63

Plate 3.4-53. Example of adult Torrey's sedge (size 50P; tag 088) at site CARETOR-2021-A on June 13, 2024 63

Plate 3.4-54. Example of adult Torrey's sedge at site ID: CARETOR-2023-C-1A on July 6, 2024 64

Plate 3.4-55. Torrey's sedge mortality (tag 404) at site ID: CARETOR-2023-B-1A on June 14, 2024 64

Plate 3.4-56. Example of Torrey's sedge recruit at site ID: CARETOR-2023-C-2A on July 6, 2024 64

Plate 3.4-57. Example of Sprengel's sedge inflorescence showing early stigma on female reproductive structures at site CARESPR-2020-B-1B on June 10, 2024 65

Plate 3.4-58. Example of adult Sprengel's sedge (tag 001) at site ID: CARESPR-2020-B-1A on June 10, 2024 66

Plate 3.4-59. Example of adult Sprengel's sedge (tag 003) at site ID: CARESPR-2020-B-1B on June 10, 2023) 66

Plate 3.4-60. Fallen willow at site ID: CARESPR-2020-B-1B on July 5, 2024 66

Plate 3.4-61. Example of adult Sprengel's sedge with inflorescences (tag 426) at site ID: CARESPR-2021-C (cohort 2) on June 10, 2024 67

Plate 3.4-62. Example of adult Sprengel's sedge with inflorescences at site ID: CARESPR-2023-D-1A on June 13, 2024 67

Plate 3.4-63. Example of adult Sprengel's sedge at site ID: CARESPR-2023-E on September 6, 2023 67

Plate 3.4-64. Example of adult Sprengel's sedge at site ID: CARESPR-2021-C (cohort 2) on September 6, 2023 67

List of Appendices

Appendix A. Potential Recipient Site Selection Methods & Results Memo

Appendix B. Data Form – Translocation and Monitoring

Appendix C. Site C *Drymocallis arguta* Status Memo

ACRONYMS & ABBREVIATIONS

Term	Definition
1G	1-gallon Pot
50P	50 mm Plug
75P	75 mm Plug
B.C. CDC	B.C. Conservation Data Centre
EIL	Erosion Impact Line
ERPT	Experimental Rare Plant Translocation
ENSCONET	European Native Seed Conservation Network
PAZ	Potential Activity Zone
PRS	Potential Recipient Site
QA/QC	Quality Assurance and Quality Control
spp.	The abbreviation "spp." (plural) indicates "several species".
sp.	The abbreviation "sp." refers to a single species.

1. INTRODUCTION

As part of the federal and provincial regulatory approvals of the Site C project, BC Hydro committed to the creation of an Experimental Rare Plant Translocation (ERPT) program to support the viability of target rare plant species affected by the project.

The ERPT program is designed to establish new populations of target rare plant species in areas that are secure, contain analogous habitat to the source populations, and are within the Peace Region. This program uses an experimental approach to identify critical factors affecting germination, establishment, growth, and survival of the target species. The results of which inform the scope of the design such that informed variations on salvage, propagation, and transplant methods can be employed. The ERPT program is updated on an ongoing basis to incorporate relevant information related to target rare plant species and translocation methods as it emerges.

The program is founded on collaborative working relationships with First Nation-owned, local businesses, and other consultants, and benefits from the shared knowledge and experience. The knowledge acquired and lessons learned can be employed to maximize the success of the program and can be shared among these partners to increase the overall understanding of these systems within the community of contributors.

This report summarizes the measures and activities undertaken in 2024 for the ERPT program. Included is a summary of the plant species of conservation concern included in the program and the general methods and activities completed for the four phases of the program: Phase 1 - propagule collection; Phase 2 - *ex-situ* propagation; Phase 3 - translocation implementation; and Phase 4 - post-translocation care, maintenance, and monitoring. Information gained from the 2024 program will inform improvements to project methods and management in 2025.

1.1 PLANT SPECIES INCLUDED IN THE PROGRAM AND THEIR CONSERVATION RANKS

An informed understanding of a species' conservation status requires consideration at global, national, and local scales. The conservation status for each target species was determined using standardized methodologies for species assessments from government agencies at these multiple relevant conservation scales. The conservation status for each target rare plant species was derived from the listing under the *Species at Risk Act*, the NatureServe Global Conservation Status (e.g., G1, G1G2), the NatureServe Subnational Rank (e.g., S1, S2), and the British Columbia Conservation Data Centre (B.C. CDC) Rank (i.e., Red-listed, Blue-listed or Yellow-listed).

1.1.1 Listing under the Species at Risk Act

Under Canada's federally regulated *Species at Risk Act* (SARA), protected species at risk are listed under Schedule 1 as special concern, threatened, endangered, extirpated, or extinct.

1.1.2 NatureServe Conservation Priority Global Rank

NatureServe establishes ranks that characterize the relative rarity and threats of a native species within the specified geographic boundaries (i.e., G - range-wide [= global;]; Table 1.1-1) or S - within-province or state [= subnational]; Table 1.1-2).

Table 1.1-1 NatureServe Global Conservation Status Ranks and Definitions

NatureServe Subnational Rank 1	Definition
G1 (Critically Imperiled)	Critically imperiled globally because of extreme rarity (often five or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation.
G1 (Critically Imperiled) to G2 (Imperiled)	A Range Rank (i.e., G1G2) is used when existing information on an element straddles the criteria defining two separate ranks. See associated rank definitions.
G1 (Critically Imperiled) to G3 (Vulnerable)	A Range Rank (i.e., G1G3) is used when existing information on an element straddles the criteria defining two separate ranks. See associated rank definitions.
G2 (Imperiled)	Imperiled globally because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation globally.
G2 (Imperiled) to G3 (Vulnerable)	A Range Rank (i.e., G2G3) is used when existing information on an element straddles the criteria defining two separate ranks. See associated rank definitions.
G3 (Vulnerable)	Vulnerable globally due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
G3 (Vulnerable) to G4 (Apparently Secure)	See associated rank definitions.
G4 (Apparently Secure)	Uncommon but not rare; some cause for long-term concern due to declines or other factors
G4 (Apparently Secure) to G5 (Secure)	See associated rank definitions.
G5 (Secure)	Common, widespread, and abundant globally.
GNA (Not Applicable)	A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

[1]*The NatureServe ranks and definitions at the national (N ranks) and global level (G ranks) are available on the NatureServe website.*

1.1.3 B.C. Conservation Data Centre Priority Rank

The B.C. CDC establishes a conservation priority rank for species within the province based on rarity, intrinsic vulnerability, environmental specificity, threats, and long- and short-term trends in population size. Species that the B.C CDC defines as at-risk are categorized as either Red-listed or Blue-listed depending on their rank status, location, and level of protection (Table 1.1-2).

Table 1.1-2. NatureServe Subnational and B.C. CDC Conservation Status Ranks and Definitions

NatureServe Subnational Rank[1]	Definition	B.C. CDC Rank
S1 (Critically Imperiled)	Critically imperiled in the province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the province.	Red-listed (any species that is a candidate for extirpated, endangered, or threatened status in BC.)
S1 (Critically Imperiled) to S2 (Imperiled)	A Range Rank (i.e., S1S2) is used when existing information on an element straddles the criteria defining two separate ranks. See associated rank definitions.	
S1 (Critically Imperiled) to S3 (Vulnerable)	See associated rank definitions.	
S2 (Imperiled)	Imperiled in the nation or province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or province.	
S2 (Imperiled) to S3 (Vulnerable)	See associated rank definitions.	Blue-listed (any species or ecosystem that is of special concern)
S3 (Vulnerable)	Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.	
S3 (Vulnerable) to S4 (Apparently Secure)	See associated rank definitions.	
S4 (Apparently Secure)	Uncommon but not rare; some cause for long-term concern due to declines or other factors.	Yellow-listed (any species or ecosystem that is at the least risk of being lost)
S4 (Apparently Secure) to S5 (Secure)	See associated rank definitions.	

NatureServe Subnational Rank[1]	Definition	B.C. CDC Rank
S5 (Secure)	Common, widespread, and abundant in the nation or state/province.	
SNA (Not Applicable)	A conservation status rank is not applicable because the species is not a suitable target for conservation activities.	n/a

[1]A Range Rank (i.e., S2S3) is used when existing information on an element straddles the criteria defining two separate ranks.

1.1.4 Plant Species included in the ERPT Program

The B.C. CDC annually assesses the provincial conservation ranks of vascular plants and bryophytes in the province. This annual assessment incorporates new information about the abundance and distribution of the province's flora, as well as newly recognized threats (or lack thereof) to known populations. The ranking update published by the B.C. CDC in 2024 (B.C. CDC 2024a) changed the conservation status rank of one taxon in the province relative to their status in 2023. No changes were made to the ranks of any of the species within the ERPT program (Table 1.1-3). Three species in the program are currently under investigation due to different uncertainties. The distribution of tall wood beauty (*Drymocallis arguta)* requires further assessment, while the identification of rock selaginella (*Selaginella rupestris*) and the verification of rocky mountain willowherb (*Epilobium saximontanum*) specimens are still being confirmed. A memo on the current status of tall wood beauty for the Site C project is presented in Appendix C. The program will be updated as new information becomes available.

Table 1.1-3. Species included in the Experimental Rare Plant Translocation Program

Scientific Name	Common Name	B.C. CDC Provincial Rank	NatureServe Provincial Status	NatureServe Global Status
Canada mountain-ricegrass	*Piptatheropsis canadensis*	Red	S1 (2019)	G4G5 (2016)
Davis' locoweed	*Oxytropis campestris* var. *davisii*	Yellow	S3S4 (2022)	G5T3 (2015)
Dryland sedge	*Carex xerantica*	Blue	S3 (2019)	G5 (2016)
Prairie buttercup	*Ranunculus rhomboideus*	Blue	S2S3 (2019)	G5 (2016)
Rocky Mountain willowherb	*Epilobium saximontanum*	Blue	S3 (2019)	G5 (1984)
Rock selaginella	*Selaginella rupestris*	Red	S2 (2019)	G5 (2016)
Slender penstemon	*Penstemon gracilis*	Blue	S3 (2019	G5 (2016)
Sprengel's sedge	*Carex sprengelii*	Blue	S3 (2019)	G5 (2016)
Torrey's sedge	*Carex torreyi*	Blue	S3? (2019)	G4G5 (2016)
Tall wood beauty	*Drymocallis arguta*	Blue	S3	G5 (2015)

2. GENERAL METHODS

2.1 PHASE 1. PROPAGULE COLLECTION

The standards for collecting and storing propagules for *ex-situ* conservation (e.g., timing, sampling, labelling, cleaning, processing, stratification, sowing, provenance) incorporate guidance outlined in Maslovat (2009) and by the European Native Seed Conservation Network (ENSCONET 2009).

2.1.1 *In-situ* Seed Collection

Field botanists collected seeds from naturally occurring populations within the Peace Region and from individuals translocated in 2023. Propagule collection occurred throughout the growing season and took into consideration local plant phenology. Field teams collected a sufficient amount of healthy seeds for propagation without taking more than the 20% of the mature seeds available.

2.1.2 *Ex-situ* Seed Collection

Nursery staff collected seeds from the nursery stock derived from previous year's seed collection efforts. Nursery staff sorted the seeds to remove non-viable seeds (i.e., empty, or poorly developed), and the remaining seeds were cleaned and dried (where necessary) to maximize viability. Cleaning included the removal of waste material from around the seed capsule, and the use of sieves, hand separation, and air separation. Seeds were then placed in cold storage at the nursery to maintain seed quality and longevity. The provenance, seed collection procedures, and quantity collected were recorded.

2.2 PHASE 2. *EX-SITU* PROPAGATION

Ex-situ propagation did not occur in 2024, however, in past years, *ex-situ* propagation involved stratification and propagation for each individual target species in a nursery environment in 2018 to 2021. Curation protocols and recommendations (ENSCONET 2009) and professional horticultural experience were used to inform the methods for this aspect of the program (see description below).

Through the pre-treatment process, seeds have been treated to simulate the natural conditions for breaking seed dormancy and initiating germination. Seeds were scarified and/or stratified as relevant for species-specific germination requirements. Scarification treatments included a short hot-water bath or sandpaper application, while stratification included immersing the seeds into cold temperatures with moisture to simulate natural germination conditions. Seeds that were not intended for planting in the subsequent year were not treated and are being stored as insurance for potential future use.

Propagation methods were developed based on the ecological conditions observed at the source populations, and included several measures and considerations (Vallee et al. 2004; Maslovat 2009) such as:

- examination of the ecological and, if available, translocation literature to determine experimental trials, including optimum founder size (i.e., number of individuals and composition of life stages), reproductive status relevant to propagation for each rare plant species, and outplanting requirements;
- review of common garden experiments as a potential source of horticultural information for a specific target species;
- exploration and implementation of a range of techniques (e.g., varying soil substrate) to determine the most effective propagation options for each target species;
- multiple germination trials to determine viability; and
- holding back source propagules in an *ex-situ* collection as material for future propagation.

All utilized *ex-situ* propagation methods have been documented, including the following:

- provenance (i.e., origin of material collected);
- type of material collected (e.g., seed, live plant);
- location and date of collection; and
- growing conditions such as potting media, temperature of propagation area, watering, and treatment of seeds.

2.3 PHASE 3. TRANSLOCATION

Translocation implementation included four components: (i) recipient site selection; (ii) transport and plant preparation; (iii) selection of planting locations within the habitat matrix; and (iv) translocation at recipient sites.

2.3.1 Recipient Site Selection

Selection of suitable recipient sites, based on the species-specific preferred habitat characteristics, was informed by the extensive existing information collected for Site C along with the expert knowledge of qualified botanists and ecologists who performed the field verification work (see Appendix A provided by Eagle Cap). Selected sites contained habitat analogous to the source populations and were situated in areas that are unlikely to be developed in the foreseeable future. All sites selected are located within the Peace Region.

In 2024, qualified botanists from Eagle Cap undertook the process of identifying additional suitable recipient sites for Canada mountain-ricegrass as the existing sites were not large enough to accommodate all of the plants. Additionally, plantings were distributed across multiple locations to avoid oversaturating any single site and to enhance the likelihood of establishment success and security. The following text summarizes the recipient site selection process (refer to Appendix A for further details).

Before verifying and selecting recipient sites in the field, a desktop review was conducted to identify potential locations. The desktop review included literature reviews for each priority species to evaluate current and relevant species information such as habitat and translocation requirements, with a particular focus on reviewing new information that had been published since 2023. The updated B.C. CDC database was reviewed to ensure that all existing occurrences known were incorporated into the analysis, and queries were run on the project's rare plant database to extract any habitat information that had been recorded during earlier years of the ERPT program.

Aerial imagery and GIS attributes were visually evaluated to identify locations with potentially suitable ecological and logistical characteristics that would maximize opportunities for successful translocation. GIS layers that were assessed for these analyses included: (i) aerial imagery of the Peace River region; (ii) property ownership (provided by BC Hydro); (iii) known element occurrences of the target species; (iv) potential recipient sites identified during earlier years of the project; (v) the Site C Project Activity Zone (PAZ); and (vi) the Site C preliminary Erosion Impact Line (EIL). This analysis resulted in the following criteria that were identified as indicative of suitable Potential Recipient Sites (PRS):

1. accessible via road or boat during the entire growing season;
2. outside of the Site C PAZ;
3. not located below the reservoir preliminary EIL (i.e., a precautionary estimate of the amount of erosion that could occur over a 100-year period);
4. located on Crown land or BC Hydro land near the Peace River;
5. within range of cell service;
6. not requiring access through a locked gate or other landowner permission;
7. contained appropriate habitat for the priority species;
8. contained low densities of non-native plants;
9. contained low levels of existing and reasonably foreseeable future anthropogenic disturbance;
10. greater than one kilometre from known sites of the same taxon;
11. not already occupied by rare plant species; and
12. located close to a water source.

This list of desirable PRS qualities describes a hypothetical ideal site such that not all criteria were likely to be satisfied. For example, field botanists attempted to avoid occupied sites when reviewing potential planting locations; however, this was only partially successful because suitable planting sites were often found to host target rare plant species. As a result, no site is likely to fulfill all the listed criteria, and trade-offs will always be necessary to ensure that the project can proceed.

Recipient sites were selected primarily based on known species-specific habitat characteristics, and in part based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a site was found to contain suitable habitat for several ERPT target species in

proximity, and so separate assessments of the microsite features were completed for each target species. Several of the target species occur together in wild populations, and thus their co-occurrence is consistent with natural conditions.

The desktop exercise generated eight potential planting areas with unique PRS points (suitable microsites) pre-identified to create more efficiency during field verification. All potential planting areas had received partial or full field checks (between June 8 and 10, and on August 3, 2024) and have also received field checks in past years (Appendix A, Table 1). As a result of the field checks, five planting areas were set aside for consideration. The two "best choice" planting areas were investigated further, and one planting area was removed from consideration due to the presence of a Red-listed species, Seneca snakeroot (*Polygala senega*). In addition to the occurrence of Seneca snakeroot, five new patches of tall wood beauty and one new patch of dryland sedge was discovered.

At the two "best choice" planting areas, multi-species PRS plots have been completed; therefore, no additional plots were completed. However, suitable supplemental planting locations for Canada mountain-ricegrass were marked to provide options for future planting.

The two planting areas met the majority of the criteria for suitable PRS sites with the exception of the following:

- greater than one kilometre from known sites of the same taxon;
- not already occupied by rare plant species; and
- located close to a water source (one of the two planting areas was able to meet this criteria).

2.3.2 Transport and Plant Preparation

Adult plants (i.e., medium to large plants in 1-gallon pots) were shipped from NATS nursery on June 5, 2024, and arrived at Dunvegan Gardens (Dunvegan) in Fort St. John on June 7, 2024. The plants were housed at the garden centre and were stored and watered until they were picked up by the planting crew on June 10, 2024. The plants were stored and watered at the crew's accommodation throughout the week until transplanted at recipient sites. Most plants species arrived in good condition. However, the prairie buttercup exhibited signs of frost damage, which occurred during transport in the refrigerator truck (Plate 2.3-1).

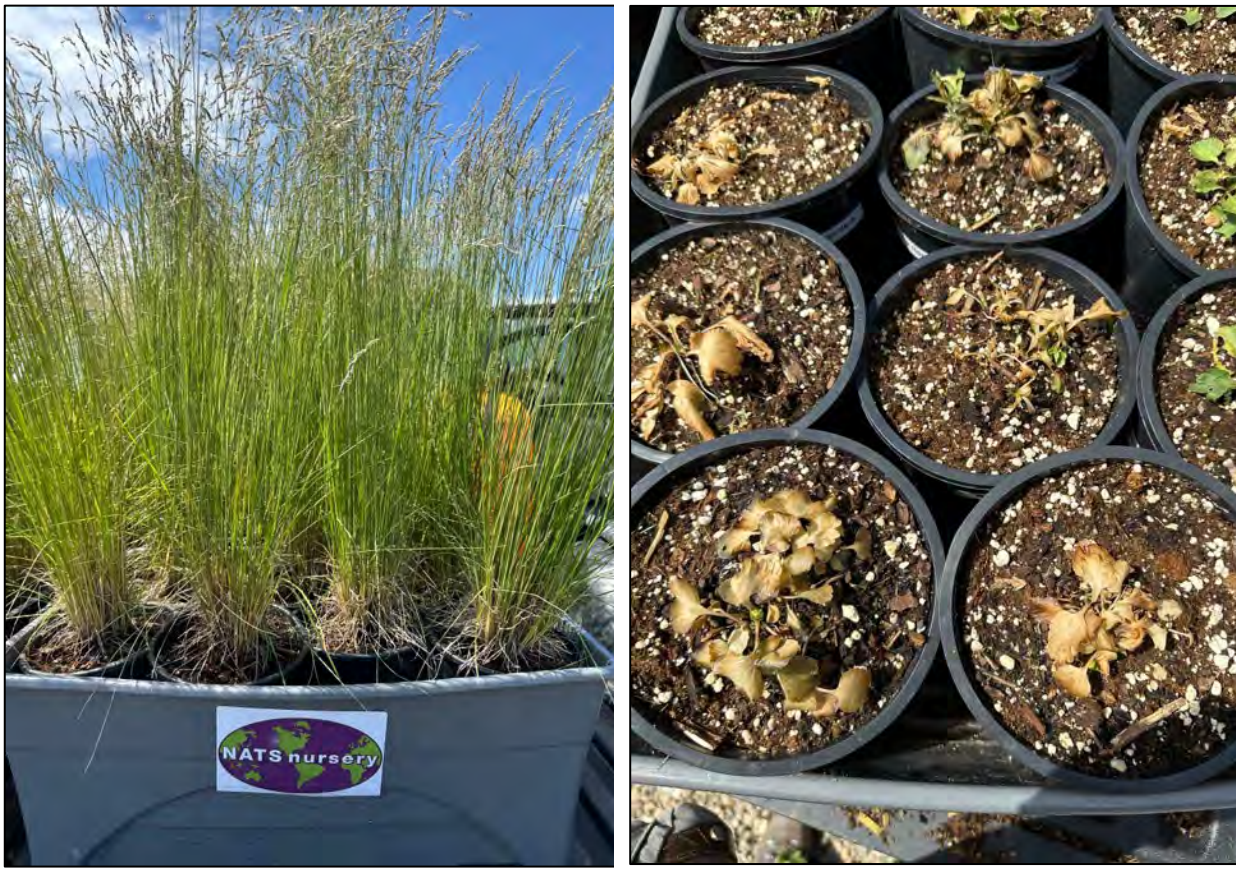


Plate 2.3-1. Canada mountain-ricegrass arrived in excellent condition. Prairie buttercup exhibited signs of frost damage, which occurred during transport in the refrigerator truck.

2.3.3 Selection of Planting Locations within the Habitat Matrix

Planting locations within the larger habitat matrix at a recipient site were identified as those that were relatively easy to access, corresponded with known ecological conditions that support the species, supported plant diversity that is similar to the source populations, were on stable substrates that are not expected to undergo erosion or deposition, had low abundance of invasive plants, and were not accessible to cattle or used intensely by native herbivores. There was limited variability in the planting patterns within species, thereby minimizing constraints on comparability across sites within species. Within species, the planting plans sought to:

- establish plant groupings such that there were similar conditions in terms of microsite conditions (e.g., soils, slope, aspect);
- create plant groupings to encourage pollinator visitation; and
- space individuals to minimize potential trampling during planting and monitoring and to minimize interspecific competition for resources (e.g., minimize density-dependent effects on survival).

2.3.4 Translocation at Recipient Sites

The specific timing windows for planting were determined based on past years' experience regarding the average first and last frost-free days for Fort St. John, as well as plant phenology, the development stage of the propagated plants, the local weather, and soil moisture conditions.

Translocation in 2024 occurred from June 10 to 14. Translocation implementation focused on planting trials at recipient sites that have greater long-term security than the locations of the source material. The recipient sites are within the known distribution range for the target plant within the Peace Region and have similar habitat to the location of the source material. Translocation efforts have also focused on out-planting larger individuals because adult translocated plants have shown higher survival than translocated seedlings (Dalrymple 2012; Bush 2022). Implementation of the translocation planting included the following:

- placement of plants into optimal microhabitats at the recipient sites, and in a spatial pattern suitable to the rare plant's biology as observed at the source populations or otherwise known;
- installation of durable, long-lasting tags to label individual plants and flagging tape to label plant groupings;
- installation of rose collars on select species to deter herbivory, and installation of zip tie rings to improve detection of plants for monitoring (where applicable);
- code systems to differentiate various experimental trials as needed to retain as much information as possible on the pathway of a given plant (e.g., from seed collection to planting) to facilitate annual assessments of success;
- marked boundaries for plants, plant groupings, and translocation site boundaries using GPS points and imported into the project GIS system;
- care and maintenance at the time of planting, such as watering and creation of microhabitat as necessary;
- documentation of each translocation effort (including time spent on each phase), which included the methods used to prepare and transport the material from the nursery to the recipient site, pre-translocation site preparation, environmental conditions, method of re-introduction, care and maintenance activities, planting density, and spatial pattern; and
- post-translocation follow-up to assess the health and status of a sample and to check for other possible problems, such as desiccation, pest insects, trampling, herbivory, or vandalism at a translocation site.

2.4 PHASE 4. MONITORING

Two levels of monitoring were conducted in 2024: interim monitoring and population[1] monitoring (previously referred to as year-end monitoring). Interim monitoring occurred at a frequency that permitted the timely identification of threats such as vandalism, desiccation, or herbivory, and allowed for subsequent mitigation measures to address these issues. Population monitoring included an assessment of:

(i) Survivorship - to determine if individuals are surviving beyond the initial transplant year;

(ii) Maturity - to determine if individuals are maturing to the flowering and fruiting stages;

(iii) Reproduction - to determine if individuals are successfully producing seeds; and

(iv) Recruitment - to determine if seeds from the population germinate successfully at the site and contributing to a second generation.

The following population traits were assessed during the monitoring program:

- plant presence (summarized as number of live/dead/absent individuals);
- vegetative growth (width or height) and/or health (qualitative assessment);
- flower production per individual;
- seed production per individual; and
- spatial extent of the population.

Interim monitoring activities also re-evaluated sites for one or more of the following to identify successes and failures to improve the survival of future plantings:

- invasive species presence, especially in close proximity to the translocated plants, and/or any species that may have inadvertently been introduced to the site during the translocation;
- herbivory or other possible problems (e.g., pest insects, trampling, ungulate grazing);
- human disturbance; and
- microsite habitat preferences.

Information gained from monitoring implementation of the various experimental translocation approaches used will help to identify which approaches are effective and to isolate inadequacies in specific methods, all within an adaptive management framework.

[1] In this report, populations are defined as the group of plants originating from the translocation efforts.

2.5 DATA ANALYSIS

The methods for preliminary data analysis were developed in 2024 and were trialed on a few sites and species to compare monitoring data between years. These methods will be applied to more sites as data continues to be collected.

The data were cleaned and organized into a single Microsoft Excel file, with the data separated into different sheets corresponding to translocation data and monitoring data by year (2020-2024). Sheets were imported into the R statistical environment (R Core Team 2023) for data management, summary, and analysis. There was variation in species' translocation and data collection histories (i.e., different sites, number of cohorts, transplant and monitoring years, etc.), which necessitated separate data management and analysis steps for each. In cases where individuals were measured twice in a single year (e.g., measured both during spring translocation and subsequent fall monitoring), the values from the latter date were retained for analysis in order to capture accurate survival data.

Generally, the same approach was taken for each species with slight variation in the data presented and years summarized. After importing each sheet into R, the data was cleaned and organized using the 'dplyr' package (Wickham et al., 2023). The different data sheets were first bound together into long format, and variables were created to facilitate the analysis:

- **Survivorship** – a binary variable (1/0), where any plant found to be 'present' in a particular year receives a '1' and any plant found to be 'absent', or 'dead' receives a '0'. Individuals found to be dead in one year were carried forward to subsequent years with a '0' for survival and 'NA' for the other variables. In some cases, individuals thought dead in one year but found to be alive in a later year were considered alive throughout.
- **Maturity** – a binary variable (1/0), where any plant that is both alive and indicating reproductive maturity (i.e., having flowering or fruiting stems present, regardless of reproductive output) receives a '1', and if not, a '0'. Individuals with a '0' for the 'survival' variable received 'NA' for the "Flowering" variable.
- **Reproduction** – A numeric (count) variable, indicating the number of flowering *or* fruiting stems recorded for each living plant. Any plant with a '0' for the 'Flowering' variable received an 'NA' for the 'Reproduction' variable.
- **Recruitment** – The number of seedlings detected adjacent to each individual being monitored in each year.

Next, the data for each species was summarized by year, site ID, and cohort[2]. Four summarized values were created for each species:

[2] Cohorts represent the chronological timing of distinct planting events at the same site ID. For example, plants that have been translocated at a new site would be considered cohort 1. Additional plantings at the same site in the next year, would be considered cohort 2.

- **Average survivorship** – the mean of the 'survivorship' variable, representing in the proportion of individuals surviving since initial planting.
- **Average flowering** – the mean of the 'flowering' variable, representing the proportion of surviving individuals that were reproductively mature.
- **Average reproduction** – the mean of the number of flowering stems, representing the average reproductive output of surviving and reproductively mature individuals.
- **Sum of recruits** – The total number (sum) of recruits found at the cohort level.

With these data summarized into a new dataframe for each species, the summarized values of each trait were plotted over time using the 'ggplot2' package (Wickham 2016) and combined into a single figure using 'ggpubr' (Kassambara 2023). Each summarized trait was plotted on the y-axis with year (2020-2024) on the x-axis, with separate-colored lines for each cohort and faceting by site. The lines connecting points within cohorts are included to aid in visualization and interpretation, and do not represent statistical trend lines between years. This graphing approach was found to be the best way to visualize the data given the variation in transplant year across sites and cohorts.

2.6 Quality Assurance and Control

Quality assurance and quality control (QA/QC) measures were used for collecting data within the field program so that methods were consistently replicated across all trials and years, and so that pertinent variables or any variations in methodology were recorded. The data form was designed to accommodate data collection at the transect, plot, or individual plant level across years (Appendix B). The data form included the following fields:

1. site details (i.e., Site ID, geographical location, slope, aspect, and elevation);
2. species information (i.e., species name, nursery of origin, seed lot, key metrics for survivorship, maturity, and reproduction);
3. potential threats (i.e., herbivory, drought, others); and
4. map outlining the relative location of each individual plant and plant grouping.

Photos were taken using the Solocator App (Civi Corp Pty Limited 2024), which were date- and time-stamped and included the UTM location of the site.

3. RESULTS

3.1 PHASE 1. PROPAGULE COLLECTION

The *in-situ* collection efforts focused on acquiring propagules for Torrey's sedge and tall wood beauty (B.C. CDC 2024b) for future propagation and translocation as required.

In-situ propagule collection efforts by Eagle Cap were successful for two target species, Torrey's sedge and tall wood beauty. Torrey's sedge seeds were not collected in 2023 as seed production was low. In 2024, however, 42 seeds from Torrey's sedge were collected from three plants that were translocated to the Beatton Valley Trails site in 2023. At the time of collection, most of the seeds had already fallen. Approximately 40,000 seeds from tall wood beauty were collected from two locations (Figure 3.1-1). In early August, approximately 20,000 seeds were collected from 170 plants at Area E, and approximately 40,000 seeds were collected from ten different stalks, from presumably the same plant, at the Cache Creek Hill site.

Ex-situ propagule collection efforts focused primarily on Canada rice-grass. Seeds were also opportunistically collected from slender penstemon and Davis' locoweed to augment the existing seedbank housed at NATS nursery (Table 3.1-1).

Table 3.1-1. Summary of Successful 2024 Propagule Collection Efforts

Common Name	Species Name	Propagule Amount and Type	Collection Timing	Collection Type	Collection Location
Tall wood beauty	*Drymocallis arguta*	~20,000 + seeds	August 2, 2024	*in-situ*	Area E
		~40,000 + seeds	August 3, 2024	*in-situ*	Cache Creek Hill
Torrey's sedge	*Carex torreyi*	42 seeds	August 2, 2024	*in-situ*	Beatton Valley Trails
Slender penstemon	*Penstemon gracilis*	~971,040 seeds (51 g)	August 17, 2024	*ex-situ*	NATS nursery potted plants
Canada mountain-ricegrass	*Piptatheropsis canadensis*	~57,680 seeds (56 g)	July 15, 2024	*ex-situ*	NATS nursery potted plants
Davis' locoweed	*Oxytropis campestris var. davisii*	~11,900 seeds (17 g)	August 17, 2024	*ex-situ*	NATS nursery potted plants

*Quantity provided from the nursery is an estimate based on seed weight.

Site C Project

Experimental Rare Plant Translocation
Propagule Collection Locations
Figure 3.1-1

Date: 2024-12-12
Map Number: BCH-069
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

EcoLogic consultants

2017-2023	2024	Target Species
●		Sprengel's sedge (*Carex sprengelli*)
●	■	Torrey's sedge (*Carex torreyi*)
●		Dryland sedge (*Carex xerantica*)
●		Davis' locoweed (*Oxytropis campestris var. davisii*)
●		Slender penstemon (*Penstemon gracilis*)
●		Canada mountain-ricegrass (*Piptatheropsis canadensis*)
●		Prairie buttercup (*Ranunculus rhomboideus*)
●		Rock selaginella (*Selaginella rupestris*)
●	■	Tall wood beauty (*Drymocallis arguta*)

3.2 PHASE 2. *EX-SITU* PROPAGATION

In 2024, no seeds were propagated and nursery staff focused on producing larger individuals of Canada mountain-ricegrass, Torrey's sedge, and rock selaginella. On April 24, 2024, three 1-gallon pots of Torrey's sedge were produced from an open flat that was sown with Torrey's sedge in July of 2023. Nursery staff continue to refine stratification methods for Torrey's sedge, which has had relatively low germination rates in all previous trials since 2020.

On April 17, 2024, thirty-nine 1-gallon pots of Canada mountain-ricegrass were produced from plugs (size 50P). Nursery staff continue to grow the five trays of rock selaginella that were produced on August 15, 2023. Slow growth of this species has been documented by the growers.

3.3 PHASE 3. TRANSLOCATION IMPLEMENTATION

Seventy-six individuals in 1-gallon pots were planted at two locations (Beatton Valley Trails and near Clayhurst) between June 10 - 14, 2024 (Figure Figure 3.3-1 and Figure 3.3-2; Table 3.3-1). The site near Clayhurst, BC, is a new recipient site to the program. To date, more than 2,000 plants from a diversity of eight different rare plant species have been translocated for this project.

Table 3.3-1. Summary of Individuals Translocated by Species and Site ID in 2024

Species	Site ID	Translocation Date	No. of Adults (1G Pots)
Prairie buttercup	RANURHO-2023-E-1A-Cohort 2	10-Jun	**8**
	RANURHO-2024-F	14-Jun	**7**
Total			**15**
Torrey's sedge	CARETOR-2023-C-1A-Cohort 2	10-Jun	**2**
	CARETOR-2024-D	14-Jun	**4**
Total			**6**
Canada mountain-ricegrass	PIPTCAN-2024-D	11-Jun	**45**
	PIPTCAN-2023-C-Cohort 2	13-Jun	**5**
	PIPTCAN-2024-E	14-Jun	**5**
Total			**55**
Grand Total			**76**

570000 580000 590000 600000 610000 620000 630000 640000

6240000 6230000 6220000 6210000

RANURHO-2022-C

CARETOR-2021-A
CAREXER-2019-C
SELARUP-2021-B

CARESPR-2020-1A & 1B
CARESPR-2021-C
CAREXER-2020-D
PENSGRA-2020-B
RANURHO-2021-A
RANURHO-2021-B
PIPTCAN-2020-B

CARESPR-2023-E

CARETOR-2023-C
CARETOR-2024-D
RANURHO-2023-E
RANURHO-2024-F
PIPTCAN-2023-C

PIPTCAN-2020-A

PENSGRA-2020-A
CAREXER-2020-E

CAREXER-2018-A
CAREXER-2018-B

SELARUP-2021-A
PENSGRA-2021-C

North Cache Creek
Cache Creek
Halfway River
Peace River
Alder Creek
Wapoose Creek
Farrell Creek
Dry Creek
Brenot Creek
Lynx Creek
Portage Creek
Maurice Creek
Bullrun Creek
Moberly River
Windy Creek
Wilder Creek
Tea Creek
Charlie Lake
Montney Creek
Beatton River
Fish Creek
Pine River
Septimus Creek
Pingel Creek

Fort St. John
Hudson's Hope

29
97

N

Earthstar Geographics

Site C Project

Experimental Rare Plant Translocation
Recipient Site Locations
Figure 3.3-1

Date: 2024-12-13
Map Number: BCH-067a
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

EcoLogic consultants

Legend

- 2024 Recipient Sites[1]
- 2018-2023 Recipient Sites[1]
- Highway
- Streams

0 2 4 6 km
1:200,000

[1]Site names correspond to the following species:

CAREXER - Dryland sedge (*Carex xerantica*)
CARETOR - Torrey's sedge (*Carex torreyi*)
CARESPR - Sprengel's sedge (*Carex sprengeliii*)
PENSGRA - Slender penstemon (*Penstemon gracilis*)
RANURHO - Prairie buttercup (*Ranunculus rhomboideus*)
SELARUP - Rock selaginella (*Selaginella rupestris*)
PIPTCAN - Canada mountain rice-grass (*Piptatheropsis canadensis*)

Sources: Esri, USGS, NOAA

CARESPR-2023-E

CARETOR-2023-C
CARETOR-2024-D
RANURHO-2023-E
RANURHO-2024-F
PIPTCAN-2023-C

OXYTCAM3-2018-A

CARESPR-2023-D
CARETOR-2023-B
RANURHO-2023-D

OXYTCAM3-2022-E

OXYTCAM3-2019-As
OXYTCAM3-2020-C

OXYTCAM3-2020-B

OXYTCAM3-2022-D

PIPTCAN-2024-D

Taylor

BRITISH COLUMBIA

ALBERTA

Site C Project

Experimental Rare Plant Translocation Recipient Site Locations

Figure 3.3-2

Date: 2024-12-13

Map Number: BCH-067b

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

EcoLogic consultants

Legend

- 2024 Recipient Site [1]
- 2018-2023 Recipient Site [1]
- Highway
- Streams

0 2 4 6

1:200,000 km

[1]Site names correspond to the following species:

CAREXER - Dryland sedge (*Carex xerantica*)
CARETOR - Torrey's sedge (*Carex torreyi*)
CARESPR - Sprengel's sedge (*Carex sprengeliii*)
PENSGRA - Slender penstemon (*Penstemon gracilis*)
RANURHO - Prairie buttercup (*Ranunculus rhomboideus*)
SELARUP - Rock selaginella (*Selaginella rupestris*)
PIPTCAN - Canada mountain rice-grass (*Piptatheropsis canadensis*)

Sources: Esri, USGS, NOAA

3.3.1 Sprengel's Sedge (*Carex sprengelii*)

Six individuals received from the nursery were unable to be planted at the Leahy Pit Road location in June 2024 due to rain affecting planting conditions (clumping silt and clay – resulting in greater air pockets). The Sprengel's sedge were also heavily root-bound, as these individuals were initially propagated three years ago and retained for translocation. They have been temporarily removed from their pots and are now being grown in the ground in Prince George, BC, to recover.

Plate 3.3-1. Rootbound Sprengel's sedge

Plate 3.3-2. Sample of Sprengel's sedge recovering in Prince George, BC

3.3.2 Torrey's Sedge (*Carex torreyi*)

Six individual Torrey's sedge (1-gallon pots) were planted at the Beatton Valley Trails location (Figure 3.3-1). Two individuals were planted at site ID: CARETOR-2023-C-1A (Plate 3.3-3; Figure 3.3-3) to augment the number of individuals planted in 2023, and four individuals were planted at a new site nearby the existing location (site ID: CARETOR-2024-D; Plate 3.3-4; Figure 3.3-4). Each plant was watered after planting and fitted with zip tie rings held in place by a numbered tag and ground staple.

Plate 3.3-3. Example of Torrey's sedge tag 012 (site ID: CARETOR-2023-C-1A; June 10, 2024)

Plate 3.3-4. Example of Torrey's sedge tag 081 (site ID: CARETOR-2024-D; June 14, 2024)

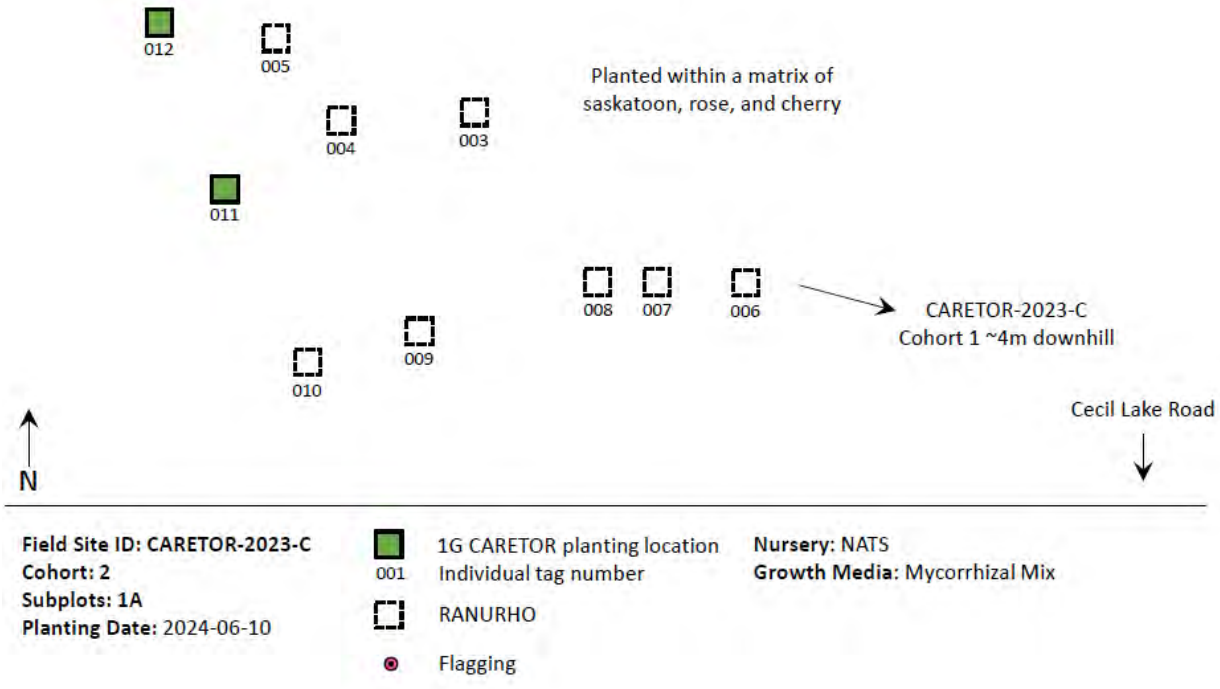


Figure 3.3-3. Torrey's sedge planting diagram at Beatton Valley Trails site ID: CARETOR-2023-C-1A

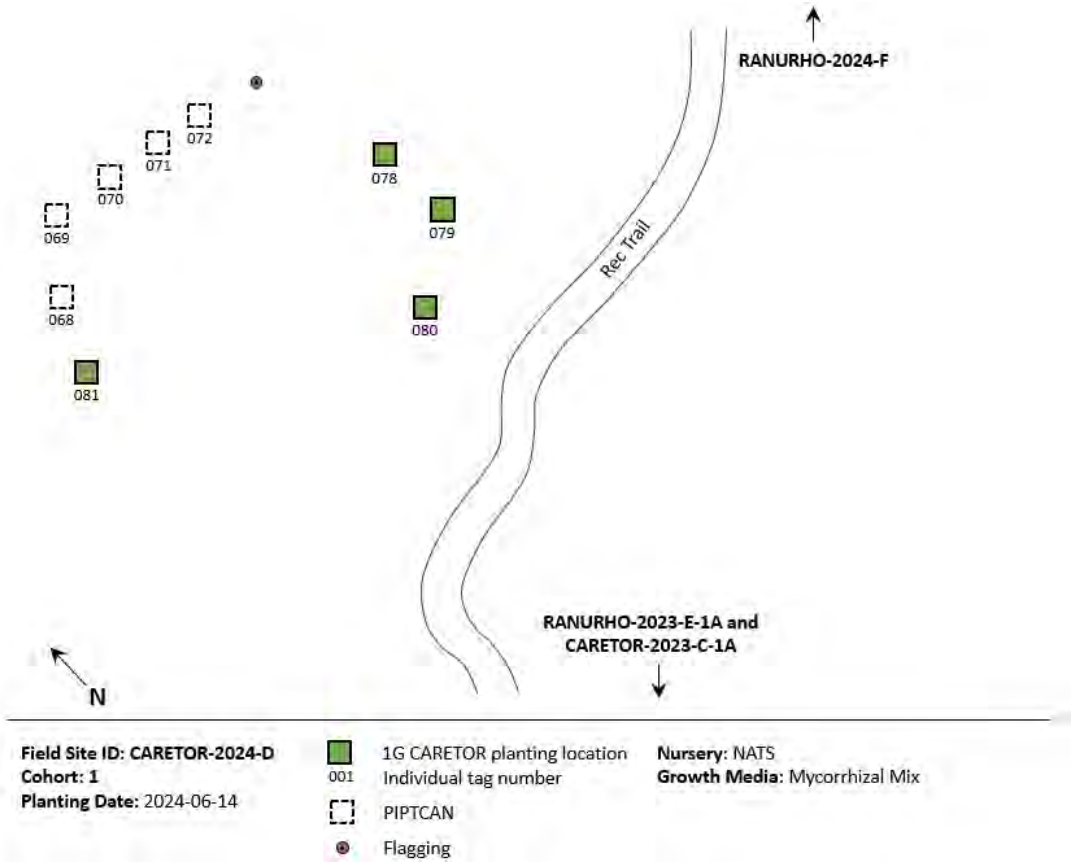


Figure 3.3-4. Torrey's sedge planting diagram at Beatton Valley Trails site ID: CARETOR-2024-D

3.3.3 Prairie buttercup *(Ranunculus rhomboideus)*

Fifteen individuals of prairie buttercup (1-gallon pots) were planted at the Beatton Valley Trails location (Figure 3.3-2). Eight individuals were planted at site ID: RANURHO-2023-E-1A to augment the number of individuals planted in 2023 (Plate 3.3-5; Figure 3.3-5), and seven individuals were planted at a new site further up the trail (site ID: RANURHO-2024-F; Plate 3.3-6; Figure 3.3-6).

The prairie buttercup received were frost-damaged during transport to Fort St. John from Langley, BC. Although much of the foliage was damaged (Plate 3.3-7 and Plate 3.3-8), the root systems remained viable (see Section 3.4.5; Plate 3.4-39 and Plate 3.4-40). After planting, all individuals were watered and rose collars were installed to minimize herbivory.

Plate 3.3-5. Prairie buttercup planting site ID: RANURHO-2023-E-1A cohort 2 (June 10, 2024)

Plate 3.3-6. Prairie buttercup planting site ID: RANURHO-2024-F (June 14, 2024)

Plate 3.3-7. Example of frost-damaged prairie buttercup tag #005 (site ID: RANURHO-2023-E-1A; June 10, 2024)

Plate 3.3-8. Example of frost-damaged prairie buttercup tag #088 (site ID: RANURHO-2024-F; June 14, 2024)

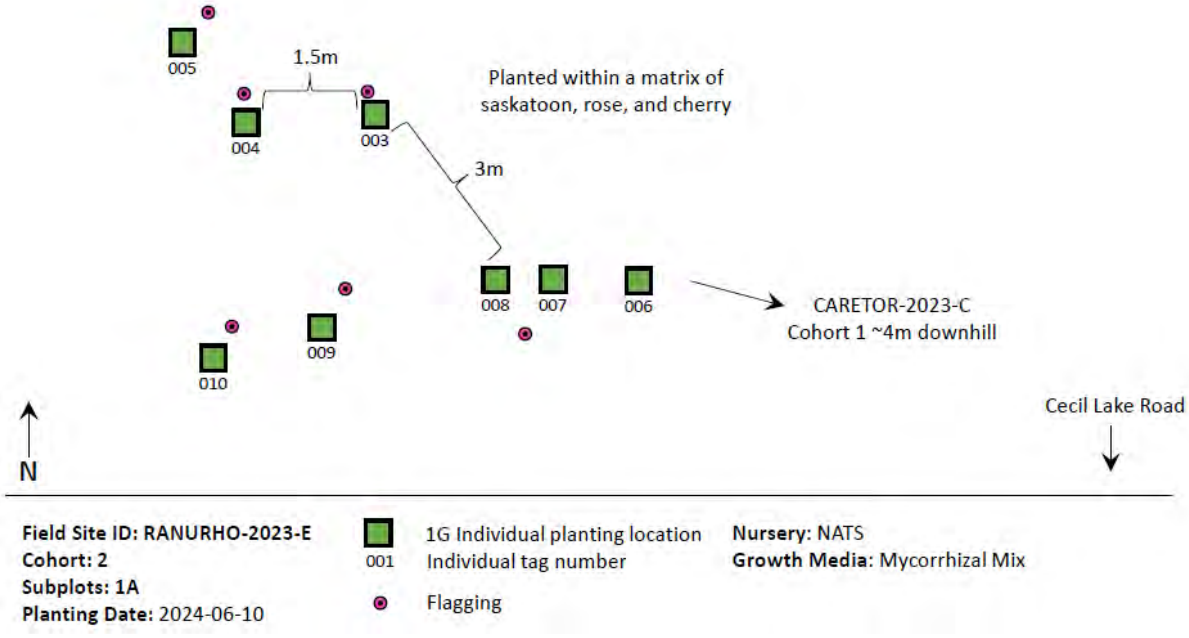


Figure 3.3-5. Prairie buttercup planting diagram at Beatton Valley Trails site ID: RANURHO-2023-E

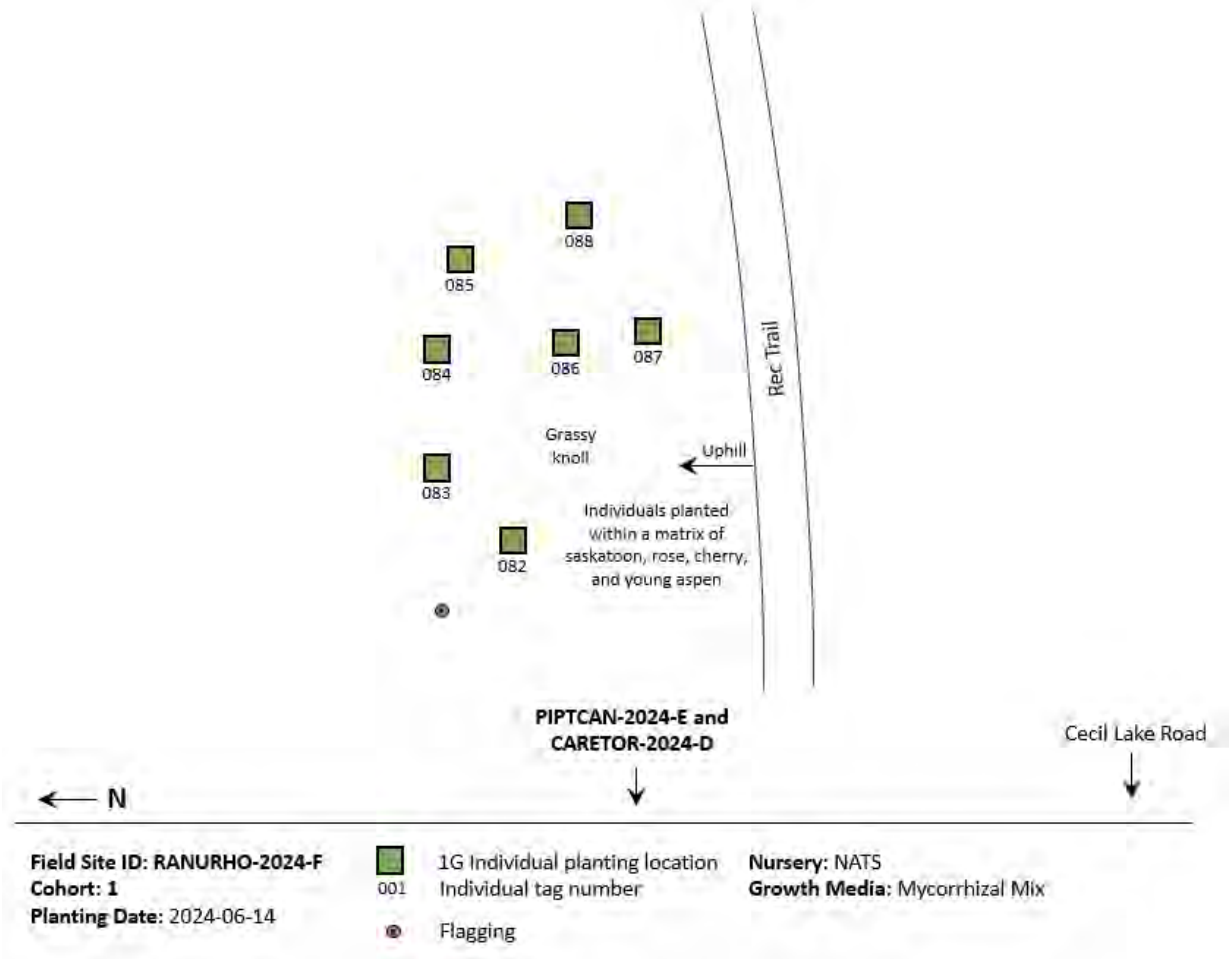


Figure 3.3-6. Prairie buttercup planting diagram at Beatton Valley Trails site ID: RANURHO-2024-F

3.3.4 Canada mountain-ricegrass (*Piptatheropsis canadensis*)

A total of 55 Canada mountain-ricegrass were planted at three sites in 2024 (site IDs: PIPTCAN-2023-C-Cohort 2, PIPTCAN-2024-D, and PIPTCAN-2024-E). All individuals were watered after planting, and zip tie rings were applied around each plant to improve detection of these plants during future monitoring (see Plate 3.3-11).

On June 11, 2024, forty-five Canada mountain-ricegrass (1-gallon pots) were planted at a new location near Clayhurst, BC. A total of nine subplots (grouped plantings within the same site; Figure 3.3-7 to Figure 3.3-9) were planted throughout the site in grassy openings within a matrix of rose, saskatoon, cherry, and soapberry shrubs (Plate 3.3-9 and Plate 3.3-10). Native populations of Torrey's sedge were also observed near some of the planting areas (Plate 3.3-12), and caution was taken to avoid disturbing this species before planting the Canada mountain-ricegrass.

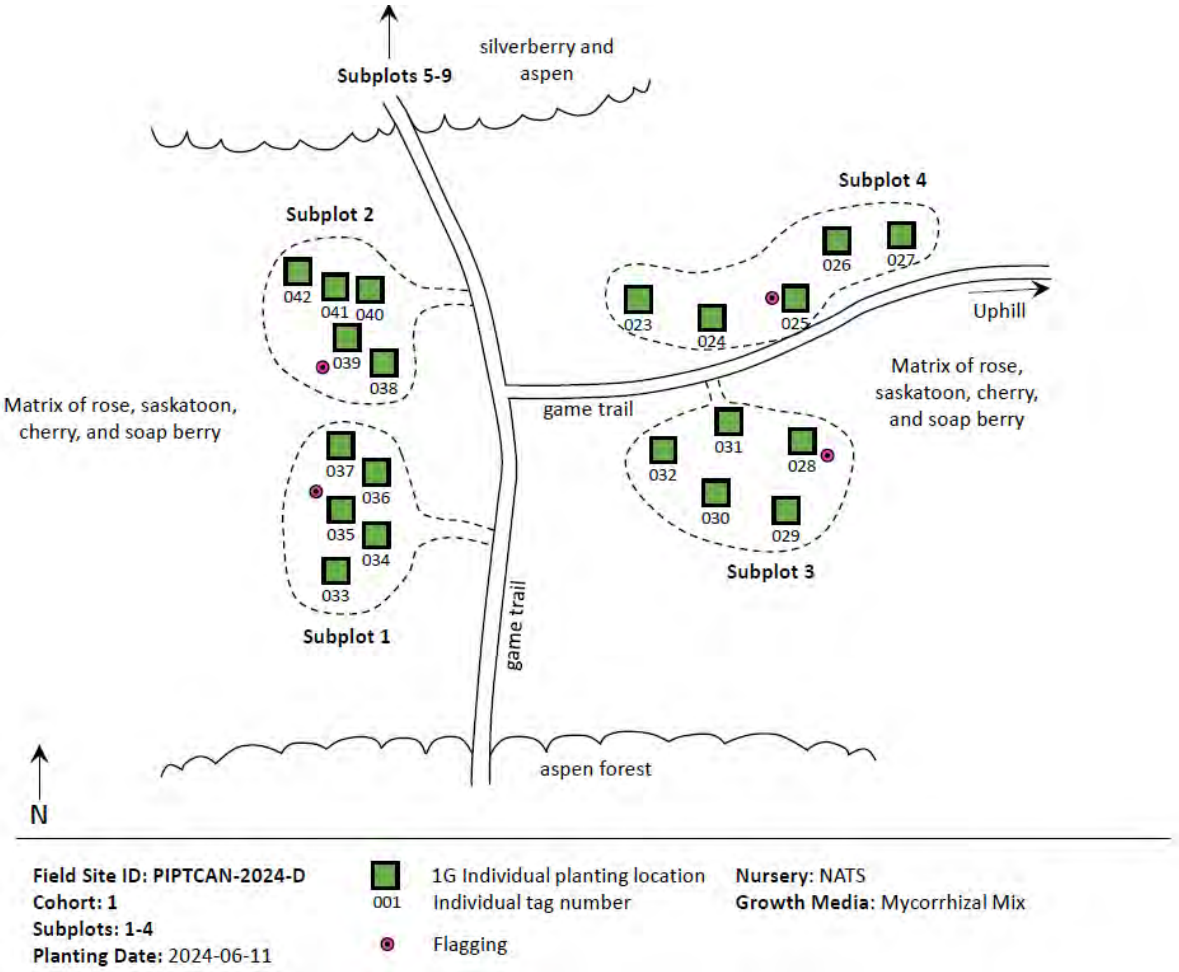


Figure 3.3-7. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 1-4)

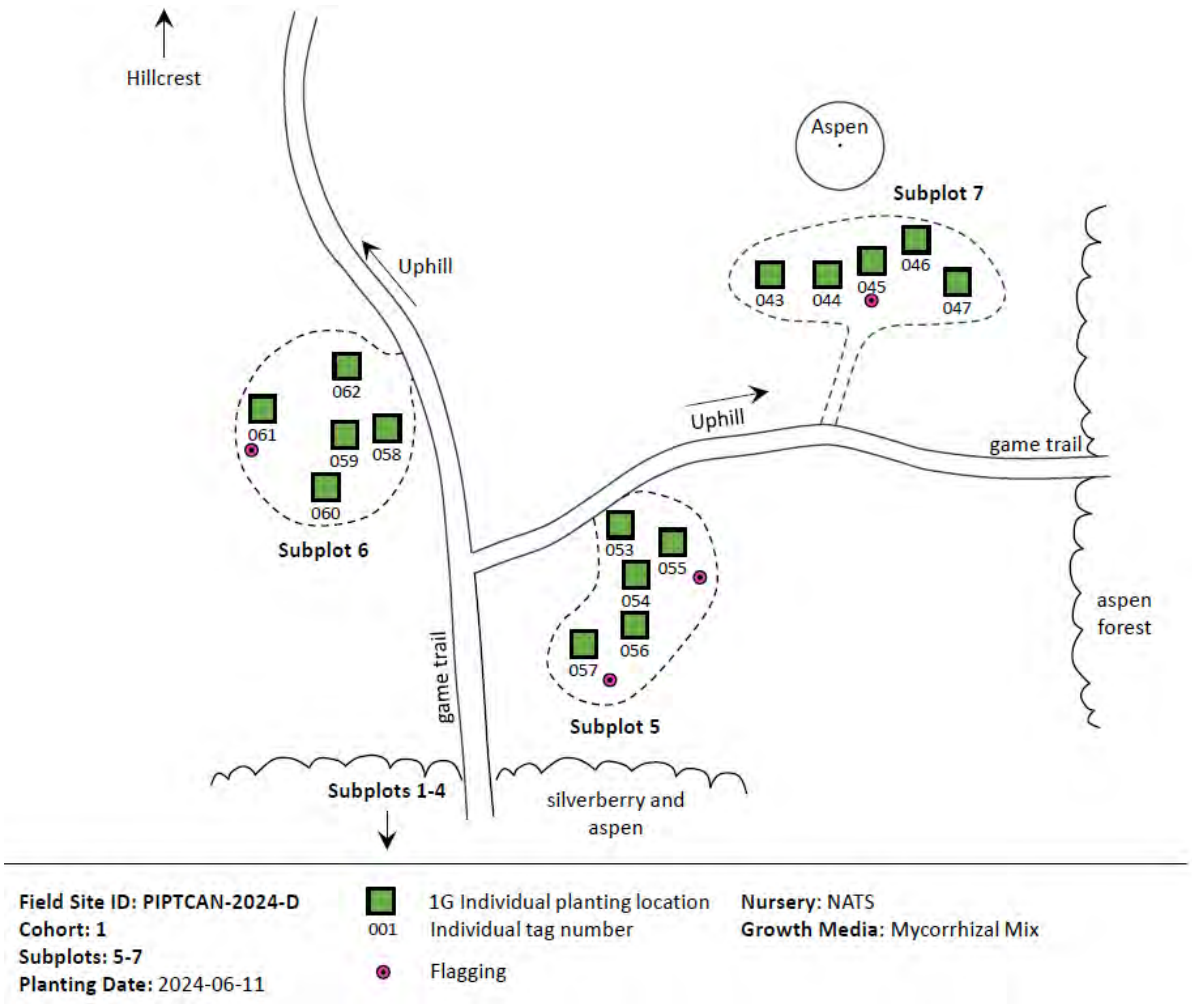


Figure 3.3-8. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 5-7)

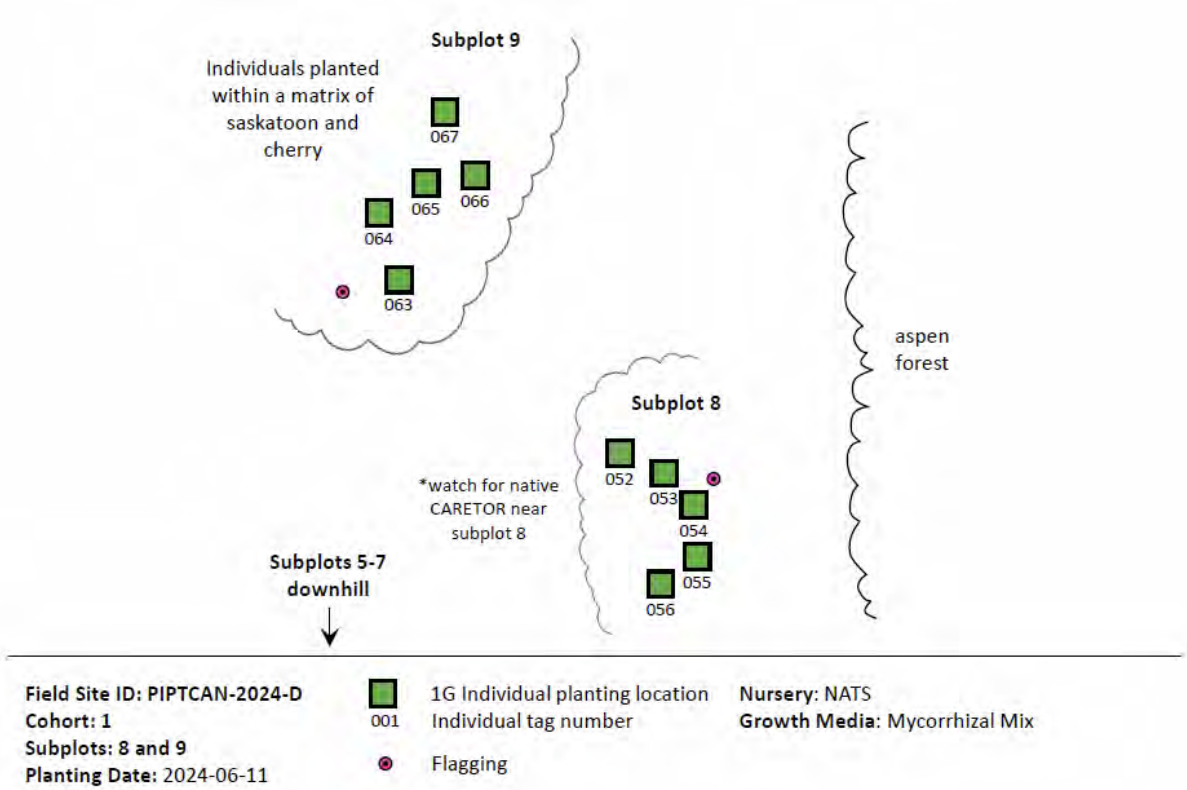


Figure 3.3-9. Canada mountain-ricegrass planting diagram at the Clayhurst site ID: PIPTCAN-2024-D (subplots 8-9)

Plate 3.3-9. General site photo (site ID: PIPTCAN-2024-D) showing matrix of grass and small shrubs bordered by larger snowberry and young aspen

Plate 3.3-10. Example of a subplot (site ID: PIPTCAN-2024-D subplot 5) with Canada mountain-ricegrass plantings (tall, light-coloured grasses in the photo)

Plate 3.3-11. Example of planted Canada mountain rice-grass with ziptie ring at the base (tag 368)

Plate 3.3-12. Example of a natural population of Torrey' sedge found near Canada mountain rice-grass planting site

On June 13, 2024, five Canada mountain-ricegrass were planted as a second cohort to bolster the existing translocated individuals at site ID: PIPTCAN-2023-C (in the Beatton Valley Trails area; Figure 3.3-10; Plate 3.3-13). In addition, five plants were translocated on June 14, 2024, at site ID: PIPTCAN-2024-E (approximately 90 meters north-east of site ID: PIPTCAN-2023-C) which shares a site with Torrey's sedge (site ID: CARETOR-2024-D; Figure 3.3-11; Plate 3.3-14).

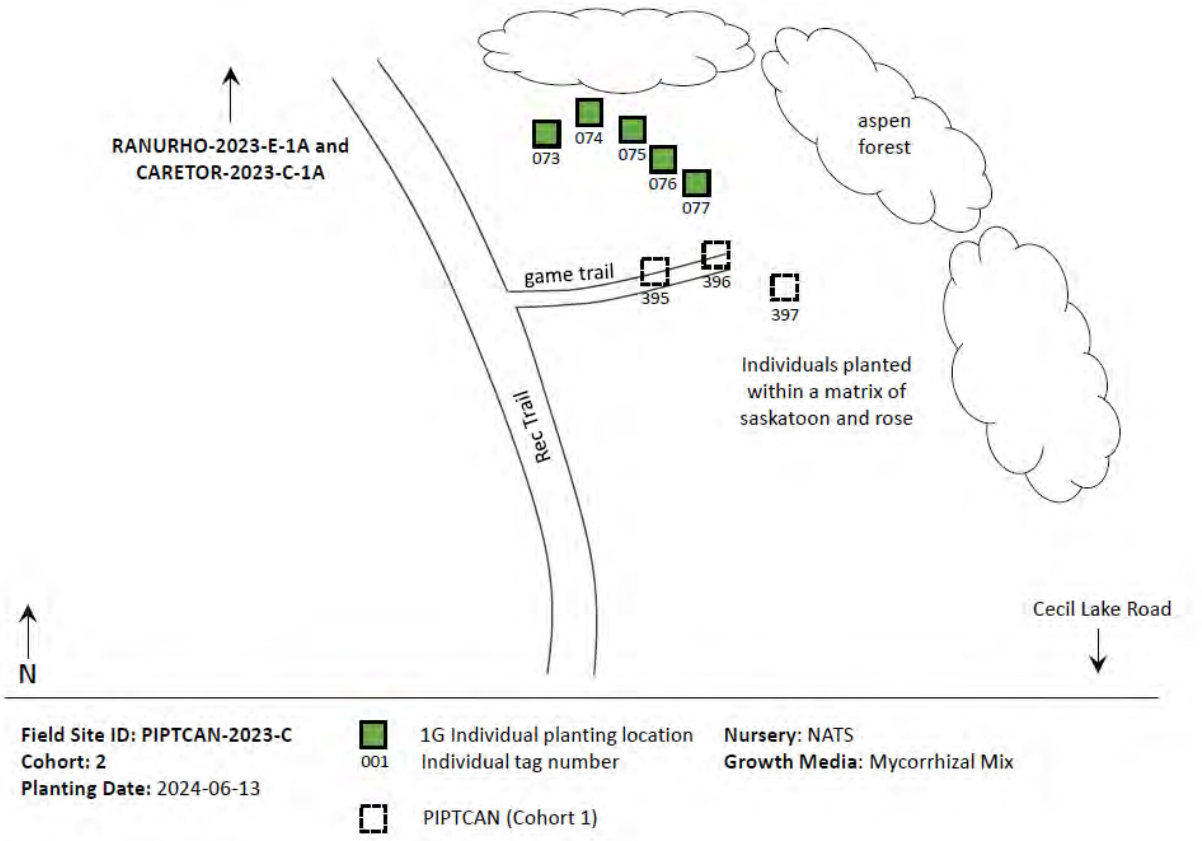


Figure 3.3-10. Canada mountain-ricegrass planting diagram at Beatton Valley Trails site ID: PIPTCAN-2023-C-Cohort 2

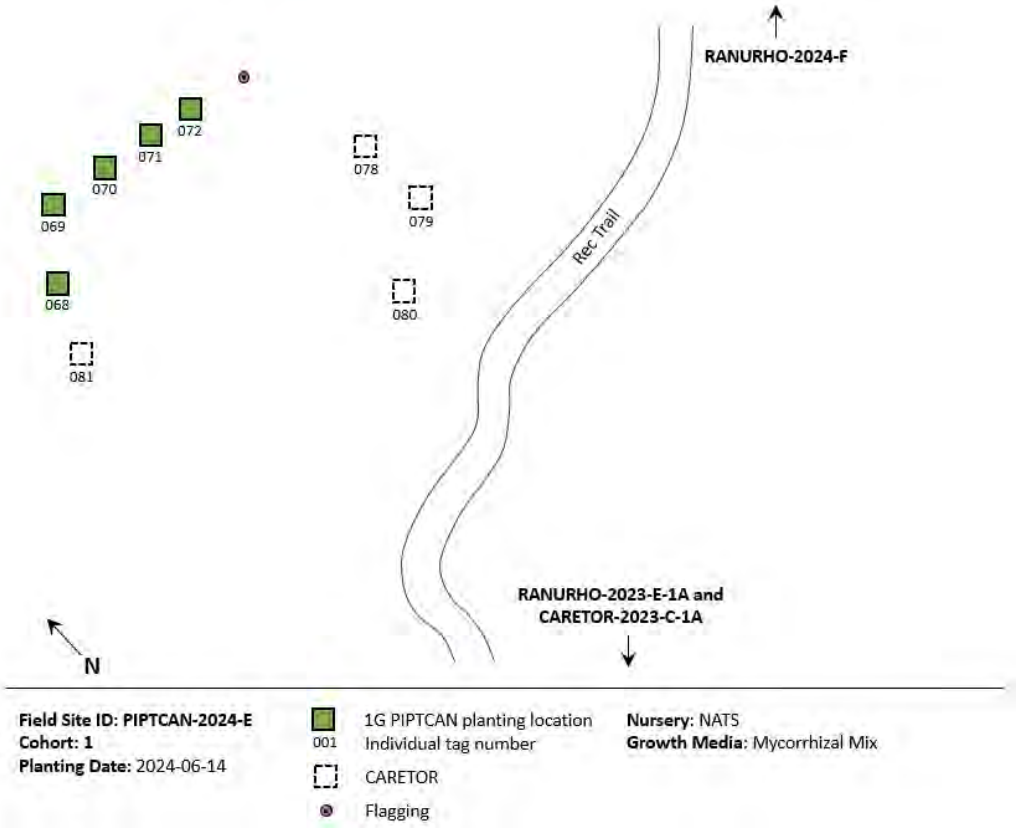


Figure 3.3-11. Canada mountain-ricegrass planting diagram at Beatton Valley Trails site ID: PIPTCAN-2024-E

Plate 3.3-13. Canada mountain-ricegrass planted at site ID: PIPTCAN-2023-C-Cohort 2 (June 13, 2024)

Plate 3.3-14. Canada mountain-ricegrass (along edges of shrubs) planted at site ID: PIPTCAN-2024-E (June 14, 2024)

3.4 MONITORING

Monitoring of individuals occurred up to two times in 2024 to correspond with seasonal changes in the phenology of each species.

Interim monitoring and/or population monitoring occurred in early spring (June), mid -summer (July and August) and early fall (late September) depending on the plant species and location. (Table 3.4-1). Refer to Figure 3.4-1 and Figure 3.4-2) for respective monitoring locations. A summary of follow up measures identified in 2024 during the interim monitoring and the 2024 status of the implementation of the follow up measures are summarized in Table 3.4-2.

Table 3.4-1. 2024 Translocated Rare Plant Species and Monitoring Sites

Species	Site ID	Interim Monitoring Date	Population Monitoring Date
Prairie buttercup	RANURHO-2021-A	July 5	June 13
	RANURHO-2021-B	July 5	June 10
	RANURHO-2022-C	-	June 11
	RANURHO-2023-D	July 5, August 29	June 13 and August 29

Species	Site ID	Interim Monitoring Date	Population Monitoring Date
	RANURHO-2023-E	July 6, August 29	June 10 and June 12
Slender penstemon	PENSGRA-2020-A	-	August 3
	PENSGRA-2020-B	-	August 2
	PENSGRA-2021-C	July 6; August 28	June 9
Rock selaginella	SELARUP-2021-A	July 6	June 9
Canada mountain-ricegrass	PIPTCAN-2020-B	-	August 2
	PIPTCAN-2023-C	July 6; August 9	August 2
Dryland sedge	CAREXER-2020-D	-	August 2
	CAREXER-2020-E	-	August 3
Torrey's sedge	CARETOR-2021-A	-	June 13
	CARETOR-2023-B	July 5, August 29	June 13
	CARETOR-2023-C	July 6, August 29	June 14
Sprengel's sedge	CARESPR-2020-B	July 5	June 10
	CARESPR-2021-C	July 5	June 10
	CARESPR-2023-D	July 5, August 29	June 13
	CARESPR-2023-E	July 6, August 29	June 12
Davis' locoweed	OXYTCAM3-2020-B	-	August 31
	OXYTCAM3-2020-C	-	August 30
	OXYTCAM3-2022-E	-	August 31

Site C Project

Experimental Rare Plant Monitoring Site Locations

Figure 3.4-1

Date: 2024-12-13

Map Number: BCH-068a

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

EcoLogic consultants

Legend

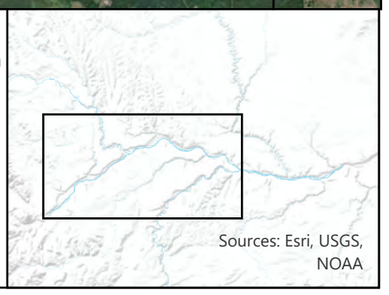
- 2024 Monitoring Sites[1]
- Highway
- Streams

0 2 4 6 km

1:200,000

[1]Site names correspond to the following species:

CAREXER - Dryland sedge (*Carex xerantica*)
CARETOR - Torrey's sedge (*Carex torreyi*)
CARESPR - Sprengel's sedge (*Carex sprengeliii*)
PENSGRA - Slender penstemon (*Penstemon gracilis*)
RANURHO - Prairie buttercup (*Ranunculus rhomboideus*)
SELARUP - Rock selaginella (*Selaginella rupestris*)
PIPTCAN - Canada mountain rice-grass (*Piptatheropsis canadensis*)



Sources: Esri, USGS, NOAA

Site C Project

Experimental Rare Plant Monitoring Site Locations

Figure 3.4-2

Date: 2024-12-13

Map Number: BCH-068b

Coordinate System: NAD 1983 UTM Zone 10N

Projection: Transverse Mercator

Datum: North American 1983

EcoLogic consultants

Legend

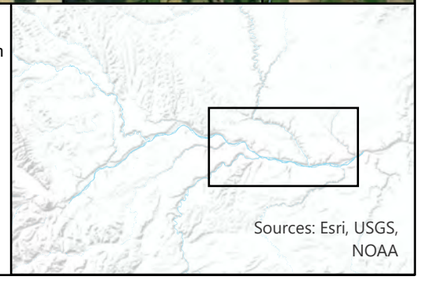
- 2024 Monitoring Site [1]
- Highway
- Streams

0 1 2 3 4 km

1:150,000

[1]Site names correspond to the following species:

CAREXER - Dryland sedge (*Carex xerantica*)
CARETOR - Torrey's sedge (*Carex torreyi*)
CARESPR - Sprengel's sedge (*Carex sprengeliii*)
PENSGRA - Slender penstemon (*Penstemon gracilis*)
RANURHO - Prairie buttercup (*Ranunculus rhomboideus*)
SELARUP - Rock selaginella (*Selaginella rupestris*)
PIPTCAN - Canada mountain rice-grass (*Piptatheropsis canadensis*)



Sources: Esri, USGS, NOAA

Table 3.4-2. Summary of Recipient Sites and Current Status

Species	Site Name	Status	Follow-up Measures (2023)	Follow-up Status (2024)
Dryland Sedge (*C. xerantica*)	CAREXER-2018-A	Inactive	na	na
	CAREXER-2018-B	Inactive	na	na
	CAREXER-2019-C	inactive	na	na
	CAREXER-2020-D	Active	Site visited once for population monitoring. Not watered.	Site visited once for population monitoring. Continue assessing the need for follow-up measures.
	CAREXER-2020-E	Active	Site visited once for population monitoring. Not watered.	Site visited once for population monitoring. Continue assessing the need for follow-up measures.
Canada mountain-ricegrass (*P. canadensis*)	PIPTCAN-2020-A	Active	Potential for use of zip tie ring technique in the future. Site access has changed since the highway was completed and requires crossing a private field for monitoring.	Not monitored due to changes in accessibility (requires crossing a private field for monitoring).
	PIPTCAN-2020-B	Active	Potential for use of zip tie ring technique in the future.	Site visited once for population monitoring. Zip tie rings not installed, however, there is potential for use of this technique to detect plants in the future.
	PIPTCAN-2023-C	Active	Potential for use of zip tie ring technique in the future.	A second cohort was planted at this location (see Section 3.3.4). Site visited for interim and population monitoring. Zip tie rings were installed around plants at this location. Assess the efficacy of zip tie rings in 2025.
	PIPTCAN-2024-D	Active	na	This is a new planting site established near Clayhurst (see Section 3.3.4). Assess the efficacy of zip tie rings in 2025.

Species	Site Name	Status	Follow-up Measures (2023)	Follow-up Status (2024)
	PIPTCAN-2024-E	Active	na	This is a new planting site established at the Beatton Valley Trail site (see Section 3.3.4). Assess the efficacy of zip tie rings in 2025.
Davis' locoweed (*O. campestris* var. *davisii*)	OXYTCAM3-2018-A	Inactive	Not visited. No follow up measures proposed for 2024 due to rank change of this variety.	Not visited. No follow up measures proposed for 2025 due to rank change of this variety.
	OXYTCAM3-2018-As (i.e. C)	Active	Opportunistically evaluated while conducting population monitoring of translocated plants at the same location. No follow up measures proposed for 2024 due to rank change of this variety.	Opportunistically evaluated while conducting population monitoring of translocated plants at the same location. No follow up measures proposed for 2025 due to rank change of this variety.
	OXYTCAM3-2020-B	Active	Fencing not required. No follow up measures proposed for 2024 due to rank change of this variety.	Site visited once for population monitoring. No follow up measures proposed for 2024 due to rank change of this variety.
	OXYTCAM3-2020-C	Active	Fencing continues to be effective. Phenocamera not reinstalled. Clover removed from some monitored plots. No follow up measures proposed for 2024 due to rank change of this variety.	Site visited once for population monitoring. No follow up measures proposed for 2024 due to rank change of this variety.
	OXYTCAM3-2022-D	Active	Not required. No follow up measures proposed for 2024 due to rank change of this variety.	Site not visited in 2024. No follow up measures proposed for 2024 due to rank change of this variety.
	OXYTCAM-2022-E	Active	Not required. No follow up measures proposed for 2024 due to rank change of this variety.	Site visited once for population monitoring. No follow up measures proposed for 2024 due to rank change of this variety.
Prairie buttercup (*R. rhomboideus*)	RANURHO-2021-A	Active	Two of three cages readjusted. One flattened cage had inflorescence growing through the cage at time of monitoring, so the cage was left in place. Watered. Consider removal of cages (in the late fall	Site visited once for population monitoring and watered. Two flattened cages removed. One replaced with rose collars and netting. Assess the efficacy of these changes and possibility of removing herbivory

Species	Site Name	Status	Follow-up Measures (2023)	Follow-up Status (2024)
			or using wire cutters to avoid damage to plant structures)	deterrents in 2025. Improve means of tracking recruits as more become detected.
	RANURHO-2021-B	Active	Reinstalled cages for two individuals. Watered. Readjust or replace collars if removed by wildlife and continue assessing the need for fencing.	Site visited once for population monitoring and watered. Reinstalled cages for both individuals. Assess the possibility of removing rose collars in 2025. Improve means of tracking recruits as more become detected.
	RANURHO-2022-C	Active	This crown parcel was observed to be fenced and stocked with cattle (after translocation). It is uncertain how long these disturbances will persist. Evaluate the need for protection from herbivory.	Less disturbance by cattle in 2024 - evaluate the need for protection from herbivory in 2025.
	RANURHO-2023-D	Active	Collars and plants had been found to be removed by wildlife during interim monitoring. Remaining individuals were watered. Evaluate the need for protection from herbivory or relocation.	Only one individual remaining near the end of the season. Evaluate the need to replant in a different microsite to minimize herbivory (e.g., avoid planting along the edge of a trail). Improve means of tracking recruits as more become detected.
	RANURHO-2023-E	Active	Plants were watered. Evaluate the need for protection from herbivory.	Plants were watered. Evaluate the need for protection from herbivory. Assess the possibility of removing rose collars in 2025. Improve means of tracking recruits as more become detected.
	RANURHO-2024-F	Active	na	This is a new planting site established at the Beatton Valley Trail site (see Section 3.3.3).
Rock selaginella (*Selaginella rupestris*)	SELARUP-2021-A	Active	Site is susceptible to erosion. Limit site visits and opportunistically sample different portions of the slope if more that one site visit is conducted.	Continue to limit site visits.
	SELARUP-2021-B	Active	Not visited. Continue assessing the need for follow-up measures.	Not visited. Continue assessing the need for follow-up measures.
Slender penstemon *(P. gracilis*)	PENSGRA-2020-A	Active	Not watered in 2023.	Continue assessing the need for follow-up measures.
	PENSGRA-2020-B	Active	Not watered in 2023.	Continue assessing the need for follow-up measures.

Species	Site Name	Status	Follow-up Measures (2023)	Follow-up Status (2024)
	PENSGRA-2021-C	Active	Watered (dry spring) and continue watering if deemed necessary.	Continue assessing the need for follow-up measures.
Sprengel's sedge (*C. sprengelii*)	CARESPR-2020-1A	Active	Watered (dry spring) and continue watering if deemed necessary.	Continue assessing the need for follow-up measures.
	CARESPR-2020-1B	Active	No laydown observed. Plants watered (dry spring). Continue to assess if fencing is required. Continue watering if deemed necessary.	Continue assessing the need for follow-up measures.
	CARESPR-2021-C	Active	Watered (dry spring) and continue watering if deemed necessary.	Clear leaf litter from zip tie rings to improve plant detectability of recruits when monitoring. Consider other ways to improve detection in 2025, as the smooth brome grows taller later in the spring and summer.
	CARESPR-2023-D	Active	Watered (dry spring) and continue watering if deemed necessary.	Continue assessing the need for follow-up measures.
	CARESPR-2023-E	Active	Watered (dry spring) and continue watering if deemed necessary.	Continue assessing the need for follow-up measures.
Torrey's sedge (*C. torreyi*)	CARETOR-2021-A	Active	Watered (dry spring) and continue watering if deemed necessary.	Improve means of tracking recruits as more become detected.
	CARETOR-2023-B	Active	Watered (dry spring) and continue watering if deemed necessary.	Improve means of tracking recruits as more become detected.
	CARETOR-2023-C	Active	Watered (dry spring) and continue watering if deemed necessary.	Improve means of tracking recruits as more become detected.
	CARETOR-2024-D	Active	na	This is a new planting site established at the Beatton Valley Trail site (see Section 3.3.2).

3.4.1 Population Monitoring

Population monitoring involved an evaluation of survivorship, maturity, reproduction, and recruitment (Table 3.4-3). These metrics are being used to evaluate population viability at recipient sites and to track establishment of the translocated plants and resulting recruitment. The year-end monitoring is critical to ensure that issues with viability or establishment can be identified and addressed as they arise.

In the table below, note that reproduction also infers maturity. A "-"value in that column simply indicates that individuals were past the flowering stage and entering the seed production stage.

Table 3.4-3. Summary of Population Monitoring Results for 2024

Species	Site Name	Survivorship		Maturity		Reproduction		Recruitment
		Survival in Relation to Total	Percent Survival	Flowering in Relation to Total	Percent Flowering	Seed Production in Relation to Total	Percent Seeding	Number of recruits observed
Canada mountain-ricegrass	PIPTCAN-2020-B	3/5	60%	-	-	3/5	60%	0
	PIPTCAN-2023-C	3/3	100%	-	-	3/3	100%	0
Davis' locoweed	OXTYCAM3-2020-B	159/294	54%	-	-	86/294	29%	60
	OXTYCAM3-2020-C	363/504	72%	-	-	107/504	21%	45
	OXYTCAM3-2022-E	9/11	82%	-	-	5/11	45%	9
Dryland sedge	CAREXER-2020-D	58/105	55%	57/105	54%	7/105	7%	0
	CAREXER-2020-E	40/50	80%	35/50	70%	2/50	4%	0
Prairie buttercup	RANURHO-2021-A	12/17	71%	-	-	1/17	6%	13
	RANURHO-2021-B	2/2	100%	-	-	2/2	100%	2
	RANURHO-2022-C	9/9*	100%	4/9	44%	4/9	44%	0
	RANURHO-2023-D	1/10	10%	-	-	1/10	10%	0
	RANURHO-2023-E	10/10	100%	3/10	30%	10/10	100%	1

Species	Site Name	Survivorship		Maturity		Reproduction		Recruitment
		Survival in Relation to Total	Percent Survival	Flowering in Relation to Total	Percent Flowering	Seed Production in Relation to Total	Percent Seeding	Number of recruits observed
Slender penstemon	PENSGRA-2020-A	25/25	100%	-	-	18/25	72%	0
	PENSGRA-2020-B	6/25	24%	-	-	3/25	12%	0
	PENSGRA-2021-C	20/20	100%	13/20	65%	0/20	0%	0
Rock selaginella	SELARUP-2021-A-Cohort 1	14/14*	100%	14/14	100%	14/14**	100%**	-**
	SELARUP-2021-A-Cohort 2	2/2*	100%	2/2	100%	2/2**	100%**	-**
Torrey's sedge	CARETOR-2021-A	8/8	100%	-	-	7/8	87%	0
	CARETOR-2023-B	9/10	90%	-	-	8/10	80%	0
	CARETOR-2023-C	10/10	100%	-	-	10/10	100%	7
Sprengel's sedge	CARESPR-2020-B-1A	2/2	100%	-	-	0/2	0%	0
	CARESPR-2020-B-1B	5/5	100%	-	-	1/5	20%	0
	CARESPR-2021-C (Cohort 1)	1/1	100%	-	-	1/1	100%	0
	CARESPR-2021-C (Cohort 2)	10/10	100%	-	-	9/10	90%	0
	CARESPR-2023-D	6/6	100%	-	-	6/6	100%	0
	CARESPR-2023-E	4/4	100%	-	-	3/4	75%	0

*Clumps of individuals; **Quantifying reproduction and recruits for this species is difficult – refer to section 3.4.7 for details.

3.4.2 Canada mountain-ricegrass (*Piptatheropsis canadensis)*

In 2024, population monitoring occurred at two sites by Eagle Cap on August 2, 2024 (site IDs: PIPTCAN-2020-B and PIPTCAN-2023-C). At site ID: PIPTCAN-2020-B, three of five (60%) clumps of Canada mountain-ricegrass were detected (Plate 3.4-1), all of which had seeds that appeared to be viable (Plate 3.4-2). These clumps were originally salvaged and translocated in October of 2020.

At site PIPTCAN-2023-C, all three 1G plants (planted in 2023 – cohort 1) were detected (100% survival) and producing seed heads (Plate 3.4-3). The second cohort, which was planted in June, was observed to be present, however, the site showed some disturbance by human activity (Plate 3.4-4). When the first cohort was planted, Eagle Cap had clipped the majority of the inflorescences to encourage root development in the first year (instead of expending energy on seed development) and improve the plants' survivability (e.g., become less attractive to herbivores). This method will be considered for future plantings of this species to improve translocation success. All plants at each subplot were present (Plate 3.4-5). The newly planted Clayhurst site (PIPTCAN-2024-D) was re-checked on August 29.

Plate 3.4-1. Sample of Canada mountain-ricegrass (tag 084) that was monitored at site ID: PIPTCAN-2020-B (August 2, 2024; photo taken by Eagle Cap)

Plate 3.4-2. Close up of Canada mountain-ricegrass (tag 084) seed head that was monitored at site ID: PIPTCAN-2020-B (August 2, 2024; photo taken by Eagle Cap)

Plate 3.4-3. Example close up of Canada mountain-ricegrass (tag 396) seed head that was monitored at site ID: PIPTCAN-2024-C-Cohort 1 (August 2, 2024; photo taken by Eagle Cap)

Plate 3.4-4. Disturbance observed at site ID: PIPTCAN-2024-C-Cohort 2 (August 2, 2024; photo taken by Eagle Cap)

Plate 3.4-5. Sample of Canada mountain-ricegrass observed at site ID: PIPTCAN-2024-D (September 6, 2024)

3.4.3 Davis' locoweed (*Oxytropis campestris var. davisii*)

Due to the rank change of this variety (from blue-list to yellow-list), 2024 was the last year of monitoring Davis' locoweed that had been planted between 2020 and 2022.

Three Davis' locoweed sites were monitored between August 30 and 31, 2024: OXYTCAM3-2020-B, OXYTCAM3-2020-C, and OXYTCAM3-2022-E (Figure 3.3-2). Site ID: OXYTCAM3-2022-D was not monitored in 2024 due to poor survival recorded in 2023. At the time of monitoring, all Davis' locoweed that had produced stalks were at the seeding stage with seed pods observed to be present or absent. Although not included in the results, estimated number of this years' stalks (without seedheads) were also documented for each individual as another indicator of reproductive potential.

In past years, some of the planted individuals were identified or suspected to be showy locoweed (*Oxytropis splendens*). These individuals have been excluded from the results.

3.4.3.1 Site OXYTCAM3-2020-B

On August 31, 2024, 294 Davis' locoweed (from 2020 and 2022 plantings) were monitored (Plate 3.4-3 to Plate 3.4-5). Out of 294 monitored individuals, 159 (54%) had survived and 86 (29%) contained seedheads. Three microsites were planted at this site: a high bench cobble site (cohort 1), understory edge (cohort 2), and a sandy-gravellier site (cohort 2; subplot NN). Monitoring results for each microsite are summarized below.

From the first cohort (planted in 2020), 31 out of 90 monitored individuals (34%) had survived and 12 out of the 90 (13%) individuals were observed to have seedheads. A total of 38 recruits were observed in cohort 1 (Plate 3.4-6) with several recruits observed to be quite large (Plate 3.4-7). As noted in previous years, cattle have been active at this site and plants have been observed to be smothered by cow dung (Plate 3.4-8) and in competition with agronomic species (e.g., alfalfa; Plate 3.4-9).

Plate 3.4-6. Sample of Davis' locoweed parent plant (tag 062) and recruit (at the end of pencil tip) observed at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)

Plate 3.4-7. Example of large Davis' locoweed recruit (foreground) located 60 cm from parent plant (background; tag 063) site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)

Plate 3.4-8. Example of cow dung smothering several plants at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)

Plate 3.4-9. Alfalfa growing with Davis' locoweed at site ID: OXYTCAM3-2020-B-Cohort 1 (August 31, 2024)

From the second cohort (planted in 2022), 105 out of 139 monitored individuals (75%) planted in the understory edge had survived and 67 out of 139 individuals (48%) were observed to have seedheads (Plate 3.4-10). Twenty recruits were observed in this cohort group (Plate 3.4-11).

Due to its location in the understory edge, the ground layer of this site possesses high amounts of leaf litter. During monitoring, leaf litter was removed from each subplot to improve detection of recruits. The abundance of leaf litter may limit the success of seed germination by preventing seed to soil contact; however, leaf litter may also provide protection for young recruits over the winter.

Plate 3.4-10. Example of Davis' locoweed planting within the understory edge subplot BB – site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)

Plate 3.4-11. Example of Davis' locoweed recruit within subplot FF - site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)

From the second cohort (planted in 2022) and planted in a sandier and gravellier microsite (subplot NN; Plate 3.4-12), 23 out of 65 monitored individuals (35%) had survived and 7 out of 65 individuals (11%) were observed to have seedheads (Plate 3.4-13). Two recruits were observed in this cohort group. Because of the loose nature of the substrate, plants and tags have been found to dislodge easier when wildlife pass through the area.

Small jumping spiders were detected emerging from the seed pods of two Davis' locoweed (Plate 3.4-14) alluding to potential value of seed pods for use by other organisms.

Plate 3.4-12. Sandy and gravelly plot NN site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)

Plate 3.4-13. Example of Davis' locoweed seeds and pods where jumping spiders were observed site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)

Plate 3.4-14. One of a few jumping spiders found inside Davis' locoweed seed pod site ID: OXYTCAM3-2020-B-Cohort 2 (August 31, 2024)

3.4.3.2 Site OXYTCAM3-2020-C

Out of 713 Davis' locoweed, 504 individuals translocated in 2020 and 2022 were monitored on August 30, 2024. Due to high numbers of translocated individuals and limited time constraints, only a sample of the population was monitored. Monitoring was focused on the same subplots monitored in 2022 (cohorts 1-3) and an additional sample of cohort 4 planted in 2022. Effort was made to sample an adequate proportion of the population across cohorts. Out of the 504 individuals monitored, 363 survived (72%; Plate 3.4-15) and 107 individuals (21%) were observed to have seed heads (Plate 3.4-16). Forty-five recruits were observed in total (Plate 3.4-17). Several plots exhibited relatively dense mats of clover growing between the transplants. In most instances, clover was removed during monitoring activities.

An abundance of leaf litter also exists at this site. During monitoring, leaf litter was removed to improve detection of recruits. In some subplots, leaf litter was replaced after monitoring in attempts to reduce the spread of clover. As in previous years, insect holes were observed on several seed pods (Plate 3.4-18).

A nearby high bench cobble site with nine subplots planted in 2022 (cohort 4) was not monitored in 2023 but was monitored in 2024. Out of 54 plants monitored, 26 had survived in which 19 were in poor to fair condition, with five individuals reported with seedheads (Plate 3.4-19 and Plate 3.4-20). These plantings were in notably poorer condition compared to the other high bench cobble site. This site appeared drier with sandier and gravellier substrate.

Plate 3.4-15. Example of size 50P Davis' locoweed growing in subplot 22 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024)

Plate 3.4-16. Example of Davis' locoweed with seedheads in subplot 19 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024)

Plate 3.4-17. Example of Davis' locoweed and recruit (near top of measuring tape) growing in subplot 16 site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024)

Plate 3.4-18. Example of Davis' locoweed with insect damage on seedpod (tag 125, subplot 15); site ID: OXYTCAM3-2020-C-Cohort 2 (August 30, 2024)

Plate 3.4-19. Davis' locoweed subplot XX; site ID: OXYTCAM3-2020-C-Cohort 4 (August 30, 2024)

Plate 3.4-20. Example of Davis' locoweed with seedpod and in poor condition (tag 159, subplot AAA); site ID: OXYTCAM3-2020-C-Cohort 4 (August 30, 2024)

3.4.3.1 Site OXYTCAM3-2022-E

On August 31, 2024, site ID: OXYTCAM3-2023-E was monitored (Plate 3.4-21), resulting in 9 of 11 (82%) surviving individuals in which five (45%) possessed seedheads. A total of nine recruits were observed. The ground cover of this planting site is abundant in mosses and lichens. This site is in close proximity to natural populations of Davis' locoweed (Plate 3.4-22).

Plate 3.4-21. Example of Davis' locoweed planting area with an abundant moss and lichen ground cover; site ID: OXYTCAM3-2022-E (August 31, 2024)

Plate 3.4-22. Example of natural population of Davis' locoweed near site ID: OXYTCAM3-2022-E (August 31, 2024)

3.4.4 Dryland sedge (*Carex xerantica*)

Dryland sedge at site IDs: CAREXER-2020-D and CAREXER-2020-E were monitored on August 2 and 3, 2024. At site ID: CAREXER-2020-D, 58 out of 105 (55%) individuals were observed to be present (Plate 3.4-23). Fifty-seven of the individuals (54%) had green stalks (culms) with or without inflorescences and seven individuals (7%) had stalks producing viable achenes (fruit bearing seed). At site CAREXER-2020-E, 40 out of 50 (80%) individuals were present (Plate 3.4-24). Thirty-five of the individuals (70%) had green stalks and two individuals (4%) had stalks producing viable achenes.

Plate 3.4-23. Example of dryland sedge (tag 060) monitored at site ID: CAREXER-2020-D – August 2, 2024

Plate 3.4-24. Example of dryland sedge monitored (tag 009) with no seed heads at site ID: CAREXER-2020-E – August 3, 2024

3.4.5 Prairie buttercup (*Ranunculus rhomboideus*)

Five prairie buttercup sites were monitored - site IDs: RANURHO-2021-A (June 13), RANURHO-2021-B (June 10), 2023, RANURHO-2022-C (June 11), RANURHO-2023-D (June 13), and RANURHO-2023-D (June 10 and 12). Interim monitoring and watering occurred on July 5 and 6, 2024 for all sites with additional monitoring occurring on August 29 at site IDs: RANURHO-2023-D and RANURHO-2023-E.

3.4.5.1 RANURHO-2021-A

At site ID: RANURHO-2021-A, 12 of the 17 (71%) individuals monitored survived. One of the surviving individuals had one seed head (Plate 3.4-25), and 13 recruits were observed during monitoring (Plate 3.4-26). Two of the three wire cages that were initially installed to prevent herbivory were removed. In previous years, the cages had been flattened by wildlife which resulted in prairie buttercup growing through the flattened cage, making monitoring more challenging (Plate 3.4-27). A new approach to protecting plants and allowing for easier monitoring was trialed for one plot (Plate 3.4-28) using a larger rose collar barrier (to deter rodents) and recycled netting (to deter larger animals).

Plate 3.4-25. Example of prairie buttercup seedhead (site ID: RANURHO-2021-A; tag 049) observed during monitoring June 13, 2024

Plate 3.4-26. Example of prairie buttercup recruit near tag 059 (site ID: RANURHO-2021-A) observed during monitoring June 13, 2024

Plate 3.4-27. Example of crushed wire cage that was later replaced June 10, 2024

Plate 3.4-28. Example of a new rose collar barrier installed on June 10, 2024

3.4.5.2 RANURHO-2021-B

Monitoring occurred at site ID: RANURHO-2021-B on June 10, 2024. The collars that had been installed previously around the plants had been torn out of the ground (a common occurrence at this site). The two

individuals that had survived in the previous year were both present in 2024 (100% survival; Plate 3.4-29) with both bearing seed heads (individual 393 – four seed heads; individual 394 – six seed heads; Plate 3.4-30. A total of two recruits were identified in the vicinity of parent plant tag 393 and one was observed to be flowering (Plate 3.4-31). Both recruits were tagged (001 and 002) for continued monitoring.

Plate 3.4-29. Sample of prairie buttercup (tag 394) on June 10, 2024 (site ID: RANURHO-2021-B)

Plate 3.4-30. Seeds observed at the base of parent plant 393 observed on June 10, 2024, (site ID: RANURHO-2021-B)

Plate 3.4-31. Flowering recruit from parent plant tag 393 observed on June 10, 2024 (site ID: RANURHO-2021-B; tag 001).

3.4.5.3 RANURHO-2023-D

At site ID: RANURHO-2023-D (Leahy Pit Road location) on June 13, 2024, one out of five (20%) individuals survived at site 1A (Plate 3.4-32) and two out of five (40%) individuals survived at site 2A (Plate 3.4-33). Insect damage was observed on individuals, presumably from grasshoppers that were able to bypass the rose collars (Plate 3.4-34). Surviving plants were watered during a follow up site visit on July 5, 2024. An interim monitoring trip on August 29 showed no surviving plants at site 2A and one surviving individual at site 1A (10% survival). No recruits were observed.

This site has been prone to continuous disturbance by wildlife, likely bears, based on chewed rose collars that were used to protect the plants. Surviving plants have been fairly small and in poor to fair condition.

Plate 3.4-32. Sample of surviving prairie buttercup with seed heads (tag 401) on June 13, 2024 (site ID: RANURHO-2023-D-1A)

Plate 3.4-33. Sample of surviving prairie buttercup with insect damage on leaves (tag 416) on June 13, 2024 (site ID: RANURHO-2023-D-2A)

Plate 3.4-34. Grasshopper nymph observed on the inside of a rose collar on June 13, 2024 (site ID: RANURHO-2023-D-2A)

3.4.5.4 RANURHO-2023-E

At site ID: RANURHO-2023-E (Beatton Valley Trail location) on June 10 and 12, 2024, all ten individuals from both sites survived and were producing multiple seedheads (as many as 96 seedheads; Plate 3.4-35). While collecting data, seeds brushed off of the seed heads and stuck to the edges of the rose collars (Plate 3.4-36). Effort was made to brush most of the seeds onto the soil. Removal of rose collars will be considered in 2025 to improve seed dispersal and seed-soil contact. Surviving plants were watered on July 6, 2024, and seeds at the base of the parent plant had changed from light green to brown in colour (Plate 3.4-37). One recruit with a seedhead was observed at site 1A (Plate 3.4-38). All plants were also watered and interim-monitored on August 29, 2024.

New 2024 plantings at the Beatton Valley Trail location (Site IDs: RANURHO-2023-E-1A-Cohort 2; RANURHO-2024-F) were interim monitored and watered on July 6 and August 29, 2024. The foliage of these individuals had suffered frost damage during transport before being planted in June (see section 3.3.3). Interim monitoring revealed that many of these plants had recovered (produced new foliage) and had developed inflorescences (Plate 3.4-39 and Plate 3.4-40).

Plate 3.4-35. Example of individual (tag 445) with high seedhead production on June 12, 2024 (site ID: RANURHO-2023-E-2A)

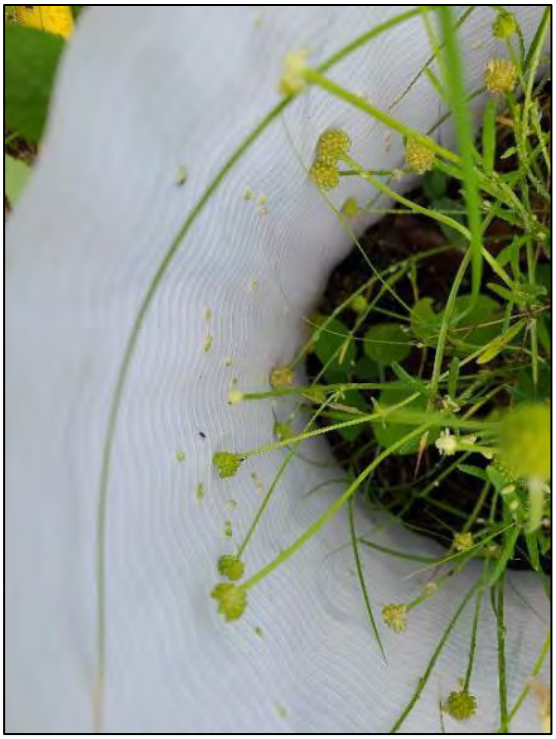


Plate 3.4-36. Seeds observed to be sticking to the edges of the rose collar and presence of aphids (small dark spots in the photo; site ID: RANURHO-2023-E-2A; tag 447)

Plate 3.4-37. Example of browning seeds on July 6, 2024, (site ID: RANURHO-2023-E-1A; tag 431)

Plate 3.4-38. Example of recruit with seedhead on June 10, 2024, (site ID: RANURHO-2023-E-1A; tag 435)

Plate 3.4-39. Example of recovering prairie buttercup tag #005 observed during interim monitoring (site ID: RANURHO-2023-E-1A; July 6, 2024)

Plate 3.4-40. Example of recovering prairie buttercup tag #088 observed during interim monitoring (site ID: RANURHO-2024-F; July 6, 2024)

3.4.5.5 RANURHO-2022-C

Site ID: RANURHO-2022-C was monitored by Eagle Cap on June 11, 2024. In 2023, there were natural and anthropogenic disturbances observed on the crown parcel (installation of electric fence, cattle grazing, clearing, and beaver activity). In 2024, there was no sign of cattle grazing, however additional clearing of vegetation was observed, resulting in loss of shrub cover. Damage to some planting tags and flagging was also observed. Evidence of new beaver activity did not appear to impact the prairie buttercup directly (Plate 3.4-41).

All nine of nine clumps of prairie buttercup that were salvaged and translocated in 2022 had surviving individuals (14 of 16; 88%). Four of the clumps showed individuals with inflorescences and seedheads (Plate 3.4-42).

Plate 3.4-41. Beaver activity and loss of shrub cover at site ID: RANURHO-2022-C (June 11, 2024)

Plate 3.4-42. Developing seedheads on a monitored adult prairie buttercup at site ID: RANURHO-2022-C (June 11, 2024)

3.4.6 Slender penstemon (*Penstemon gracilis*)

Slender penstemon at PENSGRA-2020-A and PENSGRA-2020-B were monitored by Eagle Cap on August 2 and 3, 2024. The slender penstemon at PENSGRA-2021-C (near Hudsons' Hope) were monitored on June 9, 2024, and watered and interim monitored on July 6 and August 28, 2024.

All 25 individuals at PENSGRA-2020-A were assessed and had survived (100%; Plate 3.4-43). Eighteen of the individuals were beginning to develop seed capsules. Of the 25 individuals planted at PENSGRA-2020-B, six survived (24%; Plate 3.4-44) and three of the survivors (12%) were beginning to develop seed capsules. No recruits were observed.

Plate 3.4-43. Sample of slender penstemon with inflorescences and developing seed pods at site ID: PENSGRA-2020-A (August 3, 2024)

Plate 3.4-44. Sample of slender penstemon developing seed heads at site ID: PENSGRA-2020-B (August 2, 2024)

At site PENSGRA-2021-C cohort 2 (individuals planted on the aeolian cap), all 20 plants (100%) were present when monitored on June 9, 2024, in which 13 out of 20 plants (65%) were developing inflorescences (Plate 3.4-45 to Plate 3.4-47). No recruits were detected.

Water was provided to each of the plants after interim and final monitoring was completed, and missing tags were replaced. Cohort 2 was nursery-grown and translocated in a shadier portion of the upper slope that contained stone-free aeolian soils, which may have helped retain moisture, thereby contributing to the survival of these plants.

Efforts were also made to detect survival of any salvaged penstemon that had been interplanted with salvaged selaginella in 2021. There were no penstemon detected and the low survival rate was expected due to transplant stress and the 2021 heat dome that followed.

Plate 3.4-45. Example of an adult slender penstemon (tag 056) with flower heads developing (June 9, 2024; site ID: PENSGRA-2021-C-Cohort 2)

Plate 3.4-46. Example of an adult slender penstemon (tag 056) with flower heads developing into seedheads (July 6, 2024; site ID: PENSGRA-2021-C-Cohort 2)

Plate 3.4-47. Example of an adult slender penstemon (tag 056) with seedheads (August 28, 2024; site ID: PENSGRA-2021-C-Cohort 2)

3.4.7 Rock selaginella (*Selaginella rupestris*)

At site SELARUP-2021-A (Farrell Creek founder site), rock selaginella that were salvaged in 2021 (cohort 1) and the nursery propagated selaginella (tags 096 and 065 – cohort 2) were monitored on June 9, 2024, and re-checked and watered on July 6 and August 28, 2024.

All selaginella showed dormant foliage (yellowish green) in June (Plate 3.4-48 and Plate 3.4-49) and showed green foliage with spike-like reproductive structures when observed in July (Plate 3.4-50 and Plate 3.4-51).

Rock selaginella can reproduce vegetatively (via adventitious roots) as well as sexually (via spores). Quantifying reproductive success is difficult in this species due to challenges in identifying recruits and its more complex life cycle. Spores have been observed ripening and dispersing in early June; however, new sporophytes (recruits) may not be visible until further developed (M. Krichbaum, personal communication, May 31, 2021). Observing recruits formed from fragmented and dispersed individuals is possible, however, distinguishing a recruit from the parent individual over a large area of translocated selaginella is very challenging. Because the visual condition of selaginella can vary widely within a season depending on environmental conditions, tracking growth over is challenging.

Plate 3.4-48. Example of rock selaginella tag 096 with dormant foliage on June 9, 2024 (site ID: SELARUP-2021-A-Cohort 2)

Plate 3.4-49. Example of rock selaginella tag 065 with dormant foliage on June 9, 2024 (site ID: SELARUP-2021-A-Cohort 2)

Plate 3.4-50. Example of rock selaginella tag 096 with greening leaves and developing spike-like reproductive structures on July 6, 2024 (site ID: SELRAUP-2021-A-Cohort 2)

Plate 3.4-51. Example of rock selaginella tag 096 with greening leaves and developing spike-like reproductive structures on July 6, 2024 (site ID: SELRAUP-2021-A-Cohort 2)

3.4.8 Torrey's sedge (*Carex torreyii*)

Monitoring occurred at site ID: CARETOR-2021-A on June 13, 2024, and at site IDs: CARETOR-2023-B and CARETOR-2023-C on June 13 and 14, 2024 with watering and interim monitoring conducted on July 5 and 6, 2024.

At site CARETOR-2021-A, all eight individuals (100%) survived, and seven out of eight (87%) had inflorescences. The larger (1-gallon) plants appeared to be in better condition and had more seed heads than the individuals planted as 50P plugs (Plate 3.4-52 and Plate 3.4-53). No recruits were observed.

Plate 3.4-52. Example of adult Torrey's sedge (size 1G; tag 086) at site CARETOR-2021-A on June 13, 2024

Plate 3.4-53. Example of adult Torrey's sedge (size 50P; tag 088) at site CARETOR-2021-A on June 13, 2024

At site ID: CARETOR-2023-B (Leahy Pit Road location), nine of ten (90%) Torrey's sedge had survived in which eight possessed seedheads (Plate 3.4-54). The one mortality appeared to have been pushed out of the ground due to frost heaving (Plate 3.4-55). No recruits were observed.

At site ID: CARETOR-2023-C (Beatton Valley trail location), all ten Torrey's sedge were present and producing seedheads. At site 2A, seven recruits were detected and tagged for future monitoring (Plate 3.4-56).

At site 1A, two more Torrey's sedge had been planted in June of 2024 (Section 3.3.2) and a new site ID: CARETOR-2024-D was planted with four Torrey's sedge. All individuals were accounted for during interim monitoring on July 6 and August 29.

Plate 3.4-54. Example of adult Torrey's sedge at site ID: CARETOR-2023-C-1A on July 6, 2024

Plate 3.4-55. Torrey's sedge mortality (tag 404) at site ID: CARETOR-2023-B-1A on June 14, 2024

Plate 3.4-56. Example of Torrey's sedge recruit at site ID: CARETOR-2023-C-2A on July 6, 2024

3.4.9 Sprengel's sedge (*Carex sprengelii*)

Population monitoring of Sprengel's sedge was conducted at four sites: CARESPR-2020-B (June 10), CARESPR-2021-C (June 10), CARESPR-2023-D (June 13), and CARESPR-2023-E (June 12), followed by

watering and interim monitoring in July and August. All inflorescences appeared to be in earlier stages of development (showing early stigma on the female reproductive structures – see Plate 3.4-57) compared to previous years, presumably due to cooler temperatures experienced in the spring of 2024.

Plate 3.4-57. Example of Sprengel's sedge inflorescence showing early stigma on female reproductive structures at site CARESPR-2020-B-1B on June 10, 2024

At site ID: CARESPR-2020-B-1A (planted in 2020 and 2021), two out of two monitored individuals survived, with no inflorescences observed (Plate 3.4-58). At site ID: CARESPR-2020-B-1B, five out of five individuals monitored were present (Plate 3.4-59), with one individual having produced inflorescences. During interim monitoring, site 1B showed some disturbance (fallen willow across the site; Plate 3.4-60). No recruits were observed.

All 34 Sprengel's sedge planted between three sites (CARESPR-2021-C, CARESPR-2023-D, and CARESPR-2023-D) were observed to be present and in good condition in which 25 (73%) were producing seedheads during final and interim monitoring (Plate 3.4-61 to Plate 3.4-63). No recruits were observed.

During interim monitoring in July, the individuals planted at CARESPR-2021-C were difficult to detect due to swaths of smooth brome growing at the site Plate 3.4-64). The accumulation of leaf litter also made it difficult to detect the ziptie rings installed around each plant. In 2025, action will be taken to improve locating these individuals for monitoring.

Plate 3.4-58. Example of adult Sprengel's sedge (tag 001) at site ID: CARESPR-2020-B-1A on June 10, 2024

Plate 3.4-59. Example of adult Sprengel's sedge (tag 003) at site ID: CARESPR-2020-B-1B on June 10, 2023)

Plate 3.4-60. Fallen willow at site ID: CARESPR-2020-B-1B on July 5, 2024

Plate 3.4-61. Example of adult Sprengel's sedge with inflorescences (tag 426) at site ID: CARESPR-2021-C (cohort 2) on June 10, 2024

Plate 3.4-62. Example of adult Sprengel's sedge with inflorescences at site ID: CARESPR-2023-D-1A on June 13, 2024

Plate 3.4-63. Example of adult Sprengel's sedge at site ID: CARESPR-2023-E on September 6, 2023

Plate 3.4-64. Example of adult Sprengel's sedge at site ID: CARESPR-2021-C (cohort 2) on September 6, 2023

3.5 PRELIMINARY DATA ANALYSIS

In previous years, monitoring results were summarized on an annual basis. However, with five years of data now available for certain sites, methods were developed in 2024 to facilitate comparisons of monitoring results throughout the years. Although longer-term monitoring will be required to infer trends with more certainty, patterns gleaned from preliminary analyses may provide early insight into translocation success and site suitability.

In 2024, the initial phase of analysis focused on four species: Sprengel's sedge, dryland sedge, Davis' locoweed, and slender penstemon.

3.5.1 Sprengel's sedge

Two Sprengel's sedge translocation sites were analyzed in 2024 - site IDs: CARESPR-2020-B cohorts 1 and 2 (referred to as Site B); and CARESPR-2021-C (referred to as Site C; Figure 3.3-1). Sprengel's sedge varied in survivorship across sites and cohorts (Figure 3.5-1). Survival was highest (100%) at Site B - cohort 1, intermediate (50%) at Site C - cohort 1, and lowest (22%) at Site B - cohort 2 (Table 3.5-1).

At Site B - cohort 2 and at Site C - cohort 2 (sites with the lowest survivorship), individuals were monitored the same year they were translocated which indicates that mortality appears to have only occurred that year (in 2021), with survival remaining constant in subsequent monitoring years. Transplant shock may have led to the initial mortality in those cohorts. It should be noted that sample size was low for this species (ranging from 2-9 individuals per cohort; Table 3.5-1), which should be taken into consideration when interpreting the results. For example, the majority of the data presented here for site ID: CARESPR-2021-C represents a single surviving individual between 2022-2024 and is not representative of a population of transplants.

Reproductive characteristics varied across cohorts and sites as well. At Site B, cohort 1 individuals flowered in alternating years, while cohort 2 individuals did not flower until 2024, and a maximum of 50% of individuals flowered at any given time. On the other hand, 100% of individuals at Site C flowered in their second year and continued flowering through 2024. Reproductive output varied across cohorts and years but was generally 1-3 flowering stems per individual with a peak of 2.8 average flowering stems (site B - cohort 1 in 2021).

Recruitment was low at both sites, with only a single new seedling detected in 2022 at Site B - cohort 1. Low recruitment may be attributed to low seed-to-soil contact (high leaf litter content), thereby reducing germination success. In addition, without inflorescences, Sprengel's sedge seedlings would be difficult to identify, especially when growing among other grasses and sedges.

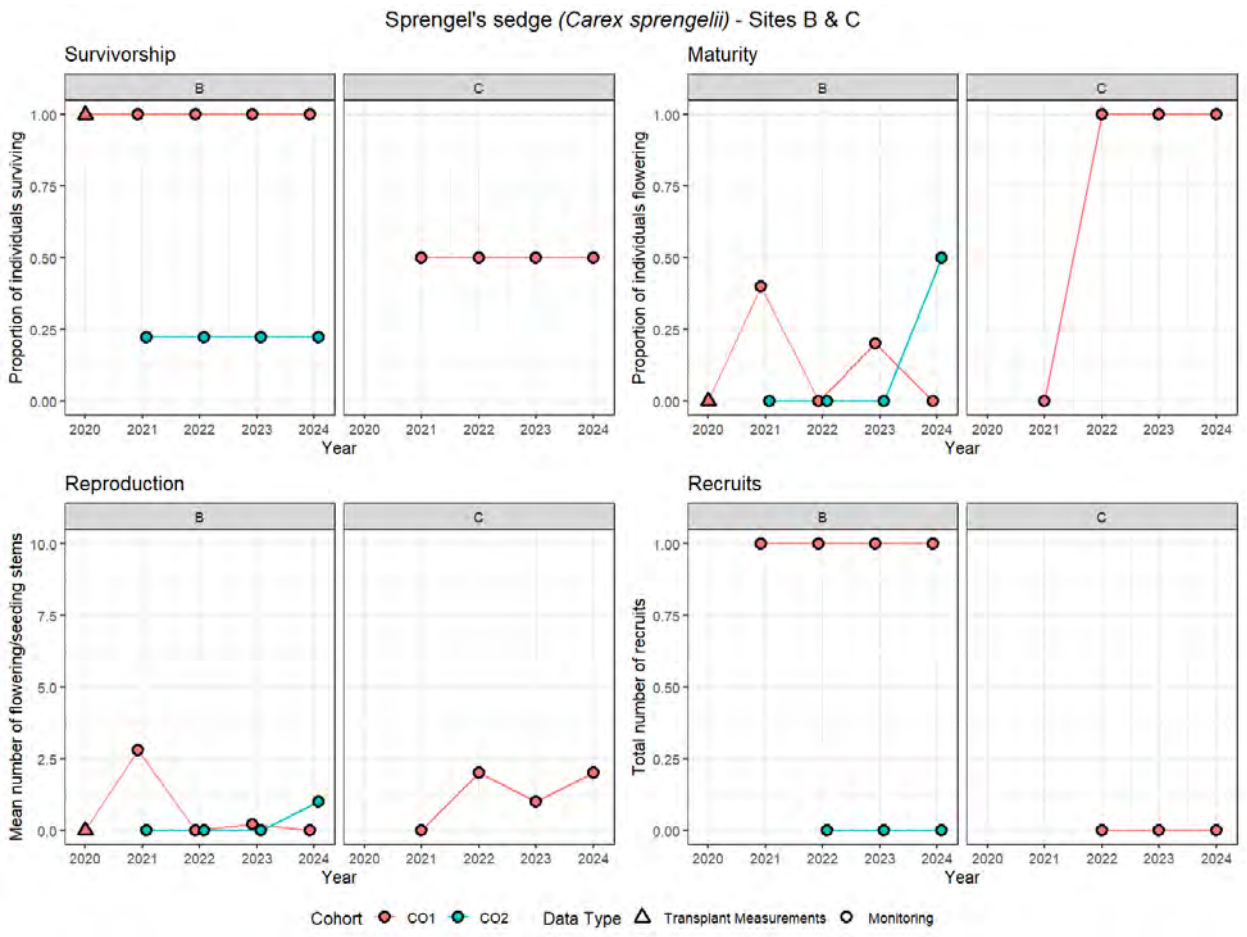


Figure 3.5-1. Patterns of survivorship, flowering, reproduction, and recruitment over time for Sprengel's sedge at site ID: CARESPR-2020-B and CARESPR-2021-C (Sites B and C). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites

Table 3.5-1. Summary statistics for Sprengel's sedge based on monitoring data collected between 2020 and 2024

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
B	CO1	2020	1	0	0	-	5
B	CO1	2021	1	0.4	2.8	1	5
B	CO1	2022	1	0	0	1	5
B	CO1	2023	1	0.2	0.2	1	5
B	CO1	2024	1	0	0	1	5
B	CO2	2021	0.22	0	0	-	9
B	CO2	2022	0.22	0	0	0	9
B	CO2	2023	0.22	0	0	0	9

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
B	CO2	2024	0.22	0.5	1	0	9
C	CO1	2021	0.5	0	0	-	2
C	CO1	2022	0.5	1	2	0	2
C	CO1	2023	0.5	1	1	0	2
C	CO1	2024	0.5	1	2	0	2

3.5.2 Dryland sedge

Two dryland sedge translocation sites were analyzed in 2024 – site IDs: CAREXER-2020-D (referred to as Site D) and CAREXER-2020-E (referred to as Site E). Dryland sedge survival trajectories differed between Sites D and E, where mortality increased more rapidly at Site D (55% survival in 2024) than at Site E (80% survival in 2024; Figure 3.5-2; Table 3.5-2). This suggests that site conditions at Site D are less favorable for dryland sedge survival compared to Site E, potentially due to differences in environmental variables (e.g., soil composition, moisture availability).

The majority of individuals (83-100%) flowered in all years, with the exception of Site D in 2023 where only 35% had flowered. The average number of flowering stems ranged between approximately 2-7 across years and sites but showed a pattern of decreasing numbers over time.

No recruits were successfully identified at either of the plots for this species. It is important to note that although recruitment may have occurred, distinguishing between seedling species (and therefore the successful identification of dryland sedge seedlings) based solely on vegetative characteristics was extremely challenging at the time of monitoring.

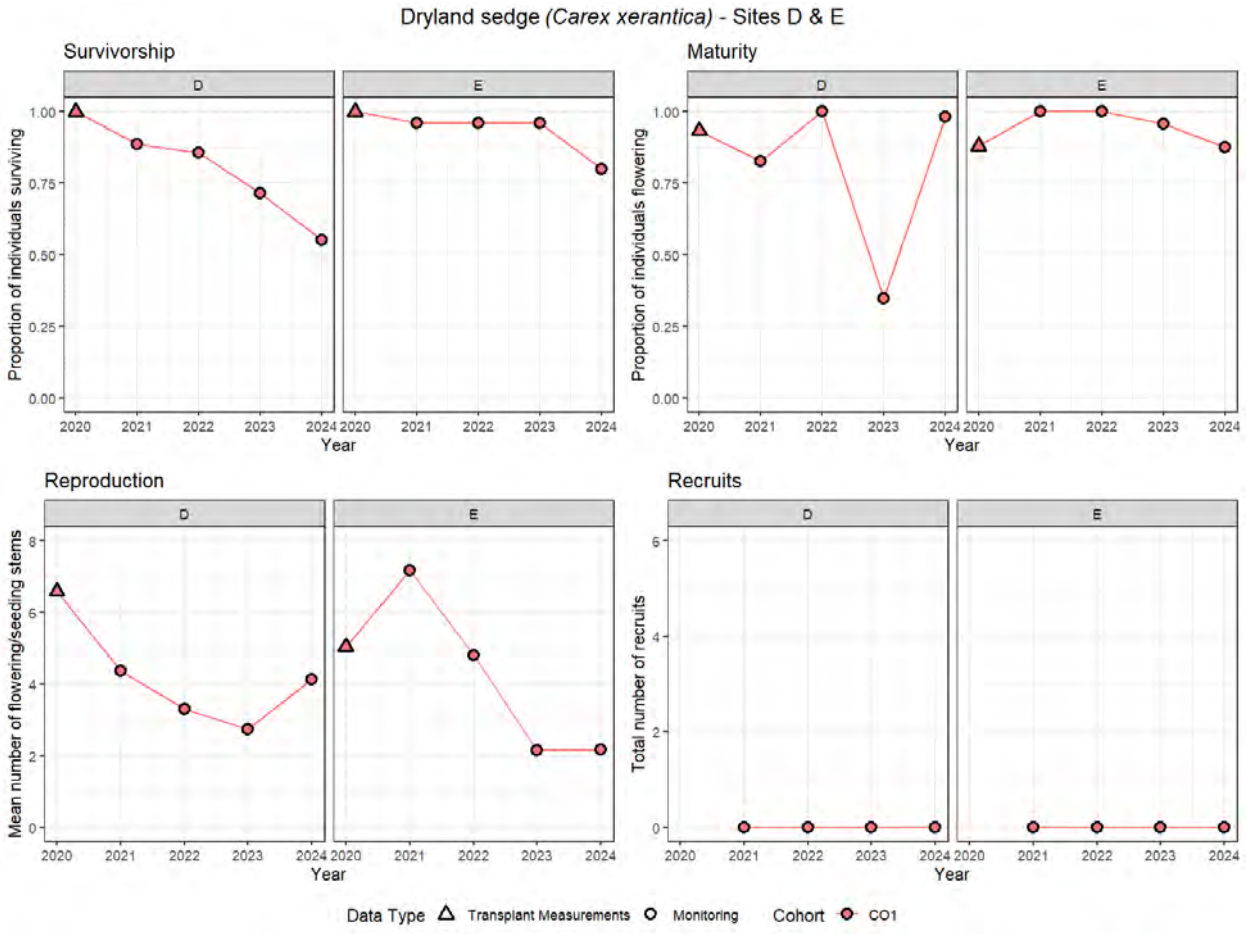


Figure 3.5-2. Patterns of survivorship, flowering, and reproduction over time for dryland sedge at site IDs: CAREXER-2020-D and CAREXER-2020-E (Sites D and E). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites

Table 3.5-2. Summary statistics for dryland sedge based on monitoring data collected between 2020 and 2024

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
D	CO1	2020	1.00	0.93	6.59	-	105
D	CO1	2021	0.89	0.83	4.37	0	105
D	CO1	2022	0.86	1.00	3.30	0	105
D	CO1	2023	0.71	0.35	2.73	0	105
D	CO1	2024	0.55	0.98	4.14	0	105
E	CO1	2020	1.00	0.88	5.05	-	50
E	CO1	2021	0.96	1.00	7.19	0	50
E	CO1	2022	0.96	1.00	4.81	0	50

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
E	CO1	2023	0.96	0.96	2.15	0	50
E	CO1	2024	0.80	0.88	2.17	0	50

3.5.3 Davis' locoweed

Two Davis' locoweed translocation sites were analyzed in 2024 – site IDs: OXYTCAM3-2020-C cohorts 1 to 4 (Site C) and OXYTCAM3-2022-E (Site E). Due to the large number of individuals translocated at Site C, it was not feasible, within the constraints of time and budget, to monitor every individual annually. As a result, the monitoring data for this site represents a subset of the full translocated population, with the sampled individuals varying each year. Despite this limitation, the sample sizes during each monitoring period were sufficiently large to provide representative averages and accurately reflect performance patterns over time.

Davis' locoweed survivorship was generally high across cohorts and sites (Figure 3.5-3; Table 3.5-3), with all cohorts maintaining over 75% survival in 2024 except at Site C – cohort 4, with 58% survival in 2024. The majority of subplots at Site C – cohort 4 were located at a different microsite than the other cohorts (more exposed and sandier) which may attribute to its lower success. While there were fewer individuals and only a single cohort transplanted at Site E, survivorship followed a similar pattern as at Site C. The overall high survival rates across sites indicate that the translocation methods employed were effective and well-suited for Davis' locoweed. Additionally, the results suggest that the selected sites provided sufficiently favorable conditions to support establishment and survival in the initial years, even under variable circumstances.

Flowering and reproductive output at Site C showed an alternating pattern over time, with sharp increases in 2021 and 2023 followed by decreases in following years, though this pattern was less pronounced in Site C - cohort 2. On the other hand, the individuals at Site E maintained consistent and intermediate reproductive traits over time.

The number of recruits detected increased over time, likely reflecting the time required for plants to establish, produce seeds, and build up a sufficient seed bank to support noticeable recruitment in subsequent years. There was variation in the number of recruits detected among cohorts, with Site C – cohort 3 reaching a maximum of 26 recruits in 2024 and the others ranging from 6-11. These recruitment patterns suggest that site conditions created favorable environments for Davis' locoweed establishment and reproduction.

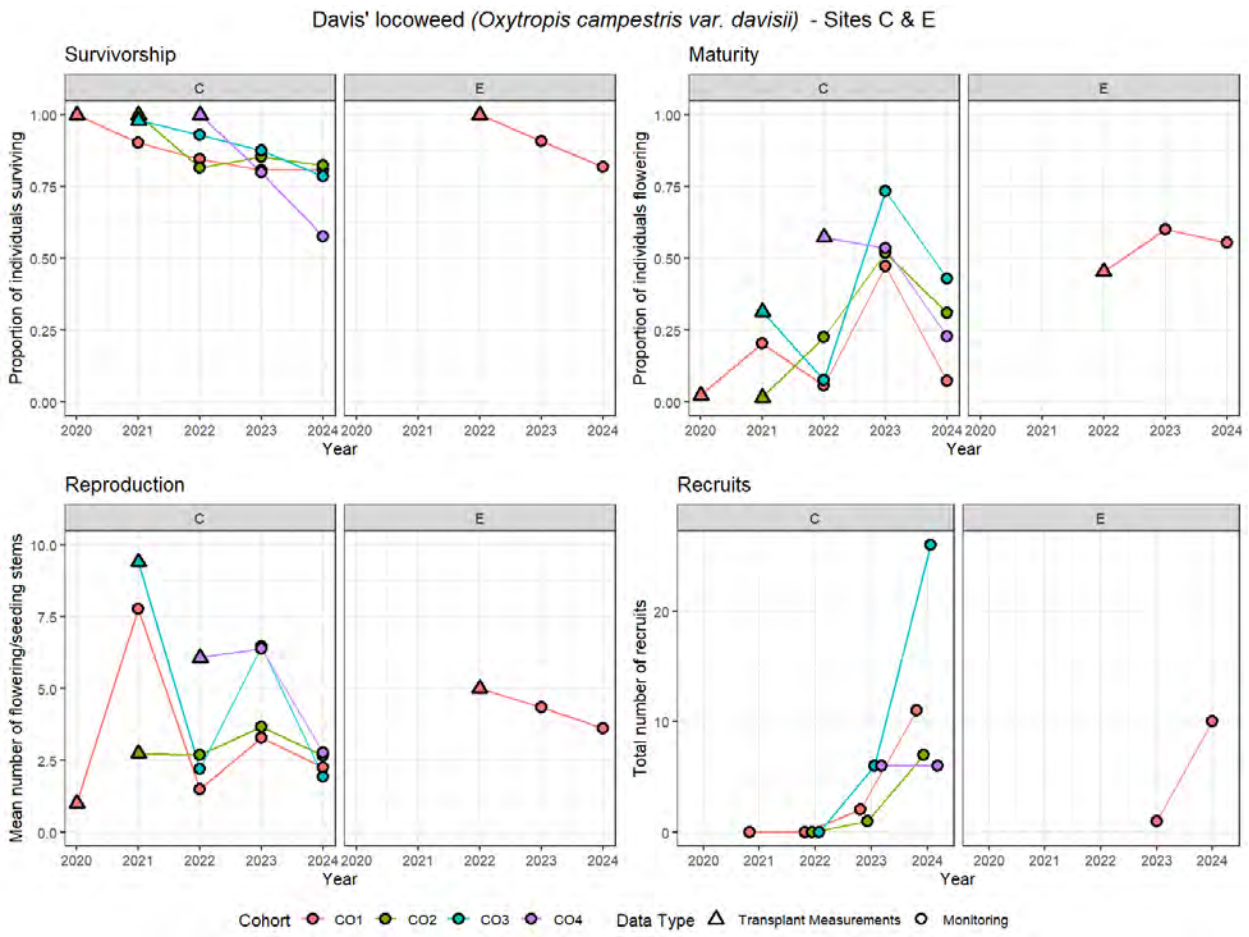


Figure 3.5-3. Patterns of survivorship, flowering, reproduction, and recruitment over time for Davis' locoweed at site IDs: OXYTCAM3-2020-C and OXYTCAM3-2022-C (Sites C and E). The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites

Table 3.5-3. Summary statistics for Davis' locoweed based on monitoring data collected between 2020 and 2024

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
C	CO1	2020	1.00	0.02	1.00	-	94
C	CO1	2021	0.90	0.20	7.76	0	94
C	CO1	2022	0.85	0.06	1.50	0	85
C	CO1	2023	0.81	0.47	3.28	2	64
C	CO1	2024	0.81	0.07	2.25	11	68
C	CO2	2021	1.00	0.01	2.75	-	349

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
C	CO2	2022	0.82	0.22	2.69	0	71
C	CO2	2023	0.86	0.52	3.67	1	139
C	CO2	2024	0.82	0.31	2.65	7	193
C	CO3	2021	0.98	0.31	9.42	-	107
C	CO3	2022	0.93	0.08	2.20	0	71
C	CO3	2023	0.88	0.73	6.46	6	113
C	CO3	2024	0.79	0.43	1.92	26	107
C	CO4	2022	1.00	0.57	6.08	-	174
C	CO4	2023	0.80	0.53	6.39	6	60
C	CO4	2024	0.58	0.23	2.77	6	168
E	CO1	2022	1.00	0.45	5.00	-	11
E	CO1	2023	0.91	0.60	4.33	1	11
E	CO1	2024	0.82	0.56	3.60	10	11

3.5.4 Slender penstemon

Three slender penstemon translocation sites were analyzed in 2024 – site IDs: PENSGRA-2020-A (Site A); PENSGRA-2020-B (Site B); and PENSGRA-2021-C (Site C). Monitoring did not occur for slender penstemon at Site A in 2021, so that time period was not included in the analysis.

Slender penstemon survivorship remained consistently high at 100% over time at Sites A and C, but showed a marked decline at Site B, where survival dropped to 24% by 2024 (Figure 3.5-4; Table 3.5-4). This sharp decline may reflect unfavorable site conditions at Site B, such as soil composition, microclimate, or other environmental factors that were less suitable for slender penstemon survival.

Reproductive traits showed an alternating pattern, with a peak in both the number of flowering individuals and stems in 2022 followed by a subsequent decline. Individuals at Site C on the other hand, peaked in the year of translocation, with a subsequent steep decline in reproductive output. A decline in flowering is expected since the translocated plants were taken from nursery conditions that tend to optimize growth and reproductive potential in controlled environments.

Recruitment was minimal across all three sites. No recruits were observed at Site A, while Site B recorded two recruits in 2021, and Site C had one recruit in both 2023 and 2024. Given the substantial proportion of individuals that reached reproductive maturity, it is unlikely that low recruitment was caused by insufficient reproductive output. Limited recruitment could be attributed to site-specific environmental constraints. At Site C for example, in combination with more exposed soils, and steeper slopes at this site, seeds could easily be carried downhill after a rain event.

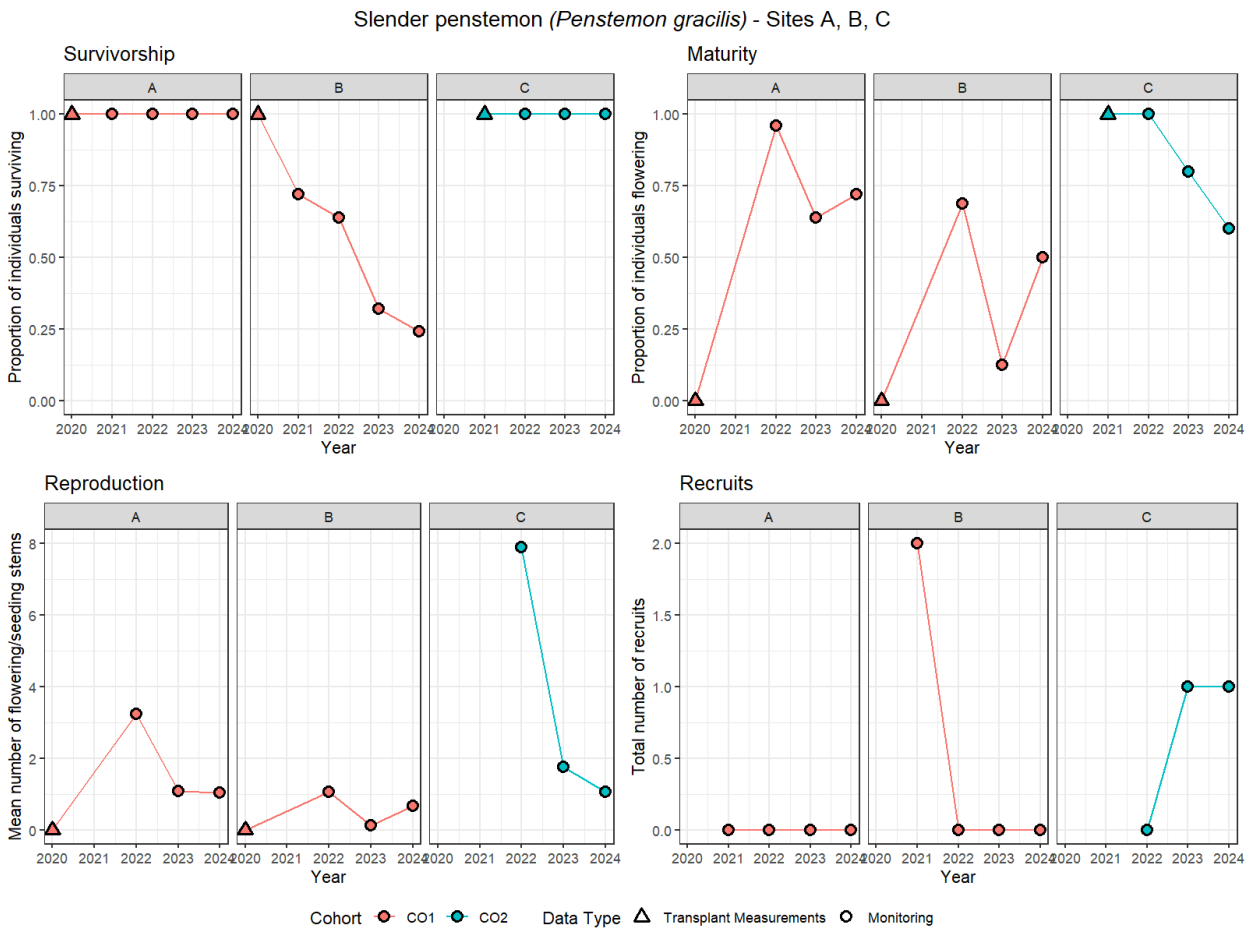


Figure 3.5-4. Patterns of survivorship, flowering, reproduction, and recruitment for slender penstemon at Sites A, B, and C. The data for sites are faceted into separate paired plots for each trait, with cohorts represented with different colored lines within sites

Table 3.5-4. Summary statistics for slender penstemon based on monitoring data collected between 2020 and 2024

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
A	CO1	2020	1.00	0	0	-	25
A	CO1	2021	1.00	-	-	0	25
A	CO1	2022	1.00	0.96	3.24	0	25
A	CO1	2023	1.00	0.64	1.08	0	25
A	CO1	2024	1.00	0.72	1.04	0	25
B	CO1	2020	1.00	0	0	-	25
B	CO1	2021	0.72	-	-	2	25
B	CO1	2022	0.64	0.69	1.06	0	25

Site ID	Cohort	Year	Average Survivorship	Average Maturity	Average Reproduction	Total Recruits	Sample Size
B	CO1	2023	0.32	0.13	0.13	0	25
B	CO1	2024	0.24	0.50	0.67	0	25
C	CO2	2021	1.00	1.00	13.50	-	20
C	CO2	2022	1.00	1.00	7.90	0	20
C	CO2	2023	1.00	0.80	1.75	1	20
C	CO2	2024	1.00	0.60	1.05	1	20

3.6 YEAR IN REVIEW SUMMARY

This section summarizes what was achieved in 2024 from goals established at the end of year 2023. The goals and efforts taken for 2024 are summarized in Table 3.6-1.

Table 3.6-1. Summary of goals achieved in 2024

2023 Goals	Achievement Status (2024)	Details
Focus propagule collection efforts on Torrey's sedge, since both *in-situ* and *ex-situ* collection efforts were unsuccessful in 2022 and 2023.	Ongoing	42 seeds were collected in-situ and sent to the native plant nursery for propagation.
Generate new plants from the Canada mountain-ricegrass seeds at native plant nurseries.	✓	The goal of generating a target of 100 Canada mountain-ricegrass was achieved in 2024 (a total of 139 one-gallon pots was made available for planting and 55 of those individuals were planted this year).
Enhance further proliferation of rock selaginella cuttings in the nursery.	In Progress	Cuttings from existing trays were used to further propagate rock selaginella in 2023. Five trays continue to be grown out (growers have observed that growth has been slow).
Generate a seed bank and new stock for species with lower germination rates (i.e., Torrey's sedge).	Ongoing	The goal of generating a target of 50 Torrey's sedge plants was communicated with the native plant nursery in 2023. A total of 12 plants were made available for planting, with six of these individuals translocated in 2024. The 42 seeds collected this year will help reach the target.

2023 Goals	Achievement Status (2024)	Details
Translocation efforts will continue to focus on distributing plants across a larger number of recipient sites to build resilience into the program and help alleviate the impacts of stochastic events (e.g., floods, fires, landslides) on the overall program objectives.	Ongoing	Canada mountain-ricegrass was planted at a new location (Clayhurst) in 2024 and two new sites were established to support Canada mountain-ricegrass, Torrey's sedge, and prairie buttercup (see Section 3.3: Translocation Implementation for further details).
Translocation will occur in the spring for those species that naturally occur in dryland habitats to facilitate establishment and survivability when moist conditions are more readily available.	✓	All translocation efforts in 2024 occurred in the spring.
Understand facets of population dynamics of select target species through statistical analysis.	In Progress	Preliminary data analysis has commenced in 2024 for four species (Davis' locoweed, Sprengel's sedge, dryland sedge, and slender penstemon).
Improve the detectability of species using alternate markings that are more visible throughout the entire growing season.	✓	Zip tie rings were placed around all translocated Torrey's sedge and Canada mountain-ricegrass in 2024. The ziptie rings have improved the detection of these species for monitoring.
Identify opportunities for improvement within an adaptive management framework.	✓	Ongoing maintenance to previously installed cages and collars, weed removal, and watering are some of the opportunities identified in 2024. See Section 3.7: Plan Forward for further details.
Develop a plan for enhancing tall wood beauty populations within the program.	In Progress	Seed collected in 2023 and 2024 has been sent to the native plant nursery for potential propagation and seeding trials will commence in 2025.

3.7 DISCUSSION

Translocation efforts will continue to focus on distributing plants across a larger number of recipient sites, increasing program resilience against stochastic events. To enhance establishment and survivability, translocation will occur in the spring —when moisture availability is higher- for species that naturally occur in dryland habitats. Additionally, for species adapted to drier conditions, translocation may be prioritized

during wetter seasons if forecasted, and supplemental watering, mulch application, and site selection with greater shade cover may be necessary if dry conditions persist.

Improving detectability remains a priority, with measures such as coloured tags and flagging remaining visible across seasons. Re-flagging routes and plot numbers will be conducted as needed to support monitoring efforts. Additional methods under consideration include collars around individual plants with low detectability (i.e., Canada mountain-ricegrass and prairie buttercup). The detection of recruits, which can be millimeter-scale seedlings in natural settings, presents a significant challenge. To address this, a combination of fine-scale field techniques and advanced technologies is being explored.

Protection against herbivory will continue through the use of rose collars, wire cages and other fencing alternatives, where needed. The decision on when to remove protective measures as plants establish is ongoing and will be guided by monitoring results.

A preliminary analytical framework was developed to evaluate the outcomes of long-term monitoring efforts for a selection of species and sites. Analyses focused on averages of key metrics that had been consistently collected: survivorship, maturity, reproduction, and recruitment. Summarizing the trajectories of these traits across sites provides insight into whether transplants are capable of establishing, reproducing, and persisting as viable populations. Results were presented through visualizations of yearly average values for each trait over time, with cohorts and sites displayed separately within species to highlight differences among transplant and monitoring years. These visualizations were accompanied by summary tables displaying the average values for each metric.

Preliminary results showed variation in species responses, both between species and across different sites within species. Sprengel's sedge exhibited high survivorship at one site but considerable mortality at others, possibly due to transplant shock or drought. Reproductive output was inconsistent, and recruitment remained limited, potentially due to environmental factors influencing seed establishment. Dryland sedge showed higher survivorship at one site than the other, with flowering rates generally high but declining over time. No successful recruitment was observed, due in part to challenges in seedling identification. Davis' locoweed demonstrated high survivorship across most cohorts, although monitoring constraints at one site affected the assessment of performance. These early findings offer valuable insights into translocation success and habitat conditions, forming a basis for ongoing monitoring efforts and a statistical framework for future analyses.

As all phases of the program work concurrently, an adaptive management framework is being used to identify and implement improvements throughout the program's duration.

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APPENDIX A. POTENTIAL RECIPIENT SITE SELECTION METHODS & RESULTS MEMO

EAGLE CAP CONSULTING
environmental consulting services

MEMO

Date: November 19, 2024

To: Natasha Bush (EcoLogic)

From: Randy Krichbaum (Eagle Cap), Margaret Krichbaum (Eagle Cap)

Subject: Site C ERPT Program: Potential Recipient Site Selection Methods & Results

INTRODUCTION

An important component of the Site C Experimental Rare Plant Translocation (ERPT) program is the selection of suitable recipient sites for planting of propagules collected from the project activity zone. Program planning in the spring of 2024 identified a need for additional recipient sites to accommodate the propagules available for outplanting. This memo outlines the methods and results of the recipient site selection work performed in 2024.

The goal of this work was to locate and document suitable recipient sites for planting of rare plant propagules (seeds, achenes, spores, and started plants). The sites needed to meet a number of criteria regarding habitat (both biotic and abiotic components), accessibility, and geographic location.

METHODS

Prefield Review

A prefield review was conducted to identify and delineate possible recipient areas for later verification in the field. The review followed a structured workflow designed to locate the optimal planting locations based on the desired site characteristics.

A team of two qualified botanists completed the majority of the prefield and field portions of this work, in consultation with the ERPT program manager. The botanists have performed extensive rare plant work in the BC Peace River area, and as such are familiar with both the habitat requirements of rare species and the logistics of working in the Peace Region.

One of the nine taxa currently in the ERPT program was selected by the program manager as being in need of additional recipient sites for translocation: *Piptatheropsis canadensis* (Canada ricegrass).

The project botanical team met in May of 2024 to review the target species list and define desired recipient site characteristics for Canada ricegrass. Each desired site characteristic was also assigned a weighting to reflect its relative importance to successful propagule establishment. This allowed for the potential recipient sites to be ranked for suitability following the field visits.

The prefield review identified 13 desirable characteristics of the potential recipient sites. While no potential recipient site can meet all of the listed criteria, the intent of the work was to locate the best possible sites given the limitations present. An ideal site would have the following characteristics:

- contain suitable high-quality habitat for the specific rare plant taxon
- be located in the Peace River region of BC
- be located on land owned by BC Hydro or on Crown land
- not be located on lands requiring access through a locked gate or other owner permission
- not be located in the Site C Project Activity Zone (PAZ)
- not be located below the reservoir preliminary Erosion Impact Line (EIL - a precautionary estimate of the amount of erosion that could occur over a 100 year period)
- be accessible by road or boat during the entire growing season
- have a low likelihood of future disturbance
- have a low percentage of non-native plants
- have good cell service
- be more than one kilometre from known occurrences of the same taxon
- not contain known occurrences of other rare plant taxa
- be close to a source of water

A literature review was conducted for each of the nine species in the 2024 ERPT program to evaluate any new information relevant to the translocation work. This included checks of recent BC Conservation Data Centre (BCCDC) information to uncover any new element occurrences or changes to rare status, and a Google Scholar search for literature on the nine species published since 2023. The review supplemented literature searches conducted in previous years for the translocation project. Queries were also run on the project rare plant database to uncover apparent habitat associations for Canada ricegrass based on updated field data.

The habitat needs for Canada ricegrass were then reviewed in order to aid in the visual evaluation of aerial imagery. These habitat affinities were: moist to dry, shrubby to open, level to sloped, aspect variable, fair to good condition native low- to mid-height shrub grassland or edges of deciduous or mixed woodlands.

Using the list of desired site characteristics, the habitat types, and other collected information, Geographic Information System (GIS) layers were visually examined and potential recipient sites were selected. Primary GIS layers used for this phase of the prefield review were:

- aerial imagery of the BC Peace River region;
- property ownership provided by BC Hydro;
- known element occurrences of the target taxa;
- potential recipient sites documented in previous years;
- the Site C Project Activity Zone; and
- the preliminary Erosion Impact Line.

Field Verification

Once recipient areas had been marked in the GIS, selected sites were inventoried in the field to determine suitability. Suitable Potential Recipient Sites (PRS) were evaluated and documented, with the data entered into

a digital form for later analysis. Data elements collected included all those typically required by the BCCDC to document rare vascular plant element occurrences, as well as ratings for each of the 13 desired site characteristics.

In addition to the vegetation composition and cover data recorded for the overall site, in certain cases three supplemental one-metre-square vegetation plots were placed in representative locations. Species codes, with their associated percent covers, were recorded on a paper form for later analysis.

Potential Canada ricegrass recipient sites were selected partially based on distance to other planting sites, with the aim of distributing them over a wide geographical extent. In some instances, a potential Canada ricegrass site was found to contain suitable habitat for several ERPT program species in close proximity, and this was noted in the site evaluation. While this does provide the option to plant other ERPT program species at the same site, with the consequent increased risk of a single disturbance event impacting multiple species, the limited number of suitable sites available necessitated using one site for several species in some cases. In addition, Canada ricegrass can occur together with several of the program species in wild populations.

RESULTS

Prefield Review

The literature search uncovered two recent references containing information potentially relevant to the translocation of the ERPT program species:

- *Native Forbs Grown Under Green Roof Conditions Have Altered Biomass Allocation Strategies and Can be Supported by Commercially-Available Arbuscular Mycorrhizal Fungi* (Durr & Ksiazek-Mikenas 2024)
- *Best practices, errors, and perspectives of half a century of plant translocation in Italy* (D'Agostino et al. 2024)

The queries run on the Site C rare plant database to identify habitat associations for the single target species needing recipient sites (Canada ricegrass) did not suggest any new correlations that had not been uncovered in previous years. These indicated that the known Canada ricegrass occurrences were found in open, mesic to xeric, relatively flat (0-3° slope) habitats.

A total of eight planting areas that appeared to have a high likelihood of meeting the requirements for Canada ricegrass recipient sites were selected from the examination of the GIS layers. The most weight was given to the *appropriate habitat types* and *ease of legal access* criteria. All eight areas were thought to contain habitat for multiple rare taxa. Not all potential planting areas in the BC Peace Region were considered; rather the review focussed on areas that appeared to be easily accessible by road from Fort St. John. Therefore, if additional potential recipient sites are required in the future, the as-yet unreviewed portions of the BC Peace region remain for consideration.

A unique PRS point was then generated for each planting area microsite thought to have suitable habitat for translocation of Canada ricegrass. These points were intended to speed the field verification work by directing the surveyors' effort on the ground towards microsites of the best quality habitat. There was no expectation

that every PRS point would be field checked, and the exact location for each actual PRS plot was to be decided in the field after a cursory area survey.

All of the PRS points used for the 2024 Canada ricegrass recipient site evaluation work had been generated previously, during the prefield reviews completed from 2019 to 2023 for the project.

Field Verification

The team of two botanists performed the field verification work between June 8 and 10, and on August 3, 2024. In preparation, the eight selected planting areas were grouped according to the general access route to allow for efficient survey days. Of the eight planting areas delineated, all received either complete or partial field checks in 2024 (Table 1). All areas were reached by road from Fort St. John, with the closest area located approximately four kilometres away, and the farthest area approximately 95 km from the town.

Table 1: ERPT Potential Planting Areas Considered in 2024

Planting Area ID	Field Checked 2024?	Field Check Date(s)	Details
6	yes	2024-06-10	Set Aside for Future Consideration
17	yes	2022-06-09, 2024-06-09	Plot completed in 2022
28	yes	2022-08-02, 2024-08-03	Plot completed in 2022; Set Aside for Future Consideration
40	yes	2020-10-09, 2022-07-28, 2023-06-08, 2024-06-09	Plots Completed in 2022
49	yes	2022-07-29, 2024-06-08	Set Aside for Future Consideration
59	yes	2023-09-08, 2024-06-08	Removed from Consideration in 2024
60	yes	2023-09-12, 2024-06-09	Set Aside for Future Consideration
61	yes	2024-06-08	Set Aside for Future Consideration

The eight field checks produced the following results:

- one planting area was removed from consideration (the area contained a new Red-Listed rare plant for the Project, *Polygala senega* [Seneca snakeroot]);
- five planting areas were set aside for future consideration; and
- two planting areas were considered to be worth investigating further.

Both “best choice” planting areas already contained previously-completed multi-species PRS plots so no additional plots were completed. Supplemental Canada ricegrass planting locations were also marked in suitable habitat near the PRS plots, where appropriate, to provide options for the planting crew.

It should be noted that during the course of the field verification surveys, seven new rare plant patches or occurrences were discovered: five patches of *Drymocallis arguta*, one patch of *Carex xerantica,* and one new occurrence of *Polygala senega.*

Discussion

The primary goal of the 2024 work was to locate additional suitable recipient sites for Canada ricegrass based on the 13 criteria listed in the Methods section above. During the course of the field verification, it became clear that the first 10 criteria were relatively easy to meet (that is, accessible planting areas outside of the Site C PAZ and EIL, on Crown or BC Hydro land near the Peace River, which contain appropriate rare plant habitat, low levels of both non-native plants and disturbance, and that have good cellular coverage).

However, the final three criteria proved much more challenging (planting areas greater than one kilometre from known sites of the same taxon, not already occupied by other rare plant species, and close to a source of water). While the prefield review specifically avoided known rare plant sites in choosing potential planting areas to evaluate, it was anticipated that new rare plant occurrences would be discovered since the goal was to target high-quality rare plant habitats. Thus, seven new rare plant sites were documented by the survey team during the field verification process in 2024. The surveyors attempted to avoid these new sites when placing PRS plots and marking supplemental planting locations, but this was not always possible: at both of the recommended planting sites, PRS plots had to be placed in the vicinity of other naturally-occurring rare plant populations. However, this compromise was considered acceptable considering that naturally-occurring multi-species rare plant sites are frequently found in the BC Peace region.

The final difficulty for PRS plot placement, as anticipated, was that a nearby source of water proved to be a challenging requirement. Of the two plots reviewed in 2024, one did have a water source, as it was located within 350 m of the Beatton River.

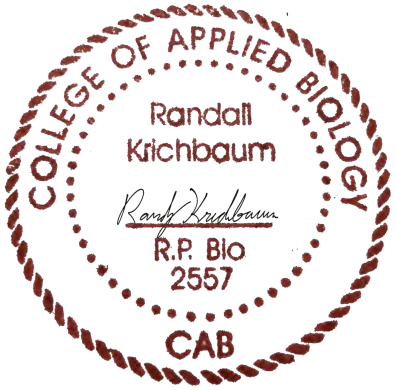
Therefore, given the above caveats, the two recipient sites recommended for Canada ricegrass in 2024 do meet the majority of the requirements of an ideal recipient site. Both sites are on Crown parcels and contain habitat suitable for Canada ricegrass (as well as other species in the ERPT program).

Closure

Reviewed and approved:

Randy Krichbaum M.Sc., R.P. Bio., P. Biol.
Senior Ecologist
Eagle Cap Consulting Ltd.

<Original signed and sealed November 19, 2024 at Calgary, Alberta>



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APPENDIX B. DATA CAPTURE FORM – TRANSLOCATION

Experimental Rare Plant Translocation Program

ECOLOGIC	**TRANSECT / PLOT / INDIVIDUAL** **Data Capture Form**	SITE + T/P	[S-_____] +
		Data Sheet Tracking Number	

Data Recorder:		*Team:*	

TRANSECT / PLOT Level Information		**TRANSECT or PLOT**	*specify*	**ID:**	

Species Name	**Recipient Site Name**	**UTMZone**	**Easting**	**Northing**	**Elev. (m)**	**Plot Solocator Photos**
dd	dd					

Outplanting Conditions			**Nursery**	dd	
Date(yymmdd)	**Weather Cond**	**Ambient Temp (*C)**	**Date Removed**	**Plug Size (mm)**	**Growth Media**

TRANSECT or PLOT		**MAP**	Y/ N	**subPLOT Information**		
Dimensions (m x m)	**Shape & Orientation**	**Loc. of Map**		**subPlot ID**	**Dimensions (m x m)**	**subPL Photos**
		dd		dd		

General Comments	

PLANT OBVS	*Example*																									
TAG NUMBER	94																									
Plant Presence	psent																									
Plant Condition	dead																									
Inflorescences (#)	4																									
Seeds (#heads /pods)	1																									
Implem / Monitor	mon																									
Photos	meth																									
Height (cm)	3																									
Surf.Area cm2	200																									
%CV of Surf. Area	40																									
Soil Mositure	ories																									
Soil Temperature	deg C																									
Mulch Type	osses																									
Mulch Depth	2																									
MicroCatch Created	s / no																									
Damage1 Type	down																									
Damage1 Extent	down																									
Damage2 Type	down																									
Damage2 Extent	down																									
Damage3Type	down																									
Damage3 Extent	down																									
Planter (name)	Bush																									

Species	**Recip. Site**	**Nursery**	**Loc. of Map**	**subPlotID**	**Plant Presence**	**Plant Cond.**	**Inflorescences (#)**	**Seeds (#heads /pods)**
list	list	list	list	instructions	list	list	instructions	instructions

Experimental Rare Plant Translocation Program

Surf.Area cm2	%CV of Surf. Area	Mulch Type	Damage Type	Damage Extent
instructions	instructions	list	list	list

ECOLOGIC

MAP / SITE DIAGRAM

SITE + T/P [S-_____] +

Data Sheet Tracking Number

Map Recorder: | *Team:*

TRANSECT / PLOT Level Information

TRANSECT or PLOT | *specify T or P* | **ID:**

Species Name	Recipient Site Name	Slope (deg)	Aspect (T)	Draw Slope Direct.	North Arrow
dd	dd				

General Comments

Draw site diagram here. Clearly illustrate locations of specific tag numbers.

APPENDIX C. SITE C *DRYMOCALLIS ARGUTA* STATUS MEMO

Date: March 7, 2025

To: Natasha Bush (EcoLogic), Alice Lee (EcoLogic)

From: Randy Krichbaum (Eagle Cap), Margaret Krichbaum (Eagle Cap)

Subject: Site C *Drymocallis arguta* Status

INTRODUCTION

This memo summarizes the ecology, distribution, and abundance of the vascular plant *Drymocallis arguta* (Pursh) Rydberg (tall wood beauty) in the Peace River Region of northeastern British Columbia (B.C.). Recent surveys suggest that the species is more widespread and abundant than previously thought; however, taxonomic uncertainty remains for this species and updates in the near future may affect the conservation status and involvement of this species in rare plant mitigation efforts for the Site C Clean Energy Project. This memo outlines current information about *D. arguta*, which could assist the B.C. Conservation Data Centre (BCCDC) in conducting future status reviews for this species.

Drymocallis arguta (Figure 1) is a glandular hairy perennial in the Rosaceae (rose family). The species grows in a wide variety of open, mesic habitats across North America east of the Rocky Mountains (Ertter et al. 2014). *Drymocallis arguta* is classified as S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2024). Globally the taxon is considered Secure (G5) (NatureServe 2024).

The taxonomy of *D. arguta* was clarified by the 2014 publication of Flora of North America (FNA), but its presence in B.C. has not been well documented. Although *D. arguta* had been sporadically collected in B.C. for years (under the synonym *Potentilla arguta* before 2014), the species was only officially added to the B.C. flora in July of 2022 (Ertter et al. 2014; BCCDC 2024). Records and collections of *D. arguta* from B.C. require review to determine those that represent *Drymocallis convallaria* (Rydberg) Rydberg (white cinquefoil), a similar-looking plant that is common west of the continental divide (Ertter et al. 2014; Beaty Biodiversity Museum 2023; Klinkenberg 2024).

Drymocallis arguta has been recorded by botanists in the Site C Project area since botanical surveys commenced 14 years ago. However, since the species was not considered a rare plant by the Provincial government until recently, no attempt was made to document its local abundance or range during these early surveys. When the taxon was added to the B.C. flora on the B.C. Blue-list of rare plants in 2022, effort began to specifically describe the distribution and abundance of *D. arguta* in the Project area.

This memo provides an overview of the work completed to-date on *D. arguta*, including recent targeted regional surveys, and includes a summary of the taxon's abundance, range, and threats in B.C. In addition, the taxonomic uncertainties regarding the species are discussed, as well as issues regarding abundance and viability.

Figure 1: *Drymocallis arguta* (tall wood beauty)

History

The current Site C Project botanical team began documenting *Drymocallis arguta* in 2011 (as *Drymocallis convallaria*) during the baseline surveys performed for the Site C Project environmental impact assessment (Hilton et al. 2013). At this time, the name *D. arguta* was not recognized for B.C., however it was noted in the Illustrated Flora of BC that the taxon was to be expected in NE B.C. (Douglas et al. 1998). Collections of *Drymocallis arguta* were made in 2012 from two locations in the Project area (the dam site, and the Area E aggregate extraction site). Starting in 2015 the species was opportunistically noted and photo-documented in the Site C Local Assessment Area (LAA) during preconstruction rare plant survey work.

In the fall of 2020, the Project botanical team was asked by members of the B.C. Flora Update Committee if *D. arguta* was being observed in the Peace region. The committee had recently updated the taxonomy of the genus *Drymocallis* in B.C. to follow the 2014 FNA treatment written by Barbara Ertter (Ertter et al. 2014). Based on new morphological and molecular evidence, plants formerly placed as *Potentilla arguta* subspecies *arguta* and *Potentilla arguta* subspecies *convallaria* were moved to the genus *Drymocallis*. An "unabashedly provisional" attempt was made in the FNA treatment to recognize the variation within that genus by elevating the two subspecies of the former *Potentilla arguta* to species level, with the recognition of the names *Drymocallis arguta* and *Drymocallis convallaria* (Ertter et al. 2014).

A key split in the Flora of North America separated the two taxa based on range, with *D. arguta* considered to be present and widespread east of the continental divide, and *D. convallaria* to be present and widespread west of the divide. Some fine morphological differences were also used to separate the two species. As of the fall of 2020, the B.C. Flora Update Committee had added *D. convallaria* to the B.C. flora, but had not made any decision about the name *D. arguta*, due to a lack of *Drymocallis* specimens from the area of NE B.C. that lies east of the continental divide, and which includes the Site C Project area.

In response to the request by the B.C. Flora Update Committee, the Project botanical team sent in two of the 2012 *D. arguta* specimens to committee member Frank Lomer for verification in December 2020, which he completed by early January 2021. Two additional *D. arguta* specimens, collected in the summer of 2021, were submitted to the Beatty Biodiversity Museum herbarium (UBC) in February 2022.

In the fall of 2021 the B.C. Flora Update Committee voted to add *D. arguta* to the B.C. flora, however it was not until late July 2022 that the B.C. Conservation Data Centre released their annual status updates. At this time, *D. arguta* was officially recognized for B.C. with a status of S3 (Vulnerable), and the taxon was placed on the Provincial Blue list of rare plant taxa.

Accordingly, the Project botanical team began documenting *D. arguta* occurrences in the Site C project area in August of 2022. Seventeen occurrences were visited and surveyed, and eight occurrences were documented based on field notes, photographs, and/or previously-collected specimens. A total of 25 occurrences were reported to the BCCDC, and thirteen specimens were submitted to UBC in October 2022 (vouchers were only collected where the number of individuals of *D. arguta* exceeded 20 in an occurrence).

Field documentation of *D. arguta* occurrences continued during the 2023 field season. Four of the incompletely documented occurrences from 2022 received field visits in order to clarify the occurrence data. In all cases the occurrences were much larger than originally reported and voucher specimens collected. One occurrence documented in 2022 was revisited and more patches of *D. arguta* were recorded with an additional voucher collected and seven new occurrences of *D. arguta* documented. A total of 12 specimens were submitted to UBC in November 2023.

2024 Regional Surveys

Because the distribution of *D. arguta* outside of the LAA was poorly defined, in 2024 targeted surveys were conducted for the species in the larger Peace Region. The goal was to gain a better understanding of the regional abundance and distribution of *D. arguta* to assist the BCCDC in evaluating the viability of the B.C. population. Since most of the targeted surveys for the species had taken place within the Site C LAA, it was hoped that these wider surveys could fill in some of the regional data gaps defining the distribution of *D. arguta.*

These surveys took place in the spring of 2024, over the course of three days. Prior to the field surveys, the Project botanical team conducted a prefield review to identify areas of likely habitat outside of the LAA beyond the known B.C. range of the species. The botanists examined aerial imagery, topographic data, occurrence data, and other habitat information in the Project Geographic Information System (GIS) database to locate suitable *D. arguta* habitat during field visits.

Once survey locations were identified, a field plan was developed to guide field survey methods and timing. In June 2024, the Project botanists visited a selection of these sites to conduct targeted surveys for *D. arguta*. Four new occurrences were documented, all of which were found near the borders of, or just outside of, the Site C Regional Assessment Area (RAA), to the north, east, and south. In addition, two occurrences were documented at Prince George, B.C. by another Site C Project biologist. This location is west of the Rocky Mountains, not in the B.C. Peace region, and represents a significant westward extension of the known B.C. range for the species. The specimens from these discoveries were verified by Frank Lomer in November 2024.

Current Situation

Abundance and Distribution

Currently there are 40 occurrences of *D. arguta* reported for B.C. between 2022-2024; 38 are located east of the continental divide in the Peace River Region, and the remaining two occurrences in Prince George, west of the Rocky Mountains. An estimated 15,513 plants have been documented in the Peace Region with an approximate total area of 12.9 hectares.

There are also three Peace Region *D. arguta* specimen records in the Consortium of Pacific Northwest Herbaria database (CPNWH 2024) that may represent new occurrences. These have not been revisited yet by the Project botanical team.

Threats

Of the 38 occurrences of *D. arguta* documented to-date in the Site C Project vicinity, none have been fully extirpated by Project construction; six occurrences have been partially impacted but continue to survive as of 2024; and 32 occurrences have sustained no known impacts from Site C construction. It is unknown whether there were occurrences of *D. arguta* in the Site C reservoir footprint since that area was not surveyed for the species. While the species has generally been found on relatively intact native grassland habitat, two of the occurrences documented in 2024 were found in disturbed locations dominated by non-native plant species. Likely the main threat to *D. arguta* will be continued degradation and loss of native grassland habitat.

Discussion

Taxonomic Uncertainty

One factor currently under discussion is whether the two taxa*, D. arguta* and *D. convallaria*, should be considered separate species in the B.C. flora, or whether they should be considered separate only at the subspecies level, as they were prior to the 2014 FNA publication, based on the treatment in the Illustrated Flora of B.C. Vol. 4 (Douglas et al. 1998). The second edition of the Flora of the Pacific Northwest, published in 2018, does not follow the FNA treatment, instead synonymising *D. convallaria* with *D. arguta* for the region covered by the flora which encompasses the states of Washington, Oregon, Idaho, and western Montana (Hitchcock & Cronquist 2018).

At issue are the features being used to separate *D. arguta* from *D. convallaria*. The key characteristics in FNA are:

- shape and vestiture of the terminal leaflet
- number of teeth per side of the terminal leaflet (including second- and third-degree teeth)
- the fraction of the total stem comprised of inflorescence
- location east or west of the continental divide

An additional minor feature detailed in the FNA species descriptions is the leaflet pair count. Unfortunately, all the morphological features have been found to be variable and make definite separation of these two taxa challenging.

Barbara Ertter, the FNA author, has clarified in an email correspondence that she relies on an assessment of the total variation of the plant features across the landscape to make a determination. The Project botanical team, after studying and documenting 38 occurrences of *D. arguta*, agree with the importance of assessing a number of different plants within each occurrence in order to understand the variation present and to determine the average set of morphological characteristics that should be used for accurate identification. The amount of seasonal plant development must also be taken into consideration. The basal leaves, which show several key features, are present during the entire growing season. The structure of the flowering stem is not fully developed until early July, but the usually robust stems then stand through the fall as the plant fruits and senesces, and the mature stems are often still present the following spring.

It is possible that until a review of a substantial portion of the B.C. collections of *D. arguta* and *D. convallaria* can be completed, no definitive decision can be made.

Abundance

The 40 occurrences of *D. arguta* known in B.C. likely represent only a fraction of those actually present. During the Site C rare plant surveys in the Peace Region, the surveyors have found that the majority of suitable habitat is occupied by *D. arguta*. Often, these occurrences are large, containing hundreds of individuals. There remain numerous patches of unsurveyed suitable *D. arguta* in the Peace Region, and it is expected that many of these areas contain viable occurrences of the species.

Viability

Most of the 40 known *D. arguta* occurrences in B.C. are not directly threatened with extirpation at this time. The individual plants at the majority of the occurrences appeared healthy and vigorous at the time of survey, and their continued existence, and possible expansion, is likely. While the Site C Project has affected known and likely undiscovered occurrences of *D. arguta*, the Project is not expected to affect the majority of the known occurrences in B.C.

Site C Work

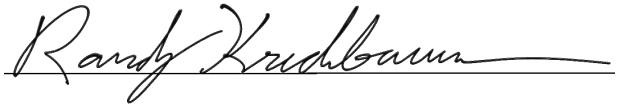
Currently, the Site C Project is treating *D. arguta* as a rare plant in the context of the preconstruction rare plant survey program. Considerable effort has been expended to find and document occurrences of the species within the Site C LAA as well as in the larger RAA. However, since construction of the Project is essentially complete, no further preconstruction rare plant surveys are planned.

The Site C Experimental Rare Plant Translocation (ERPT) program also treats *D. arguta* as a rare plant. However, since the species has been listed as rare in B.C. only recently, no translocations have occurred. Given that the regional population of *D. arguta* is large, vigorous, and widely distributed, and that the Site C Project is not affecting the majority of the regional occurrences, direct translocation of the species is not being undertaken at this time.

Project botanists are providing input to the BCCDC and the B.C. Flora Update Committee working to clarify the taxonomic status and rarity classification of the species, however it may be several years, or even decades, before the taxonomy of *Drymocallis* in B.C. is settled. If future investigations show that the Peace Region *D. arguta* population is more threatened than currently believed, active translocation efforts can be undertaken at that time.

CLOSURE

Reviewed and approved:



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Eagle Cap Consulting Ltd.

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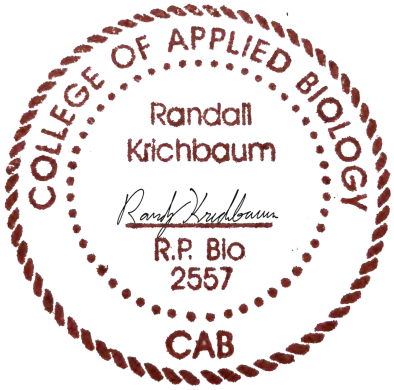

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Appendix 9. 2024 Ground-Nesting Raptors Annual Report

Site C Clean Energy Project
Ground-Nesting Raptor Monitoring
2024 Annual Report

PRESENTED TO

British Columbia Hydro and Power Authority

MARCH 26, 2025
ISSUED FOR USE
FILE: 704-ENW.PENW03042-02.GNRM24

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Site C Clean Energy Project
Ground-Nesting Raptor Monitoring
2024 Annual Report

FILE: 704-ENW.PENW03042-02.GNRM24
March 26, 2025

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and Power Authority and their agents. Saulteau EBA Environmental Services Joint Venture does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro and Power Authority, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Saulteau EBA Environmental Services Joint Venture's Services Agreement. Saulteau EBA Environmental Services Joint Venture's Limitations on Use of This Document are provided in Appendix D of this report.

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors (i.e., Short-eared Owl [*Asio flammeus*] and Northern Harrier [*Circus hudsonius*]) in the area of British Columbia Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2024. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program. This report describes the methods used to conduct the surveys and provides a summary of the results.

The 2024 ground-nesting raptor surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl. Surveys were completed within three cleared portions of the Site C construction headpond: Cache Creek, Bear Flats, and along the Peace River between the Halfway River and Moberly River. Ground-nesting raptor surveys were completed at each transect and standwatch station up to six times during May and June 2024 (three daytime surveys and three evening surveys at select sites). The cleared portions near Bear Flats and Cache Creek were accessed on foot and the areas along the Peace River were accessed by boat.

No Short-eared Owls were detected during the field surveys. Northern Harriers were observed sixteen (16) times within the Bear Flats and Peace River areas. There were eleven (11) observations during the early May visit (May 1 – 3), three (3) observations during the early June visit (June 4 – 10), and two observations during the late June visit (June 20 – 27). No behaviours suggestive of Northern Harrier nesting were observed.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1.0 INTRODUCTION 1

2.0 EXISTING DATA 1

3.0 METHODS 2
3.1 Transect Survey Protocol 3
3.2 Standwatch Survey Protocol Without Transects 3

4.0 RESULTS 4
4.1 Habitat at Survey Areas 4
4.2 Transect Results 6
4.3 Standwatch Results 6

5.0 DISCUSSION 7

6.0 REFERENCES 8

LIST OF TABLES IN TEXT

Table 1: Species Covered in the Ground-Nesting Raptor Follow-up Monitoring Program 1
Table 2: 2024 Survey Dates and Times 2
Table 3: Habitat at Peace River Standwatch Stations and Transects During the 2024 Surveys 4
Table 4: Northern Harrier Observations During 2024 Transect Surveys 6

APPENDIX SECTIONS

FIGURES

Figure 1 Project Overview of Transects and Standwatch Station Locations
Figure 2 Bear Flats Transect Stations
Figure 3 Cache Creek and Peace River Standwatch Stations
Figure 4 Peace River Standwatch Stations
Figure 5 Peace River Transect #1 and Transect #2 Standwatch Stations
Figure 6 Peace River Transect #3 Standwatch Stations
Figure 7 Peace River Transect #4 Standwatch Stations
Figure 8 Peace River Transect #5 Standwatch Stations

APPENDICES

Appendix A Incidental Raptor Observations
Appendix B Survey Station HIstory 2016 – 2024
Appendix C Project Qualified Environmental Professionals
Appendix D Limitations on the Use of This Document

1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors in the area of British Columbia Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2024. The surveys were part of BC Hydro's Ground-Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). Ground-nesting raptor surveys have occurred annually since 2016. This report describes the methods used to conduct the surveys and provides a summary of the results from 2024.

The Ground-nesting Raptor Follow-up Monitoring Program is specifically focused on two ground-nesting raptor species: Short-eared Owl (*Asio flammeus)* and Northern Harrier (*Circus hudsonius)* (Table 1).

Table 1: Species Covered in the Ground-Nesting Raptor Follow-up Monitoring Program

Common Name	Scientific Name	BC List	COSEWIC [1] Status	SARA [2] Status
Short-eared Owl	*Asio flammeus*	Blue	Threatened	Schedule 1 – Special Concern
Northern Harrier	*Circus hudsonius*	Yellow	Not at Risk	-

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada.
[2] SARA – *Species at Risk Act*.

The objectives of the ground-nesting raptor monitoring program are to determine the following:

- The number of Northern Harrier and Short-eared Owl nesting in areas cleared within the construction headpond prior to reservoir filling;
- The effects of seasonal construction headpond flooding on Northern Harrier and Short-eared Owl nests; and
- The use of open fields within mitigation properties by Northern Harrier and Short-eared Owl as nesting habitat.

2.0 EXISTING DATA

Baseline surveys for Northern Harrier were conducted in 2010 in the Regional Assessment Area, which included the dam site and reservoir, the Peace River valley surrounding the reservoir, adjacent plateau areas north and south of the river, and the transmission line (Hilton et al. 2013). During the baseline surveys, one Northern Harrier was observed within the proposed reservoir footprint and 15 were observed outside the Peace River valley in plateau areas. An additional 50 Northern Harriers were recorded incidentally between 2006 and 2016. The majority of these observations were associated with agricultural fields and upland habitats outside of the Peace River valley. No nests of Northern Harrier were identified during the baseline studies. For the ground-nesting raptor follow-up monitoring conducted annually since 2016, Northern Harrier have been observed hunting within and adjacent to the proposed reservoir and one nest was found within the proposed reservoir footprint although not within an area cleared for reservoir filling.

Baseline surveys for Short-eared Owl were conducted in 2006, 2010, and 2012 in the Regional Assessment Area (Hilton et al., 2013). Short-eared Owls were not detected during surveys in 2006, although one was observed incidentally during another survey. Twelve Short-eared Owls were detected during surveys in 2010, with one detection indicating evidence of breeding (begging calls). No Short-eared Owls were observed in 2012. One of the 12 Short-eared Owl observations during the three years of baseline surveys was within the Peace River valley; all other observations were outside the valley in neighbouring plateau areas. For the ground-nesting raptor follow-up monitoring conducted annually since 2016, no Short-eared Owls have been observed in or adjacent to cleared portions of the reservoir or elsewhere in the Peace River valley.

BC Hydro has identified three mitigation properties (i.e., Marl Fen, Rutledge and Wilder Creek) within which old field habitat will be established and managed to provide nesting habitat for Northern Harrier and short-eared Owl (BC Hydro 2016). Surveys of the mitigation properties were conducted in 2016 and 2017. Ground-nesting raptor use of the mitigation properties has been well documented and further surveys would likely not provide new information. Surveys of the mitigation properties were therefore not conducted in 2024. Surveys of these areas will be conducted again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications in the mitigation properties, whichever occur first.

3.0 METHODS

Following methodology adapted from the Resource Inventory Committee (RIC) *Inventory Methods for Raptors* (RIC 2001), field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl. Surveys were conducted in cleared portions of the construction headpond between the dam site and the Halfway River.

Surveys were conducted at 36 standwatch stations at the Bear Flats, Cache Creek, and Peace River sites (Table 2, Figures 1 to 8; Appendix B provides a full list of stations surveyed from 2016-2024). Among the three areas:

- Bear Flats had a single transect with five standwatch stations located along its length (Figure 2).
- Cache Creek consisted of a single standwatch station (Figure 3).
- Peace River was the largest survey area, with five transects (for a total of 25 standwatch stations) between the Moberly River and Cache Creek and five standwatch stations located between Cache Creek and the Halfway River (Figures 3 to 8). No new survey stations were established within the Peace River area in 2024.

Within these three areas, ground-nesting raptor surveys were conducted up to six times between May and June 2024 to capture early, middle, and later stages of their breeding season. Bear Flats and Cache Creek were accessed by foot and the cleared Peace River areas were accessed by boat. Surveys were completed by two teams of two observers. Each team was composed of a biologist with raptor survey experience and a field assistant (Appendix C).

Table 2: 2024 Survey Dates and Times

Survey Location	First Visit	Second Visit (Evening)	Third Visit	Fourth Visit (Evening)	Fifth Visit (Evening)	Sixth Visit
Bear Flats	May 3, 2024 07:53 – 10:22	May 3, 2024 19:43 – 21:02 (Only surveyed BFSW01, 02 and 03)	June 10, 2024 06:57 – 09:48	June 10, 2024 20:32 – 21:27 (Only surveyed BFSW01 and 02)	June 26, 2024 20:22 – 21:09 (Only surveyed BFSW01 and 02)	June 27, 2024 08:33 – 11:08
Cache Creek	Could not survey due to access issues.	Could not survey due to access issues.	June 10, 2024 08:10 – 08:30	June 10, 2024 21:45– 22:05	June 26, 2024 21:45 – 22:05	June 27, 2024 7:23 – 7:43
Peace River	May 1, 2024 06:51 – 15:01 & May 2, 2024 06:57 – 15:46	No evening surveys conducted	June 4, 2024 06:24 – 14:42 & June 6, 2024 09:35 – 11:36	No evening surveys conducted	No evening surveys conducted	June 20, 2024 05:55 – 12:51 & June 22, 2024 09:14 – 11:02

Northern Harrier are diurnal, and research suggests they are generally active between 05:30 and 21:30 (Smith et al. 2011). Short-eared Owls are crepuscular so optimal survey timing is in the evening just prior to twilight (Wiggins at al. 2006). While most surveys were conducted during daytime hours, three evening surveys were conducted at three select sites to increase the likelihood of detecting any Short-eared Owl present (the “evening” visit columns in Table 2). The evening surveys were limited to areas that could be safely accessed by truck due to the logistical and safety considerations that come with conducting surveys in cleared portions of the reservoir that require boat access. Evening surveys would involve boating in very low light or dark conditions after surveys are complete, which would not be considered a safe work practice by BC Hydro.

General habitat information for each survey station was noted during surveys to determine the quality of the cleared area as hunting and nesting habitat for ground-nesting raptors. Notes were taken on vegetation species present and height of vegetation regrowth and photographs of the surrounding habitat were taken.

3.1 Transect Survey Protocol

The transect surveys were conducted by walking at a speed of 0.5 – 2 km/hr while looking and listening for birds. Surveyors stopped whenever required to confirm identification and record data. The walking transects were located only in cleared portions of the reservoir and were the same transects surveyed in previous years. Surveyors selected walking paths that provided visual coverage of the entire portion of suitable habitat in each area. During the transect, surveyors stopped at each established standwatch station to complete a standwatch survey. When located along transects, standwatch stations were spaced approximately 400 m to 600 m apart. From each standwatch station the surveyors had a view from the previous standwatch station to the next station in the transect. Adding these standwatches into the transect surveys allowed surveyors to observe areas for longer periods to increase the potential to observe bird activity and nesting behaviour for the purpose of locating ground-nesting raptor nests. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3; 12 – 19 km/hr), rain or fog, when bird activity and detectability were likely to be low. The order that the stations were visited was different on each of the survey days so that time of day varied between visits.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations (Appendix A). Since ground-nesting raptor nests can easily be destroyed by human traffic, surveyors were instructed to observe for behaviour suggesting a nest was nearby (e.g., one or both of the pair returning to the same location with nesting materials or food, a pair of Northern Harriers exchanging prey or nesting materials through aerial passes, or a male Short-eared Owl defending a nest with distraction displays) rather than conduct intensive foot searches to locate a nest.

3.2 Standwatch Survey Protocol Without Transects

Standwatch surveys in the absence of associated transects were conducted in cleared portions of the reservoir that (1) could not be visited by foot due to impassible terrain, and/or (2) could not be linked with other standwatch stations to form a transect. Standwatch stations were located in areas with good visibility of the cleared area. Standwatches were conducted by observing from a stationary position for approximately 20 minutes. Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 – 19 km/hr), rain or fog. The time of day and order that the stations were visited varied on each of the survey days. Ground-nesting raptor observations were collected following the same protocol as described in Section 3.1 for transect surveys.

4.0 RESULTS

4.1 Habitat at Survey Areas

A description of the habitat at each survey station is provided in Table 3. Photographs of the habitat at each station are presented on Figures 2 to 8.

Table 3: Habitat at Peace River Standwatch Stations and Transects During the 2024 Surveys

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Bear Flats Survey Area – Transect Only			
Bear Flats Transect ▪ BFSW01 ▪ BFSW02 ▪ BFSW03 ▪ BFSW04 ▪ BFSW05	Winter 2018/2019	5	The cleared area was experiencing vegetation regrowth with high percent cover (> 90%) of grasses, forbs and shrubs. Shrubs and pole saplings ranged from 0.5 m to 2.5 m tall and dominant species included trembling aspen and saskatoon. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
Cache Creek Survey Area – Standwatch Only			
CCSW07	Partial clearing in Winter 2016/2017 Partial clearing in Winter 2018/2019	7 5	Reestablished vegetation is dominated by grasses and patches of low shrubs approximately 1-2 m in height. The area is oriented south towards Cache Creek, bounded by Highway 29 to the north and surrounded by deciduous riparian forests.
Peace River Survey Area – Transect and Standwatch			
Peace River Transect #1 ▪ PRSW02 ▪ PRSW03 ▪ PRSW04	Winter 2017/2018	6 Brushed in winter 2022	A cleared river valley bench with herbaceous and shrubby regrowth covering > 90% of the cleared area. The cleared area was brushed in winter 2022, and the shrub regrowth remained below 50 cm in height. The dominant shrubs are prickly rose, saskatoon and wolf willow. It is bounded on the northern and southern sides by intact strips of open riparian forest between the cleared area and the Peace River.
Peace River Transect #2 ▪ PRSW05 ▪ PRSW06 ▪ PRSW07 ▪ PRSW08	Winter 2017/2018	6 Brushed in winter 2022	A cleared stretch of coniferous forest on a north-facing slope with abundant grass, herb and shrub regrowth covering > 90% of the area. The cleared area was brushed in winter 2022, and the shrub regrowth remained below 50 cm in height. The transect is bounded to the south by the Peace River, and to the north and west by coniferous forest.
Peace River Transect #3 ▪ PRSW11 ▪ PRSW12 ▪ PRSW13 ▪ PRSW14 ▪ PRSW15	Winter 2018/2019 (Except PRSW15 which was cleared 2019 / 2020)	5 4 Partially brushed in winter 2022	A large, cleared area encompassing Tea Island. The old back channels that braid through this area are dominated by forbs and grasses, and the upland areas are revegetating with forbs, grasses and shrubs. Vegetation cover along the transect was high (>90%). Four of the stations were brushed in winter 2022 and shrubs regrowth remained below 50 cm in height. PRSW15 remains unbrushed, and most of the shrubs are around 1.0 m tall, with some 2.0 m tall balsam poplar saplings. The transect is bounded by dry south-facing slopes to the north and an intact strip of riparian forest along the Peace River to the south.

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
Peace River Transect #4 ▪ PRSW16 ▪ PRSW17 ▪ PRSW18 ▪ PRSW19 ▪ PRSW20 ▪ PRSW21 ▪ PRSW22 ▪ PRSW23	Winter 2019/2020	4 Brushed in winter 2022	The flat floodplain areas and the southern slopes were cleared and mulched, with grass, herb and shrub regrowth covering >90% of the area. The cleared area was brushed in winter 2022 and the shrubs regrowth remained below 50 cm in height. It is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clearcut areas.
Peace River Transect #5 ▪ PRSW24 ▪ PRSW25 ▪ PRSW26 ▪ PRSW27 ▪ PRSW28	Winter 2019/2020	4 Partially brushed in winter 2022	This area had been cleared and mulched. Some exposed soils, and abundant small and large woody debris still remain. Vegetation regrowth was moderate and consisted of grasses, herbs and shrubs covering approximately 90% of the area. Dominant shrub species are prickly rose and soopolallie. The majority of the transect was brushed in winter 2022 and shrubs regrowth within these areas remained below 50 cm. Vegetation was not brushed at PRSW26, or south of PRSW27. In these areas, shrubs and pole saplings had grown up to 2.5 m in height. The transect is bounded to the north by the Peace River, and to the south by coniferous forest. Riparian buffers were left around the perimeters of the clearcut areas.
PRSW31	Winter 2019/2020	4	The area had been cleared and mulched. Approximately >90% of the area was experiencing vegetation regrowth, and consisted of grasses, herbs and shrubs around 1.5 m to 2.0 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW32	Winter 2019/2020	4	The area had been cleared and mulched. Approximately 85% of the area was experiencing vegetation regrowth, and consisted of grasses, herbs and low shrubs around 1.0 m in height. Some balsam poplar saplings are 2.0 m tall. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW33	Winter 2019/2020	4	The area had been cleared and mulched. Approximately 90% of the area was experiencing vegetation regrowth and consisted of grasses, herbs and shrubs under 1.0 m to 1.5 m in height. The station is located on a river island and a riparian buffer was left around the perimeter of the cleared island.
PRSW34	Winter 2019/2020	4 Brushed in winter 2022	A small, cleared area surrounded by mainly deciduous trees. Approximately >90% of the cleared and grubbed area was experiencing vegetation regrowth and consisted mostly of grasses, herbs and low shrubs. The cleared area was brushed in winter 2022, and the shrub regrowth remained below 50 cm in height. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
PRSW35	Winter 2019/2020	4 Brushed in winter 2022	A small, cleared area surrounded by mainly deciduous trees. Approximately >90% of the cleared and grubbed area was experiencing vegetation regrowth and consisted mostly of grasses, herbs and low shrubs. The cleared area was brushed in winter 2022, and the shrub regrowth remained below 50 cm in height. It is bounded to the east and south by the Peace River and to the north by floodplains, and Highway 29.

4.2 Transect Results

Fourteen Northern Harriers were observed during transect surveys within the Bear Flats and Peace River survey areas (Table 4; Figure 2-8). Twelve observations occurred at standwatch stations along the transect, and two observations occurred on-transect between stations. The majority of the Northern Harrier observations (11) occurred during the early May visit. No nests or potential nests were observed along any of the transects surveyed.

There were no Short-eared Owl observed during the transect surveys.

Table 4: Northern Harrier Observations During 2024 Transect Surveys

Survey Area	Location	Date	Time	Count	Sex
Peace River	PRSW27	1-May-24	7:25	1	Male
Peace River	On-transect between PRSW19 and PRSW20	1-May-24	11:17	1	Female
Peace River	On-transect between PRSW18 and PRSW19	1-May-24	11:48	1	Male
Peace River	PRSW16	1-May-24	13:01	1	Male
Peace River	PRSW03	1-May-24	14:12	1	Male
Peace River	PRSW15	2-May-24	09:49	1	Female
Peace River	PRSW13	2-May-24	10:33	1	Female
Bear Flats	BFSW01	3-May-24	08:06	1	Female
Bear Flats	BFSW03	3-May-24	09:12	1	Male
Bear Flats	BFSW05	3-May-24	10:22	1	Female
Bear Flats	BFSW02	3-May-24	20:10	1	Unknown
Peace River	PRSW19	4-Jun-24	08:54	1	Male
Peace River	PRSW05	4-Jun-24	13:15	1	Female
Bear Flats	BFSW02	10-Jun-24	07:50	1	Male

4.3 Standwatch Results

Two male Northern Harriers were observed at standwatch station PRSW32 within the Peace River survey area on June 22, 2024 at 10:00 am. There were no Short-eared Owls observed during the standwatch surveys.

5.0 DISCUSSION

The first clearing of the headpond area occurred in fall/winter 2016/2017 and continued incrementally each year through to winter 2020. Prior to the third growing season, vegetation regrowth in cleared areas remained moderate (less than 75% coverage, and shrubs below 0.5 m in height) and suitable ground-nesting raptor breeding habitat in cleared areas appeared to be absent or of very low quality. Cleared areas in their third growing season and beyond had high coverage of grasses, forbs and taller shrubs and appeared to provide suitable breeding habitat for ground-nesting raptors. Over the winter of 2022, the vegetation in many of the clearings was brushed to a height of 30 cm or shorter in preparation for reservoir flooding. By summer of 2024, the majority of vegetation within these brushed areas remained below 50 cm in height. The brushed areas provided less cover for ground-nesting raptors and may have reduced the amount of suitable breeding habitat in the headpond area.

Sixteen Northern Harriers were observed during the 2024 transect and standwatch surveys within the Bear Flats and Peace River survey areas. The majority of Northern Harrier observations (i.e., 11 of the 16) occurred during the early May visit. Northern Harrier are short-distance migrants. Individuals that overwinter in southern BC begin their migration north in late March and reach the Peace River area by mid-April (BC ENV 2013). The birds observed within the reservoir footprint in early May are likely passing through the area on their northern migration or looking for suitable nesting sites in the Peace River region. All Northern Harrier observed in 2024 were flying or hunting. No evidence of nesting behaviour was exhibited by any of the individuals observed.

Short-eared Owls were not detected during the 2024 ground-nesting raptor surveys, which is consistent with the previous years' findings. Short-eared Owls have not been observed in or adjacent to the Project footprint since surveys began in 2016. Short-eared Owl favour large open areas for nesting such as grasslands, hay fields, other agricultural lands, or diked areas in wetlands (COSEWIC 2021). It is likely that the dense, uniform shrub re-growth within the cleared headpond areas did not provide suitable breeding habitat for this species, and individuals in the area used more suitable habitat in nearby agricultural areas.

Filling of the Site C reservoir began on August 25, 2024 and was completed 11 weeks later on November 7, 2024. This year (2024) was the last year of ground-nesting raptor surveys within the cleared portions of the headpond, as all areas are now inundated. Surveys within the mitigation properties will continue into the operations phase.

The ground-nesting raptor surveys conducted between 2016 and 2024 found no nesting Northern Harrier or Short-eared Owl within cleared areas of the construction headpond. Therefore, effects of seasonal flooding on Northern Harrier or Short-eared Owl nests within the headpond appears negligible.

6.0 REFERENCES

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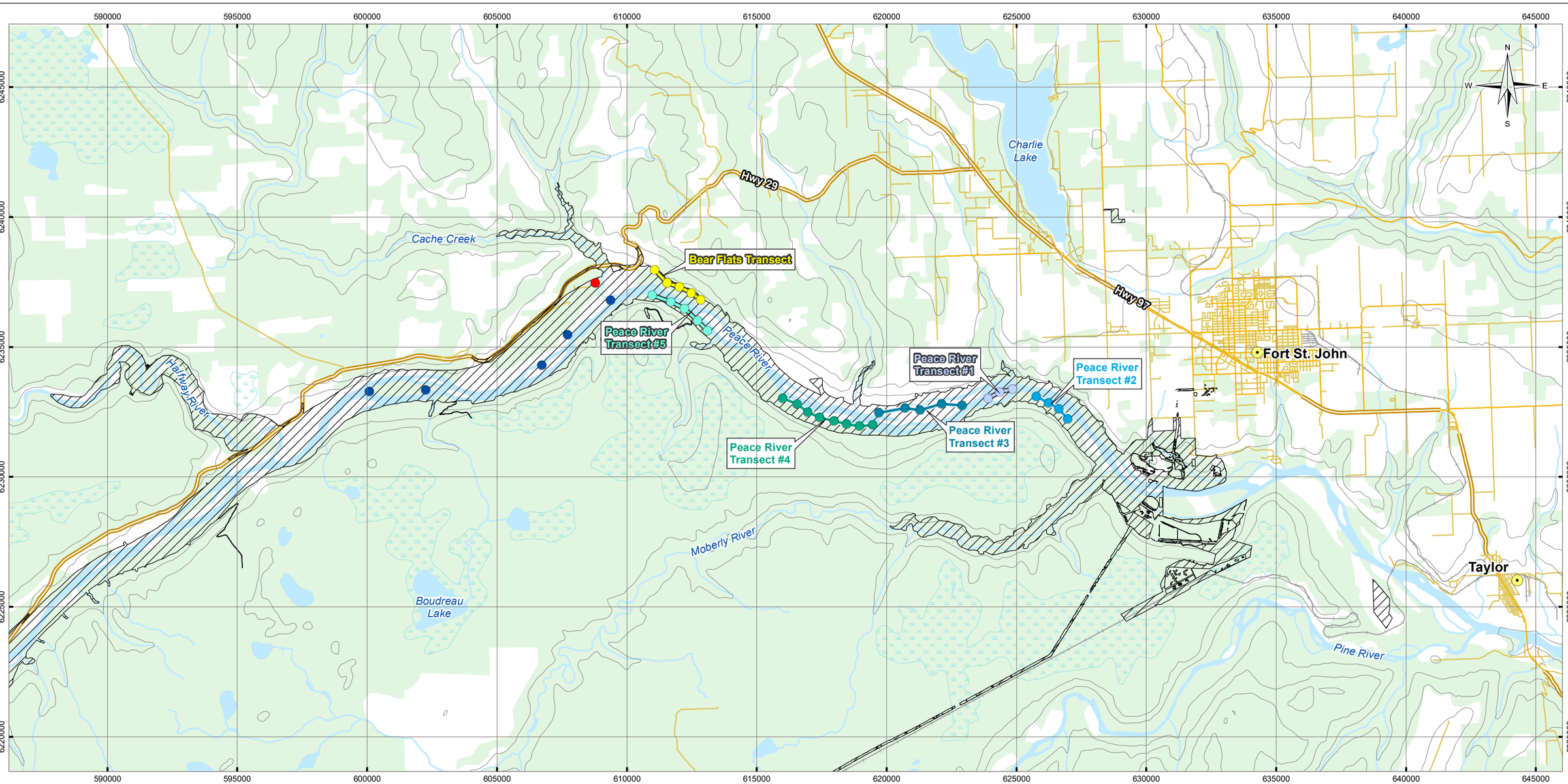
FIGURES

Figure 1 Project Overview of Transects and Standwatch Station Locations
Figure 2 Bear Flats Transect Stations
Figure 3 Cache Creek and Peace River Standwatch Stations
Figure 4 Peace River Standwatch Stations
Figure 5 Peace River Transect #1 and Transect #2 Standwatch Stations
Figure 6 Peace River Transect #3 Standwatch Stations
Figure 7 Peace River Transect #4 Standwatch Stations
Figure 8 Peace River Transect #5 Standwatch Stations



LEGEND

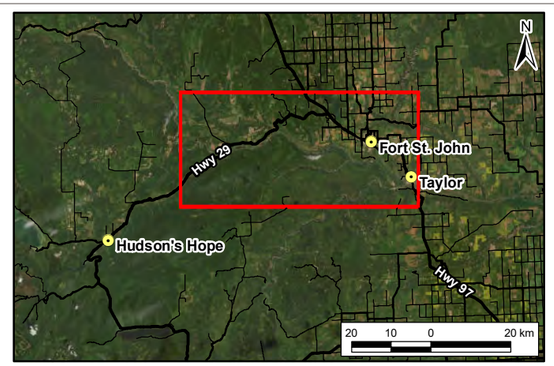
- Project Footprint

Standwatch Station
- Cache Creek
- Peace River

Transect Standwatch Station
- Bear Flats
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

Transect
- Bear Flats
- Peace River #1
- Peace River #2
- Peace River #3
- Peace River #4
- Peace River #5

- Populated Place
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Residential Area
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area



NOTES
Base data source: CanVec 1:250,000 (2019).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Project Overview of Transects and Standwatch Station Locations

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DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02

CLIENT BC Hydro Power smart

TETRA TECH

Figure 1

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610500 611000 611500 612000 612500 613000 613500 614000

6238000 6237500 6237000 6236500

Hwy 29

BFSW01

Bear Flats Transect

BFSW02

BFSW03

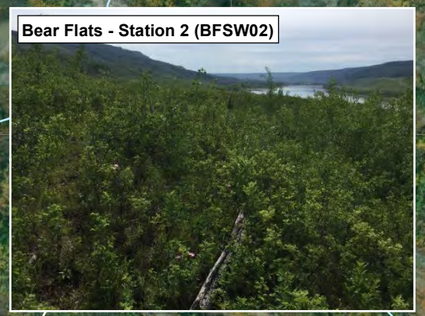
BFSW04

BFSW05

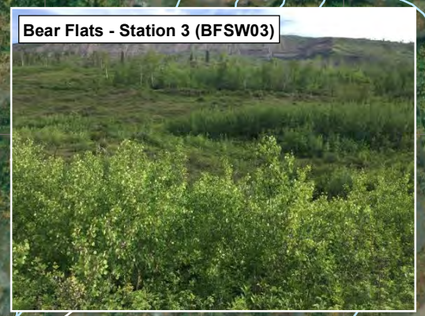
Peace River

Bear Flats - Station 1 (BFSW01)

Bear Flats - Station 2 (BFSW02)



Bear Flats - Station 3 (BFSW03)



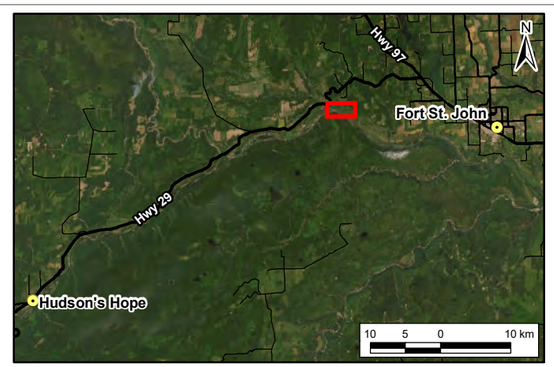
Bear Flats - Station 4 (BFSW04)

Bear Flats - Station 5 (BFSW05)

N W E S

LEGEND

- Northern Harrier Observation
- Bear Flats Transect Standwatch Station
- Bear Flats Transect
- Project Footprint
- Highway
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2021).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Bear Flats Transect Stations

PROJECTION: UTM Zone 10	DATUM: NAD83				CLIENT: BC Hydro Power smart
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FILE NO.: PENW03042-02_Fig02_BearFlats.mxd					
OFFICE: Tt-VANC	DWN: SL	CKD: BB	APVD: EH	REV: 0	Figure 2
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02				

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605000 606000 607000 608000 609000 610000 611000 612000

6237000 6236000 6235000 6234000

Cache Creek - Station 7 (CCSW07)

CCSW07

Cache Creek

PRSW35

Peace River - Station 35 (PRSW35)

Watson Rd

Hwy 29

Peace River

PRSW34

Peace River - Station 34 (PRSW34)

Peace River - Station 33 (PRSW33)

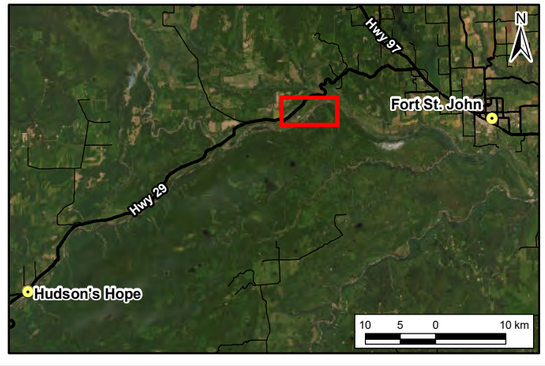
PRSW33

N W E S

605000 606000 607000 608000 609000 610000 611000 612000

LEGEND

- Northern Harrier Observation
- Cache Creek Standwatch Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2018-2021).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Cache Creek and Peace River Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH

FILE NO.
PENW03042-02_Fig03_CC_PR.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	MRB	EH	0

DATE
March 26, 2025

PROJECT NO.
ENW.PENW03042-02

Figure 3

G:\ENVIRONMENTAL\PENW\PENW03042-02\Maps\GNRM_2024\PENW03042-02_Fig03_CC_PR.mxd modified 3/26/2025 by Stephanie.Leusink

598000 599000 600000 601000 602000 603000 604000 605000

6234000 6233000 6232000 6231000

Upper Cache Rd

Hwy 29

Szoo Rd

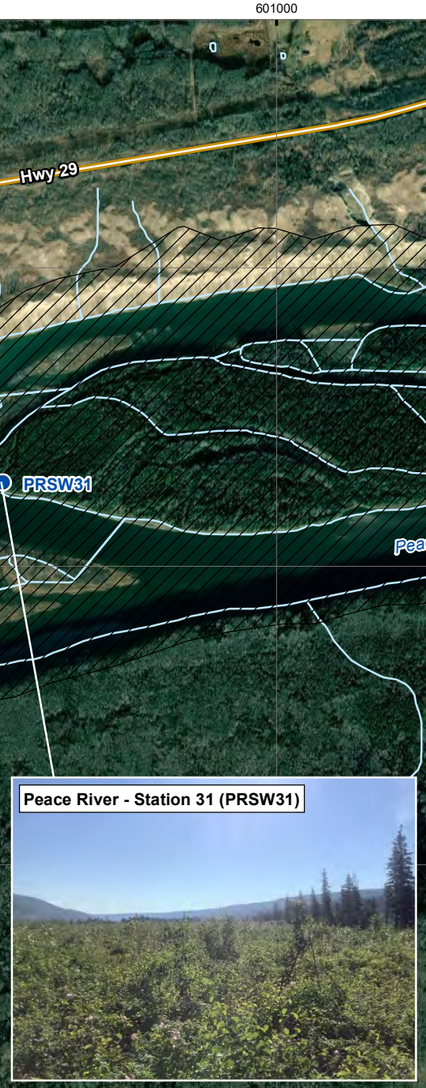
N W E S

PRSW31

PRSW32

Peace River

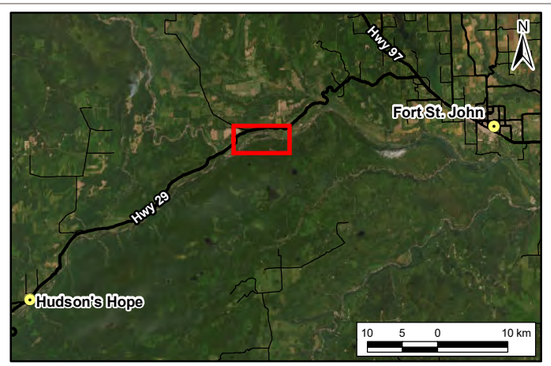
Peace River - Station 31 (PRSW31)



Peace River - Station 32 (PRSW32)

LEGEND

- Northern Harrier Observation
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2018).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Peace River Standwatch Stations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC Hydro Power smart

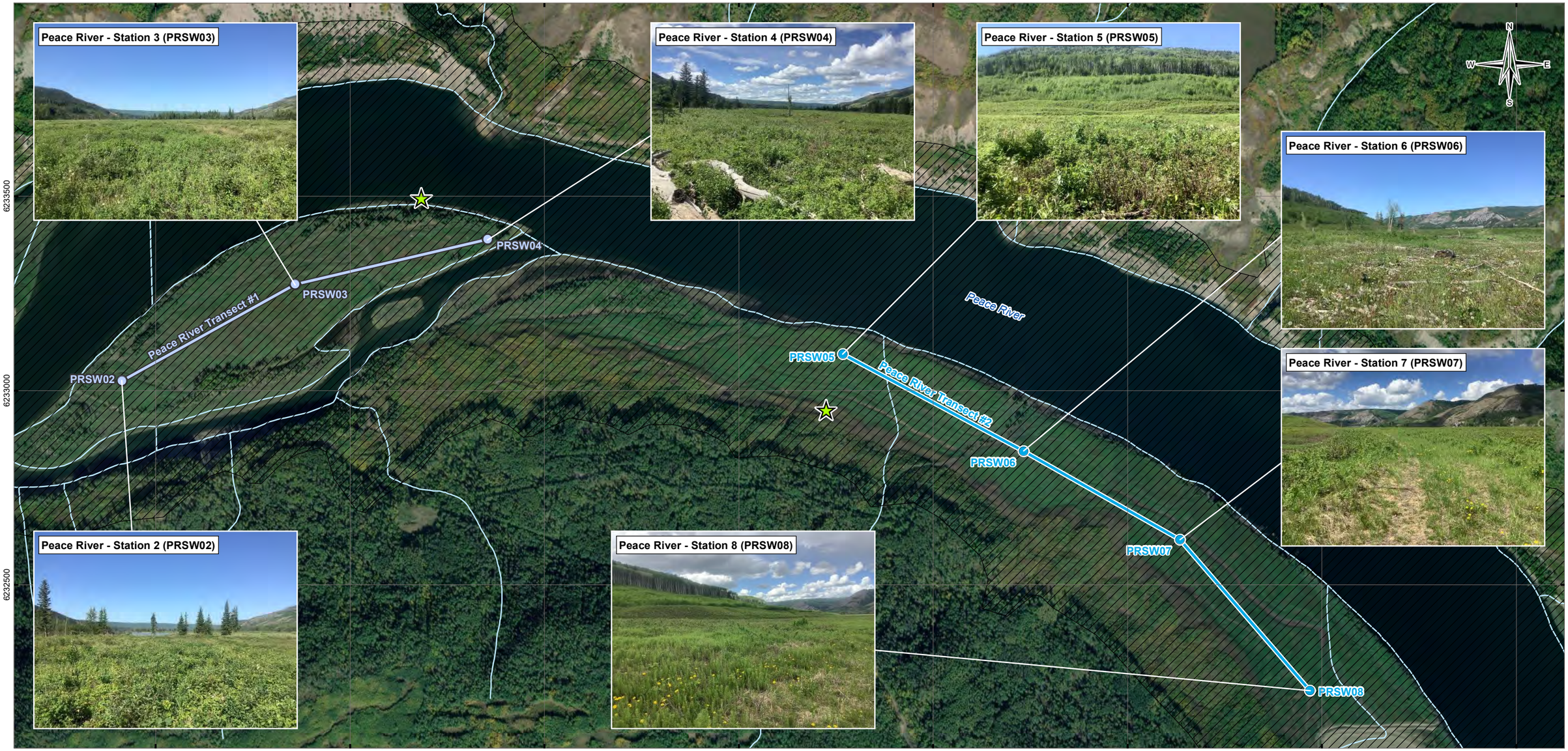
Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH

FILE NO.				
PENW03042-02_Fig04_PeaceR.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	SL	MRB	EH	0
DATE	**PROJECT NO.**			
March 26, 2025	ENW.PENW03042-02			

Figure 4

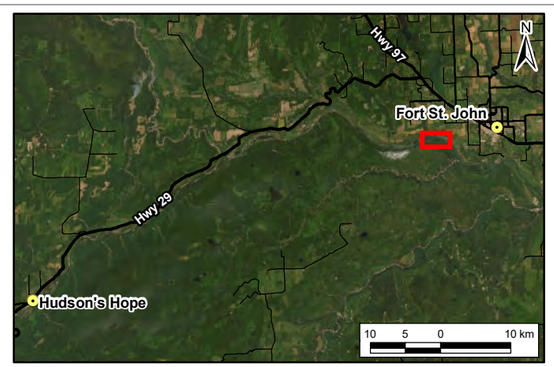
G:\ENVIRONMENTAL\PENW\PENW03042-02\Maps\GNRM_2024\PENW03042-02_Fig04_PeaceR.mxd modified 3/26/2025 by Stephanie.Lesink



G:\ENVIRONMENTAL\PENW\PENW03042-02\Maps\GNRM_2024\PENW03042-02_Fig05_PeaceR_T1T2.mxd modified 3/26/2025 by Stephanie Leusink

LEGEND

- Northern Harrier Observation
- Peace River Transect #1 Standwatch Station
- Peace River Transect #2 Standwatch Station
- Peace River Transect #1
- Peace River Transect #2
- Project Footprint
- Watercourse
- Waterbody



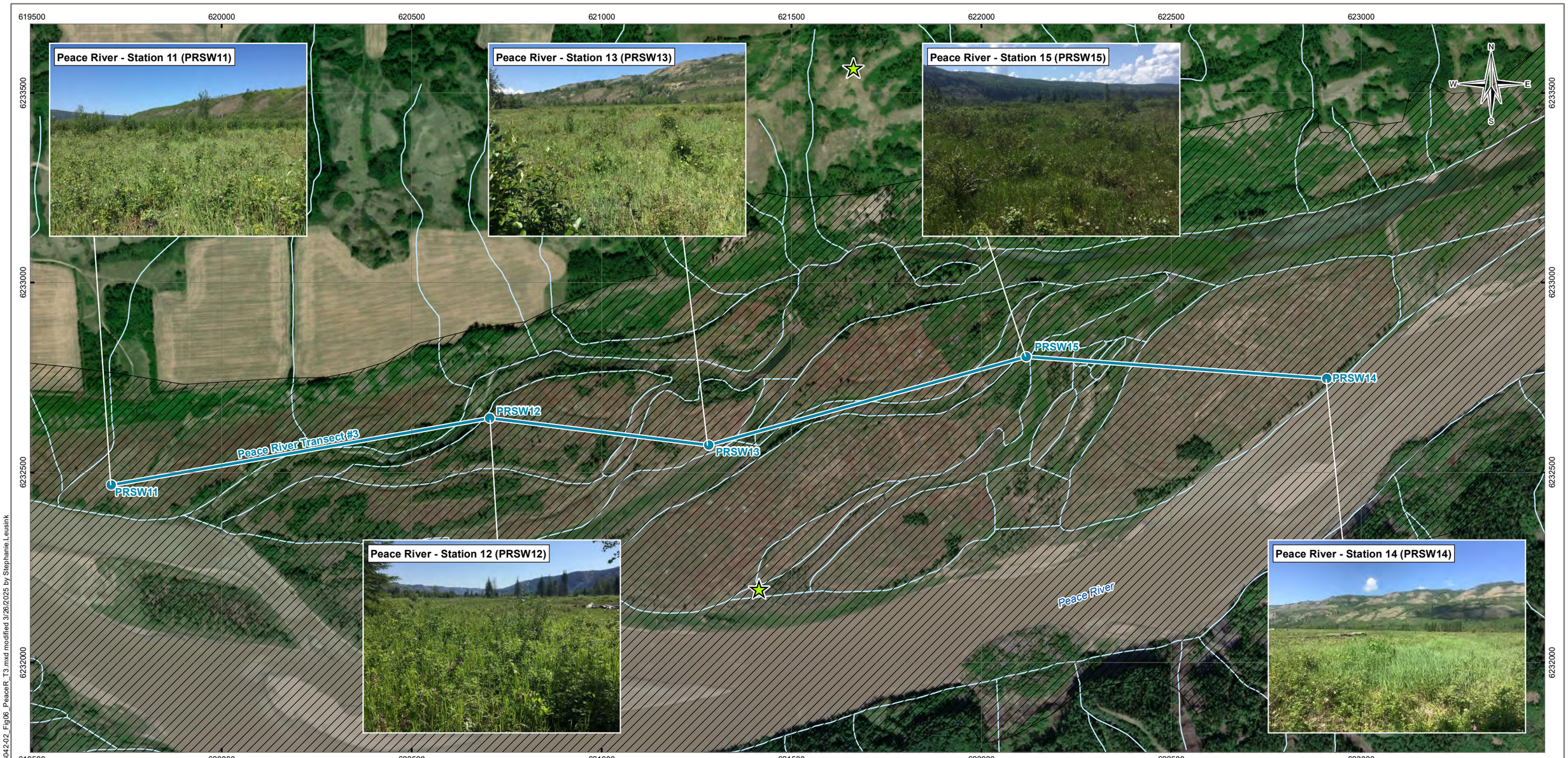
NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2022).

STATUS
ISSUED FOR USE

SITE C
GROUND-NESTING RAPTOR MONITORING
2024 ANNUAL REPORT

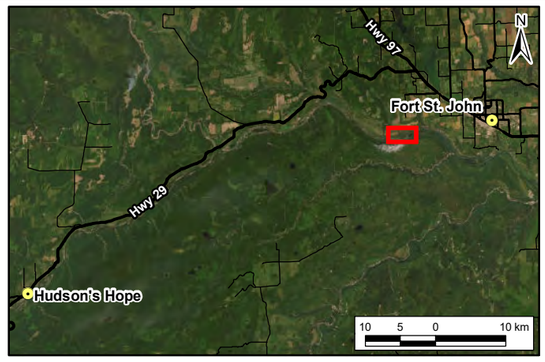
Peace River Transect #1 and Transect #2 Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83	CLIENT: BC Hydro Power smart			
Scale: 1:10,000 (200 100 0 200 Metres)		TETRA TECH			
FILE NO.: PENW03042-02_Fig05_PeaceR_T1T2.mxd					
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: EH	REV: 0	Figure 5
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02				



LEGEND

- Northern Harrier Observation
- Peace River Transect #3 Standwatch Station
- Peace River Transect #3
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2023).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

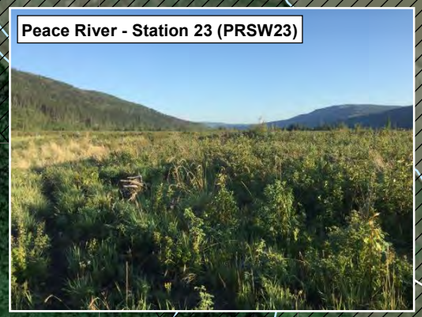
Peace River Transect #3 Standwatch Stations

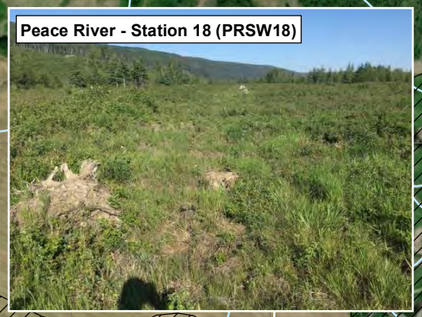
PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC Hydro Power smart
Scale: 1:10,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: PENW03042-02_Fig06_PeaceR_T3.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: EH	REV: 0
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02			Figure 6

G:\ENVIRONMENTAL\PENW\PENW03042-02\Maps\GNRM_2024\PENW03042-02_Fig06_PeaceR_T3.mxd modified 3/26/2025 by Stephanie.Lesiuk

615000 615500 616000 616500 617000 617500 618000 618500 619000 619500 620000 620500

6233500 6233000 6232500 6232000 6231500





PRSW23 Peace River Transect #4 PRSW22 PRSW21 PRSW20 PRSW19 PRSW18 PRSW17 PRSW16

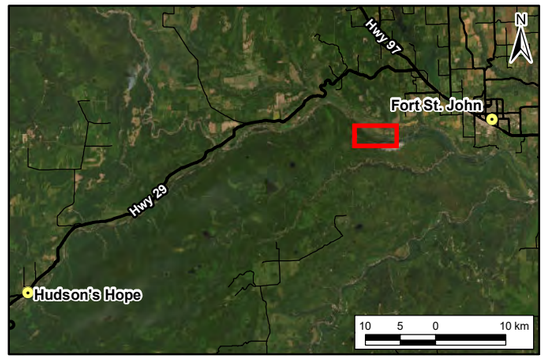
Peace River

N W E S

615000 615500 616000 616500 617000 617500 618000 618500 619000 619500 620000 620500

LEGEND

- Northern Harrier Observation
- Peace River Transect #4 Standwatch Station
- Peace River Transect #4
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2023).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Peace River Transect #4 Standwatch Stations

PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC Hydro Power smart
Scale: 1:15,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: PENW03042-02_Fig07_PeaceR_T4.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: EH	REV: 0
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02			Figure 7

G:\ENVIRONMENTAL\PENW\PENW03042-02\Maps\GNRM_2024\PENW03042-02_Fig07_PeaceR_T4.mxd modified 3/26/2025 by Stephanie Lesunk

610000 610500 611000 611500 612000 612500 613000 613500 614000 614500

6237000 6236500 6236000 6235500

PRSW28
Peace River Transect #5
PRSW27
PRSW26
PRSW25
PRSW24
Peace River

Peace River - Station 28 (PRSW28)

Peace River - Station 26 (PRSW26)

Peace River - Station 25 (PRSW25)

Peace River - Station 27 (PRSW27)

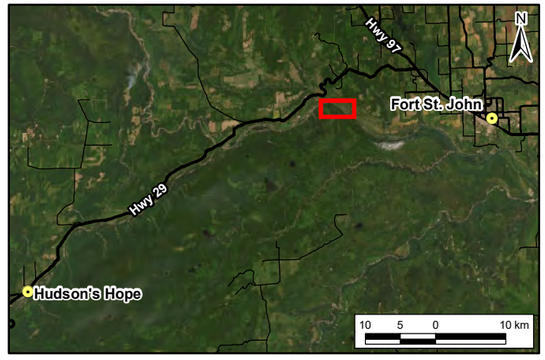
Peace River - Station 24 (PRSW24)

N W E S

610000 610500 611000 611500 612000 612500 613000 613500 614000 614500

LEGEND

- Northern Harrier Observation
- Peace River Transect #5 Standwatch Station
- Peace River Transect #5
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019).
Imagery from ESRI; Maxar (2021-2023).

STATUS
ISSUED FOR USE

SITE C GROUND-NESTING RAPTOR MONITORING 2024 ANNUAL REPORT

Peace River Transect #5 Standwatch Stations

PROJECTION: UTM Zone 10				DATUM: NAD83	CLIENT: BC Hydro Power smart
Scale: 1:12,000 (200 100 0 200 Metres)					TETRA TECH
FILE NO.: PENW03042-02_Fig08_PeaceR_T5.mxd					
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: EH	REV: 0	Figure 8
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02				

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APPENDIX A
INCIDENTAL RAPTOR OBSERVATIONS

Table A.1: Incidental Observation of Other Raptors During Ground-Nesting Raptor Surveys

Common Name	Scientific Name	BC List	COSEWIC/SARA	Number Observed		
				Bear Flats	Cache Creek	Peace River
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	Not at Risk (May 1995)	1	-	7
Merlin	*Falco columbarius*	Yellow	Not at Risk (April 1985)	-	-	12
American Kestrel	*Falco sparverius*	Yellow	-	4	-	3
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	Not at Risk (May 1984)	4	-	38
Great Horned Owl	*Bubo virginianus*	Yellow	-	-	1	-

APPENDIX B
SURVEY STATION HISTORY 2016 – 2024

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year								
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021	2022	2023	2024
Compensation Sites	Wilder Creek Lands	No	-	-	-	Surveyed	Surveyed	Not surveyed *						
	Ruttledge Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *						
	Marl Fen Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *						
Highway 29	H29SW01	No	10	604838	6234918		Surveyed	Surveyed	Surveyed	Not surveyed. Active Haul Road				
	H29SW02	No	10	607633	6236693		Surveyed	Surveyed	Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.			
	H29SW03	No	10	609150	6237937		Surveyed	Surveyed	Renamed CCSW05 and included in the CC Transect.					
	H29SW04	No	10	606078	6234708			Surveyed	Not Surveyed. Active Construction (Gravel Pit)					
	H29SW05	No	10	606918	6235242			Surveyed	Surveyed	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement.				
	H29SW06	No	10	607050	6235314					Established to replace H29SW05	Surveyed	Not surveyed due to access issues - active construction area.		
Peace River	PRSW01	No	10	623128	6232853		Surveyed	Surveyed	Surveyed	Redundant				
	PRSW02	Peace River Transect 1	10	623914	6233025		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW03		10	624359	6233273		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW04		10	624854	6233389		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW05	Peace River Transect 2	10	625768	6233094		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW06		10	626233	6232844		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW07		10	626635	6232616		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW08		10	626969	6232228		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW09		10	627381	6231920		Surveyed	Surveyed	Not Surveyed. Active Construction					
	PRSW10	No	10	617729	6232813				Surveyed	Redundant				
	PRSW11	Peace River Transect 3	10	619709	6232467				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW12		10	620706	6232643				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW13		10	621282	6232572				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW14		10	622910	6232747				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW15		10	622118	6232805					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW16	Peace River Transect 4	10	619462	6232003					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW17		10	618963	6231942					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW18		10	618468	6232038					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW19		10	617978	623215					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW20		10	617429	6232291					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW21		10	616965	6232496					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW22		10	616559	6232794					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW23		10	616002	6233031					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW24	Peace River Transect 5	10	613099	6235624					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW25		10	612727	6236012					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW26		10	612220	6236478					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW27		10	611697	6236730					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW28		10	610982	6236991					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW29	No	10	597439	6231064					Surveyed	Not surveyed. Site not within Headpond Area.			
	PRSW30	No	10	598178	6232247					Surveyed	Not surveyed. Site not within Headpond Area.			
	PRSW31	No	10	600081	6233281					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW32	No	10	602255	6233351					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW33	No	10	606725	6234293					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW34	No	10	607721	6235469					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW35	No	10	609368	6236803					Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW36	No	10	598278	6232689					Surveyed - Called HRSW04 in the field.	Not surveyed. Site not within Headpond Area.			

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year								
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021	2022	2023	2024
Moberly River	MRSW01	No	10	628328	6230312				Surveyed	Not Surveyed. Active Construction				
Bear Flats	BFSW01	Bear Flats Transect	10	611077	6237965				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	BFSW02		10	611561	6237465				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	BFSW03		10	612031	6237301				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	BFSW04		10	612483	6237076				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	BFSW05		10	612839	6236812				Surveyed	Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
Cache Creek	CCSW01	Cache Creek Transect	10	607653	6239245				Surveyed	No Access due to high water levels	Not Surveyed. Active Construction			
	CCSW02 / CCSW02B		10	608345	6239034				Surveyed	Surveyed	Not Surveyed. Active Construction			
	CCSW03		10	608729	6238798				Surveyed	Surveyed	Not Surveyed. Active Construction			
	CCSW04		10	609093	6238402				Surveyed	Surveyed	Not Surveyed. Active Construction			
	CCSW05		10	609318	6237699				Surveyed	Surveyed	Not Surveyed. Active Construction			
	CCSW06	No	10	609057	6237557					Surveyed	Not Surveyed. Active Construction			
	CCSW07	No	10	608790	6237457						Established to replace CCSW06	Surveyed	Surveyed	Surveyed
Halfway River	HRSW01 / HRSW01-2	No	10	595783	6231568				Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.			
	HRSW02	No	10	596262	6231237				Surveyed	Not Surveyed. Active Construction				
	HRSW03	No	10	595800	6231049				Surveyed	Not Surveyed. Active Construction				
Lynx Creek	LCSW01	No	10	571702	6214556					Surveyed	Not surveyed. Site not within Headpond Area.			
	LCSW02	No	10	572132	6214265					Surveyed	Not surveyed. Site not within Headpond Area.			

Footnotes:

General - Green cell indicates the site was surveyed. Red cell indicates the site was not surveyed

* Surveys of the mitigiation areas will be performed again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications.

APPENDIX C
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project Manager, Report Reviewer
Elyse Hofs, B.Sc., Dipl.T., R.P.Bio. Tetra Tech Canada Inc.	Field Data Collection, Data Entry, Report Author
Natasha Gidluck, B.Sc., B.I.T. Tetra Tech Canada Inc.	Field Data Collection

APPENDIX D
LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

1.1 USE OF DOCUMENT AND OWNERSHIP

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

TETRA TECH professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by TETRA TECH of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

Appendix 10. Portage Mountain Bat Mitigation Technical Report

2023 Analysis

Mitigation Effectiveness for Bats at Portage Mountain Technical Data Report

Photo Credit: F. Martinez-Nunez

Photo Credit: F. Martinez-Nunez

Prepared for:

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Site C Clean Energy Project
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December 17, 2024

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Executive Summary

BC Hydro's quarry on Portage Mountain in northwestern BC operated from 2019 to 2021 to supply aggregate for the construction of BC Hydro's Site C Clean Energy Project in the Peace River valley. The quarry was close to highly suitable rock crevice habitat used by federally designated at-risk bat species. The Portage Mountain quarry operated under spatial and temporal constraints intended to minimize impacts on bats and bat habitat. Mitigation exceeded provincial Best Management Practices for bats and included a 300-m spatial setback between all quarry activities and the approximate locations of crevices identified as potential hibernacula, and temporal constraints on blasting, which was curtailed during their hibernation period. To identify residual impacts to bats and bat habitat due to construction and operations at Portage Mountain, bioacoustics detectors were deployed to monitor bat activity. Bat activity was monitored year-round between 2017 and 2023.

Using funds provided by BC Hydro, the provincial government began bat acoustic monitoring at five sentinel sites (i.e., control sites) in northeastern BC in fall 2020 with data available until April 30, 2023.

This technical data report, prepared by Ausenco Sustainability ULC for BC Hydro, examines the effectiveness of mitigation measures implemented at Portage Mountain Quarry to protect bat populations during the Site C Clean Energy Project. The approach used here augments other types of analyses explored in an earlier report (Hemmera 2022). This study focuses on two key objectives:

1. Examine bat activity among species acoustics groups between Portage Mountain and sentinel sites to provide an ecological context for Portage Mountain.
2. Compare bat activity among species acoustics groups pre- and post-operations at Portage Mountain.

The study area includes the Portage Mountain Quarry and adjacent cliffs and five sentinel sites in northeastern British Columbia. Acoustic data from bat detectors, collected continuously from 2017 to 2023 at Portage Mountain and from 2020 to 2023 at sentinel sites, were analyzed to assess bat activity. For study design continuity, the period of June 19 to July 31 for the years 2018 and/or 2022 was selected for analysis as it is an especially active period for bats and had continuous data. This study focused on the active season for bats, as blasting was timed to avoid their hibernation period, making impacts on hibernacula less relevant. While a potential carry-over effect cannot be ruled out, monitoring bat hibernacula is challenging, with data being too limited to draw firm conclusions. Past monitoring reports show inconsistent bat swarming during blasting years, with swarming detected in 2019 and 2021 but not in 2020. However, more years of data are needed to assess any unusual patterns during swarming. Winter hibernation activity has been consistently documented for most bats since 2017, but not for Myotis species, which is expected. Spring emergence remains difficult to interpret, though it likely occurred annually throughout pre-and post-operations of the quarry.

Analyzing bat activity data from acoustic detectors is challenging due to the high variability in the data, making it difficult to confidently identify trends or causal relationships. Moreover, limited baseline data were collected before quarry development, and technical difficulties during detector deployment further complicated the process. While some trends and correlations were identified in this report, the conclusions are presented cautiously given the data's limitations and gaps caused by equipment malfunctions.

Key findings include:

1. Significant differences in activity patterns between myotis bats (*Myotis spp.*), EPFULANO bats (including big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*)), and migratory bats (including eastern red bats (*Lasiurus borealis*) and hoary bats (*Lasiurus cinereus*)). Overall, myotis were consistently observed in higher numbers compared to EPFULANO or migratory bats, and migratory bats had the fewest detections both within individual sites and across multiple years.
2. Variation among species and sites in summer was consistent with an expectation for species-specific habitat-use patterns. The Portage Mountain and the sentinel sites were difficult to compare due to large data gaps and existing site differences. For instance, Portage Mountain habitat is primarily used by myotis bats, while other bat groups were better represented at certain sentinel sites.
3. Differences in bat activity observed among years during the active season showed no evidence of a negative impact of quarry operations on bat activity. For instance, where EPFULANO and myotis bats demonstrated an increase in detections post-operations. In contrast, migratory bats showed a tendency to decrease. However, as migratory bats present a small demographic at Portage Mountain, it is challenging to determine the exact impact of blasting and operational activities. Due to the lack of multiple years of data both before and after the event, it was not possible to control for variability caused by natural 'year effects.' As such the cause of the observed differences between the two monitoring periods remains unclear. However, given the direction and magnitude of the observed differences following quarry operations, the data provide confidence that no biologically significant decrease in bat activity occurred following the completion of quarry operations, as compared to levels observed prior to the start of these operations.

Ultimately, the avoidance of direct habitat alterations and the implementation of spatial and temporal mitigations appear to have been sufficient to assure continued use of the Portage Mountain bluffs. Reclamation efforts at the Portage Mountain Quarry, including the creation of rock crevice features intended for bat roosting and hibernating habitats, are ongoing, and may increase availability suitable rocky roosting habitat, which is likely limiting in this region. This report underscores the importance of tailored conservation strategies and ongoing monitoring to ensure the protection of diverse bat species in industrial areas. Further research is recommended to address data gaps and improve understanding of bat behaviour in relation to environmental covariates.

This work was performed in accordance with Purchase Order 4130005798 between Ausenco Sustainability ULC, a wholly owned subsidiary of Ausenco Engineering Canada ULC (Ausenco), and BC Hydro (Client), dated March 31, 2022. This report has been prepared by Ausenco, based on fieldwork conducted by Ausenco, for sole benefit and use by BC Hydro. In performing this work, Ausenco has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

This Executive Summary is not intended to be a stand-alone document, but a summary of findings as described in the following Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Table of Contents

Executive Summary i

List of Acronyms and Abbreviations v

List of Symbols and Units of Measure v

1.0 Introduction 1

2.0 Methods 3

2.1 Study Area 3

2.1.1 Portage Mountain 3

2.1.2 Sentinel Sites 6

2.2 Environmental Covariates 8

2.3 Bat Activity 8

2.4 Data Processing and Management 8

2.5 Data Analysis 9

2.5.1 Species and Site Differences 9

2.5.2 Pre-and Post-Operation Trends in Bat Activity 10

3.0 Results 11

3.1 Species and Site Differences 11

3.2 Pre- and Post-Operation Trends in Bat Activity 14

4.0 Discussion 16

5.0 Closure 18

6.0 References 19

List of Tables

Table 2-1 Bat Monitoring Program Components Conducted at Portage Mountain and Sentinel Sites 3

Table 2-2 Detector Names and Locations at Portage Mountain Quarry 4

List of Figures

Figure 2-1 Bat Detector Locations – Portage Mountain 5
Figure 2-2 Bat Detector Locations - Sentinel Sites 7
Figure 3-1 Bat Activity Per Night from Acoustic Detectors at Sentinel and Portage Mountain Quarry (PMQ) Sites During Summer 2022 12
Figure 3-2 Comparison of Bat Species Activity by Detector Location During Summer 2022 13
Figure 3-3 Comparison of Pre-and Post-Operations Bat Activity at Portage Mountain Detectors 279 and NH 14
Figure 3-4 Predicted Number of Files by Species Acoustics Groups for Portage Mountain Detectors NH and 279, Pre-and Post-Operation from Mixed Effects Model. 15

List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
BC	British Columbia
BMP	Best Management Practice(s)
quarry; PMQ	Portage Mountain Quarry
Project	Site C Clean Energy Project
SARA	Species at Risk Act

List of Symbols and Units of Measure

Symbol / Unit of Measure	Definition
˚C	Degrees Celsius
%	Per cent
km	Kilometre
m	Metre

1.0 Introduction

Bats in British Columbia (BC) exhibit a broad diversity, occupying various habitats and employing distinct survival strategies. Their complex temporal and spatial annual cycles pose significant challenges when mitigating potential impacts. It could be argued that the term "bat" has, at times, hindered conservation efforts due to its generalization of these highly diverse species (Lausen et al. 2022). Furthermore, bat annual life stages – including hibernation, emergence, pup-rearing, and swarming – may be executed in distinct locations. Additionally, each bat species has specific habitat requirements for drinking, foraging, and selecting day and night roosts in both summer and winter. Their behaviours, whether facultative or potentially culturally driven, are influenced by multiple factors including weather, physiology, hormone levels, or a combination thereof (Turrisi et al. 2021; Patricelli 2023, Fenton 1997). There is a high level of natural variability in nightly bat activity, which can be influenced by insect phenology, time of day, weather and the sex or reproductive condition of individuals (Fischer et al. 2009; Gorman et al. 2021; Fraser et al. 2020; Hayes 1997; Sherwin et al. 2000; Talerico 2008). The natural variability in bat behaviour can make it challenging to detect how they respond to stressors (e.g., noise levels). Understanding these dynamics is opaque but required for effective conservation strategies tailored to the unique needs of each species. In the absence of such understanding, precautionary avoidance measures are often implemented to mitigate risk to bats. Monitoring the impacts after these measures are in place can help confirm whether they have successfully provided biologically meaningful protection.

Advances in technology have empowered researchers to understand activity patterns of animals over extended periods and spatial scales. Among these technological advancements, bioacoustics technology has emerged as an efficient, non-invasive tool for examining bat activity patterns and species diversity over long durations. Bioacoustic devices can provide a metric of bat activity based on the number of bat calls recorded within approximately 50 metres of the detectors; this activity can also be differentiated among groups of bats based on their call morphology (Fraser et al., 2020; Lausen 2016). This acoustic data is invaluable for confirming the presence of individual species groups and tracking changes in bat species diversity over time, enhancing our understanding of bat ecology. For bats, ultrasonic acoustic data captures echolocation calls, making it especially useful for documenting their activity in flight. While acoustic monitoring can offer some insights into the use of roosting habitats, interpreting echolocation data in this context assumes that activity can be related to roosting features nearby. These assumptions can be checked by field observation of bats exiting roosts, which has been done at the Portage Mountain sites.

Portage Mountain, approximately 15 kilometres (km) west of Hudson's Hope in northwestern BC (**Figure 2-1**), is the site of a quarry developed to supply aggregate for the construction of BC Hydro's Site C Clean Energy Project in the Peace River valley. Many bat species, including two endangered Schedule 1 of the Species at Risk Act (SARA) bat species (little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*)) are known to be present and likely hibernating at Portage Mountain (Hemmera 2022, Ausenco 2024). Production blasting and extraction of quarry rock took place during the summers of 2019, 2020, and 2021. Hemmera (2022) determined that production blasting did not exceed the recommended thresholds (e.g., 150 decibels (dB) of sound concussion, 15 pounds/square inch, and 15 millimetre/second of peak particle velocity) from the provincial Bat Best Management Practices (BMPs). Refer to Ausenco (2024) for details of construction activities. To reduce potential disturbance to hibernating bats, BC Hydro implemented a temporal restriction on all blasting activities between

September 15 and May 15 and 300-m setback between all quarry activities and the approximate locations of crevices identified as potential hibernacula (BC Hydro 2020). This exceeded provincial BMPs which recommends that high intensity activities (such as those associated with quarry construction and operations) should not occur between October and April, and a 100 m core area buffer be established around identified bat maternity and hibernation sites (BC Ministry of Environment 2016a, b, c). To identify impacts to bats and bat habitat due to construction and operations at Portage Mountain, bioacoustics detectors were deployed to test the efficacy of the temporal and spatial mitigation implemented.

The data generated over the course of this monitoring project provide a rare opportunity to examine large-scale patterns in bat activity across species acoustics groups, and to assess the effectiveness of mitigation, as recommended by provincial BMPs. A previous report documented activity of big brown and silver-haired bats during the winter hibernation period before production blasting (winter of 2017/2018), and the following three consecutive winters (Hemmera 2022). The results showed strong evidence that these species, which are prone to winter arousal, hibernated despite blasting activities during their active season. This was not confirmed for myotis species; however, winter arousal is not a well-documented behaviour for myotis. Myotis bats were observed swarming in late summer/early fall (an indicator associated with local hibernation), and potentially emerging from the hibernacula sites each spring. In this study we focussed on bat activity during the summer period when blasting activities occurred, and specifically compared the pre-and post-operation activity levels to assess for impacts resulting from the quarry operation. This assessment has broader relevance to the support the effectiveness of recommended mitigation measures as recommended by the BC Bat BMPs (BC Ministry of Environment 2016a, b, c).

The objectives of this study were to:

1. Examine bat activity among species acoustics groups between Portage Mountain and sentinel sites to provide an ecological context for Portage Mountain; and
2. Compare bat activity among species acoustics groups pre- and post-operations at Portage Mountain.

The following predictions were made:

1. Bat activity will vary between species acoustics groups at the Portage Mountain and sentinel sites due to differing habitat characteristics available; and
2. If the implemented temporal and spatial mitigation was effective, then no decline in bat activity will be detected at Portage Mountain post-operations of the quarry.

Due to the high variability in bat activity both within and across years, and the lack of sufficient data to separate year-to-year effects from project-induced impacts, this analysis cannot provide definitive conclusions. However, by characterizing variability across comparable years, observed differences can help address concerns about significant population-level impacts, such as site abandonment, depending on the direction and magnitude of those differences.

2.0 Methods

Methods implemented at Portage Mountain were developed in consultation with the Vegetation and Wildlife Technical Committee and local biologists (Hemmera 2018). At Portage Mountain, 5 detectors were deployed around the quarry and 5 sentinel site detectors were deployed within 120km of the quarry. The province began bat acoustic monitoring at five sentinel sites in 2021 (**Table 2-1**). Noise and vibration monitoring was conducted only at Portage Mountain during quarry construction and operations (**Table 2-1**).

Table 2-1 Bat Monitoring Program Components Conducted at Portage Mountain and Sentinel Sites

Monitoring Activity	2017	2018	2019	2020	2021	2022	2023
Portage Mountain Bioacoustics Monitoring	X	X	X	X	X	X	X
Noise and Vibration Operation Activity	–	X	X	X	X	-	-
Sentinel Bioacoustics Monitoring	–	–	–	–	X	X	X

The sentinel sites were too distant from quarry activities to warrant noise and vibration monitoring. See **Section 2.1.1** and **2.1.2** for details on the Portage Mountain and sentinel sites, respectively.

2.1 Study Area

The study areas consist of the Portage Mountain study area, in which bat activity has been monitored continuously since 2017, and the sentinel sites, at which bat activity has been monitored since 2021.

2.1.1 Portage Mountain

The Portage Mountain study area has been described in Hemmera (2020, 2022) and is briefly summarized here. The bat monitoring study area (**Figure 2-1**) includes the quarry (BC Hydro 2020) and the adjacent cliffs to the north and south within approximately 750 metres (m) of the quarry. The Portage Mountain cliffs are located in a forest dominated by hybrid white spruce (*Picea engelmannii* x *glauca*) and trembling aspen (*Populus tremuloides*). The two main areas of the cliff (north and south) are separated by an unnamed creek gully that drains into Dinosaur Reservoir.

Five Wildlife Acoustics Songmeter detectors (SM2, SM4BAT-ZC with SMM-U1 or SMM-U2 microphones) were installed at unique locations within the study area. Detector models and history details are described in Ausenco (2024). The rationale behind selection of locations for long-term bat detectors on the north and south cliffs of Portage Mountain was described in Hemmera (2019). These long-term monitoring stations are associated with suspected hibernacula and maternity roost sites around Portage Mountain Quarry (PMQ) and associated cliffs.

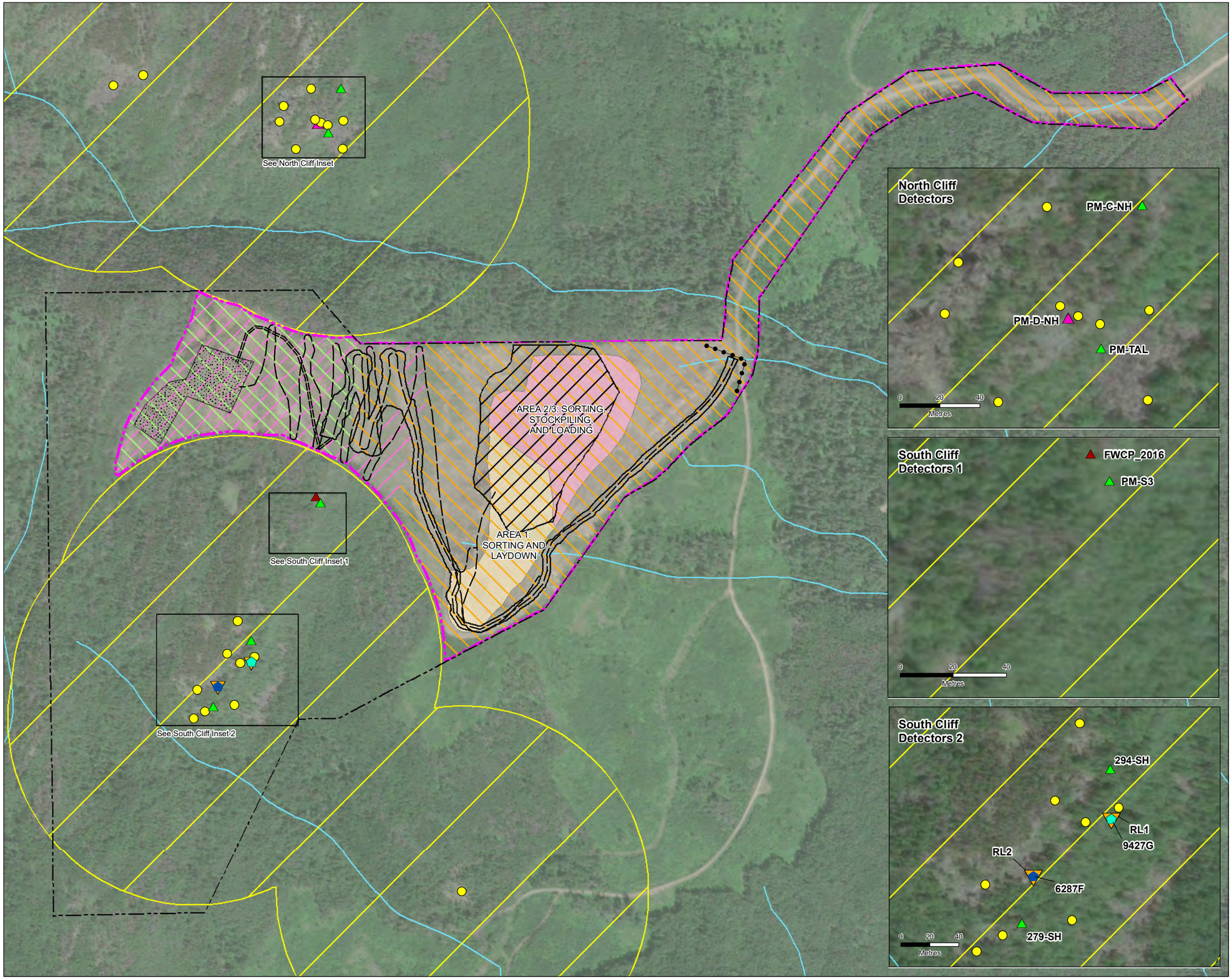
The detectors identified in **Table 2-2** have been operating continuously since their installation, although some data gaps have occurred due to equipment issues (Hemmera 2020). The detectors were visited every other month to download data and to verify they were operational. Detector settings have been described in Hemmera (2019).

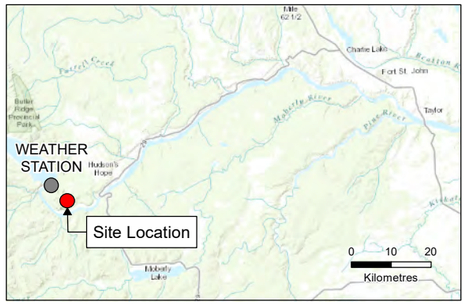
Table 2-2 Detector Names and Locations at Portage Mountain Quarry

Detector Name	Location	Deployment Date
NH	North Cliff	2017-2023
279	South Cliff	2017-2023
294	South Cliff	2017-2023
S3	Between South Cliff and Quarry	2017-2023
TAL	Talus Field at North Cliff	2020-2023

Site C Clean Energy Project
Wildlife Mitigation and Monitoring Services

Study Area and Bat Detector Locations for Portage Mountain Bat Monitoring





Legend

- Permanent Bat Detector
- Bat Detector (Historic)
- Short-Term Bat Detector
- Confirmed Maternity Roost
- Potential Hibernacula
- Potential Maternity Roost
- Roost Logger
- Weather Station
- Security Fencing
- In Quarry Access Road
- Quarry Haul Road
- Stockpile Road
- Site Boundary
- Potential Hibernacula - 300m Buffer
- Portage Mountain LOO
- Stripping/Overburden Stockpile Area
- Quarry Road
- Stockpile & Sort Area
- Quarry Development Area
- Grubbing Area by BC Hydro
- Clearing Area by BC Hydro
- Area 1: Sorting and Laydown
- Area 2/3: Sorting, Stockpiling, and Loading

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Base Data: BC Hydro, 2017
- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

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Hemmera An Ausenco Company

BC hydro

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2.1.2 Sentinel Sites

Using funds provided by BC Hydro, the provincial government began bat acoustic monitoring at five sentinel sites (i.e., control sites) in northeastern BC in fall 2020 with data available until April 30, 2023.

The sentinel site study design differs from the design at Portage Mountain. Sentinel site data were collected from five detectors spaced relatively far apart (e.g., > 5 km), and therefore each site has different environmental characteristics that are likely to influence bat activity (i.e., the sentinel detectors have spatial independence). In comparison, all the Portage Mountain detectors are relatively close together (detectors < 1.5 km apart and clustered within two distinct cliff areas). An additional difference between Portage Mountain and sentinel monitoring effort is the spread of monitoring over the project life cycle (**Table 2-1**).

There were five sentinel sites (**Figure 2-2**) selected based on previous records of bat activity and potential suitability for bat roosting habitat (hibernacula and maternity roosts) (M. Kellner, personal communication, 2020) at which bats were monitored in northwestern BC. All sentinel sites represent cliff crevice habitat, similar to the one observed at Portage Mountain. From Portage Mountain, Rainbow Rocks detector is 26 km northwest, Bear Flats and Tea Creek are 67 and 76 km northeast, and Hasler Bluffs and Bergeron Cliffs are 43 and 113 km south, respectively. Some data gaps occurred due to detector equipment issues.

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Wildlife Mitigation and Monitoring Services

Figure 2-2 Bat Detector Locations - Sentinel Sites

Legend

- Portage Mountain Quarry
- Sentinel Site
- Weather Station
- Site C Dam Site
- Geographic Location
- Highway
- Provincial Boundary

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence - Province of British Columbia
- Base Data: BC Hydro, 2017
- Aerial Image: World Topo Base

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Ausenco BC hydro

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2.2 Environmental Covariates

Bat activity, such as breeding or winter arousal, is known to be correlated with weather, such as temperature (Erickson and West 2002; Gorman et al. 2021; Hayes 1997; Wolbert et al. 2014). BC Hydro provided hourly air temperature data in degrees Celsius (˚C) from their weather station at the Portage Mountain Quarry (**Figure 2-1**). Technological issues, such as data gaps and malfunctions of acoustic detectors and paired weather loggers, posed significant obstacles to continuous environmental and acoustic data collection. Thus, the relationship to environmental covariates was not incorporated in this data analysis but is summarized in a qualitative manner.

2.3 Bat Activity

Studies using bat activity as a metric have several assumptions (Gannon et al. 2003; Hayes 1997, 2000) to simplify analyses and facilitate comparisons across studies. Assumptions for bioacoustics data include:

- Recorded bat calls reflect the use of a site by bats
- Bat detectors do not always record every bat in the air space at any given moment.

Acoustic activity does not indicate the number of bats in an area, but a relative index of activity at various temporal and spatial scales. Bat activity was monitored year-round from 2017-2023 at the Portage Mountain and from 2020-2023 at the sentinel sites. Detectors are not able to distinguish between multiple bats moving or a single bat repeatedly moving past a detector. Thus, the data presented represents relative levels of bat activity per night rather than absolute measures of bats. The total number of bat flights were summed over each night for analysis.

Bat activity was not defined or evaluated by annual cycle stage. The high variability in phenology (i.e., correlation with environmental conditions) can make critical stages (i.e., swarming) difficult to define with bioacoustics data (Hemmera 2022).

2.4 Data Processing and Management

Acoustic data processing methods used in 2024 were identical to those of previous years. The acoustic data processing followed a conservative approach as recommended for the processing of acoustic data by Lausen (2016). Refer to Ausenco (2024) for details on the acoustic data processing methods.

The species detected at Portage Mountain are a mixture of migratory and hibernating bats (refer to Ausenco (2024)), and the onset and duration of annual life stages will vary between species (Whitaker Jr and Rissler 1992; van Schaik et al. 2015) and by overwintering strategy. To examine differences in bat activity patterns by species, bats species were lumped into acoustic species groups (myotis bats, EPFULANO bats, migratory bats). The EPFULANO bats species acoustics groups were comprised of big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*). Although silver-haired bats can hibernate or migrate, in this analysis silver-haired bats were combined with big brown as they are acoustically similar and have been lumped together in past analyses for consistency. The migratory bats species acoustics groups were comprised of eastern red bats (*Lasiurus borealis*) and hoary bats (*Lasiurus cinereus*). The myotis bats species acoustics groups comprised of little brown myotis (SARA Schedule 1 Endangered; BC Blue-listed), long-eared myotis (*Myotis evotis*), northern myotis (SARA Schedule 1 Endangered; BC Blue-listed), and long-legged myotis (*Myotis Volans*).

2.5 Data Analysis

The data collection periods for the detectors at Portage Mountain and the sentinel sites differed. At Portage Mountain, the five detectors recorded data from as early as August 21, 2017, to as late as October 13, 2023. In contrast, the five detectors at the sentinel sites recorded data between April 11, 2020, and April 30, 2023. Additionally, there were large data gaps at various times throughout the study at both Portage Mountain and the sentinel sites. See Hemmera (2022) and Ausenco (2024) for complete summary of the data availability and gaps for each detector. To compare differences in bat activity between the Portage Mountain and sentinel sites, both datasets were subset to have matching dates of continuous data. Due to the large data gaps pre-operations, the limited pre-existing baseline bat activity data brought challenges when comparing pre- and post-operations conditions (see Hemmera (2022) for further details on pre-operations data availability).

For study design continuity, the period of June 19 to July 31 for the years 2018 for PMQ and 2022 for both sites were selected for all analysis as it is an especially active period for bats with complete data for certain detectors. Bat activity levels vary considerably through the year, driven by seasonal weather patterns and life stages. With an increasing abundance in insects and warmer temperatures, summer is considered the most active period for bats (BC Ministry of Environment 2016c). Although peak parturition varies with local weather conditions, most bats have given birth by early August and have consistently high activity in June to July (BC Ministry of Environment 2016c).

There are varying spatial degrees of site independence between Portage Mountain and the sentinel sites. Specifically, the sentinel sites are spaced farther apart than the Portage Mountain detectors and are considered spatially independent. All five sentinel sites were included in the analysis. Although spatially closer together than the sentinel sites, due to the unique habitats covered at the north and south cliffs, the Portage Mountain detectors 279 and NH were retained for this analysis. The north cliff habitat was unique with a clear line of sigh of the quarry, resulting in higher noise levels detected during operations (Dailyde et al. 2020). Moreover, the detectors 279 and NH were retained as they provided more continuous data than the spatially similar detectors 294 and S3 (refer to **Figure 2-1**). Detector TAL wasn't deployed until 2020, and thus could not contribute data pre-operations (refer to **Table 2-2** and **Section 2.5.2**).

All statistical analyses described below in **Section 2.5.1** and **2.5.2** were performed using the software R version 4.1.1 (R Core Team 2024). Mixed effects models with a negative binomial distribution were used as data samples were too small to be transformed (log) to increase normality (Zar 1999). The R package MASS was used to fit a negative binomial mixed effects model to account for overdispersion in the data (Venables and Ripley 2002). A critical value of $p = 0.05$ was used in all tests.

2.5.1 Species and Site Differences

Site and species were evaluated in conjunction to examine patterns of species acoustic groups and provide ecological context for Portage Mountain available bat habitat. For instance, due to the available habitat existing at each site, Portage Mountain may be more suitable for myotis bats, whereas Bear Flats may be more suitable for big brown bats.

Differences in bat activity levels by each species acoustics group was examined using the sentinel and Portage Mountain dataset from 2022. To remove confounding variables of potential activity differences through proximity to operation activities, a mixed effects model was implemented. Due to the nature of bat acoustic data (e.g., spatial autocorrelation, temporal autocorrelation, and unequal sampling), generalized linear mixed effects models are regularly used to test bat acoustic data (Perks and Goodenough 2020; Jameson and Willis 2014; Muthersbaugh et al. 2019). A negative binomial distribution was used because overdispersion was an issue when a Poisson distribution was used. The variance of the data was much larger than the mean, further supporting the use of a negative binomial distribution. The number of acoustic files per night was the response variable, with a random effect of detector site and night to control for variation in bat activity across nights and detectors. To highlight the stochasticity of bats, the standard error of the mean is reported.

2.5.2 Pre-and Post-Operation Trends in Bat Activity

Production blasting at the Portage Mountain Quarry was ongoing from 2019 to 2021. Previous exploratory analyses considered various activity during quarry operations (Hemmera 2022). This objective is to evaluate if the mitigation implemented during the operations of the Quarry was effective in avoiding a long-term population-level impact on bats. This study used the most robust data available (i.e., during active season) and contrasts across years immediately before versus after quarry operations. The Portage Mountain acoustic data was compared pre- and post-operations to examine if there were differences in bat activity among species acoustics groups pre- and post- operations. Due to data limitations described in Section 2.5, pre- and post-operations dates were defined as:

- Pre-operations: June 19, 2018 to July 31, 2018
- Post-operations: June 19, 2022 to July 31, 2022.

To analyze the differences in bat activity levels between pre-and post-operation years, and among the various species acoustics groups (myotis bats, EPFULANO bats, and migratory bats), we employed a mixed effects model with a negative binomial distribution. The number of acoustic files per night was the response variable, with a random effect of detector site and night. To highlight the stochasticity of bats, the standard error of the mean is reported.

3.0 Results

The pre-operation and post-operation periods at Portage Mountain were active for 43 nights and had 11,622 and 16,275 detections, respectively. Portage Mountain and sentinel sites had a total of 16,275 and 113,569 detections in 2022, respectively. Refer to Ausenco (2024) for a detailed summary of the active nights, data gaps, and total detections of 2022-2023 and Hemmera (2022) for 2017-2022. Results of the long-term passive acoustic monitoring and concurrent emergence counts for the previous years are presented in Hemmera (2018, 2019, 2022) and Ausenco (2024).

The mean temperatures between pre- and post-operations were nearly identical at 16 ˚Celsius (˚C) with a high of 32 ˚C and a low of 6 ˚C. Pre-operations had a greater standard deviation of warmer temperatures than post-operations by 2 ˚C at 6 ˚C.

3.1 Species and Site Differences

All species acoustics groups exhibited differences in the timing and frequency of activity in 2022. There were large differences in relative activity of bat species acoustics groups. For instance, myotis bats had the highest detection at 67% of total detections. EPFULANO bats accounted for 29% of the total detections, and migratory bats had the lowest detections at only 4% of the total detections at both Portage Mountain and sentinel sites.

There were temporal differences observed in bat activity by species acoustics groups (**Figure 3-1**). In **Figure 3-1**, the heatmap demonstrates an overview of activity intensity (number of acoustic files per night) over time and across locations. The box plots summarize distribution and variability in bat behaviour across sites and species. EPFULANO myotis, and migratory bats had variations in peak activity (i.e., the date with the highest number of detections) with differences varying up to a month. For instance, myotis bats had the highest interval of activity earliest in the year, July 3. Migratory bats had peak activity later in the month (July 14), and EPFULANO bats peak activity occurred on July 30, two weeks later.

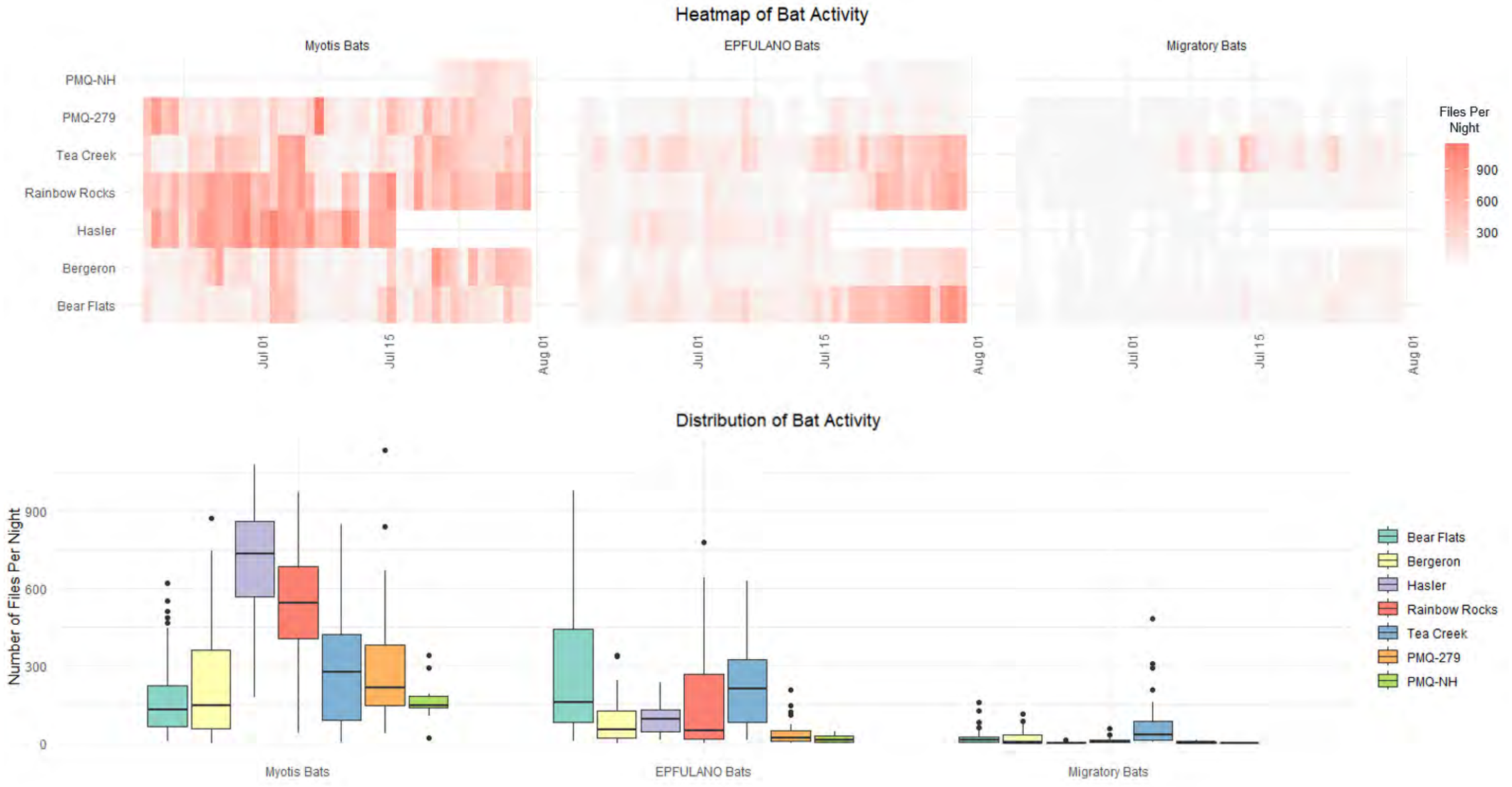

Figure 3-1 Bat Activity Per Night from Acoustic Detectors at Sentinel and Portage Mountain Quarry (PMQ) Sites During Summer 2022

Figure 3-1 demonstrates how bat activity over time is unique to each species group. For instance, EPFULANO bats were active later in the summer (mid July to August), with higher activity frequently detected at Bear Flats and Tea Creek. Myotis bats displayed higher daily variations in movement compared to other species acoustics groups and were detected in highest numbers at all sites, except Bear Flats. Migratory bats were detected in low numbers and had the shortest period of high activity in mid July.

A strong relationship was observed between bat species acoustics groups and the amount of bat activity recorded per night. Myotis bats had the highest predicted amount of nightly activity, with twice as many predicted detections as EPFULANO bats per night (coef = 1.34, SE = 0.09, z = 14.22, p < 0.0001). Migratory bats had the lowest predicted number of files per night (coef = -1.92, SE = 0.09, z = -28.74, p < 0.0001).

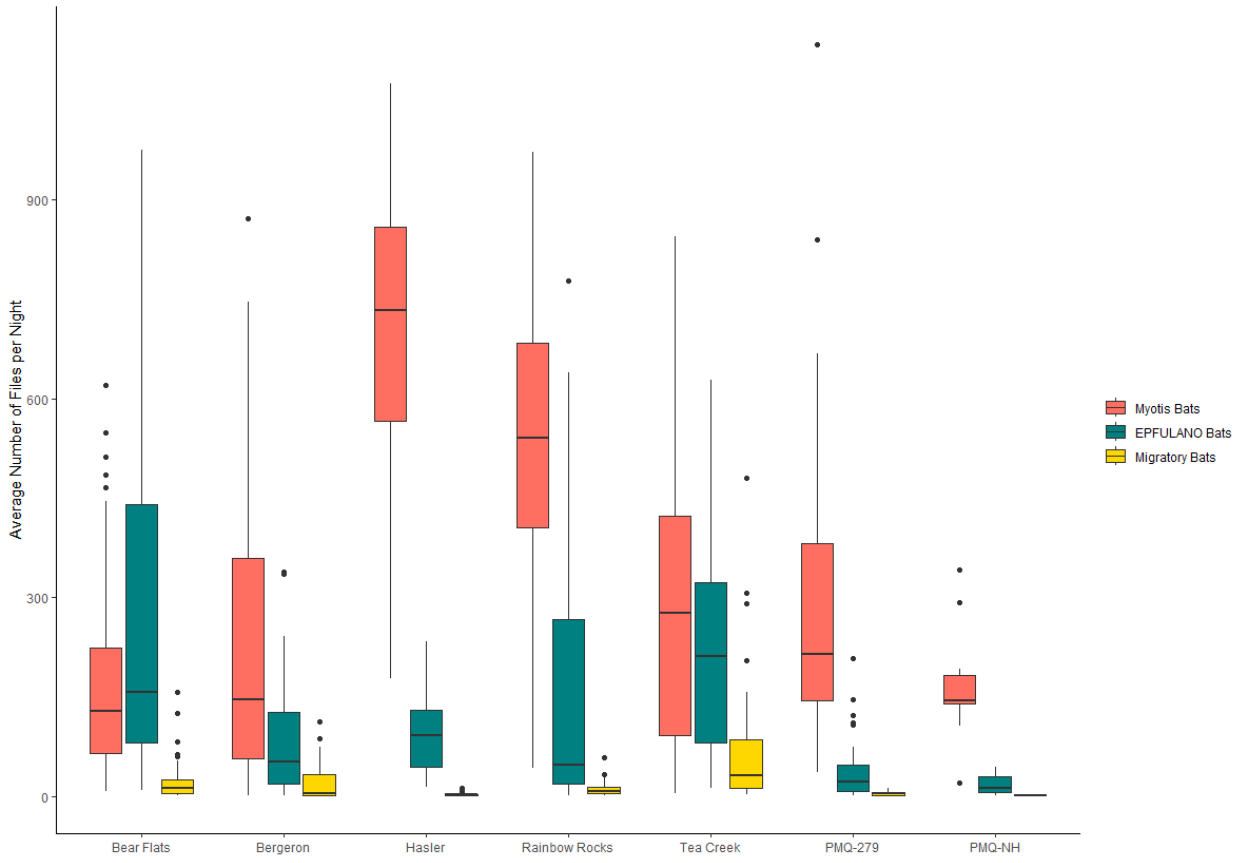

Figure 3-2 Comparison of Bat Species Activity by Detector Location During Summer 2022

Relative activity levels of bats varied between habitats and species acoustics groups. Between the sentinel sites and Portage Mountain, there were variations in differences between the Portage Mountain and sentinel sites with bat activity (the random intercept for each detector has a larger variance (σ^2 = 0.6666) and standard deviation (σ =0.8164) compared to the night recorded (σ^2 = 0.3592, σ =0.5993). This suggests that there is more variability in the baseline levels across different detectors than across different nights. Portage Mountain detectors identified comparable levels of myotis bats to those at sentinel sites. However, the Portage Mountain detectors had less big brown bats than sentinel sites. Portage Mountain's NH detector identified the smallest number of bats out of any other detector (**Figure 3-2**). Tea Creek had the highest number of migratory bats detected (**Figure 3-2**).

3.2 Pre- and Post-Operation Trends in Bat Activity

There were differences between the species identified at both the south (detector 279) and north (detector NH) cliffs. At detector 279 in post-operations, all bat species acoustics groups saw an increase in activity. In contrast, at detector NH, myotis bats were observed in higher numbers, but similar, yet smaller numbers of EPFULANO bats and migratory bats were observed (**Figure 3-3**).

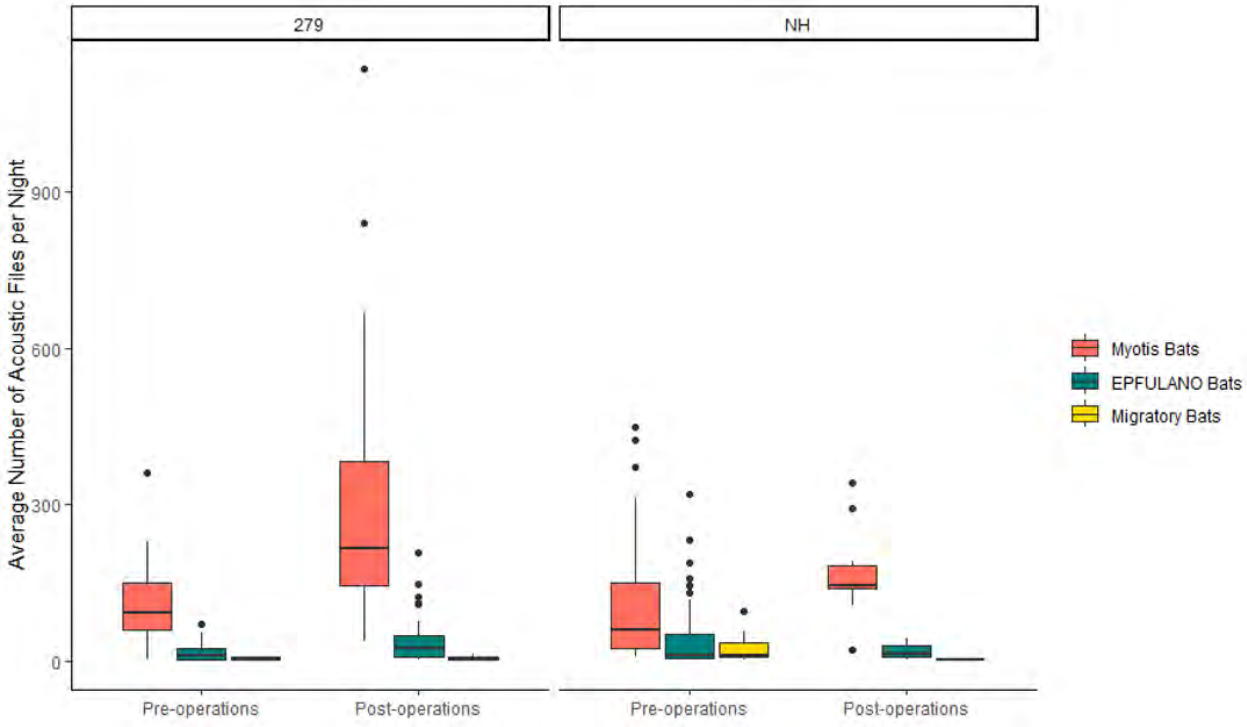

Figure 3-3 Comparison of Pre-and Post-Operations Bat Activity at Portage Mountain Detectors 279 and NH

There was an overall statistically significant increase in bat observations during the post-operation period compared to the pre-operation period (coef = 4.5, SE = 0.13, z = 35.45, p < 0.0001; **Figure 3-4**). Statistically significant higher bat activity was observed for myotis bats in the post-operation period compared to pre-operation period (coef = 1.02, SE = 0.18, z = 5.62, p < 0.0001; **Figure 3-4**). In contrast, migratory bats had a statistically significant decrease in activity post-operations (migratory bats; coef = - 2.07, SE = 0.22, z = -9.57, p < 0.0001; EPFULANO bats: **Figure 3-4)**. Post-operations, EPFULANO bats increased at detector 279 and decreased at detector NH (**Figure 3-3; Figure 3-4**).

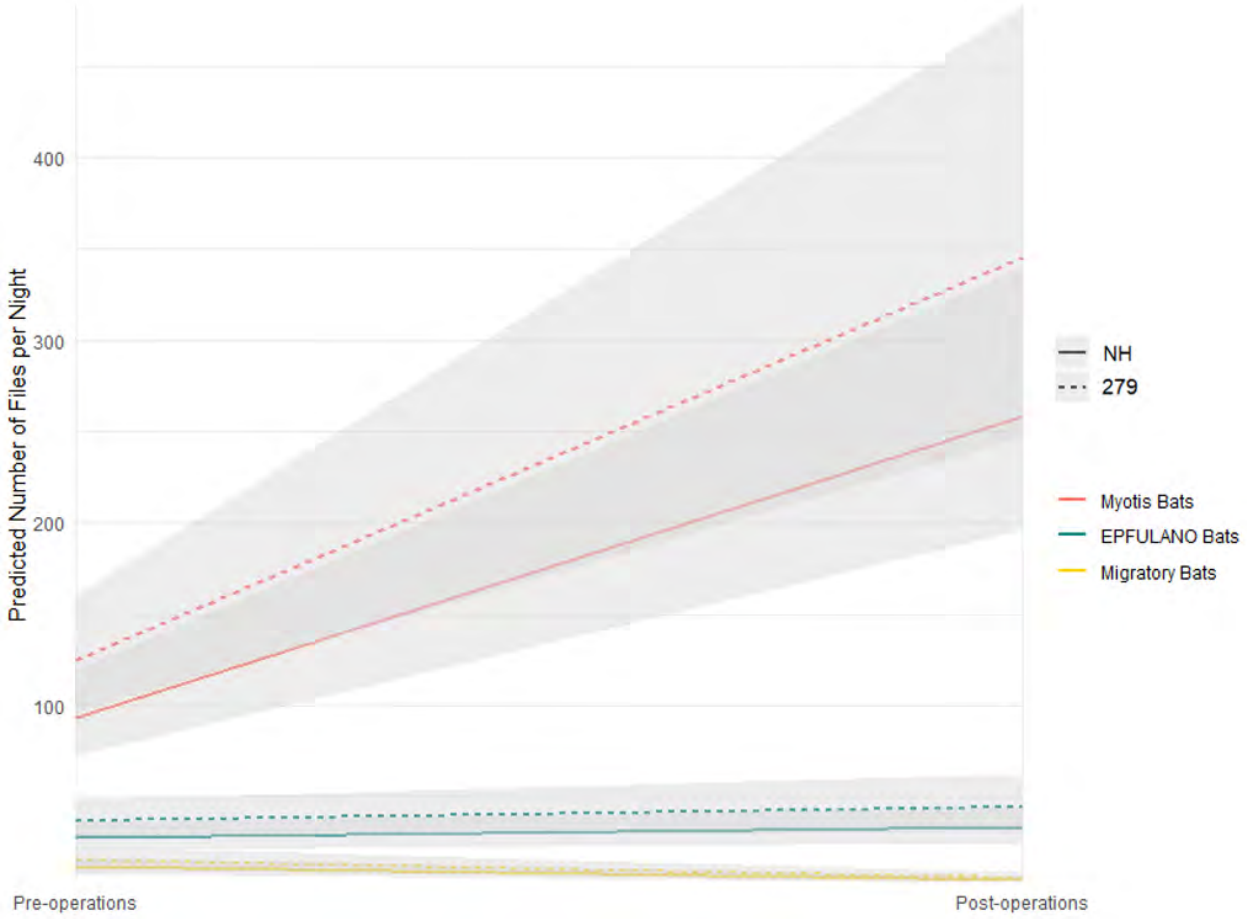

Figure 3-4 Predicted Number of Files by Species Acoustics Groups for Portage Mountain Detectors NH and 279, Pre-and Post-Operation from Mixed Effects Model.

4.0 Discussion

Our study compared activity among three acoustically distinct groups of bats, revealing different summer activity patterns and different usage among sites. Myotis were consistently observed in higher numbers compared to EPFULANO or migratory bats, and migratory bats had the fewest detections both within individual sites and across multiple years. The predicted abundance of bat species groups would be expected to change seasonally, as well. Our study focused on the June-July period, but in late fall to early spring, it would be expected that big brown bats would have higher bat activity than myotis bats. It is expected that migratory bats would be less abundant than other bats during the summer period, as migration doesn't typically begin until August and September. The behaviours of these bat groups are known to be influenced by several factors, including weather, physiology, and hormone levels (Fischer et al. 2009; Gorman et al. 2021; Fraser et al. 2020; Hayes 1997; Sherwin et al. 2000; Talerico 2008). Myotis exhibited significant day-to-day variation in activity and strong seasonal variation. Conversely, EPFULANO bats displayed extended periods of activity, peaking between mid-July to August.

This seasonal and behavioural variability complicates the detection of significant changes in bat activity due to substantial annual, species-specific, and individual differences. It is important to acknowledge that variations in bat activity could also be due to physiological factors such as age, sex, reproductive status, and health, as well as external factors like prey availability and predation risk. Additionally, the potential impacts of white nose syndrome - a fungal infection that may affect yearly and species-specific behaviour, though it is not known to be present in the region – have not been investigated at the sentinel sites or at Portage Mountain. Despite efforts to control for variability, significant factors, such as annual variation, remain unaccounted for and continue to pose challenges in interpretating acoustic bat data.

The results of this study highlight how bat activity levels are highly variable among sites and among species acoustic groups. Each bat species group analyzed in this study requires specific habitat preferences (Lausen et al. 2022). Differences in bat activity and species abundance between sentinel sites and Portage Mountain underscores the importance of habitat variability and site-dependent factors in determining the presence and activity of specific bat species in an area. For this study, the Portage Mountain and the sentinel sites were difficult to compare due to large data gaps and existing site differences. Our study broadly suggests that the Portage Mountain habitat is primarily suitable for myotis bats, while other bat groups are less prominent, being better represented at certain sentinel sites. Continued monitoring at sentinel sites would be valuable for confirming these patterns and could potentially provide a foundation for conserving some of these areas as biodiversity conservation targets.

A major source of variation that we were unable to estimate in this study, or previously was the natural year-to-year variability. Year effects are often notable in long- term bat monitoring studies (Hemmera 2022), and without monitoring for multiple years before and after quarry operations, its impossible to estimate a typical random year effect or assign causation to observed changes over time. However, since the changes observed at Portage Mountain were largely positive, it suggests that if any long-term negative impacts occurred, they were likely not biologically significant, as the effect size would have to be small compared to annual variability in order to account for our results. Alternatively, the increase in myotis and EPFULANO populations could be due to natural population growth in the area, or perhaps increased site usage following habitat augmentation from quarry operations. While none of these potential interpretations can be confirmed, our study does not support the conclusion that there was a biologically significant negative impact on myotis and EPFULANO bat populations during the summer high activity period.

To the best of our knowledge, this study is the first long-term investigation into the effectiveness of provincially recommended spatial and temporal setbacks for blasting mitigation on bats in British Columbia (BC). During the 2022 post-operation period, acoustic detections of bats indicated ongoing habitat use at Portage Mountain. In Ausenco (2024), the emergence counts also had a paralleling increase in bats observed post-production blasting. To add complexity, where EPFULANO and myotis bats demonstrated an increase in detections post-operations, migratory bats showed a tendency to decrease. As migratory bats present a small demographic at Portage Mountain, it is challenging to determine the exact impact, if any, of blasting and operational activities. This study did not account for annual variability of migratory bats across sentinel sites, which could be informative to determine if the decrease in migratory bats detected was due to natural annual variation or an impact from operation activities. Nevertheless, the implementation of spatial and temporal mitigations appear overall beneficial in minimizing potential negative impacts to bats during quarry activities. Reclamation efforts at the Portage Mountain Quarry, including the creation of rock crevice features intended for bat roosting and hibernating habitats, are ongoing, and may increase the availability of rocky roosting habitat, which could be limiting for bats in the Peace lowlands east of the Rockies.

Several challenges were encountered during the study. The variability in impact intensity, as reported by Hemmera (2022), further complicated the assessment of mitigation effectiveness. For instance, many variables impact the level of noise and how far noise travels, including distance to blast, vegetation, weather, and geography. Specifically, as reported in Dailyde et al. (2020) quarry noise levels at the north cliff were higher than at the south cliff because there is a clear line of sight from the quarry. Where myotis bats exhibited an increase in activity post-operations, there was a decrease in migratory and EPFULANO bat activity at the NH detector where the blasting noise was higher. Bats also may have a threshold response to disturbance (Bennett and Zurcher 2013), where no change is evident in bat activity until a particular level of disturbance is reached and may vary by species, life stage and sex. Measuring environmental and bat-related variables accurately was challenging due to the dynamic and complex nature of the ecosystems involved. Additionally, technological issues, such as data gaps and malfunctions of acoustic detectors and paired weather loggers, posed significant obstacles to continuous data collection. Significant data gaps precluded continuous or comprehensive comparisons of bat activity between pre- and post-operation periods.

In summary, implementing spatial and temporal mitigation measures that exceed the recommended provincial BMPs appear to have successfully supported the ongoing use of the Portage Mountain bluffs by bats. This conclusion is further supported by a statistically significant increase in detections of EPFULANO and myotis bats in the June-July period following operations. The report emphasizes the importance of tailored conservation strategies and continuous monitoring to protect bat species during industrial projects. It is essential that permanent bat detectors are maintained and inspected frequently with regular data downloads throughout the duration of the monitoring program. Additional research is recommended to address current data gaps and to enhance understanding of bat behavior in relation to environmental factors.

5.0 Closure

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

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Appendix 11. Portage Mountain Artificial Bat Hibernacula Memo

Inter-office memo

To: Brent Matsuda Date: March 18, 2025

From: Arshad Khan

CC: Justin Krilow, Harry van Oort

Subject: Portage Mountain Quarry Reclamation – Bat Hibernacula Construction

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Portage Mountain Quarry (PMQ) located 14 km west of Hudson's Hope, BC was a source of rock (riprap) for construction works on Highway 29, related to the Site C clean energy project. Site clearing began in 2016, initial test blasting began in 2018, and production blasting occurred between 2019 and 2021. Rock hauling from stockpiles in the lower quarry continued into 2022. Physical reclamation works at PMQ began in August 2023, and was completed in November 2024.

Prior to site clearing and quarry development, assessments in 2012 – 2013 (Keystone Wildlife Research Ltd., 2014) identified hibernacula and maternity roosts near the proposed quarry. Following best management practices (BMPs) for bats in relation to mine development (BC MOE, 2016), appropriate buffer zones were established around these critical habitat features. Sarell and Alcock (2017) confirmed that the new quarry footprint did not include any sensitive bat habitat and did not infringe on the buffers established around nearby habitat features, and recommended ongoing monitoring of surrounding habitat features continue during quarry operations, and that the creation of hibernating habitat be considered during future quarry reclamation.

The Site C Environmental Assessment Certificate (EAC) E14-02 (EAC, 2014) included conditions that required BC Hydro to create hibernation and roosting locations for bats to compensate for any sensitive habitat that was lost or could not be avoided.

Quarry operations were able to avoid spatial impacts to nearby bat habitat by altering quarry design and the limits of the proposed haul road (Figure 1). Noise monitoring during trial blasting quarry operations ensured that the BC BMPs for bats were adhered to. Noise and vibration levels had a concussion of less than 150 decibels, shock waves less than 15 psi, and peak particle velocity less than 15mm/s (RWDI, 2018).

Temporal disturbance was mitigated against by adhering to a no-blasting window between September 15th and May 15th to avoid sensitive timing windows for bat hibernation.

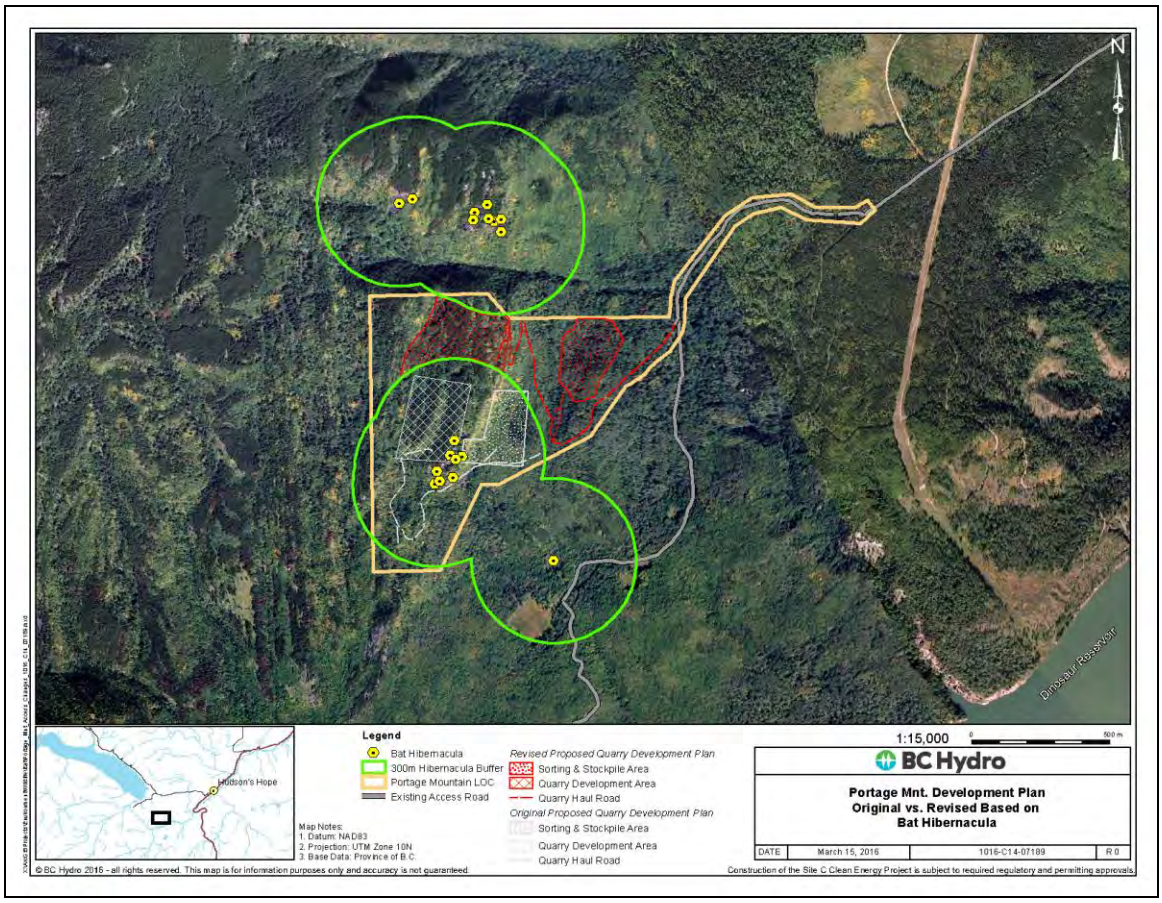

Figure 1. Original and revised PMQ development plans

Because nearby sensitive habitat was avoided, and there was no loss of habitat due to quarry development, BC Hydro asserts that Condition 16 in Schedule B of EAC E14-02 was satisfied. The BC BMPs were exceeded in terms of timing (i.e., no blasting between September 15 and May 15 vs. the recommended October to May period), spatially (i.e., 300 m buffer around documented hibernacula instead of 100 m) and any blasting parameters well below the recommended noise and vibration levels (BC Hydro 2023). However, BC Hydro recognizes that Site C has a large footprint impact, and that bat hibernacula habitat is likely limiting in the region and opted to construct bat hibernacula during quarry reclamation.

BC Hydro engaged a bat subject matter expert (SME) Mike Sarell to provide expertise in developing functional designs for artificially constructed bat hibernacula that could meet the microclimatic conditions required by hibernating bats. A novel approach involving drilling, blasting, and auguring caves was proposed. A total of four sites were selected for the creation of these caves and work commenced in 2023, with the completion of three locations by September 14, 2023. With swarming and winter hibernation imminent, and the no-blasting window approaching, the decision was made to reschedule the construction of the last hibernaculum to 2024. Safety and logistical concerns around drilling and blasting at the fourth location resulted in the decision to install a culvert-style bat hibernaculum instead of blasting another cave. Construction of

the culvert hibernaculum began on September 15, 2024, and was completed by October 19, 2024.

Figures 2 and 3 show the locations of the four artificially constructed hibernacula at PMQ and Table 1 provides additional details.

Figure 2. Locations of the four artificial bat hibernacula constructed at PMQ: 2-20, 1-30, 1-31, and CH-1

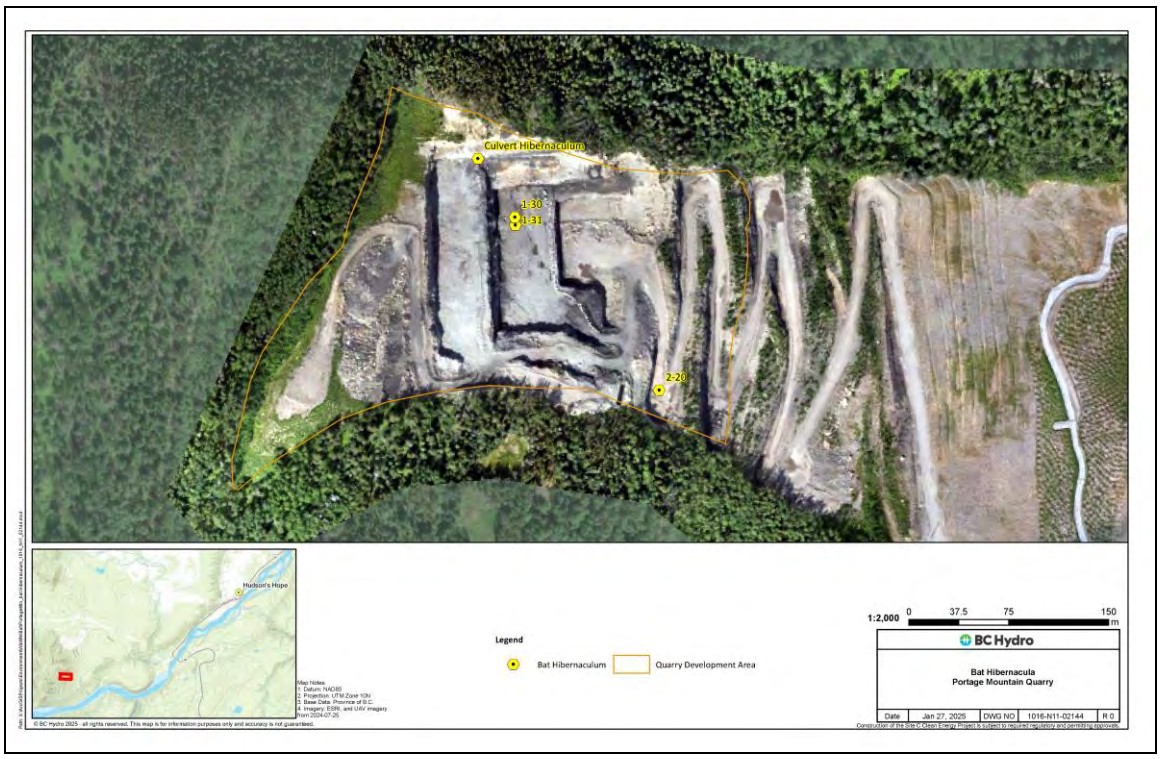

Figure 3. Map showing locations of the four artificial bat hibernacula constructed at PMQ.

Instrumentation to measure temperature and humidity inside the constructed hibernacula was installed at each location. Multipoint string thermistors (TH0022-Q148562-1) from RST Instruments were housed in perforated polyvinyl chloride (PVC) pipe and installed at the cave sites 2-20, 1-30, and 1-31 in 2023, and at the culvert hibernaculum, site CH-1 in 2024. Thermistors were connected to RST's DT Series dataloggers (DT2055B-T-USB-D_CELL).

In 2024, HygroVue10 hygrometers paired with CR350 dataloggers from Campbell Scientific were installed at each hibernaculum except site 2-20. Rock fall or movement inside the cave at site 2-20 posed safety challenges for the installation of hygrometers, and risked damaging the previously installed thermistors, so no hygrometer was installed in 2-20. Table 1 summarizes the details of the four constructed hibernacula.

Table 1. Summary details of constructed hibernacula at PMQ

Name	Location	Type of Structure	Depth (m)	Number of Thermistor Nodes (T)	Number of Hygrometer Nodes
2-20	Switchback 6	Cave	20	5	0
1-30	Bench 2	Cave	24	7	2
1-31	Bench 2	Cave	30	7	2
CH-1	Bench 3	Buried culvert	20	5	2

Additional details on the construction methods for both types of hibernacula, noise monitoring during construction, instrumentation installed, and photographs can be found the technical memo from Tetra Tech (2025) in Appendix A.

In October 2024, BC Hydro installed six Titely Scientific Ranger Advanced Acoustic Recording Units (ARUs) with omnidirectional microphones at PMQ. All instrumentation and ARUs installed at PMQ were new. Four of the ARUs were installed with the microphone positioned inside an entrance slit to each artificial hibernaculum. Two additional ARUs were positioned outside, one on Bench 2 and one on Bench 3, installed on a 4-m-tall pole, to record swarming and emergence acoustic activity. Each ARU was connected to a solar panel to provide power. Based on manufacturer recommendations and biologists familiar with the use of ARUs, they were set to continuous sample mode and zero cross sound format. This was determined to provide the best balance between capturing bat acoustic signals and maximizing battery life.

Results

In general, bats prefer hibernation sites where temperatures are above freezing with no drastic fluctuations (Zukal et al., 2017). Temperature measurements from cave sites 2-20, 1-30, and 1-31 from February 2024 to October 2024 were analyzed and appeared to provide a zone of stable temperatures (Figures 4, 5, and 6). However, no humidity data was available at the time of writing. Once data downloads and analysis are completed in 2025, the suitability of the artificial hibernacula at PMQ, in terms of temperature and humidity, should become clearer. Temperature, humidity, and acoustic monitoring of the artificial hibernacula at PMQ is ongoing.

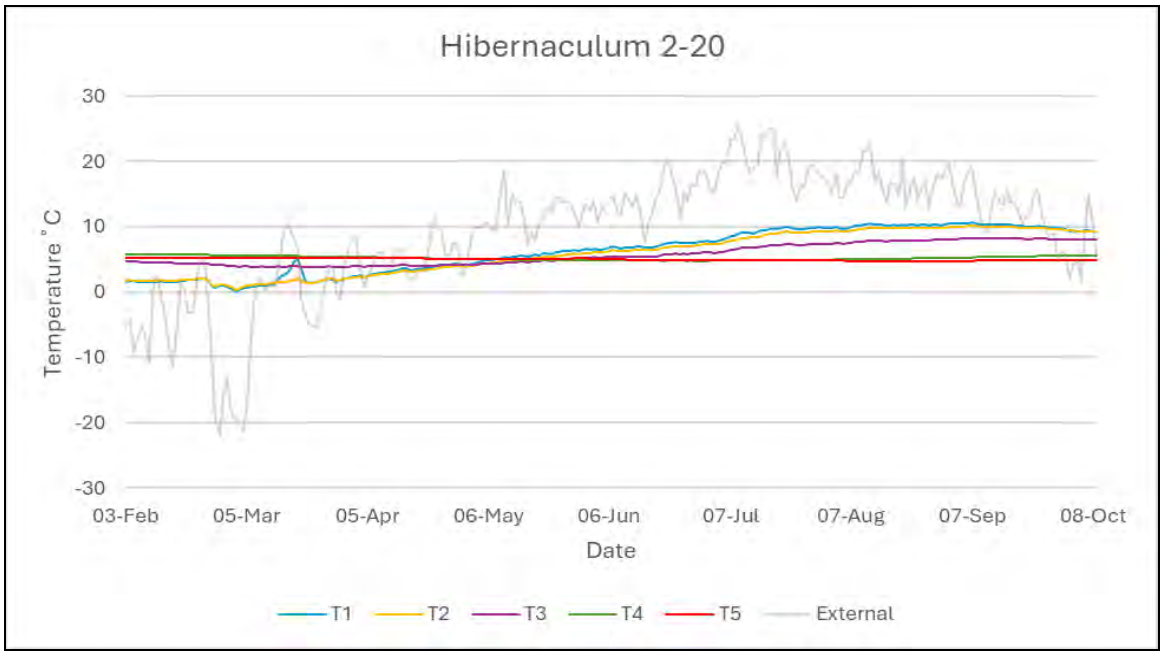

Figure 4. Results of temperature monitoring at hibernaculum 2-20 from February 3 to October 9, 2024

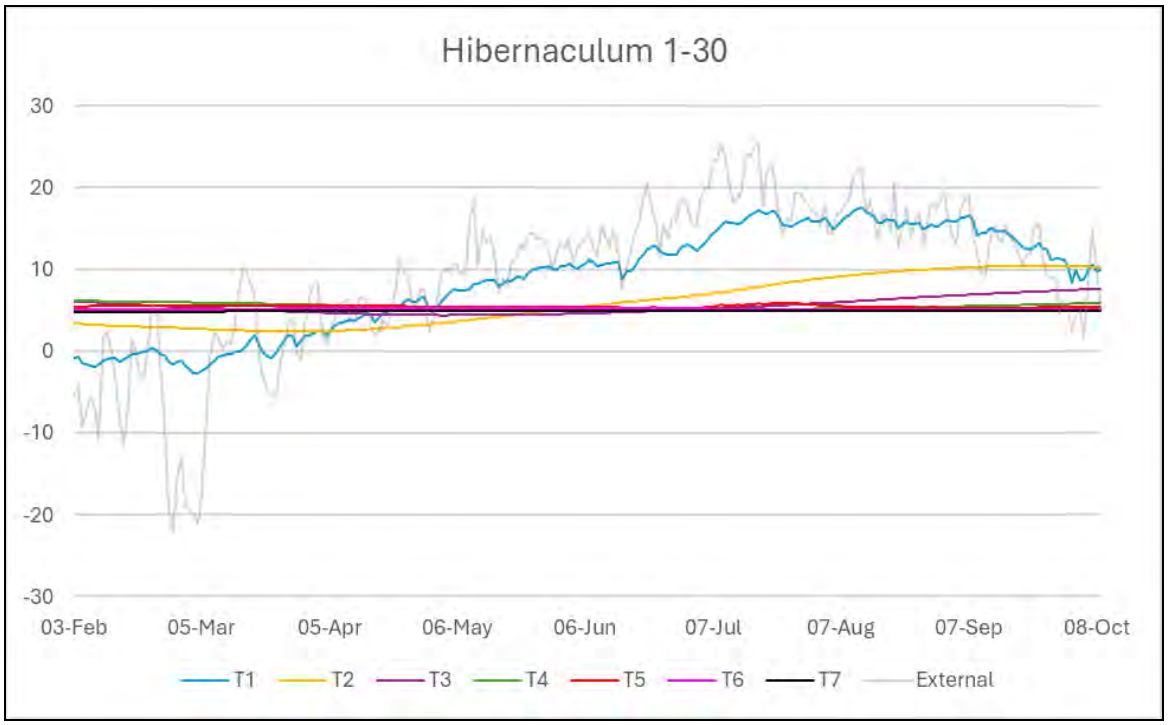

Figure 5. Results of temperature monitoring at hibernaculum 1-30 from February 3 to October 9, 2024

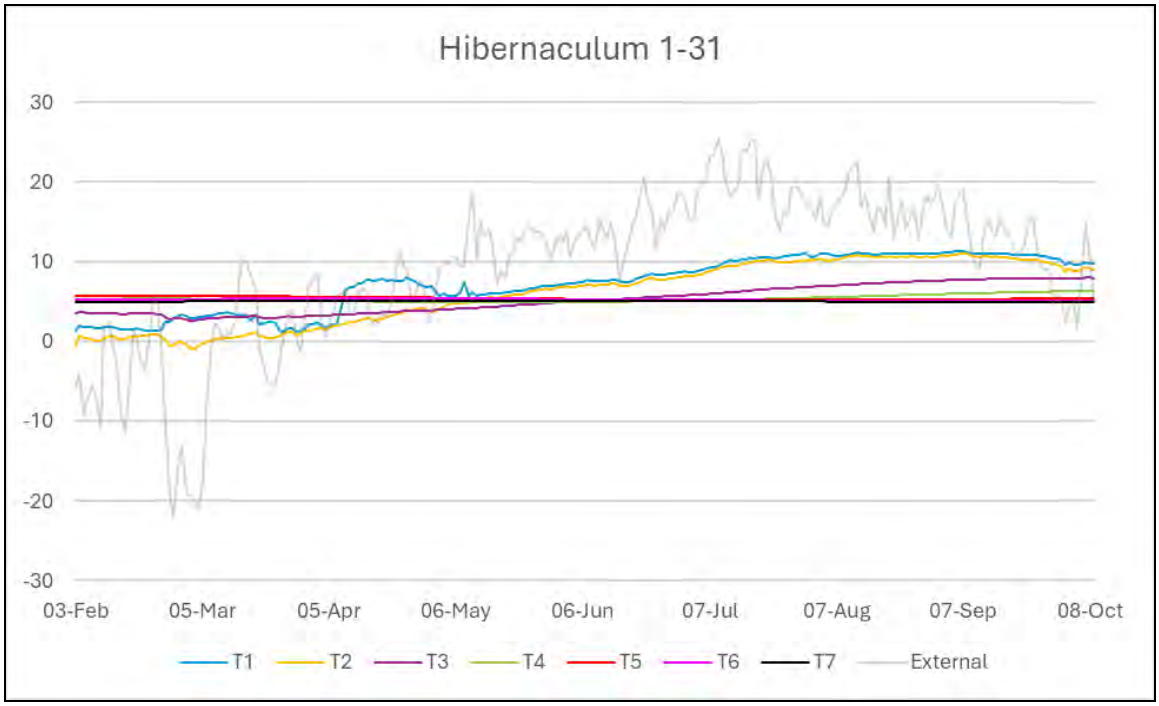

Figure 6. Results of temperature monitoring at hibernaculum 1-31 from February 3 to October 9, 2024

Recommendations

All four constructed hibernacula at PMQ were built to the design conceptualized by the bat SME. These features became available for use in November 2024, once physical reclamation works at PMQ was complete. Since bats would have already chosen hibernating sites by this time, no use of these features was expected during the winter of 2024-2025. It is recommended that the ARUs are checked prior to emergence in 2025 to determine how they performed in winter conditions, and to assure they are functioning during the onset of the active season.

It is recommended to service the ARUs at minimum twice annually. Once in April-May, when the ambient ARUs should be switched to full spectrum recording, and the second time in the fall, when the ambient ARUs should be switched back to zero cross-recording for the winter. Zero cross-recoding will only record the loudest frequency and highest amplitude sounds, but will not drain batteries as quickly. The microphones located inside each hibernaculum should remain on the zero cross-setting year round.

During these visits, the ARUs should be checked for any physical damage from rodents, ensure the solar panel are working, and SD cards should be swapped out. A third visit in the summer to ensure the system is working as intended is recommended. Any required decontamination protocols outlined in the standard operating procedures for minimizing white nose syndrome transmission should be followed (WLRS and MOF, 2023).

We trust this memo provides adequate information on the construction and ongoing monitoring of the bat hibernacula at PMQ as part of quarry reclamation. If you have any questions or comments, please contact the undersigned.

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Reviewed by:
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APPENDIX A

TETRA TECH

TECHNICAL MEMO

February 16, 2025

ISSUED FOR USE
734-22162916-MEM-C0001-00
Via Email: Matt.Barnette@bchydro.com

Attention: Matthew Barnette MBA, MSc., P.Ag. Environmental Specialist,
Arshad Khan, BSc, BIT, CESCL, Natural Resource Specialist
Justin Krilow, MSc, RP Bio, Project Manager
Brian Oldford, Construction Manager

From: Joe Shook, B.Sc. Project Manager
Anders Frappell, P.Eng FGS Team Leader, Rock Engineering Group
Ryan Wizbicki, P.Eng., Design Coordinating Engineer

Subject: Portage Mountain Quarry Bat Hibernacula: Design and Construction Summary

1.0 INTRODUCTION

Riprap material for the Site C Clean energy Project was produced at the Portage Mountain Quarry (PMQ) until the spring of 2022. With riprap production complete, BC Hydro is undertaking reclamation works. The Site C Clean Energy Project Environmental Assessment Certificate (EAC) Condition 16 states

> *"If loss of sensitive wildlife habitat or important wildlife areas cannot be avoided through Project design or otherwise mitigated, the EAC Holder must implement the following measures, which must be described in the Vegetation and Wildlife Mitigation and Monitoring Plan. The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation measures:*
>
> *following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats."*

To address these requirements, BC Hydro considered suitable areas for the creation of bat habitat in the development of its CEMP and reclamation plans.

An outbreak of a fungal disease, known as white-nose syndrome (WNS), has killed millions of bats in North America. During the course of the Site C project, and as a direct result of WNS. the little brown myotis and northern myotis received emergency listings as Endangered by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and were added to Schedule 1 of the Species at Risk Act (SARA). PMQ provided a unique opportunity to create suitable habitat. Bats and bat hibernacula were identified to the south and north of the PMQ site. The production of riprap resulted in vertical, nearly vertical, or very steep (>30%) rock faces with fractures suitable for roosting and congregation. During riprap production, Senior Biologist and Bat Subject Matter Expert, Mike Sarrell, conceptualized constructing artificial bat hibernacula into the vertical rock faces, using readily available construction equipment, which would mimic bat hibernation conditions found in natural caves and anthropogenic sites like mines, and could also isolate habitat from extreme temperature variations in the area. Tetra Tech Canada Inc (Tetra Tech) and EcoLogic Consultants Ltd (EcoLogic), were requested by BC Hydro to advance the concept, develop a design package, and support construction. In Fall 2023 BC Hydro retained Duz Cho Construction L.P. (DCCLP) and its subcontracting partners, Glacier Blasting (Glacier) and Dyno Nobel (Dyno), to construct the drilled hibernacula. In Fall 2024 BC Hydro retained DCCLP to construct a culvert hibernacula against the north wall of bench 3 at PMQ.

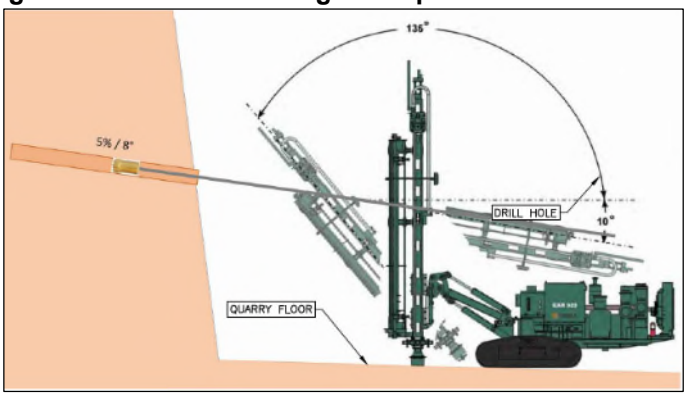
The following summarizes the design process and construction activities completed to date.

2.0 DESIGN

2.1 Concept Generation – Drilled Hibernacula

The design objective was to create microclimates suitable for bat hibernation. Caverns with cross section 0.8 m to 1.2 m wide and 20 m to 30 m deep were estimated to provide suitable overwintering habitat. Tetra Tech envisioned using down-the-hole drill rigs to bore large diameter drillholes (up to 10" diameter), then using explosives to blast the rock spine between the holes and then auguring the fractured rock out to create a mini-cave. Locating the hibernacula at least 3.0 m above ground surface on the rock face would allow a down-the-hole drill rig to fix the mast in a non-traditional way and drill sub-horizontally (see Figure 1). In the horizontal configuration, the drilling could also be tilted at a 5% to 8% inclined angle providing a slope to drain the cave if water were to infiltrate. A series of explosives could be set at predetermined depths in the boreholes with initiation set on delays/predetermined timing to evacuate the blasted rock from the hole. It was envisioned that additional auguring of the cavern would be required to address rock not evacuated in the blast.

Figure 1- Horizontal drilling concept.



2.1.1 Design Codes

Although there are no specific design codes or recommendations for the creation of bat hibernacula the following codes, specifications and guidelines were drawn upon during the design.

- BC MoTI Standard Specifications 2020: 204 – Rock Cuts, 206 – Rock Bolts, 207 – Slope Mesh for Rock Cuts, 204 for Scaling and Trim Blasting
- International Society of Explosives Engineers – *ISEE Field Practice Guidelines for Blasting Seismographs*
- BC MoE 2016 – Best Management Practices Guidelines for Bats in British Columbia – Chapter 2- Mine Developments and Inactive Mine Habitats.
- Supplement to CHBDC S6:19 – Section 6 – Foundations and Geotechnical Systems (July 27, 2022)

2.1.2 Site Setting

Tetra Tech and Ecologic completed site reconnaissance in summer 2022. Tetra Tech's Geotechnical engineer looked for favorable conditions for horizontal drilling and long-term stability of the hibernacula, including rock mass, strength and lack of rock discontinuities. Geological mapping, from the original site investigations, suggested that bedding planes were favorable, dipping into the face. These conditions were confirmed to still be present after riprap

production. EcoLogic's biologist reviewed the site for proximity to supporting features such as food supply (wetlands) and forest (roosting and congregation opportunities). Tetra Tech and EcoLogic selected six possible locations. Six potential locations were considered of which two were chosen to support hibernacula sites (Figures 2 and 3). These two sites were selected as they could support two drilled hibernacula

Figure 2- Location of the two sites selected for creation of the bat hibernacula.

Figure 3- Photo of the rock face where the artificial bat hibernacula were created at Sites 1-30 and 1-31 (formerly 1-20). Orange markings are the surveyed drillpoints.

Figure 4- Photo of the rock face where the artificial bat hibernacula were created at Sites 2-30 and 2-20 (2 central markings). Orange markings are the surveyed drillpoints.

2.1.3 Design Process

The drilling and blasting process used in mining rock requires collaboration with contractors and supplier design inputs such as blast patterns, initiation sequence, energy confinement and distribution calculations. Under WorkSafe BC Regulation 21 Blasting Operations the blaster provides the blast plan. This project also required specialty drill and blast planning for the horizontal drilling and sequential blasting to collapse and evacuate material. Tetra Tech developed a reference concept, that provided the project objectives, minimum standards, and blasting design criteria. DCCLP, and its subcontractors, used the reference concept as a basis, but adjusted its approach and after each drillhole and with each blast. Section 3.0 Construction describes how the blast design evolved during construction. The reference concept is shown on Figures 5 and 6. It included the following provisions:

- Localized geotechnical stabilization at each of the hibernacula sites to permit safe working by the contractor's personnel. Stabilization work included rock scaling, rock bolting, and installing temporary drape mesh.
- Two hibernaculum sites with one 20 m and one at 30 m deep cavern at each site.
- Drilling 3.0 m above ground level to facilitate construction equipment reach and to avoid anthropogenic penetration and snow accumulation.
- Three large diameter (200 mm to 300 mm diameter) drillholes, set in a triangular pattern, and drilled using a Down-the-Hole (DTH) hammer drilling machine or rock roller. A triangular pattern was recommended to have debris fall to the bottom hole, which could be augured out more easily. The reference concept also advised that a centre breakout hole may be required to allow the blast energy to move the rock into.
- Boreholes spacing between 125 mm to 250 mm apart and drilled at the same dip and dip direction into the rock face.
- Boreholes inclined at a gradient of 8° (5%) above horizontal to ensure the holes will drain water, create a dry environment for the bats, and allow their body heat to rise inside the cavern.
- The rock remaining in-between the three boreholes to be blasted with explosives, on sequenced delay charges, to evacuate the rock from the holes. Blasting out the centre rock to create a roughened surface in the cavern, allowing bats to grip on to the rock.
- Following blasting, remaining rock to be removed using a suitably sized auger drill, unifying the three boreholes into a triangular shaped cavern.

Figure 5- Reference Concept Showing Construction Details.

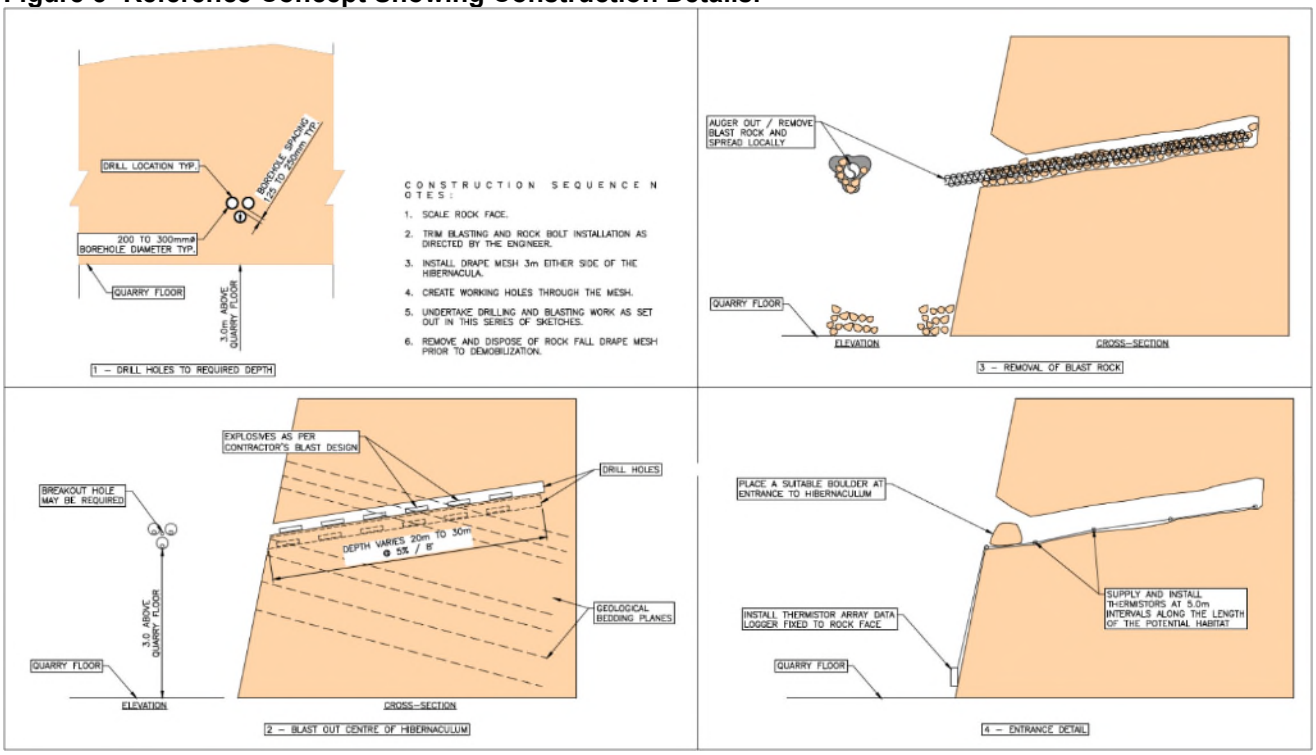


Figure 6- Reference Concept Showing Hibernacula Entrances.

2.1.4 Procurement

Bat hibernacula was originally tendered requesting a Lump Sum bid per hibernacula. The proponent expressed that Lump Sum carried undue risks due to the unique nature of the work and potential cost risks. A revised package was proposed based on unit prices with individual items for stabilization, drilling and blasting (linear metre drilled), and cleanout (auguring). Again, the contractor advised there was a significant amount of risk on it and its subcontractors and requested work on a Time and Materials (T&M) basis. Recognizing that it was unique design

and there would be changes to the drill layout, blast plan, and explosive timing, during construction, BC Hydro accepted the T&M approach.

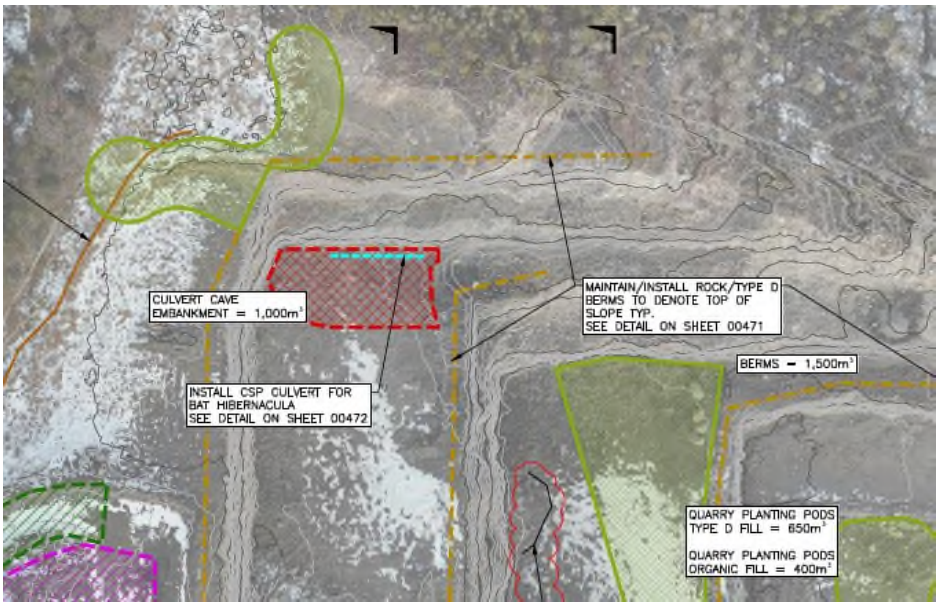
2.2 Concept Generation – Culvert Hibernacula

The design objective for the culvert hibernacula was similar to that of the drilled hibernacula, to create a microclimate suitable for bat hibernation. The difference from the drilled hibernacula being that to create a hibernaculum in an already vacant space using the quarry wall and backfill over the hibernacula sufficiently enough to create and insulating layer to create the microclimate. This would also include adding features within the culvert to create habitat that simulates naturally occurring hibernacula and roosting spaces.

2.2.1 Site Setting

Tetra Tech, the Bat Subject Matter Expert, and BC Hydro determined a suitable location for the culvert hibernacula to be on Portage Mountain Quarry's bench 3. Placement of the culvert hibernacula along the North wall of the quarry would allow for use of the vertical wall to be used for the reduction of fill needed to cover the culvert hibernacula as well as use the thermal properties of the mountain side. There is also enough space here to construct the hibernacula of 20 m in length. The segment at the south end of the culvert hibernacula can also be left exposed so that sunlight will add thermal energy to the entrance and help to warm the hibernacula.

Figure 7- Location of the Culvert Hibernacula



2.2.2 Design Process

An additional artificial hibernaculum was planned for the 2024 construction season. This additional hibernaculum was designed to be constructed by placing a culvert and burying it with fill material to provide the insulation necessary so that the conditions in the culvert remained suitable for bats to hibernate through the winter. The concept was developed for the construction of a culvert hibernacula on Bench 3 of Portage Mountain Quarry. The reference concept is shown on Figures 8 through 11. This reference concept of this culvert hibernaculum included the following:

- Culvert hibernacula on Bench 3 of Portage Mountain Quarry.
- 1,200mm CSP culvert at the length of 20 m.
- Galvanized, aluminized type II laminated corrugated steel pipe, made watertight from outside with gaskets.
- Culvert to be placed on a bed of 200 mm of sand, overlain by geotextile.
- Culvert is placed with a gradient of approximately 2% sloping down towards the entrance (south end).
- Construction and insertion of an octagonal wooden tube within each segment of culvert that is constructed of 19mm untreated plywood that is grooved with 6mm grooves on 6 mm spacing.
- Culvert is to be filled around until covered with previously stripped overburden from the top of the quarry and the placement of a 100mm thick expanded polystyrene (EPS) insulation.
- Fill is then to be placed to 3.5m above the top of the culvert along the rock face and then sloped 3:1 away from the rock face, using Type “D” fill compacted in lifts.
- The culvert entrance feature is to be constructed of rock and mortar containing six rectangular entrance slots measuring 6mm by 22mm. An access hatch is also to be left in the base of the entrance feature to allow for visual inspection and access to instrumentation in the culvert hibernaculum.
- Boulders are to be placed next to the entrance feature to 1.0 m height to block the view from the west and create a wind break.

Figure 8- Reference Concept Layout

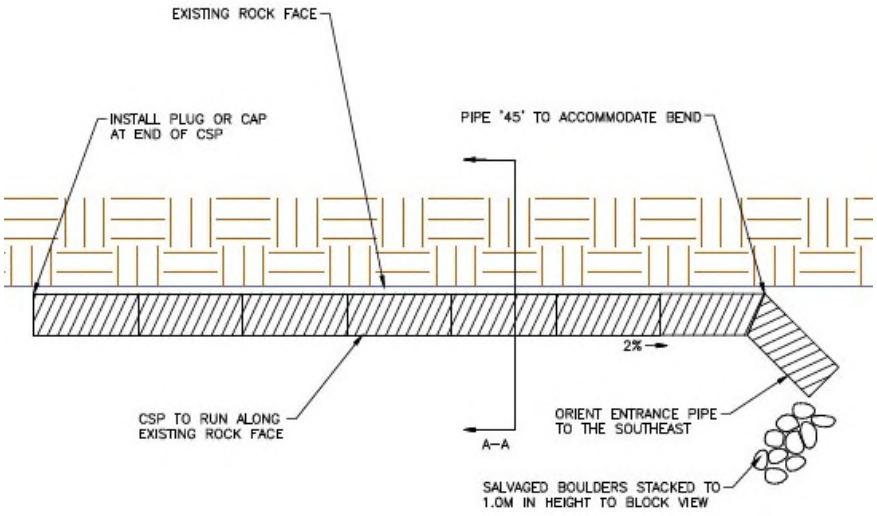


Figure 9- Reference Concept Placement Section

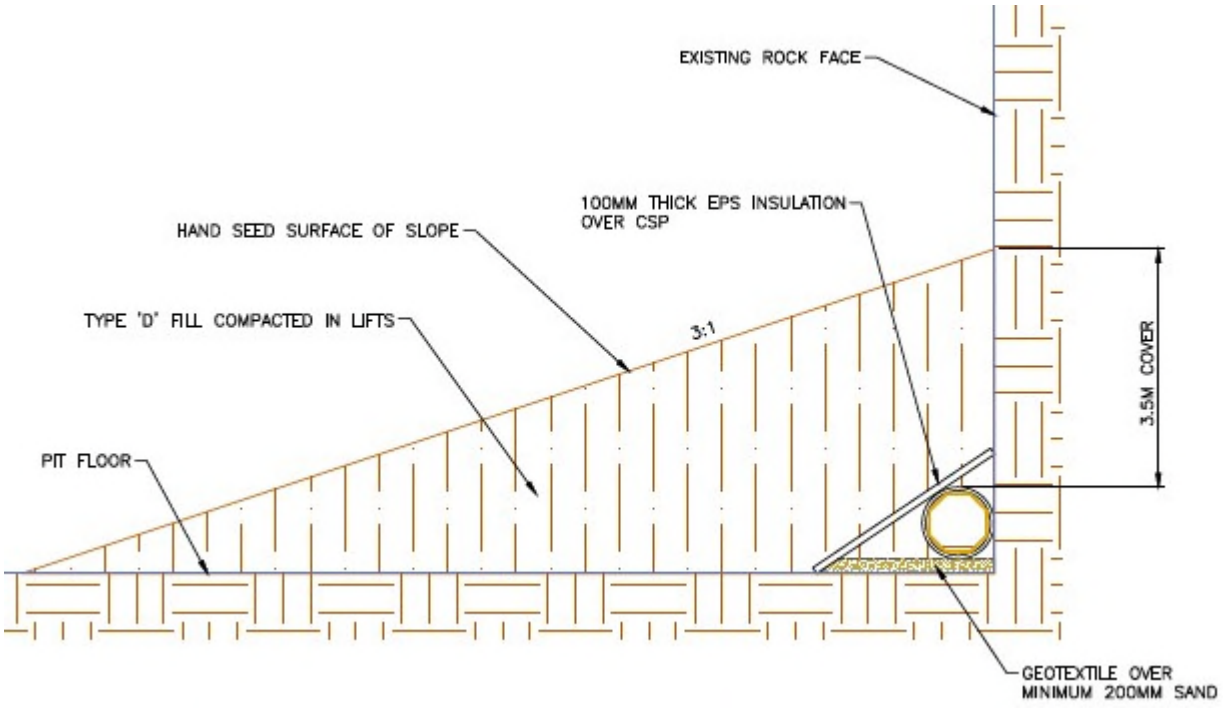


Figure 10- Reference Concept Interior Treatment Section

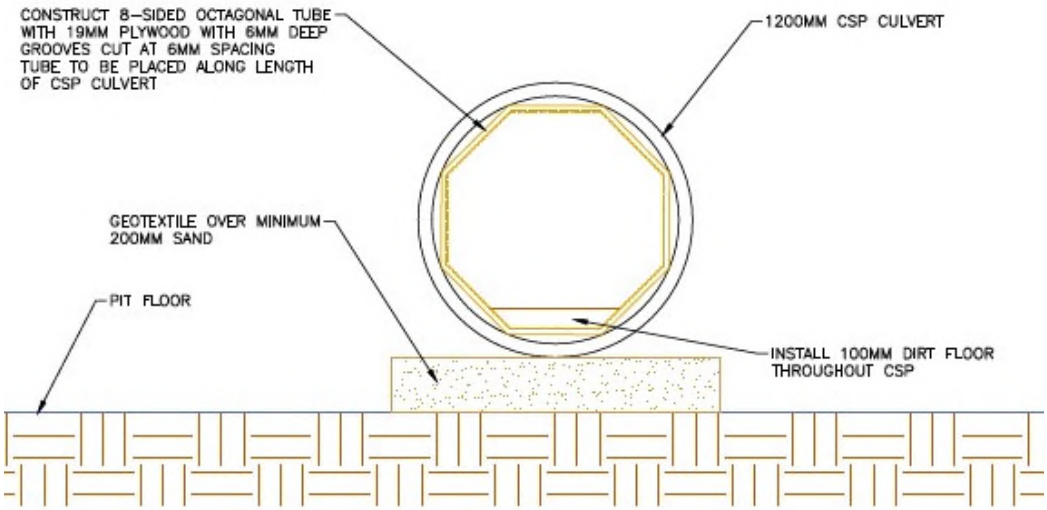
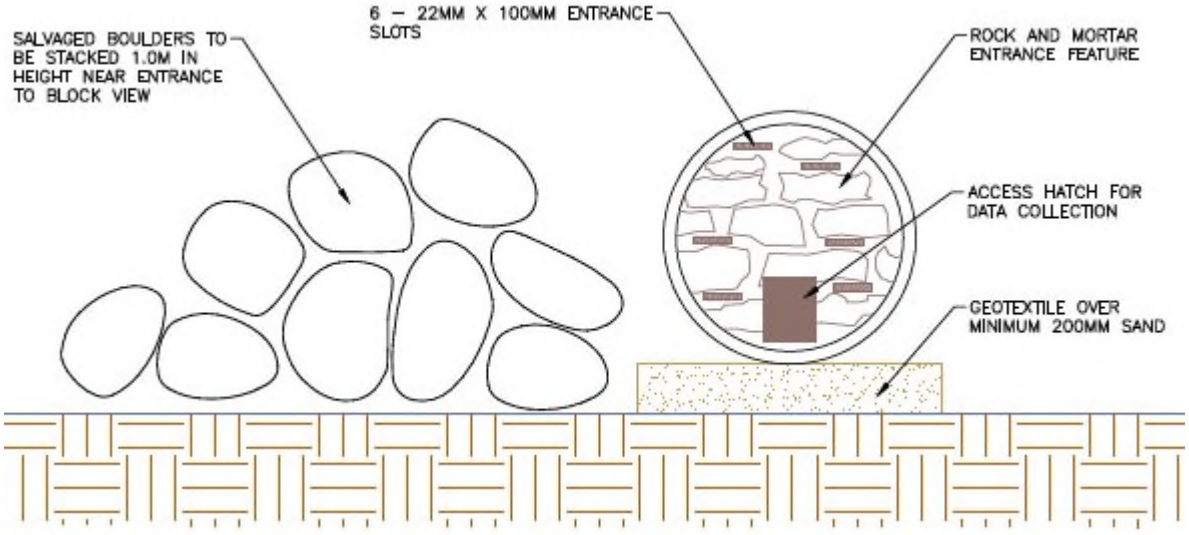


Figure 11- Reference Concept Entrance Feature



2.2.3 Procurement

The construction of the culvert hibernacula was included in the 2024 scope, to be completed on a T&M basis except for the stripping, sorting and placement of the fill material. The fill material was to be excavated from the organics stockpile at the top of PMQ, sorted and hauled near the culvert hibernaculum for future placement and a per cubic metre basis. The placement of the fill is to be completed via Type “D” Fill on a per cubic metre basis.

3.0 CONSTRUCTION

3.1 Drilled Hibernacula

3.1.1 Stabilization

The existing rock faces, in the Quarry, contains loose and potentially unstable rock blocks as unavoidable remnants of the rip rap production. The Contractor used a combination of mechanical and hand scaling to address these undesirable features at the two hibernacula sites. Scalers rappelled from the top of the slope or, used steel pry bars and air bags (also known as pneumatic pillows) to remove loose rocks. Mechanical scaling was completed with an excavator at Site 2-20 and 2-30 due to a potentially unstable overhead wedge. Scalers presented rock bolting locations, for review and acceptance, then completed bolting over a number of days. Figures 7 through 10 show stabilization works.

Figure 12- Rock bolt locations, voids, and lineation's as provided by scalers.

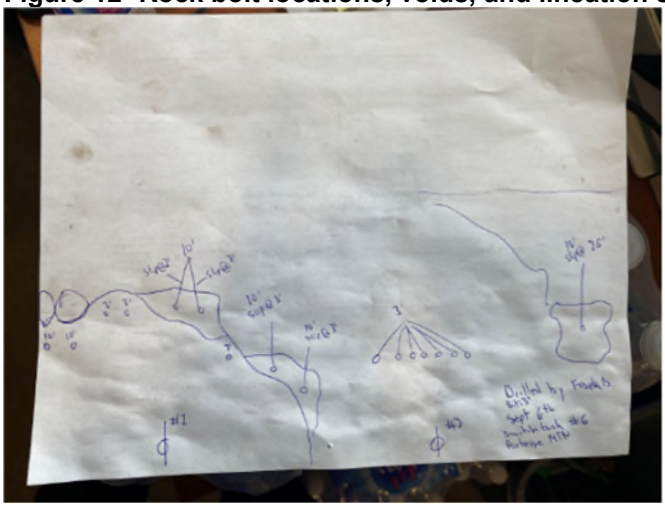
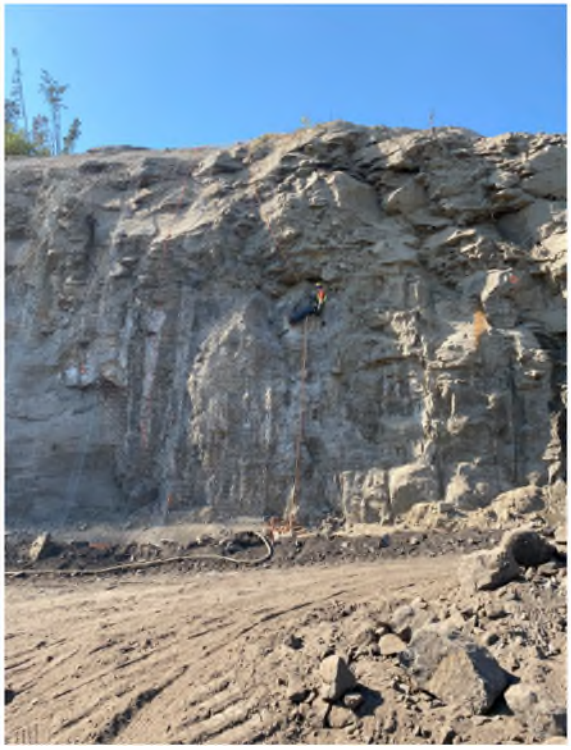


Figure 13- Removal of loose material at the crest of slope using a blowpipe.

Figure 14- Installing anchors above the drillhole locations.

Figure 15- Hand Scalers grouting loose rock above the drillhole locations.



After scaling the Contractor commenced installing the slope mesh. The Reference Concept called for 3 m of mesh on either side of the hibernacula locations. The Contractor extended the mesh to 7 m on either side for safety reasons as personnel and secondary equipment worked below these faces beyond the mesh zone and there were potential blind spots between equipment operators (see Figure 16). At Site 2 there was a 10 m high mixed ground slope extending beyond the crest. The slope comprised loose side-cast material from quarry operations. The Contractor completed test hole digs to determine bedrock depth. Material was pulled back at the crest of the slope and a trench excavated parallel to the crest for mesh placement and to backfill instead of drilling and placing mesh soil anchors.

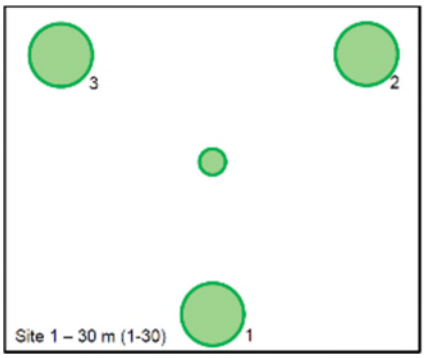
Figure 16- Slope mesh being place at Sites 1-30 and 1-31.

On the overburden slope above Site 2, the contractor was concerned that small rocks and soil could pass through the mesh aperture. The Contractor proposed lining the mesh with geotextile to manage this risk and brought rolls to site; however, its subcontractor, Glacier excavated material to create a debris catch bench above the crest. Additional anchors were used to conform the mesh to the slope to resist the mobilization of material.

3.1.2 Site 1-30

Site 1-30 (originally Site 1-20) was the initial drilling and blasting location. Setup for the Site 1-30 drilling included constructing a levelling pad and scaffolding for survey, loading explosives, and scoping. Glacier advised that the drilling would be most stable at a slightly higher elevation of 3.3 m off the floor. The bat hibernacula location and drilling layout was surveyed (See Figure 17). The Contractor proposed a blast plan based on the Reference Concept layout including three 10” diameter relief holes in an inverted triangle pattern and one 4.25” blasthole in the middle.

Figure 17- Drilling Layout at 1-30



Drilling commenced on a 10” hole, with centralizers on the drilling steel to reduced hole deviation (see Figure 18). Progress was limited due to insufficient air from the compressor or broken blow tube. A second compressor was mobilized to site and drilling recommenced. At about 3.0 m depth the driller realized the drill rig was setup with the boom resting on cradle which meant there was no room to position the rig for the lower 10” hole (See Figure 19). Rods were pulled and survey marked up a new 4” hole location above the hole. Drilling was completed over the next two days to approximately 25 m depth (See Figure 20). Upon completion Dyno Nobel completed a survey of the drillholes using a bore hole deviation tool (Boretrak survey). The results indicated the relief hole was straight in plan view but gained a 2° rise over the depth, equating approximately 1.0 m raise from true alignment at depth. Drilling of the 10” holes deviated in downward direction, likely due to the weight of hammer, and horizontally crossing each other. The borescope survey confirmed that the drill hole was in good rock with no slips or cavities encountered.

Figure 18: Drill steel for 10” boreholes with centralizers to reduce hole deviation.

Figure 19- Positioning the rig for drilloing the 10” boreholes.

Figure 20- Drillhole at ~25m depth

Drillholes were loaded with 2” diameter packaged explosives. Electronic detonators were used to ensure complete detonation. Two inch explosive packages were utilized due to concerns regarding dead-pressing (blast overpressure makes the explosives too dense to explode) and unexploded material sterilizing the hibernacula. The resulting blast resulted in a shotgun effect where the explosive energy was released to the environment, reducing the efficiency of the explosive to break the rock, except for two locations between approximately 8 m and 12.5 m deep and 18.75 m and 23.75 m deep where caverns were created where the spine of rock broke through to the relief holes. It’s likely that the shotgun effect was due to the blast energy overcoming the stemming (inert material used to keep the blast energy in the hole). The borescope verified that the drillholes were interconnected, and breakage, was present, creating caverns at depth (see Figure 21). The shotgun effect also destabilized the face, ripping the anchors from the mesh (See Figure 22).

Figure 21- Borehole scope graph showing broken rock (highlighted sections). 4.25” hole trace shown in red. 10” diameter hole traces show in purple, green and yellow.

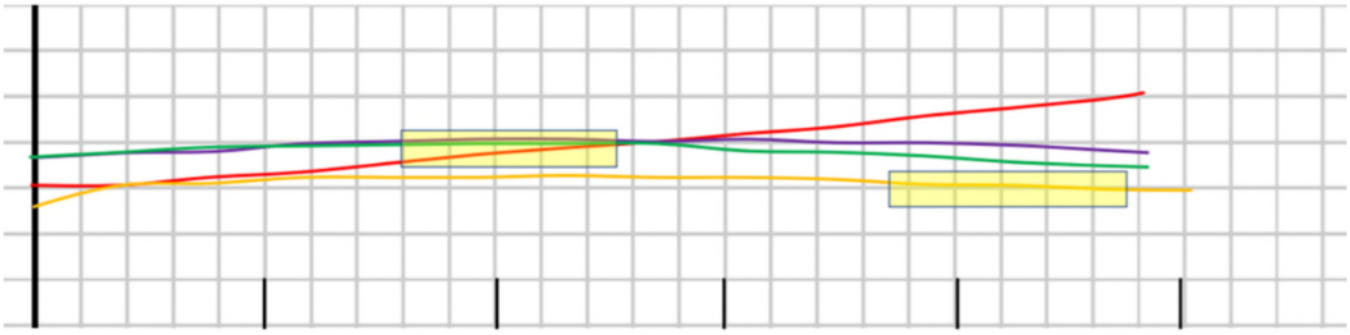


Figure 22: Face of Site 1-30 after initial blasting.

Geophones were installed to monitor vibration, but likely decoupled from the bedrock during the blast, resulting in inaccurate readings (Decoupling is where the acceleration forces the geophone to leave the surface which it is mounted to). Slope mesh was also detached by the blast and needed to be re-established before the entrance features constructed. Consideration was given to re-blasting the drillholes; however, the Glacier and the rock engineers had concerns about further destabilizing of the slope. The results were reviewed with the SME and given the interconnectedness of the drillholes, the caverns depths, and being an experimental approach, it was decided to keep the feature as is and monitor for bat population. A modified entrance feature was created by using a hydraulic breaker to remove rock to create an alcove and mortaring the drillholes with spaces for bat access/egress (See Figures 23 and 24).

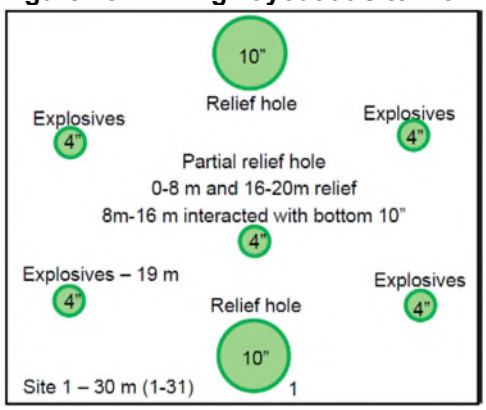
Figure 23- Mortared drillhole with bat entry slot

Figure 24- Mortared drillholes with steel door for thermistors inserts.

3.1.3 Site 1-31

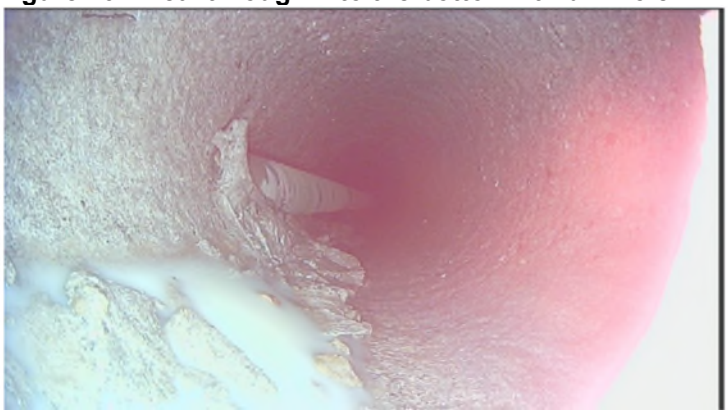
Given the results at Site 1-30, the drillers proposed reconfiguring the drillhole layout and slope angle, increasing to three inch (3”) diameter explosive product, and eliminating the use of explosive gasses velocity measuring cable. The 3” explosives reduced the decoupling of the charge to the rock effectively increasing the energy delivered into the rock increasing fragmentation. Tetra Tech’s rock engineer worked with Glacier and Dyno to reconfigure the drilling layout to include two 10” relief holes and five explosive holes (see Figure 25). The new configuration kept the drill rig operating in the same plane between holes. Based on the new layout and the deviation encountered at 1-31, drilling was set at a 4° incline.

Figure 25- Drilling Layout at Site 1-31.



Site 1-31 was originally planned as a 20 m deep hole, but as Site 1-30 only achieved 25 m, it was extended to 30 m depth. The 4” explosive holes were drilled first followed by the relief holes. At about 8 m depth the lower relief hole deviated into the 4” hole causing PVC debris to come out of the boring (See Figure 26). The boring followed the alignment from 8 m to 16 m depth. The top right 4” hole deviated around 20 m to 22 m upwards up to 8°. The top 10” relief hole had a slight upwards deviation. During scoping of the top left explosive hole the Boretrak equipment broke and could not be fixed. To proceed without the scope, a light was attached to the Boretrak to manually gauge hole deviation.

Figure 26- Breakthrough into the bottom 10” drillhole.



The revised blast plan for Site1-31 included blasting the top and bottom of one side at the same time with a delay and then have the second two top and bottom go off simultaneously. The holes were stemmed, relief holes grouted, and loaded through the day with a blast occurring at end of shift.

Figure 27– Sieves Were Used to Create Appropriately Sized Stemming

Figure 28– Grouting the Relief Holes

Figure 29– Loading Explosives

The blast successfully collapsed the rock between the drillhole voids and evacuated material from the hole. Borehole videos showed less remaining rock walls than anticipated and minimal debris in the cavern. The smooth wall of the borehole was also disrupted with irregularities, cracks, and fissures. A decision made that no auguring would be required.

Figure 30– Cavern at 11 m deep

Figure 31– Irregularities in wall

Figure 32– Limited material remaining at floor of cavern

The blast successfully evacuated material from the newly formed cavern but was large enough to create instabilities above the bat cave. Additional mechanical and hand scaling was required. Slope mesh was re-installed to allow entry features construction to be completed.

Figure 33– Face of 1-31 After Blasting

Figure 34– Overhang Requiring Additional Trim Blasting

Figure 35– Sites 1-30 and 1-31

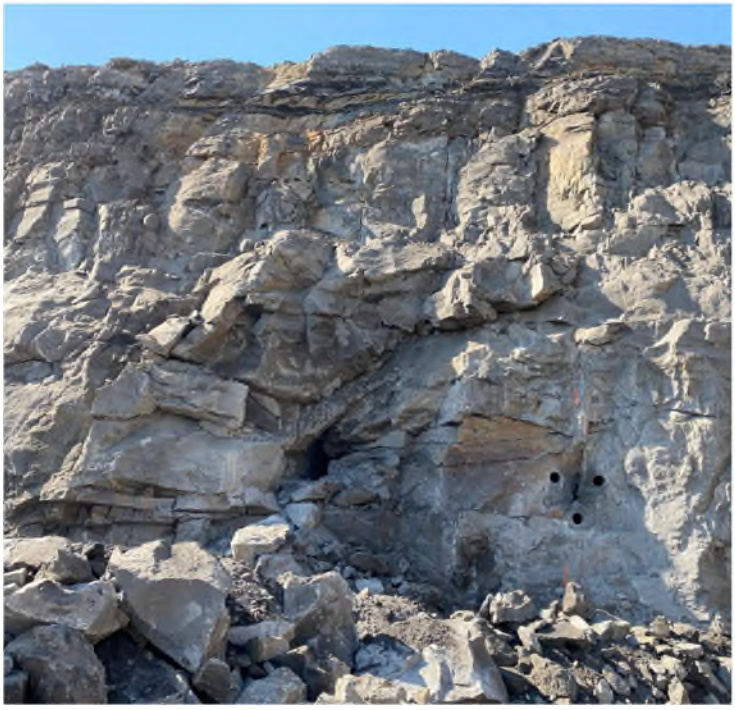


Figure 36– Vibration Monitoring Locations

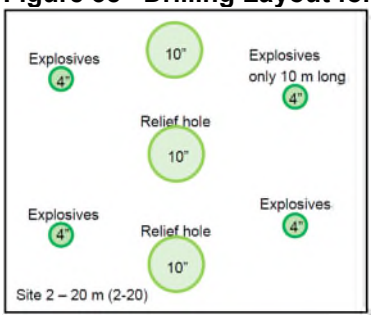
The blasting resulted in a 0.8 m opening. Originally, the design called for the placement of large boulders within the opening. Due to concerns regarding pack rats, a revised entrance feature was developed consisting of a mortared wall with flat 200 mm rocks. Wooden bat entry plugs 7/8” x 8” x 6” were inserted into the mortared wall and removed to provide entry for bats. Perforated PVC pipe was installed to the limits of the cavern. An 8” x 8” x 6” wooden box with a streel door was also inserted to provide access to the perforated pipe and house the data loggers. Thermistors were installed through the box and connected to the data loggers.

Figure 37– Bat Entry Features

3.1.4 Site 2-20

One 20 m and one 30 m cave were planned at Switchback 6 (Site 2). However, due to the seasonal blast restriction window (Construction not permitted past September 15) a decision was made to focus on Site 2-20 and complete three of the four hibernacula. Setup for Site 2-20 occurred at roughly the same time as drilling and blasting of Site 1-30 and 1-31. As noted above, scalers had concerns about overburden slope above the site releasing loose rock as well as overhangs on the face. They also expressed concern about hollow sounding rock when drilling rock bolts and anchors. A decision was made to move 20-2 slight slightly to the south to avoid the overhang and allow for a better mesh tie to the rock bolts. The drill layout was the same as Site 1-31; however, a centre 10” relief hole was utilized instead of an explosive hole. In addition, the Blasting Engineer did not believe grouting of the relief holes provided value and in fact may have resulted in some more breakage at the face of Site 1-31 than anticipated.

Figure 38– Drilling Layout for 2-20



Drilling was faster than at Site 1 due to the presence of weaker sandstone. The top 4” hole deviated into bottom 4” hole on the right side at around 10 m depth, likely due to a seam at 9 m causing deviation. To avoid the seam the left side holes were moved out a small amount resulting in no deviation. Without the Boretrak survey, Dyno used a flashlight to determine deviation, it was estimated at 5.5° overall slope for top 10” and 4.5° overall slope for bottom two. Based on that information it was decided to drill the 4” at 4°.

Figure 39- Borehole scope graph showing drilling deviation

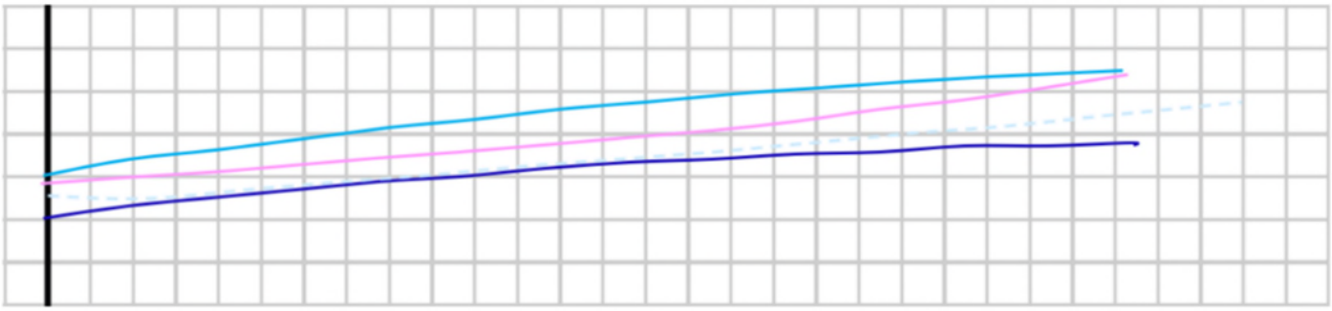


Figure 40– Dyno estimating borehole deviation with a flashlight

Loading, stemming, and blasting followed the same approach as Site 1-30 with blasting, on delay, on one side then the other, and the three inch (3”) blastex packaged explosives. At 1-31 the blast tore slope mesh and rock anchors from the face. Learning from the first site, the scalers set anchors to minimize damage to the mesh and maximize salvage.

Similar to Site 1-31, the blast successfully collapsed the rock between the drillholes and evacuated material from the hole. The borehole videos show irregularities, less remaining rock walls than anticipated, and minimal debris in the cavern. No additional auguring was required.

Figure 41– Site 2-20 Loading Pattern

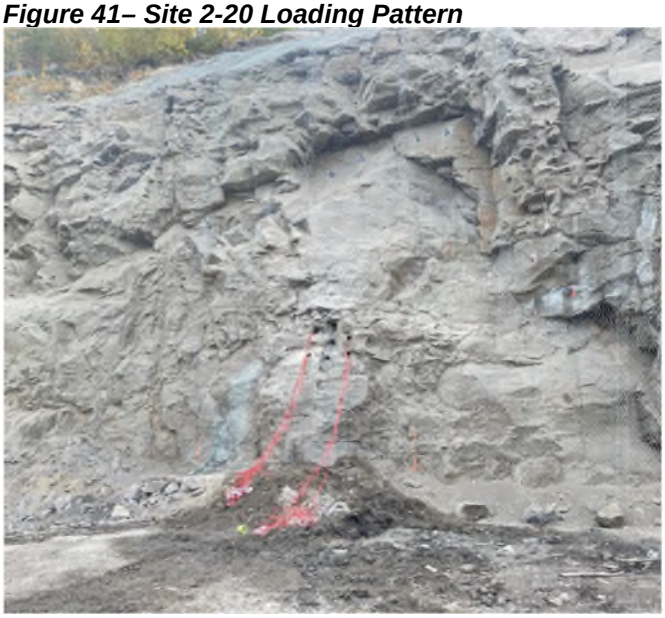


Figure 42– Site 2-20 After the Blast

Figure 43– Inserting Borescope Camera

Figure 44– Cavern at 16m depth

Figure 45– Cavern at 14m Depth

Figure 46– Cavern at 12m Depth

Figure 47– Cavern at 5m Depth

Figure 48- Geophones

The blasting resulted in a 0.8 m opening. Similar to 1-31, a mortared wall with flat 200mm rocks, bat entry plugs, and a wooden box was constructed at the cavern entrance. Thermistors were installed through the box and connected to the data loggers

Figure 49– Bat Entry Features

3.2 Vibration Monitoring

Blast vibrations were recorded, by the contractor, with geophones located adjacent but removed from the sites (see Figure 36 and Figure 48). Tetra Tech has calculated the vibration at the existing hibernacula sites (North Bluff and South Bluff) adjacent to the site.

Vibrations are estimated using the Scaled Distance equation:

$$PPV = k\left(\frac{D}{\sqrt{W}}\right)^{\beta}$$

Where:

- k and β are site specific constants (dimensionless)
- D is the distance from the blast to the hibernacula / geophone (m)
- W is the mass of explosives detonated (kg).

From Tetra Tech's analysis of previous blasts during riprap production at PMQ the following site constants were developed for a 95% confidence in the estimate:

Table A: Site Constants Developed from PMQ Blast Analysis

Constant	β	k
North Bluff	-1.602	798.83
South Bluff	-1.622	831.26

Seismographs were used to monitor ground vibrations within the quarry footprint. The seismographs recorded the following vibrations presented in Table B:

Table B: Seismograph Recordings

Hibernacula Blast Site	D1 (m)	PPV 1 (mm/s)	Estimate mass explosive (kg)	D2 (m)	PPV2 (mm/s)	Estimate mass explosive (kg)
1-30	51.6	47.7	78.9	91.6	19.0	78.8
1-31	52.2	85.297	167	86.9	41.370	187.4
2-30	83.6	19.560	68.1	118.7	21.343	153.1

Where:

- D1 is the distance to the nearest geophone attached to the seismograph (3D vector distance)
- D2 is the distance to the nearest geophone attached to the seismograph (3D vector distance)
- PPV is the recorded Peak Vector Sum (3D vibration wave) at each geophone.

These data were used to estimate the mass of explosives detonated in each blast. These mass estimates were used to estimate the peak particle velocity at the boundary of the 300 m construction exclusion zone.

Table C: Estimates of Peak Particle Velocity at the limits of construction

Blast	Highest Mass of Explosive	PPV at 300 m (mm/s)	
		South Bluff Hibernacula	North Bluff Hibernacula
1-30	78.9	2.8	2.8
1-31	187.4	5.7	5.6
2-30	153.1	4.8	4.7

Note, the ground vibration limit at the existing hibernacula sites is 15 mm/s. As shown in Table C above, the estimated PPV at the existing hibernacula sites was about 30% of the limit, therefore considered acceptable.

3.3 Bench 3 Culvert Hibernaculum

Initial preparation of the pit floor was completed by filling of the area to give a reasonable starting working surface graded appropriately. Above this prepared surface pit floor, a 200mm layer of sand covered by geotextile was placed as the base of the culvert hibernacula. This surface was prepared and graded with a 2% slope from back to front (north to south) to provide some drainage in case of water infiltration as well as to keep the temperature in the hibernacula above freezing (heat rises to the back of the hibernacula). The 1200mm CSP culvert was placed in segments for the overall length of the hibernacula to be 20 m long. Prior to placement of each segment an octagonal tube was constructed out of 19mm plywood that had 6mm deep groves cut at 6mm spacing along the length of the CSP culvert.

Figure 50- Culvert Hibernacula Placement

Figure 51- Culvert Insert and Dirt Floor

Figure 52- Culvert Fill and Insulation

Figure 53- Culvert Entrance Feature

4.0 INSTRUMENTATION

4.1 Thermistors

4.1.1 Drilled Hibernaculum

After drilling the caverns, multipoint thermistors from RST Instruments (TH0022-Q148562-1) were installed at Sites 1-30, 1-31, and 2-20, for ongoing data collection by BC Hydro. The thermistors have temperature nodes at 5 m intervals. An RST data Logger (DT2055B-T-USB-D_CELL) with USB connection was installed. The data logger was set to record daily at noon and midnight.

4.1.2 Culvert Hibernaculum

Multipoint thermistors from RST Instruments (TH0022-Q148562-1) were installed, with temperature nodes at 5 m intervals. An RST data Logger (DT2055B-T-USB-D_CELL) with USB connection was installed. The data logger was set to record on the same interval as the drilled hibernaculum, daily at noon and midnight.

4.2 Hygrometers

4.2.1 Drilled Hibernaculum

In 2024, single point string HygroVUE10 hygrometers from Campbell Scientific were installed in Site 1-30 and 1-31, with humidity nodes at 5 m and approximately 30 m intervals. Hygrometers were threaded through the PVC pipe used for the thermistors. A Campbell Scientific CR350 Data logger was installed at each location A hygrometer was not installed in 2-20 as the PVC pipe used for installation was damaged within the cavern.

4.2.1 Culvert Hibernaculum

A single point string HygroVUE 10 hygrometer from Campbell Scientific were installed in the culvert hibernaculum, with humidity nodes at 5 m and approximately 20 m intervals. A Campbell Scientific CR350 Data logger (was installed at each location.

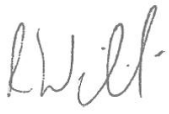
5.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro, or for any Project other than the creation of hibernacula at the Portage Mountain Quarry site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

6.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.



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Appendix 12. 2024 Snake Den Monitoring Memo

Inter-office memo

To: Brent Matsuda Date: March 11, 2025

From: Arshad Khan

CC: Jessica Brunet

Subject: Snake Hibernaculum 82.1 – September 2024 Occupancy Surveys

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Acronyms used:

AQ: air quality
STL: snout-tail length
THSI: *Thamnophis sirtalis* (Common gartersnake)
THEL: *Thamnophis elegans* (Western gartersnake)

Two species of gartersnake (*Thamnophis sirtalis* & *Thamnophis elegans*) are present in the Peace River valley and are at risk from the effects of reservoir clearing and construction activities associated with the Site C project (BC Hydro, 2013).

Mitigation efforts included the construction of snake hibernacula to offset the loss of habitat due to valley-bottom clearing and subsequent reservoir inundation (BC Hydro, 2015). Six hibernacula were constructed in 2020, and a seventh hibernaculum (82.1) was constructed in July 2023 near Cache Creek. Temperature probes and a HOBO H21-USB datalogger were installed in September 2023 at this location. All seven constructed hibernacula are located on the north side of the Peace River (WSP, 2024).

As per the Site C Gartersnake Mitigation and Monitoring Program plan (BC Hydro, 2018) to meet Environmental Assessment Certificate Condition 21, monitoring surveys were to begin the spring after installation and conducted twice a year for three years (2024, 2025, 2026).

In September 2024, BC Hydro conducted snake surveys at artificial snake hibernaculum 82.1, located near Bear Flats Cache Creek (Figure 1), to assess for occupancy. This hibernaculum is located approximately 750 m north of the Peace River (10V 610717E, 6238153N) on a south-facing slope (Photo 1). Two rounds of monitoring were completed with each round consisting of three surveys. Survey methods followed those outlined in Section 3.1 of the WSP 2023 snake hibernaculum monitoring report (WSP, 2024).

No snakes or snake sign was observed during the first round of monitoring (September 10 to 12, 2024), and four snakes – one THSI and three THEL – were observed during the second round of monitoring (September 16 to 18, 2024). The results from the September 2024 occupancy monitoring are summarized in Table 1.

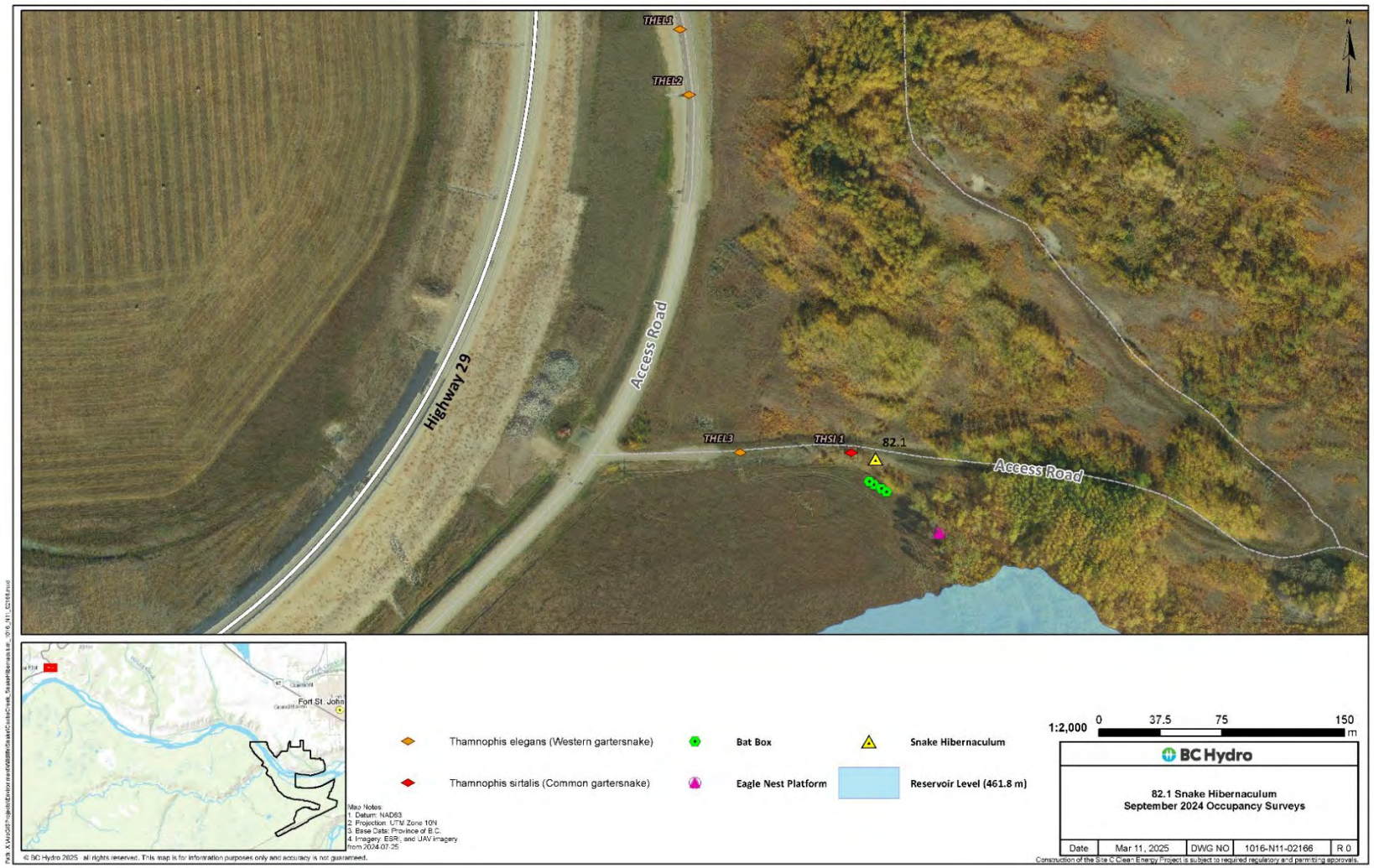

Figure 1. Map showing hibernaculum 82.1 and surrounding area

Photo 1. Entrance to snake hibernaculum 82.1

Table 1. September 2024 snake occupancy surveys at Hibernaculum 82.1

Monitoring Round	Survey #	Date (YYYY-MM-DD)	Start Time (MST)	End Time (MST)	Weather	Temperature at Hibernaculum Entrance	Result
1	1	2024-09-10	14:38	13:17	18˚ C Sunny with clouds	Not measured	No snakes or snake sign observed
	2	2024-09-11	14:05	13:03	17˚ C Sunny with clouds	Not measured	No snakes or snake sign observed
	3	2024-09-12	15:26	16:05	18˚ C Sunny with clouds	Not measured	No snakes or snake sign observed
2	4	2024-09-16	15:16	16:45	Sunny with clouds	24˚ C (start) 22˚ C (end)	**One THSI observed** ~20m west of hibernaculum entrance. Unable to capture snake. Snake location: UTM 10V 610699, 6238169.
	5	2024-09-17	14:48	15:32	Sunny with clouds	21˚ C (start)	**One THEL** (~50cm STL) observed on the paved access road to the hibernaculum. Released below the road into a mix of rocks and vegetation. See Photo 5 Snake location: UTM 10V 610605, 6238431
	6	2024-09-18	11:45	13:31	Sunny with clear skies	19˚ C (start) 24˚ C (end)	Two snakes observed ▪ **One THEL** (~40cm STL) on the paved access road. Similar location but not the same snake as September 17 observation. Released below the road into rocks and vegetation. Snake location: UTM 10V 610609, 6238391 ▪ **One THEL** (~59cm STL). Released at hibernaculum entrance. See Photo 6. Snake location: UTM 10V 610631, 6238172

Survey Notes

- There are fences both north and south of the hibernaculum. To the north is private property so the fence was not crossed to survey. Habitat in the private property is low-medium value, mainly shrubs between 24-48" tall and almost no bare ground or rocky areas where snakes would likely bask.

- Areas west of the hibernaculum with rock and riprap were thoroughly surveyed for snake presence and snake sign.

- The temperature measured at the hibernaculum entrance with a southern aspect, was consistently higher than temperature readings taken elsewhere around the monitoring location. On September 16 and 17, the temperature readings at the hibernaculum entrance were over 20˚ C. Table 1 includes temperatures measured during surveys.

- The concrete slabs and other cover objects near the hibernaculum entrance were carefully lifted to check for snake presence or sign.

- There were obvious signs of cow activity and piles of dung around the hibernaculum (Photo 2). Trampling may have compacted the soil covering the hibernaculum so additional soil and grass seed may be required to stabilize soil cover.

- A field with short grass and vegetation with a southern aspect is located to the south. A fenced-in, air quality (AQ) station has tall grass (> 36") which could not be surveyed. There was a concrete pad observed at the northeast corner of the AQ station which could serve as a place for snakes to sun bask (Photo 3).

- Any snakes that were captured were handled carefully to measure total length (STL) and were transported to release locations in a pillowcase. Table 1 includes details of snake release locations.

- An attempt was made to download the datalogger on September 23, 2024, but was unsuccessful (Photo 4). A connection to the datalogger could not be established.

- On December 6, 2024 a successful connection to the datalogger was established, data was downloaded, and the AA lithium ion batteries were replaced. Data logging recommenced in December 2024, and is ongoing. Downloaded data spanned September 29, 2023 to October 24, 2024.

- There were numerous errors in the downloaded data, including random erroneous dates, and temperatures. The external temperature probe appeared to have been damaged sometime in July 2024 and began to log temperatures as low as -91˚ C and as high as 500˚ C, until the batteries died in October 2024. Downloaded data is included as a separate Excel file titled Snake_82.1.csv and stored in J:\SiteC\Environmental\Wildlife\5. DATA\Area 5 snakes\Cache Creek Snake Den temp data 2024. Summary details on the downloaded data is included in Appendix A.

- Firewalls and other system restrictions could impact the ability to connect to the data logger. Datalogger software (HOBOware) installation notes are included in Appendix B. These should be reviewed prior to the first site visit, to ensure the software is correctly installed and working.

Photo 2. Entrance to hibernaculum 82.1 (note cow dung at bottom left)

Photo 3. Concrete pad in the field near fenced AQ station

Photo 4. HOBO H21-USB datalogger, September 23, 2024

Photo 5. Western gartersnake (*Thamnophis elegans*) observed on paved access road leading to hibernaculum.

Photo 6. Western gartersnake being released at hibernaculum entrance.

Recommendations

Hibernaculum 82.1 was constructed in July 2023, and internal and external temperature sensors were installed in September 2024. The sensors were connected to a data logger, and temperature data was collected between September 29, 2023 and October 23, 2024. Data collection stopped when the batteries were depleted. In December 2024 the batteries were replaced and data collection recommenced, and is ongoing.

This hibernaculum should be monitored until the end of 2026, which would be three years of monitoring, as per the Gartersnake Mitigation and Monitoring Program (BC Hydro 2018).

Damage to the external sensor has resulted in erroneous data for external temperature. The replacement of this sensor is recommended. However, consideration should be given to the fact that this location is easily accessible to the public who use nearby trails. Domestic animals and wildlife also frequent the area, and the chances of a replacement sensor being damaged are high.

Other sources of external temperature data are available nearby, the closest one being a BC Hydro weather station in the field adjacent to hibernaculum 82.1. This station will be operational for at least five years into the operation of Site C, and this source would be an easy source of external temperature. Other weather stations nearby can be searched for at the following link (Meteorological Data Portal).

The available data from September 2023 to October 2024 should be quality controlled. Erroneous dates should be corrected, and erroneous external temperature data can be replaced with one of the sources suggested above. When spring occupancy surveys are conducted in 2025, the data should be downloaded again, which will provide internal temperature for two consecutive winter periods. Analyzing this data will provide an indication on how effective the hibernaculum is for snakes to overwinter, or if any modifications need to be considered.

We trust this memo provides adequate information on hibernaculum 82.1 occupancy surveys completed in September 2024. If you have any questions or comments please contact the undersigned.

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BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement. Volume 2: Assessment Methodology and Environmental Effects Assessment. Section 14: Wildlife Resources. Report prepared by Hilton, S. Keystone Wildlife Research Ltd. Submitted to CEAA on 7 August 2013. 116 pages.

BC Hydro. 2015. Site C Clean Energy Project Vegetation and Wildlife Mitigation and Monitoring Plan.180 pages.

BC Hydro. 2018. Site C Clean Energy Project Vegetation and Wildlife Mitigation and Monitoring Gartersnake Mitigation and Monitoring Program. 11 pages.

WSP. 2024. Site C Wildlife Mitigation Structures: Snake Hibernacula Monitoring 2024 Report. Prepared for BC Hydro. WSP Doc No. CA0006012.0622-003-R-Rev2; July 16, 2024. 26 pages.

APPENDIX A – Snake Den 82.1 Summary of Downloaded Data

External Sensor	Internal Sensor
Series: Temp, °C (2m) Sensor Info • Serial Number: 21645933 • Sub Sensor Number: 1 • Part Number: S-TMB-XXXX • Label: 2m • Resolution: 12 bit Devices Device Info • Product: HOBO Micro Station Logger • Serial Number: 21672686 • Version Number: 5.00 • Manufacturer: Onset Computer Corporation • Device Memory: 524288 • Header Created: 09/29/23 02:22:57 GMT-07:00 PM Deployment Info • Full Series Name: Temperature, °C • Launch Name: Snake_82.1 • Deployment Number: 3 • Wrap Enabled: No • Launch Time: 09/29/23 02:23:03 GMT-07:00 PM • Logging Interval: 01 Hr 00 Min 00 Sec • Sampling Interval: None • Launch GMT Offset: -7 Hr 0 Min • Battery Type: Lithium Series Statistics • Samples: 9,362 • Max: 537.327 • Min: -91.857 • Avg: -5.226 • Std Dev (σ): 82.694 • First Sample Time: 09/29/23 02:23:05 GMT-07:00 PM • Last Sample Time: 10/23/24 03:23:05 GMT-07:00 PM	Series: Temp, °C (6m) Sensor Info • Serial Number: 21721856 • Sub Sensor Number: 1 • Part Number: S-TMB-XXXX • Label: 6m • Resolution: 12 bit Devices Device Info • Product: HOBO Micro Station Logger • Serial Number: 21672686 • Version Number: 5.00 • Manufacturer: Onset Computer Corporation • Device Memory: 524288 • Header Created: 09/29/23 02:22:57 GMT-07:00 PM Deployment Info • Full Series Name: Temperature, °C • Launch Name: Snake_82.1 • Deployment Number: 3 • Wrap Enabled: No • Launch Time: 09/29/23 02:23:03 GMT-07:00 PM • Logging Interval: 01 Hr 00 Min 00 Sec • Sampling Interval: None • Launch GMT Offset: -7 Hr 0 Min • Battery Type: Lithium Series Statistics • Samples: 9,362 • Max: 10.541 • Min: 3.564 • Avg: 7.098 • Std Dev (σ): 2.407 • First Sample Time: 09/29/23 02:23:05 GMT-07:00 PM • Last Sample Time: 10/23/24 03:23:05 GMT-07:00 PM

APPENDIX B – HOBOware installation notes

HOBOware for PC and Mac, Version 3.7.28
Last updated February 2024
Welcome to HOBOware. This version of HOBOware is available to customers of Onset Computer Corporation under the terms of the Software License Agreement contained in the installation programs. This agreement is also available via the Onset Web site at:
http://www.onsetcomp.com/corporate/legal/software-license-agreement

Useful Links

a. Onset-HOBO-H21-USB-Micro-Station.pdf
b. Quick Start for the HOBO® Micro Station (H21-USB)
c. HOBO Micro Station (H21-USB) Manual

Installation of HOBOware software:
PC Users:
Please double-click "HOBOware_Setup.exe". When the installer comes up, follow the instructions.

Mac Users:
The procedure will vary depending on whether you are working from a product CD or USB Drive or a downloaded installer file.

If using a CD or USB Drive: Please double-click "HOBOware.pkg" and follow the instructions.

If you have downloaded the installer, go to System Preferences > Security & Privacy > General. Be sure "Allow applications downloaded from:" is set to "Mac App Store and identified developers" or "Anywhere". please double-click the file named HOBOware_Signed_Installer.dmg, then double-click the HOBOware.pkg file. **NOTICE:** Versions of OS X earlier than macOS 10.14 are no longer supported but HOBOware may still work on earlier versions of OS X.

The Java Runtime Environment (JRE) for Windows, available from Oracle America, Inc., is now bundled with HOBOware so you no longer need to have a Java Runtime Environment separately installed on your computer. HOBOware for Windows comes with Java 8 and HOBOware for Macintosh comes with Java 9.

Please Note:
For Mac users upgrading from a pre-3.2.2 HOBOware release, the HOBOware folder has moved from the user's Library/Application Support folder to the user's Documents folder.

Sample datafiles are contained in the installer and are also on the CD or USB Drive. On the PC, these files are also installed in the common documents area at \Users\Public\Public Documents\HOBOware Public Files\Sample Datafiles on Windows 10 or 11. On the Mac, these files are installed in the user's Documents/HOBOware/Sample Datafiles folder.

When upgrading to a newer version:
It is highly recommended that you do not use older versions of HOBOware once you have upgraded to a newer version of HOBOware. As noted above, some files change locations as HOBOware continues to evolve and having those files in two or more places can causes unforeseen problems when running HOBOware.

System Requirements:
HOBOware 3.7.28 has some basic common System Requirements that are presented in the list below. If using

HOBOware as the data collection server for a network of Indoor Wireless HOBO data nodes you may want to consider the configuration guidelines provided in the table. There are more detailed configuration recommendations available on the Onset Web site at http://www.onsetcomp.com/tech-note/hoboware-performance

* PC: Windows 10 (Home, Pro), Windows 11 (Home, Pro).
* Mac: macOS Versions 12.0 (Monterey), 13.0 (Ventura), 14 (Sonoma)
  While HOBOware may run using a previous version of OS X, those earlier versions of OS X are specifically no longer supported.
* One of the following Internet browsers: The most recent version of Safari, Microsoft Internet Explorer, Microsoft Edge, Firefox or Google Chrome.
* Minimum screen resolution of 1024x768. Recommended screen resolution of 1280x800 or greater particularly for non-English users.
* 256+ colors
* Processor Speed, Memory and Disk Space:

	High End	**Mid-Range**	**Low End**	**Lowest End**
CPU	2.9 GHz dual core	2.0 GHz dual core	1.8 GHz dual core	1.8 GHz dual core
RAM	3 GB	2 GB	1.5 GB	1 GB
Disk Space * see note	100 GB+	50 GB+	20GB+	300 MB
User Model	4	3	2	1

The User Model row suggests some guidelines for using the Processor Speed and Memory table:
User Model 1 - Using HOBO Data loggers only, no data nodes – traditional desktop user
User Model 2 - Using HOBO Data loggers and up to 5 data nodes, 20 sensors
User Model 3 – Using HOBO Data loggers and up to 50 data nodes, 100 sensors
User Model 4 – Using HOBO Data loggers and up to 100 data nodes, 200 sensors

* Disk Space – Defining the disk space requirements for HOBOware depends on the proposed use. The table above describes the disk space needed for a traditional desktop user, allowing for installation of the program and storage of data files. For users of HOBO data nodes, the space requirements depend on a variety of factors, including the number of nodes, the number of sensors, the frequency of data sampling, the longevity of deployments, and other factors. Please see the Knowledge Base and visit the Forums on the Onset Web site for more details, at http://www.onsetcomp.com/support

NOTICE
HOBOware 3.7.28 is built with 1.8.0_382 on Windows and on OS X.

Time zone note: Now that the Java Runtime Environment is bundled with HOBOware, there may be problems updating to the Olson Timezone Database for a given locale. Onset is looking into this problem and will offer an option for this in the future.

Bug Fixes in HOBOware 3.7.28

Update distributed Java environment to Corretto 1.8.0_382
Baro Assistant screen not appearing correctly on Mac in foreign language

***** Known Issues *****

HOBOnode Viewer does not work on Macintosh
HOBOnode Manager and the Plot/Export feature for the HOBOnode database work on both Windows and Macintosh. But the feature to view HOBOnode Manager as a website, HOBOnode Viewer, does not work on

Macintosh. Read on if you want to know the reason.

In order to digitally sign and notarize HOBOware for Macintosh Operating Systems 10.14.5 and above, we were forced to use Java 9 to bundle with HOBOware but there is a problem getting HOBOnode Viewer to work with Java 9. We are able to use Java 8 on the Windows version of HOBOware and HOBOnode Viewer continues to work with Java 8.

So, if you need to use HOBOnode Viewer, please use the Windows version of HOBOware.

Bug introduced with HOBOmobile v1.9.1 corrected
If an MX1102, the CO^2 Logger, has been launched with HOBOmobile v1.9.1, the header of the logger datafile will be reported to be corrupted if older versions of HOBOware attempt to launch, read out or check the status of the logger. HOBOware 3.7.15 and above correct that problem.

Gmail and HOBOnode Alarm Alerts and Data Delivery
Google has tightened security on its Gmail SMTP servers so using smtp.gmail.com to deliver HOBOnode Alarm Alerts or HOBOnode Data will fail. Starting with HOBOware v3.7.14, we have enabled you to use Gmail for these features IF YOU ARE WILLING TO DECREASE THE SECURITY OF YOUR GMAIL ACCOUNT. We do not recommend this but if you need this ability, that is a possible way to do it.

If you use HOBO Data Nodes and never shut down HOBOware and background HOBO Data Node Communication
Using HOBO Data Nodes and the associated database takes a lot of memory. To help with this, we use a disk caching utility to temporarily save some data stored in RAM to the disk drive. But the disk data file can grow as long as HOBOware and/or background HOBO Data Node Communication is running. So, you may want to completely shut down HOBOware and the background HOBO Data Node Communication every week or so to reset the size the of the disk data cache file.

Another option is to reconfigure the disk cache utility but this can be a complex procedure so you should contact Onset Computer Support for more information.

HOBOnode Manager on Windows
There may be a problem using HOBOnode Manager on some Windows computers if the "USB Selective Suspend Setting" is enabled. This shuts down the USB port if no activity is detected. To disable this feature (list here is modified from the page linked below):

1. Open **Control Panel**
2. Go to: **Hardware and Sound->Power Options**
3. Find your preferred power plan and click “Change plan settings”
4. Click “Change advanced power settings”
5. A dialog box will open
6. Find the entry “USB settings” and expand it
7. Expand the entry “USB selective suspend setting”
8. Use the drop-down menu to disable the setting in the dialog
9. Click "OK"

For more information, you can go to this link at Gizmo's Freeware:
http://www.techsupportalert.com/content/how-fix-annoying-windows-usb-problem.htm

The Optic USB Base Station and Windows 10 and 11
Updates to Windows 8.1 and Windows 10 cause a problem with the Onset Optic USB Base Station (part number

BASE-U-4) and the HOBO Waterproof Shuttle (part number U-DTW-1). The new Windows power saving updates may cause the Base Station and Waterproof Shuttle to appear inactive even though there is a device physically attached. This will impact any loggers used with the optic base station or shuttle, including: U20, U22, U23, U24, U26, UA Pendant, UTBI TidbiT.

There are three known workarounds:
1) Unplug and plug the Optic Base Station or Waterproof Shuttle each time you change loggers attached to them.

2) Open the Device Manager and force a scan of USB devices.
  a) Select Settings and then select the Devices group.
  b) In this group, select Connected Devices (from the list on the left).
  c) Find Device Manager under "Related Settings" near the bottom and select it
  d) In Device Manager, select "Universal Serial Bus Controllers" opening a list of USB devices.
  e) At the top of the window, select Action and pick "Scan for hardware changes".
  f) HOBOware should now detect the logger insertion.

3) Modify a key in the Windows Registry associated with the Optic Base Station or Waterproof Shuttle. This procedure is available in this Microsoft Knowledge Base Article in the Workaround section. When you get to the section needing the Onset Computer Corporation Vendor ID, use VID_0F1B. The Product ID for the Optic USB Base Station Product ID is PID_0070. The Product ID for the Waterproof Shuttle is PID_0A04. You will also need to know the Product ID for the loggers to detect when the logger in removed. You can use methods in the Microsoft Knowledge Base Article to find the Product ID for the loggers you are using.

OS X 10.11 (El Capitan) and U30, Waterproof Shuttle and RX Stations
A bug in early releases of Apple's OS X 10.11 (El Capitan) causes failures in Onset U30 USB Weather Station, HOBO RX Remote Monitoring Station data loggers and the Waterproof Shuttle (U-DTW-1) USB communications. But this problem was fixed in OS X 10.11.4 (release 4) so we highly recommend that if you are using OS X 10.11 that you update to the latest version of that operating system.

***** Other Known Issues *****

* Firmware Update for UX-series loggers may not work on Windows 8. Windows 8 is no longer supported by Microsoft and updates needed to work properly with USB devices may not be available. So, we suggest either: 1) using a Windows 7 computer for Firmware Update or 2) upgrade to Windows 8.1 or Windows 10. After the Windows update, reinstall HOBOware so the correct DLL needed for Firmware Update can be installed.

* The Alarm & Readout Tool is not supported with HOBOware 3.5 or later. For questions or assistance, refer to http://www.onsetcomp.com/support.

* The Conductivity Data Assistant is not offered in the Plot Dialog for data that has been imported from Text or CSV (comma separated value) files. The Conductivity Data Assistant is only offered for U24 data files either read from disk or read out from a U24 Conductivity/Salinity logger.

* The RX Station Manager cannot load the Ethernet Configuration screen after power-up but before the RX Station has attempted to connect to HOBOlink. The error message is, "Manager is unable to retrieve configuration. Close Manager and retry." So, when powering the RX Station, leave the USB cable unplugged, allow the system to initialize and attempt connecting to HOBOlink (Connection label flashes); it does not matter if the attempt succeeds or fails. Then connect the USB cable and use RX Station Manager to access the Ethernet Configuration.

* The RX Station Manager Conditions panel does not support collection of the reading for an analog sensor where warm-up (excitation) time is more than approximately 3 seconds. In this case, an error message will appear: "Manager is unable to refresh all sensor conditions."

* The RX Station Manager Conditions panel may not include a Smart Sensor when logging at a 1 second interval and many Smart Sensors are attached. In this case, an error message will appear: “Manager is unable to display all configured sensors.” To workaround this issue, temporarily stop logging.
* When importing HOBOware CSV (Comma Separated Value) files from HOBOlink Custom Data and Data Delivery features, you cannot use commas in the name of the series, the series units or in a series label.

* When importing HOBOware CSV files from HOBOlink Custom Data and Data Delivery features, you can embed a double quotes character (ASCII 34 or 22 hex) in the strings by escaping the double quote character with a backslash '\' character (ASCII 92 or 5C hex). So, this label could be used to show inches, "Rain on the roof \" ".

* After pasting a series into a plot, the Remove Series feature will not work correctly. It may remove the wrong series and the order of series in the Plot's Details Pane will be changed and be incorrect.

* A new feature for reading out a RX Station with HOBOware is known to be slow and error-prone when running under Windows XP or on very slow computers (for instance, a 1.6 GHz Pentium with 2 GB RAM). Windows XP support was dropped for HOBOware version 3.7.3 so this shouldn't be a problem for users with compatible computers.

* After updating the firmware of the MX1102 Temperature/Humidity/CO^2 logger (with the "Update Device Firmware" item under the Help menu), you may see the firmware version being reported as R0-Pnnn where 'nnn' is the correct version number but the radio transceiver firmware, 'R', is reported as 0. The radio firmware version will be shown correctly after removing power and then powering up the logger.

* Reordering the columns of HOBOnode Manager can result in checkbox cells of the table not working. Please leave the order of the columns in their default state.

* The new CABLE-ADAP24 external input cable for measuring DC voltages from 0 - 24 volts maximum cannot be used with HOBOnode Manager which means that new cable adapter cannot be used on an ZW HOBOnodes that take external sensors.

* Loggers launched in HOBOware 3.7.28 cannot be read out in versions of HOBOware prior to HOBOware 3.7.28. As a general rule, we discourage launching loggers in one version of HOBOware and then reading the logger out in an earlier version. Please be sure to upgrade all your versions of HOBOware.

* The Data Assistants (also called Post-Processors) available with HOBOware v3.5.0 and later must not be used with versions of HOBOware prior to version 3.5.0. In addition, the Data Assistants available with versions of HOBOware prior to version 3.5.0 must not be used with HOBOware version 3.5.0 and later.

* If you create your HOBOnode Manager database in HOBOware 3.5 or later, you will not be able to access the HOBOnode Manager in HOBOware versions prior to 3.5. If you must use a previous version of HOBOware, you will need to uninstall the current (3.5.0 or later) version and then install the older version. The HOBOnode Manager will then be accessible again in the older version of HOBOware.

* The HOBOnode Manager database cannot be used with any versions of HOBOware earlier than 3.2.2 once it has run the required utility for performance improvement.

* Not all measurement types are supported by the Import Text Data feature.

* Changing a series description or units in the Series Properties will not be reflected in the Details pane or Points table if the series was launched with a label. The legend, however will show these changes.

* Legacy files (e.g. TBI32 data files) launched with a delayed start time that occurs in a different phase of Daylight

Savings time than the launch time, will plot with timestamps that do not properly follow the DST change.

* The Undo function does not work when trying to undo a pasted series.
* It is not possible to paste State series into a project file that already contains State series.

* When merging datafiles, if the datafile being merged contains state or event series that select Merge to No Series, the timestamps on the resultant plot will be invalid when saved to a project file. Also when merging project files, for series that select Merge to no Series existing axes are not used causing duplicate axes.

* When merging datafiles with State series, the resultant merged State series may cause a series color change.

* In the Alarms pane of the Series Properties window, the value slider to set an alarm may have incorrect minimum and maximum values for some of the pulse sensors.

* The Bulk Export Tool preference to include YAML headers currently does not result in YAML headers being created.

* In HOBOnode Manager, on the Alarms tab when using the "Apply default actions" to multiple alarms feature, it is possible that the next time you view one the selected alarms by clicking the alarm icon in the HOBOnode Manager table, it may not show the applied default actions. However if you re-open the HOBOnode Manager, the default actions are now there.

* When running on a non-English desktop there is the remote possibility that you may encounter a problem bringing up the Launch window. This has been found to be a conflict in a few locales when using the 12-hour time format, and has been corrected for all tested locales. To get around the problem should you encounter it please go to Preferences, and under the Display category, in the Date/Time section, change the Time Format to 24-hour.

* From the Export Settings Preferences pane, if selecting the option, “Include sensor serial number, or label if available,” and also selecting the option, "No quotes or commas in headings, properties in parentheses", if a label is present the sensor serial number will not be included.

* When running in a non-English locale please be aware that the keyboard accelerator keys have not been changed to adapt to the non-English language. For example, the key to select the crosshair tool when plotting is C regardless of the language of the user interface. Please see the application Help for details on these accelerator keys.

* When launching a HOBO Pendant with only events enabled (no temp, no battery logging), HOBOware correctly sets the logging interval to one hour (so the battery doesn't drain), but incorrectly sets the internal information used by shuttles to re-launch the logger to a one-second interval. This is fine for the initial launch, but if the logger is re-launched with either the U-DT-1 or U-DTW-1 shuttle it starts "logging" at one second, draining the battery. It isn't logging data since it isn't supposed to, but it does wake up once a second, causing the battery to drain faster than expected.

* Plots with series that logged over the Spring or Fall time change will not display the time change.

* Occasionally HOBOware may report that communications with the logger failed - just retry the operation.

* While in a locale which formats numbers as follows "123 456 789,00", when entering a number in an input field, do not use the spacebar to input the grouping separator. The grouping separator is a no-break space character, and the spacebar will insert a space character, which the input field will treat as an invalid character. It is best to enter the number without any grouping separator(s) and when you leave the input field, the value will format itself correctly.

* When a serial logger (HOBO Weather Station, HOBO Micro Station, HOBO Energy Logger) is awaiting an interval,

delayed, or button start, the sensor readings are not updated in the Status window. This is a hardware limitation. When logging begins, sensor readings will update as usual.

* At low screen resolutions (1024x768), plots with many series (and therefore many Y axes), may initially display too small. A message "Plot Panel Too Small" will display across the plot when this occurs. To see the plot, try maximizing HOBOware to full screen size. If this does not work, try hiding the details pane and points table.

* Changing the units of a series using the right-click menu item "Convert Series Units" will work for everything except the Y-axis values used by that series. Use the Main Menu item "Edit | Convert Units" or the Toolbar button "Convert units for all series" instead.

* The HOBO U14 can be launched without the Temperature channel or the Relative Humidity channel selected, although there will be a warning about this condition. The logger will continue to display current conditions of those channels, but no data will be logged and alarms will not work.

* The battery state for the HOBO U23 loggers (-001, -002, -003 and -004 versions) is shown as Good at battery voltages above 2.85 V. The battery state should be shown as Good only when the voltage reads 3.1 V or higher.

* Users of the HOBO Energy Logger (H22-001) may find that they are warned, "The battery voltage on this logger is too low to use excitation power." This warning is sometimes given even when the battery voltage is high enough to supply excitation power. We suggest that you make your own decision based on the voltage reading from the Status window or from the battery gauge near the top of the Launch window.

That dialog's warning should not be confused with the dialog whose text, "This logger's battery is very low..." is only issued when the logger battery is dangerously low. You should NOT ignore this dialog's warning.

* The Bulk Export Tool preferences may not show up in the Preferences window under some circumstances. Closing the Preferences window and re-opening usually corrects the problem.

* Entering non-alphanumeric characters in the Help Search field can cause the search to fail. Close the Help and reopen it if this occurs.

Windows Only:

* If you are receiving a User Access Control warning every time you start HOBOware 3.2.2 or later version, be sure that you are not running HOBOware in Compatibility mode. To check this, right-click the HOBOware desktop shortcut, go to the Compatibility tab and uncheck the Compatibility options particularly that for "Run as administrator".

* HOBOware does not support roaming user profiles.

* By default, HOBOware maps all .hobo and .dtf files to itself. This will remove the mapping from GreenLine or BoxCar Software. If you would like to remap the file types to the original software, use the Map/Unmap buttons in the General pane of HOBOware Preferences. To use the Map/Unmap feature you'll need to run HOBOware with administrator privileges, otherwise you get a series of "error modifying registry" messages. Even while running as administrator, occasionally the Map/Unmap buttons in Preferences may produce an error message. Simply click the button again and the mapping should proceed properly.

* If the logger you plug in has never been seen by your computer before, the Found New Hardware balloon will appear next to the Windows Taskbar and any default action on plug will not work. If you wait until the system informs you the device is ready and unplug the logger and plug it back in, the default action on plug will then happen.

* When exporting points to Excel, it is possible that the resultant Excel file may not open in the exact same format when opened in Excel on a Macintosh system.

* When exporting details to text, it is possible that the resultant text file may not open in the exact same format when opened in a text editor on a Macintosh system.

* As described in the manual, bitmap images of the graph can be pasted directly into many applications. However, the following steps are needed to paste the graph into a WordPad document:
From the Insert menu, choose Object.
In the Insert Object dialog, click the Create New button.
Choose Bitmap Image from the list. Click OK. This should create a frame in your document.
From the Edit menu, choose Paste. The graph should appear within the frame.

Windows 7 Only:
* Occasionally when reading out a logger you will not be able to enter a file name in the Save window. Canceling this window and reading out the logger again, usually fixes this issue such that you can now enter a name.

Mac Only:
* Merging datafiles may not work on the Mac (macOS or OS X). This is an intermittent problem and will be fixed in a future release of HOBOware.

* The original version of the Pendant Base Station has a known issue that results in slower communications with versions of HOBOware for Mac. This will not affect the validity of the data. Pendant Base Stations with serial numbers below #961469 have this problem. The serial number is visible through the clear plastic of the Base Station on a white label. Please check periodically for an update to HOBOware that addresses this issue, or contact Onset Computer Corporation Technical Support (http://www.onsetcomp.com/support) for a free replacement Pendant Base Station.

* At times, it is possible that the HOBOware menu enters a disabled state, where the items in the menu are disabled. If you restart HOBOware, the menu will return to its normal state. Be sure to save any unsaved data before restarting HOBOware.

* When exporting points to Excel, it is possible that the resultant Excel file may not open in the exact same format when opened in Excel on a Windows system.

* When exporting details to text, it is possible that the resultant text file may not open in the exact same format when opened in a text editor on a Windows system.

* HOBOware for Mac may experience problems when using a Keyspan USB to Serial Adapter that is attached to a USB hub. It is recommended that Keyspan USB to Serial adapters be attached directly to the USB port on the computer to avoid this issue.

* For HOBOware 3.5.0 and above, the Mac installer will only place the HOBOware application in /Applications. Previous versions allowed installing HOBOware anywhere in the file structure.

* The HOBOware updater will acknowledge that a previous version of HOBOware is installed in other places in the file structure and will allow the updater to run but the updater will only place the HOBOware v3.5.0 (and above) application in /Applications.

* For HOBOware 3.5.0, beware that in the future, you will be able to install this version over later versions of HOBOware but you will get no warning that you are overwriting a newer version of HOBOware with an older version. Versions of HOBOware previous to v3.5.0 gave a warning about this downgrade.

Questions or comments? Please direct to Onset Computer Corporation at
1-800-LOGGERS (1-800-564-4377) or go to http://www.onsetcomp.com/support/contact & fill out the form.

Appendix 13. 2024 Cavity-Nesting Birds Annual Report

Site C Clean Energy Project
Cavity-nesting Species Mitigation and Monitoring Program: Nest Box Monitoring 2024 Annual Report

PRESENTED TO

British Columbia Hydro and Power Authority

MARCH 26, 2025
ISSUED FOR USE
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Site C Clean Energy Project
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March 21, 2025

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and Power Authority and their agents. Saulteau EBA Environmental Services Joint Venture does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro and Power Authority, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Saulteau EBA Environmental Services Joint Venture's Services Agreement. Saulteau EBA Environmental Services Joint Venture's Limitations on Use of This Document are provided in Appendix D of this report.

EXECUTIVE SUMMARY

In the spring of 2024, Saulteau EBA Environmental Services Joint Venture (SEES JV) completed basic maintenance and monitoring of nest boxes that were previously installed by Ausenco for British Columbia Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C", the Project). These surveys were part of BC Hydro's Cavity-nesting Mitigation and Monitoring Program for secondary cavity-nesting birds. Nest boxes were installed by Ausenco in 2017, 2019, 2020, and 2022. This report describes the methods used to monitor nest boxes in 2024 and provides a summary of the results.

From June 2 to 6, 2024, Tetra Tech Canada Inc. (Tetra Tech) monitored 107 nest boxes around the Site C Project footprint. Maintenance of unused nest boxes was minimal, involving the replacement of old debris with clean wood shavings only if there were no signs of use. Of the 107 nest boxes monitored, 85 (79%) were considered operational, and 42 (49%) of these showed signs of use. Five nest boxes contained active nests: four were occupied by adult American Kestrels, and one by an adult Bufflehead.

The 2024 nest box occupancy rate recorded by Tetra Tech (49%) aligns with rates from previous years. Nest boxes were often occupied by species not initially targeted by the design, demonstrating their versatility in providing nesting opportunities for a variety of species. Notably, three of the five nest boxes with active nests in 2024 were also used in previous years, indicating a tendency for birds to reuse established nest boxes.

Nest box monitoring conducted in 2024 represents a continuation of monitoring and maintenance of nest boxes after installation. Nest box use and condition will continue to be monitored every two years from construction through the first 10 years of Project operations.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1.0 INTRODUCTION 1

2.0 BACKGROUND 1
2.1 Nest Box Construction and Installation 1
2.2 Nest Box Monitoring 3

3.0 METHODS 5
3.1 Nest Box Monitoring 5
3.2 Nest Box Maintenance 5

4.0 RESULTS 5

5.0 DISCUSSION 16

6.0 REFERENCES 16

LIST OF TABLES

Table 2-1: Bird target species, habitat preferences, and number of nest boxes previously installed. 1
Table 2-2: Nest box installation specifications for each target species 3
Table 4-1: Status of nest boxes surveyed in 2024 5
Table 4-2: Wildlife species identified to be using operational nest boxes in 2024 7

LIST OF FIGURES

Figure 1. Nest Box Locations 4
Figures 2a-h. 2024 Nest Box Locations 8

APPENDICES

Appendix A Nest Box Monitoring and Maintenance Schedule – 2024
Appendix B 2024 Nest Box Monitoring Results
Appendix C Project Qualified Environmental Professionals
Appendix D Tetra Tech's Limitations on the Use of This Document

1.0 INTRODUCTION

In the spring of 2024, Saulteau EBA Environmental Services Joint Venture (SEES JV) conducted basic maintenance and monitoring of nest boxes built and installed for British Columbia Hydro and Power Authority (BC Hydro), as a part of the Site C Clean Energy Project ("Site C", the Project). These surveys are a component of BC Hydro's Cavity-nesting Mitigation and Monitoring Program ("the program"). The program began in 2017 and will continue through the first 10 years of the operation of Site C (BC Hydro 2023). The program establishes short-, medium-, and long-term mitigation for the Project's impact on avian cavity-nesting species, including passerines (songbirds), Northern Flicker (*Colaptes auratus*), tree cavity-nesting waterfowl, and tree cavity-nesting raptors (falcons, hawks, and owls). Short-term mitigation involves installing nest boxes and monitoring their use from construction through the first 10 years of Project operations. Medium- and longer-term mitigation strategies include creating snags and retaining select forest stands.

The objectives of the Cavity-nesting Mitigation and Monitoring Program are to:

1. Mitigate habitat loss for cavity-nesting species that are documented to use habitats within the area affected (e.g., inundated) by the reservoir filling (i.e., the Project footprint).

2. Monitor the effectiveness of that mitigation to inform adjustments via adaptive management.

This report is focused on providing an annual update of the program's short-term mitigation, including nest box installation, monitoring, and maintenance for cavity-nesting species conducted in 2024.

2.0 BACKGROUND

2.1 Nest Box Construction and Installation

Baseline surveys conducted from 2008 to 2012 documented 27 species of cavity-nesting birds that use habitats within the project footprint (BC Hydro 2013). Of these species, 20 are secondary cavity nesters (Table 2-1), meaning that they reuse previously excavated or naturally formed cavities in trees. Fourteen nest box designs (Table 2-1) were constructed to accommodate all 20 species of cavity-nesting birds, with some designs intended to support multiple species (BC Hydro 2023).

Table 2-1: Bird target species, habitat preferences, and number of nest boxes previously installed[1].

Species Group	Nesting Habitat Preference[2]	Box Type	Species Supported	Number of Boxes Installed to Date
Passerines	▪ Utilizes a variety of forested habitats, including deciduous and coniferous forests of most structural stages. ▪ Brown Creeper and Nuthatch species prefer older mature forests. ▪ House Wren utilize more open forested habitat. ▪ Mountain Bluebirds utilize open lowland and sagebrush habitats.	A / BC / B1	Black-Capped Chickadee Boreal Chickadee Red-Breasted Nuthatch White-Breasted Nuthatch House Wren Brown Creeper	44
		A2 / B2	Mountain Bluebird Tree Swallow Violet-Green Swallow	57

[1] From Ausenco (2024).
[2] Nesting habitat preferences for target bird species collected from the Audubon Guide to North American Birds (Audubon 2024).

Species Group	Nesting Habitat Preference[2]	Box Type	Species Supported	Number of Boxes Installed to Date
	▪ Swallows utilize open and semi-open areas near water, including cultivated fields.			
Waterfowl	▪ Need a clear route from nesting areas to a watercourse. ▪ Bufflehead can utilize younger forests with smaller trees. ▪ Goldeneye require mature forest surrounding clear, cold water.	E1	Bufflehead	11
		F	Barrow's Goldeneye Common Goldeneye Hooded Merganser	50
		D / G	Common Merganser	19
Raptors	▪ Utilize forests of various structural stages where smaller species are found in younger forests and larger species in older forests. ▪ American Kestrel requires nesting habitat adjacent to open fields for hunting.	E2	Boreal Owl Northern Saw-Whet Owl	29
		E3	American Kestrel	17
		C	Northern Pygmy- Owl	26
		B3	Northern Hawk-Owl	23
		H	Barred Owl	2
			Total	**278**

Nest boxes were strategically placed by Ausenco in optimal areas for each species group, while also considering land availability and future access (Figure 1). They were required to be located on lands owned or leased by BC Hydro or on Crown land, outside planned clearing boundaries, above the high-water mark, and in suitable but suboptimal habitats. Installation by Ausenco followed criteria outlined in the Cavity Nesting Species Mitigation and Monitoring Program (BC Hydro 2023), James (1984), and using 2016 ecosystem mapping data.

Various other additional factors derived from literature and expert knowledge were also considered by Ausenco for the installation of nest boxes. These include:

- Bird distribution and abundance information from Site C baseline studies in the area;
- Proximity to a food source for all species (e.g., wetlands, water sources);
- Known species habitat associations;
- Typical nesting height (Table 2-1);
- The density of nest boxes within an area (i.e., spacing between nest boxes) (Table 2-2); and
- Within lower suitability habitat that has a relatively low proportion of cavity-nest trees but with high potential to develop into more suitable habitat over time.

Table 2-2: Nest box installation specifications for each target species[3].

Species Group	Common Name	Scientific Name	Minimum Spacing Between Boxes (m)	Nest Box Height (m)
Passerines	Black-Capped Chickadee	*Poecile atricapillus*	150-200	1.5-4.5
	Boreal Chickadee	*Poecile hudsonicus*	150-200	1.5-3
	Brown Creeper	*Certhia americana*	150	1.0-10
	House Wren	*Troglodytes aedon*	30	1.5-3
	Mountain Bluebird	*Sialia currucoides*	90	1.2-1.8
	Red-Breasted Nuthatch	*Sitta canadensis*	50	1.5-4.5
	Tree Swallow	*Tachycineta bicolor*	10-30	1.5-1.8
	Violet-Green Swallow	*Tachycineta thalassina*	10-30	2.75-4.5
	White-Breasted Nuthatch	*Sitta carolinensis*	300	1.5-6
Waterfowl	Barrow's Goldeneye	*Bucephala islandica*	150-200	1.8-6
	Bufflehead	*Bucephala albeola*	50-150	1.5-3
	Common Goldeneye	*Bucephala clangula*	1000	1.8-9
	Common Merganser	*Mergus merganser*	100	2.4-5.2
	Hooded Merganser	*Lophodytes cucullatus*	30	1.8-7.6
Raptors	American Kestrel	*Falco sparverius*	500-800	3.5-6
	Barred Owl	*Strix varia*	1000	4.5-9
	Boreal Owl	*Aegolius funereus*	150	≥3
	Northern Hawk-Owl	*Surnia ulula*	500-700	≥3
	Northern Pygmy- Owl	*Glaucidium gnoma*	400-500	≥3
	Northern Saw-Whet Owl	*Aegolius acadicus*	400-500	≥3

A total of 278 nest boxes have been installed to date on the Project (Figure 1). This includes:

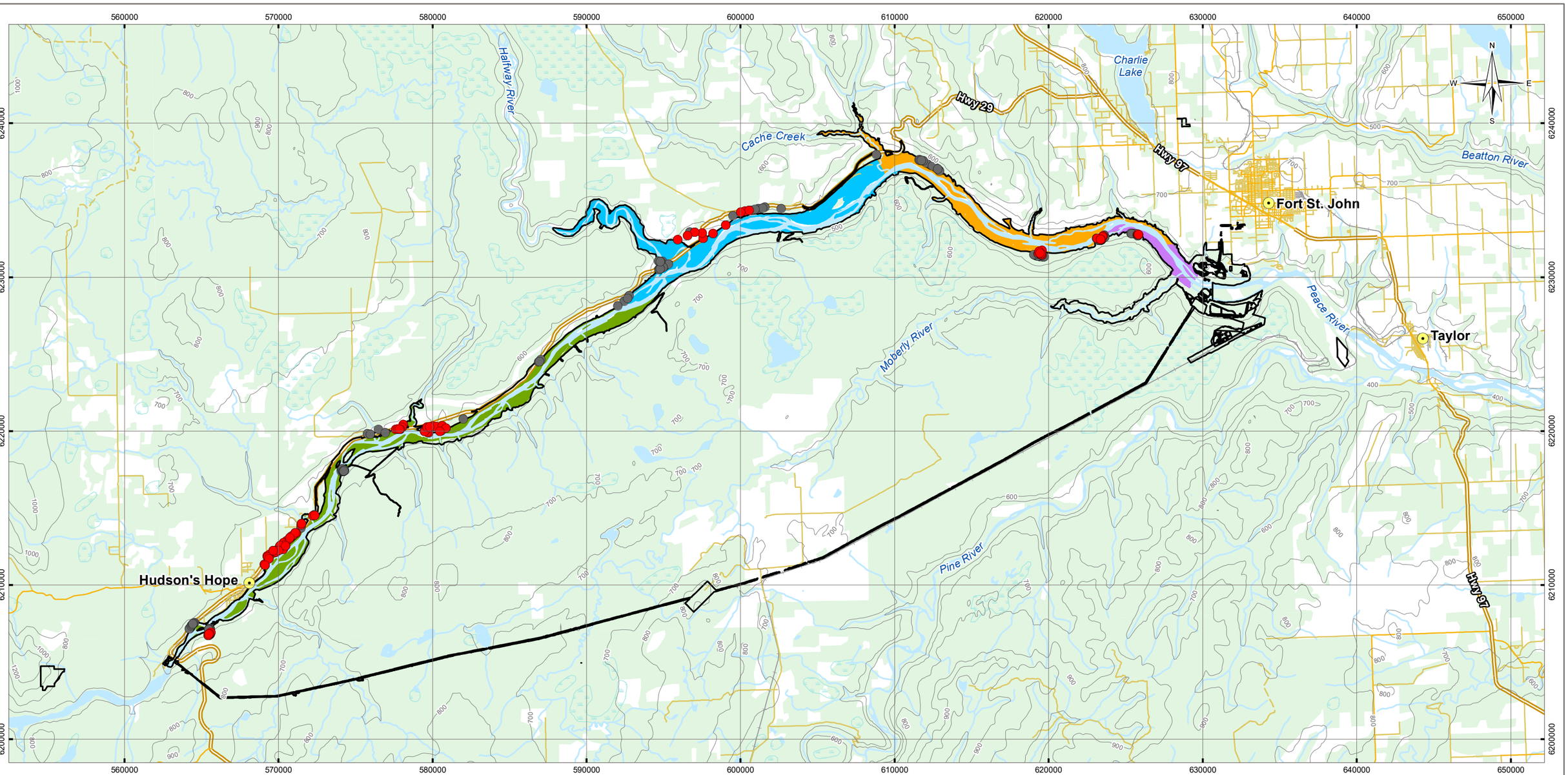
- 97 nest boxes on the north side of the Peace River in 2017
- 83 nest boxes on the south side of the Peace River in 2019
- 88 nest boxes on the north and south sides of the Peace River in 2020
- 10 nest boxes on the south side of the Peace River in 2022

BC Hydro plans to establish nest boxes for all cavity-nesting bird species within the riparian vegetation buffer that will be planted along the edge of the reservoir on BC Hydro-owned lands after reservoir filling has occurred (BC Hydro 2023).

2.2 Nest Box Monitoring

Nest boxes are to be monitored once every two years throughout construction and through the first 10 operating years of the project (Appendix A). Boxes installed in 2017 were monitored in 2020 and in 2022 by Ausenco (Hemmera 2020, Ausenco 2022). Boxes installed in 2019 and 2020 were monitored in 2021 and 2023 by Ausenco (Hemmera 2022, Ausenco 2024). In addition to monitoring the 97 nest boxes installed in 2017, Tetra Tech monitored 10 other nest boxes that were installed by Ausenco in 2022 (Appendix B).

[3] From Ausenco 2024.



LEGEND

- Project Footprint

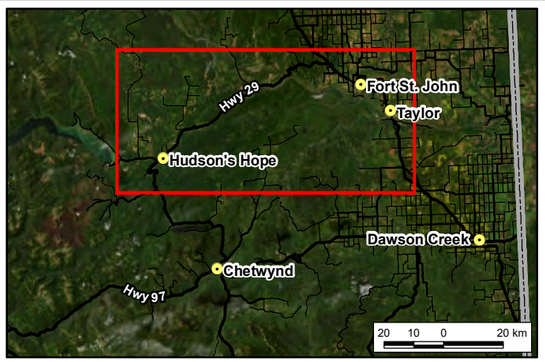
Nest Box Locations

- Monitored in 2024
- Not Monitored in 2024

Reservoir Section

- Eastern
- Lower
- Middle
- Western

- Populated Place
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Residential Area
- Contour (100 m)
- Watercourse
- Waterbody
- Wetland
- Wooded Area



NOTES
Base data source: CanVec 1:250,000.

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

Nest Box Locations

PROJECTION UTM Zone 10		**DATUM** NAD83		**CLIENT** BC Hydro Power smart
Scale: 1:250,000 — 5 2.5 0 5 Kilometres				TETRA TECH
FILE NO. PENW03042-02_Fig01_Cavity_Overview.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 1**

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3.0 METHODS

3.1 Nest Box Monitoring

Monitoring was conducted by a team of two qualified environmental professionals (QEPs; Appendix C) from June 2 – 6, 2024. Monitoring methods were intended to minimize disturbance to active nests. The QEPs would approach the nest box discretely, watching and listening for bird activity. When adults were visibly using a box, we would record and observe from a distance, and attempt to determine the nesting stage through behaviour. If no use was evident from nest box observation, we approached the nest box structure and tapped lightly on it to provoke a response. If no bird appeared at the entrance, a pole-mounted camera was used to inspect the nest box. If nesting activity was documented but no adult birds were observed at the box, egg and nest characteristics (e.g., nesting material type, egg colour, shape, and size) were used to identify the species occupying the box, if possible. The nest box surveys were timed to occur during incubation and early nestling nest stages to increase the likelihood of detecting use.

Throughout the surveys, we recorded data electronically on species use, box type and location, weather conditions, detection method, and general notes informing environmental context.

3.2 Nest Box Maintenance

Nest box maintenance was kept minimal per direction from BC Hydro. Maintenance activities were confined to cleaning out old debris from nest boxes and replacing it with clean wood shavings. If there was uncertainty about whether a nest box was actively being used by birds, we did not perform maintenance work. We made minor repairs to nest boxes, when possible. We did not, however, repair nest boxes found with significant damage.

4.0 RESULTS

Tetra Tech monitored 107 nest boxes in 2024 (Figures 1 & 2a-h, Appendix B). Ten nest boxes were monitored for the first time in 2024, after being installed in 2022. Fifteen nest boxes could not be located. We suspect that these boxes were destroyed or removed during the construction of the Project. There were 85 nest boxes operational and six nest boxes were found destroyed (Table 4-1, Figures 2a-h). We removed wasp nests from 11 nest boxes (e.g., Photo 1) and replaced nesting material in 22 boxes (e.g., Photo 2). Four nest boxes were reactivated. We did not monitor 10 nest boxes listed in previous Ausenco reports as being destroyed or removed. The status of each box at the time of monitoring is presented in Appendix B.

Table 4-1: Status of nest boxes surveyed in 2024

Nest Box Status	Number of Nest Boxes
Deactivated	1
Destroyed	6
Gone/Missing	15
Operational	85
Total	**107**

Photo 1: View of a wasp nest present within nest box B1-06.

Photo 2: View of new aspen wood shavings added to replace old nesting material.

Photo 3: View of nesting material present within nest box E2-20.

Photo 4: View of Northern Flicker feathers observed within nest box F-09.

We found signs of use in 42 of the 85 operational nest boxes (Figures 2a-h). Within the operational nest boxes, we observed nesting material in 32 boxes (38%), feathers in 13 boxes (15%), and five boxes (6%) contained eggs or individuals directly observed to be using the box (Photo 3, Photo 4, and Photo 5, respectively).

Out of the 107 monitored nest boxes, we found signs of rodent use in 13 nest boxes (Photo 6), while 29 showed signs of use by birds (Figures 2a-h, Table 4-2). Five nest boxes contained active nests. Adult American Kestrels (*Falco sparverius*) were observed using four nest boxes (Figures 2c-e). We observed four eggs in nest box E3-04, five eggs in nest box E3-11 (Photo 6), and adults were observed to be using nest boxes E3-13 and E3-15 (Photo 7). An adult Bufflehead (*Bucephala albeola*) was found in nest box F-29 (Photo 8). To avoid disturbing the kestrels and Buffleheads, we did not investigate these boxes further and assumed they were incubating eggs. Feathers from Northern Flicker (*Colaptes auratus*) were found in nest box F-09 (Photo 4), suggesting that it was used for nesting.

Table 4-2: Wildlife species identified to be using operational nest boxes in 2024

Species Using Nest Box	Number of Nest Boxes
American Kestrel	4
Bufflehead	1
Northern Flicker	1
Unknown rodent species	12
Red Squirrel	1
Unknown bird or mammal species	23
Total	**42**

Photo 5: View of American Kestrel eggs observed within nest box E3-11.

Photo 6: View of the rodent nest and chewing around the entrance of nest box A2-62.

Photo 7: View of American Kestrel observed within nest box E3-13.

Photo 8: View of Bufflehead observed within nest box F-29.

623000 623500 624000 624500 625000 625500 626000 626500

6233500 6233000 6232500 6232000

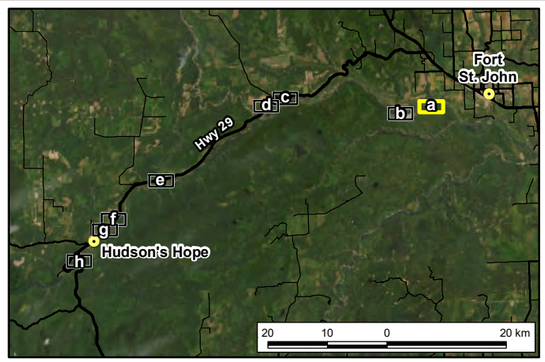
Peace River

A2-40
A2-60
A-023
A2-65
A2-73
E2-09
B3-63b
B3-64c
B3-16
E1-06
E1-06c
E1-06b
(Unknown)

N W E S

LEGEND

- Nest Box - Used
- Nest Box - Confirmed Destroyed
- Nest Box - Suspected Destroyed
- Nest Box - Not Used
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2023)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC Hydro Power smart
Scale: 1:10,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: ED	REV: 0
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02			Figure 2a

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617500 618000 618500 619000 619500 620000 620500 621000

6232000

6231500

6231000

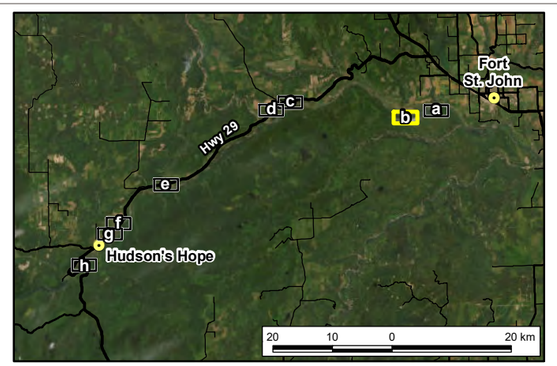
Peace River

A-019
A-008
G-11
OWL-1
C-07
E1-05a (Unknown)
G-08
F-12 (Rodent)
F-20 (Unknown)
F-09 (Northern Flicker)
F-44
G-03 (Unknown)
A2-71 (Rodent)

N W E S

LEGEND

- Nest Box - Used
- Nest Box - Confirmed Destroyed
- Nest Box - Suspected Destroyed
- Nest Box - Not Used
- Project Footprint
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2023)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: BC Hydro Power smart
Scale: 1:10,000 (200 100 0 200 Metres)				TETRA TECH
FILE NO.: PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: ED	REV: 0
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02			Figure 2b

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598500 599000 599500 600000 600500 601000 601500 602000

6235000 6234500 6234000 6233500

N W E S

Upper Cache Rd

Hwy 29

E2-20
(Unknown)

B3-10
(Unknown)

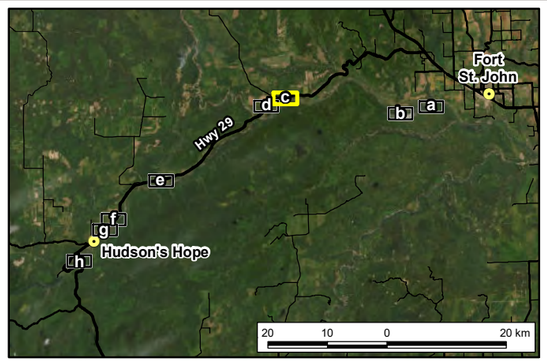
E2-03
(Unknown)

E3-11
(American Kestrel)

Peace River

LEGEND

- Nest Box - Used
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2018)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION UTM Zone 10	**DATUM** NAD83			**CLIENT** BC Hydro Power smart
Scale: 1:10,000 — 200 100 0 200 — Metres				TETRA TECH
FILE NO. PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 2c**

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595000 595500 596000 596500 597000 597500 598000 598500

6233500 6233000 6232500 6232000

N W E S

E3-13
(American Kestrel)

A2-62
(Rodent)

E3-14
(Rodent)

E3-16

A2-58

E3-15
(American Kestrel)

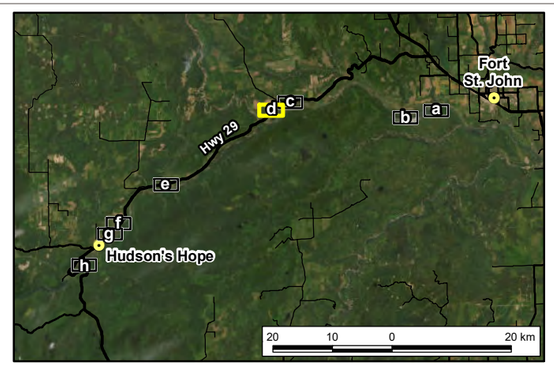
Hwy 29

Halfway River

Peace River

LEGEND

- Nest Box - Used
- Nest Box - Confirmed Destroyed
- Project Footprint
- Highway
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2018)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION UTM Zone 10	**DATUM** NAD83			**CLIENT** BC Hydro Power smart
Scale: 1:10,000 — 200 100 0 200 — Metres				TETRA TECH
FILE NO. PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 2d**

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577500 578000 578500 579000 579500 580000 580500 581000

6221000 6220500 6220000 6219500

N W E S

Fairrell Creek

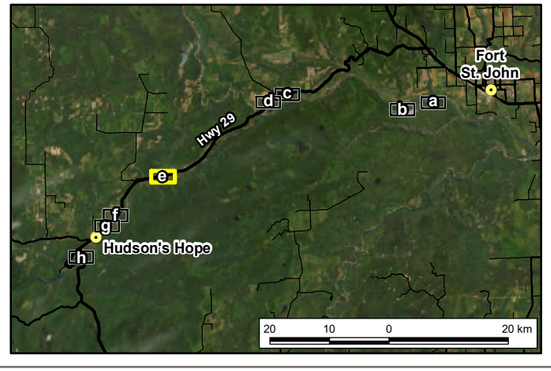
Hwy 29

Peace River

B3-06 (Unknown)
C-01
F-07
E1-05
F-08
F-32
G-07
B3-11
E2-28 (Rodent)
E3-01
E3-02 (Rodent)
E3-03 (Unknown)
E3-04 (American Kestrel)
A2-51
A2-36
A2-55 (Unknown)
A2-76 (Unknown)
A2-79 (Rodent)
A2-45 (Unknown)
A2-37 (Unknown)
E3-05 (Unknown)
B3-17 (Unknown)

LEGEND

- Nest Box - Used
- Nest Box - Reactivated
- Nest Box - Confirmed Destroyed
- Nest Box - Suspected Destroyed
- Nest Box - Not Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



NOTES
Base data source:
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Imagery from ESRI; Maxar (2022)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION UTM Zone 10		**DATUM** NAD83		**CLIENT** BC Hydro Power smart
Scale: 1:10,000 — 200 100 0 200 Metres				TETRA TECH
FILE NO. PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 2e**

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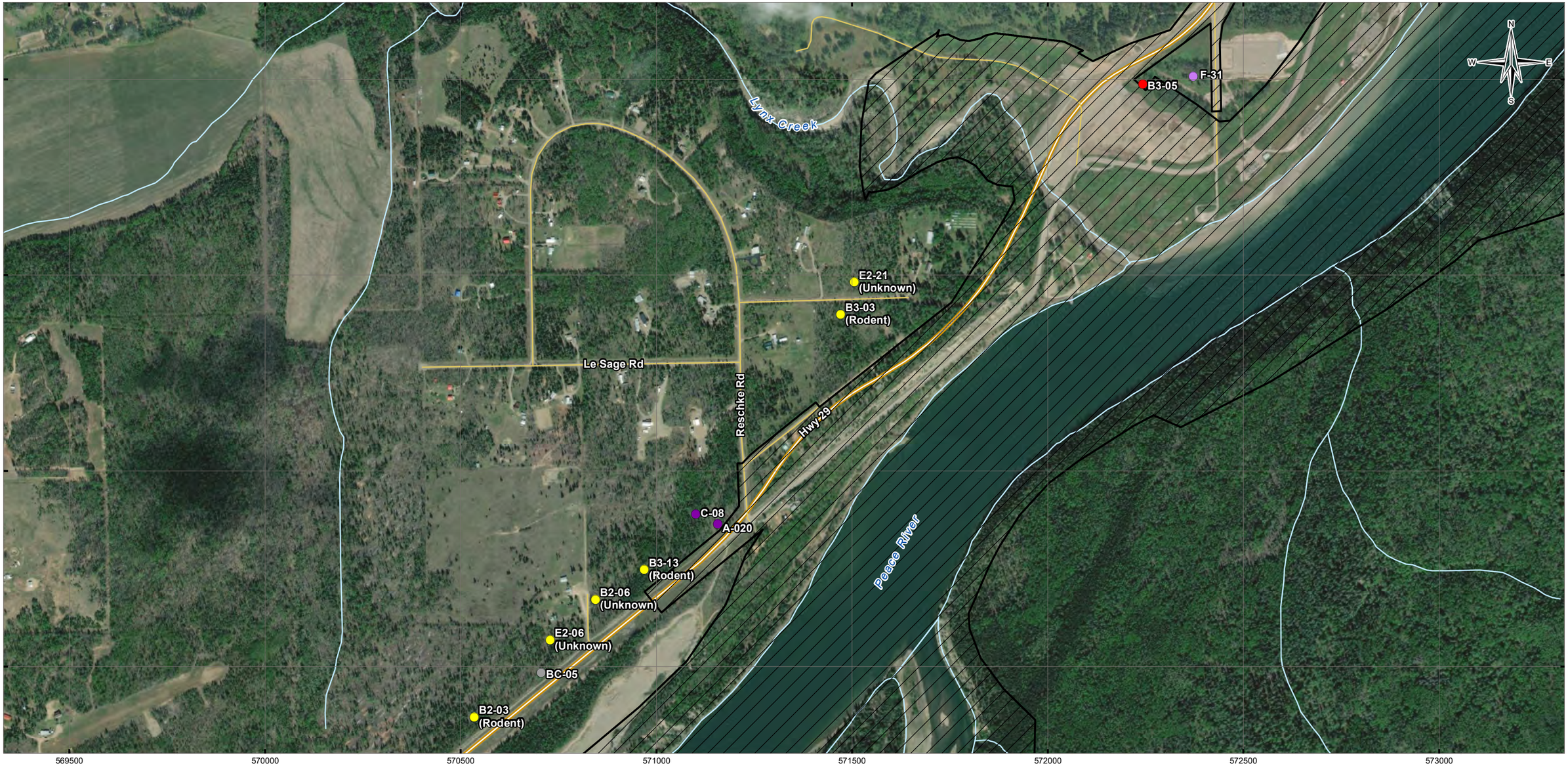

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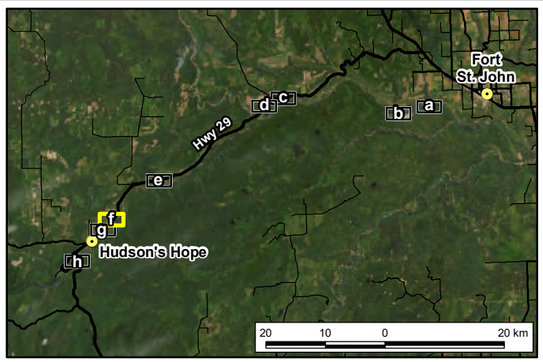
LEGEND

- Nest Box - Used
- Nest Box - Reactivated
- Nest Box - To be Reactivated
- Nest Box - Confirmed Destroyed
- Nest Box - Not Used
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2016/2023)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION UTM Zone 10	**DATUM** NAD83			**CLIENT** BC Hydro Power smart
Scale: 1:10,000 — 200 100 0 200 Metres				TETRA TECH
FILE NO. PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE Tt-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 2f**

568000 568500 569000 569500 570000 570500 571000 571500

6212500

6212000

6211500

B2-03 (Rodent)
B3-07 (Unknown)
A-002 (Rodent)
BC-03
C-03 (Rodent)
E2-10
A-021
B3-12
A-017
E2-17
B1-02 (Unknown)
C-13 (Unknown)
BC-02
C-12
B3-20
Powell Rd
Hwy 29
Peace River
B3-14
B1-01 (Rodent)
BC-01
C-22 (Unknown)
E2-01 (Unknown)
B3-02
E2-13

N W E S

568000 568500 569000 569500 570000 570500 571000 571500

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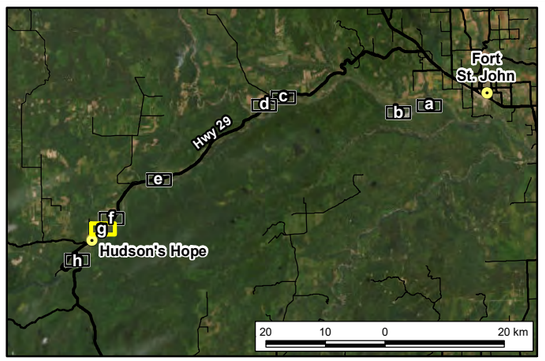
LEGEND

- Nest Box - Used
- Nest Box - Not Used
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2016)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION UTM Zone 10	**DATUM** NAD83			**CLIENT** BC Hydro Power smart
Scale: 1:10,000 — 200 100 0 200 Metres				TETRA TECH
FILE NO. PENW03042-02_Fig02_Cavity_Detail.mxd				
OFFICE TI-VANC	**DWN** SL	**CKD** MRB	**APVD** ED	**REV** 0
DATE March 26, 2025	**PROJECT NO.** ENW.PENW03042-02			**Figure 2g**

564000 564500 565000 565500 566000 566500 567000 567500

6207500 6207000 6206500 6206000

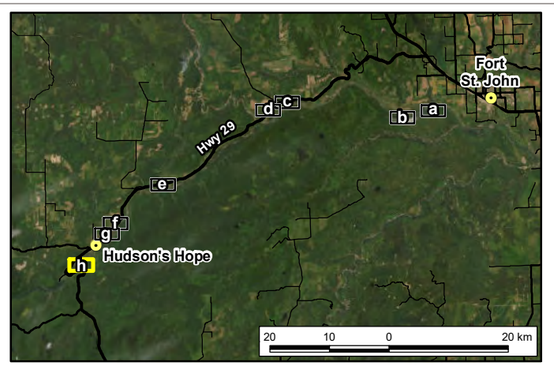
N W E S

A-014
A-011
F-29 (Bufflehead)
A2-35
F-18
B1-03
G-15
C-18
A2-75
B1-06
A2-59
A-010
F-11
C-02
F-17
E2-02
A-025
A2-74

Hwy 29
Peace River
Hwy 29

LEGEND

- Nest Box - Used
- Nest Box - Not Used
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



NOTES
Base data source:
CanVec 1:50,000 (2019)
Imagery from ESRI; Maxar (2017)

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
NEST BOX MONITORING REPORT 2024

2024 Nest Box Locations

PROJECTION: UTM Zone 10	DATUM: NAD83				CLIENT: BC Hydro Power smart
Scale: 1:10,000 (200 100 0 200 Metres)					TETRA TECH
FILE NO.: PENW03042-02_Fig02_Cavity_Detail.mxd					
OFFICE: Tt-VANC	DWN: SL	CKD: MRB	APVD: ED	REV: 0	Figure 2h
DATE: March 26, 2025	PROJECT NO.: ENW.PENW03042-02				

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5.0 DISCUSSION

The 2024 occupancy rate of 49% is consistent with the rates documented by Ausenco in 2022 and 2023 (Ausenco 2022, Ausenco 2024) and is comparable to another study on artificial nests in California for multiple species of oak woodland birds, which found an occupancy rate of less than 50% (Milligan and Dickinson 2016). This consistency supports the conclusion that the nest boxes are providing cavity nesting habitat as anticipated. In many cases, it was unclear whether the nesting material was from birds or rodents. At the time of monitoring, five of the 42 boxes (12%) were occupied by birds, and one box (2%) was occupied by a Red Squirrel (*Tamiasciurus hudsonicus*).

There were 14 types of nest boxes designed for the Project to accommodate a variety of secondary cavity-nesting bird species. Kestrels consistently used the E3 nest boxes, which were specifically designed for them, while a Bufflehead nested in an F nest box, originally intended for other waterfowl species. These observations demonstrate that nest boxes can provide nesting opportunities for a range of species, including those not initially targeted by the design. Additionally, three of the five nest boxes with active nests also showed signs of use in previous years (Hemmera 2020, Ausenco 2022). For example, the F-29 box had active Bufflehead nests in 2020, 2022, and again in 2024 (Hemmera 2020, Ausenco 2022). This evidence suggests that once birds establish the use of a nest box, they tend to reuse it in subsequent years.

As per the Cavity Nesting Species Mitigation and Monitoring Program (BC Hydro 2023), maintenance (e.g., adding nesting materials) and repair (e.g., replacing damaged or missing boxes) is recommended to take place in subsequent cavity nesting surveys.

6.0 REFERENCES

Ausenco Sustainability Inc. [Ausenco]. 2022. Cavity Nesting Mitigation and Monitoring Program – 2022 Annual Report: Memorandum Prepared for BC Hydro, Burnaby, BC.

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APPENDIX A

NEST BOX MONITORING AND MAINTENANCE SCHEDULE – 2024

Appendix A: Nest Box Monitoring and Maintenance Schedule

Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
1	A-001	10V	623323	6232377	A	2020	X		X		X		X
2	A-002	10V	570234	6212621	A	2017		X		X		X	
3	A-003	10V	619231	6231391	A	2020	X		X		X		X
4	A-004	10V	623322	6232394	A	2019	X		X		X		X
5	A-005	10V	619506	6231332	A	2020	X		X		X		X
6	A-006	10V	574294	6217447	A	2019	X		X		X		X
7	A-007	10V	623161	6232509	A	2019	X		X		X		X
8	A-008	10V	619431	6231680	A	2019	X		X		X		X
9	A-009	10V	619178	6231410	A	2020	X		X		X		X
10	A-010	10V	565528	6206830	A	2017		X		X		X	
11	A-011	10V	565569	6206890	A	2017		X		X		X	
12	A-012	10V	619266	6231374	A	2020	X		X		X		X
13	A-013	10V	574206	6217412	A	2019	X		X		X		X
14	A-014	10V	565575	6206895	A	2017		X		X		X	
15	A-015	10V	623330	6232414	A	2019	X		X		X		X
16	A-016	10V	623281	6232381	A	2019	X		X		X		X
17	A-017	10V	569754	6212234	A	2017		X		X		X	
18	A-018	10V	619114	6231432	A	2020	X		X		X		X
19	A-019	10V	619569	6231730	A	2019	X		X		X		X
20	A-020	10V	571157	6213365	A	2017		X		X		X	

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
21	A-021	10V	570084	6212502	A	2017		X		X		X	
22	A-022	10V	623435	6232430	A	2019	X		X		X		X
23	A-023	10V	623527	6232660	A	2019	X		X		X		X
24	A-024	10V	623470	6232451	A	2019	X		X		X		X
25	A-025	10V	565469	6206757	A	2017		X		X		X	
26	A-026	10V	565515	6207097	A	2019	X		X		X		X
27	A2-27	10V	619291	6231502	A2	2019	X		X		X		X
28	A2-28	10V	623605	6232595	A2	2019	X		X		X		X
29	A2-29	10V	625768	6232789	A2	2019	X		X		X		X
30	A2-30	10V	565570	6207141	A2	2019	X		X		X		X
31	A2-31	10V	619650	6231308	A2	2020	X		X		X		X
32	A2-32	10V	619312	6231492	A2	2019	X		X		X		X
33	A2-33	10V	625765	6232789	A2	2019	X		X		X		X
34	A2-34	10V	565506	6207135	A2	2019	X		X		X		X
35	A2-35	10V	565546	6206865	A2	2017		X		X		X	
36	A2-36	10V	579592	6220129	A2	2017		X		X		X	
37	A2-37	10V	579745	6219895	A2	2017		X		X		X	
38	A2-38	10V	565538	6207163	A2	2019	X		X		X		X
39	A2-39	10V	574144	6217418	A2	2019	X		X		X		X
40	A2-40	10V	623539	6232680	A2	2019	X		X		X		X

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
41	A2-41	10V	625549	6232818	A2	2020	X		X		X		X
42	A2-42	10V	574185	6217434	A2	2019	X		X		X		X
43	A2-44	10V	579631	6220167	A2	2017		X		X		X	
44	A2-45	10V	579660	6219905	A2	2017		X		X		X	
45	A2-46	10V	619385	6231529	A2	2019	X		X		X		X
46	A2-47	10V	623269	6232386	A2	2019	X		X		X		X
47	A2-48	10V	619482	6231331	A2	2020	X		X		X		X
48	A2-49	10V	625447	6232837	A2	2020	X		X		X		X
49	A2-50	10V	625358	6232849	A2	2020	X		X		X		X
50	A2-51	10V	579658	6220177	A2	2017		X		X		X	
51	A2-52	10V	625659	6232779	A2	2020	X		X		X		X
52	A2-53	10V	623448	6232427	A2	2019	X		X		X		X
53	A2-55	10V	579581	6220107	A2	2017		X		X		X	
54	A2-56	10V	574090	6217459	A2	2019	X		X		X		X
55	A2-57	10V	623597	6232585	A2	2019	X		X		X		X
56	A2-58	10V	597579	6232505	A2	2017		X		X		X	
57	A2-59	10V	565487	6206788	A2	2017		X		X		X	
58	A2-60	10V	623522	6232650	A2	2019	X		X		X		X
59	A2-61	10V	625607	6232800	A2	2020	X		X		X		X
60	A2-62	10V	597524	6232876	A2	2017		X		X		X	
61	A2-63	10V	623388	6232408	A2	2019	X		X		X		X

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
62	A2-64	10V	565548	6207162	A2	2019	X		X		X		X
63	A2-65	10V	623514	6232630	A2	2019	X		X		X		X
64	A2-66	10V	579496	6220039	A2	2017		X		X		X	
65	A2-67	10V	565527	6207151	A2	2019	X		X		X		X
66	A2-68	10V	565505	6207138	A2	2019	X		X		X		X
67	A2-69	10V	574102	6217410	A2	2019	X		X		X		X
68	A2-70	10V	619618	6231316	A2	2020	X		X		X		X
69	A2-71	10V	619477	6231480	A2	2019	X		X		X		X
70	A2-72	10V	579483	6219999	A2	2017		X		X		X	
71	A2-73	10V	623147	6232510	A2	2019	X		X		X		X
72	A2-74	10V	565443	6206742	A2	2017		X		X		X	
73	A2-75	10V	565491	6206785	A2	2017		X		X		X	
74	A2-76	10V	579624	6220137	A2	2017		X		X		X	
75	A2-79	10V	579497	6219970	A2	2017		X		X		X	
76	A2-80	10V	625773	6232779	A2	2019	X		X		X		X
77	A2-81	10V	619543	6231327	A2	2020	X		X		X		X
78	B1-00	10V	619369	6231370	B1	2020	X		X		X		X
79	B1-01	10V	569274	6211892	B1	2017		X		X		X	
80	B1-02	10V	569781	6212237	B1	2017		X		X		X	
81	B1-03	10V	565550	6206849	B1	2017		X		X		X	

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
82	B1-04	10V	565581	6207119	B1	2019	X		X		X		X
83	B1-05	10V	574090	6217383	B1	2019	X		X		X		X
84	B1-06	10V	565580	6206819	B1	2017		X		X		X	
85	B1-06b	10V	625793	6232770	B1	2019	X		X		X		X
86	B2-01	10V	574185	6217377	B2	2019	X		X		X		X
87	B2-02	10V	565519	6207086	B2	2019	X		X		X		X
88	B2-03	10V	570535	6212871	B2	2017		X		X		X	
89	B2-04	10V	565470	6207119	B2	2019	X		X		X		X
90	B2-05	10V	574164	6217436	B2	2019	X		X		X		X
91	B2-06	10V	570844	6213171	B2	2017		X		X		X	
92	B3-01	10V	565530	6207127	B3	2019	X		X		X		X
93	B3-02	10V	569080	6211332	B3	2017		X		X		X	
94	B3-03	10V	571471	6213900	B3	2017		X		X		X	
95	B3-04	10V	619370	6231534	B3	2019	X		X		X		X
96	B3-05	10V	572243	6214487	B3	2017		X		X		X	
97	B3-06	10V	578095	6220418	B3	2017		X		X		X	
98	B3-07	10V	570332	6212747	B3	2017		X		X		X	
99	B3-08	10V	565563	6207144	B3	2019	X		X		X		X
100	B3-09	10V	619459	6231352	B3	2020	X		X		X		X
101	B3-10	10V	600284	6234290	B3	2017		X		X		X	

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
102	B3-11	10V	579657	6220249	B3	2017		X		X		X	
103	B3-12	10V	570315	6212316	B3	2017		X		X		X	
104	B3-13	10V	570969	6213247	B3	2017		X		X		X	
105	B3-14	10V	569422	6211988	B3	2017		X		X		X	
106	B3-15	10V	574203	6217365	B3	2019	X		X		X		X
107	B3-16	10V	623408	6232428	B3	2022				X		X	
108	B3-17	10V	580587	6220020	B3	2017		X		X		X	
109	B3-18	10V	574168	6217545	B3	2019	X		X		X		X
110	B3-19	10V	582007	6220773	B3	2020	X		X		X		X
111	B3-20	10V	569761	6212104	B3	2017		X		X		X	
112	B3-63b	10V	623370	6232420	B3	2022				X		X	
113	B3-64c	10V	623430	6232420	B3	2022				X		X	
114	BC-01	10V	569341	6211898	BC	2017		X		X		X	
115	BC-01S	10V	619557	6231328	BC	2020	X		X		X		X
116	BC-02	10V	569687	6212193	BC	2017		X		X		X	
117	BC-02b	10V	619709	6231322	BC	2020	X		X		X		X
118	BC-03	10V	570427	212611	BC	2017		X		X		X	
119	BC-03b	10V	619301	6231364	BC	2020	X		X		X		X
120	BC-04	10V	623098	6232505	BC	2019	X		X		X		X

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
121	BC-04b	10V	619031	6231449	BC	2020	X		X		X		X
122	BC-05	10V	570706	6212984	BC	2017		X		X		X	
123	BC-NN	10V	623307	6232385	BC	2020	X		X		X		X
124	C-01	10V	578035	6220263	C	2017		X		X		X	
125	C-02	10V	565541	6206791	C	2017		X		X		X	
126	C-03	10V	570128	6212577	C	2017		X		X		X	
127	C-04	10V	625680	6232780	C	2020	X		X		X		X
128	C-05	10V	564320	6207287	C	2020	X		X		X		X
129	C-06	10V	564549	6207560	C	2020	X		X		X		X
130	C-07	10V	619344	6231550	C	2019	X		X		X		X
131	C-08	10V	571101	6213389	C	2017		X		X		X	
132	C-09	10V	564485	6207516	C	2020	X		X		X		X
133	C-10	10V	625586	6232815	C	2020	X		X		X		X
134	C-11	10V	564245	6207185	C	2020	X		X		X		X
135	C-12	10V	569858	6212146	C	2017		X		X		X	
136	C-13	10V	570026	6212244	C	2017		X		X		X	
137	C-14	10V	625486	6232808	C	2020	X		X		X		X
138	C-15	10V	575784	6219840	C	2017		X		X		X	
139	C-16	10V	564364	6207390	C	2020	X		X		X		X
140	C-17	10V	625629	6232806	C	2020	X		X		X		X

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							2021	2022	2023	2024	2025	2026	2027
141	C-18	10V	565552	6206844	C	2017		X		X		X	
142	C-19	10V	625383	6232811	C	2020	X		X		X		X
143	C-20	10V	564289	6207240	C	2020	X		X		X		X
144	C-21	10V	619341	6231532	C	2019	X		X		X		X
145	C-22	10V	569295	6211831	C	2017		X		X		X	
146	C-23	10V	564221	6207146	C	2020	X		X		X		X
147	C-X1	10V	564345	6207356	C	2020	X		X		X		X
148	C-X2	10V	564417	6207428	C	2020	X		X		X		X
149	C-X3	10V	564446	6207480	C	2020	X		X		X		X
150	D-01	10V	594855	6231017	D	2020	X		X		X		X
151	D-02	10V	594689	6231033	D	2020	X		X		X		X
152	D-03	10V	594751	6231018	D	2020	X		X		X		X
153	E1-01	10V	595017	6230676	E1	2020	X		X		X		X
154	E1-02	10V	565600	6206907	E1	2017		X		X		X	
155	E1-03	10V	594709	6230523	E1	2020	X		X		X		X
156	E1-04	10V	595107	6230731	E1	2020	X		X		X		X
157	E1-05	10V	577716	6220121	E1	2017		X		X		X	
158	E1-05a	10V	619505	6231524	E1	2022				X		X	
159	E1-06	10V	625792	6232760	E1	2020	X		X		X		X
160	E1-06b	10V	625826	6232742	E1	2022				X		X	

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							2021	2022	2023	2024	2025	2026	2027
161	E1-06c	10V	625837	6232754	E1	2022				X		X	
162	E1-07	10V	612689	6237111	E1	2020	X		X		X		X
163	E1-09	10V	612899	6236931	E1	2020	X		X		X		X
164	E2-01	10V	569379	6211706	E2	2017		X		X		X	
165	E2-02	10V	565488	6206750	E2	2017		X		X		X	
166	E2-03	10V	600556	6234330	E2	2017		X		X		X	
167	E2-04	10V	586885	6224479	E2	2020	X		X		X		X
168	E2-05	10V	601164	6234449	E2	2020	X		X		X		X
169	E2-06	10V	570728	6213068	E2	2017		X		X		X	
170	E2-07	10V	592782	6228778	E2	2020	X		X		X		X
171	E2-08	10V	600750	6234337	E2	2020	X		X		X		X
172	E2-09	10V	623382	6232446	E2	2022				X		X	
173	E2-10	10V	570469	6212542	E2	2017		X		X		X	
174	E2-11	10V	625774	6232717	E2	2019	X		X		X		X
175	E2-12	10V	587029	6224639	E2	2020	X		X		X		X
176	E2-13	10V	569139	6211291	E2	2017		X		X		X	
177	E2-14	10V	592434	6228414	E2	2020	X		X		X		X
178	E2-15	10V	601582	6234541	E2	2020	X		X		X		X
179	E2-16	10V	592664	6228621	E2	2020	X		X		X		X
180	E2-17	10V	569654	6212239	E2	2017		X		X		X	

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
181	E2-18	10V	565549	6207109	E2	2019	X		X		X		X
182	E2-19	10V	586958	6224535	E2	2020	X		X		X		X
183	E2-20	10V	600014	6234231	E2	2017		X		X		X	
184	E2-21	10V	571506	6213981	E2	2017		X		X		X	
185	E2-22	10V	594956	6230681	E2	2020	X		X		X		X
186	E2-23	10V	601429	6234482	E2	2020	X		X		X		X
187	E2-25	10V	600951	6234393	E2	2020	X		X		X		X
188	E2-26	10V	625759	6232732	E2	2019	X		X		X		X
189	E2-27	10V	572335	6214565	E2	2017		X		X		X	
190	E2-27b	10V	594667	6231045	E2	2020	X		X		X		X
191	E2-28	10V	580029	6220328	E2	2017		X		X		X	
192	E3-01	10V	580218	6220305	E3	2017		X		X		X	
193	E3-01b	10V	592026	6228135	E3	2020	X		X		X		X
194	E3-02	10V	579810	6220274	E3	2017		X		X		X	
195	E3-03	10V	580634	6220329	E3	2017		X		X		X	
196	E3-04	10V	580883	6220189	E3	2017		X		X		X	
197	E3-05	10V	580476	6219988	E3	2017		X		X		X	
198	E3-07	10V	575965	6219796	E3	2017		X		X		X	
199	E3-08	10V	608821	6237942	E3	2020	X		X		X		X
200	E3-09	10V	576497	6220114	E3	2017		X		X		X	

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Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
201	E3-11	10V	599035	6233383	E3	2017		X		X		X	
202	E3-12	10V	596709	6232926	E3	2017		X		X		X	
203	E3-13	10V	597016	6232916	E3	2017		X		X		X	
204	E3-14	10V	598209	6232835	E3	2017		X		X		X	
205	E3-15	10V	595929	6232435	E3	2017		X		X		X	
206	E3-16	10V	596553	6232707	E3	2017		X		X		X	
207	E3-20	10V	574147	6217530	E3	2019	X		X		X		X
208	F-01	10V	612395	6237257	F	2020	X		X		X		X
209	F-02	10V	623602	6232609	F	2019	X		X		X		X
210	F-03	10V	576941	6219891	F	2017		X		X		X	
211	F-04	10V	565494	6207126	F	2019	X		X		X		X
212	F-05	10V	571449	6213686	F	2019	X		X		X		X
213	F-06	10V	623340	6232412	F	2019	X		X		X		X
214	F-07	10V	577627	6220115	F	2017		X		X		X	
215	F-08	10V	577750	6220123	F	2017		X		X		X	
216	F-09	10V	619482	6231520	F	2019	X		X		X		X
217	F-10	10V	625790	6232707	F	2019	X		X		X		X
218	F-11	10V	565463	6206770	F	2017		X		X		X	
219	F-12	10V	619460	6231510	F	2019	X		X		X		X
220	F-13	10V	595052	6230712	F	2020	X		X		X		X

Appendix A: Nest Box Monitoring and Maintenance Schedule

Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
221	F-14	10V	565470	6207116	F	2019	X		X		X		X
222	F-15	10V	619322	6231503	F	2019	X		X		X		X
223	F-16	10V	623635	6232606	F	2019	X		X		X		X
224	F-17	10V	565440	6206733	F	2017		X		X		X	
225	F-18	10V	565606	6206921	F	2017		X		X		X	
226	F-19	10V	623405	6232421	F	2019	X		X		X		X
227	F-20	10V	619525	6231489	F	2022				X		X	
228	F-21	10V	612926	6236882	F	2020	X		X		X		X
229	F-22	10V	574210	6217425	F	2019	X		X		X		X
230	F-23	10V	623616	6232730	F	2019	X		X		X		X
231	F-24	10V	623276	6232393	F	2019	X		X		X		X
232	F-25	10V	625763	6232751	F	2019	X		X		X		X
233	F-26	10V	612312	6237311	F	2020	X		X		X		X
234	F-27	10V	594928	6231018	F	2020	X		X		X		X
235	F-28	10V	574270	6217458	F	2019	X		X		X		X
236	F-29	10V	565528	6206854	F	2017		X		X		X	
237	F-30	10V	574256	6217427	F	2019	X		X		X		X
238	F-31	10V	572371	6214507	F	2017		X		X		X	
239	F-32	10V	577923	6220125	F	2017		X		X		X	
240	F-33	10V	594835	6230571	F	2020	X		X		X		X

Appendix A: Nest Box Monitoring and Maintenance Schedule

Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
241	F-34	10V	595319	6230835	F	2020	X		X		X		X
242	F-35	10V	594819	6231008	F	2020	X		X		X		X
243	F-36	10V	611638	6237630	F	2020	X		X		X		X
244	F-37	10V	623585	6232570	F	2019	X		X		X		X
245	F-38	10V	612211	6237352	F	2020	X		X		X		X
246	F-39	10V	625793	6232681	F	2019	X		X		X		X
247	F-40	10V	623597	6232571	F	2019	X		X		X		X
248	F-41	10V	612355	6237299	F	2020	X		X		X		X
249	F-42	10V	572313	6214546	F	2017		X		X		X	
250	F-43	10V	594972	6230618	F	2020	X		X		X		X
251	F-44	10V	619562	6231425	F	2022				X		X	
252	F-45	10V	594715	6230476	F	2020	X		X		X		X
253	F-46	10V	611688	6237572	F	2020	X		X		X		X
254	F-47	10V	623636	6232587	F	2019	X		X		X		X
255	F-48	10V	612051	6237427	F	2020	X		X		X		X
256	F-49	10V	611785	6237550	F	2020	X		X		X		X
257	G-01	10V	594788	6230535	G	2020	X		X		X		X
258	G-02	10V	612454	6237226	G	2020	X		X		X		X
259	G-03	10V	619508	6231480	G	2019	X		X		X		X
260	G-04	10V	611586	6237623	G	2020	X		X		X		X

Appendix A: Nest Box Monitoring and Maintenance Schedule

Nest Box Number	Nest Box ID	UTM Zone	UTM Easting	UTM Northing	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (to be extended 10 years post-construction)						
							2021	2022	2023	2024	2025	2026	2027
261	G-05	10V	623337	6232402	G	2019	X		X		X		X
262	G-06	10V	594787	6231013	G	2020	X		X		X		X
263	G-07	10V	577860	6220126	G	2017		X		X		X	
264	G-08	10V	619530	6231526	G	2022				X		X	
265	G-09	10V	611874	6237556	G	2020	X		X		X		X
266	G-10	10V	612792	6237018	G	2020	X		X		X		X
267	G-11	10V	619387	6231660	G	2019	X		X		X		X
268	G-12	10V	611655	6237589	G	2020	X		X		X		X
269	G-13	10V	565554	6206868	G	2017		X		X		X	
270	G-14	10V	611747	6237578	G	2020	X		X		X		X
271	G-15	10V	565496	6206811	G	2017		X		X		X	
272	OWL-1	10V	619439	6231550	OWL	2019	X		X		X		X
273	OWL-2	10V	602631	6234449	OWL	2020	X		X		X		X
274	OWL-3	10V	599505	6233988	OWL	2020	X		X		X		X

APPENDIX B

2024 NEST BOX MONITORING RESULTS

Appendix B: 2024 Nest Box Monitoring Results

Nest Box ID	2024 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
A-002	6/3/2024	A	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Nest box contains a rodent nest and is filled to the top with grasses.
A-008	6/4/2024	A	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A-010	6/2/2024	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-011	6/2/2024	A	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Cleaned out non-active wasp nests.
A-014	6/2/2024	A	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Large wasp nest - inactive. Cleaned out wasp nest.
A-017	6/2/2024	A	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance. No nesting material or other signs of use.
A-019	6/4/2024	A	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A-020	6/5/2024	A	NA	NA	NA	Operational	Clean/add wood shavings	Re-activated nest box.
A-021	6/3/2024	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-023	6/3/2024	A	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A-025	6/2/2024	A	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Large wasp nest - inactive. Cleaned out wasp nest.
A2-35	6/2/2024	A2	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Cleaned out non-active wasp nests.
A2-36	6/6/2024	A2	Visual	No	NA	Operational	Clean/add wood shavings	No nesting material or signs of use.
A2-37	6/6/2024	A2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Nest box was filled with sticks leaves and bark.
A2-40	6/4/2024	A2	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A2-45	6/6/2024	A2	Visual	Yes	Unknown bird or mammal	Operational	None	Sticks and dark black feathers observed within nest box
A2-51	6/6/2024	A2	NA	NA	NA	Destroyed	NA	Destroyed
A2-55	6/6/2024	A2	Visual	Yes	Unknown bird or mammal	Operational	Clean/add wood shavings	No additional nesting material observed within nest box. Light coloured down feathers present.
A2-58	6/3/2024	A2	NA	NA	NA	Destroyed	NA	Confirmed destroyed
A2-59	6/2/2024	A2	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Large wasp nest - inactive. Cleaned out wasp nest.
A2-60	6/2/2024	A2	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A2-62	6/3/2024	A2	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Nest box has been moved to different location. Rodent chewing around exit hole. Grass rodent nest observed.
A2-65	6/4/2024	A2	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A2-71	6/4/2024	A2	Visual	Yes	Rodent	Operational	Clean/add wood shavings	Grass rodent nest observed. Rodent chew marks at entrance.
A2-73	6/4/2024	A2	NA	NA	NA	Gone/Missing	NA	Could not find nest box. There were no nest box or trees of sufficient size to support a nest box. Suspected nest box is destroyed or removed.
A2-74	6/2/2024	A2	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance. Signs of squirrel use at tree base. No signs of nesting within nest box
A2-75	6/2/2024	A2	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Cleaned out non-active wasp nests.

Appendix B: 2024 Nest Box Monitoring Results

Nest Box ID	2024 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
A2-76	6/6/2024	A2	Visual	Yes	Unknown bird or mammal	Operational	None	Grass, leaves, feathers, and fur observed within nest box
A2-79	6/6/2024	A2	Visual	Yes	Rodent	Operational	Clean/add wood shavings	Grass rodent nest observed within box. Rodent chew marks at entrance.
B1-01	6/2/2024	B1	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Grass rodent nest observed within box. Rodent chew marks at entrance.
B1-02	6/2/2024	B1	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Nesting materials including feathers, bark strips, lichen observed. Rodent chew marks on entrance
B1-03	6/2/2024	B1	Pole Camera Examination	No	NA	Operational	None	Old wasp nest and dead wasps inside. Needs cleaning. bear claw marks at tree base. Long ladder needed to access and maintain box
B1-06	6/2/2024	B1	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks on the outside back panel of nest box. Inactive wasp nests present. Longer ladder needed to properly access and maintain.
B2-03	6/3/2024	B2	Pole Camera Examination	Yes	Rodent	Operational	None	Rodent chew marks at entrance. Grass rodent nest observed within box.
B2-06	6/3/2024	B2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Rodent chew marks at entrance hole. Grass and lichen nesting materials present.
B3-02	6/2/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-03	6/3/2024	B3	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Grasses, moss and fur present in copious amounts. Evidence of rodent chewing around exit hole.
B3-05	6/5/2024	B3	NA	NA	NA	Destroyed	NA	Destroyed
B3-06	6/3/2024	B3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Filled to entrance hole with sticks
B3-07	6/3/2024	B3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Leaves and grasses present
B3-10	6/4/2024	B3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Filled with grasses and twigs to entrance hole, fur present
B3-11	6/6/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
B3-12	6/3/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
B3-13	6/3/2024	B3	Pole Camera Examination	Yes	Rodent	Operational	None	Nest box has lichen, leaves and grasses. Rodent chew marks on entrance hole
B3-14	6/2/2024	B3	Pole Camera Examination	No	NA	Operational	None	Little holes around the entrance. No nesting material or signs of nesting in box
B3-16	6/4/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
B3-17	6/6/2024	B3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Grasses and bark present within box
B3-20	6/2/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
B3-63b	6/4/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
B3-64c	6/4/2024	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
BC-01	6/2/2024	BC	Pole Camera Examination	No	NA	Operational	None	No nesting material in box
BC-02	6/2/2024	BC	Pole Camera Examination	No	NA	Operational	None	No nesting material in box
BC-03	6/3/2024	BC	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
BC-05	6/3/2024	BC	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
C-01	6/5/2024	C	NA	NA	NA	Operational	Clean/add wood shavings	Reactivated nest box

Appendix B: 2024 Nest Box Monitoring Results

Nest Box ID	2024 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
C-02	6/2/2024	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-03	6/3/2024	C	Pole Camera Examination	Yes	Rodent	Operational	None	Grass rodent nest observed within box. Rodent chew marks at entrance.
C-07	6/4/2024	C	NA	NA	NA	Destroyed	NA	Nest box fallen off of tree. Return to re install.
C-08	6/5/2024	C	NA	NA	NA	Operational	Clean/add wood shavings	Reactivated nest box
C-12	6/2/2024	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
C-13	6/3/2024	C	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Fur or fine feathers observed scattered throughout wood shavings
C-18	6/2/2024	C	Pole Camera Examination	No	NA	Operational	None	Filled with large twigs and an old wasp nest. Longer ladder needed to properly access
C-22	6/2/2024	C	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Nesting material comprising of grasses and bark
E1-05	6/5/2024	E1	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
E1-05a	6/4/2024	E1	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Feathers and unknown dark black objects inside nest box.
E1-06	6/6/2024	E1	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
E1-06b	6/4/2024	E1	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Small number of sticks scattered in nest box along with down feathers
E1-06c	6/4/2024	E1	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
E2-01	6/2/2024	E2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Nesting material comprising of grasses.
E2-02	6/2/2024	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
E2-03	6/4/2024	E2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Grasses and bark observed in nest box
E2-06	6/3/2024	E2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	Clean/add wood shavings	Grasses and some down feathers observed in nest box.
E2-09	6/4/2024	E2	NA	NA	NA	Destroyed	NA	Nest box missing base. Marked as destroyed
E2-10	6/3/2024	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
E2-13	6/2/2024	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
E2-17	6/2/2024	E2	Pole Camera Examination	No	NA	Operational	None	Unidentified object in nest box - dark grey. Nest box on dead tree. No other signs of nesting
E2-20	6/4/2024	E2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Lichen, moss, bark, and down feathers observed in the nest box.
E2-21	6/3/2024	E2	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Feathers and grasses observed in the nest box.
E2-28	6/6/2024	E2	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Grass rodent nest observed within box. Rodent chew marks at entrance.
E3-01	6/6/2024	E3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
E3-02	6/6/2024	E3	Pole Camera Examination	Yes	Rodent	Operational	Clean/add wood shavings	Grass rodent nest observed within box. Rodent chew marks at entrance.
E3-03	6/6/2024	E3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Grass and down feathers observed in nest box.

Appendix B: 2024 Nest Box Monitoring Results

Nest Box ID	2024 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
E3-04	6/6/2024	E3	Pole Camera Examination	Yes	AMKE	Operational	None	In use by an American Kestrel incubating 4 eggs. Adult flew out of nest box upon approach.
E3-05	6/6/2024	E3	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Leaves, grasses, and bark observed in nest box.
E3-11	6/3/2024	E3	Visual	Yes	AMKE	Operational	None	In use by an American Kestrel incubating 5 eggs. Adult flew out of nest box upon approach.
E3-13	6/6/2024	E3	Visual	Yes	AMKE	Operational	None	In use by an American Kestrel. Adult visible within nest box. Maintained distance from nest box to avoid disturbing the individual.
E3-14	6/3/2024	E3	Visual	Yes	Rodent	Operational	None	Occupied by a Red Squirrel
E3-15	6/6/2024	E3	Visual	Yes	AMKE	Operational	None	In use by an American Kestrel. Adult visible within nest box. Maintained distance from nest box to avoid disturbing the individual.
E3-16	6/6/2024	E3	NA	NA	NA	Destroyed	NA	Destroyed. Major repairs required.
F-07	6/5/2024	F	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
F-08	6/5/2024	F	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
F-09	6/4/2024	F	Pole Camera Examination	Yes	NOFL	Operational	None	Black feather and yellow feather observed. Grasses scattered throughout bottom of nest box
F-11	6/2/2024	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
F-12	6/4/2024	F	Pole Camera Examination	Yes	Rodent	Operational	None	Rodent chew marks at entrance. Feathers present inside nest box. Need a large ladder to properly access.
F-17	6/2/2024	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
F-18	6/2/2024	F	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Removed wasp nest.
F-20	6/4/2024	F	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Feathers present in nest box
F-29	6/2/2024	F	Pole Camera Examination	Yes	BUFF	Operational	None	In use by a Bufflehead, presumably incubating eggs. After observing adult in box, maintained distance from box to avoid unnecessary disturbance.
F-31	6/5/2024	F	NA	NA	NA	Deactivated	None	Larger ladder needed to reactivate
F-32	6/5/2024	F	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
F-44	6/4/2024	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box
G-03	6/4/2024	G	Pole Camera Examination	Yes	Unknown bird or mammal	Operational	None	Lichen, moss, sticks, leaves, and bark present in nest box.
G-07	6/5/2024	G	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
G-08	6/4/2024	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box. Nest box tree also used as a bear rub.
G-11	6/4/2024	G	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.
G-15	6/2/2024	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of nesting in box.
OWL-1	6/4/2024	OWL	NA	NA	NA	Gone/Missing	NA	Could not find nest box. Suspected nest box is destroyed or removed.

APPENDIX C

PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio., P.Biol. Tetra Tech Canada Inc.	Project Manager, Report Author
Eric Digel, B.Sc., B.I.T. Tetra Tech Canada Inc.	Field Data Collection, Data Entry, Report Author
Sarah Boisvert, Dipl.T., B.Sc. Tetra Tech Canada Inc.	Field Data Collection

APPENDIX D

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

1.1 USE OF DOCUMENT AND OWNERSHIP

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The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

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TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

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Appendix 14. 2024 Bald Eagle Nest Surveys Annual Report

March 11, 2025

Attention:

Brent Matsuda
Senior Environmental Coordinator, BC Hydro
Site C Clean Energy Project

Re: Bald Eagle Nest Monitoring 2024 Annual Report

1.0 INTRODUCTION

This memo summarizes the findings of bald eagle (*Haliaeetus leucocephalus*) nest surveys conducted by West Moberly-DWB Limited Partnership (WM-DWB) in May and June 2024. The purpose of the surveys was to document the status of known and newly constructed bald eagle nests along the Peace River between the Peace Canyon Dam and the British Columbia – Alberta border, at wetlands near the Site C transmission line, and at artificial bald eagle mitigation nesting structures. The 2024 work is a continuation of the surveys completed in 2016 through 2023 (Hemmera 2016, 2018a, 2018b, 2019, 2021, 2022; Ausenco 2022, 2023) and during baseline studies for the Site C Clean Energy Project (Keystone 2009). Formatting and text from previous reporting (Ausenco 2023) has largely been retained at the request of BC Hydro for consistency; however, data has been updated to summarize the results of the 2024 monitoring season.

Bald eagle nest surveys were conducted with two objectives:

1. Determine the status (active/not active) and productivity (number of fledged chicks) of known and new bald eagle nests in the study area, and
2. Provide the data to BC Hydro to inform Site C construction mitigation.

Data collected during these surveys provide information on the spatial distribution, timing, and productivity of bald eagle nests in the study area.

1.1 BACKGROUND

Construction of the Site C reservoir has resulted in removal of bald eagle nest trees. The former BC Ministry of Forests Lands and Natural Resource Operations, now the Ministry of Water, Land, and Resource Stewardship, issued Eagle Nest Permit FJ14-154018 on July 6, 2015 under the BC Wildlife Act allowing BC Hydro to remove bald eagle nests in the Peace Region in Management Units 7-31 through 7-35 (BC Hydro 2021). Permit FJ23-790247 was in effect for bald eagle nest removal during the 2024 survey period. To mitigate the permitted nest removal, installation of at least 38 artificial nesting platforms was required as part of Environmental Assessment Certificate (EAC) Condition 21. Artificial nest platform installations have occurred since 2019, with a total of 43 nest structures (mostly basket-style installations and some flat, wooden, platforms) completed in 2023. The nest platforms were placed 200 to 600 m from the Site C reservoir shoreline which were intended to appeal to nesting bald eagles once the reservoir was filled (BC Hydro 2021) as they were considered to be too far from water to attract them prior to reservoir filling (Travsky and Beauvais 2004).

Annual bald eagle nest monitoring has been conducted in the Site C footprint since 2016 to document eagle usage of natural tree nests and artificial nest platforms as they are installed. In the first days and

weeks after hatching, bald eagle nestlings grow quickly and large size differences among siblings is common (Bortolotti 1986a). In nests hatching two chicks, there is generally a 95% survival rate (Bortolotti 1986b). In nests hatching a third chick, the smallest chick is typically out-competed for food by its larger siblings and starves (Gerrard and Bortolotti 1988, as cited in Buehler 2021).

The long duration of breeding precludes second clutches in natural bald eagle populations (Buehler 2021; Newton 2010). Exceptions may occur when eggs or nestlings are artificially removed as part of captive breeding programs (Morrison and Walton 1980; Wood and Collopy 1993), or eggs are lost early in the season (Steenhof and Newton 2007). No second clutches have been observed in the study area to date.

2.0 METHODS

Three rounds of bald eagle nest surveys were conducted by helicopter on May 17 and 31, and June 13, 2024, with a two-person crew consisting of a crew lead (Brian Paterson, R.P.Bio., Zonal Ecosystem and Wildlife Consultants Ltd.) and a WM-DWB wildlife technician, following methods outlined in the Resources Inventory Committee "Inventory Methods for Raptors" (RIC 2001). The crew lead has consistently surveyed this route since the 2017 survey year. The study area was included the Peace River Valley from the Peace Canyon Dam near Hudson's Hope to the British Columbia - Alberta Border, as well as natural wetlands adjacent to the Site C transmission line right-of-way.

Previously identified nest locations from past aerial surveys (Ausenco 2023) were visited. In addition to known nests, a search was simultaneously conducted for new nests. No new bald eagle nests were reported by crews working for BC Hydro in 2024. Nests that were known to be destroyed since the previous year's surveys (e.g., nest disintegrated, host tree failed naturally, or host tree was felled) were not visited in 2024, but searches were conducted in those areas for newly constructed nests. BC Hydro provided locations of new platform nest installations, which were also visited.

Observations recorded at each known or new bald eagle nest (or stick nests constructed by other species) included nest status ("active", "inactive", "unknown"), bird species observed, and the number of eggs, chicks, and nestlings. Older eagle nests that were used by other bird species were categorized as "active (other)" and were not included when calculating the proportion of active bald eagle nests.

Nest status was determined by the presence of attending adults or evidence of eggs or nestlings. Annual productivity was calculated as the sum of the estimated productivity from active nests divided by the number of active nests. The following assumptions were used to determine nest status and productivity:

- Active eagle nests were those with evidence of bald eagle adults attending the nest during any one of the field surveys.
- The number of chicks fledged (nest productivity) was determined as follows:
    - For nests that were active on the last survey: the number of chicks in a nest at the last observation, except nests with three chicks which were assumed to fledge two chicks (Gerrard and Bortolotti 1988, as cited in Buehler 2021);
    - For nests that were inactive on the last survey: the number of chicks last observed in a nest if the chicks had been assessed to be of fledging age.
- No eagles attempted second clutches.

As this is an interim annual report, only simple summary statistics (i.e., nests active, estimated fledged chicks per active nest) were calculated. Survey results were provided to BC Hydro in Excel (.csv) and spatial (.kml) format, including applicable comments and coordinates for each nest.

3.0 SURVEY RESULTS

Surveyors conducted three visits at nearly all of the tree and platform nests; however, three tree nests could only be surveyed on the third visit due to active forest fires during the beginning of the survey period near Cameron Lake. Moreover, 11 additional artificial platform nests were identified by BC Hydro after the first survey, which were included in the second and third surveys. Of the three tree nests within five nautical miles of the Cameron Lake fire, all three contained chicks (Table 1). None of the 11 added platforms were active.

Surveyors visited 34 tree nests, of which all were potentially usable (i.e., detected on surveys and still standing and available for use) and 43 artificial nesting platforms in 2024 (Appendix A). The first use of an artificial nesting platform along the Site C corridor by a bald eagle was recorded during 2024. Platform *Eagle_41.1B,* located on the south side of the Peace River across from Wilder Creek (between Site C and Cache Creek), was observed with an incubating adult on the first survey on May 17, 2024, and a chick was observed during the second (May 31, 2024) and third surveys (June 13, 2024). Of the 34 potential tree nests, 21 (62%) were used by bald eagles (i.e., eggs, incubating adult or chicks observed during at least one survey) and 10 were either inactive or used by species other than eagles (Table 1). Thirty-one chicks were observed and assumed fledged, with chick numbers ranging from one to two chicks per nest. The estimated fledging success in 2024 was 1.48 fledged chicks per active nest.

Table 1. Bald Eagle Nest Status and Productivity 2016 – 2024.

Nest Status	2016	2017	2018	2019	2020	2021	2022	2023	2024
Tree Nests									
Active eagle use	NEI	34	28	29	25	25	19	24	21
Inactive (incl. non-eagle use)	8	7	15	19	16	17	18	9	13
Percent Active	-	**83**	**65**	**60**	**61**	**60**	**51**	**73**	**62**
Not Detected/Tree Gone	-	18	4	6	11	15	0	5	0
Unknown	52	-	1	0	0	0	0	0	0
Total Nests Surveyed	**60**	**59**	**48**	**54**	**52**	**57**	**37**	**38**	**34**
Estimated productivity (total chicks)	**NEI**	**39**	**34**	**42**	**46**	**32**	**22**	**28**	**31**
Estimated young fledged per active nest (fledging success rate)	**NEI**	**1.15**	**1.21**	**1.45**	**1.84**	**1.28**	**1.16**	**1.17**	**1.48**

Nest Status	2016	2017	2018	2019	2020	2021	2022	2023	2024
Artificial Nesting Structures									
Active	-	-	-	0	0	0	0	0	1
Inactive	-	-	-	3	3	29	29	30	42
Total Structures Surveyed	-	-	-	**3**	**3**	**29**	**29**	**30**	43
Estimated productivity (total chicks)	-	-	-	**0**	**0**	**0**	**0**	**0**	1
Estimated young fledged per active nest (fledging success rate)	-	-	-	**0**	**0**	**0**	**0**	**0**	1

Note: NEI = not enough information
"-" indicates no data

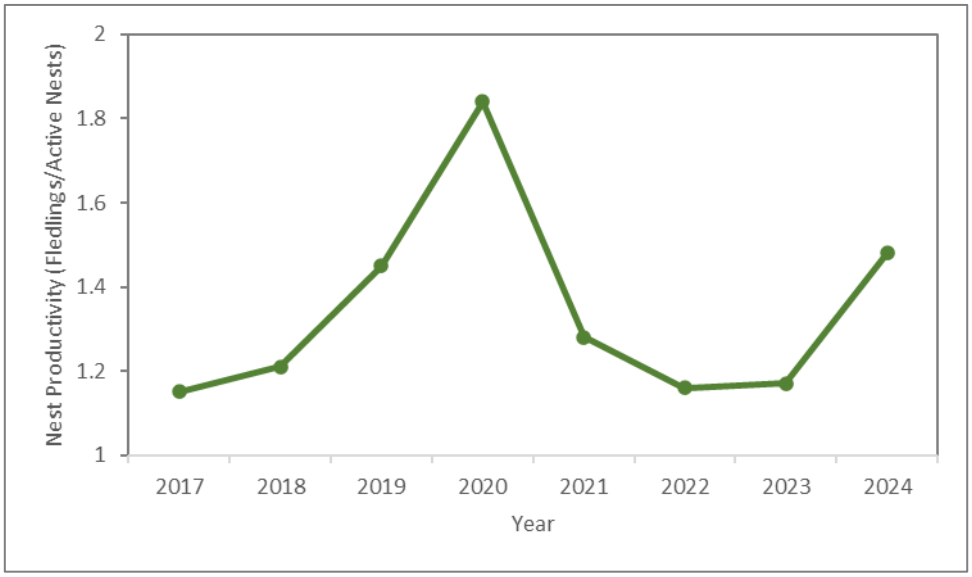

Figure 1. Annual bald eagle nest fledging success rate from 2017 to 2024.

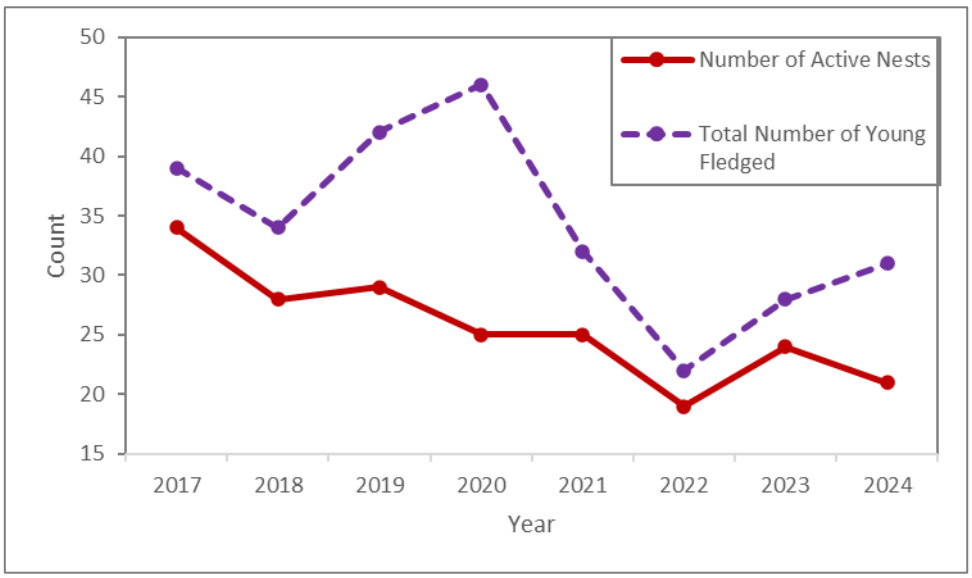

Figure 2. Number of active bald eagle nests and total number of young fledged per year from 2017 to 2024.

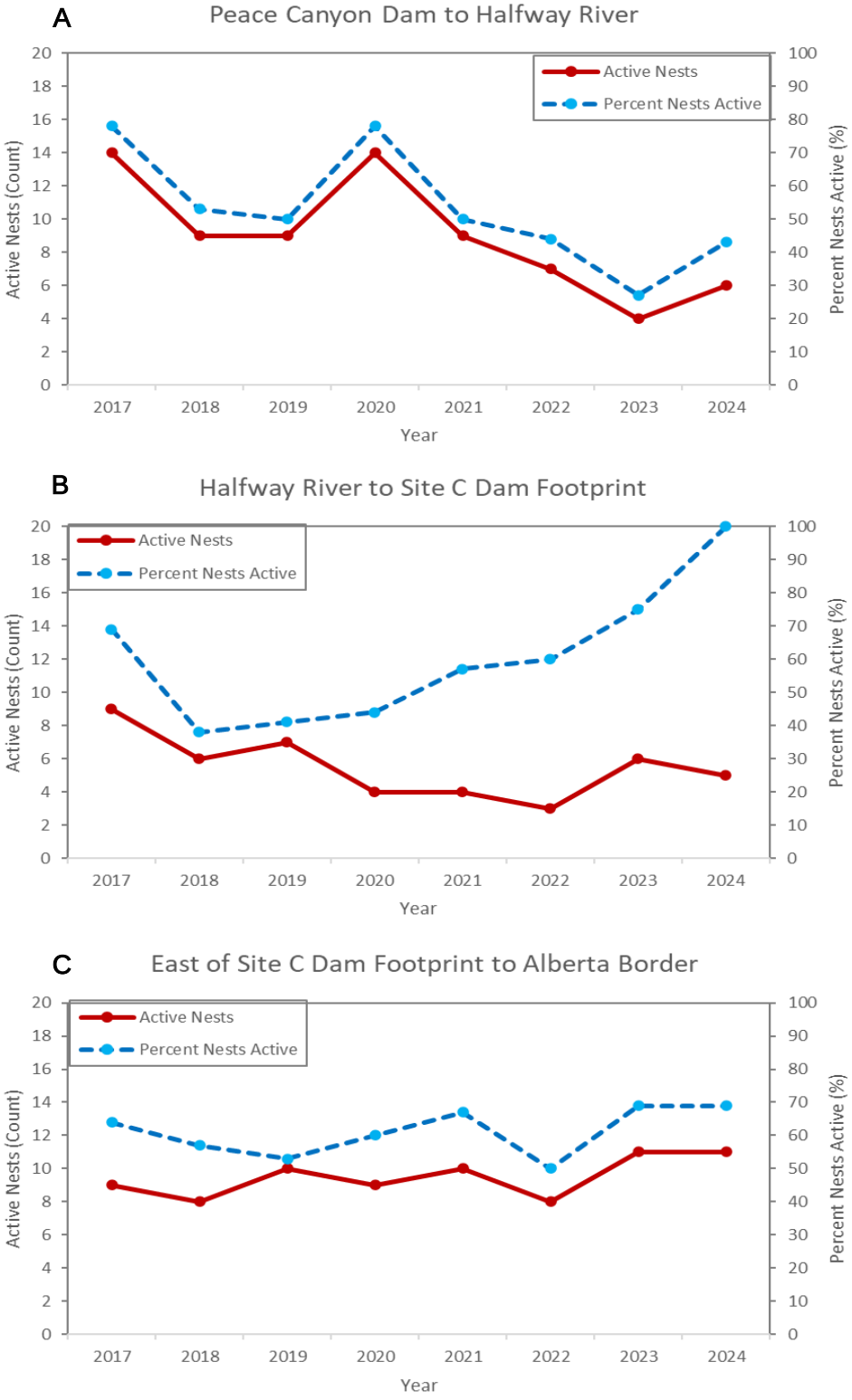

Figure 3. Active tree nests displayed as count and as a percentage of total tree nests by year for three regions in the survey area: **A**: Peace Canyon Dam to the confluence of the Halfway River with the Peace River; **B**: Halfway River to the eastern boundary of the Site C Dam footprint, west of Taylor, BC; **C**: Site C Dam to the Alberta border.

This is the eighth year of annual productivity monitoring of the bald eagles nesting in the study area (2017 to 2024). Data collected in 2024 indicate an increase in the total numbers of chicks fledged compared to 2023; however, the total number of chicks fledged in 2024 (n = 31), is slightly below the average value from 2017 – 2023 (n = 35). The highest productivity observed was 46 fledged bald eagles in 2020, which declined by more than half (n = 22) in 2022. Fledging success also decreased after its peak of 1.84 chicks per nest in 2020 to 1.16 and 1.17 in 2022 and 2023, respectively. Fledging success of tree nests increased to 1.48 in 2024, the second highest success rate observed since monitoring began in 2017 and above the 2017 – 2023 average of 1.32 fledglings per nest (Figure 1). Studies conducted in 1995 and 1997 around the Williston Reservoir, approximately 188 km upstream of the Site C dam, averaged 0.78 fledged chicks per active nest, lower than what was observed in our surveys along the Peace River corridor (Merkens *et al*. 1997; Booth *et al*. 1999).

The number of total active nests was greatest in 2017 with 34 active nests observed, which dropped to a low in 2022 when only 19 active nests were observed. The 2024 data show a total of 21 active tree nests which is less than the 2017 – 2023 average of 26 active tree nests (Figure 2). By examining nest activity by region of the Peace River corridor, a decrease in active nests and percent of nests active have been observed in the Peace Canyon Dam to Halfway River region (Figure 3A). While the number of available nests has decreased in the Halfway River to Site C Dam stretch of the river since 2017 due to nest tree removal, the occupancy of available nest has increased annually, reaching 100 percent occupancy in 2024 (Figure 3B). Downstream of the Site C Dam, the number of bald eagle nests and occupancy has increased slightly since 2017 (Figure 3C).

4.0 DISCUSSION

In preparation for filling the Site C reservoir, forested areas within and adjacent to the Peace River have been cleared, substantially altering bald eagle nesting habitat, particularly the availability of suitable, large diameter trees that supported or could support bald eagle nests. Productivity of raptors is influenced by many factors, including environmental conditions, disease, human activity and available nesting habitat (Gende *et al*. 1997; Travisky and Beauvais 2004). Based on nest activity and availability data collected since 2017, the number of eagles nesting in the upper reaches of the Site C corridor (Peace Canyon Dam to Halfway River) has decreased since 2017. This is not unexpected given this area has historically had the highest number of available nests and nesting activity and has been most impacted by nest tree removal. It appears that eagles that previously nested in the upper reach of the Peace River, may be moving downstream, mainly into the Halfway River to Site C Dam area. Tracking nest availability, occupancy, and productivity is essential to understanding the effects of the Site C Dam on local bald eagle populations.

The first use of an active artificial nesting structure within the Site C corridor was observed in 2024, which provides evidence that the artificial structures may be used by bald eagles to offset the loss of natural tree nesting habitat. The Site C reservoir was filled in the fall of 2024 after the 2024 eagle nest surveys were completed. Associated landscape changes, such as a reduction in the distance from water to nesting habitat has since occurred, and bald eagle productivity and artificial nest use may increase in the 2025 nesting period onwards.

Surveys using the methods described here have occurred annually through the construction phase of the Project and will continue through the first 10 years of operations, as per the commitments in the Site C Bald Eagle Mitigation and Monitoring Program (BC Hydro 2021) and EAC Condition 21.

5.0 CLOSURE

This work was performed in accordance with the contract requirements between WM-DWB and BC Hydro. This report has been prepared and rendered based on fieldwork conducted by WM-DWB, solely for use by BC Hydro. The information and recommendations presented in this report were based on the diligent review of guidelines, regulation, legislation, available records and background knowledge using accepted professional practices and standards. The conclusions of this report should be considered under reference to the scope of the project.

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APPENDIX A

Nest Survey Results 2024

Row ID	Nest ID	Latitude	Longitude	First Detected	2024 Activity	Species	Nest Substrate
1	22	56.13563	-120.64073	pre-2014	Inactive	-	Tree
2	29	56.10791	-120.09915	pre-2014	Active (fledged)	Bald Eagle	Tree
3	38	56.10516	-120.44154	pre-2014	Active (fledged)	Bald Eagle	Tree
4	100	56.15796	-120.75181	pre-2014	Active (fledged)	Bald Eagle	Tree
5	104	56.19497	-120.80077	pre-2014	Active (fledged)	Bald Eagle	Tree
6	146	56.00520	-121.95997	pre-2014	Active (fledged)	Bald Eagle	Tree
7	203	55.99701	-121.72124	pre-2014	Inactive	-	Tree
8	222	56.09350	-120.34967	pre-2014	Active (fledged)	Bald Eagle	Tree
9	225	56.00347	-121.67735	pre-2014	Active (other)	Common Raven	Tree
10	607	56.11830	-120.54547	2017	Inactive	-	Tree
11	611	56.00278	-121.67980	2017	Inactive	-	Tree
12	802	56.19521	-120.84743	2019	Active (fledged)	Bald Eagle	Tree
13	803	56.11214	-120.52948	2019	Active (fledged)	Bald Eagle	Tree
14	804	56.13809	-120.01969	2019	Active (fledged)	Bald Eagle	Tree
15	805	56.06438	-121.09503	2019	Active (fledged)	Bald Eagle	Tree
16	806	56.13613	-120.64282	2019	Inactive	-	Tree
17	1100	55.99477	-121.65667	2021	Inactive	-	Tree
18	1102	56.10305	-120.25499	2021	Active (fledged)	Bald Eagle	Tree
19	1103	56.19153	-121.51116	2021	Active (other)	Common Raven	Tree
20	1105	56.24904	-121.14629	2021	Active (fledged)	Bald Eagle	Tree
21	1106	56.00555	-121.67447	2021	Active (fledged)	Bald Eagle	Tree
22	2201	56.0115	-121.92308	2022	Active (fledged)	Bald Eagle	Tree

Row ID	Nest ID	Latitude	Longitude	First Detected	2024 Activity	Species	Nest Substrate
23	2202	56.02804	-121.89961	2022	Active (fledged)	Bald Eagle	Tree
24	2203	56.11968	-121.66675	2022	Inactive	-	Tree
25	2204	56.13295	-121.62031	2022	Inactive	-	Tree
26	2205	56.16553	-121.56509	2022	Active (fledged)	Bald Eagle	Tree
27	2206	56.17717	-121.52208	2022	Inactive	-	Tree
28	2207	56.22567	-121.39790	2022	Active (fledged)	Bald Eagle	Tree
29	2208	56.14070	-120.71230	2022	Inactive	-	Tree
30	2209	56.11386	-120.48277	2022	Active (fledged)	Bald Eagle	Tree
31	2210	56.09842	-120.18405	2022	Active (fledged)	Bald Eagle	Tree
32	2211	55.97833	-121.99086	2022	Active (fledged)	Bald Eagle	Tree
33	2301	56.19058	-120.89107	2023	Active (fledged)	Bald Eagle	Tree
34	2401	56.12047	-120.55096	2024	Inactive	-	Tree
35	82.1	56.27494	-121.21140	2024	Inactive	-	Artificial
36	115.2	56.26696	-121.27370	2024	Inactive	-	Artificial
37	118.1	56.2583	-121.28423	2024	Inactive	-	Artificial
38	126	56.24313	-121.32064	2024	Inactive	-	Artificial
39	262	56.11707	-121.78712	2024	Inactive	-	Artificial
40	268	56.10175	-121.81059	2024	Inactive	-	Artificial
41	272.2	56.08980	-121.82769	2024	Inactive	-	Artificial
42	276	56.07811	-121.82767	2024	Inactive	-	Artificial
43	351.1	56.04266	-121.88782	2024	Inactive	-	Artificial
44	397	56.02166	-121.90713	2024	Inactive	-	Artificial

Row ID	Nest ID	Latitude	Longitude	First Detected	2024 Activity	Species	Nest Substrate
45	Eagle 249	56.12294	-121.72933	2024	Inactive	-	Artificial
46	Eagle_134 _West	56.24284	-121.32593	2021	Inactive	-	Artificial
47	Eagle_14.1	56.22483	-120.93805	2021	Inactive	-	Artificial
48	Eagle_142	56.24337	-121.39449	2021	Inactive	-	Artificial
49	Eagle_144	56.23522	-121.40398	2021	Inactive	-	Artificial
50	Eagle_147	56.23081	-121.41371	2021	Inactive	-	Artificial
51	Eagle_151	56.23171	-121.43510	2021	Inactive	-	Artificial
52	Eagle_153	56.22785	-121.45057	2021	Inactive	-	Artificial
53	Eagle_153 _East	56.22949	-121.44242	2021	Inactive	-	Artificial
54	Eagle_167	56.25048	-121.50582	2021	Inactive	-	Artificial
55	Eagle_182 C	56.18959	-121.51610	2021	Inactive	-	Artificial
56	Eagle_216 B	56.18720	-121.52462	2021	Inactive	-	Artificial
57	Eagle_217	56.18436	-121.53404	2021	Inactive	-	Artificial
58	Eagle_246	56.11960	-121.70063	2021	Inactive	-	Artificial
59	Eagle_247 east	56.11782	-121.70977	2021	Inactive	-	Artificial
60	Eagle_249 _East	56.11805	-121.72080	2021	Inactive	-	Artificial
61	Eagle_254 _West	56.12484	-121.75518	2021	Inactive	-	Artificial
62	Eagle_257 N	56.12191	-121.76874	2021	Inactive	-	Artificial
63	Eagle_258 _East	56.12063	-121.77700	2021	Inactive	-	Artificial
64	Eagle_268	56.10171	-121.81042	2021	Inactive	-	Artificial
65	Eagle_326	56.07072	-121.85407	2021	Inactive	-	Artificial
66	Eagle_41.1 A	56.21323	-121.06435	2021	Inactive	-	Artificial

Row ID	Nest ID	Latitude	Longitude	First Detected	2024 Activity	Species	Nest Substrate
67	Eagle_41.1 B	56.21411	-121.07576	2021	Active	Bald Eagle	Artificial
68	Eagle_48	56.23015	-121.09307	2021	Inactive	-	Artificial
69	Eagle_49.1 B	56.21773	-121.10538	2021	Inactive	-	Artificial
70	Eagle_49.2 B	56.21560	-121.09437	2021	Inactive	-	Artificial
71	Eagle_75	56.25455	-121.18467	2021	Inactive	-	Artificial
72	Eagle_75.1	56.25009	-121.17684	2021	Inactive	-	Artificial
73	Gates Island	56.10869	-121.79515	2021	Inactive	-	Artificial
74	p32	56.24048	-121.12966	2018	Inactive	-	Artificial
75	p39	56.23498	-120.95523	2018	Inactive	-	Artificial
76	p47	56.23297	-121.10032	2018	Inactive	-	Artificial
77	Peaceview	56.24593	-121.28262	2024	Inactive	-	Artificial

242

243

APPENDIX B

Active Bald Eagle Nests and Assumed Productivity 2024

Row ID	Nest ID	Survey 1 May 17, 2024	Survey 2 May 31, 2024	Survey 3 June 13, 2024	Total Chicks Fledged
1	29	2 grey chicks	2 grey feathered chicks with adult perched nearby	2 dark chicks one adult in nest	2
2	38	Adult with one chick grey down	1 grey chick no adult	1 grey chick	1
3	100	2 grey chicks no adult present	Transitioning to darker feathers, one chick a bit younger	2 dark chicks	2
4	104	2 adults present. 1 grey feathered chick	2 grey chicks no adult present	Adult nearby. Two chicks grey turning dark.	2
5	146	Avoided due to Cameron Lake fire buffer	Avoided due to Cameron Lake fire buffer	1 dark chick	1
6	222	Adult with one grey chick	1 grey chick no adult	1 dark chick	1
7	802	2 grey chicks. Adult on nest	2 grey chicks no adult present	2 dark chicks	2
8	803	Adult and 2 grey chicks	Adult and 2 grey chicks	1 chick	1
9	804	Adult and 3 grey chicks	Adult and 2 chicks transitioning from grey to dark	2 grey chicks	2
10	805	Adult on nest with two grey chicks. Other adult perched nearby	2 grey chicks	2 grey black chicks and adult present	2
11	1102	Adult and 1 grey chick. Other adult nearby	Adult and dark feathered chick in nest	Large dark chick	1
12	1105	1 adult, 2 grey chicks more advanced grey with some darker feathers	2 dark feathered chicks with adult nearby	Dark chick perched ready to fledge	1
13	1106	Adult on nest with 1 grey chick. Other adult nearby. Food in nest	Adult in nest with 2 grey chicks	Mottled chick adult nearby	1
14	2201	Avoided due to Cameron Lake fire buffer	Avoided due to Cameron Lake fire buffer	2 mottled chicks	2
15	2202	Adult incubating. Nest good	Adult and grey chick in nest	Adult and grey chick	1
16	2205	Adult on nest with two grey chicks	Older dark feathered chick and adult in nest	1 dark chick with flight feathers	1
17	2207	Adult incubating	2 grey chicks no adult	Mottled chick	1
18	2209	2 older chicks. 1 all black feathers other black and grey mottled.	2 large chicks with dark feathers	2 chicks dark grey feathers. One perched on rim of nest.	2

Row ID	Nest ID	Survey 1 May 17, 2024	Survey 2 May 31, 2024	Survey 3 June 13, 2024	Total Chicks Fledged
19	2210	1 grey chick. No adults	Adult and dark feathered chick	2 adults nearby 1 dark chick didn't approach too close	1
20	2211	Avoided due to Cameron Lake fire buffer	Avoided due to Cameron Lake fire buffer	2 dark chicks	2
21	2301	Adult on nest with 2 grey chicks	Adult perched nearby two grey chicks	Dark chicks two adults perched nearby	2
22	Eagle_41.1B	Adult incubating	Adult and 1 grey chick	1 grey chick	1

255

256