

## **Appendix 15. 2025 Ground Nesting Raptors Report**



# Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2025 Annual Report



PRESENTED TO  
**British Columbia Hydro and Power Authority**

MARCH 13, 2026  
ISSUED FOR USE  
FILE: 704-ENW.BIOS03193-01.GNRM25

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# Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2025 Annual Report

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MARCH 13, 2026

## PRESENTED TO

**Site C Clean Energy Project  
BC Hydro and Power Authority**  
P.O. Box 49260  
Vancouver, BC V7X 1V5

## PRESENTED BY

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## LIMITATIONS OF REPORT

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## 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 2025. 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 2025 ground-nesting raptor surveys were conducted in BC Hydro's Marl Fen, Rutledge and Wilder Creek mitigation properties. This was the third year of ground-nesting raptor surveys within BC Hydro's mitigation properties, with the first two survey years occurring in 2016 and 2017. Surveys were conducted at 27 standwatch stations established within the three mitigation properties up to three times during May and June 2025. Surveys followed methodology adapted from the Resource Inventory Committee (RIC) Inventory Methods for Raptors (RIC 2001).

Northern Harriers were observed three times within the mitigation properties, once at Rutledge and twice at Wilder Creek. All three of the Northern Harrier observations occurred during the early May visit. Northern Harrier observations in 2025 were comparable to 2016 and 2017 results at Rutledge and Wilder Creek, while fewer observations were recorded at Marl Fen. No nests or potential nesting was observed in any of the areas surveyed.

No Short-eared Owls were detected during the field surveys. Short-eared Owl has only been observed once at Marl Fen in 2016.

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### APPENDICES

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## 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 2025. The surveys were part of BC Hydro’s Ground-nesting Raptor Follow-up Monitoring Program which have occurred annually since 2016 (BC Hydro 2016). This report describes the methods used to conduct the surveys and provides a summary of the results from 2025.

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 <sup>1</sup>	COSEWIC <sup>2</sup> Status	SARA <sup>3</sup> Status
Short-eared Owl	<i>Asio flammeus</i>	Blue	Threatened	Schedule 1 – Special Concern
Northern Harrier	<i>Circus hudsonius</i>	Yellow	Not at Risk	-

<sup>1</sup> Species are assigned a provincial conservation status depending on if they are extirpated, endangered or threatened (Red List), special concern (Blue List) or secure and not at risk of extinction (Yellow List).

<sup>2</sup> COSEWIC – Committee on the Status of Endangered Wildlife in Canada.

<sup>3</sup> 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.

The first two objectives listed above were addressed by conducting eight years (i.e., from 2017 to 2024) of ground-nesting raptor surveys in cleared portions of the construction headpond between the dam site and Halfway River (SEES JV 2018; SEES JV 2019; SEES JV 2020a; SEES JV 2020b; SEES JV 2022a; SEES JV 2022b; SEES JV 2024; SEES JV 2025). Filling of the Site C reservoir began on August 25, 2024 and was completed 11 weeks later on November 7, 2024. As all previously surveyed areas within the headpond are now inundated, the first two objectives are no longer relevant to future monitoring. All ground-nesting raptor surveys conducted from 2025 onwards will focus on addressing the third objective by conducting surveys at the three mitigation properties (Marl Fen, Rutledge and Wilder Creek) into the operations phase.

## 2.0 REGULATORY CONTEXT

The ground-nesting raptor monitoring program addresses conditions of the Project’s Environmental Assessment Certificate (EAC), the Federal Decision Statement (FDS) and the Project’s two Conditional Water Licences. Specifically, the program addresses Condition 21 of the provincial EAC to include surveys of ground-nesting raptors as part of a Vegetation and Wildlife Mitigation and Monitoring Plan. It also addresses Condition 16 of the FDS which outlines requirements for species at risk, including measures to identify, assess and monitor potential effects on species at risk, which includes Short-eared Owl. Finally, the program fulfils monitoring and reporting obligations tied to Conditional Water Licences 132990 and 132991, where ground-nesting raptors are identified under Program Area 9 for review by the Vegetation and Wildlife Technical Committee (VWTC). Together, the conditions of the EAC, FDS and water licences establish the purpose of the ground-nesting raptor monitoring program (BC Hydro 2016).

## 3.0 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 owl surveys in 2006, although one was observed incidentally during other Site C baseline survey work for other species. 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<sup>1</sup>.

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. During these two survey years, Northern Harrier was detected 10 times at Marl Fen, twice at Wilder Creek, and once at Rutledge; and Short-eared Owl was detected once at Marl Fen in 2016<sup>1</sup>. Surveys of the mitigation properties were not conducted between 2018 and 2024 because ground-nesting raptor use of the mitigation properties was well documented and further surveys would likely not provide new information. Surveys of the mitigation properties were to be conducted again when the reservoir had been inundated or following substantial land use changes or habitat modifications in the mitigation properties, whichever occur first.

## 4.0 METHODS

### 4.1 Survey Areas

The Ground-nesting Raptor Follow-up Monitoring Program specifies that surveys will be completed in:

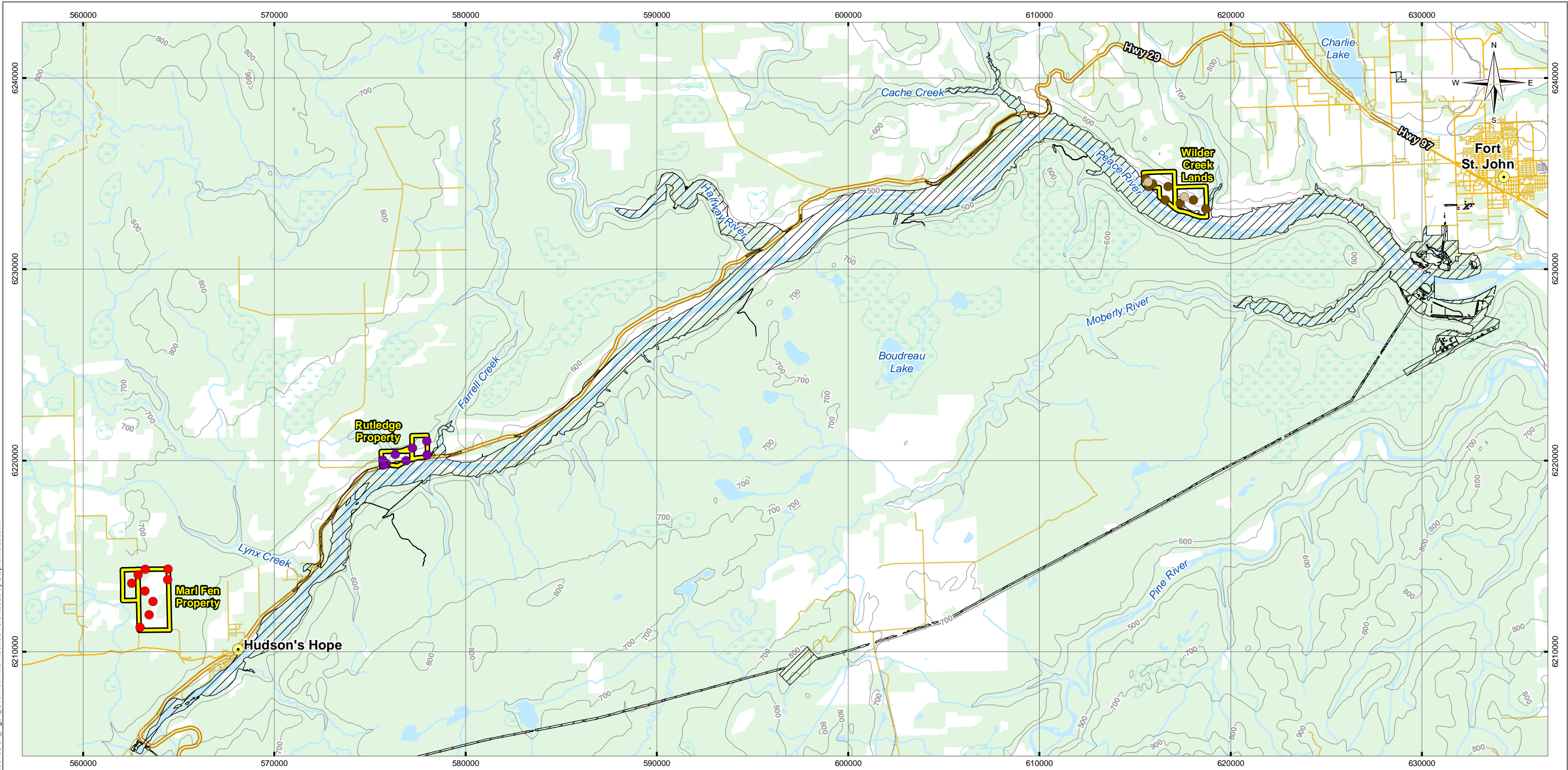
- Areas cleared within the construction headpond during construction prior to reservoir filling, and
- The BC Hydro mitigation & compensation properties (Marl Fen, Rutledge and Wilder Creek).

Filling of the reservoir was completed in November 2024, inundating all of the ground-nesting raptor survey stations within the construction headpond. The last ground-nesting raptor surveys within the headpond were completed in June 2024.

The 2025 ground-nesting raptor surveys were conducted in the Marl Fen, Rutledge and Wilder Creek compensation properties (Figure 1).

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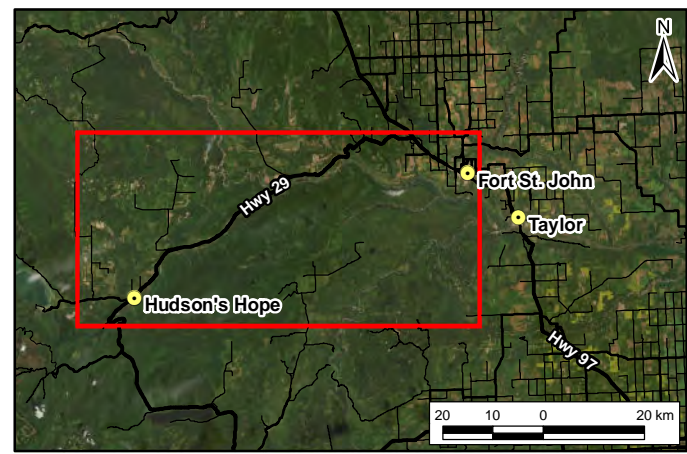
<sup>1</sup> One Short-eared Owl was observed at Marl Fen in 2016; however, Marl Fen is not located within the Peace River Valley.



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**LEGEND**

- Project Footprint
- Mitigation Property
- Standwatch Station**
- Marl Fen
- Rutledge
- Wilder Creek
- Wilder Creek - Visit 1 Only
- 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).

**SITE C  
GROUND-NESTING RAPTOR MONITORING  
2025 ANNUAL REPORT**

**Project Overview of  
Standwatch Station Locations**

<b>PROJECTION</b> UTM Zone 10	<b>DATUM</b> NAD83	<b>CLIENT</b> BC Hydro Power smart
Scale: 1:200,000		
<b>FILE NO.</b> BIOS03193-01_Fig01_Overview.mxd	<b>CLIENT</b> TETRA TECH	
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB
<b>DATE</b> October 31, 2025	<b>APVD</b> EH	<b>REV</b> 0
<b>PROJECT NO.</b> ENW.BIOS03193-01		<b>Figure 1</b>

**STATUS**  
ISSUED FOR REVIEW

## 4.2 Ground-Nesting Raptor Surveys

Within the three BC Hydro mitigation properties, ground-nesting raptor surveys were conducted three times between May and June 2025 to capture early, middle, and later stages of their breeding season (Table 2). Surveys followed methodology adapted from the Resource Inventory Committee (RIC) *Inventory Methods for Raptors* (RIC 2001), with standwatch stations surveyed to detect Northern Harrier and Short-eared Owl. 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 A).

**Table 2: 2025 Ground-Nesting Raptor Survey Dates and Times**

Survey Location	First Visit		Second Visit		Third Visit	
Marl Fen	May 2, 2025 13:06 – 16:36		June 6, 2025 10:38 – 11:23	June 9, 2025 07:47 – 10:51	June 24, 2025 08:45 – 10:22	June 25, 2025 07:54 – 10:14
Rutledge	May 1, 2025 08:23 – 13:11		June 6, 2025 09:56 – 10:16	June 9, 2025 06:13 – 09:53	June 19, 2025 04:58 – 09:17	
Wilder Creek	May 1, 2025 14:33 – 15:23	May 2, 2025 08:13 – 10:13	June 8, 2025 07:08 – 12:04		June 19, 2025 04:35 – 09:04	

Ground-nesting raptor surveys were conducted at 27 standwatch stations established within the three mitigation properties (Table 3; Figures 2 - 4). Standwatch stations were located in areas with good visibility of the surrounding area. Photographs taken at each station are presented on Figures 2 to 4.

Not all standwatch stations were surveyed three times. Some stations in Wilder Creek were not surveyed during the first visit due to concerns about slope stability, and were instead surveyed from different vantage points (Stations WCSW09 and WCSW10) that provided a similar view to that of the original survey stations. Regardless of which stations were surveyed, each of the three survey rounds at Wilder Creek provided near total coverage of the mitigation property.

**Table 3: Standwatch Stations Visited in Each Survey Area**

Standwatch Station	Visit 1	Visit 2	Visit 3	Zone	Easting	Northing
	May 1 or 2, 2025	June 6, 8 or 9, 2025	June 19, 24 or 25, 2025			
<b>Marl Fen</b>						
MFSW01	✓	✓	✓	10	562884	6214025
MFSW02	✓	✓	✓	10	563252	6214301
MFSW04	✓	✓	✓	10	563455	6211918
MFSW05	✓	✓	✓	10	562995	6211268
MFSW06	✓	✓	✓	10	563673	6212632
MFSW07	✓	✓	✓	10	563246	6213164
MFSW08	-	✓	-	10	564426	6213760
MFSW09	✓	✓	✓	10	564438	6214318
MFSW10	✓	✓	✓	10	562548	6213584

Standwatch Station	Visit 1	Visit 2	Visit 3	Zone	Easting	Northing
	May 1 or 2, 2025	June 6, 8 or 9, 2025	June 19, 24 or 25, 2025			
<b>Rutledge</b>						
RUSW01	✓	✓	✓	10	576882	6219980
RUSW02	✓	✓	✓	10	575852	6219821
RUSW03	✓	✓	✓	10	575747	6219750
RUSW04	✓	✓	✓	10	577996	6220283
RUSW05	✓	✓	✓	10	577982	6220986
RUSW06	✓	✓	✓	10	577235	6220645
RUSW07	✓	✓	✓	10	576324	6220311
RUSW08	✓	✓	✓	10	575676	6220009
<b>Wilder Creek</b>						
WCSW01	✓	✓	✓	10	618051	6233613
WCSW02	✓	✓	✓	10	616734	6234307
WCSW03	-	✓	✓	10	615742	6234311
WCSW04	-	✓	✓	10	617356	6233438
WCSW05	✓	✓	✓	10	615927	6234437
WCSW06	-	✓	✓	10	615541	6234729
WCSW07	-	✓	✓	10	616581	6233612
WCSW08	✓	✓	✓	10	618694	6233152
WCSW09	✓	-	-	10	615680	6234533
WCSW10	✓	-	-	10	617589	6233775

Standwatch surveys were conducted by observing from a stationary position for 20 minutes. All surveys were conducted during daylight hours. 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 time of day and order that the stations were visited varied on each of the survey days in order to minimize the effect of time of day on raptor activity and detectability. When transiting between stand watch stations, surveyors continued to look and listen for birds and potential hunting perches (e.g., fence posts and short trees) were searched opportunistically for evidence of use by raptors. Surveyors stopped whenever required in order to confirm identification and to record data.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations (Appendix B). 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.

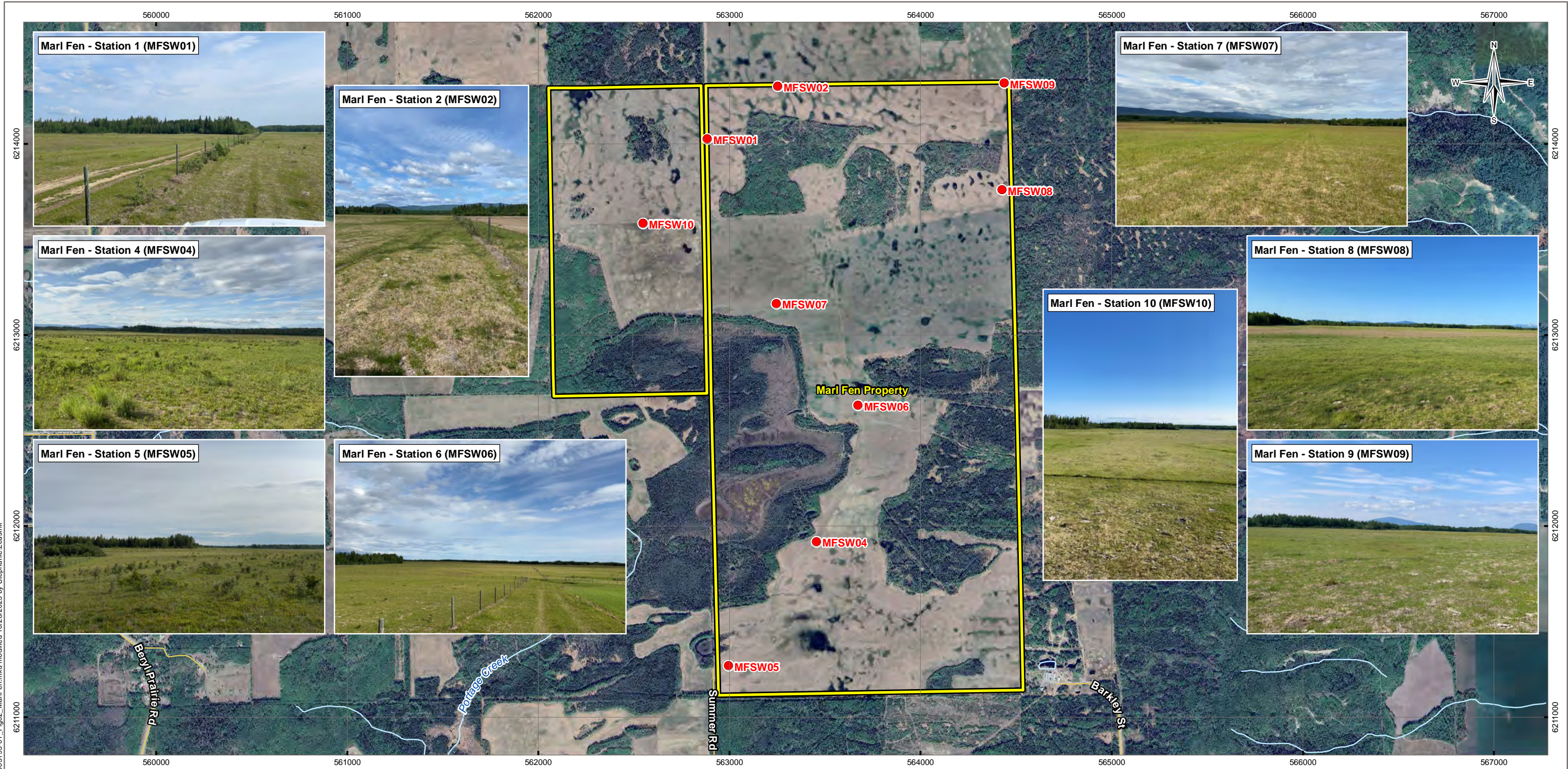
## 5.0 RESULTS

Ground-nesting raptors were observed at two of the three mitigation properties – Rutledge and Wilder Creek (Table 4; Figures 2-4). All observations were of Northern Harriers: one at Rutledge and two at Wilder Creek. All three of the Northern Harrier observations occurred during the early May visit. No nests or potential nesting was observed at any of the areas surveyed.

Short-eared Owl was not observed during 2025 ground-nesting raptor surveys.

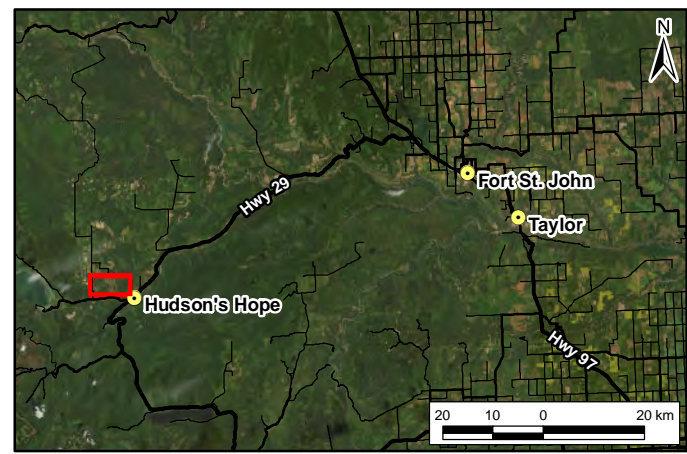
**Table 4: Northern Harrier Observations During 2025 Surveys**

Survey Area	Location	Date	Time	Count	Sex	Age Class	Activity
Rutledge	RUSW07	1-May-25	12:21	1	Female	Adult	Gliding on the bluffs then perched in a stand of trees.
Wilder Creek	WCSW08	1-May-25	15:05	1	Female	Adult	Soaring
Wilder Creek	WCSW10	2-May-25	08:19	1	Male	Adult	On the ground with prey, being mobbed by a murder of crows.



**LEGEND**

- Marl Fen Standwatch Station
- Mitigation Property
- Local Road
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from Google Earth; Airbus (2023).

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**Marl Fen Standwatch Stations**

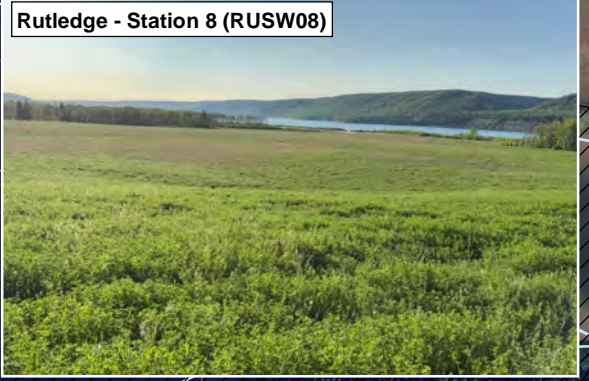
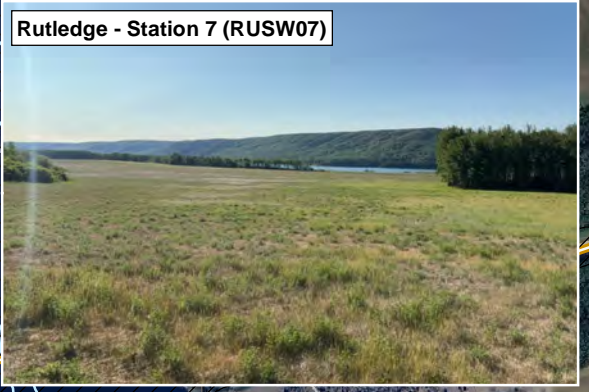
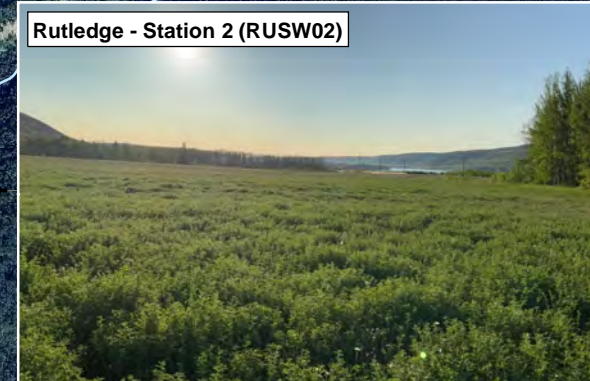
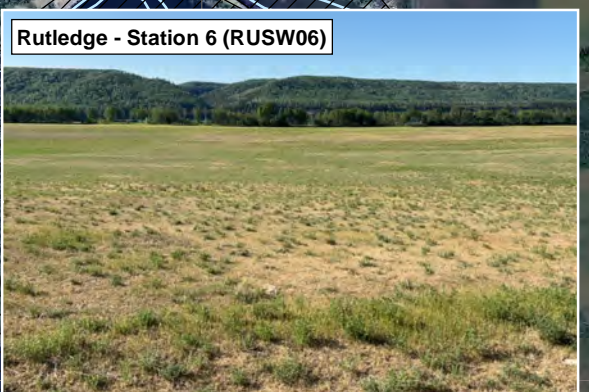
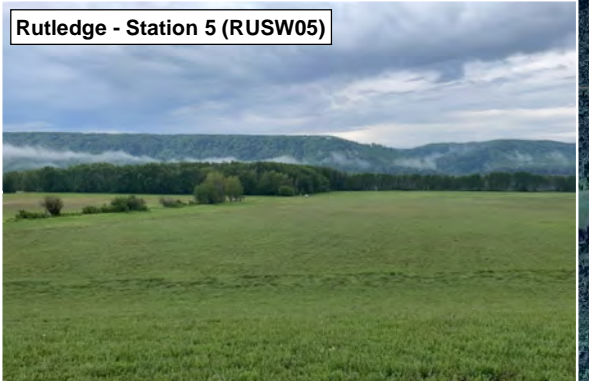
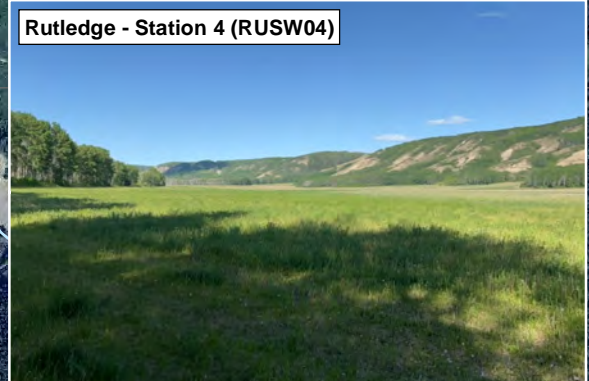
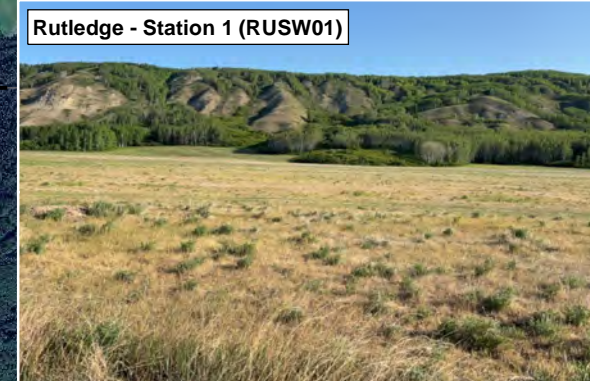
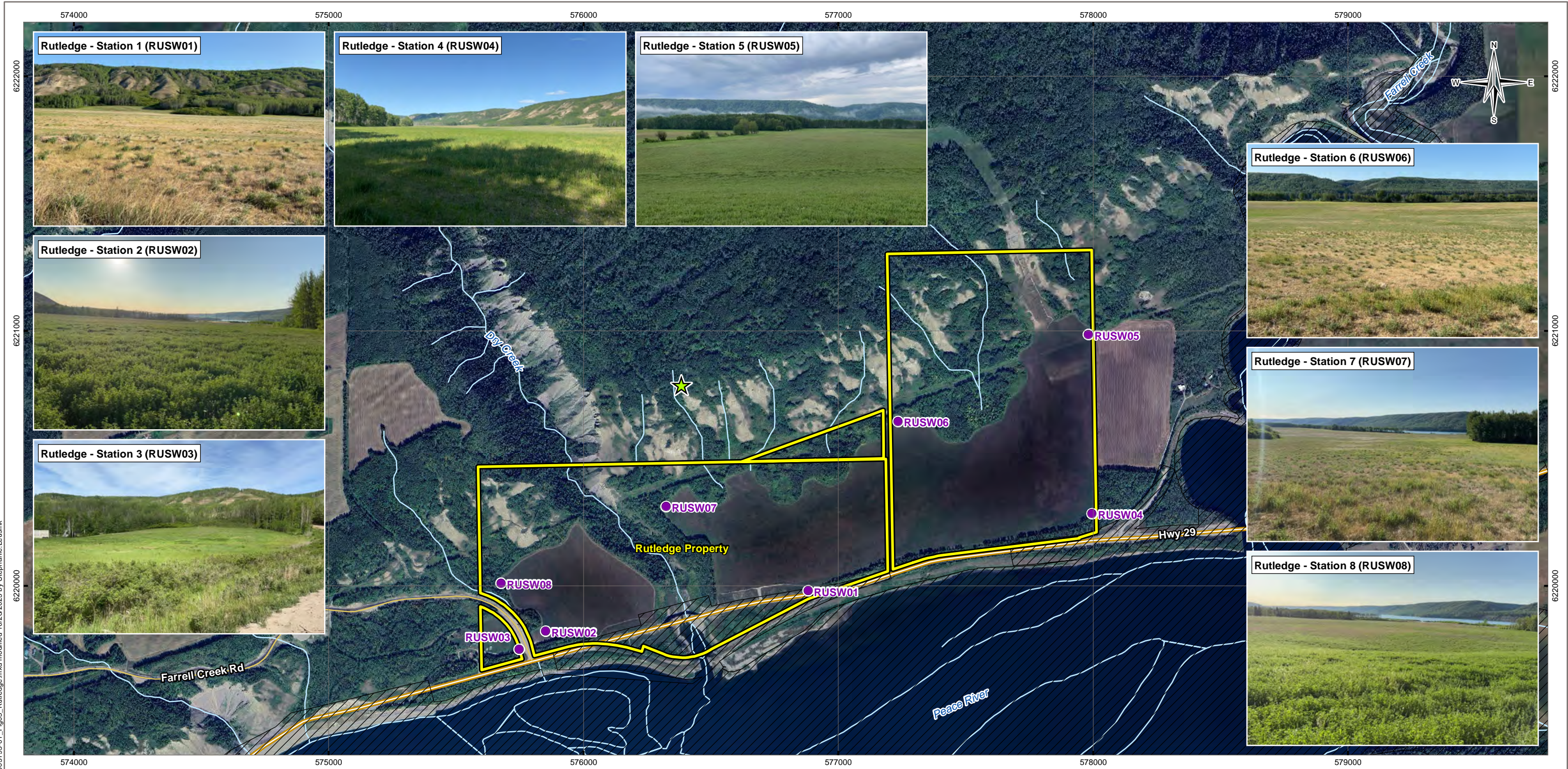
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Scale: 1:20,000 400 200 0 400 Metres				
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OFFICE Tl-VANC	DWN SL	CKD MRB	APVD EH	REV 0
DATE October 28, 2025	PROJECT NO. ENW.BIOS03193-01			



**Figure 2**

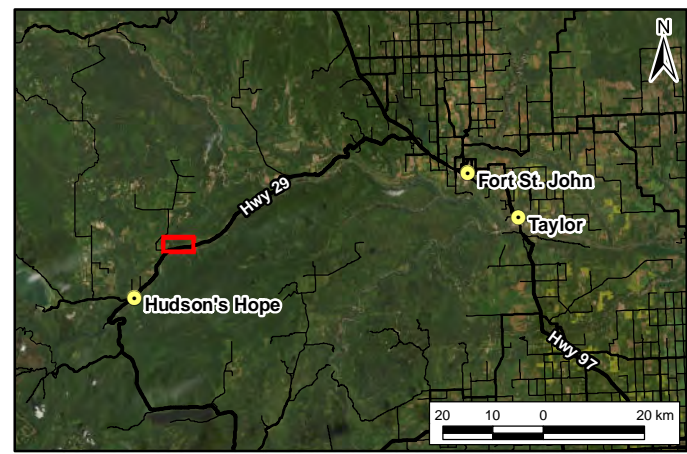
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ISSUED FOR REVIEW

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**LEGEND**

- Rutledge Standwatch Station
- ★ Northern Harrier Observation
- Mitigation Property
- Project Footprint
- Highway
- Local Road
- ~ Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from Google Earth; Airbus (2025).

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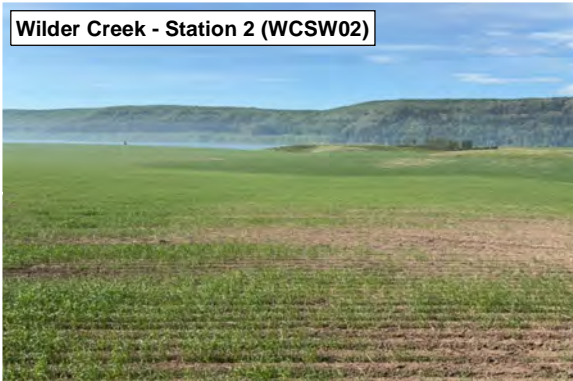
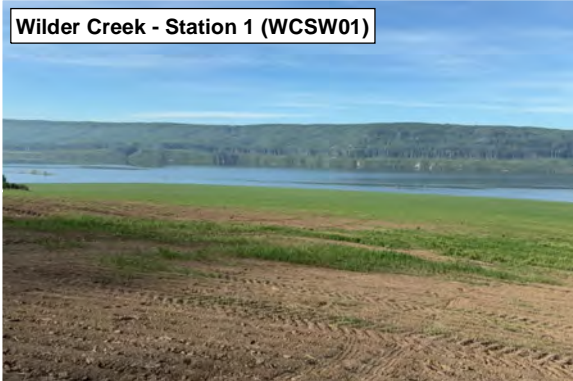
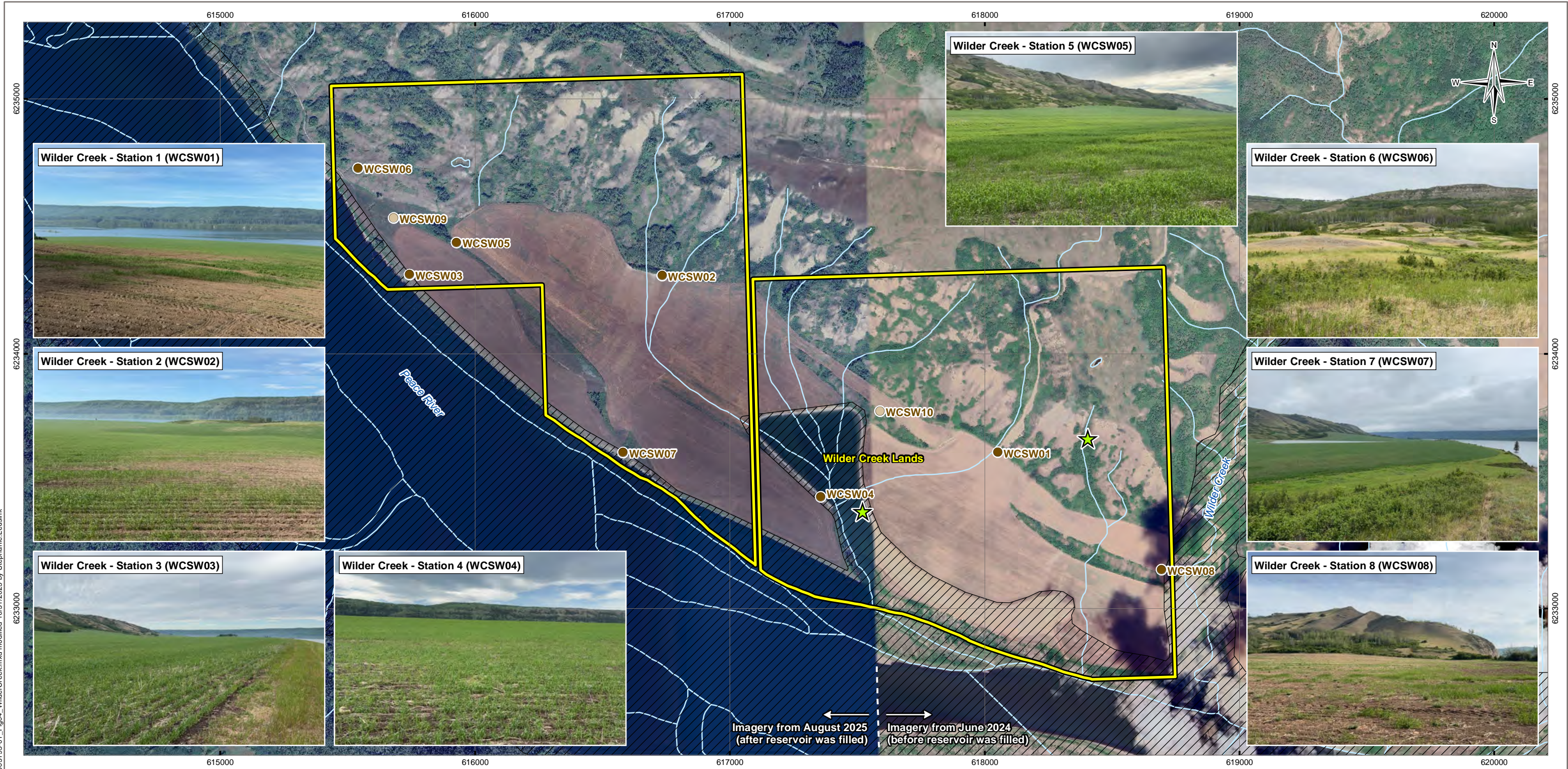
**Rutledge Standwatch Stations**

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OFFICE Tl-VANC	DWN SL	CKD MRB
APVD EH	REV 0	
DATE October 28, 2025	PROJECT NO. ENW.BIOS03193-01	

**STATUS**  
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**Figure 3**

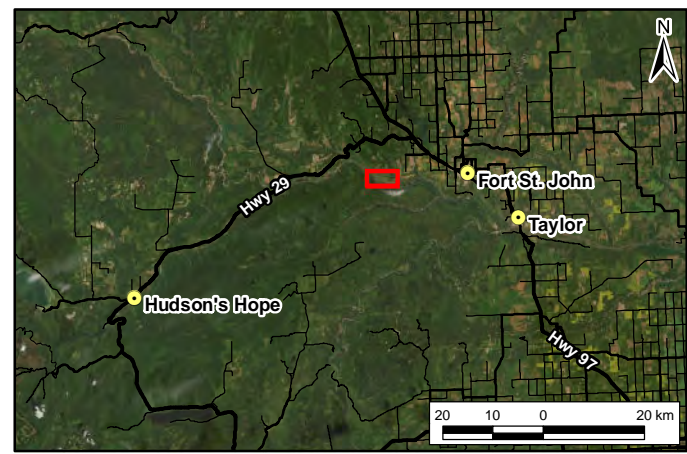
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← Imagery from August 2025 (after reservoir was filled)      → Imagery from June 2024 (before reservoir was filled)

**LEGEND**

- Wilder Creek Standwatch Station
- Wilder Creek Standwatch Station - only surveyed during Visit 1
- ★ Northern Harrier Observation
- ▭ Mitigation Property
- ▨ Project Footprint
- ~ Watercourse
- ☪ Waterbody



**NOTES**  
 Base data source: CanVec 1:50,000 (2019).  
 Imagery from Google Earth; Airbus (Left: 2025 / Right: 2024).

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**Wilder Creek Standwatch Stations**

PROJECTION UTM Zone 10	DATUM NAD83	CLIENT <b>BC Hydro</b> Power smart
Scale: 1:15,000 300 150 0 300 Metres		
FILE NO. BIOS03193-01_Fig04_WilderCreek.mxd	CLIENT <b>TETRA TECH</b>	
OFFICE Tl-VANC	DWN SL	CKD MRB
APVD EH	REV 0	
DATE October 31, 2025	PROJECT NO. ENW.BIOS03193-01	

**Figure 4**

**STATUS**  
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## 6.0 DISCUSSION

This was the third year of ground-nesting raptor surveys within BC Hydro's three mitigation properties conducted by SEES JV. The 2025 surveys were conducted eight years after the first two survey years in 2016 and 2017. The ground-nesting raptor surveys within the mitigation properties are planned to continue in the spring and summer of 2026.

Three Northern Harriers were observed during the 2025 standwatch surveys within BC Hydro's mitigation properties. One individual was observed at Rutledge and two individuals were observed at Wilder Creek. All three Northern Harrier observations 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 mitigation properties in early May are likely passing through the area on their northern migration or looking for suitable nesting sites in the Peace River region. No evidence of nesting behaviour was exhibited by any of the individuals observed.

Northern Harrier observations in 2025 were comparable to 2016 and 2017 results at Rutledge and Wilder Creek, while fewer observations were recorded at Marl Fen. In 2016, there were eight Northern Harrier observations (six at Marl Fen, one at Rutledge, and one at Wilder Creek), with six of the observations during May surveys and two during June surveys. In 2017, there were five Northern Harrier observations (four at Marl Fen, and one at Wilder Creek), with one of the observations during a May survey and four during June or July surveys. Across the three monitoring years, 62.5% of observations occurred in May.

Short-eared Owls were not detected during the 2025 ground-nesting raptor surveys. Short-eared Owl has only been observed once at Marl Fen in 2016 during a survey conducted in May. Short-eared Owl favour large open areas for hunting and nesting such as grasslands, shrublands, tundra, wetlands and agricultural areas (COSEWIC 2021). Nesting sites are typically located in dry areas beside vegetation that is large enough to conceal an adult bird and nestlings, but there have been records of nesting in stubble fields and hay fields (COSEWIC 2021). The agricultural habitat within Marl Fen, Rutledge and Wilder Creek appeared to provide suitable foraging and breeding habitat for this species.

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# APPENDIX A

## PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

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<b>Name and Affiliation</b>	<b>Project Role</b>
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Elyse Hofs, B.Sc., Dipl.T., R.P.Bio. Tetra Tech Canada Inc.	Field Data Collection, Data Entry, Report Author
Zoe Osberg, B.Sc., P.Biol. Tetra Tech Canada Inc.	Field Data Collection
Natasha Gidluck, B.Sc., B.I.T. Tetra Tech Canada Inc.	Field Data Collection

# APPENDIX B

## INCIDENTAL RAPTOR OBSERVATIONS

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**Table B.1: Incidental Observation of Other Raptors During Ground-Nesting Raptor Surveys**

Common Name	Scientific Name	BC List <sup>1</sup>	COSEWIC/SARA	Number Observed		
				Marl Fen	Rutledge	Wilder Creek
Cooper's Hawk	<i>Accipiter cooperii</i>	Yellow	Not at Risk (May 1996)	1	-	-
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Yellow	Not at Risk (May 1995)	4	1	-
Rough-legged Hawk	<i>Buteo lagopus</i>	Blue	Not at Risk (May 1995)	1	-	3
Swainson's Hawk	<i>Buteo swainsoni</i>	Red	-	1	-	-
Merlin	<i>Falco columbarius</i>	Yellow	Not at Risk (April 1985)	1	1	-
American Kestrel	<i>Falco sparverius</i>	Yellow	-	3	-	1
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Yellow	Not at Risk (May 1984)	-	-	3
Osprey	<i>Pandion haliaetus</i>	Yellow	-	-	-	2
Unknown Raptor	-	-	-	1	1	-

<sup>1</sup> Species are assigned a provincial conservation status depending on if they are extirpated, endangered or threatened (Red List), special concern (Blue List) or secure and not at risk of extinction (Yellow List).

# APPENDIX C

## LIMITATIONS ON THE USE OF THIS DOCUMENT

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# LIMITATIONS ON USE OF THIS DOCUMENT

## NATURAL SCIENCES

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### 1.5 INFORMATION PROVIDED TO SEES JV BY OTHERS

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This Professional Document is based solely on the conditions presented and the data available to SEES JV 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 exploration, investigation, and assessment.

SEES JV 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.



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### 1.7 ENVIRONMENTAL ISSUES

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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.

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### 1.8 NOTIFICATION OF AUTHORITIES

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SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV 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 SEES JV in its reasonably exercised discretion.

## **Appendix 16. Portage Mountain Artificial Bat Hibernacula Memo**

# Site C Clean Energy Project

## Portage Mountain Quarry Reclamation

### Artificial Bat Hibernacula Monitoring 2024 - 2025



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## List of Abbreviations

AQ	Air Quality
ARU	Acoustic Recording Unit
BC	British Columbia
BMP	Best Management Practice
CSP	Corrugated Steel Pipe
EAC	Environmental Assessment Certificate
FS	Full Spectrum Ultrasonic Recording
km	Kilometre
LOC	Limits of construction
mm	Millimetre
n	Number/number of
NE	Northeast
PMQ	Portage Mountain Quarry
psi	Pounds per Square Inch
PVC	Poly Vinyl Chloride
RH	Relative Humidity
SARA	Species At Risk Act
SME	Subject Matter Expert
SOP	Standard Operating Procedure
WNS	White Nose Syndrome
ZC	Zero Cross Ultrasonic Recording

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# 1 Introduction

The Site C Clean Energy Project (the Project) is the third hydroelectric dam on the Peace River in northeastern British Columbia (BC). Associated project work at the Hudson’s Hope shoreline protection berm and Highway 29 realignments required substantial riprap for construction which was predominantly sourced from Portage Mountain Quarry (PMQ), located 14 kilometres (km) west of Hudson’s Hope. Portage Mountain’s geology includes numerous caves and crevices, where the microclimatic conditions and geology appear to provide the ideal conditions for bats to roost and hibernate. The area has known geothermal activity, and the Hudson’s Hope steam vents are less than 4 km west of Portage Mountain.

The Project’s Environmental Assessment Certificate (EAC) # E14-02, 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 (EAC, 2014, Schedule B, Condition 16). Since sensitive bat habitat was avoided and there was no habitat loss due to quarry development, BC Hydro asserted that Condition 16 in Schedule B of EAC # E14-02 was satisfied. However, recognizing that the Project had a large environmental footprint, BC Hydro voluntarily constructed bat hibernacula during quarry reclamation. BC Hydro engaged a bat subject matter expert (SME) Mike Sarell to provide expertise in developing functional designs for artificial bat hibernacula that would be suitable for the environmental conditions and incorporate physical features for bat species known to hibernate at Portage Mountain.

Initial assessments of bat species in the Peace River valley were completed between 2005 and 2009 using mist-netting, acoustic sampling, radio-tracking, and DNA analysis. Of the nine bat species likely to be present in the Peace River valley, eight species were confirmed present (Keystone and Kingbird 2009a; 2009b). All eight species were also confirmed to occur at Portage Mountain (Keystone, 2014; Sarell and Alcock, 2017). Table 1 summarizes the eight bat species confirmed in the Peace River valley and Portage Mountain, and their conservation and migratory status (Lausen et al., 2022).

Table 1. Summary of Bat Species, Conservation Status, and Migratory Status in the Peace River Valley and PMQ.

Scientific name	Common name	BC Status	COSEWIC Status	Winter Behaviour
<i>Eptesicus fuscus</i>	Big brown bat	Yellow	None	Resident
<i>Lasionycteris noctivagans</i>	Silver-haired bat	Yellow	None	Resident/Migratory
<i>Lasiurus borealis</i>	Eastern red bat	None	None	Migratory
<i>Lasiurus cinereus</i>	Hoary bat	Yellow	None	Migratory
<i>Myotis evotis</i>	Western long-eared myotis	Yellow	None	Resident
<i>Myotis lucifugus</i>	Little brown myotis	Yellow	Endangered	Resident
<i>Myotis septentrionalis</i>	Northern myotis	Blue	Endangered	Resident
<i>Myotis volans</i>	Long-legged myotis	Yellow	None	Resident

Site assessments at Portage Mountain, prior to quarry development, identified the presence of bat hibernacula (Keystone Wildlife Research Ltd. [Keystone], 2014). Portage Mountain, and the entire Peace River valley between Fort St. John and Hudson's Hope, has been identified as critical habitat for northern myotis (*Myotis septentrionalis*) and little brown myotis (*Myotis lucifugus*), both listed on Schedule 1 of the Species At Risk Act (SARA). Critical habitat has been identified as a limiting factor in the recovery of the species (Environment Canada, 2018).

Following best management practices (BMPs) for bats in relation to mine development (BC MOE, 2016), appropriate buffer zones were established around critical habitat features. The haul road and quarry footprint were redesigned to account for the habitat buffers. The proposed quarry, sorting and stockpiling location were relocated to the north and east respectively (Figure 1) to avoid sensitive habitat. Within the revised quarry footprint (Figure 2), emergence and acoustic data suggested that no hibernacula were present. It was recommended that ongoing monitoring of surrounding habitat features continue during quarry operations, and that the creation of bat hibernation habitat be considered during future quarry reclamation (Sarell and Alcock, 2017). Site clearing began in 2016, and initial test-blasting in 2018.

Monitoring studies were conducted on the bat habitat around the quarry, prior to clearing and quarry development, as well as during quarry development and rock extraction (Sarell and Alcock, 2017; Hemmera, 2020; Hemmera, 2021; Ausenco, 2023; Ausenco, 2024). Monitoring ceased in 2024 once drilling and blasting was concluded, and physical reclamation works completed. Results of the monitoring prior to quarry development, and during rock extraction, indicated that no noteworthy variation in species composition or habitat use was discernable (Hemmera, 2020; Hemmera, 2021; Ausenco, 2023; Ausenco, 2024).

Quarry operations (Figure 3) were able to avoid spatial impacts to nearby bat habitat by altering quarry design and the limits of the proposed haul road. Noise and vibration monitoring during blasting for quarry operations ensured that the BC bat BMPs were followed. Noise and vibration levels from blasting were limited to a concussion of less than 150 decibels, shock waves less than 15 psi, and peak particle velocity less than 15mm/s (RWDI 2018, 2020). Sound levels measured at the monitoring locations indicated a negligible difference (+2 dB) between construction and non-construction periods (Dailyde et al., 2022). Lights were shrouded for early morning and night operations and directed away from the blast face and adjacent habitat features. Temporal disturbance was mitigated against by adhering to a no-blasting window between September 15th and May 15th annually, to avoid sensitive timing windows for bat hibernation, in compliance with the BMPs (BC MOE, 2016) and guidelines set forth in MFLNRO (2014).

Production blasting occurred between 2019 and 2021. Rock hauling from the stockpile in the lower quarry continued into 2022. Physical reclamation works began in August 2023, however delays in finalizing reclamation designs, as well as contractor and material procurements meant extended reclamation efforts up to November 2024.

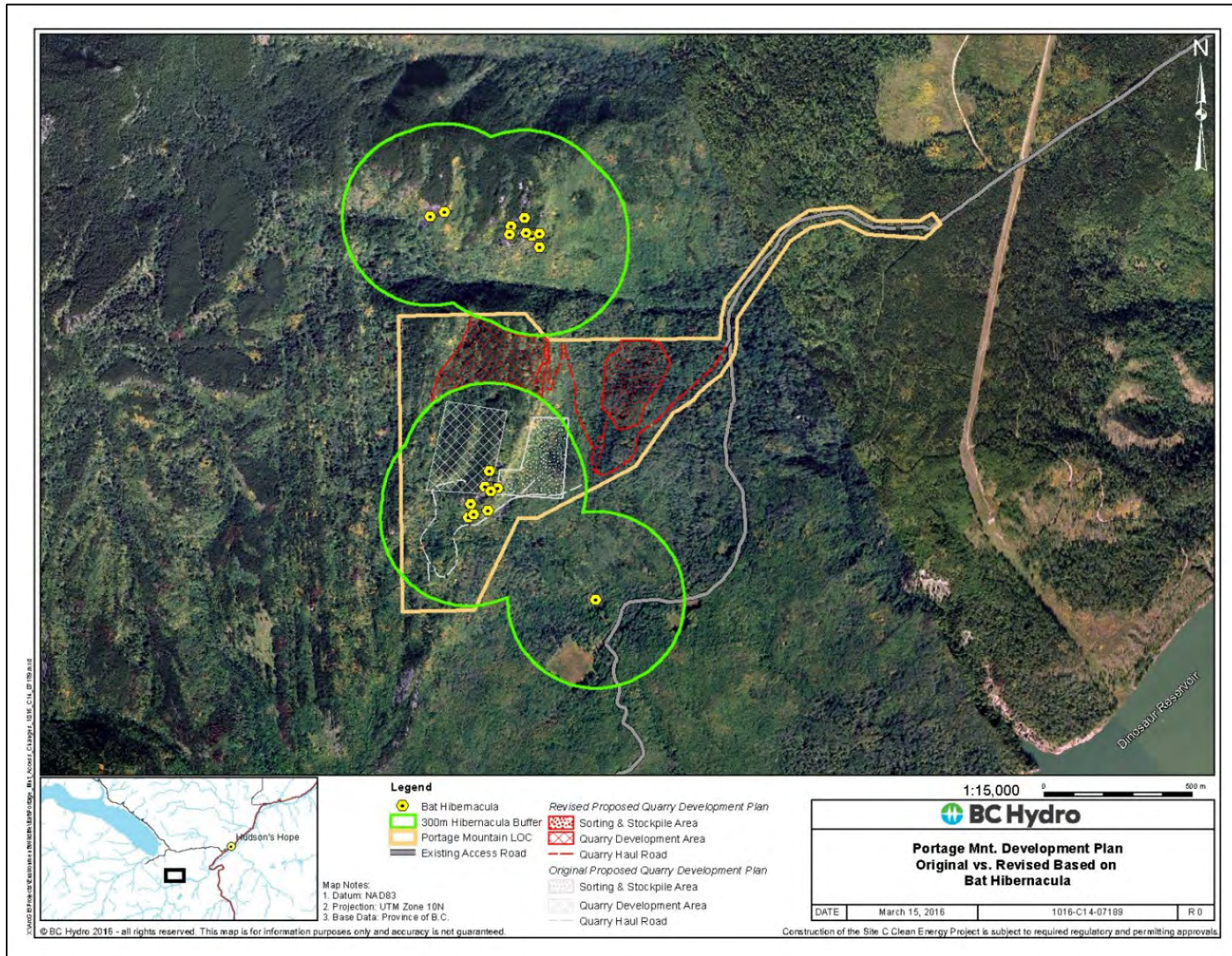


Figure 1. Location of Portage Mountain Quarry showing original and revised development plan areas

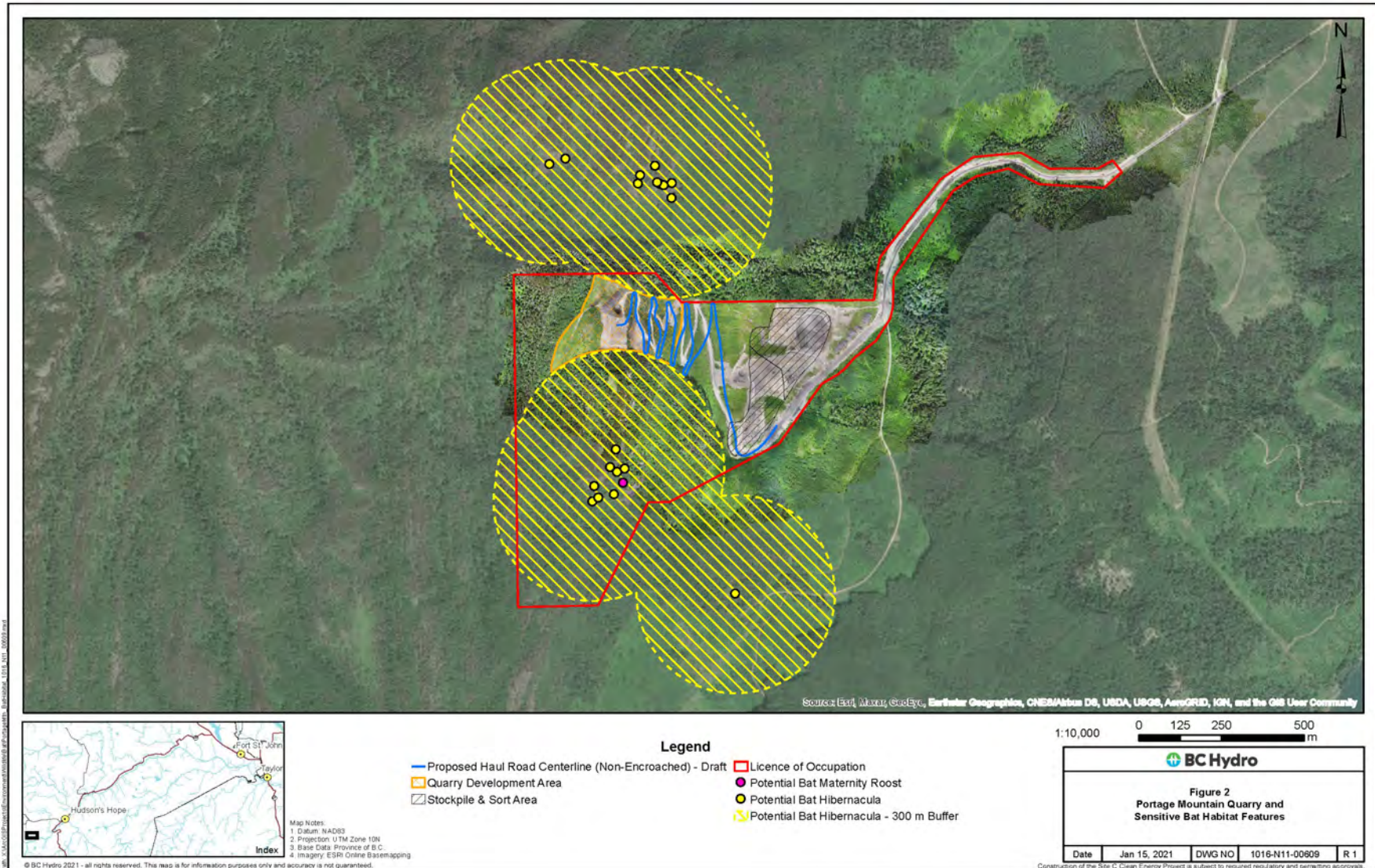


Figure 2. Map of PMQ showing the proposed haul road and nearby sensitive bat habitat features



*Figure 3. Production mining at PMQ during the summer of 2021*

## 2 Methods

### 2.1 Artificial Hibernacula Construction

Two types of experimental hibernacula were proposed for construction. One design involved drilling, blasting, and auguring, to create a cave-like structure, and the second was a buried culvert design. Both types were designed to mimic natural features known to encourage roosting and hibernation. A total of four hibernacula were proposed for construction during PMQ reclamation using the drilling, blasting, and auguring method.

However, due to costs and project timing implications, three hibernacula were constructed using the drilling and blasting method and the fourth hibernaculum was constructed using the buried culvert (Figure 4). Table 2 summarizes the name and location of each hibernaculum, along with construction type, and instrumentation installed.

Table 2. Summary of Constructed Hibernacula at PMQ.

Name	Location	Type	Depth (m)	Thermistors (n)	Hygrometers (n)
<b>2-20</b>	Switchback 6	Cave	20	5	0
<b>1-30</b>	Bench 2	Cave	24	7	2
<b>1-31</b>	Bench 2	Cave	30	7	2
<b>CH-1</b>	Bench 3	Culvert	20	4	2



Figure 4. PMQ haul road and upper quarry showing the locations of the four constructed hibernacula summarized in Table 2

### 2.1.1 Drilled and Blasted Hibernacula

Three hibernacula were constructed by drilling, blasting, and auguring rock to form caves that were 0.8 – 1.2 m wide and 20 – 30 m deep. For each of these features, three boreholes were drilled into the rock wall in a triangular pattern, before blasting, to create a rough surface. An auger drill was used to remove the blasted rock joining the boreholes into a triangular- shaped cavern (Tetra Tech, 2025).

The openings created from the drilling, blasting, and auguring, were covered using mortar and locally available rock, and entrance slits were created for bat access. A hatch was included to provide access to instrumentation installed in each hibernaculum. As the hibernacula were finished too late for bat hibernation occupancy, the entrance slits were blocked with wood during winter 2023-2024 to exclude use of the cave hibernacula by other wildlife establishing there before bat occupancy. As physical reclamation works progressed down the quarry in November 2024, these wood inserts were removed to make the features accessible to bats.

Figures 5A, B, C shows the entrance features at sites 2-20, 1-30, and 1-31 respectively.

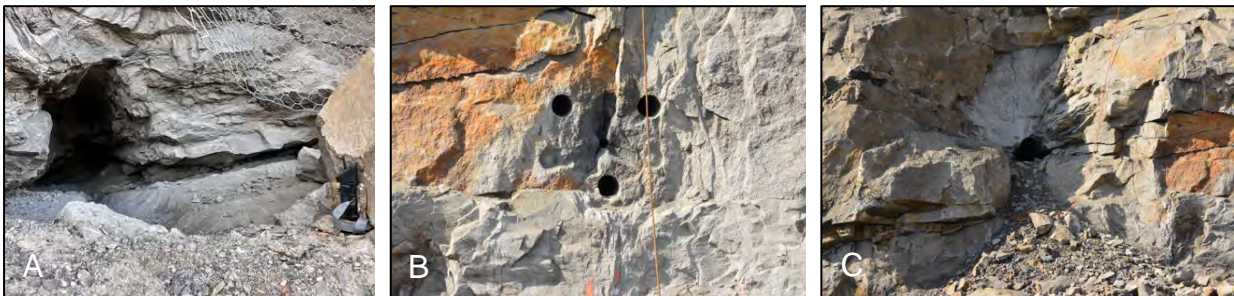


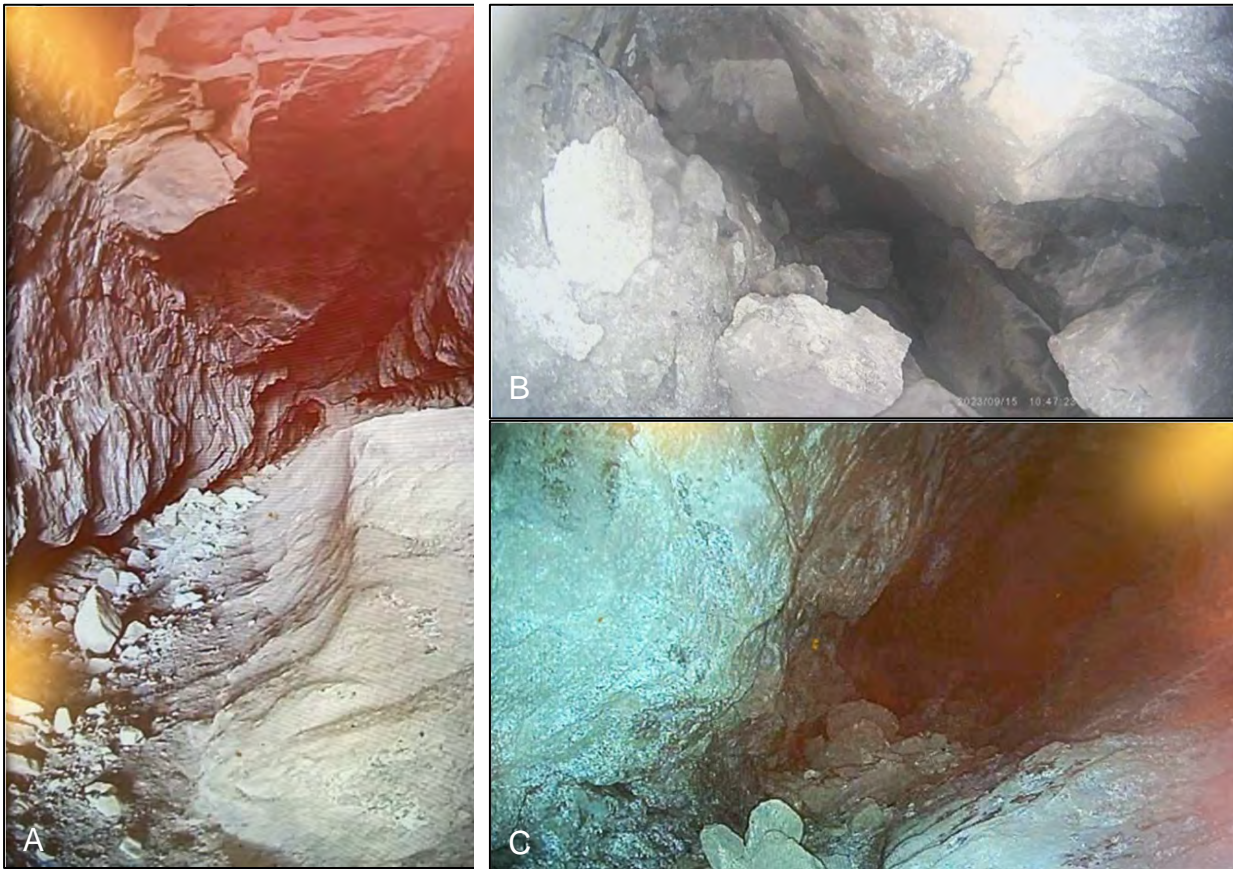
Figure 5. Sites 2-20 (A), 1-30 (B), and 1-31 (C) Following Drilling and Blasting.

Figures 6A, B, C shows the same locations following mortaring of the entrances and wooden block to temporarily block wildlife access during ongoing construction activities.



Figure 6. Mortar and Stone Entrance Features at Sites 2-20 (A), 1-30 (B), and 1-31 (C)

A borehole camera was used to collect images from inside each of the caves to determine if the blast had created the desired effect of roughened heterogenous surfaces inside (Figures 7A-C).



*Figure 7. Boreoscope Images Showing the Insides of the Drilled Hibernacula at Sites 1-31 (A), 2-20 (B), and 1-30 (C).*

### 2.1.2 Culvert Hibernaculum

A fourth hibernaculum designed and installed on bench three consisted of a 1200 mm galvanized aluminum laminated corrugated steel pipe (CSP) culvert with a wooden plug at one end. Design drawings are shown in Appendix A Figure 16. Inside it included an octagonal plywood insert with scoring along its length spaced 6 mm apart, to allow for a grooved surface for bats to hang from. Sand was then spread along the floor of the culvert (Figures 8A, 8B). The culvert was placed on a bed of sand covered with geotextile fabric. Like the cave hibernacula, the entrance was enclosed using rock and mortar with a hatch for accessing instrumentation.

Insulation panels were added over the top of the culvert before being backfilled with topsoil strippings and seeded with a native seed mix consisting of Canada wild rye, slender wheatgrass, American vetch, rough fescue, and Rocky Mountain fescue (Figures

9A, 9B). Field fitting was required to complete the installation of the culvert which had to be placed further from the rock wall than the design indicated with more insulation panels used than anticipated. All the changes from the original design drawings were summarized within the as-built drawings provided by the contractor’s survey team.



Figure 8. Construction of the culvert hibernaculum showing scored plywood inserts and a sand base.



Figure 9. Insulation panels (A) and final soil cover and windbreak boulders (B) during construction of the culvert bat hibernaculum.

## 2.2 Temperature and Humidity Instrumentation

Multipoint string thermistors from RST Instruments, model TH0022-Q148562-1, were housed in perforated polyvinyl chloride (PVC) pipe and installed at sites 2-20, 1-30, and 1-31 in 2023, and in site CH-1 in 2024 (Tetra Tech, 2025). These were connected to RST’s DT Series data loggers (DT2055B-T-USB-D\_CELL) to monitor thermistor condition and record temperature data.

In October 2024, Campbell Scientific HygroVue10 hygrometers paired with CR350 data loggers, were installed in each hibernaculum except site 2-20. Two hygrometers were installed at each site to track humidity through the length of the hibernacula. At site 2-20, no hygrometers were installed as suspected rock fall or movement inside the cave posed safety challenges for installation with the risk of damaging previously installed thermistors. Table 2 summarizes the temperature and humidity instrumentation installed at each location.

Predictions can be made to estimate the relative humidity inside the constructed hibernacula. Temperature (T), relative humidity (RH) and dewpoint temperature  $T_d$  are related as shown in the formula:

$$T_d = T - ((100 - RH)/5)$$

While the relationship between  $T_d$  and RH is not linear, for all values of  $RH > 50\%$  it is satisfactory to use the above formula (Lawrence, 2005).

The data collected at the AQ station in Hudson’s Hope includes relative humidity, and thus, the  $T_d$  can be calculated. Assuming the  $T_d$  is similar both outside and inside the constructed hibernacula, and using the internal temperature data, a range of internal relative humidity can be inferred.

This is based on the assumption that there is limited airflow via convection into, or out of, the constructed caves. While precise internal relative humidity might not be predicted, having a possible range of internal RH can provide an indication whether the hibernacula fall into the preferred RH range of 60% - 100% (Lausen et al., 2022).

Using the formula below (Lawrence, 2005), we can calculate the lower and upper ranges of predicted RH in each hibernaculum, which is summarized in the Table 3.

$$RH = 100 - 5(T - T_d)$$

*Table 3. Predicted relative humidity in each artificial cave hibernaculum.*

	<b>2-20</b>	<b>1-30</b>	<b>1-31</b>
Lowest RH	11.05	11.8	12.75
Highest RH	109.48	100.63	91.95

Data collection stations were installed at each location (Figures 5 and 6) to allow for downloading data without having to approach close to the rock wall, lowering the safety hazards associated with rock fall. All installed instrumentation was purchased new as per provincial standard operating procedures (WLRS and MOF, 2023) to mitigate against the introduction of the fungus (*Pseudogymnoascus destructans*) that causes white-nose syndrome (WNS).

## 2.3 Acoustic Monitoring

In October 2024, four Titley Scientific Ranger acoustic recording units (ARUs) with an ultrasonic omnidirectional microphone were installed inside each hibernaculum. The microphones were located just inside an entrance slit at each of the hibernacula and were positioned to record vocalizations inside the hibernacula to assess bat use over the winter.

Studies of bat phenology indicate that bats swarm prior to hibernation. Swarming includes increased flight in and around hibernation sites and the presence of multiple species. This occurs annually in late fall (Glover and Altringham, 2008). While the reasons for swarming are not fully understood, mating, assessing potential hibernation site suitability, and sharing this information between individuals are believed to be some of the reasons (Van Schaik et al., 2015).

Two additional ARUs with an omnidirectional microphone were installed on poles on the road switchback benches to capture any swarming activity around the artificial hibernacula. External microphones were positioned 3-4m above ground level. All ARUs were fitted with freshly formatted memory cards and were connected to solar panels for power. Table 4 below summarizes the locations of all six ARUs deployed.

Table 4. Locations and recording settings of ARUs at PMQ.

ARU Identifier	Location	Fall/Winter Settings	Spring/Summer Settings
Rgr 1	CH-1 internal	Continuous, ZC*	Continuous, ZC
Rgr 2	1-31 internal	Continuous, ZC	Continuous, ZC
Rgr 3	1-30 internal	Continuous, ZC	Continuous, ZC
Rgr 4	2-20 internal	Continuous, ZC	Continuous, ZC
Rgr 5	Bench 3 ambient	Continuous, ZC	Night mode, FS+
Rgr 6	Bench 2 ambient	Continuous, ZC	Night mode, FS

\* ZC – zero cross recording

+ FS – full spectrum recording

Figure 10 shows an ARU with wire mesh set up on the back of the data collection station at site 1-31. Wire mesh was used to deter rodents where exposed cables could be chewed or otherwise damaged. Figure 11 shows data collection stations at sites 1-30 and 1-31.

For winter bat monitoring, all ARUs was set to continuous recording, with sound format set to zero cross. The advantages of zero cross recordings are smaller file sizes, longer battery life, and clear call shapes when analyzing acoustics. The disadvantage is that only the loudest frequency sound is recorded which may not be a bat.

Due to ongoing construction activities, the entrances to the artificial hibernacula were blocked and unavailable to bats until October 2024, so bats were not expected to use them over the winter of 2024-2025. However, setting up the acoustic monitoring in advance allowed for changes and upgrades to the setup prior to the first winter of

availability for bats. This ensures that any potential issues with the equipment were addressed, and a robust monitoring system established.



*Figure 10. An ARU attached to the data collection station at hibernaculum Site 1-31 enclosed by wire mesh to prevent wildlife tampering.*

Following the installation of thermistors at sites 2-20, 1-30, and 1-31 in 2023, resetting and calibration of the thermistors was required at the start of 2024; temperature data collection was initiated February 3, 2023, and is ongoing. Each thermistor logs the temperature twice daily. Thermistor data was downloaded periodically in 2024 with the final download of the year on October 9, 2024.

Based on the preliminary results of temperature data from the artificial hibernacula, it is predicted that these features could be used by bats as early as the winter of 2025-2026. The lifespan of the data logger batteries is expected to be between 5 – 7 years based on manufacturer technical specifications and are replaceable. The lifespan of the cave design hibernaculum is expected to be longer than the culvert design. The plywood inserts in the culvert hibernaculum will eventually break down, however this is not expected to occur until long after the conclusion of the monitoring program. Monitoring of the artificial hibernacula is expected to continue until use of these features by bats is confirmed. If no

use is confirmed after three full seasons of monitoring, then funding for further monitoring will be discussed.



*Figure 11. ARUs installed at hibernacula Sites 1-30 and 1-31.*

## 3 Results

### 3.1 Temperature Monitoring

Average daily temperatures for each thermistor were plotted with the daily average external temperature from the AQ station. Figures 12 – 14 show the results of internal temperatures plotted against external air surface temperatures for artificial hibernacula 2-20, 1-30, and 1-31 respectively. While the first one or two thermistors (i.e., T1, T2) closer to the hibernaculum opening recorded larger variability as external temperature changed, the deeper reaches of the cave showed less variability in temperature.

### 3.2 Relative Humidity Monitoring

Due to the technical issues with downloading data in 2025, there is no humidity data available yet. Downloading relative humidity data will be attempted again in 2026.

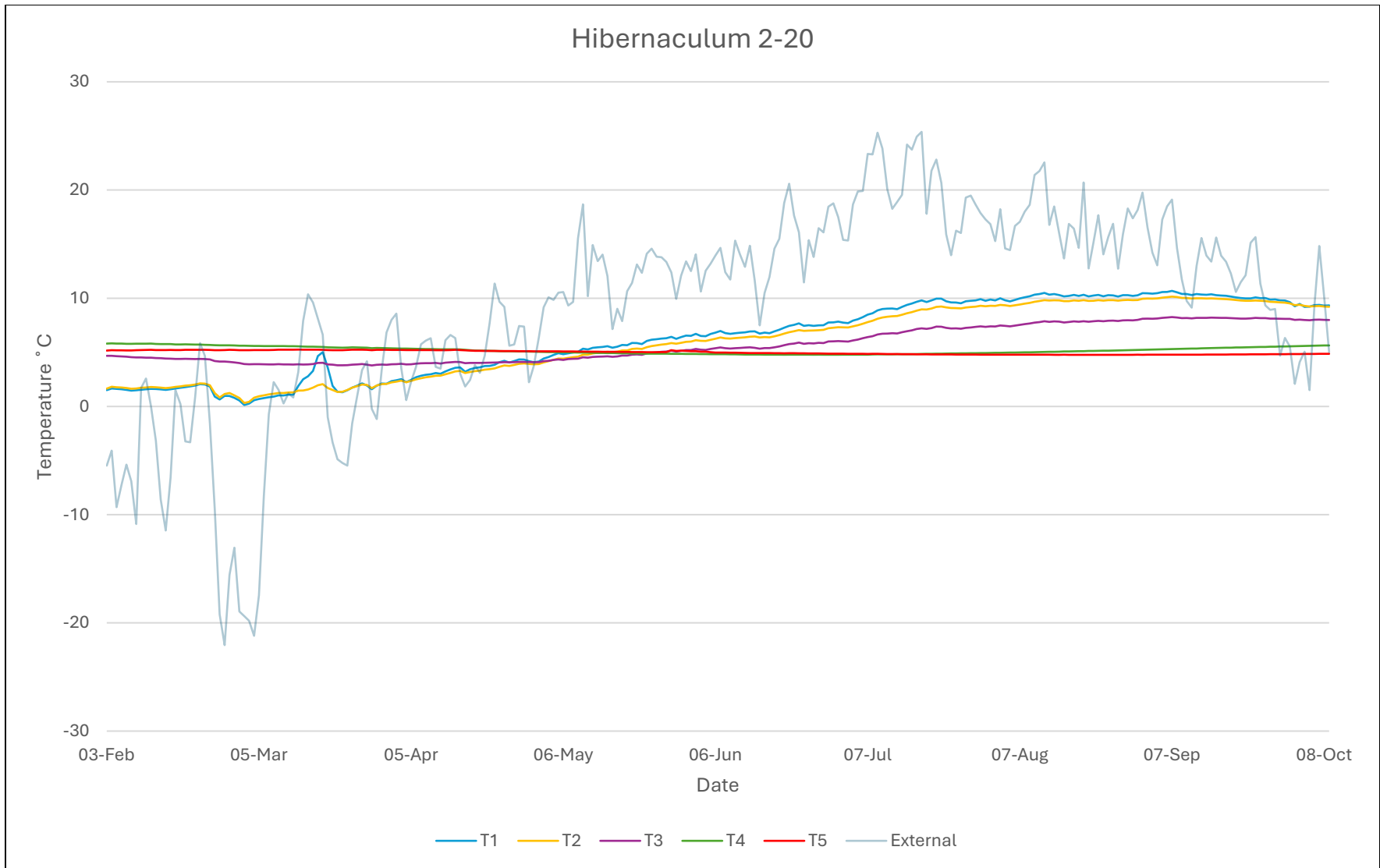


Figure 12. Results of temperature monitoring at Hibernaculum 2-20 from February 3 to October 9, 2024.

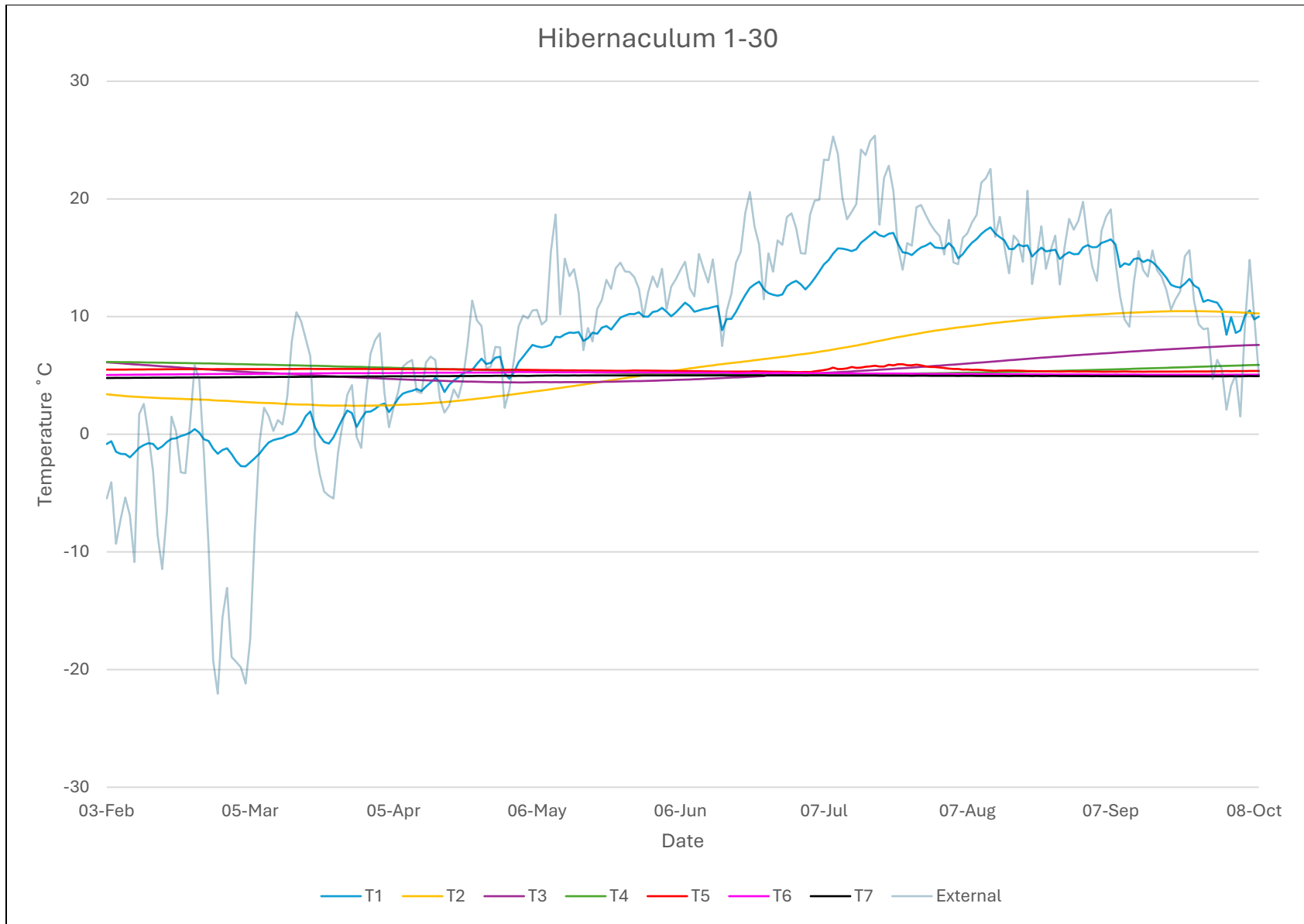


Figure 13. Results of temperature monitoring at Hibernaculum 1-30 from February 3 to October 9, 2024.

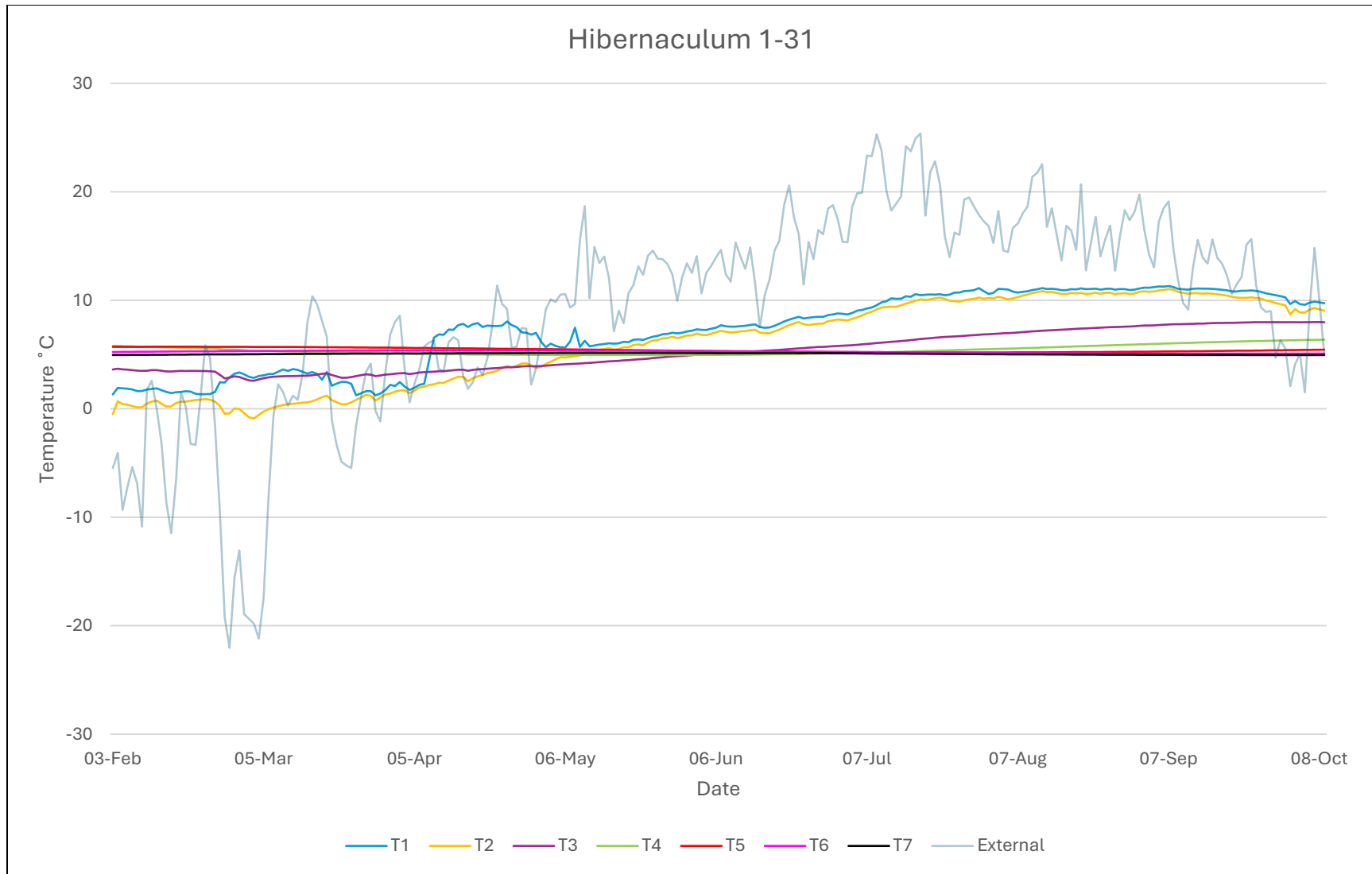


Figure 14. Results of Temperature Monitoring at Hibernaculum 1-31 from February 3 to October 9, 2024.

### 3.3 Acoustic Monitoring

Acoustic monitoring of the artificial hibernacula is ongoing. To date, no acoustic evidence of bats has been noted. The SD cards are swapped twice every year, in the spring, prior to emergence, and once again in the fall prior to hibernation.

## 4 Discussion

Generally, bats prefer hibernation sites where temperatures are above freezing, with no drastic temperature fluctuations, and high humidity levels (Lausen et al., 2022). In BC most resident species will overwinter in caves or abandoned mines where the temperature is between 0 – 5 °C (Nagorsen et al., 1993). A species-specific review of temperatures at which hibernating bats have been found in a state of torpor is summarized in Table 5 (Webb et al., 1996; Lausen et al., 2022).

Within species, preferred hibernation temperatures and site selection may vary based on immediate environment (e.g., latitude, local geography, weather conditions, refugia), and other individualized factors including genetics, fitness, sex, age, and reproductive stage. It was found that bats appeared to choose microsites with similar characteristics and temperature regimes across a range of latitudes (McGuire et al., 2021a).

The silver-haired bat is one of the more cold-tolerant species which overwinters in most of BC (De Freitas, 2023). The eastern red bat (*Lasiurus borealis*) is expanding its range westward, but it mostly hibernates in tree crevices and leaf litter and is not known to overwinter in NE BC. Similarly, the hoary bat (*Lasiurus cinereus*) is also known to use tree crevices and hollows to hibernate and is believed to migrate out of BC to overwinter (Lausen et al., 2022).

Table 5. Known Hibernation Temperature Ranges for Bat Species in the Peace River Valley.

Scientific Name	Common Name	Hibernation Temperature Range
<i>Eptesicus fuscus</i>	Big brown bat	-10 to 20 °C
<i>Lasionycteris noctivagans</i>	Silver-haired bat	6 - 7 °C
<i>Lasiurus borealis</i>	Eastern red bat	Not known to overwinter in NE BC
<i>Lasiurus cinereus</i>	Hoary bat	Not known to overwinter in NE BC
<i>Myotis evotis</i>	Western long-eared myotis	Above 0 °C
<i>Myotis lucifugus</i>	Little brown myotis	-4 to 13°C
<i>Myotis septentrionalis</i>	Northern myotis	0.6 to 13.9 °C
<i>Myotis volans</i>	Long-legged myotis	2 – 3 °C

From what is known in BC, suitable bat hibernation temperatures occur in the range of 0-5°C, most often in caves and abandoned mines (Nagorsen et al., 1993). Preliminary temperature data from the three artificial cave hibernacula clearly show an area of stable

temperature in the middle and rear of the caves remaining above 0°C despite external temperatures falling below 0°C. Temperature fluctuations occur closer to the cave entrances. However, a range of temperatures within a hibernation site can be beneficial as not all individuals within a species choose the same hibernation temperatures, and microsite selection within hibernacula is driven by individual fitness (Boyles et al., 2017). This is like McLure et al. (2020) who found that subterranean temperatures increased further from cave entrances, with greater temperature variability closer to cave entrances.

Temperature is only one factor to consider for suitable over-wintering sites (McGuire et al., 2021b). Evaporative water loss is a factor in hibernation site selection, and it is understood that bats choose sites with high humidity (Perry, 2013). The selection of winter hibernation sites with high humidity is favoured by bats, to reduce the arousals from torpor to hydrate (Mas et al., 2022). Predictions for relative humidity indicate that the constructed caves and culvert hibernacula at PMQ meet the preferential requirements for humidity levels in winter hibernation sites. These predictions will be validated once hygrometer data is downloaded in 2026.

Both temperature and humidity can be affected by hibernacula characteristics such as internal topography, cave depth, elevation, latitude as well as more localized factors such as the ingress of water, air, and thermal inputs (Perry, 2013; Webb et al., 1996). Additionally, De Boer et al. (2013) showed that the internal size and structure of the hibernacula were just as important as climatic conditions inside the hibernacula, and that the surrounding landscape and presence of humans was an important consideration when studying site selection by hibernating bats.

Known geothermal activity in the vicinity of the cave hibernacula, and airflow due to convection within each hibernaculum could also be impacting internal temperatures in ways that are not understood. Additionally, if bats begin to use these features, their presence inside will likely affect internal temperature. Regardless of whether internal temperatures in the hibernacula are directly related to variations in external temperature, our findings indicated that a stable band of temperature was present in all three cave hibernacula.

While long term trends are difficult to extrapolate from the limited data available, it appears promising that the constructed cave hibernacula could meet the temperature requirements for selection as a hibernation site by bats present at PMQ

The analysis of temperature and humidity data in 2026 will provide more insight into the efficacy of the artificial hibernacula at PMQ. Ongoing work to monitor occupancy will hopefully demonstrate that the novel methodologies employed here are viable options to mitigate against habitat loss for bat species that are of particular concern both locally, and more broadly in North America.

## 5 Conclusions and Recommendations

It is recommended that the ARUs be serviced at minimum twice annually, once in the spring and once in the fall. Servicing will ensure the units are functioning and monitor damage from the elements or rodents, and that memory cards are changed. Solar panels should be checked to ensure they are functional, and reoriented if required.

The ARUs that are monitoring acoustics within the constructed hibernacula should always be set to zero cross-sampling. However, ambient ARU sampling mode should be changed seasonally. In the spring, prior to emergence, these should be set to full spectrum sampling, to ensure that sounds of all frequencies are recorded. In the fall, prior to hibernation but ideally late enough in the season to capture swarming, the ambient ARUs should be set back to zero cross sampling for the winter.


Data downloads were attempted in 2025 however the download stations did not work as expected. Preliminary analysis of the issue indicated that the cables connecting the data loggers to the download station are too long to facilitate data transfer. Replacing the existing cables with active cables is being considered. Active cables have a built-in signal booster and require a power source. In the summer of 2026 data will be downloaded directly from the data loggers while the feasibility of cable upgrades to the download stations is assessed. Given the overhead hazards, this will be done in the summer, to avoid increased risk in the spring following the freeze-thaw cycles over winter that, would have loosened overhead rocks.

A guide to changing and formatting memory cards and setting the sampling mode on the ARUs is included in Appendix B. A guide to downloading thermistor and hygrometer data will be developed once the download issues are fixed in 2026.

Decontamination protocols for minimizing WNS transmission (WLRS and MOF, 2023) should be followed by anyone servicing the monitoring equipment and completing data downloads, especially if any internal microphones need to be serviced or replaced.

## 6 Closure

This report was prepared with the most up to date information available at the time of writing. If you have any questions or comments, please contact the undersigned.

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# APPENDIX A

## Culvert Hibernaculum Design Drawings



# Appendix B

Titely Ranger Job Aid


These units can suffer from moisture and corrosion issues if they are opened and closed in foul weather. Best practice is to bring units inside and let them warm up or cool down to ambient conditions before opening, and to leave them open to air out before storing.

Never store units with batteries inside.

For additional information refer to the Titley Ranger User Manual

[Ranger-User-Manual-Version-1.1.pdf](#)

### New Unit

1. Add 4 batteries to the main (left/yellow) bank – unit will automatically turn on.
2. On the Main Dashboard – press the Settings icon 
  - a. Press [Region]
  - b. Set time zone (-7 GMT)
  - c. Press return button (↵)
  - d. Press [Asset Tag], and set following:
    - i. Company = BCH
    - ii. Asset ID = Rgr1, Rgr2, Rgr3. etc.
  - e. Press return button twice to get back to Main Dashboard
3. Turn off unit by holding the power button located above the touchscreen for 2 seconds.
  - a. Press the red power button on the touchscreen to turn off.

### Deployment Preparation

1. Insert one SD card into slot 1 (128 GB Scandisk Ultra recommended)
2. Plug in externa power or Add 8 batteries – unit will automatically turn on.
3. Format SD 1 card:
  - a. on touchscreen, press the top left SD card (1) icon .
  - b. Press [Erase...], then [Yes]
  - c. After acknowledging message, press [OK]
  - d. Press the eject button (looks like SD card with arrow) on top left.
  - e. With 'safe to remove' message – remove SD.
  - f. Press the return button.
4. Insert one SD card into slot 2.
5. Format SD 2 card:
  - a. on touchscreen, press the top right SD card (2) icon.
  - b. Press [Erase...], then [Yes]
  - c. After acknowledging message, press the eject button (looks like SD card with arrow)

- d. Hit the return arrow.
6. Insert SD 1 card again so that both cards are now loaded, empty, and formatted.
7. Set Sampling Mode:
  - a. Press the Mode button, left of the touchscreen, to one of four options.
    - i. For winter bat monitoring, Continuous Mode is recommended (bottom option)
    - ii. For active season bat monitoring, Night Only Mode is recommended (second from bottom)
8. Set sound format:
  - a. On Main Dashboard of touchscreen, press the microphone button.
  - b. Press “ZC Ultrasonic” to minimize power consumption (e.g., for winter), or for monitoring inside roost passages etc.
  - c. Press “FS Ultrasonic” for normal bat monitoring during active season – this allows for best species identification.
  - d. Press “Acoustic” for bird monitoring.
  - e. Press “Simultaneous” for bird and bat.
9. Either leave running or turn off unit and turn on again on location.

### Field Setup

1. Turn on (if batteries inside) or insert power source (e.g., solar kit)
2. Attach the mic(s)
3. Check status with magnet.
4. Continue with set up (mounting etc.)

### Card Swap

1. Access the SC card menu by tapping on either SD card button.
2. Select the appropriate card slot and tap eject card.
3. DO NOT remove an SD card without ejecting or turning off power to the unit first.
4. Eject both cards following the above steps.
5. Insert new cards into the slots.
6. Format new SD cards following the step 5 in [Deployment Preparation](#) above.
7. Check status with the magnet as described in [Field Setup](#) above.
8. Store SD cards from each unit in separate envelopes to ensure proper data management.

## **Appendix 17. 2025 Bat Box Monitoring Report**



**West Moberly-DWB Limited Partnership**

# **BC Hydro Site C Clean Energy Project: Bat Box Monitoring Program 2025 Annual Report**



**Prepared for: BC Hydro and Power Authority**  
Attn: Brent Matsuda, M.Sc., R.P.Bio.



**Prepared by: West Moberly-DWB Limited Partnership**  
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Date: 2026-03-31 | DWB file: W2522-064 | Revision: 2



**OQM** | Organizational Quality Management Program

# Signature Page

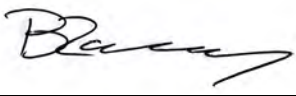
Signature Page West Moberly-DWB Limited Partnership is pleased to submit this report for your review. This report has been prepared using sound technical and professional judgment, based on our knowledge and experience, applicable regulatory framework, industry best management practices, and current understanding of Program conditions, design, and Program setting.

REPORT TITLE: BC Hydro Site C Clean Energy Project:  
Bat Box Monitoring Program 2025 Annual Report

PREPARED FOR: British Columbia Hydro and Power Authority

REVISION: 2

WRITTEN BY:   
Adam Sprott, R.P.Bio, P.Biol, A.Ag.

REVIEWED BY:   
Ben Rauscher, P.Ag.



REVISION HISTORY				
DATE	VERSION	REVIEW TYPE <sup>1</sup>	REVIEWED BY (NAME, COMPANY)	CHANGES MADE FOLLOWING REVIEW
MARCH 27, 2026	0	CLIENT	BRENT MATSUDA, BC HYDRO	CLARIFICATIONS AND FORMATTING
MARCH 30, 2026	1	CLIENT	BRENT MATSUDA, BC HYDRO	CLARIFICATIONS AND FORMATTING

<sup>1</sup> Editorial Review: Reviewed for formatting, grammar, spelling, etc.  
Professional Review: Reviewed for content and professional signoff  
Client Review: Reviewed by client  
Regulatory Review: Reviewed by regulatory agency if necessary.  
Peer Review: Reviewed for content and errors by peer.

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We do not represent, warrant, undertake or guarantee:

- That all Program environmental-related information has been received.
- That regulations and standards of practices shall remain constant through the duration of the Program.
- That the use of guidance in the report will lead to any particular outcome or result; or, in particular,
- That by using the guidance in the report, the client will be approved by the contract holder for the applied works.

# Executive Summary

Monitoring activities were completed during the 2025 season of 121 bat roosting structures at 20 sites as per the Site C Vegetation and Wildlife, Bat Mitigation and Monitoring Program (BC Hydro, 2022). Bat use of the box structures was evaluated through occupancy and guano surveys, emergence point counts, and temperature loggers. Guano surveys suggested greater occupancy at more western sites and at higher levels than has been previously observed (WSP, 2024). Emergence point counts varied between sites but demonstrated activity at sites with large guano deposits suggesting that the five survey sites had high bat occupancy of either a large number of bats or frequent use by a moderate number of bats. Temperature data suggested some boxes may exceed ideal temperatures for bat occupation, particularly in boxes on west-facing slopes in the eastern area of the Program. For long-term management, 36 boxes at six sites were identified as candidates for relocation, and 22 boxes at six sites were identified having potential for long-term monitoring and retention.

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# 1.0 INTRODUCTION

West Moberly-DWB Limited Partnership (WM-DWB) was retained by British Columbia Hydro and Power Authority (BC Hydro) to monitor bat boxes for the Site C Clean Energy Project (the Project) Bat Mitigation and Monitoring Program (Program; BC Hydro, 2022). The scope of work included providing Qualified Environmental Professionals (QEPs) and environmental technicians to assess the occupation and use of bat boxes installed upstream of the Site C dam along the north shore of the reservoir. This report discusses the observations of the 2025 bat box monitoring season.

Eight bat species are known to occur in the Peace Region (Lausen et al. 2022):

- Big Brown Bat (*Eptesicus fuscus*)
- Silver-haired Bat (*Lasionycteris noctivagans*)
- Hoary Bat (*Lasiurus cinereus*)
- Eastern Red Bat (*Lasiurus borealis*)
- Long-eared Myotis (*Myotis evotis*)
- Little Brown Bat (*Myotis lucifugus*)
- Northern Myotis (*Myotis septentrionalis*)
- Long-legged Myotis (*Myotis volans*)

Of these eight species, Little Brown Bat and Northern Myotis are listed as Endangered under the Species at Risk Act (SARA, 2026), with Hoary Bat, Little Brown Bat, and Northern Myotis Blue listed (special concern) by the BC Conservation Data Centre (2026).

The establishment of bat boxes throughout the Project footprint was conducted to mitigate the loss of summer roosting habitat for free-roosting bats resulting from reservoir fill in the fall of 2024. This report includes an overview of the work completed as well as best management practices (BMPs) that were implemented during key phases of the Program.

## 1.1 REGULATORY CONTEXT

The requirements for monitoring of wildlife resources during Project construction and operations are set out in the provincial Environmental Assessment Certificate (EAC), Schedule B-Table of Conditions, and the Federal Decision Statement (FDS), issued by the Government of Canada. Details are provided below.

### 4.1 Provincial Environmental Assessment Certificate

Condition 16 of the EAC issued by the Province of British Columbia, 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 at least the following compensation measures:*

- A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into a new bridge design located within the Peace River valley.
- Following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats.

### 4.2 Federal Decision Statement

The requirements for addressing bats in the FDS are in relation to Condition 16 which states:

*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;*

*16.3.6 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*

*16.6 The Proponent shall implement the plan and provide to the Agency analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and for the first 10 years of operations.*

MOTI did not allow installation of bat boxes on the new bridges constructed on Hwy 29 so this Program focused on the establishment of bat boxes throughout the Project footprint in response to mitigation considerations for the rock extraction activities conducted at Portage Mountain.

## 1.2 LOCATION AND BACKGROUND INFORMATION

The Program area stretches along the north shore of the Site C reservoir for approximately 70 km (west) of Fort St. John, BC. Bat box locations are shown in Figures 1, 2, & 3. All sites were accessible by vehicle although several sites required access over private land.

Bat boxes had been previously installed during the 2018 – 2020 field seasons (WSP, 2024). Bat roost boxes were constructed using designs from Bat Conservation International (Tuttle et al., 2004) and the Pennsylvania Game Commission (Butchkoski and Hassinger, 1997). Two designs of bat boxes were installed: rocket boxes (24.3 x 24.3 x 91.4 cm tall with a 25.4 x 25.4 cm roof) and maternity boxes (44.5 x 10.5 cm x 78.7 cm tall with a 16.5 x 48 cm roof). These boxes were painted either dark brown/black or light brown and mounted on 2.5 – 3 m tall steel poles. A total of 120 boxes in 20 clusters were installed, with each cluster containing two rocket boxes and four maternity boxes housed on four poles. Each pole housed either a single rocket box or two maternity boxes. In addition, a stand-alone bat condo (243.8 x 243.8 x 259.1 cm tall) was also installed. Photographs of bat box designs are included in Appendix A.

Guano screens were also installed beneath the bat box poles (WSP 2024). Most boxes have a four-legged, ground-level screen around the base of the pole raised about two feet off of the ground. In response to damage from wildlife and/or livestock (Bat\_21.4, Bat\_82.1, Bat 272.2N and Bat \_272.2 S) a more robust screen structure was installed at chest height attached directly to the pole. Photographs of guano screen designs are included in Appendix A.



**Figure 1.** General overview map of the Program area and location. Red points mark the locations of the bat box clusters with the Site C Dam marked in light blue.



**Figure 2.** Overview map of the eastern Program area. Red points mark the locations of the bat box clusters with the Site C Dam marked in light blue.



**Figure 3.** Overview map of the western Program area. Red points mark the locations of the bat box clusters.

## 2.0 SUMMARY OF MONITORING AND ASSESSMENT ACTIVITIES

During the 2025 season, WM-DWB conducted the following monitoring and assessment activities:

- inspections and maintenance of the bat boxes and guano screens;
- three occupancy surveys of most bat box structures;
- one evening of emergence point counts and acoustic detections at a subset of five bat box sites; and
- temperature logger installation within a subset of 12 bat boxes;

These activities and the corresponding results are summarized below.

### 2.1 OCCUPANCY SURVEYS

During the three occupancy surveys through the 2025 season, bat boxes and guano screens were assessed for:

- structural condition, including damage to boxes, mounting poles, and guano screens;
- presence and quantity of bat guano as an indicator of recent use;
- visual observations of bats using an endoscopic camera to inspect inside the boxes; and
- audible bat vocalizations observed by the field personnel.

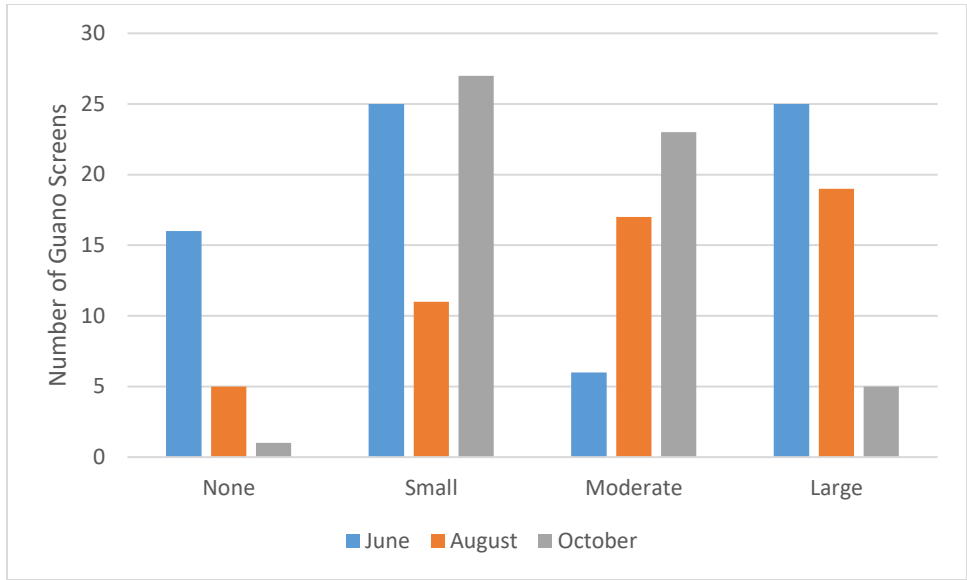
Observing guano quantities beneath the bat boxes provides a general estimate of bat box use and occupancy (Kunz and Reynolds, 2003). The amount of guano deposited on the screens was scored as either 'Small', 'Moderate', or 'Large'. Small quantities were scored as less than 100 pellets and suggested infrequent use by bats. Moderate quantities were scored as between 100 and 1000 pellets and suggested relatively frequent use by a small number of bats or infrequent use by many bats. Large quantities were scored as more than 1000 pellets and suggested frequent use by many bats. This scale was updated from the WSP (2024) methodology of Small (<15 pellets), Moderate (15 – 100 pellets), or Large (>100 pellets), as of the many guano counts significantly exceeded the 100-pellet threshold. Consequently, the guano scoring scale has been adjusted to reflect the relative difference between guano counts in 2025. Photographs of the different guano scoring categories are included in Appendix A.

All screens were cleaned after each field visit, and any screens damaged from wildlife, livestock, or weather were repaired. A pole housing two maternity boxes at site Bat\_153 was found broken and laying on the ground and could not be repaired in 2025.

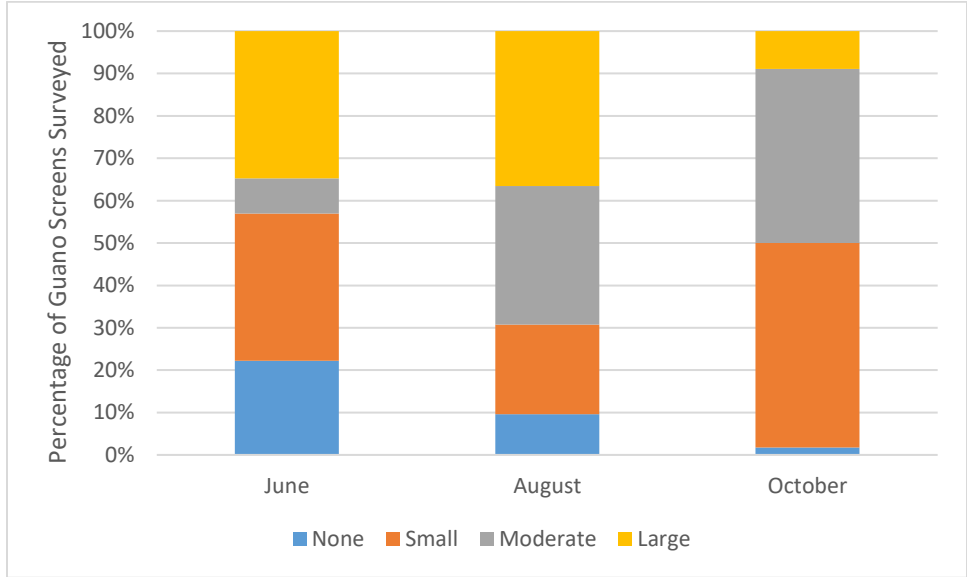
Occupancy surveys were conducted by a WM-DWB biologist and an environmental technician, the results of which are presented in Figures 4 & 5 and are summarized below:

- Between June 11 and 19 2025, a monitoring team conducted site visits to the 20 bat box clusters to inspect 121 bat boxes including the Bat Condo and 81 screens.
  - Nine screens were too damaged to accurately assess guano deposition.
  - Large quantities of guano were observed at sites Bat\_21.4, Bat\_82.1, Bat\_134, Bat\_144, Bat\_145, Bat\_153, Bat\_258, Bat\_258NE, Bat\_272.2N, and Bat\_272.2S.
  - Bats were audibly or visually observed in 21 boxes at 6 sites including Bat\_144, Bat 145, Bat 258NE, Bat\_258, Bat 272.2N, Bat 272.2S.

- Of the 72 surveyed screens, 78% showed some sign of bat occupation with 35%, 8%, and 35% having Small, Moderate, or Large quantities of guano present respectively.
- Between August 3 and 7, 2025, the monitoring team conducted site visits to 13 clusters to inspect 78 bat boxes and 52 screens. This survey was conducted in August instead of late July due to the bat mortalities discovered in the preliminary July 21, 2025 survey (See Section 2.5) and to avoid disturbing any pups that may have been present at that time.
  - Twenty-nine screens were too damaged or could not be accessed through private property to accurately assess guano deposition.
  - Large quantities of guano were observed at sites Bat\_144, Bat\_145, Bat\_153, Bat\_258, Bat\_258NE, Bat\_272.2N, and Bat\_272.2S.
  - Bats were audibly or visually observed in 29 boxes at seven sites including Bat\_144, Bat\_145, Bat\_153, Bat\_258NE, Bat\_258, Bat\_272.2N, and Bat\_272.2S.
  - Of the 52 surveyed screens, 90% showed some sign of bat occupation with 21%, 33%, and 37% having Small, Moderate, or Large quantities of guano present respectively.
- Between October 1 and 4, 2025, the monitoring team conducted site visits to 18 clusters to inspect 108 bat boxes and 72 screens.
  - Twenty-five screens were too damaged or unable to access through private property to accurately assess guano deposition.
  - Moderate quantities of guano were observed at sites Bat\_21.4, Bat\_82.1, Bat\_134, Bat\_144, Bat\_145, Bat\_153, Bat\_254, Bat\_258, Bat\_258NE, Bat\_272.2N, Bat\_272.2S, and Bat\_330.
  - Large quantities of guano were observed under boxes Bat\_145 C/D, Bat\_258 C/D, Bat\_272.2N1, Bat\_272.2S, and Bat\_330.2 A/B which were all maternity boxes.
  - No bats were audibly or visually observed.
  - Of the 56 surveyed screens, 98% showed some sign of bat occupation with 48%, 41%, and 9% having Small, Moderate, or Large quantities of guano present respectively, with only one box (Bat\_217E F) devoid of guano.



**Figure 4:** Number of guano screens surveyed with No guano, Small, Moderate, or Large quantities observed during the bat occupancy surveys in 2025.



**Figure 5:** Proportion of guano screens surveyed with No guano, Small, Moderate, or Large quantities observed during the bat occupancy surveys in 2025.

## 2.2 EMERGENCE POINT COUNTS

Emergence point counts were completed at five bat box sites after pups were volant. On July 21, 2025, a reconnaissance survey of 11 sites was conducted to select clusters with high bat activity for the emergence surveys. Four of the previous surveyed sites (Bat\_272.2S, Bat\_258NE, Bat\_145, and Bat 272.2N), were re-selected for the emergence surveys to provide a comparison with results from previous years (WSP, 2024). Site BAT\_153 was substituted due to the fallen maternity box with site Bat\_258 which was consistently observed to have large guano deposits. Due to low guano deposits observed at the Bat Condo, surveys were not conducted at this site.

Surveys were completed over five consecutive nights between August 3-7, 2025 to ensure similar seasonal and weather conditions between surveys. All bat boxes were visually inspected before the survey to ensure bats were present. Emergence counts were performed by a crew of two WM-DWB personnel each night including a biologist and a technician. Both observers sat facing towards the bat boxes so that the boxes and emerging bats were silhouetted against the sky. Surveys began one hour before sunset and ended one hour after sunset or when lighting conditions became too dim for observers to accurately identify the silhouettes of flying or emerging bats. The results of the emergence point count surveys are summarized below:

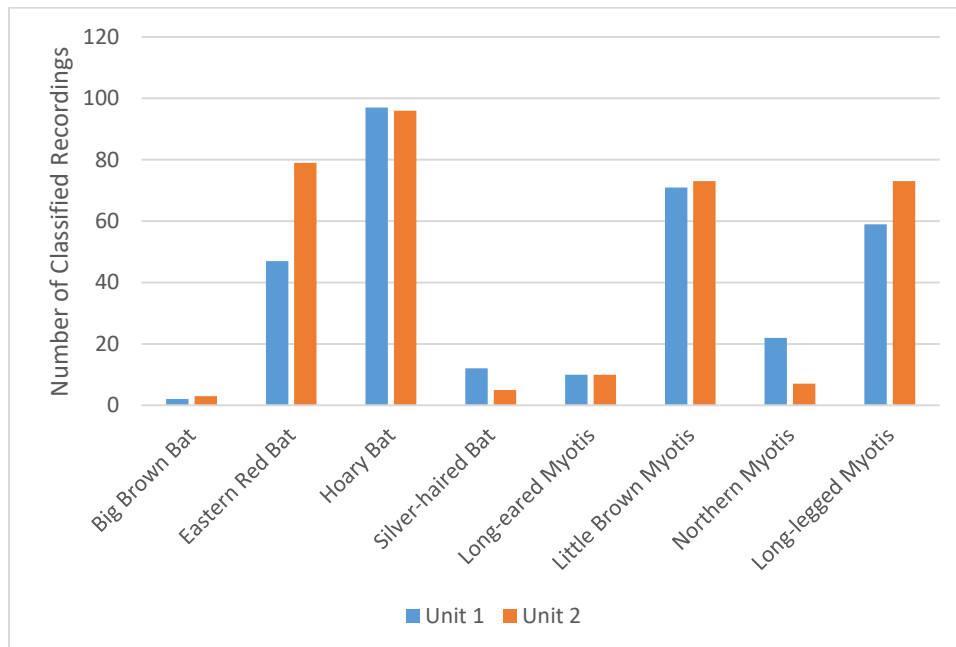
- **Bat\_272.2S:** An emergence point count was conducted August 3, 2025 for 1 hr 55 min (20:20-22:15). Site conditions recorded a temperature of 23.4°C and 18°C at 20:00 and 22:00 respectively, a wind speed of 11 km/h at 21:00, and 60% cloud cover. A total of 29 bats were observed directly emerging from the bat boxes: two from box C/D (maternity dark), 22 from box E (rocket dark), and five from box F (rocket dark). An additional 15 bats were observed flying near the boxes.
- **Bat\_258NE:** An emergence point count was conducted August 4, 2025 for 1 hr 48 min (20:37-22:25). Site conditions recorded a temperature of 19.2°C and 16°C at 20:00 and 22:00 respectively, a wind speed of 8 km/h at 21:00, and 30% cloud cover. A total of 16 bats were observed directly emerging from the bat boxes: 11 from boxes A/B (maternity light), and five from box E (rocket dark). An additional 34 bats were observed flying near the boxes.
- **Bat\_258:** An emergence point count was conducted August 5, 2025 for 1 hr 55 min (20:20-22:15). Site conditions recorded a temperature of 18.7°C and 19°C at 20:00 and 22:00 respectively, a wind speed of 5 km/h at 21:00, and 90% cloud cover. A total of 13 bats were observed directly emerging from the bat boxes: 11 from boxes A/B (maternity dark), and two from boxes C/D (maternity dark). An additional 20 bats were observed flying near the boxes.
- **Bat\_145:** An emergence point count was conducted August 6, 2025 for 1 hr 55 min (20:20-22:15). Site conditions recorded a temperature of 16.8°C and 15.1°C at 20:00 and 22:00 respectively, a wind speed of 4 km/h at 21:00, and 80% cloud cover. A total of 29 bats were observed directly emerging from the bat boxes: 10 from boxes C/D (maternity light) and 19 from box F (rocket dark). An additional 48 bats were observed flying near the boxes.
- **Bat\_272.2N:** An emergence point count was conducted August 7, 2025 for 1 hr 55 min (20:20-22:15). Site conditions recorded a temperature of 17.4°C and 15.5°C at 20:00 and 22:00 respectively, a wind speed of 4 km/h at 21:00, and 10% cloud cover. A total of 114 bats were observed directly emerging from the bat boxes: 34 from boxes A/B (maternity dark), 39 from boxes C/D (maternity light), and 41 from box F (rocket dark). An additional 168 bats were observed flying near the boxes.

## 2.3 ACOUSTIC SPECIES IDENTIFICATION

During the emergence point count surveys, two Song Meter Mini Bat ultrasonic acoustic detectors (Wildlife Acoustics, 2026a) were installed underneath the bat box poles with the microphones facing upwards towards the underside of the bat boxes. A survey was not conducted at the Bat Condo site (Bat\_330.2) as large guano counts had not been observed at the Condo during occupancy surveys in 2025 or in previous years (WSP, 2024). Acoustic recordings were analyzed in Kaleidoscope Pro v5.9.0 (Wildlife Acoustics, 2026b) using automatic bat classifiers with conservative settings. Calls classified as noise or 'No ID' were discarded, and the likelihood of bat species presence was evaluated using p-values produced from a maximum likelihood estimator.

Hoary Bat, Eastern Red Bat, Little Brown Bat, and Long-legged Myotis species calls were considered more likely present during the surveys from both detectors with significantly more classified calls than the other species and p-values near 0. Long-eared Myotis and Northern Myotis were also considered likely present, however far fewer classified calls were recorded and Northern Myotis was considered likely present by the recordings of only one detector. While calls from Big Brown Bat and Silver-haired Bat were classified, the resulting p-values were near 1 and so these species were considered less likely to have been recorded.

Species classification of acoustic calls of bats emerging from a roost involves a degree of uncertainty. Calls of related species can be similar and may be mis-classified within a species group. Furthermore, the range of acoustic detectors may exceed the area viewed by observers and recorded calls may be from bats flying in the vicinity of the bat boxes but having roosted in other areas. Acoustic classification is also limited to the presence or absence of a species at a given time as individual bats cannot be identified or counted from the calls. Nevertheless, acoustic detection of bat calls is useful data for determining which bat species are likely present within a roost. The species classification of acoustic data is presented in Figure 6.



**Figure 6:** Species classification of acoustic recordings during the emergence surveys conducted between August 3 – 7 2025.

## 2.4 TEMPERATURE LOGGER DATA

Twelve temperature loggers (HOBO MX2201) were installed during the first occupancy surveys completed between June 11 – 19 2025 and were removed during the final survey between October 1 – 4 2025. Three were installed light rocket boxes (53 E, 82.1 E, and 272.2 N E), one in a dark rocket box (82.1F), four in light maternity boxes (62 C/D, 82.1 A/B, 145 C/D, 153 A/B), three in dark maternity boxes (82.1 C/D, 217 E A/B, and 258 NE A/B), and one in the bat condo. The mean temperature, standard deviation, and maximum and minimum temperatures recorded by the loggers are presented in Table 1.

Box 82.1 A/B recorded the highest maximum temperature (61.1 °C), potentially as a result of greater sun exposure on a west facing slope. In contrast, Box 145 C/D exhibited the lowest minimum temperature (-3.2 °C), potentially due to shade from aspen forest immediately to the west. The Bat Condo displayed the most stable thermal range, varying from approximately 6 °C to 49 °C, which is consistent with its larger internal volume and enhanced thermal insulation.

Four loggers were installed at site Bat\_82.1 to provide a direct comparison of different bat box designs under the same conditions. Temperature loggers in the maternity boxes recorded higher maximum and lower minimum temperatures throughout the season than the rocket boxes. Whereas, the temperature loggers in the light boxes recorded a greater range of temperatures than the dark boxes, suggesting bat box design may have a greater impact on temperature range than colour. However, further temperature data should be collected before any conclusions are drawn.

**Table 1:** Seasonal temperature logger data recorded per bat box.

Box ID	Type	Color	Mean Temp (°C)	SD (°C)	Min Temp (°C)	Max Temp (°C)
53 E	Rocket	Light	20.52	8.24	1.03	41.18
62 C/D	Maternity	Light	19.92	8.77	0.51	52.21
82.1 A/B	Maternity	Light	20.00	10.63	-1.85	61.13
82.1 C/D	Maternity	Dark	20.14	9.63	-1.33	48.26
82.1 E	Rocket	Light	20.07	8.64	-0.60	43.63
82.1 F	Rocket	Dark	20.53	8.82	-0.56	45.43
145 C/D	Maternity	Light	20.67	9.81	-3.22	48.05
153 A/B	Maternity	Light	22.40	9.03	0.21	44.83
217E A/B	Maternity	Dark	19.19	8.84	-1.72	49.59
258 NE A/B	Maternity	Dark	22.29	11.81	-0.05	55.77
272.2 N E	Rocket	Light	18.48	6.66	0.13	36.89
Bat Condo	Condo	Dark	24.73	7.77	5.79	48.56

## 2.5 MORTALITIES

Throughout the 2025 season, a total of eight bat mortalities were observed on the guano screens beneath the bat boxes. Following the discovery of bat mortalities, WM-DWB contacted BC Hydro and the Ministry of Water, Land, and Resource Stewardship (MWLRS) to determine if the carcasses were appropriate for preservation and sampling. However, all carcasses were in poor condition so were not preserved. Five bat carcasses were discovered during the July 21, 2025 reconnaissance survey and three additional carcasses were discovered during the August 3 – 7, 2025 occupancy and emergence surveys. The details of the bat boxes where the carcasses were discovered is presented in Table 2.

**Table 2:** Bat mortalities observed during the 2025 surveys.

Bat Site	Box ID	Box Type	Number of Mortalities July 21 2025	Number of Mortalities August 03 – 07 2025
Bat_145	F	Rocket Dark	0	1
Bat_153	E	Rocket Light	0	1
Bat_258	C/D	Maternity Dark	1	1
Bat_258	F	Rocket Dark	1	0
Bat_258NE	E	Rocket Dark	1	0
Bat_272.2N	E	Rocket Light	1	0
Bat_272.2S	A/B	Maternity Light	1	0

### 3.0 FUTURE MONITORING

Monitoring activities will be continued in 2026 and 2027 and will include:

- bat box and guano screen assessment for damage and repairs early in the season;
- three occupancy and guano surveys conducted throughout the season;
- emergence point counts conducted at five sites over consecutive nights; and
- temperature logger installation in a subset of boxes which were occupied and unoccupied during 2025

### 4.0 ADAPTIVE MANAGEMENT AND SUPPLEMENTARY MONITORING

The Site C Bat Mitigation and Monitoring Program document (BC Hydro 2022) includes several recommendations relating to adaptive management:

- Roost boxes not being used within four years of installation will be moved to another location or additional boxes will be constructed at the new location(s)
- A selection of boxes with documented use by large numbers of bats will be identified for long-term (e.g. 20 years) or permanent (for the life of the Project) retention and monitoring.
- All boxes used by little-brown myotis or northern myotis will be retained for the life of the Project.
- Temperatures of boxes will be monitored for temperatures that approach 40°C, as temperatures higher than that may be fatal for bats
- New technologies or methods for monitoring should be considered for incorporation into the Program

Lower bat occupancy was observed at sites closer to the Site C Dam on slopes that were west facing (Bat\_48, Bat\_53, Bat\_55, and Bat\_62). These sites are more open and may be more exposed to direct sunlight and consequently experience higher temperatures in the bat boxes. However, the screens at many of these sites were damaged during the 2025 season which may have affected observations. Lower bat occupancy was also observed at sites where woody vegetation obscured the bat boxes from the reservoir and adjacent fields or open meadows to the north of the bat boxes (Bat\_217E and Bat\_217W).

General trends in the bat occupancy data suggest several sites may be identified for relocation due to low use. After this year's monitoring efforts, 36 bat boxes at six sites that may be candidates for relocation include: Bat\_48, Bat\_53, Bat\_55, and Bat\_62, Bat\_217E, Bat\_217W. However, further data may need to be collected before a decision on relocation of these bat boxes can be determined. Whereas, 22 bat boxes at six sites Bat\_144, Bat\_145, Bat\_153, Bat\_272.2N, Bat\_272.2S, and Bat\_330.2 (including the Bat Condo) demonstrate substantially higher levels of bat activity and may be recommended as sites for long-term retention and monitoring.

In addition to the methods planned for future monitoring, supplemental activities and installations could be implemented. These may include:

- upgraded guano screens to the more robust design to reduce wildlife and/or livestock damage;
- repair of the fallen bat boxes at site BAT\_153;
- extended acoustic surveys over longer periods at high occupancy sites;
- increased emergence point counts at different times in the season;
- collection and analysis of guano for DNA species identification; and
- early spring guano testing for white-nosed syndrome

## 5.0 CLOSING REMARKS

Monitoring activities were completed during the 2025 season as per the Site C Vegetation and Wildlife, Bat Mitigation and Monitoring Program (BC Hydro, 2022). Bat use of the box structures was evaluated through occupancy and guano surveys, emergence point counts, and temperature loggers. Future monitoring will continue through the 2026 and 2027 seasons. This report has been prepared for BC Hydro and, including the activities described therein, have been reviewed and approved by an appropriate QEP.

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# APPENDICES

# APPENDIX A

## Photographs



Jun 17, 2025 12:43:04  
10V 617494 6233915  
351° N

Don Phillips Way  
Charlie Lake  
Peace River  
British Columbia  
Altitude: 502.6m  
Speed: 0.1km/h  
BAT\_53E

Photo 1: Example of a rocket box with a ground-level guano screen and temperature logger installed at box Bat\_53 E.



Photo 2: Example of a light maternity box with a robust chest-level guano screen and temperature logger installed at box Bat\_82.1 A/B.



Jun 17, 2025 10:25:09  
10V 590776 6227473  
222° SW

Hudson's Hope  
Peace River  
British Columbia  
Altitude:483.0m  
Speed:0.2km/h  
BAT\_217WESTAB

Photo 3: Examples of light and dark maternity boxes at site Bat\_217W.



Jun 18, 2025 12:16:42  
10V 571463 6214120  
177° S

19542 Chapman Road  
Hudson's Hope  
Peace River  
British Columbia  
Altitude:484.9m  
Speed:1.4km/h  
BAT 330.2 CONDO

Photo 4: The Bat Condo located at site Bat\_330.2.

Date & Time: Wed, Oct 01, 2025 at 10:50:03 PDT  
Position: 31 S 166021 0 (Error)  
Altitude: 0ft (Error)  
Datum: WGS-84  
Azimuth/Bearing: 311° N49W 5529mils Error (Error)  
Elevation Grade: +006%  
Horizon Grade: +002%  
Zoom: 1.0X  
bat



Photo 5: Arrangement of the Bat Condo and bat boxes at site Bat\_330.2 on October 01 2025.



Photo 6: Small guano score inside Bat Condo on October 01 2025.



Jun 18, 2025 10:32:00  
10V 577592 6220624  
355° N  
9011 Wallace Avenue  
Hudson's Hope  
Peace River  
British Columbia  
Altitude: 483.0m  
Speed: 1.1km/h  
BAT 254F

Photo 7: Example of ground-level guano screen with no guano observed underneath box Bat\_254 F on June 18 2025.



Photo 8: Example of a Small guano score (<100 pellets) at box Bat\_82.1 C/D on August 07 2025.



Photo 9: Example of a Moderate guano score (100 -1000 pellets) underneath box Bat\_272.2N A/B on August 03 2025.



Photo 10: Example of a Large guano score underneath boxes Bat\_258 C/D on August 04 2025.



Photo 11: Ground-level guano screen underneath box Bat\_153 A/B damaged by wildlife on August 07 2025.



Photo 12: Ground-level guano screen underneath box Bat\_247 A/B destroyed by livestock on June 19 2025.



Jun 16, 2025 14:03:12  
10V 595959 6232442  
30° NE  
Charlie Lake  
Peace River  
British Columbia  
Altitude:479.9m  
Speed:1.2km/h  
BAT 153CD

Photo 13: Fallen maternity boxes at site Bat\_153 C/D.

# **APPENDIX B**

## **Occupancy Surveys, Emergence Point Counts, and Acoustic Data**

**Table B1:** Occupancy surveys data.

Site ID	Box ID	Box Type/Color	June Survey Guano Score	August Survey Guano Score	October Survey Guano Score
Bat_21.4	A/B	Maternity/Dark	L	D	S
	C/D	Maternity/Light	S	D	M
	E	Rocket/Dark	D	D	M
	F	Rocket/Light	S	D	S
Bat_48	A/B	Maternity/Light	S	D	D
	C/D	Maternity/Dark	S	D	D
	E	Rocket/Light	N	D	D
	F	Rocket/Light	S	D	D
Bat_53	A/B	Maternity/Dark	N	D	D
	C/D	Maternity/Light	N	D	D
	E	Rocket/Light	S	D	D
	F	Rocket/Light	N	D	D
Bat_55	A/B	Maternity/Light	D	D	D
	C/D	Maternity/Light	D	D	D
	E	Rocket/Light	D	D	D
	F	Rocket/Light	S	D	D
Bat_62	A/B	Maternity/Dark	S	D	D
	C/D	Maternity/Light	S	D	D
	E	Rocket/Dark	S	D	D
	F	Rocket/Dark	S	D	D
Bat_82.1	A/B	Maternity/Light	M	M	M
	C/D	Maternity/Dark	S	M	S
	E	Rocket/Light	S	S	S
	F	Rocket/Dark	M	S	S

Site ID	Box ID	Box Type/Color	June Survey Guano Score	August Survey Guano Score	October Survey Guano Score
Bat_134	A/B	Maternity/Light	M	M	M
	C/D	Maternity/Dark	D	M	S
	E	Rocket/Light	S	M	S
	F	Rocket/Dark	M	M	M
Bat_144	A/B	Maternity/Light	L	L	M
	C/D	Maternity/Dark	L	L	S
	E	Rocket/Dark	L	M	M
	F	Rocket/Light	L	L	S
Bat_145	A/B	Maternity/Dark	S	S	S
	C/D	Maternity/Light	L	L	L
	E	Rocket/Light	S	N	S
	F	Rocket/Dark	L	L	S
	G	Maternity/Dark	L	L	S
Bat_153	A/B	Maternity/Light	M	L	M
	C/D	Maternity/Light	D	D	D
	E	Rocket/Light	D	L	M
	F	Rocket/Dark	M	L	M
Bat_217W	A/B	Maternity/Light	S	N	S
	C/D	Maternity/Dark	D	N	S
	E	Rocket/Light	N	S	S
	F	Rocket/Light	N	S	S
Bat_217E	A/B	Maternity/Dark	S	N	S
	C/D	Maternity/Dark	N	N	S
	E	Rocket/Light	S	S	S
	F	Rocket/Light	N	S	N

Site ID	Box ID	Box Type/Color	June Survey Guano Score	August Survey Guano Score	October Survey Guano Score
Bat_246	A/B	Maternity/Light	N	D	D
	C/D	Maternity/Dark	N	D	D
	E	Rocket/Light	N	D	D
	F	Rocket/Dark	N	D	D
Bat_247	A/B	Maternity/Dark	D	D	D
	C/D	Maternity/Light	N	D	D
	E	Rocket/Dark	S	D	D
	F	Rocket/Light	N	D	D
Bat_254	A/B	Maternity/Dark	S	S	S
	C/D	Maternity/Light	S	S	M
	E	Rocket/Dark	N	S	S
	F	Rocket/Dark	N	M	S
Bat_258	A/B	Maternity/Dark	L	L	M
	C/D	Maternity/Dark	L	L	L
	E	Rocket/Dark	L	L	M
	F	Rocket/Dark	L	L	M
Bat_258NE	A/B	Maternity/Dark	L	M	M
	C/D	Maternity/Dark	L	M	M
	E	Rocket/Dark	L	L	M
	F	Rocket/Dark	L	L	S
Bat_272.2N	A/B	Maternity/Dark	L	L	L
	C/D	Maternity/Light	L	L	M
	E	Rocket/Light	L	M	S
	F	Rocket/Dark	L	M	M

Site ID	Box ID	Box Type/Color	June Survey Guano Score	August Survey Guano Score	October Survey Guano Score
Bat_272.2S	A/B	Maternity/Light	L	L	L
	C/D	Maternity/Dark	L	L	M
	E	Rocket/Dark	L	M	M
	F	Rocket/Dark	L	M	M
Bat_330.2	A/B	Maternity/Dark	S	M	L
	C/D	Maternity/Light	S	M	M
	E	Rocket/Dark	L	M	S
	Con	Condo	S	S	S

Small guano score = S; Moderate guano score = M; Large guano score = L; No guano observed = N;  
Screen damaged or site inaccessible = D

**Table B2:** Classified bat acoustic recording data.

Acoustic Detector	Species – Latin Name	Species – Common Name	Number of Classified Detections	Maximum Likelihood Estimated P-Value	Presence
Unit 1	<i>Eptesicus fuscus</i>	Big Brown Bat	2	1	Less Likely
	<i>Lasiurus borealis</i>	Eastern Red Bat	47	0	More Likely
	<i>Lasiurus cinereus</i>	Hoary Bat	97	0	More Likely
	<i>Lasionycteris noctivagans</i>	Silver-haired Bat	12	1	Less Likely
	<i>Myotis evotis</i>	Long-eared Myotis	10	0.001276	More Likely
	<i>Myotis lucifugus</i>	Little Brown Myotis	71	0	More Likely
	<i>Myotis septentrionalis</i>	Northern Myotis	22	0.001639	More Likely
	<i>Myotis volans</i>	Long-legged Myotis	59	0	More Likely
	No ID		410		
Unit 2	<i>Eptesicus fuscus</i>	Big Brown Bat	3	1	Less Likely
	<i>Lasiurus borealis</i>	Eastern Red Bat	79	0	More Likely
	<i>Lasiurus cinereus</i>	Hoary Bat	96	0	More Likely
	<i>Lasionycteris noctivagans</i>	Silver-haired Bat	5	1	Less Likely
	<i>Myotis evotis</i>	Long-eared Myotis	10	0.000195	More Likely
	<i>Myotis lucifugus</i>	Little Brown Myotis	73	0	More Likely
	<i>Myotis septentrionalis</i>	Northern Myotis	7	1	Less Likely
	<i>Myotis volans</i>	Long-legged Myotis	73	0	More Likely
	No ID		493		

**Table B3:** Emergence point counts data.

Date	Site Surveyed	Survey Duration	Temperature (°C) at 20:00*	Temperature (°C) at 22:00*	21:00 Wind Speed*	Cloud Conditions	Bat Observations in Vicinity of Bat Boxes	Bat Box Emergence Observations
August 03 2025	272.2S	1 hr 55 min (20:20 -22:15)	23.4	18.0	11	60% cover, no moon	15	Boxes C/D (MD): 2 Box E (RD): 22 Box F (RD): 5
August 04 2025	258NE	1 hr 48 min (20:37 -22:25)	19.2	16.0	8	30% cover, hazy moon	34	Boxes A/B (ML): 11 Box E (RD): 5
August 05 2025	258	1 hr 59 min (20:12 – 22:11)	18.7	19.0	5	90% cover, overcast	20	Boxes A/B (MD): 11 Boxes C/D (MD): 2
August 06 2025	145	1 hr 43 min (20:15 – 21:58)	16.8	15.1	4	80% cover, hazy moon	48	Boxes C/D (ML): 10 Box F (RD): 19
August 07 2025	272.2N	2 hr 3 min (20:04 – 22:07)	17.4	15.5	4	10% cover, blue sky/clear moon	168	Boxes A/B (MD): 34 Boxes C/D (ML): 39 Box F RD): 41

\*Environment Canada Fort St John.

Maternity box = M; Rocket box = R; Dark box = D; Light Box = L

## **Appendix 18. 2025 Western Toad & Gartersnake Downstream Monitoring Report**

# Downstream Western Toad and Gartersnake Monitoring Program 2025

## Site C Vegetation and Wildlife



Prepared for:  
**BC Hydro and Power Authority**

March 31, 2026

Technical Report – R0

Project No.: 25021  
Client File: n/a



## Executive Summary

This report presents the results of the 2025 Downstream Western Toad and Gartersnake Monitoring Program associated with the Site C Clean Energy Project. The program is intended to monitor the distribution and relative abundance of western toad (*Anaxyrus boreas*), common gartersnake (*Thamnophis sirtalis*), and western gartersnake (*Thamnophis elegans*) downstream of the Site C dam during the operational phase of the project.

Monitoring is conducted to verify conclusions presented in the Environmental Impact Statement (EIS) regarding potential effects of downstream hydrological alterations on herptile species and to satisfy Condition 21 of the Environmental Assessment Certificate (EAC), as outlined in Section 8 of the Vegetation and Wildlife Monitoring Plan (BC Hydro 2015), as well as relevant conditions of the Federal Decision Statement (FDS). The monitoring program is subject to requirements under the *Wildlife Act* and the *Species at Risk Act* (SARA), and all field methods and data collection were conducted by qualified professionals in accordance with applicable provincial standards and guidance developed by the BC Resources Information Standards Committee.

Preoperational baseline surveys were conducted between 2018 and 2020 by Hemmera Envirochem Inc. (Hemmera) to characterize baseline conditions prior to Project operations. Operational monitoring commenced in 2025 following completion of construction and reservoir fill, with Blackbird Environmental LP retained to conduct monitoring for the first ten years of operations (2025-2035). No surveys occurred between 2020 and 2025, reflecting the program schedule, under which the three years of downstream monitoring required for the construction period were completed in 2018-2020 and operational monitoring resumed in 2025.

During May to July 2025, Blackbird surveyed a total of 14 sites for western toads and 14 sites for gartersnakes. Five western toad sites were located in the impact study area (Pine River to Beatton River) and nine in the control study area (Site C dam to Pine River). Western toads were detected at 100% of impact sites and 78% of control sites, with breeding evidence observed at the majority of wetted sites in both study areas. A substantial proportion of sites identified during the preoperational period were found to be dry or anthropogenically altered in 2025, resulting in their lack of breeding suitability. Consequently, the 2025 field season represented a census of all available suitable wetted habitat rather than a balanced control-impact design which is consistent with baseline studies conducted by Hemmera.

Gartersnake surveys were conducted using time-constrained visual encounter methods, consistent with the approach adopted during the later preoperational period. A total of 29 gartersnakes were observed during the 2025 field season, with detections occurring at 71% of impact sites and 14% of control sites. Western gartersnakes were observed more frequently than common gartersnakes.

Changes in habitat availability, site conditions, and the unbalanced distribution of control and impact sites constrained application of the original before-after-control-impact study design and limited the statistical power of some analyses. To support robust and defensible interpretation of results, Blackbird retained Poisson Consulting Inc. to provide guidance on analytical approaches appropriate for unbalanced sampling and variable detection. These recommendations inform both interpretation of the 2025 results and the proposed analytical framework for future monitoring years.

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## Acronyms and Abbreviations

BACI	Before-After-Control-Impact
BC	British Columbia
BSc	Bachelor of Science
CPESC	Certified Professional in Erosion and Sediment Control
e.g.	<i>exempli gratia</i> , for example
EAC	Environmental Assessment Certificate
EIS	Environmental Impact Statement
FDS	Federal Decision Statement
i.e.	<i>id est</i> , that is
LAA	Local Assessment Area
MFLNRO	Ministry of Forests, Lands, Natural Resource Operations
MOE	Ministry of Environment
MSc	Master of Science
MWLAP	Ministry of Water Land and Air Protection
N/A	Not Applicable
PAg	Professional Agrologist
RISC	Resource Inventory Standards Committee
RPBio	Registered Professional Biologist
RISC/RIC	Resource Inventory Standards Committee / Resource Inventory Committee
SARA	<i>Species at Risk Act</i>

## Table of Revisions

Revision No.	Date	Reason/Type of Revision
R0	March 31, 2026	Original report issued

## 1 Introduction

The Site C Clean Energy Project (the Project) is a hydroelectric dam on the Peace River located 14 kilometres southwest of Fort St. John in northeastern British Columbia (BC). Dam construction and reservoir fill was completed in fall 2024 making the Project the fourth largest producer of hydroelectricity in BC (BC Hydro 2026). Prior to implementation the Project was subject to studies to determine baseline environmental conditions and environmental assessment by the Canadian Environmental Assessment Agency and the BC Environmental Assessment Office (BC Hydro 2026). After a joint panel review, the Project received several conditions associated with the provincial Environmental Assessment Certificate (EAC) and the Federal Decision Statement (FDS) issued in 2014 (BC Hydro 2026). The Downstream Western Toad and Gartersnake Monitoring Program was established in 2018 to survey and monitor the distribution of western toad and gartersnake populations downstream of the Site C dam to satisfy the regulatory requirements and conditions outlined in the EAC.

Baseline studies were conducted in 2013 to assess amphibian and reptile (herptile) species present within and adjacent to Site C. The Environmental Impact Statement (EIS) included a review of historic herptile sightings and baseline surveys in the local assessment area (LAA; Keystone Wildlife Research Ltd. 2013). All amphibian and reptile species known to occur in the Peace Region were observed during baseline assessments, including boreal chorus frog (*Pseudacris maculata*), wood frog (*Lithobates sylvaticus*), western toad (*Anaxyrus boreas*), long-toed salamander (*Ambystoma macrodactylum*), Columbia spotted frog (*Rana luteiventris*), common gartersnake (*Thamnophis parietalis*), and western gartersnake (*Thamnophis elegans*; Keystone Wildlife Research Ltd. 2013).

Baseline survey results indicated that gartersnake species and western toads were appropriate indicator species to assess potential Project-related effects. Western toad is the only listed herptile species in the Peace Region federally classified as a species of Special Concern under Schedule 1 of the *Species at Risk Act* (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; DataBC 2026).

The study area encompasses the portion of the river downstream of the dam to the confluence of the Pine River (i.e., impact study area), which represents the reach subject to the greatest hydrological fluctuations during dam operations. Areas downstream of the Pine River to the Beatton River comprise the control study area and were expected to experience minimal hydrological change during the construction phase of the dam, as upstream flows would remain largely unaltered (Keystone Wildlife Research Ltd. 2013). The EIS outlined that only short-term impacts to hydrology were expected during the construction phase; however, dam operations were expected to influence downstream hydrology (Keystone Wildlife Research Ltd. 2013).

This monitoring study was originally designed using a before-after-control-impact (BACI) framework to assess the distribution and abundance of herptiles and changes in suitable habitat in the Peace River basin in response to dam operations. The EIS outlined that monitoring of pre-operational baseline conditions was conducted in the control and impact areas from 2018 to 2020 by Hemmera Envirochem Inc. (Hemmera). Operational (post-construction) monitoring is planned for the first ten years of operations (2025-2035) to document changes in habitat use and herptile distribution from alterations in hydrologic function downstream of the Site C dam as outlined in Section 8 of the *Vegetation and Wildlife Monitoring Plan* (BC Hydro 2015).

The subject report and subsequent annual reports will address conclusions in the EIS related to potential changes in habitat availability, species abundance, and distribution. This report presents the results of Blackbird Environmental LP's (Blackbird) 2025 field season and summarizes the core findings, methods, preliminary data analysis, and interpretation of results within the context of observed site conditions. The information presented herein establishes a foundation for subsequent annual reporting and long-term evaluation of downstream herptile monitoring during Project operations.

## **2 Approaches and Methods**

### **2.1 Study Area**

The study area is directly downstream of the Project, as outlined by the *Vegetation and Wildlife Monitoring Plan*, from the dam site to the Peace River's confluence with the Beaton River (BC Hydro 2015). This represents an approximately 37 km stretch of the Peace River.

The impact area is located between the Memorial Bridge, approximately 70 m downstream of the dam site, and the Peace River's confluence with the Pine River. This area was projected to be subject to the greatest hydrological fluctuations during Project operations. The control area is located from the Pine River to the Beaton River. The impact and control areas represent an approximate area of 16 km and 21 km, respectively; see Appendix A (Figure 1) for site map.

### **2.2 Habitat Suitability Assessment**

In 2018, during the pre-operational baseline, potentially suitable wetlands (i.e., survey sites) were identified using Terrestrial Ecosystem Mapping (TEM) and aerial imagery within the study area (Hemmera Envirochem Inc. 2019). Identified habitat was ground-truthed by Hemmera (2019) to confirm habitat type, suitability, and accessibility. See Appendix A (Figure 2) for TEM mapping results from Hemmera (2021).

Available habitat was categorized into wet forest and wetland habitat types by Hemmera (Hemmera Envirochem Inc. 2019). These categories are retained in this report for continuity with the pre-operational dataset. It is not clear how these sites were classified by Hemmera or where the information was obtained from. In 2020, there were 17 sites considered to be suitable for western toads, eleven of which were in the control area (Hemmera Envirochem Inc. 2021). For gartersnakes, nine sites were deemed suitable, five of which were in the control area (Hemmera Envirochem Inc. 2021).

As outlined in the workplan (BC Hydro 2015), Blackbird reassessed available suitable habitat (i.e., pre-operational baseline survey sites) on May 19, 2025. During the field assessment, Blackbird identified that twelve of the previously assessed wetlands were dry or altered by anthropogenic activity, rendering them unsuitable for the life history requirements of western toads. An additional pre-operational baseline survey site was not included in the operational survey assessment due to the inaccuracy of the provided spatial data. The remaining survey sites were supplemented with new sites using a DJI Mavic 3T drone to determine the presence of remaining wetted areas in the study zones. The drone was flown above Crown land and in public airspace. An additional eleven sites were added in 2025.

Similarly, previously wetted sites suitable for gartersnakes during the pre-operational baseline assessments that were dry during the operational phase were also removed from the 2025 surveys, as foraging opportunities were limited and occurrence was therefore unlikely. After communications regarding the survey site modifications with Brent Matsuda from BC Hydro (pers. comm. May 23, 2025), it was determined that additional survey sites should be selected. Ten new sites were added to the study based on life-history characteristics of the region's snake species (i.e., four control area survey sites and six impact area survey sites), resulting in 14 gartersnake survey sites in total. See Appendix A (Figures 3 and 4) for survey site locations and Appendix B for representative site photos.

### **2.3 Survey Timing**

Field surveys were conducted in three sampling periods in May, June, and July to align with the seasonal activity of western toads and gartersnakes in the Peace Region.

Western toads typically breed from early May through June, congregating at breeding ponds, often breeding multiple times. To capture this activity period, a minimum of three surveys were conducted during the breeding and larval stages of the western toad. Detecting egg masses and tadpoles is the most effective method for confirming presence or not detected for this species. As the number of surveys without detections increases, the likelihood of western toad absence increases accordingly (MacKenzie et al. 2018).

Survey timing for gartersnakes was adjusted to coincide with periods when individuals are most active and hence most visible; specifically, when they are emerging from or returning to their hibernacula. After dispersal to foraging areas, gartersnakes become significantly more difficult to detect, making targeted timing essential to enhance detection.

## 2.4 Environmental Data

Real-time hydrometric data and air temperature data were obtained for the May–September survey period from the nearest available recording stations. In the study area, historical data from the pre-operational phase were also obtained. Water level and discharge rates, measured every five minutes, were obtained from the Peace River Taylor station (ID 07FD002). Hourly air temperature (°C) data was obtained from the Fort St. John A station (ID 1183000). Readings are also publicly available from the Environment and Climate Change Canada website (Environment and Climate Change Canada 2025a; 2025b).

## 2.5 Western Toad Distribution and Relative Abundance

### 2.5.1 Habitat Characterization

Wetland habitat types were classified using Terrestrial Ecosystem Mapping (TEM) methodology and field-based wetland classification guidance outlined by MacKenzie and Moran (2004). Table 1 outlines the habitat type and size of each survey site. Habitat types are used to describe dominant physical and vegetative conditions relevant to western toad life-history requirements.

In 2025, Blackbird field staff visited five sites in the impact study area and nine sites in the control study area to conduct transect surveys for western toad. Survey periods occurred between May 21 and 25, June 6, 7, and 10, and July 7, 8, and 10, 2025.

All survey sites, except for OW11, were small enough in size to be surveyed using the methods outlined in Section 2.5.2. Survey site OW11 is a large beaver-influenced pond that was stratified into two smaller (i.e., 100 m) transects to sample selected sections of suitable habitat in accordance with RIC (1998a) guidance.

For clarity, only sites that retained wetted habitat during the 2025 field season were included in western toad presence and habitat assessments.

Table 1: Sampling sites and characteristics for western toad habitat assessments

Site Name	Habitat Type	Study Area	Size (ha)
OW12	Shallow open water	Control	1.55
WS2	Willow sedge	Control	0.18
BB4	Shallow open water	Control	0.03
BB5	Shallow open water	Control	0.01
BB7	Shallow open water	Control	0.01
BB8	Shallow open water	Control	0.05
BB9	Shallow open water	Control	0.14
OW13A	Shallow open water	Control	1.60
OW11*	Shallow open water	Impact	0.48
OW1	Shallow open water	Impact	3.13
BB1	Shallow open water	Impact	0.03
BB2	Shallow open water	Impact	0.01
BB3	Shallow open water	Impact	0.32
OW20	Shallow open water	Impact	0.81

\*Toad and snake survey site.

### **2.5.2 Systematic Visual Searches**

Survey methods followed the protocol for systematic visual searches from the *Inventory Methods for Pond-Breeding Amphibians and Painted Turtle* (RIC 1998a). All amphibians observed during surveys were recorded including wood frog, Columbia spotted frog, long-toed salamander, and boreal chorus frog.

Survey methodology during the 2025 assessments was adapted from the previous pre-operational baseline surveys. Specifically, the operational phase assessments in 2025 avoided walking in and agitating water, to avoid sedimentation that can be detrimental to egg masses and tadpoles and reduce survivability (Wood and Richardson 2008, Wood 2005, Gillespie 2002).

Western toad tadpoles typically congregate in the warmest, shallowest parts of waterbodies and egg masses are laid in the littoral zone (Corkran and Thoms 2020). They will breed repeatedly throughout the season with tadpoles emerging from eggs in a week to ten days depending on water temperature (Matsuda et al. 2006). Systematic surveys were conducted along curvilinear transects encompassing the shallow littoral and near-shore zones of each waterbody, consistent with survey zones and water-depth guidance outlined in RIC (1998a).

All surveyors were equipped with binoculars and polarized sunglasses to aid in detection. Surveys were conducted during warm, sunny conditions when toad tadpoles were most likely to be active and visible in shallow waters. Cooler, inclement weather (e.g., rain, wind) was avoided, as western toad tadpoles tend to shelter under leaf litter and aquatic vegetation during such periods, reducing detectability and potentially resulting in underestimates of relative abundance.

### **2.5.3 Environmental Monitoring**

Habitat data was collected during the initial visit to each study site. Recorded parameters included wetland type, percent cover of emergent and submergent vegetation, substrate type (i.e., silt, sand, organic, or mud), and riparian vegetation. The substrate categories are from *Wetlands of British Columbia: A Guide to Identification* by MacKenzie and Moran (2004).

Blackbird crews collected turbidity, pH, dissolved oxygen, conductivity, water temperature, and air temperature measurements. Three turbidity readings were taken at each survey site and were averaged. Weather conditions were also recorded, as well as photographs taken in landscape orientation in the four cardinal directions (i.e., north, south, east, and west), and water depth was measured from a fixed point.

Turbidity was measured using an Extech TB400 turbidity meter; dissolved oxygen with an Extech DO210; water temperature and conductivity with an Oakton EcoTestr; and air temperature with an Extech 39240 waterproof thermometer.

### **2.5.4 Environmental DNA**

As outlined in the BC Hydro workplan (BC Hydro 2015) environmental DNA (eDNA) methodology may be used as a supplementary method to support presence/not detected determinations for western toads at survey sites where visual surveys do not confirm occurrence. eDNA is not intended to estimate abundance and is not applied at sites where visual confirmation of western toad presence has been obtained.

eDNA sampling was not conducted during the 2025 field season, as visual surveys confirmed western toad presence at the majority of suitable sites and the primary objective for the first year of operational monitoring was to re-establish baseline site availability and distribution using consistent visual methods.

## 2.6 Gartersnake Distribution and Relative Abundance

### 2.6.1 Habitat Characterization

Habitat types used to describe gartersnake survey sites reflect field-based characterization of dominant site conditions relevant to gartersnake foraging, movement, and thermoregulation. These habitat descriptors are intended to support interpretation of gartersnake distribution within the study area rather than to represent formal ecosystem mapping units (Table 2).

Field crews visited seven sites in the impact area and seven sites in the control area over three survey periods (i.e., May 21 to 25, June 6, 7, and 10, and July 8 and 10, 2025). Each site was surveyed twice during the field season.

Table 2: Sampling sites and characteristics for gartersnake habitat assessments

Site Name	Habitat Type	Study Area	Size (ha)
BBS1	Non-forested floodplain	Control	0.23
BBS2	Non-forested floodplain	Control	1.12
BBS3	Non-forested floodplain	Control	0.48
BBS10	Non-forested floodplain	Control	0.8
OW13B	Non-forested floodplain	Control	2.21
TS	Non-forested floodplain	Control	0.29
WS2	Willow sedge	Control	0.18
BBS5	Non-forested floodplain	Impact	0.32
BBS6	Non-forested floodplain	Impact	0.14
BBS7	Non-forested floodplain	Impact	0.13
BBS8	Non-forested floodplain	Impact	0.38
WH5	Non-forested floodplain	Impact	1.46
OW11*	Shallow open water	Impact	0.39
WH2	Non-forested floodplain	Impact	1.77

\*Toad and snake survey site.

#### 2.6.1.1 Transects

Prior to field surveys, habitat characterization was completed for each survey site to support future research applications. Characterization parameters were drawn from the *Species Inventory Fundamentals* (Ministry of Environment, Lands and Parks 1998), as well as the *Field Manual for Describing Terrestrial Ecosystems* (BC MOE 2010).

#### Surface Substrate

The proportion of ground surface covered by each class of substrate (Table 3) was recorded. If a substrate class was not present a zero was recorded.

Table 3: Surface substrate class descriptions. Adapted from BC MOE (2010).

Substrate Class	Description
Organic Matter	Superficial accumulations of organic materials, including the following: <ul style="list-style-type: none"> <li>• Organic layers of any thickness overlying mineral soil; or &gt;2cm thickness over gravels, cobbles, stones, or bedrock;</li> <li>• Layers of decaying wood &lt;10 cm thick;</li> <li>• Large animal droppings; and</li> <li>• Areas covered by mats of bunchgrass (mats include L horizon)</li> </ul>
Decaying Wood	Fallen trees, large branches on the ground surface, and partially buried stumps with an exposed edge. <ul style="list-style-type: none"> <li>• Does not include freshly fallen material that has not started decomposition.</li> <li>• May be covered with mosses, lichens, liverworts, or other plants.</li> <li>• If an organic layer has developed over the wood, decaying wood must be &gt;10 cm thick, otherwise it is classed as organic matter.</li> </ul>
Bedrock	Exposed consolidated rock. <ul style="list-style-type: none"> <li>• May have a covering of live mosses, lichens, liverworts, or other epilithic plants.</li> <li>• Does not qualify as bedrock if covered by unconsolidated minerals or dead organic material &gt;2 cm in thickness.</li> </ul>
Rock (cobbles and stones)	Exposed unconsolidated rock fragments >2 mm (i.e., coarse fragments) in diameter. <ul style="list-style-type: none"> <li>• May be covered by mosses, lichens, liverworts; or an organic layer &lt;2 cm in thickness.</li> </ul>
Mineral Soil	Unconsolidated mineral material of variable texture not covered by organic materials. <ul style="list-style-type: none"> <li>• May have a partial cover of live mosses, lichen, and liverworts.</li> <li>• Often associated with cultivation, tree tip-ups, active erosion or deposition, severe fires, or late snow retention areas.</li> </ul>
Water	Streams, puddles, or areas of open water in bogs or fens.

### **Mesoslope Position**

Each hibernacula location had the mesoslope position documented. The mesoslope position indicates the location of the transect relative to the localized catchment area. Mesoslope position was classified according to definitions from BC MOE (2010), which describe relative slope position within the local catchment.

### **Simple Coarse Woody Debris**

A 30 m transect was established from the centre point of each transect. Coarse woody debris (CWD) was assessed using a line-intersect method to estimate CWD volume and volume by decay class. Decay classes were assigned following standard classifications outlined in the *Field Manual for Describing Terrestrial Ecosystems* (BC MOE 2010).

CWD pieces intersecting the transect centre line were recorded in accordance with the FS882-7 coarse woody debris field form. Where debris densities were high, sampling along the transect was discontinued once the field form was filled, and the length of transect sampled to that point was recorded. For each CWD piece observed, diameter was measured at the point of intersection with the transect centre line and recorded to the nearest 0.1 cm. Where debris was hollow, an equivalent diameter was estimated to approximate the volume of remaining wood, consistent with BC MOE (2010) guidance.

### **Vegetation**

A 1m x 1m plot was assessed at the centre point of each transect to estimate percent cover of dominant species in the tree, shrub, herb, and moss/lichen layers. The three dominant species were recorded for each layer. The percent cover of each layer was estimated as a portion of the plot.

#### **2.6.1.2 Hibernaculum**

Detailed habitat characteristics were obtained if hibernacula were found. Characterization parameters were drawn from the Ministry of Environment, Lands and Parks (1998), and BC MOE (2010).

**Vegetation**

A 1m x 1m plot was placed at a random point near the entrance of the hibernaculum to estimate the percent cover of all species present in each layer (i.e., tree, shrub, herb, and moss/lichen). The total percent cover for each species as a percentage of the sample area (plot) was recorded.

**Biogeoclimatic Ecosystem Classification (BEC)**

Using the BC BEC system hibernacula sites were classified into site series and modifiers as described in *A Field Guide for Site Identification and Interpretation for the Boreal White and Black Spruce Zone of British Columbia* (Ministry of Forests and Range 2011).

**Soil**

Soil moisture regime (SMR) and soil nutrient regime (SNR) were recorded at each hibernacula location. Field procedures were based on the specifications outlined in Section 2 of the BC MOE (2010). Soil analyses were conducted in the field using hand tools (e.g., auger or shovel). Soil moisture regime and soil nutrient regime were classified in the field based on criteria outlined in BC MOE (2010), using hand texturing, soil characteristics, and organic matter content.

**2.6.2 Artificial Cover Objects**

The use of artificial cover objects (ACOs) was removed from the operational phase of the study due to the lack of use by gartersnakes documented during the pre-operational baseline assessments. The majority of ACOs placed were not recovered by Hemmera field crews, and no spatial data for their locations were available for the 2025 field season.

### 2.6.3 Time Constrained Visual Encounter Surveys

Systematic visual searches followed the *Inventory methods for snakes* (RIC 1998b) document closely. Transect search methodology was implemented in accordance with Hemmera's previous studies and BC Hydro's outlined workplan (BC Hydro 2015), to the extent practicable, to maintain statistical relevance between pre-operational and operational phases. Previous survey times were not provided to Blackbird; however, searches did not exceed two hours and were recorded for analysis.

Surveys were not conducted during periods of inclement weather, with a minimum temperature threshold of 10 °C. Sampling was conducted during the warmest periods of the day, occurring after 12:00 pm, when snakes were most likely to be basking. Searches focused on optimal habitat, including shorelines, edges of gullies, and natural barriers. The most productive sites for detecting multiple individuals are typically associated with den sites or areas of concentrated movement (RIC 1998b).

A minimum crew size of two surveyors conducted time constrained transect searches. Surveyors searched survey sites by hand as thoroughly as possible, inspecting all cover objects or potential places of refuge within the transect area. Transects were used as a guide to maintain consistency; however, surveyors focused on optimal habitat (RIC 1998b). Surveyors were approximately five to ten metres apart during the surveys.

Transects were placed randomly within the sampling area. A fixed point was randomly selected for the centre of the transects and surveys took place 100 m in either direction for a total transect length of 200 m. The width of transects (i.e., 5-25 m) was adjusted based on habitat, visibility, vegetation density, and cover structure. Transect widths were not standardized during pre-operational surveys and were therefore adjusted in 2025 to reflect site-specific conditions, consistent with Olson and Warner (2003). Snake data collected included species, life stage (i.e., adult, juvenile, or young of the year), approximate length (if possible), and behavioural observations.

Multiple samples were taken throughout the season to capture variable seasonal success and to account for changes in detection associated with breeding, dispersal, and weather conditions (RIC 1998b). To reduce disturbance to snakes and snake habitat, the same cover objects were not flipped repeatedly, and sites remained undisturbed for a minimum of two weeks between surveys (RIC 1998b).

Location of each transect and appropriate environmental conditions were recorded including:

- Air temperature (°C);
- Weather conditions (i.e., cloud cover, precipitation, etc.);
- Survey start and end times;
- Snake observation time;
- Wind speed (Beaufort scale);
- Surveyors' initials; and
- Date of survey.

## 2.7 Incidental Sightings

All incidental sightings of herptiles encountered outside of surveys were recorded, including during travel to and from survey sites. Information recorded includes nearest plot number, UTM coordinates, species information (i.e., name, quantity, life stage), habitat, time, weather conditions, and behaviour at the time of observation.

### **3 Data Management and Analysis**

Blackbird retained Poisson Consulting Inc. (Poisson) to provide independent statistical advice for the subject project. Poisson provided feedback on site selection, statistical methodology, and interpretation of results in consideration of changes to site availability and survey design between the pre-operational and operational phases. The goal was to ensure that analyses remain statistically defensible while acknowledging constraints related to survey methodology (i.e., transition from artificial cover objects to time-constrained visual encounter surveys for gartersnakes) and the availability of suitable survey sites.

Western toad and gartersnake observations were collected on field data forms and compiled into a database. Data was reviewed for quality control including species identification, count data, and outliers in environmental parameter readings.

The total number of western toads per life stage and gartersnakes per species detected by each survey method was recorded for each of the three survey periods. Relative abundance data are expressed as the number of toads detected per 100 m of transect and the number of gartersnakes detected per person-hour (RIC 1998b). As noted during the pre-operational assessments, true abundance would require either a complete census or estimation of individuals not detected during surveys, which is not feasible under the scope of this Project (Hemmera Envirochem Inc. 2021).

## 4 Results

A total of 14 western toad sites were surveyed (five in impact and nine in control) and 14 gartersnake sites (seven sites in impact and seven in control). The totals for western toad and gartersnake presence includes survey sites that are surveyed for both species.

### 4.1 Habitat Assessment

#### 4.1.1 *Western Toad*

Reductions in available western toad survey sites occurred in 2025, with a decrease in available survey sites from the end of pre-operational surveys in 2020. In the control, the available survey sites were reduced by five and in the impact, they were reduced by two survey sites. Appendix C presents habitat characteristics derived from field assessments conducted in 2025.

Means for recorded environmental parameters are outlined in Table 4. Mean values for most parameters were higher at impact area survey sites compared to control sites, except for conductivity, which was lower in the impact area ( $449.2 \pm 175.97 \mu\text{S/cm}$ ). Variability among sites was high, particularly for conductivity, turbidity, and dissolved oxygen (see Table 5 for standard deviations).

Table 4: Average water and air temperature, average pH, average conductivity, and turbidity for toad sites

Study Area	Sample Size	Average Water Temperature (°C)	Average Air Temperature (°C)	Average pH	Average Conductivity (s/cm)	Average Turbidity (cm)	Average Dissolved Oxygen
Impact	n=5	20.32	22.62	8.51	449.20	70.65	18.48
Control	n=9	17.99	18.57	8.23	600.72	31.84	16.05

Table 5: Standard deviations for recorded environmental parameters for toad survey sites

Study Area	Sample Size	Water Temperature	Air Temperature	pH	Conductivity	Turbidity	Dissolved Oxygen
Impact	n=5	3.00	3.95	0.80	175.97	5.68	8.35
Control	n=9	2.70	3.54	0.45	386.79	5.68	5.32

#### 4.1.2 *Gartersnake*

Appendix C presents habitat characteristics derived from field assessments conducted in 2025.

No hibernacula were identified during the 2025 field season; however, western gartersnake young of the year were observed at survey sites BBS5 and BBS8, indicating potential use of nearby areas for reproduction or early life-stage habitat.

## 4.2 Distribution and Relative Abundance

### 4.2.1 Western Toad

Western toads were detected in 100% of surveyed sites in the impact study area and 78% of surveyed sites in the control study area. Breeding activity (i.e., egg masses, tadpoles, adult breeding behaviour) was observed in 80% of sites in the impact area and 78% of sites in the control area. Occupancy results for western toad survey sites are summarized in Table 6. Presence/not-detected determinations were based on visual confirmation of western toad life stages during surveys conducted in May, June, and July 2025.

Table 6: Occupancy for surveyed western toad sites for 2025

Site Name	Study Area	Presence/Not Detected	Evidence of Breeding
OW20	Impact	Present	Yes
OW11*		Present	No
OW1		Present	Yes
BB1		Present	Yes
BB2		Present	Yes
OW13A	Control	Present	Yes
BB3		Not Detected	No
BB4		Present	Yes
BB7		Present	Yes
BB9		Present	Yes
BB5		Not Detected	No
OW12		Present	Yes
BB8		Present	Yes
WS2		Present	Yes

\*Toad and snake survey site.

No western toad adults or egg masses were observed during the 2025 field season due to limited boat operator availability during early-season surveys when adults and egg masses would have been present and more visible. As a result, relative abundance estimates are based on observations of tadpoles only. This limitation will be addressed for the 2026 field season.

Relative abundance values for western toad tadpoles are presented in Table 7. Relative abundance for western toad tadpoles is expressed as a percentage of total observations in 2025 to facilitate comparison among sites in a year with highly uneven breeding activity, where measures of dispersion (e.g., standard deviation) provide limited additional interpretive value. This approach differs from previous years, when Hemmera reported relative abundance for western toads (all life stages) in decimal form; however, the two metrics are directly comparable and convey the same underlying pattern of relative site use (Hemmera Envirochem Inc. 2019, 2020, 2021).

Table 7: Western toad average relative abundance per 100 m transect for tadpoles for 2025

Site Name	Study Area	Relative Abundance (%)
OW20	Impact (n=5)	30%
OW11*		0%
OW1		12%
BB1		41%
BB2		17%
OW13A	Control (n=9)	1%
BB3		0%
BB4		13%
BB7		11%
BB9		41%
BB5		0%
OW12		23%
BB8		6%
WS2		6%

\*Toad and snake survey site.

We did not observe tadpoles at survey sites OW11, BB3, and BB5 during the 2025 field season. One juvenile western toad was observed at survey site OW11, indicating presence within the local area but not confirming breeding at that site during the survey period. Survey site OW13A exhibited very low tadpole abundance, representing approximately 1% of the total tadpoles observed in the control study area. The highest relative abundance of western toad tadpoles occurred at survey site BB9 in the control study area, accounting for approximately 41% of observed tadpoles.

#### 4.2.2 Gartersnake

Gartersnakes were detected at 71% of survey sites in the impact study area and 14% of survey sites in the control study area. A total of 29 individual gartersnakes were observed during time-constrained visual encounter surveys conducted in 2025 (Table 8).

Both common gartersnake and western gartersnake were detected during surveys; however, western gartersnakes accounted for the majority of observations. Gartersnake detections were concentrated at a small number of sites, with the highest number of individuals observed at survey site BBS8 in the impact study area.

Table 8: Gartersnake survey site totals for 2025

Site Name	Study Area	Common Gartersnake	Western Gartersnake	Site Total
BBS5	Impact	0	3	3
BBS6		0	0	0
BBS7		1	0	1
BBS8		1	19	21
WH5		0	0	0
OW11*		1	0	1
WH2		1	0	1
BBS1	Control	0	2	2
BBS2		0	0	0
BBS3		0	0	0
BBS10		0	0	0
OW13B		0	0	0
TS		0	0	0
WS2		0	0	0
			<b>Total</b>	<b>29</b>

\*Toad and snake survey site.

Relative abundance of gartersnakes, expressed as the number of snakes detected per person-hour, was 0.87 snakes per person-hour in the impact study area and 0.08 snakes per person-hour in the control study area. Average search time per site was similar between study areas, with a mean of 1.26 hours per site in the impact area and 1.27 hours per site in the control area (Table 9).

Table 9: Gartersnake search times and relative abundance 2025

Site Name	Study Area	Average Search Time	Snakes per person-hour
BBS5	Impact (n=7)	1:15:35	0.92
BBS6		1:00:12	0
BBS7		1:05:02	0.31
BBS8		1:34:36	5.25
WH5		1:10:23	0
OW11*		1:39:20	0.31
WH2		1:02:13	0.34
BBS1	Control (n=7)	1:01:00	0.68
BBS2		1:09:43	0
BBS3		1:10:12	0
BBS10		1:39:32	0
OW13B		1:16:23	0
TS		1:32:08	0
WS2		1:05:48	0

\*Toad and snake survey site.

### 4.3 Incidental Sightings

Throughout the 2025 field season, ten incidental observations of target species were recorded outside of standardized survey periods. These observations included four common gartersnakes (including one shed), four western gartersnakes, and two western toads. Incidental sightings were documented opportunistically during travel to and from survey sites and were recorded to provide supplementary information on species presence within the study area.

The shed observed during the field season was identified using scale counts and morphological characteristics based on published identification guidance (Matsuda et al. 2006; St. John 2021). Incidental sightings were evenly distributed between the impact and control study areas, and all observations are summarized in Table 10.

Table 10: Incidental sightings of gartersnake and western toad during the 2025 field season

Nearest Survey Site	Coordinates	Species	Date
OW1	10N 635759 6229896	Common gartersnake	2025-07-08
BB5	10N 649839 6222573	Western gartersnake	2025-07-10
BB9	10N 651067 6222179	Common gartersnake	2025-07-10
BBS8	10N 638916 6226756	Western toad	2025-07-25
TS	10N 647865 6223706	Western toad	2025-07-25
BBS5	10N 637480 6227036	Western gartersnake	2025-07-25
BBS5	10N 637483 6229048	Western gartersnake	2025-07-25
BBS5	10N 637432 6229121	Western gartersnake	2025-07-25
BBS5	10N 637251 6229334	Common gartersnake (shed)	2025-06-21
BB9	10N 652166 6221877	Common gartersnake	2025-06-10

### 4.4 Environmental DNA

No evidence of western toad breeding activity was observed at survey sites OW11, BB5, and BB3 during the 2025 field season. If no breeding activity is observed in 2026 then eDNA sampling will be conducted at these locations during the 2026 field season.

## 5 Discussion

### 5.1 Habitat Assessment

The habitat data collected during the 2025 field season will be used to inform interpretation of monitoring results throughout the first ten years of operations, with a cumulative assessment planned for 2035. Preliminary analyses may be conducted sooner if any trends begin to emerge. Information collected in 2025 reflects site conditions during the first year of operational-phase monitoring and is intended to establish a reference point for subsequent annual comparisons. Detailed habitat characteristics are provided in Appendix C.

#### 5.1.1 *Western Toad*

Environmental parameters recorded at survey sites exhibited minimal variation for water temperature, air temperature, and pH. Higher variability was observed for turbidity, conductivity, and dissolved oxygen. Variation in turbidity was most pronounced at survey sites OW20 and BB2, where evidence of ungulate use (i.e., tracks, scat, and direct observation) was documented during field surveys. An elk cow and calf were observed walking through wetted habitat at OW20 during surveys.

Elevated turbidity and variability in dissolved oxygen have been shown to influence amphibian larval growth and survival under some conditions (Wood and Richardson 2008), and conductivity has been associated with amphibian occupancy patterns in other systems (Klaver et al. 2013). While these factors may influence relative productivity among sites, breeding activity and tadpole presence were observed at the majority of wetted sites in both study areas in 2025. As a result, the observed habitat conditions are interpreted as potential modifiers of site-level productivity rather than constraints on western toad habitat use during the 2025 field season.

Conductivity values varied among survey sites, and the factors influencing this variability are not fully understood. While higher conductivity has been positively associated with western toad occupancy in other systems (Klaver et al. 2013), this relationship was not consistently reflected across sites in 2025, suggesting that additional factors such as fish presence, wetland size, and availability of emergent and submergent vegetation also influence habitat suitability.

In 2025, reductions in available western toad survey sites occurred for two primary reasons: limited availability of wetted habitat and anthropogenic disturbance within portions of the project footprint. As noted during pre-operational monitoring (Hemmera Envirochem Inc. 2021), the limited number of suitable wetlands within the study area resulted in the program effectively becoming a census of all available habitat rather than a balanced sampling design. Nine of the 14 western toad survey sites occurred within the control area. This limits the statistical applicability of a traditional BACI analysis for this species because an unbalanced sampling design results in high uncertainty and a higher likelihood of inaccuracy (Poisson Consulting Ltd. 2026).

#### 5.1.2 *Gartersnake*

Availability of suitable gartersnake survey sites was constrained by private land access, anthropogenic disturbance, and the loss of previously wetted sites identified during the pre-operational phase. Survey sites represented a range of habitat types that support different aspects of gartersnake life-history requirements, including foraging, movement, and proximity to potential hibernacula. Appendix C outlines habitat survey results in accordance with RIC methodology (RIC 1998b).

Open-water sites such as OW11 are likely used primarily for foraging, as evidenced by the presence of amphibians and fish. In contrast, sites such as OW13B may have been used by transient gartersnakes moving between habitats, reducing the likelihood of detection during surveys. Once gartersnakes disperse from hibernacula, detection probability decreases substantially, consistent with observations documented in previous studies (RIC 1998b).

The north bank of the Peace River may provide preferred conditions for hibernacula due to increased solar exposure and warmer microclimates. All observations of young-of-the-year gartersnakes occurred at riverbank sites characterized by non-forested floodplain habitat, suggesting that hibernacula may be located nearby. However, no hibernacula were directly observed during the 2025 field season.

## 5.2 Distribution and Relative Abundance

### 5.2.1 *Western Toad*

Field surveys conducted in 2025 did not capture observations of adult western toads or egg masses due to limited early-season boat access and warmer-than-average spring conditions resulting in missing the ideal survey timing window. Tadpoles were present as early as May 19, 2025, indicating that breeding activity likely occurred prior to the earliest surveys. As a result, relative abundance estimates for 2025 are based on tadpole observations only.

Western toad distribution varied among available wetted sites in both study areas. Western toads typically select breeding sites characterized by shallow water, sandy substrates, and abundant emergent and submergent vegetation, and generally avoid sites with fish presence (Browne and Paszkowski 2018). Fish are a limiting factor for toad populations as they feed on eggs and tadpoles (Browne and Paszkowski 2018). Survey site OW11, a beaver-influenced pond with confirmed fish presence, did not exhibit evidence of breeding activity, consistent with observations from the pre-operational period.

Water levels at survey sites BB3 and BB5 fluctuated substantially during the 2025 field season. BB3 is directly connected to the Peace River and is subject to river-level fluctuations, while BB5 periodically dried during the season. Relative abundance varied among sites with confirmed tadpole presence and appeared to correspond with site size and vegetation availability, with smaller or less vegetated sites supporting fewer individuals.

Tadpoles were not evenly distributed within surveyed wetlands. Surveyors typically observed one or two dense aggregations within the littoral zone, which may have influenced counts depending on transect placement. Western toad tadpoles are known to aggregate to reduce predation risk, mitigate desiccation, and facilitate thermoregulation (Browne and Paszkowski 2018).

### 5.2.2 *Gartersnake*

Gartersnake detections were most frequent at sites offering a combination of suitable foraging habitat and proximity to potential hibernacula. The presence of young-of-the-year gartersnakes at sites BBS5 and BBS8 likely contributed to higher detection rates at these locations. Western gartersnakes were observed more frequently than common gartersnakes during the 2025 field season. While this pattern may reflect differences in habitat use, distribution, or population characteristics between species, the available data do not allow these factors to be distinguished. As a result, observed differences in detection rates are interpreted descriptively rather than as evidence of underlying causal mechanisms.

Survey timing influenced detection rates, particularly at sites with dense vegetation or limited microhabitat features. Sites such as OW13B were characterized by dense grasses and understory vegetation, which reduced visibility and increased search time. In contrast, shoreline sites with limited cover, including TS, BBS5, BBS6, and BBS8, more frequently supported observations of basking individuals.

## 5.3 Environmental DNA

Environmental DNA sampling was not implemented during the 2025 field season but will be incorporated in future monitoring years where visual confirmation of western toad presence is not obtained. Western toad presence and breeding activity can vary in response to temperature, hydrology, and predator presence (Browne and Paszkowski 2018; Corkran and Thoms 2020; Klaver et al. 2013).

Integration of eDNA methods in future years will support interpretation of presence/not-detected results at sites where visual detections are limited.

## 6 Recommendations

The Peace River basin is subject to inter-annual hydrological variability, which influences the seasonal availability of habitat for herptiles. All survey sites identified over the duration of the monitoring program should continue to be tracked for changes in habitat availability, and sites that are dry or unsuitable in a given year should be re-evaluated in subsequent years to support long-term interpretation of trends.

Consistent with statistical guidance provided by Poisson, future analyses should apply approaches that accommodate unbalanced sampling designs and variable detection probability. As habitat availability and site distribution continue to change over time, analytical methods should be selected that remain robust to these constraints and support defensible interpretation of results across years.

Survey sites for western toads that were not wetted during the 2025 field season should remain part of the monitoring framework, as these sites may retain sufficient water to support breeding in future years. Similarly, gartersnake survey sites where no detections occurred in 2025 should continue to be surveyed, as absence of detections does not necessarily indicate absence of use.

Surveys for western toads will occur earlier in May to improve detection of adult and egg mass life stages. Limited early-season access during the 2025 field season constrained surveys during peak breeding activity; this issue has been addressed for the 2026 field season.

Sampling for eDNA sampling should be incorporated selectively in future field seasons at sites where visual confirmation of western toad presence is not obtained, to support interpretation of presence/not-detected results and complement visual survey methods.

### 7 Statement of Limitations

Services provided by Blackbird for this report have been conducted in a manner consistent with the level of skill, care and competence ordinarily exercised by registered members of the profession of biology and related environmental disciplines currently practicing under similar conditions and like circumstances in the same jurisdiction in which the services were provided.

The evaluations contained in this report are based on professional judgement, calculations, and experience and are inherently imprecise. Biological, physical, and hydrological conditions other than those indicated may exist at the site.

The recommendations and conclusions contained in this report pertain only to the site conditions observed by Blackbird at the time of the inspection. Since site conditions may change over time, this report is intended for use within the context of the monitoring period described herein.

The conclusions of this report are based in part on information provided by others. Blackbird believes this information to be accurate but cannot guarantee or warrant its accuracy or completeness.

The information presented in this report was acquired, compiled, and interpreted exclusively for the client for the purposes described in this report. It is intended only for internal use by the client and for use by government agencies regulating the specific activities to which it pertains. Blackbird does not accept any responsibility for the use of this report, in whole or in part, for any purpose other than intended or by any third party whatsoever.

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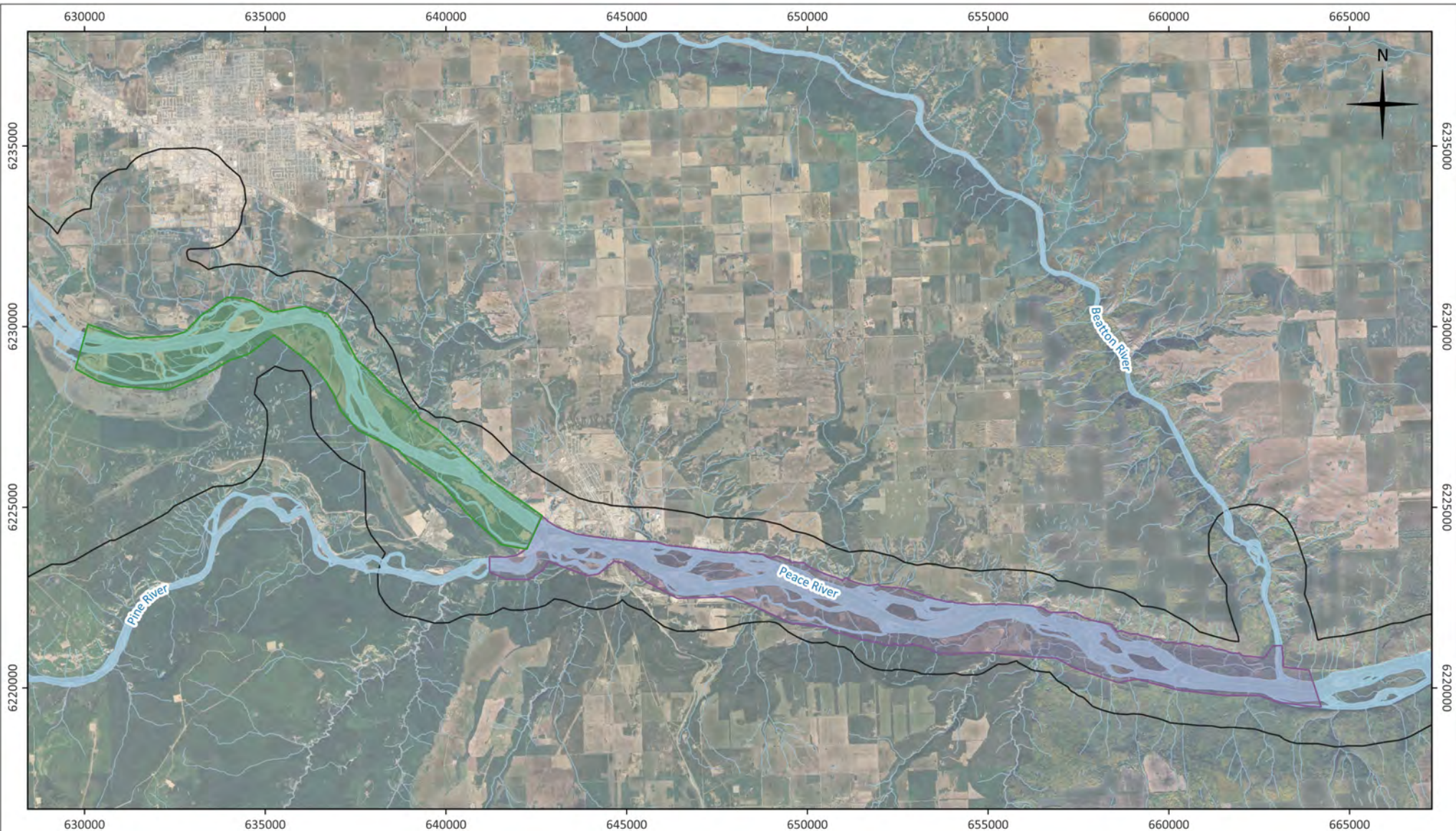
Matthias Loeseken, MSc, PAg, RPBio, CPESC

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## **Appendix A Maps**



**Disclaimer**

UTM Zone 10, NAD 83  
 Date of data acquisition: n/a  
 Data Credit: Blackbird Environmental LP, BC Geodata Warehouse  
 For representational purposes only, all locations are approximate.

**Legend**

- FWA Stream Network
- Site C Assessment Area
- Surface Waterbody
- Study Zone
- Control Area
- Impact Area

Horizontal Scale 1:150,000



Map to scale when plotted on a page 216 mm x 279 mm (Letter)



**BC Hydro and Power Authority**

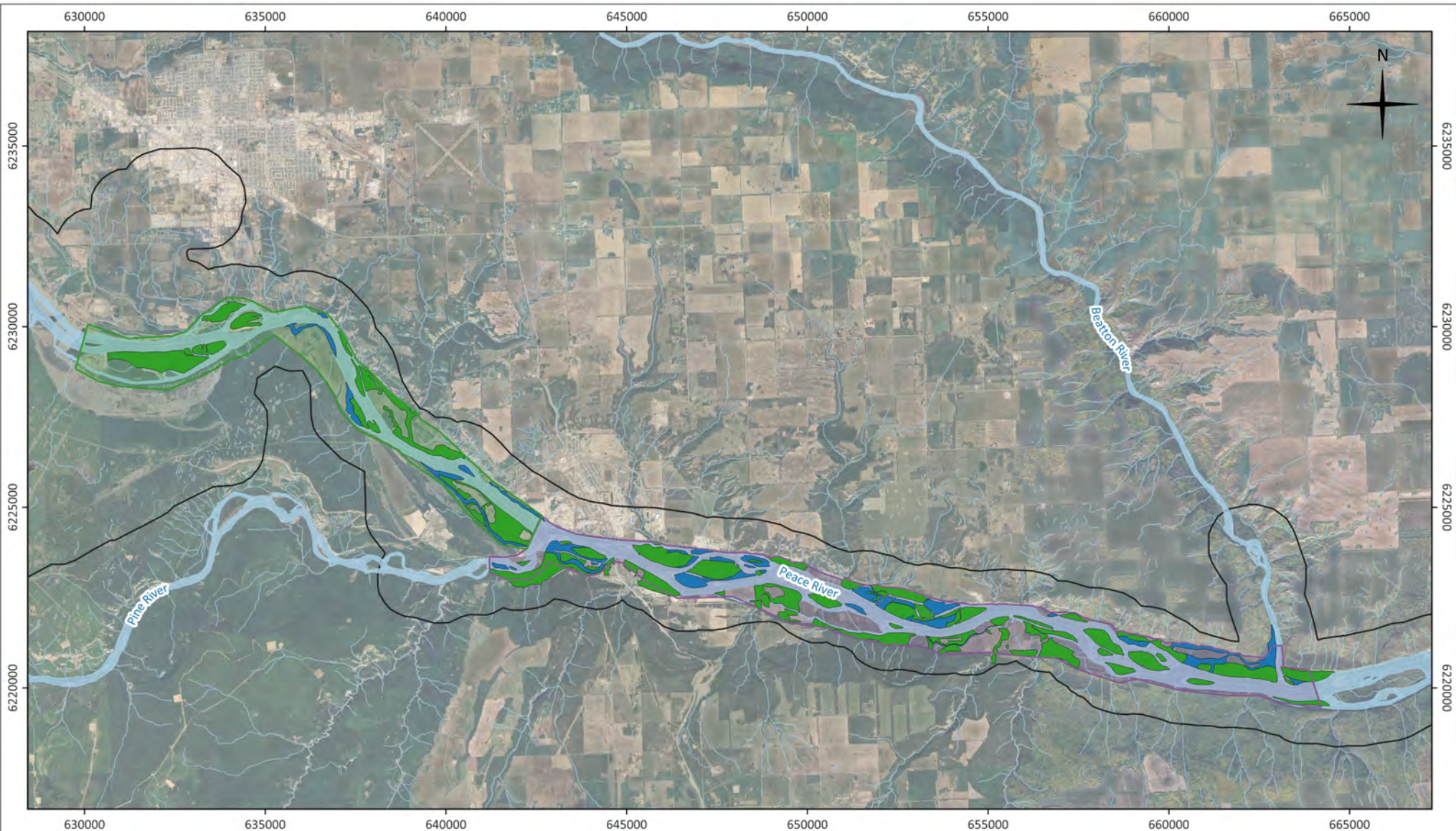
**Downstream Western Toad and Gartersnake  
 Monitoring Program  
 Site C Vegetation and Wildlife  
 Project Overview Map**

Our File:	25021	BCH File:	n/a	Revision No.:	0
SAP:	4500134823	GIS:	MC	Date:	Mar. 11, 2026



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**Figure 1**



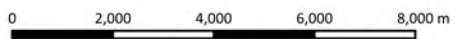
**Disclaimer**

UTM Zone 10, NAD 83  
 Date of data acquisition: n/a  
 Data Credit: Blackbird Environmental LP, BC Geodata Warehouse  
 For representational purposes only, all locations are approximate.

**Legend**

- FWA Stream Network
- Site C Assessment Area
- Surface Waterbody
- Wet Forest
- Wetland
- Study Zone
- Control Area
- Impact Area

Horizontal Scale 1:150,000



Map to scale when plotted on a page 216 mm x 279 mm (Letter)



**BC Hydro and Power Authority**

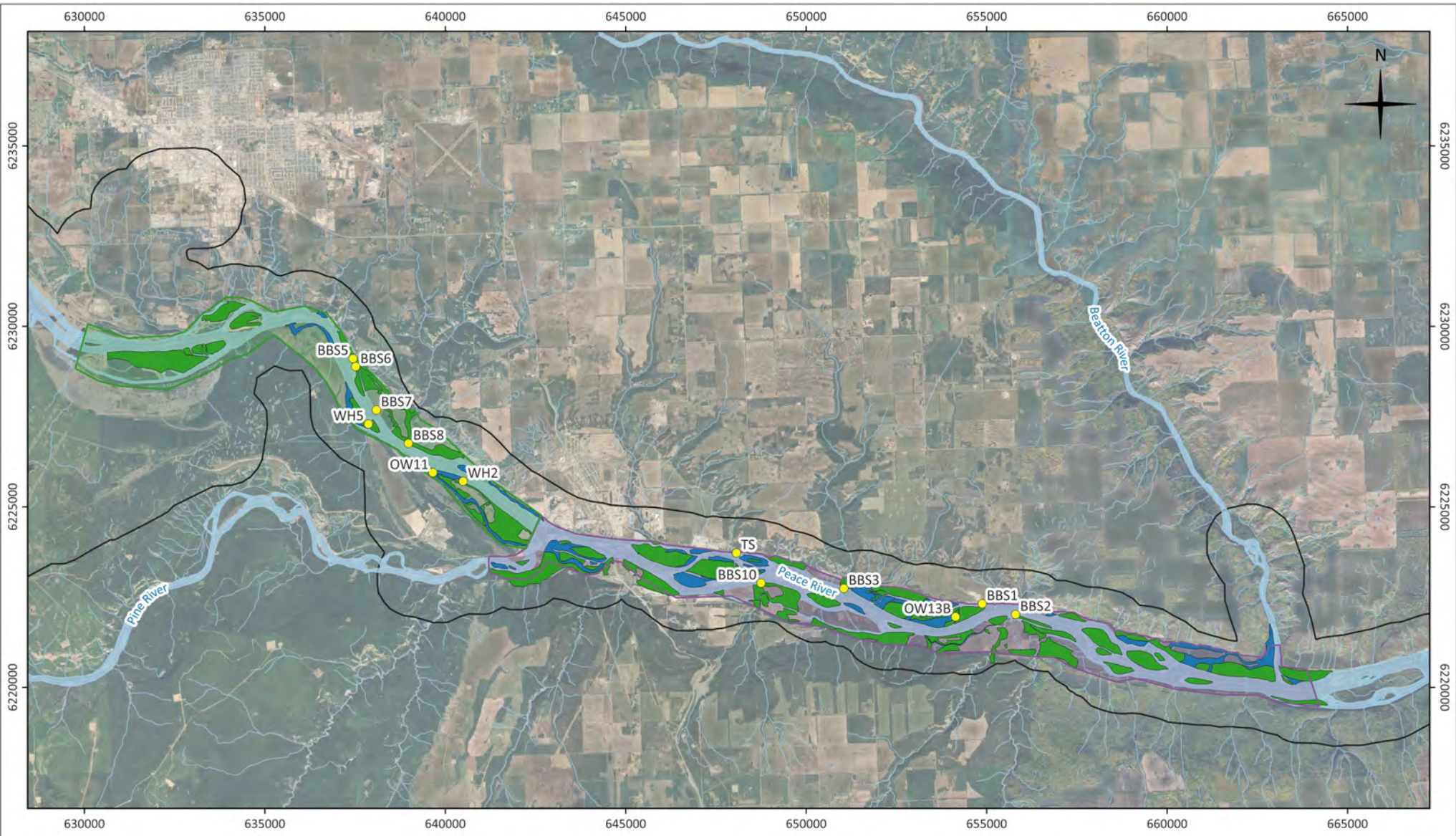
**Downstream Western Toad and Gartersnake  
 Monitoring Program  
 Site C Vegetation and Wildlife  
 Habitat Type (TEM) Overview Map**

Our File:	25021	BCH File:	n/a	Revision No.:	0
SAP:	4500134823	GIS:	MC	Date:	Mar. 11, 2026



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**Figure 2**



**Disclaimer**

UTM Zone 10, NAD 83  
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**Legend**

- Gartersnake Survey Site
- FWA Stream Network
- Site C Assessment Area
- Surface Waterbody
- Habitat Type (TEM) Wet Forest
- Wetland
- Study Zone Impact Area
- Control Area

Horizontal Scale 1:150,000



Map to scale when plotted on a page 216 mm x 279 mm (Letter)



**BC Hydro and Power Authority**

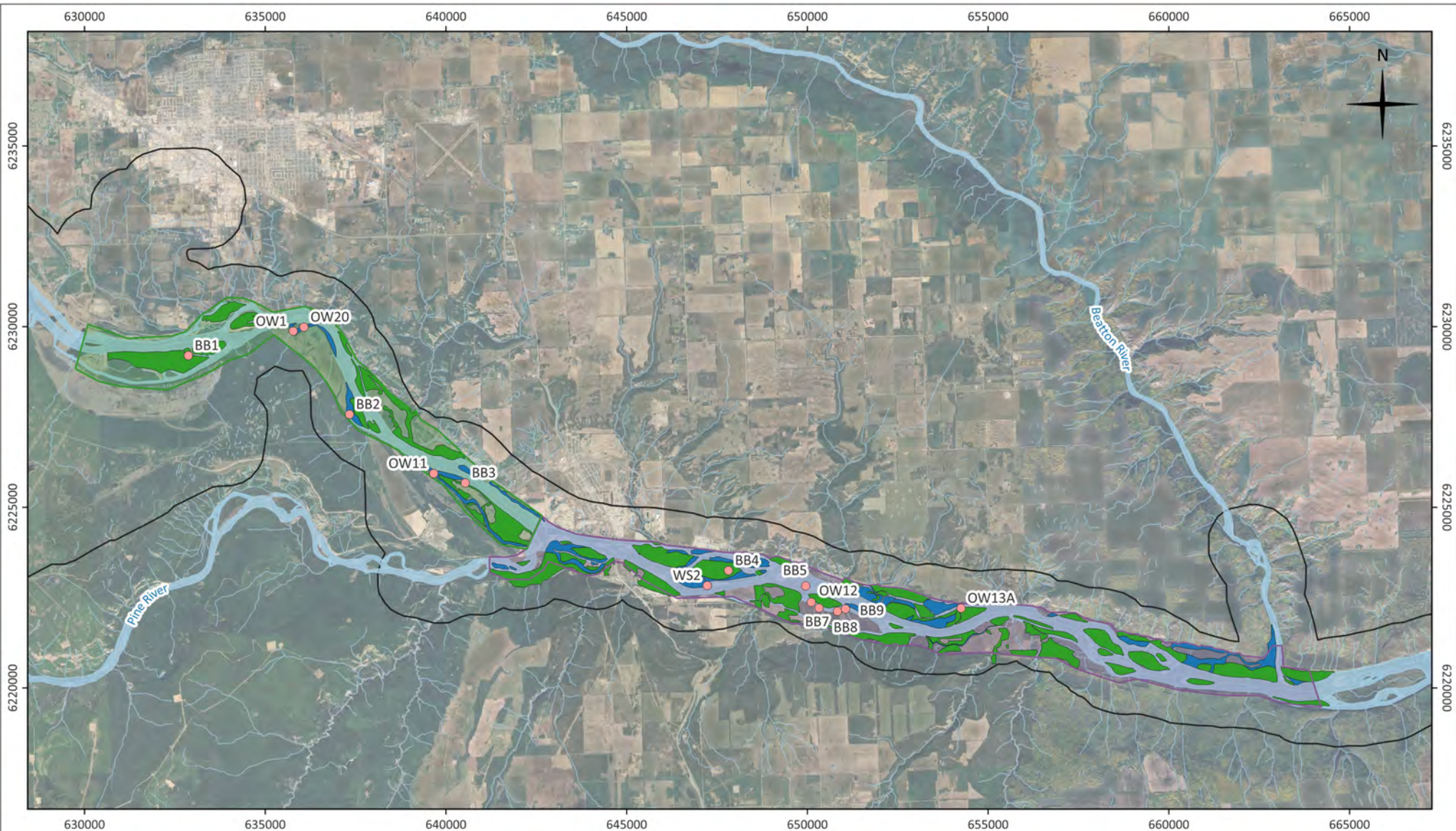
**Downstream Western Toad and Gartersnake Monitoring Program  
 Site C Vegetation and Wildlife Gartersnake Survey Site Map**

Our File:	25021	BCH File:	n/a	Revision No.:	0
SAP:	4500134823	GIS:	MC	Date:	Mar. 11, 2026



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**Figure 3**



**Disclaimer**

UTM Zone 10, NAD 83  
 Date of data acquisition: n/a  
 Data Credit: Blackbird Environmental LP, BC Geodata Warehouse  
 For representational purposes only, all locations are approximate.

**Legend**

- Western Toad Survey Site
- FWA Stream Network
- Site C Assessment Area
- Surface Waterbody
- Wet Forest
- Wetland
- Habitat Type (TEM)**
- Control Area
- Impact Area
- Study Zone**

Horizontal Scale 1:150,000



Map to scale when plotted on a page 216 mm x 279 mm (Letter)



**BC Hydro and Power Authority**

**Downstream Western Toad and Gartersnake  
 Monitoring Program  
 Site C Vegetation and Wildlife  
 Western Toad Survey Site Map**

Our File:	25021	BCH File:	n/a	Revision No.:	0
SAP:	4500134823	GIS:	MC	Date:	Mar. 11, 2026



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**Figure 4**

**Appendix B Photos**

Photo 1: View of survey site OW6 in May 2025. A western toad and gartersnake survey site in the pre-operational study phase. During the survey period of 2025, OW6 is a representative dry site.



Photo 2: View of representative western toad habitat at survey site BB8 during the June 2025 field survey.



Photo 3: View of survey site BBS8 during the July 2025 field session. This survey site had the highest density of snakes in the project footprint.



Photo 4: View of survey site OW11 during the June 2025 field session. This site is from the pre-operational survey period for snakes and toads. No western toad breeding activity was confirmed at this site.



Photo 5: View of western toad tadpoles congregating in the littoral zone of wetland habitat at survey site OW20 on May 20, 2025.



Photo 6: View of western gartersnake at survey site BBS7 on June 10, 2025.

## Appendix C Habitat Characteristics

Wetland habitat characteristics for western toad survey sites in 2025.

Site Name	Study Area	Habitat Type	Wetland Feature Class	Emergent Vegetation (%)	Submergent Vegetation (%)	Substrate	Riparian Vegetation
OW1	Impact	Shallow open water	Seasonal	10	30	Silt	Graminoid
OW11*	Impact	Shallow open water	Semi-permanent	20	40	Silt	Mixed Forest
OW20	Impact	Shallow open water	Seasonal	30	70	Silt	Graminoid
BB1	Impact	Shallow open water	Seasonal	5	55	Organic matter/ Silt	Graminoid/Mixed Forest
BB2	Impact	Shallow open water	Seasonal	5	90	Silt	Graminoid/ Deciduous Forest
BB3	Impact	Shallow open water	Semi-permanent	60	20	Silt	Graminoid
OW12	Control	Shallow open water	Permanent	75	25	Silt	Deciduous
WS2	Control	Willow sedge	Permanent	15	10	Silt	Graminoid/ Deciduous Forest
OW13A	Control	Shallow open water	Semi-permanent	30	60	Silt	Graminoid
BB4	Control	Shallow open water	Seasonal	20	75	Silt	Graminoid/ Deciduous Forest
BB5	Control	Shallow open water	Seasonal	75	25	Silt	Deciduous forest
BB7	Control	Shallow open water	Semi-permanent	10	50	Silt	Deciduous Forest
BB9	Control	Shallow open water	Semi-permanent	30	65	Silt	Shrub/ Deciduous Forest

\*Toad and snake survey site.

Substrate characteristics (percent cover) for gartersnake survey sites in 2025.

Site Name	Survey Area	Organic Matter (%)	Decaying wood (%)	Bedrock (%)	Rock (%)	Mineral Soil (%)	Water (%)
BBS5		40	0	0	50	10	0
BBS6		30	5	0	60	5	0
BBS7		40	0	0	55	5	0
BBS8	Impact	25	5	0	35	30	5
WH5		90	10	0	0	0	0
OW11*		5	5	0	0	0	90
WH2		70	15	0	0	15	0
BBS1		85	5	0	10	0	0
BBS2		40	15	0	10	30	5
BBS3		15	10	0	30	45	0
BBS10	Control	20	50	0	20	5	5
OW13B		60	5	0	20	0	10
TS		45	10	0	25	20	0
WS2		70	15	0	0	15	0

\*Toad and snake survey site.

Vegetation characteristics for gartersnake survey sites in 2025.

Site name	Tree species	Vegetation						
		Total cover (%)	Shrub species	Total cover (%)	Herb species	Total cover (%)	Moss/Lichen species	Total cover (%)
BBS5	n/a	0	Rose sp. (65%), green alder (35%)	10	Grass sp. (60%), chive sp. (20%), locoweed (10%)	90	n/a	0
BBS6	Green alder (90%), balsam poplar (10%)	5	Rose sp. (70%), willow sp. (30%)	20	Grass sp. (60%), white clover (20%)	75	n/a	0
BBS7	n/a	0	Willow sp. (75%), rose sp. (20%), red-osier dogwood (5%)	5	Grass sp. (70%), chive sp. (20%), locoweed sp. (10%)	95	n/a	0
BBS8	n/a	0	Willow sp. (95%), red-osier dogwood (5%)	20	Grass sp. (70%), locoweed sp. (20%), birds-foot trefoil (10%)	80	n/a	0
WH5	Balsam poplar (90%), white spruce (10%)	10	Willow sp. (80%), black cottonwood (20%)	15	Smooth brome (50%), locoweed (30%)	75	n/a	0
OW11*	White spruce (100%)	10	Green alder (50%), red-osier dogwood (35%), rose sp. (15%)	30	Beak sedge sp. (65%), small-flowered bulrush (30%), cattail sp. (5%)	50	Stairstep moss (50%), lungwort (25%), red-stem feather moss (25%)	10
WH2	n/a	0	Willow sp. (100%)	60	Grass sp. (45%), horsetail sp. (45%), silverweed sp. (10%)	40	n/a	0
BBS1	Paper birch (100%)	5	Willow sp. (70%), green alder (30%)	35	Bluejoint grass (80%), dandelion (15%), silverweed sp. (5%)	60	n/a	0
BBS2	n/a	0	Willow sp. (90%), green alder (10%)	60	Horsetail sp. (60%), bluejoint grass (30%), sedge sp. (10%)	50	n/a	0
BBS3	n/a	0	Willow sp. (100%)	50	Birds-foot trefoil (45%), bluejoint grass (45%), chive sp. (10%)	50	n/a	0
OW13B	n/a	0	Willow sp. (100%)	35	Horsetail sp. (20%), sedge sp. (75%), cattail sp. (5%)	35	n/a	0

\*Toad and snake survey site.

Vegetation								
Site name	Tree species	Total cover (%)	Shrub species	Shrub species	Herb species	Total cover (%)	Moss/Lichen species	Total cover (%)
TS	n/a	0	Willow sp. (80%), green alder (10%), black cottonwood (10%)	20	Birds foot trefoil (75%), locoweed (20%), white clover (5%)	80	n/a	0
BBS10	n/a	0	Willow sp. (30%), green alder (70%)	30	Common horsetail (80%), common dandelion (20%)	70	n/a	0

## **Appendix 19. Accounting Framework 2025 Update**

**Site C Clean Energy Project  
Vegetation and Wildlife Compensation  
Accounting Framework**

Updated  
January 6, 2026

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## **1.0 INTRODUCTION**

### **1.1 Background**

BC Hydro and Power Authority (BC Hydro) received environmental approval for the Site C Clean Energy Project (Site C; Project) in October 2014 from the federal and provincial governments. As part of this approval, the provincial government issued Environmental Assessment Certificate E14-02 and the federal government issued a Decision Statement under Section 54 of the Canadian Environmental Assessment Act (2012). These documents outlined the Conditions associated with the approval of Site C and included the mitigation measures and follow-up programs that must be fulfilled by BC Hydro.

All vegetation- and wildlife-related requirements of the provincial Environmental Assessment Certificate (EAC) and the Federal Decision Statement (FDS) issued for the Project are described in a single document, the Vegetation and Wildlife Mitigation and Monitoring Plan (VWMMP, referred to here as the Plan). The Plan outlines how BC Hydro will comply with the EAC and FDS conditions relating to vegetation and wildlife.

The Vegetation and Wildlife Technical Committee (VWTC) was formed with senior technical specialists from the Ministry of Environment and Climate Change Strategy (MOECCS), the Ministry of Land, Water, and Resource Stewardship (MLWRS, formerly the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD or truncated as MFLNRO), and the Canadian Wildlife Service (CWS) of Environment and Climate Change Canada (ECCC). The purpose of the VWTC is to support BC Hydro in developing detailed approaches for implementing the Plan and to provide agency leads with a sufficient understanding of the Plan to advise statutory decision makers (e.g., provincial Comptroller of Water Rights, federal Impact Assessment Agency of Canada [IAAC]) regarding ongoing and future licensing and permitting decisions.

Schedule A of Conditional Water Licence 132990 and Conditional Water Licence 132991 (Schedule A) directs the VWTC to review 16 mitigation and monitoring Program Areas. Most of these program areas align with mitigation being implemented to fulfill requirements of the FDS and EAC. However, some Program Areas extend to concerns not covered by the FDS or EAC and are therefore associated with commitments that are in addition to those that are explicitly required by FDS or EAC conditions (e.g., mitigation for loss of bald eagle nests, mitigation for loss of suitable denning habitat for fisher).

### **1.2 Compensation Requirements**

Planning for mitigation of the effects of Site C is based on the mitigation hierarchy, as described within the 2014 BC Environmental Mitigation Policy:

- 1) avoid impacts on environmental values and associated components.
- 2) minimize impacts on environmental values and associated components.
- 3) restore on-site the environmental values and associated components that have been impacted.
- 4) offset impacts on environmental values and associated components.

In general, the effects of Site C on vegetation and wildlife resources cannot be avoided entirely because of the site-specific nature of the Project and its main components (i.e., a hydroelectric

dam with an associated generating station, reservoir and transmission line). The construction and operation of Site C will result in adverse effects that were determined by the Joint Review Panel to be significant for wildlife, vegetation and ecological communities (including wetlands). Federal and provincial approval conditions for Site C require mitigation to reduce the Project's potential adverse environmental effects. Impacts on vegetation and wildlife are minimized primarily through Site C Project design considerations (e.g., siting transmission towers to minimize impacts to wetlands) and construction guidelines, as required by various Site C approval conditions and good practice. Guidelines on construction practices are described in the Site C Construction Environmental Management Plan (CEMP). The reduction in potential impacts due to the minimizing of impacts through design considerations and construction guidelines is considerable. For example, to be precautionary due to uncertainty in Project design, estimates of wetland impacts presented in the EIS were based on the Project Activity Zone, a broad area within which impacts had potential to occur. These impact estimates included all wetlands in the transmission line right-of-way. However, through careful Project design and construction management, substantial potential wetland impacts were avoided or minimized (e.g., through the careful siting of transmission line towers, guy anchors and access roads).

As another example, again to be precautionary, in the EIS it was assumed that identified bat roosts with potential to be hibernacula at Portage Mountain would be lost due to quarry construction and operation, and that bat disturbance and mortality could occur due to blasting near potential hibernacula in winter. However, the Portage Mountain Quarry (PMQ) was redesigned after the EIS was submitted to avoid direct impacts to bat hibernacula, including rerouting the access road, prohibiting blasting at PMQ from September 15 to May 15, and prohibiting blasting within 300 m of bat hibernacula year-round. This exceeded provincial Best Management Practices (BMPs), which recommended a 100 m buffer for bat hibernacula and no blasting between October to May (BC MOE. 2016). Noise and vibration monitoring conducted at Portage Mountain Quarry found that construction and operation of the quarry were unlikely to have resulted in sound concussion, shock wave, or peak particle velocity exceeding any BMP thresholds at the identified bat hibernacula or cliff-based maternity roosts at PMQ.

In addition, restoration was conducted throughout the Project footprint in impacted areas that did not need to be permanently disturbed, as described in the Soil Management, Site Restoration and Revegetation Plan (Appendix H of the CEMP). Therefore, additional mitigation fell under the category of 'offsets,' which is generally referred to as compensation in FDS and EAC conditions. For consistency, this is also referred to as compensation within this Accounting Framework document.

Approval conditions that either directly required compensation or for which compensation was not required but contributed to effective mitigation, are listed in Appendix 1. The compensation required by federal and provincial approval conditions, and Schedule A Program Areas, are summarized in Table 1.

### **1.3 The Need for an Accounting System**

FDS approval conditions 11.3 and 11.4 and EAC Condition 12 describe wetland compensation targets of no net loss of wetland function or area. No other federal or provincial conditions for Site C describe defined targets for compensation, but it is nonetheless important that compensation actions be tracked.

The Accounting Framework is intended to describe the approach for tracking biological losses and gains directly associated with Site C as appropriate for each relevant approval condition

and/or Schedule A Program Area, with the understanding that losses and gains will accrue over several years, and therefore it may be some time before accounting could be completed. Although it was to be used for tracking compensation actions, the Accounting Framework was not initially a regulatory requirement (i.e., not explicitly required by any provincial or federal Project approval condition, nor explicitly required under Schedule A of Site C's conditional water licences). Moreover, the Accounting Framework was not intended to set an expectation of no net loss objectives for any mitigation program or collection or programs with the exception of wetland compensation, for which the objective of no net loss was required under EAC Condition 12 and FDS Conditions 11.3 and 11.4.4. However, on July 13, 2018, the Accounting Framework was added by the BC Comptroller of Water Rights (BC MFLNRORD 2018). This update serves to provide information on how the draft 2023 Accounting Framework has since been implemented.

Table 1. Summary of mitigation completed under Site C approval conditions and associated accounting metrics

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
FDS 10.3.3	8.1: Songbirds 8.2: Waterfowl and Shorebirds	Aquatic and riparian habitat mitigation for migratory birds	No	Habitat value - Habitat Value Hectares calculated for non-wetland and riparian habitats for all associated migratory bird species	<ul style="list-style-type: none"> <li>Assessments described in the Non-wetland Migratory Bird Habitat memo submitted to VWTC on September 11, 2025</li> </ul>
				Abundance – waterbird monitoring program	<ul style="list-style-type: none"> <li>Updates provided in VWMMP Annual Reports</li> <li>Mitigation includes littoral habitat enhancement and riparian planting for the reservoir, as described in the memo, <i>Effects of Fish Habitat Offset Projects on Migratory Birds</i> (i.e., River to Reservoir memo)</li> <li>Population monitoring via measures of change over time</li> <li>Abundance final assessment to be determined once sufficient post-impact data are available; reservoir fill occurred in fall 2024</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
FDS 10.3.4, 10.3.6	8.1: Songbirds 8.3: Common nighthawk 8.4: Woodpeckers	Compensation and verifying the accuracy of EIS predictions for non-wetland habitat for migratory birds, including habitat associated with Canada Warbler, Cape May Warbler and Bay-Breasted Warbler	No	Habitat value – Habitat Value Hectares calculated for all represented migratory bird species, including separate accounting for each of Canada Warbler, Cape May Warbler and Bay-breasted Warbler	<ul style="list-style-type: none"> <li>Assessments described in the Non-wetland Migratory Bird Habitat Memo submitted to VWTC on September 11, 2025</li> </ul>
FDS 11.3, 11.4.4 EAC 12	2.1: Wetland Function Assessment	Wetland compensation, with the objective of no net loss of wetland function	Yes	Area and wetland functional value – wetland areas by wetland type; wetland functional value as per the Wetland Function Assessment	<ul style="list-style-type: none"> <li>Assessments described in the Wetland Mitigation and Compensation Memo submitted to VWTC on July 10, 2025</li> </ul>
FDS 16.3.3, 16.3.4, 16.3.6	2.1: Wetland Function Assessment 8.1: Songbirds 8.2: Waterfowl and Shorebirds 8.3: Common Nighthawk	Mitigation and verifying the accuracy of EIS predictions for species at risk, at-risk and sensitive ecological	No	Habitat value - Habitat Value Hectares for provincially and federally listed migratory bird species at risk appropriately sampled through breeding bird surveys	<ul style="list-style-type: none"> <li>Assessments described in the Memo for Non-wetland Migratory Bird Habitat submitted to VWTC on September 11, 2025</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
	9: Ground Nesting Raptors 11.1: Rare Plant Translocation	Communities and Rare Plants		Abundance – waterbird monitoring program	<ul style="list-style-type: none"> <li>• Updates provided in VWMMP Annual Reports</li> <li>• EIS assessed impacts based on predicted changes in general habitat classes (river, backchannel, lake and wetland) as an indicator</li> <li>• Mitigation included littoral habitat enhancement and riparian planting as described in the memo <i>Effects of Fish Habitat Offset Projects on Migratory Birds</i> (i.e., the River to Reservoir memo)</li> <li>• Population monitoring considered to be a direct and effective measure of change over time</li> </ul>
				Area - suitable Yellow Rail nesting habitat	<ul style="list-style-type: none"> <li>• Details provided in 2022 VWMMP Annual Report</li> <li>• EIS habitat suitability model was appropriate due to the simplicity of broad-scale Yellow Rail habitat associations (i.e., sedge wetlands)</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
				Area - suitable Bank Swallow nesting habitat	<ul style="list-style-type: none"> <li>• 2022 Hemmera / BGC report predicted a net increase in steep erodible slopes (i.e., suitable nesting habitat) due to reservoir creation</li> <li>• Nesting Bank Swallow surveys were conducted independently by CWS and BC Hydro in summer 2025, in addition to erosion monitoring by BGC; both monitoring assessments determined similar number of colonies and burrows as surveys conducted in 2021, prior to reservoir fill with new colonies being established</li> <li>• BC Hydro assessment of Bank Swallow habitat provided in report to VWTC on October 17, 2025</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
				Area – suitable Short-eared Owl nesting habitat	<ul style="list-style-type: none"> <li>• EIS stated that although there were few observations of ground-nesting raptors made during baseline studies, there was the potential for cleared areas of the reservoir to provide suitable breeding habitat.</li> <li>• There have been no detections of Short-eared Owl during targeted surveys within cleared portions of the reservoir</li> <li>• See Appendix 2 for a technical memorandum concluding that impacts to Short-eared Owl are less than predicted in the EIS</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
				Area - suitable bat roosting habitat	<ul style="list-style-type: none"> <li>EIS used a precautionary approach to predicted impacts to bats, including the assumptions that identified likely bat hibernacula at Portage Mountain would be lost due to quarrying activity and that blasting could occur within 300 m of hibernacula in winter</li> <li>Portage Mountain Quarry (PMQ) was redesigned after the EIS was submitted to avoid direct impacts to bat hibernacula</li> <li>Blasting was prohibited at Portage Mountain from September 15 to May 15 and prohibited within 300 m of identified likely bat hibernacula year-round</li> <li>Final report assessment by Ausenco (formerly Hemmera) that impacts for bats were less than those predicted in the EIS was submitted with the 2024 VWMMP Annual Report</li> </ul>
				Area - extent of affected at-risk and sensitive ecological communities	<ul style="list-style-type: none"> <li>Assessments described in the Non-wetland Migratory Bird Habitat memo submitted to VWTC on September 11, 2025</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
				Occurrence – rare plant occurrences	<ul style="list-style-type: none"> <li>EIS used a precautionary approach to predict impacts to rare plants</li> <li>Number of rare plant species affected by the Project has decreased from 39 at the time of the EIS in 2013 to 13 due to downlisting in 2022</li> <li>See Appendix 4 for a technical memorandum concluding that impacts to rare plants are less than predicted in EIS</li> </ul>
EAC 16	5.2: Gartersnake Hibernacula	Construction and installation of artificial gartersnake hibernacula	Yes	Mitigation structures – gartersnake hibernacula	<ul style="list-style-type: none"> <li>Seven artificial gartersnake hibernacula have been constructed as of December 2023</li> </ul>
	10: Cavity Nesting Species	Construction and installation of waterfowl nest boxes	No	Mitigation structures - nest boxes suitable for waterfowl	<ul style="list-style-type: none"> <li>277 nest boxes have been installed for cavity nesting birds, which includes 80 boxes designed for waterbirds</li> </ul>
	4: Bats	Bat roost boxes for consideration by MOTI for integrating into Hwy 29 bridges	No	Mitigation structures – bat roost boxes integrated into Hwy 29 bridges	<ul style="list-style-type: none"> <li>MOTI did not allow the installation of bat roost boxes on bridges due to health and safety and logistical concerns for maintenance crews</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
	4: Bats	Creation of hibernating and roosting sites for bats following rock extraction at Portage Mountain	No	Mitigation structures – constructed bat hibernation and roosting sites at Portage Mountain	<ul style="list-style-type: none"> <li>EAC Condition 16 states that this requirement is only “if loss of sensitive wildlife habitat or important wildlife areas cannot be avoided through Project design or otherwise mitigated.” The quarry was redesigned to avoid habitat loss so implementing this mitigation is a precautionary step</li> <li>Four artificial bat hibernacula were voluntarily installed at PMQ as part of the reclamation plan</li> <li>BC Hydro is conducting long-term monitoring to evaluate use and hence effectiveness</li> </ul>
	3: Fisher	Creation of fisher CWD piles and arboreal den sites	No	Mitigation structures - constructed CWD piles and arboreal den boxes	<ul style="list-style-type: none"> <li>119 CWD piles constructed</li> <li>88 den boxes also installed</li> </ul>
	1: Ungulate Winter Range	Identify and maintain suitable BC Hydro-owned lands for ungulate winter range	No	Area - identified ungulate winter range (UWR) on BC Hydro-owned lands	<ul style="list-style-type: none"> <li>Total area of 1197.3 ha designated as UWR among BC Hydro-owned lands for Site C</li> </ul>
EAC 24	3: Fisher	Mitigation for loss of suitable denning habitat for fisher	Yes	Mitigation structures – fisher den boxes	<ul style="list-style-type: none"> <li>88 fisher den boxes were installed from 2018 to 2020 and were monitored annually with no reproductive use observed, possibly due to sufficient natural denning opportunities or a low local fisher population density</li> </ul>

Condition	Schedule A Program Area	Required Mitigation		Metrics / Indicators	Comments
		Description	Defined Target?	Description	
N/A	4: Bats	Construction and installation of bat roost boxes	Yes	Mitigation structures – bat roost boxes	<ul style="list-style-type: none"> <li>• 120 bat boxes and one bat condo established</li> <li>• 13 more boxes to be installed at the dam site; 10 bat boxes and one bat condo in the Area A reclamation area and two bat boxes at the Cultural Centre in 2026 and 2027</li> </ul>
N/A	7: Eagles	Mitigation for loss of bald eagle nests	Yes	Mitigation structures – Bald Eagle artificial nesting structures	<ul style="list-style-type: none"> <li>• 42 eagle artificial nesting structures have been installed</li> </ul>
N/A	10: Cavity Nesting Species	Mitigation for loss of suitable nesting habitat for cavity nesting birds	No	Mitigation structures - nest boxes	<ul style="list-style-type: none"> <li>• 277 boxes have been installed for cavity nesting birds</li> </ul>
N/A	10: Cavity Nesting Species	Mitigation for loss of suitable nesting habitat for cavity nesting birds	No	Mitigation structures – suitable trees for cavity nesting species	<ul style="list-style-type: none"> <li>• Fungal inoculation and stem manipulation for wildlife tree creation</li> <li>• Funding provided to UNBC starting in 2026 for grad student research to assess effectiveness of inoculation to speed up wildlife tree creation process</li> <li>• Additional mitigation expected through non-wetland migratory bird habitat compensation</li> </ul>

## 2.0 Objectives

BC Hydro's Accounting Framework has two objectives:

- To provide a system for efficiently tracking measurable gains and losses in vegetation and wildlife indicators selected as measures for compensation to meet FDS or EAC Project approval conditions associated with Site C; and
- To provide a mechanism for communicating progress on compensation to regulators, stakeholders, and First Nations.

The development of the Accounting Framework has taken place in an iterative fashion, becoming increasingly detailed and refined as BC Hydro worked with the VWTC to develop a mutually acceptable approach.

## 3.0 Accounting System

### 3.1 Accounting Metrics

Best practices for the selection of metrics for the measurement of change in ecological systems require that metrics should be “science-based, quantifiable, consistent, repeatable, and related to the conservation goals for the species<sup>1</sup>”. BC Hydro used four general metrics in the Accounting Framework for Site C based on the specific requirements of the associated FDS or EAC condition(s), or the commitments associated with Schedule A Program Areas: mitigation structures; habitat value; area and wetland functional values; and abundance and occurrence. The application of these metrics for specific indicators is provided in Table 1, and the general approaches are described in Sections 3.2.1 through 3.2.4.

### 3.2 Loss-gain Accounting

Central to the design of a compensation program is a credible and transparent accounting framework for quantifying the biological losses and gains at the Project (impact) site and compensation sites as appropriate for each relevant approval condition and/or Schedule A Program Area. Accounting was to be performed separately for each compensation target (e.g., wetlands) to provide a transparent assessment of the net effect of Site C on each target. Developing an accounting system required the selection of appropriate metrics or indicators as well as the application of accounting principles that facilitate direct comparisons between impact and compensation sites.

In 2015, BC Hydro estimated approximately 700 hectares (ha) of wetlands would be impacted by the Project. However, this was not confirmed or ground-truthed and was conservatively assessed using limited Terrestrial Ecosystem Mapping (TEM) data available at the time. In 2024-2025, upon completion of reservoir fill and land-disturbing activities, BC Hydro conducted a re-assessment indicating that 299 ha of wetland had been impacted by the Project.

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<sup>1</sup> US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2023).

Working with Ducks Unlimited Canada (DUC), BC Hydro undertook wetland compensation in the form of wetland creation and wetland “rebuilt.” Compensation was calculated by considering additionality – the benefits that accrue due to mitigation actions, and which otherwise would not have occurred. Constructing a wetland is a considered compensation because if the wetland wasn’t constructed it wouldn’t exist. Wetland rebuilds (i.e., rebuilding constructed wetland water control infrastructure) are considered compensation because, without intervention, water licences for those wetlands require that their water control infrastructure be decommissioned or rebuilt at the end of their engineered lifespan, which is about 30 years for historically constructed wetlands. DUC did not have the funds for rebuilding the wetlands, and therefore they would have been decommissioned if BC Hydro had not provided the necessary funds and the wetlands would have been lost as they drained or returned to a more riverine system. This additionality principle is discussed more in Section 4.5. The ‘rebuilt’ concept was accepted by the Canadian Wildlife Service of Environment and Climate Change Canada on March 15, 2021 and by the BC Ministry of Environment and Climate Change Strategy as being suitable for wetland compensation on March 16, 2021.

To date, through our work with DUC, BC Hydro has established 269.7 ha of created or rebuilt wetland offsets among five wetlands in the Peace Region (Table 2). Of the five wetlands, Golata Ranch was a new wetland built on agricultural land where no wetland previously existed. This wetland is a ~50 ha marsh/sedge wetland, including one seven-hectare pond and 14 smaller ponds of varying sizes. The remaining four wetlands were wetland rebuild projects.

Currently, construction of a new wetland complex, designed by DUC, is underway in Area A at the Site C dam site. This will result in an additional 35 ha of new wetlands completed by December 2027 bringing the total area of compensation wetlands to 304.7 ha. Overall Table 2 shows that the planned and completed wetland compensation will result in a 5.7 ha gain in wetland area compared to the area of impacted wetlands (299 ha).

Table 2. Restored or created wetlands compensating for 299 ha wetland loss

<b>Wetlands Created or Restored to Date</b>	<b>Size (hectares)</b>
Golata Canyon Ranch	49.6
Doig-Beatton East Marsh	21.2
Doig-Beatton West Marsh	20.1
Cutbank Lake	152.3
Scott Lake	26.5
<b>SUB-TOTAL</b>	<b>269.7</b>
<b>Wetlands currently under construction as of December 2025</b>	
Area A	35
<b>TOTAL</b>	<b>304.7</b>

Further details on the discrepancy between the 2015 and 2025 impact assessments is described in the Wetland Mitigation and Compensation Memo sent to the IAAC, ECCC, and the BC Environmental Assessment Office (EAO) on July 10, 2025. The methods used and calculations of wetland loss impacts in terms of area and function and how mitigation and compensation offsetting efforts have now exceeded losses through rebuilding,

restoring, and creating new wetlands is discussed further in Section 3.2.3 of this report. This was also detailed in the Memo which outlined how the regulatory requirements regarding mitigation, compensation, and monitoring to offset the impacts of the Project on wetlands now satisfies compliance conditions and program closure.

### **3.2.1 Habitat Structures**

The metric for wildlife mitigation structures is the number of artificial mitigation structures constructed. For each appropriate approval condition and Schedule A Program Area, the number of mitigation structures constructed is stated in Table 1. For mitigation structures it is not practical to calculate the number of naturally occurring habitat structures in a given area for specific species or species groups because baseline habitat data was not collected at such a fine resolution<sup>3</sup>. For example, although extensive bird and bat surveys were conducted, cryptic cavity nests and bat roosts were not searched for in forested areas and the abundance of those features is very difficult to estimate.

Although such habitat features (e.g., tree cavities or trees in which cavities could occur) could theoretically be estimated (albeit crudely), there is no requirement to do so implied in the respective approval conditions or Schedule A Program Areas, nor is there any apparent purpose for doing so. The clearest exception to this is for Bald Eagle nests, for which the mitigation and monitoring plan (Schedule A Program Area 7) specifies that there should be two artificial nesting structures installed for every one of the active natural nests that were present in a given year during baseline studies. The maximum number of active bald eagle nests in a year that was observed during baseline studies was 19, and so the minimum number of bald eagle artificial nesting structures required was 38. A total of 42 bald eagle artificial nesting structures were installed (Table 1). Regardless, the effective and efficient metric for wildlife mitigation structures is the number of mitigation structures constructed relative to program commitments.

### **3.2.2 Habitat Value**

Non-wetland migratory bird habitat compensation required by FDS condition 10.3.4, does not specify an end point or target amount for habitat compensation. For the accounting of losses and gains for broad, habitat-based compensation, BC Hydro used species-specific habitat-based indicators supplemented by those that represent migratory bird species and species groups by assigning a habitat value to each habitat type. This tracked the areal extent of habitats and the associated habitat value per selected indicator species or species group per habitat type.

Habitat value is a standardized, unitless measure of relative use of a habitat by a species or species group. It is calculated for selected indicators that parsimoniously maximizes the use of available data. As such, the approach varies by species and species group. For example, habitat value calculations for non-wetland migratory birds use estimated population density and probability of occurrence or incidence depending on the data available. See Appendix 3 for the updated 2025 calculations.

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<sup>3</sup> Standard practice for development applications is to sample a subset of the most visible types of habitat structures, rather than attempt a complete inventory of all types of habitat structures.

Habitat value measures for each species are first standardized to sum to 1 for each species across habitats, and then for each habitat across species. Standardizing the bird habitat values in this way ensured that all bird species were weighted equally independent of their abundance. The standardized bird habitat values are then combined (summed) into groups of species (e.g., songbirds, woodpeckers, listed species, all species) to produce an integrated measure of habitat value for different levels of aggregation of the bird community. The use of the standardized habitat values has two main benefits:

- Species can be combined or “rolled-up” into groups using a common currency, even when those species differ in data availability and the method used to determine relative habitat value; this is important because there is no single measure of expected use or preference that can be calculated for all species.
- Each species is equally weighted when combined with others. If the bird habitat values were not standardized, then a combined habitat value would be strongly biased toward the most commonly occurring species.

The Accounting Framework tracks the areal extent of individual habitats of different calculated values. This is determined by applying the habitat value assessment to the TEM developed for the Site C Local Assessment Area (LAA). Additional TEM was also developed for compensation areas so losses and gains could be measured with the same indicators. Habitat value and area were then combined by weighting the classes of habitat based on their value<sup>4</sup> and multiplying by their respective areas to get a single measure of Habitat Value Hectares (HVH). These HVH represent the central metric for calculating non-wetland migratory bird habitat losses due to the Project footprint and gains due to compensation sites (Table 1; Appendix 3).

### **3.2.3 Area and Wetland Functional Values**

FDS condition 16.3.6 requires “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.” BCH used a combination of monitoring and habitat suitability mapping to assess how actual impacts compare to those predicted using the key assumptions from the EIS (Table 1). For example, for Short-eared Owl, field surveys and subsequent data analysis confirmed that impacts due to the Project were less than those predicted in the EIS (Appendix 2).

For at-risk and sensitive ecological communities, the indicator is the areal extent of the at-risk and sensitive ecological communities affected by the Project (Table 1). Change in ecological communities was measured using GIS to determine the areal extent of each at-risk and sensitive ecological community that was impacted by the Project, as well as the areal extent of those protected or constructed as compensation for Site C.

Change in area per wetland type was measured using GIS once reservoir fill was complete. This was calculated post-reservoir fill primarily because the wetland impact

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<sup>4</sup> For example, habitats of different value could be assigned the following coefficients: Nil = 0; Low = 0.33; Mod = 0.66; High = 1

footprint could only be accurately determined once the Project's dam site construction activities were all completed. Prior to reservoir fill, impacts could only be estimated based on projections and modeling, whereas post-reservoir filling assessments, monitoring and updated mapping from ground-truthed vegetation clearing and Environmental Completion Reports provided more accurate measurements. While a preliminary wetland impact footprint calculation was conducted during pre-construction in 2015, it was considered a conservative estimate because the full extent of the Project footprint was yet to be finalized at the time.

Indicators for changes in wetland habitat were assessed as area per wetland type and the functional values measured through the Wetland Function Assessment (WFA; Table 1). The WFA is a complex tool, developed through extensive consultation with the VWTC, that uses representative indicators for the range of ecological functions provided by wetlands that support biodiversity to evaluate the relative value of wetland functions per unit area of each wetland type, and to measure the change in the value of those functions across wetlands.

The original WFA (NPS 2018) included three components: (1) classification of wetland types and areas within the area to be affected by Site C, (2) selection of wetland indicator species, and (3) identification of important wetland habitat functions. The WFA considers the importance of wetland functions for specific wildlife and plant groups during important periods of their lifecycles (DUC 2025). The wetland habitat functional groups include migratory birds, amphibians, bats, fauna species at risk, flora species at risk and species important to Aboriginal land use. For some groups, functions were further subdivided to generate a total of 12 "function types" (Table 3).

Using the WFA methodology, DUC determined the wetland functional losses for the impacted wetlands and gains from the compensation wetlands for each wetland category. This was derived by inputting the spatial hectares for each wetland type into a model accounting for calculated changes in values for a variety of wetland functions, across all affected wetland types. This approach recognizes that some wetland functions may have a net loss while others a net gain (i.e., not all lost functions will be equally gained and vice-versa).

As indicated in Table 3, wetland compensation measures implemented to date have resulted in a net positive gain in wetland functions. Note that some functions within wetland systems will overlap. For example, amphibians and bats will still feed in breeding and roosting habitats. As wetlands mature, it is anticipated that additional functions will establish over time, likely mitigating some of the currently deficient functions.

Full details on the wetland area impacts and the WFA, including calculations of wetland losses in area and functions due to the Project and wetland gains as a result of compensation, was provided in a Memo sent to regulators (ECCC, IAAC, EAO) on July 10, 2025. This is also detailed in the final Wetland Mitigation and Compensation Plan initially drafted by DUC in 2025 and finalized by BC Hydro which will be included in the 2025 VWMMP Annual Report.

Table 3. Total functional hectare loss from the 299-hectare Site C wetland impact footprint and total functional hectare gains from the completed habitat compensation sites to date plus estimated gain from completed Area A and overall net functional balance

	Wetland Function Types (Represented as “functional hectares”)												Overall Functional Balance
	Wildlife												
	Migratory Birds - Nesting	Migratory Birds - Brood-rearing	Migratory Birds - Feeding	Migratory Birds - Migration	Amphibians - Breeding	Amphibians - Feeding	Amphib Hibernation	Bats - Feeding	Bats - Roosting	Species-At-Risk	Plants - Primary Secondary Species	Aboriginal Land Use	
<b>Total loss: Wetland Impact Footprint</b>	<b>27.2</b>	<b>59.1</b>	<b>54.3</b>	<b>63.9</b>	<b>44.6</b>	<b>28.8</b>	<b>85.6</b>	<b>34.7</b>	<b>62.1</b>	<b>43.5</b>	<b>27.7</b>	<b>34.0</b>	
Total gain from the five completed habitat compensation projects to date	32.9	79.2	67.9	75.3	52.4	20.9	69.3	27.2	32.4	28.5	9.0	15.5	
1. <i>Golata Canyon Ranch</i>	15.1	8.4	10.6	6.6	10.6	6.6	4.8	5.0	4.1	9.0	2.9	n/a	
2. <i>Doig-Beaton East Marsh</i>	3.0	8.1	6.6	7.3	5.0	1.3	4.7	2.0	0.7	2.7	0.7	0.9	
3. <i>Doig-Beaton West Marsh</i>	3.6	5.5	5.1	5.1	4.1	1.8	4.1	2.0	1.9	2.7	0.9	1.4	
4. <i>Scott Lake</i>	1.3	10.3	7.8	9.8	5.3	1.0	7.5	2.4	1.7	2.1	1.1	1.3	
5. <i>Cutbank Lake</i>	9.9	46.9	37.8	46.5	27.4	10.2	48.2	16.3	24.0	12.0	3.4	11.9	
Estimated gain from Area A once completed	5.7	14.9	12.1	12.7	9.0	2.1	7.2	3.4	0.0	5.0	1.3	1.0	
<b>Total gain from above compensation projects</b>	<b>38.6</b>	<b>94.1</b>	<b>80.0</b>	<b>88.0</b>	<b>61.4</b>	<b>23.0</b>	<b>76.5</b>	<b>31.1</b>	<b>32.4</b>	<b>33.5</b>	<b>10.3</b>	<b>16.5</b>	
<b>Net functional balance (gains minus losses)</b>	<b>11.4</b>	<b>35.0</b>	<b>25.7</b>	<b>24.1</b>	<b>16.8</b>	<b>-5.8</b>	<b>-9.1</b>	<b>-3.6</b>	<b>-29.7</b>	<b>-10.0</b>	<b>-17.4</b>	<b>-17.5</b>	<b>19.9</b>

### **3.2.4 Abundance and Occurrence**

Habitat-based indicators were not appropriate for all species or ecological communities. For example, while habitat changes for waterbirds can be measured, changes in waterbird abundance, particularly on the Peace River, were expected to be a more direct and effective measure of change for the local waterbird population (Table 1). This is because the Peace River component of the waterbird monitoring program was developed using a Before-After-Control-Impact (aka. BACI) design to distinguish between background and Project-related changes in waterbird abundance and diversity.

For rare plants at the scale of the area affected by Site C, abundance is more difficult to measure so occurrence is a more appropriate indicator for measuring change (Table 1). Rare plant occurrences were lost due to construction, but this loss was minimized in part through design changes that minimized the Site C footprint, as well as the propagation and translocation of plants in advance of site disturbance through the Rare Plant Translocation Program. An assessment was conducted to confirm that impacts on rare plants due to Site C were less than those predicted in the EIS (Appendix 4).

## **4.0 Compensation Principles and Considerations**

A key consideration when conducting loss-gain accounting is ensuring that losses and gains are truly comparable<sup>5</sup>. There are a number of best practice principles that BC Hydro adopted within the Accounting Framework so that losses and gains between the impact and compensation sites were directly comparable as much as possible<sup>6</sup>. A summary of the best practices this review was based on is presented in Appendix 5.

### **4.1 Landscape Conservation Planning**

Virtually all best practice biodiversity offsetting frameworks reviewed for the Accounting Framework recognize the importance of conducting mitigation work within the context of a larger landscape conservation plan. This approach allows for the selection of the highest priority conservation sites in the region and facilitates the incorporation of landscape considerations into loss-gain accounting (e.g., ensuring that compensation sites have equal or greater connectivity than impact sites). In addition, a landscape conservation plan facilitated the selection of compensation sites that made the greatest contribution to other regional conservation objectives.

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<sup>5</sup> Business and Biodiversity Offsets Programme (BBOP). 2012. Resource Paper: No Net Loss and Loss-Gain Calculations in Biodiversity Offsets.

<sup>6</sup> Best practice biodiversity offsetting frameworks reviewed to identify best practice principles include: Environment Canada - Operational Framework for Use of Conservation Allowances (2012); "BC MOE - Procedures for Mitigating Impacts on Environmental Values (Environmental Mitigation Procedures) Version 1.0 May 27, 2014; IFC PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012); South Africa - Draft National Biodiversity Offset Policy (2017); Victoria's Native Vegetation Management (2017); Australia Federal Government - Environment Protection and Biodiversity Conservation Act 1999 and Environmental Offsets Policy October 2012; US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2016); NSW - Biodiversity Conservation Regulation (2017); Business and Biodiversity Offsets Programme (BBOP) (2012).

BC Hydro reviewed landscape scale conservation plans and datasets that could support the selection of offset sites in the Peace River region. The review found two conservation datasets with outputs that provided comprehensive coverage of the Peace River Basin region, three regional conservation plans that provided partial coverage, and several relevant spatial datasets that supported the selection of the highest priority conservation sites in the region. This facilitated the incorporation of landscape considerations into loss-gain accounting. These plans and datasets are described in detail in Appendix 6.

## **4.2 Proximity of Compensation Sites**

Most biodiversity offsetting frameworks prefer that compensation sites occur as close as possible to the impact site. This practice increases the chance that impact- and compensation sites are ecologically equivalent (see below for further discussion on ecological equivalence), and that impacts to cultural and ecosystem services for local communities are mitigated. However, this is not a universal requirement. For example, Environment Canada (2012) requires proximity only when ecological information supporting offset site selection is poor. Other offsetting frameworks allow offsets to be located anywhere within a larger offset catchment area defined by political boundaries or by recovery plans.

Flexibility in the selection of offset locations facilitates considerations of “trading up” through potentially addressing higher priority biodiversity conservation concerns than those impacted by the Project (see Section 4.6 for further discussion). In addition, flexibility in offset location is necessary when compensation opportunities close to the impact site are lacking. For example, while wetland compensation opportunities were pursued in the Peace Region, DUC found that cost-effective opportunities were limited so also explored potential wetland compensation opportunities in the Omineca Region west and north of Prince George. However, all the wetland creation and rebuild projects to date were conducted in the Peace Region.

## **4.3 Durability of Compensation Benefits**

Best practices for biodiversity offsetting require that the benefits generated from compensation sites endure for at least as long as project impacts. For Site C, some offsets are only intended to provide short- and/or medium-term mitigation. However, the ecological benefits of ungulate winter range protection, wetland compensation, and non-wetland migratory bird habitat compensation are intended to last for the life of the Project. BC Hydro employed two measures to ensure such durability: legal security and funding security.

BC Hydro considered several approaches to obtaining permanent legal security for their compensation sites. This included consideration of approaches such as the delineation of reserves or special management zones, purchase of private lands and/or transfer of ownership of BC Hydro’s non-operational surplus lands to conservation groups, and purchase of conservation easements on private lands. For most of the wetland rebuilds conducted by DUC (Table 2), compensation sites were located on public lands (i.e., provincial crown land) which helped to mitigate impacts to the current use of lands and resources by Aboriginal people (e.g., FDS 11.4.4). Legal security was obtained through a conservation covenant (e.g., Golata), statutory right-of-way (e.g., Cutbank), License of Occupation (e.g., Area A), or Conservation Agreement with the (provincial) Crown (aka.

Crown Protocol Agreement) combined with a Water Licence (e.g., Doig-Beatton, Scott Lake).

The greatest challenge for land securement and use for conservation mitigation and compensation purposes has been the designation of almost all farmable land within the Peace Region as Agricultural Land Reserve (ALR). Proposing use of ALR-designated land for non-agricultural use, including for conservation purposes, requires authorization by the Agricultural Land Commission (ALC), a provincial agency that works with local governments to preserve land with agricultural capability for food production. The ALC designates land where agriculture is the priority use, protecting it from development and encouraging farming by regulating non-farm uses. Therefore, the process of changing the status of lands occurring within the ALR to provide long-term conservation and protection requires a great deal of negotiation with the ALC. While this may exclude wetlands occurring within forested habitats, it poses challenges for those occurring in open areas or adjacent to them.

Due to these challenges and the cost of purchasing property in the Peace Region with no guarantee that the ALC would allow a covenant or other long-term protective designation on the land, BC Hydro chose to establish protection using its non-operational surplus lands that were acquired along the reservoir and in adjacent areas for safety, flooding, and construction purposes in the early stages of Site C. Many of these properties contain suitable habitat for non-wetland migratory birds. With construction completion and reservoir filling, BC Hydro reassessed the availability of these properties and their potential value to contribute to the Non-wetland Migratory Bird Habitat (NWMBH) compensation program.

As such, BC Hydro's approach to NWMBH compensation consists of the acquisition of properties for this purpose and/or the establishment of covenants or other protections on existing BC Hydro-owned properties such that they will continue to provide NWMBH into perpetuity regardless of ownership. In addition, restoration and creation of wetlands, and reclamation of areas impacted by Project construction were conducted throughout the Peace Region but were not factored into the calculations for compensation credit. Details on this process were provided in the *NWMBH Program Status of Compliance Memo* sent to ECCC and IAAC on September 11, 2025.

To be effective and meaningful, biodiversity offsetting requires the protection of compensation sites and ongoing management to maintain this status. Initially, BC Hydro considered endowment funding for the long-term management of NWMBH and wetland compensation sites. However, for the wetland projects undertaken by DUC, BC Hydro provided management and maintenance funding to cover 30 years of maintenance for the wetland rebuilds, which is the approximate lifespan of rebuilt water control structures upon which they would require replacement.

#### **4.4 Technical Risk**

Best practices for biodiversity offsetting required that BC Hydro take steps to maximize the likelihood that compensation properties are successful from a technical perspective to deliver intended benefits for compensation targets. An extensive review and discussion was conducted to assess various approaches and feasibility of implementation given the specific Site C context. A summarized compilation of best practices that BC Hydro reviewed for this consideration is presented in Appendix 5. These considerations included:

- Compiling evidence for the effectiveness of compensation mechanisms from the grey and peer-reviewed literature, and from interviews with people involved in similar types of projects, to consider compensation mechanisms most likely to succeed;
- Partnering with experienced parties such as land trusts for the effective management of offset properties. To this end, BC Hydro engaged in discussions with the BC Parks Foundation, the Nature Conservancy of Canada, the Land Conservancy of BC, and the Nature Trust of BC, but none were able to provide appropriate partnership opportunities for Site C;
- Focussing on offsets for which the likelihood of meeting intended objectives was maximized;
- Ecological monitoring of compensation properties to assess their effectiveness and allow adaptive management of compensation approaches to support meeting specific mitigation objectives where necessary; and,
- Replacement or effective modification of any failed and required compensation projects, for the duration that a particular offset is required.

Considered together when feasible, these measures would reduce technical risk surrounding compensation programs.

#### **4.5 Additionality**

Best practices for biodiversity offsetting require that compensation sites produce benefits that are “additional” to those that would have occurred in the absence of the biodiversity offset. For example, purchasing remote land that is under no foreseeable threat would not produce additional conservation benefits, and as a result, would not be suitable as a biodiversity offset.

Biodiversity offsets are of two general types that differ with respect to how they demonstrate additionality. Restoration offsets restore or enhance degraded sites and have clear, measurable additionality (i.e., the difference between the initial site condition and the final condition of the restored site). “Averted loss” offsets manage threats to natural habitats in good condition and avoid the degradation or loss of biodiversity values at these sites. Averted loss offsets require the consideration of a baseline or business as usual (BAU) scenario against which the benefits of the offset can be measured. The burden of proof for demonstrating additionality for averted loss offsets varies considerably across the offsetting frameworks reviewed for this document. Examples range from quantitative estimates of habitat loss based on land change modelling of baseline and Project impact scenarios have been used, to qualitative approaches for characterizing additionality such as an agreement by regulators that targeted habitats are generally at risk.

BC Hydro sought additionality by evaluating different options for averted loss compensation sites for wetland and/or non-wetland migratory bird compensation by compiling information on historic rates of ecosystem loss and degradation for offset sites in the Peace Region by drawing on published studies, grey literature, and expert interviews. This information formed the basis to develop additionality considerations that were used to determine the degree to which compensation sites would generate additional benefits for the compensation targets and other environmental benefits (e.g., habitat protection for non-target wildlife species).

To maximize additionality per unit area and cost-effectiveness, averted loss compensation sites were selected based on those in which habitat enhancement would result in the greatest improvement in habitat capability or provision of ecological functions and those in which more immediate timing was warranted based on the potential to lose the opportunity.

As discussed in Section 3.2, additionality was implemented by DUC through the rebuilding of water control structures funded by BC Hydro. In the absence of external funding, established water licences would have required DUC to decommission water control structures at the end of their engineered lifespan and return the constructed wetlands to pre-construction hydrologic conditions, effectively destroying the constructed area of those wetlands. By providing the necessary funding to DUC to rebuild those aging water control structures and maintain them for the life of the Site Project, BC Hydro averted the areal loss of those wetlands had the water control infrastructure been decommissioned. Additionality calculations and methods are provided in greater detail in the Wetland Mitigation and Compensation Plan included in the 2025 VWMMP Annual Report.

#### **4.6 Ecological equivalence**

Most best practice biodiversity offsetting frameworks require that as a starting point, compensation sites are chosen to produce benefits that are functionally equivalent to those impacted by a project. However, some frameworks provide leeway and allow for the possibility of “trading up,” or in other words, choosing compensation sites that produce benefits that are more important from a conservation perspective than those that were impacted (see examples in Appendix 5).

BC Hydro’s Accounting Framework incorporates the principle of ecological equivalence because the habitat value assessments and functional models used account for Project impacts and also the benefits of compensation sites. To the degree that impact and compensation sites are ecologically dissimilar, this may result in different habitat value scores, with corresponding different areal requirements for compensation. To the greatest extent possible, BC Hydro pursued compensation sites that were of equal or greater suitability or function than were impacted by Project activities. BC Hydro also only pursued wetland compensation for which there was little to no uncertainty regarding ecological effectiveness. The compensation wetlands were selected by DUC, who also developed the WFA methodology to assess the extent of wetland functions lost while creating new wetlands or restoring old wetlands to compensate for wetland losses. The WFA was discussed and adjusted throughout 2016-2018 and was accepted and considered complete by the VWTC on April 26, 2018.

#### **5.0 Summary and Concluding Steps**

Biodiversity offset accounting metrics for addressing FDS conditions, EAC conditions, and the requirements of Schedule A Program Areas are summarized in Table 1. Each category of metric is described in Section 3, and underlying compensation principles for biodiversity offsets are expanded upon in Section 4.

Calculation of the final metrics used in this Accounting Framework was conducted post-reservoir fill as the final Site C development footprint needed to be verified including areas that were permanently versus temporarily disturbed or completely undisturbed. This could only be determined once all detailed vegetation clearing maps and environmental

completion reports could be synthesized and reviewed as Project activities finished in various areas and site reclamation designs finalized. This information all fed into the calculations of impacted wetlands and non-wetland migratory bird habitat and assessment of the areal extent and functions offset by the compensation sites. Specifics for wetland offsets and non-wetland migratory bird offsets are provided in Table 1.

BC Hydro continues to work with DUC to identify and capitalize on ecologically-appropriate wetland compensation opportunities. This includes the wetland creation program currently underway in Area A of the Site C dam area which will result in 35 ha of new wetlands by the end of December 2027.

Development of offsets for wetland compensation and non-wetland migratory bird habitat compensation for Site C follows the compensation principles described within this Accounting Framework (Section 4). BC Hydro has expended great effort to maximize the habitat value and additionality per unit cost of offsets, as well as minimize any technical risk associated with potential offsets that could result in outcome uncertainties and complicate the calculation of additionality.

Through Memos sent to the IAAC, ECCC, and EAO on July 10 and September 11, 2025, BC Hydro provided details on how mitigation, monitoring and compensation offsetting efforts now satisfy compliance conditions and program closure for the Wetland Mitigation and Compensation Program and the Non-wetland Migratory Bird Habitat Program. As of January 5, 2026, ECCC and EAO have stated that they have no further comments on the Wetland Mitigation and Compensation Program on October 30, 2025 and January 2, 2026 respectively. No comments have been received to date on the Non-wetland Migratory Bird Habitat Program of which a follow-up letter was sent to IAAC on December 9, 2025, summarizing the offset ratios presented in the Memo to formally close out the requirements of Federal Decision Statement Condition 10.

## 5.0 References

- BC MFLNRORD (BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development). 2018. Site C Clean Energy Project Conditional Water Licence C132990 and C132991. Decision on Schedule A Monitoring, Mitigation and Compensation Projects. July 13, 2018. File No. 7001837.
- BC MOE (BC Ministry of Environment). 2016. Best Management Practices Guidelines for Bats in British Columbia. Chapter 2: Mine Developments and Inactive Mine Habitats. 68 pp.
- Environment Canada. 2012. Operational Framework for Use of Conservation Allowances. Cat. No. En14-77/2012E-PDF. Available at: [https://publications.gc.ca/collections/collection\\_2012/ec/En14-77-2012-eng.pdf](https://publications.gc.ca/collections/collection_2012/ec/En14-77-2012-eng.pdf).
- NPS (Native Plant Solutions). 2018. Assessment of Wetland Function for the Site C Clean Energy Project. Prepared for BC Hydro by L. Ross, P. Rose, J. Raizenne, L. Dupuis, and L. Armstrong.

## Appendix 1. Regulatory Commitments Related to Compensation

**Table A1. Federal Decision Statement and Environmental Assessment Certificate Conditions Related to Compensation Requirements**

Condition #	Condition	Compensation Requirement
FDS 10.3.3	The plan shall include measures to mitigate the changes in aquatic and riparian-related food resources and other habitat structures associated with a change from a fluvial to a reservoir system	Does not specifically require compensation but will be compensated through riparian habitat creation.
FDS 10.3.4	The plan shall include compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler.	Specifically requires compensation.
FDS 11.3	The Proponent shall, in developing the plan, describe how the mitigation hierarchy and the objective of no net loss of wetland functions were considered.	Specifically requiring compensation (describes wetland compensation objective).
FDS 11.4.4	The plan shall include compensation measures to address the unavoidable loss of wetland areas and functions supporting migratory birds, species at risk, and the current use of lands and resources by Aboriginal people in support of the objective of full replacement of wetlands in terms of area and function.	Specifically requires compensation (describes wetland compensation objective).
FDS 16.3.3	The plan shall include measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants.	Does not specifically require compensation. Mitigation provided through Project design considerations and CEMP. However, compensation will accrue by satisfying other overlapping compensation requirements.
EAC 11	<p>EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes:</p> <ul style="list-style-type: none"> <li>• Assistance (financial or in-kind) to the managing organization of suitable habitat enhancement projects in the RAA (RAA as defined in the amended EIS).</li> </ul>	Specifically requires compensation.

Condition #	Condition	Compensation Requirement
	<ul style="list-style-type: none"> <li>Direct purchase of lands in the RAA and manage these lands and suitable existing properties owned by the EAC Holder to enhance or retain rare plant values where opportunities exist.</li> </ul> <p>The EAC Holder must engage with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.</p>	
EAC 12	<p>(edited to remove non-relevant parts)</p> <p>The EAC Holder must develop a Wetland Mitigation and Compensation Plan. The Wetland Mitigation and Compensation Plan must include an assessment of wetland function lost as a result of the Project that is important to migratory birds and species at risk (wildlife and plants). The Wetland Mitigation and Compensation Plan must be developed by a QEP with experience in wetland enhancement, maintenance and development.</p> <p>The Wetland Mitigation and Compensation Plan must include at least the following:</p> <ul style="list-style-type: none"> <li>Information on location, size and type of wetlands affected by the Project;</li> <li>A defined mitigation hierarchy that prioritizes mitigation actions to be undertaken, including but not limited to: <ul style="list-style-type: none"> <li>Avoid direct effects where feasible;</li> <li>Minimize direct effects where avoidance is not feasible;</li> <li>Maintain or improve hydrology where avoidance is not feasible;</li> <li>Replace like for like where wetlands will be lost, in terms of functions and compensation in terms of area;</li> <li>Improve the function of existing wetland habitats; and</li> <li>Create new wetland habitat</li> </ul> </li> </ul>	Specifically requires compensation.
EAC 16	<p>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.</p> <p>The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation measures:</p> <ul style="list-style-type: none"> <li>Compensation options for wetlands must include fish-free areas to manage the effects of fish predation on invertebrate and amphibian eggs and larvae and young birds.</li> </ul>	Specifically requires compensation.

Condition #	Condition	Compensation Requirement
	<ul style="list-style-type: none"> <li>• Mitigation for the loss of snake hibernacula, artificial dens must be included during habitat compensation.</li> <li>• Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.</li> <li>• Establishment of nest boxes for cavity-nesting waterfowl developed as part of wetland mitigation and compensation plan and established within riparian vegetation zones established along the reservoir on BC Hydro-owned properties.</li> <li>• A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into new bridge designs located within the Peace River valley.</li> <li>• Following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats.</li> <li>• Creation of natural or artificial piles of coarse woody debris dispersed throughout the disturbed landscape to maintain foraging areas and cold-weather rest sites, and arboreal resting sites, for the fisher population south of the Peace River.</li> </ul>	
EAC 24	<p>The EAC Holder must identify suitable lands for ungulate winter range by the end of the first year of construction, on BC Hydro-owned lands, or Crown lands, in the vicinity of the Project in consultation with FLNR. If FLNR determines that identified winter range is required, the EAC Holder must identify and maintain suitable BC Hydro-owned lands for ungulate winter range to the satisfaction of FLNR and for the length of time determined by FLNR.</p>	Specifically requires compensation.

## **Appendix 2**

### **Verification of the Accuracy of Predicted Effects to Short-eared Owl**



**To:** Brock Simons, Terrestrial Biodiversity Specialist, Site C Clean Energy Project  
**Date:** February 27, 2023  
**c:**  
**Memo No.:**  
**From:** Jeff Matheson, Tetra Tech Canada Inc.  
**File:** 704-ENV.VENV03095-01.001  
**Subject:** Verification of the Accuracy of Predicted Effects to Short-eared Owl

## 1.0 INTRODUCTION AND BACKGROUND

For the BC Hydro Site C Clean Energy Project (the Project), Federal Decision Statement (FDS) condition 16.2 requires “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.” In addition, FDS condition 16.3.6 requires “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”. This document is intended to address the verification of the accuracy of predicted effects to Short-eared Owl (*Asio flammeus*), a species listed as Special Concern under Schedule 1 of the Species at Risk Act (SARA).

The environmental Impact Statement (EIS) identified the following predicted effects to Short-eared Owl:

- **Habitat Alteration and Fragmentation:** Loss of 1,705.0 ha of suitable habitat in the Local Assessment Area (12.0% reduction) during construction and further 359 ha loss during operations (additional 2.5% reduction) (Hilton *et al.*, 2013a). Short-eared Owl were predicted to benefit from the early seral vegetation maintained along the transmission line.
- **Disturbance and Displacement:** Displacement of raptors (including Short-eared Owl) due to temporary flooding and from sensory disturbance from construction activities during nesting.
- **Mortality:** Any Short-eared Owl nests located within areas flooded annually upstream of the dam during construction would be lost.

Confidence in EIS predictions was considered high for habitat alteration because of simple and well-understood habitat associations and the conservatively defined PAZ. Confidence was considered low for disturbance, displacement, and mortality because of uncertainty regarding the extent to which ground-nesting birds would use newly cleared areas in the reservoir for nesting prior to reservoir filling. The following sections discuss the accuracy of effects of the Project predicted in the EIS to Short-eared Owl when considering currently available data.

## 2.0 HABITAT LOSS

The EIS provided an estimated loss of Short-eared Owl habitat based on the project footprint (referred to as the Project Activity Zones; PAZ) estimated at the time. Due to uncertainty regarding the precise location and area of Project footprint components, the PAZ overestimated the size of the footprint to err on the side of a precautionary impact assessment. The EIS assumed a footprint of 15,756.4 ha (Appendix B in Hilton *et al.*, 2013b). The expected footprint has been updated with (1) revised and refined footprint data for those project components that have already

been constructed, and (2) inclusion of only permanent alteration as a result of the project (i.e., does not include areas to be reclaimed). The estimated footprint (last update was September 2020) is 13,192.0 ha. This revised estimate is 16% smaller in area than the estimate in the EIS. Suitable habitat for Short-eared Owl within the revised project footprint, including the operational effects from erosion, is estimated to be 1,484 ha. This is 28% less than reported in EIS.

### 3.0 DISTURBANCE AND DISPLACEMENT

Disturbance and displacement of Short-eared Owl as a result of project activities assumes that Short-eared Owl are present in proximity to the project footprint and project activities. Baseline surveys conducted in 2006, 2010, and 2012 detected no Short-eared Owl within the footprint and one Short-eared Owl outside the footprint but in the LAA. All remaining Short-eared Owl detections were in areas outside the LAA. Ground-nesting raptor surveys have been conducted in the headpond area annually since 2016. No Short-eared Owls have been detected in or near the headpond area to date. At present, evidence suggests that there are no or very few Short-eared Owls that may be disturbed or displaced by the project.

### 4.0 MORTALITY

The construction headpond is the area that may be temporarily flooded during construction. Ground-nesting raptor surveys have been conducted in the headpond area annually since 2016. No Short-eared Owls have been detected in or near the headpond area to date. At present, evidence suggests that there are no or very few Short-eared Owls nesting in the headpond area. Therefore, it is expected that no or very few incidents of mortality of Short-eared Owl eggs and young due to temporary flooding during construction. Ground-nesting raptor surveys of the headpond area will continue annually until the reservoir has been filled to further evaluate this assessment.

### 5.0 SUMMARY AND CONCLUSIONS

The EIS identified potential effects to Short-eared Owl to be habitat alteration and fragmentation, disturbance and displacement, and mortality. To account for uncertainty while minimizing the risk of underestimating Project effects, the EIS took a precautionary approach of erring on the side of overestimating Project impacts. This resulted in a footprint (i.e., the PAZ) that overestimated expected habitat impacts because of uncertainty regarding the precise location and area of Project footprint components. In addition, due to uncertainty regarding the use of cleared areas of the reservoir by Short-eared Owl for nesting, it was assumed that annual flooding of those areas during construction would result in displacement of nesting birds and mortality of young. However, using updated data the Project footprint is 16% smaller in area than the EIS PAZ and loss of suitable Short-eared Owl habitat is 28% less than reported in the EIS. In addition, data collected during baseline surveys and annual surveys of the headpond area suggest that there are no or very few Short-eared Owls nesting in the headpond area that could be impacted by flooding during Project construction. Actual habitat impacts, disturbance and displacement, and mortality for Short-eared Owl are less than predicted in the EIS.

## 6.0 REFERENCES

Hilton, S., L. Simpson, and L. Andrusiak. 2013a. Part 6 Raptors. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013b. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

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## 8.0 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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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.

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### 1.7 ENVIRONMENTAL ISSUES

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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.

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### 1.8 NOTIFICATION OF AUTHORITIES

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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 3**

### **Habitat Value Accounting Metric for Non-Wetland Migratory Birds**

2025 Bird habitat value worksheet used for accounting of offsets for non-wetland migratory birds.

Common Name	Survey Group	BC List *	COSEWIC *	SARA *	Sample Incidence *	Include in Habitat Value Score? *	Habitat Value Estimation Source *	Habitat Classification Scheme *	7-class *			16-class *			Coniferous				Deciduous			Riparian Forest			Wetland				Dry Sl.	Cultiv.	Non-veg.
									CMF	CYF	CSH	DMF	DYF	DSH	RMF	RYF	RSH	FBS/FBT	WRI	WSH	WGR	DSG/DSS	CUL	NVE							
									Coniferous-mature forest	Coniferous-young forest	Coniferous-shrub	Deciduous-mature forest	Deciduous-young forest	Deciduous-shrub	Riparian-mixed mature forest	Riparian-mixed young forest	Riparian-mixed shrub	Fen/bog	Wetland-riparian	Wetland-shrub	Wetland-graminoid	Dry slopes	Cultivated	Non-vegetated							
Mourning Dove	Songbirds	Y	-	-	2	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Common Nighthawk *	CONI	B	SC	SC	92	Yes	Density	16-class	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.31	0.00	0.19	0.00	0.07	0.08	0.08	0.15	0.00	0.08	0.15	0.00	0.00		
Black Swift	Songbirds	B	E	E	1	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Ruby-throated Hummingbird	Songbirds	B	-	-	1	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Rufous Hummingbird	Songbirds	Y	-	-	1	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00		
Calliope Hummingbird	Songbirds	Y	-	-	1	N.D. in valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Belted Kingfisher *	Songbirds	Y	-	-	25	Could not estimate	Could not estimate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Yellow-bellied Sapsucker	Woodpeckers	Y	-	-	156	Yes	Density	16-class	0.07	0.09	0.00	0.11	0.13	0.13	0.08	0.07	0.07	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
American Three-toed Woodpecker	Woodpeckers	Y	-	-	50	Yes	Density	16-class	0.24	0.26	0.00	0.09	0.03	0.03	0.07	0.02	0.02	0.00	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Black-backed Woodpecker	Woodpeckers	Y	-	-	2	Too few	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Downy Woodpecker	Woodpeckers	Y	-	-	27	Yes	Density	16-class	0.00	0.16	0.00	0.09	0.21	0.00	0.08	0.32	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Hairy Woodpecker	Woodpeckers	Y	-	-	72	Yes	Density	16-class	0.14	0.04	0.00	0.12	0.08	0.16	0.10	0.02	0.06	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Northern Flicker	Woodpeckers	Y	-	-	56	Yes	Density	16-class	0.07	0.12	0.00	0.07	0.03	0.21	0.01	0.08	0.25	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Pileated Woodpecker	Woodpeckers	Y	-	-	35	Yes	Density	16-class	0.03	0.04	0.00	0.19	0.11	0.12	0.25	0.05	0.04	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Eastern Kingbird	Songbirds	Y	-	-	25	Yes	Occupancy	7-class	0.00	0.00	0.00	0.04	0.04	0.04	0.27	0.27	0.27	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Olive-sided Flycatcher	Songbirds	Y	SC	SC	53	Yes	Occupancy	7-class	0.08	0.08	0.08	0.01	0.01	0.01	0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.10	0.05	0.12	0.00	0.00	0.00	0.00	0.00		
Western Wood-Pewee	Songbirds	Y	-	-	284	Yes	Density	16-class	0.05	0.08	0.04	0.06	0.10	0.02	0.01	0.01	0.02	0.04	0.03	0.38	0.10	0.02	0.02	0.03	0.00	0.00	0.00	0.00	0.00		
Yellow-bellied Flycatcher	Songbirds	Y	-	-	35	Yes	Occupancy	7-class	0.06	0.06	0.06	0.28	0.28	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Alder Flycatcher	Songbirds	Y	-	-	356	Yes	Density	7-class	0.01	0.01	0.01	0.03	0.03	0.03	0.04	0.04	0.04	0.11	0.11	0.11	0.11	0.11	0.17	0.06	0.07	0.00	0.00	0.00	0.00		
Least Flycatcher	Songbirds	Y	-	-	1488	Yes	Density	16-class	0.04	0.04	0.05	0.13	0.11	0.07	0.09	0.09	0.06	0.01	0.03	0.07	0.03	0.04	0.04	0.09	0.00	0.00	0.00	0.00	0.00		
Hammond's Flycatcher	Songbirds	Y	-	-	46	Yes	Incidence	16-class	0.18	0.05	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00		
Dusky Flycatcher	Songbirds	Y	-	-	15	Yes	Occupancy	7-class	0.00	0.00	0.00	0.02	0.02	0.02	0.09	0.09	0.09	0.11	0.11	0.11	0.11	0.11	0.23	0.00	0.00	0.00	0.00	0.00	0.00		
Pacific-slope Flycatcher	Songbirds	Y	-	-	69	Yes	Occupancy	7-class	0.11	0.11	0.11	0.17	0.17	0.17	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00		
Eastern Phoebe	Songbirds	Y	-	-	36	Yes	Occupancy	7-class	0.04	0.04	0.04	0.07	0.07	0.07	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.13	0.08	0.00	0.00	0.00	0.00	0.00	0.00		
Say's Phoebe	Songbirds	Y	-	-	3	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Northern Shrike	Songbirds	Y	-	-	2	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Blue-headed Vireo	Songbirds	Y	-	-	193	Yes	Density	7-class	0.16	0.16	0.16	0.06	0.06	0.06	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.09	0.07	0.06	0.00	0.00	0.00	0.00	0.00		
Philadelphia Vireo	Songbirds	Y	-	-	13	Yes	Occupancy	7-class	0.03	0.03	0.03	0.05	0.05	0.05	0.09	0.09	0.09	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Warbling Vireo	Songbirds	Y	-	-	1020	Yes	Density	16-class	0.06	0.10	0.10	0.09	0.08	0.06	0.07	0.06	0.03	0.10	0.03	0.09	0.01	0.03	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	
Red-eyed Vireo	Songbirds	Y	-	-	1585	Yes	Density	16-class	0.08	0.05	0.08	0.08	0.08	0.06	0.10	0.07	0.08	0.02	0.06	0.04	0.00	0.08	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	
Canada Jay	Songbirds	Y	-	-	222	Yes	Density	7-class	0.33	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Blue Jay	Songbirds	Y	-	-	64	Yes	Occupancy	7-class	0.06	0.06	0.06	0.02	0.02	0.02	0.07	0.07	0.07	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Black-billed Magpie	Songbirds	Y	-	-	108	Yes	Occupancy	7-class	0.02	0.02	0.02	0.02	0.02	0.02	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.07	0.04	0.00	0.00	0.00	0.00	0.00		
American Crow	Songbirds	Y	-	-	205	Yes	Density	7-class	0.04	0.04	0.04	0.02	0.02	0.02	0.05	0.05	0.05	0.12	0.12	0.12	0.12	0.07	0.01	0.11	0.00	0.00	0.00	0.00	0.00		
Common Raven	Songbirds	Y	-	-	334	Yes	Density	7-class	0.05	0.05	0.05	0.06	0.06	0.06	0.10	0.10	0.10	0.02	0.02	0.02	0.02	0.16	0.07	0.05	0.00	0.00	0.00	0.00	0.00		
Tree Swallow	Songbirds	Y	-	-	109	Yes	Occupancy	7-class	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.18	0.18	0.18	0.18	0.08	0.02	0.09	0.00	0.00	0.00	0.00	0.00		
Violet-green Swallow	Songbirds	Y	-	-	22	Yes	Occupancy	7-class	0.04	0.04	0.04	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.32	0.00	0.00	0.00	0.00	0.00		
Northern Rough-winged Swallow	Songbirds	Y	-	-	2	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Bank Swallow	Songbirds	Y	T	T	31	Yes	Occupancy	7-class	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.10	0.10	0.10	0.10	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Barn Swallow	Songbirds	Y	SC	T	7	N.D. in valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Black-capped Chickadee	Songbirds	Y	-	-	407	Yes	Density	7-class	0.07	0.07	0.07	0.05	0.05	0.05	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00		
Boreal Chickadee	Songbirds	Y	-	-	80	Yes	Occupancy	7-class	0.18	0.18	0.18	0.02	0.02	0.02	0.03	0.03	0.03	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Red-breasted Nuthatch	Songbirds	Y	-	-	529	Yes	Occupancy	7-class	0.15	0.15	0.15	0.05	0.05	0.05	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00		
White-breasted Nuthatch	Songbirds	Y	-	-	13	Yes	Occupancy	7-class	0.06	0.06	0.06	0.10	0.10	0.10	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Brown Creeper	Songbirds	Y	-	-	8	Yes	Incidence	16-class	0.20	0.34	0.00	0.00	0.04	0.00	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
House Wren	Songbirds	Y	-	-	191	Yes	Density	7-class	0.04	0.04	0.04	0.15	0.15	0.15	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.00		
Winter Wren	Songbirds	B	-	-	33	Yes	Occupancy	7-class	0.29	0.29	0.29	0.04	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Marsh Wren	Songbirds	Y	-	-	22	Yes	Occupancy	7-class	0.00	0.00	0.00	0.01	0.01	0.01	0.00</																

Common Name	Survey Group	BC List *	COSEWIC *	SARA *	Sample Incidence *	Include in Habitat Value Score? *	Habitat Value Estimation Source *	Habitat Classification Scheme *	7-class *			16-class *			Coniferous			Deciduous			Riparian Forest			Wetland				Dry Sl.	Cultiv.	Non-veg.
									CMF	CYF	CSH	DMF	DYF	DSH	RMF	RYF	RSH	FBS/FBT	WRI	WSH	WGR	DSG/DSS	CUL	NVE						
									Coniferous-mature forest	Coniferous-young forest	Coniferous-shrub	Deciduous-mature forest	Deciduous-young forest	Deciduous-shrub	Riparian-mixed mature forest	Riparian-mixed young forest	Riparian-mixed shrub	Fen/bog	Wetland-riparian	Wetland-shrub	Wetland-graminoid	Dry slopes	Cultivated	Non-vegetated						
Swainson's Thrush	Songbirds	Y	-	-	1479	Yes	Density	16-class	0.11	0.10	0.04	0.11	0.07	0.04	0.10	0.07	0.05	0.05	0.03	0.10	0.03	0.02	0.03	0.04	0.03	0.05				
Hermit Thrush	Songbirds	Y	-	-	741	Yes	Density	16-class	0.03	0.06	0.03	0.04	0.08	0.12	0.03	0.11	0.08	0.08	0.07	0.04	0.03	0.04	0.07	0.04	0.07	0.08				
American Robin	Songbirds	Y	-	-	1311	Yes	Density	16-class	0.05	0.05	0.13	0.05	0.05	0.10	0.07	0.07	0.07	0.04	0.07	0.06	0.03	0.05	0.07	0.06	0.06	0.06				
Varied Thrush	Songbirds	Y	-	-	55	N.D. in valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Gray Catbird	Songbirds	Y	-	-	28	Yes	Occupancy	7-class	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.06	0.00				
Bohemian Waxwing	Songbirds	Y	-	-	2	N.D. in valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Cedar Waxwing	Songbirds	Y	-	-	296	Yes	Density	16-class	0.02	0.05	0.15	0.02	0.05	0.12	0.01	0.04	0.04	0.19	0.03	0.08	0.09	0.05	0.03	0.03	0.03	0.03				
American Pipit	Songbirds	Y	-	-	3	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Evening Grosbeak	Songbirds	Y	SC	T	50	Yes	Occupancy	7-class	0.09	0.09	0.09	0.06	0.06	0.06	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16				
Purple Finch	Songbirds	Y	-	-	161	Yes	Occupancy	7-class	0.07	0.07	0.07	0.10	0.10	0.10	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.12	0.00	0.00				
Red Crossbill	Songbirds	Y	-	-	20	Yes	Occupancy	7-class	0.15	0.15	0.15	0.10	0.10	0.10	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
White-winged Crossbill	Songbirds	Y	-	-	80	Yes	Occupancy	7-class	0.23	0.23	0.23	0.05	0.05	0.05	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00				
Pine Siskin	Songbirds	Y	-	-	282	Yes	Density	7-class	0.07	0.07	0.07	0.04	0.04	0.04	0.04	0.04	0.11	0.11	0.11	0.11	0.11	0.01	0.01	0.02	0.07	0.07				
Chipping Sparrow	Songbirds	Y	-	-	815	Yes	Density	16-class	0.04	0.07	0.12	0.05	0.03	0.03	0.04	0.05	0.06	0.16	0.13	0.03	0.06	0.02	0.04	0.04	0.07	0.07				
Clay-colored Sparrow	Songbirds	Y	-	-	613	Yes	Density	7-class	0.01	0.01	0.01	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.25	0.13	0.15	0.15	0.15				
Vesper Sparrow	Songbirds	Y	-	-	156	Yes	Occupancy	7-class	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.46	0.37	0.05	0.05				
Savannah Sparrow	Songbirds	Y	-	-	152	Yes	Density	7-class	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.87	0.02	0.02	0.02				
LeConte's Sparrow	Songbirds	Y	-	-	9	Yes	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Fox Sparrow	Songbirds	Y	-	-	104	Yes	Occupancy	7-class	0.03	0.03	0.03	0.02	0.02	0.02	0.11	0.11	0.11	0.05	0.05	0.05	0.05	0.09	0.04	0.22	0.22	0.22				
Song Sparrow	Songbirds	Y	-	-	326	Yes	Density	7-class	0.02	0.02	0.02	0.02	0.02	0.02	0.07	0.07	0.07	0.13	0.13	0.13	0.13	0.01	0.01	0.16	0.16	0.16				
Lincoln's Sparrow	Songbirds	Y	-	-	889	Yes	Density	16-class	0.01	0.02	0.12	0.02	0.03	0.08	0.02	0.04	0.12	0.10	0.15	0.06	0.10	0.02	0.05	0.07	0.07	0.07				
Swamp Sparrow	Songbirds	Y	-	-	101	Yes	Density	7-class	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.00				
White-throated Sparrow	Songbirds	Y	-	-	2474	Yes	Density	16-class	0.06	0.06	0.12	0.07	0.08	0.11	0.08	0.06	0.04	0.04	0.03	0.04	0.04	0.07	0.05	0.05	0.05	0.05				
White-crowned Sparrow	Songbirds	Y	-	-	25	Yes	Incidence	16-class	0.00	0.02	0.00	0.07	0.11	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.12	0.46	0.00	0.00	0.00				
Dark-eyed Junco	Songbirds	Y	-	-	617	Yes	Density	7-class	0.10	0.10	0.10	0.04	0.04	0.04	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.04	0.06	0.02	0.02	0.02				
Western Meadowlark	Songbirds	Y	-	-	2	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Baltimore Oriole	Songbirds	B	-	-	122	Yes	Occupancy	7-class	0.01	0.01	0.01	0.17	0.17	0.17	0.08	0.08	0.08	0.04	0.04	0.04	0.04	0.00	0.06	0.00	0.00	0.00				
Red-winged Blackbird	Songbirds	Y	-	-	330	Yes	Density	7-class	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.24	0.24	0.24	0.24	0.00	0.00	0.00	0.00	0.00				
Brown-headed Cowbird	Songbirds	Y	-	-	594	Yes	Density	16-class	0.03	0.05	0.05	0.07	0.06	0.11	0.04	0.07	0.04	0.13	0.05	0.14	0.07	0.03	0.02	0.04	0.04	0.04				
Rusty Blackbird	Songbirds	B	SC	SC	15	Yes	Incidence	16-class	0.00	0.00	0.00	0.00	0.03	0.33	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Brewer's Blackbird	Songbirds	Y	-	-	48	Yes	Occupancy	7-class	0.00	0.00	0.00	0.13	0.13	0.13	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.05	0.33	0.00	0.00	0.00				
Common Grackle	Songbirds	Y	-	-	4	Too few	Incidence	16-class	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Ovenbird	Songbirds	Y	-	-	1344	Yes	Density	16-class	0.09	0.11	0.09	0.18	0.15	0.07	0.08	0.05	0.03	0.01	0.02	0.00	0.01	0.03	0.05	0.02	0.02	0.02				
Northern Waterthrush	Songbirds	Y	-	-	269	Yes	Occupancy	7-class	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.07	0.07	0.09	0.09	0.09	0.09	0.05	0.00	0.17	0.17	0.17				
Black-and-white Warbler	Songbirds	Y	-	-	377	Yes	Density	7-class	0.06	0.06	0.06	0.07	0.07	0.07	0.11	0.11	0.11	0.06	0.06	0.06	0.06	0.01	0.01	0.04	0.04	0.04				
Tennessee Warbler	Songbirds	Y	-	-	809	Yes	Occupancy	7-class	0.10	0.10	0.10	0.06	0.06	0.06	0.08	0.08	0.08	0.06	0.06	0.06	0.06	0.01	0.01	0.02	0.02	0.02				
Orange-crowned Warbler	Songbirds	Y	-	-	583	Yes	Density	7-class	0.05	0.05	0.05	0.13	0.13	0.13	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.12	0.06	0.05	0.05	0.05				
Nashville Warbler	Songbirds	Y	-	-	1	N.D. in valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Connecticut Warbler	Songbirds	B	-	-	44	Yes	Occupancy	7-class	0.03	0.03	0.03	0.05	0.05	0.05	0.00	0.00	0.00	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00				
MacGillivray's Warbler	Songbirds	Y	-	-	30	Yes	Occupancy	7-class	0.33	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Mourning Warbler	Songbirds	Y	-	-	174	Yes	Occupancy	7-class	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.06	0.06	0.03	0.03	0.03	0.03	0.11	0.04	0.09	0.09	0.09				
Common Yellowthroat	Songbirds	Y	-	-	374	Yes	Occupancy	7-class	0.01	0.01	0.01	0.03	0.03	0.03	0.05	0.05	0.05	0.16	0.16	0.16	0.16	0.01	0.02	0.05	0.05	0.05				
American Redstart	Songbirds	Y	-	-	764	Yes	Density	16-class	0.10	0.02	0.12	0.09	0.05	0.06	0.18	0.12	0.05	0.06	0.02	0.04	0.02	0.03	0.03	0.02	0.02	0.02				
Cape May Warbler	Songbirds	B	-	-	18	Yes	Occupancy	7-class	0.09	0.09	0.09	0.02	0.02	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00				
Magnolia Warbler	Songbirds	Y	-	-	247	Yes	Occupancy	7-class	0.12	0.12	0.12	0.04	0.04	0.04	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.00	0.00	0.03	0.03	0.03				
Bay-breasted Warbler	Songbirds	R	-	-	10	Yes	Incidence	16-class	0.16	0.05	0.00	0.09	0.02	0.34	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Yellow Warbler	Songbirds	Y	-	-	1800	Yes	Density	16-class	0.06	0.04	0.04	0.09	0.08	0.10	0.07	0.07	0.06	0.04	0.06	0.07	0.04	0.07	0.05	0.06	0.06	0.06				
Blackpoll Warbler	Songbirds	Y	-	-	36	Yes	Occupancy	7-class	0.06	0.06	0.06	0.04	0.04	0.04	0.24	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Yellow-rumped Warbler	Songbirds	Y	-	-	1558	Yes	Density	16-class	0.12	0.16	0.05	0.10	0.06	0.03	0.09	0.04	0.03	0.05	0.06	0.06	0.04	0.01	0.03	0.07	0.07	0.07				
Townsend's Warbler	Songbirds	Y	-	-	47	Yes	Incidence	16-class	0.12	0.14	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00				
Black-throated Green Warbler	Songbirds	B	-	-	418	Yes	Occupancy	7-class	0.20	0.20	0.20	0.06	0.06	0.06	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00				
Canada Warbler	Songbirds	B	SC	T	209	Yes	Density	7-class	0.20	0.20	0.20	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Wilson's Warbler	Songbirds	Y	-	-	117	Yes	Occupancy	7-class	0.11	0.11	0.11	0.07	0.07	0.07	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.06	0.12	0.06	0.06	0.06				
Western T																														

Common Name	Survey Group	BC List *	COSEWIC *	SARA *	Sample Incidence *	Include in Habitat Value Score? *	Habitat Value Estimation Source *	Habitat Classification Scheme *	7-class *			16-class *			Dry Sl.				Cultiv.	Non-veg.					
									Coniferous			Deciduous			Riparian Forest			Wetland				Dry Sl.	Cultiv.	Non-veg.	
									CMF	CYF	CSH	DMF	DYF	DSH	RMF	RYF	RSH	FBS/FBT	WRI	WSH	WGR	DSG/DSS	CUL	NVE	
Coniferous-mature forest	Coniferous-young forest	Coniferous-shrub	Deciduous-mature forest	Deciduous-young forest	Deciduous-shrub	Riparian-mixed mature forest	Riparian-mixed young forest	Riparian-mixed shrub	Fen/bog	Wetland-riparian	Wetland-shrub	Wetland-graminoid	Dry slopes	Cultivated	Non-vegetated										
Total richness									82	83	71	79	92	82	78	76	77	73	80	78	75	75	73	71	
Total richness of included species ("Yes" in column J)									61	62	51	60	65	62	59	57	58	54	61	59	54	54	54	52	
Number of listed species									8	8	7	8	9	10	7	6	7	7	7	6	7	7	7	8	
Habitat Value Coefficient									6.852	7.027	5.942	5.337	12.351	7.263	5.781	4.903	5.072	5.610	5.360	5.580	6.315	7.103	4.859	3.643	
Standardized Habitat Value Coefficient									0.069	0.071	0.060	0.054	0.125	0.073	0.058	0.050	0.051	0.057	0.054	0.056	0.064	0.072	0.049	0.037	
Listed Species Habitat Value Coefficient									1.162	1.046	0.999	0.640	2.603	1.339	0.869	0.526	0.832	1.063	0.623	0.432	0.506	0.409	0.279	0.671	
Standardized Listed Species Habitat Value Coefficient									0.083	0.075	0.071	0.046	0.186	0.096	0.062	0.038	0.059	0.076	0.045	0.031	0.036	0.029	0.020	0.048	
Combined Habitat Value (50:50 weight of all species together and listed species only)									0.076	0.073	0.066	0.050	0.155	0.084	0.060	0.044	0.055	0.066	0.049	0.044	0.050	0.050	0.034	0.042	
Combined Habitat Index																			Total						
Area in Footprint (ha)									1062	580	75	312	1634	295	238	294	627	42	401	31	56	217	952	968	7784
Footprint Habitat Value Hectares									80.8	41.1	4.5	16.8	203.8	21.6	13.9	14.6	32.1	2.4	21.7	1.7	3.6	15.5	46.7	35.6	556.7
Wilder Ck/Rutledge Offset Areas (ha)									0	9.73	4.66	0	48.66	13	0	4.63	0	0	0	0	0	177.79	286.7	16.8	562.0
Marl Fen Offset Area (ha)									0	84.5	11.7	0.0	37.0	51.2	0.0	0.0	0.0	35.6	0.0	1.8	15.6	0.0	399.5	0	636.8
BCH Parcel Offset Areas (ha)									21.6	25.0	2.9	34.7	364.4	57.1	0.0	0.0	0.0	0.1	0.9	0.0	0.0	185.0	238.4	56.7	986.8
Total Offset Areas (ha)									21.6	119.2	19.3	34.7	450.0	121.3	0.0	4.6	0.0	35.7	0.9	1.8	15.6	362.8	924.5	73.5	2185.5
Offset Areas Habitat Value Hectares									1.6	8.7	1.3	1.7	69.9	10.2	0.0	0.2	0.0	2.4	0.0	0.1	0.8	18.3	31.9	3.1	150.3
Offset Ratio									2.0%	21.1%	28.2%	10.3%	34.3%	47.3%	0.0%	1.4%	0.0%	98.4%	0.2%	4.4%	21.8%	117.8%	68.2%	8.7%	27.0%

**\* Notes:**

All songbirds and woodpeckers (plus Common Nighthawk) recorded during surveys conducted 2006-2019 are listed.

BC List: Y = Yellow, B = Blue, R = Red.

COSEWIC and SARA: SC = Special Concern, T = Threatened.

Survey incidence is the number of surveys that a species was detected in.

For songbird point counts, 2,589 surveys were conducted.

For woodpecker call-playback surveys, 439 surveys were conducted.

For Common Nighthawk, automated recording units were used to survey 117 locations for 7 days.

Species recorded in less than 5 surveys were excluded from further analysis.

Species that were not recorded in the Peace River valley upstream of the dam were excluded from further analysis (denoted as not detected (N.D.) in valley).

Estimates of Belted Kingfisher density, occupancy or incidence could not be completed as their habitat (waterbodies and watercourses) could not be adequately surveyed using the point count methods used to survey other species.

Table values are standardized measures of bird habitat value (0-1).

Bird habitat values were derived from estimates of density, occupancy or incidence reported previously in SEES JV (2020a, 2020b, 2020c).

Estimates of species density, occupancy or incidence were completed for 16 bird habitat classes where possible, or 7 bird habitat classes if a model could not be fit for the 15 bird habitat classes.

For Common Nighthawk, only non-forested habitats were surveyed. Since forested habitats were not surveyed, density estimates were not calculated.

Forested units were assigned a bird habitat value of 0 because they are not commonly used by Common Nighthawk.

## **Appendix 4**

### **Evaluation of Site C EIS Rare Plant Predictions**

**Date:** October 11, 2022  
**To:** Brock Simons (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 currently constructing 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 10 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 nine 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 was 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 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 (moving them from the provincial *Red* or *Blue* lists, to the *Yellow* list). As a result, currently only 13 rare vascular taxa in 76 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 direct-effects polygon now affects nine rare vascular plant taxa in 28 occurrences, from the 30 taxa in 142 occurrences reported in the EIS.

As clearing for Project construction nears completion, the disturbance to rare plant occurrences can also be evaluated to a greater extent. Of the 28 known rare vascular plant occurrences in the current direct-effects polygon,

- 15 occurrences (54%) are still extant;
- 6 occurrences (21%) have been extirpated by Project activities; and
- 7 occurrences (25%) 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 appear to 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 28 rare vascular plant occurrences are known in the current direct-effects polygon out of a total of 76 known in the LAA, which is approximately 37%: a reduction in the magnitude of effect from that predicted in the EIS.

The predicted area of direct rare plant impact can also be compared. The EIS used a direct-effects polygon of approximately 19,836 ha to calculate construction effects to rare plants. The current direct-effects polygon is 27% smaller at 14,494 ha. 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. Approximately 50% of the known rare plant occurrences in the current direct-effects polygon have not been extirpated by the Project, and it does not appear that the majority will be in the future. A further 25% were only partially extirpated by the Project. 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 generally 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. Even though the full Project is not yet completed and in operation, clearing activities outside of the reservoir footprint are largely finished, and within the reservoir footprint it can be assumed with relative certainty that all rare plant occurrences located there will be extirpated.

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 apparently less than were predicted using the assumptions. Not all rare plant occurrences in the direct-effects polygon have been (or are expected to be) extirpated, with many still surviving. Rare plant occurrences adjacent to Project facilities appear to be surviving 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 actual and predicted Project construction disturbance area, is 27% smaller than the direct-effects polygon used in the EIS. Furthermore the original direct-effects polygon contains more than 98% of the current direct-effects polygon, with only 296 ha (out of 14,494 ha) 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 rare plants are located.

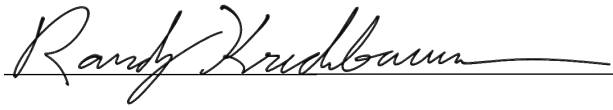
It appears that mitigation efforts have been successful at reducing Project impacts to rare plant occurrences, and providing compensatory value for certain unavoidable impacts. Direct avoidance and reduction of impacts to rare plant occurrences has been facilitated in some cases, and plants have been 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. In general then, 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.

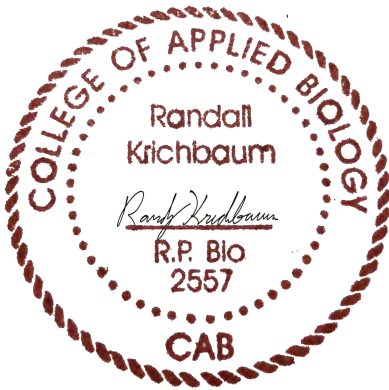
## CLOSURE

Reviewed and approved:



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

*<Original signed and sealed October 11, 2022 at Calgary, Alberta>*



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**Appendix 5**  
**Best Practice Principles for Offsetting**

Offset principle	Aspect	Environment Canada - Operational Framework for Use of Conservation Allowances (2012)	BC MOE - Procedures for Mitigating Impacts on Environmental Values (Environmental Mitigation Procedures) Version 1.0 May 27, 2014	IFC PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012)	South Africa - Draft National Biodiversity Offset Policy (2017)	Victoria's Native Vegetation Management (2017)	Australia Federal Government - Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012	US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2016)	NSW - Biodiversity Conservation Regulation (2017)	Business and Biodiversity Offsets Programme (BBOP) (2012)
Spatially explicit	Proximity									
	<i>Ecosystem</i>	No spatial constraints if ecologically equivalent	Locate offsets "on-site" or "in-proximity"	Located within the region	Offsets located so that they deliver priority areas for conservation or improve connectivity	Offsets located within bioregions or sub-units of Catchment Management Authority	Offsets located to address priority actions for species or ecosystem	Onsite mitigation preferred -but offsite is permitted if onsite not possible	Offsets should be located in or near adjacent sub-regions	Offsets located close to impact site for impacts to ecosystem services; impacts to biodiversity can occur in wider landscape
	<i>Species</i>	(If information poor, offsets should be as close as possible to impact site)						Offsets should be located in priority conservation areas located in landscape plans		
Large-scale conservation plan	Yes - requires/allows assessment of ecological benefit at larger spatial scales	Yes - offsets should deliver landscape scale benefits	Yes - offsets should contribute to regional conservation goals	Requires regional prioritization plan	Yes - landscape scale approach is required	Yes -offset sites prioritized by recovery plans, management plans etc.	Yes - landscape level planning identifies priority sites for mitigation (species status assessments, recovery plans, and/or 5- year reviews)	Species conservation plans identify priority offset sites	Offset site selection should be supported by landscape level analyses	
Ecological equivalence	In-kind	Offset should benefit equivalent ecological function at another site.	Offset should benefit the same environment component as was impacted	Offset should initially consider the same biodiversity values as were impacted	Offsets should benefit the same components as impacted by project	Offsets should be equivalent for the most significant vegetation communities	Offsets should be functionally equivalent (e.g., foraging habitat for a particular species)	Offsets must benefit the affected species	Offsets should be equivalent for the most significant vegetation communities and for threatened species	Offsets should be equivalent with respect to type, amount and condition of biodiversity; landscape context; timing or temporal occurrence of biodiversity

Offset principle	Aspect	Environment Canada - Operational Framework for Use of Conservation Allowances (2012)	BC MOE - Procedures for Mitigating Impacts on Environmental Values (Environmental Mitigation Procedures) Version 1.0 May 27, 2014	IFC PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012)	South Africa - Draft National Biodiversity Offset Policy (2017)	Victoria's Native Vegetation Management (2017)	Australia Federal Government - Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012	US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2016)	NSW - Biodiversity Conservation Regulation (2017)	Business and Biodiversity Offsets Programme (BBOP) (2012)
	Trading up?		Allowed - must justify why deviations from like-for-like will generate better environmental outcome	Allowed - if impacted biodiversity is not a priority, then trading up may be permitted	Allowed - in exceptional cases, an offset targeting a more threatened ecosystem or species may be permitted	Allowed - an offset targeting a more threatened ecosystem or species may be permitted for vegetation of lower significance	Allowed - among functional habitat types for a species, if another type is more limiting than the one impacted	Allowed - conservation actions that meet objectives in recovery plan for a species (e.g., threat reduction, ex situ breeding, reintroductions, wildlife overpasses etc.)	Allowed - if proponent can demonstrate no in-kind offsets are available, can offset against a more threatened species (note: there is an exclusion list)	Allowed - if other biodiversity areas are of higher priority for conservation
Legal security (permanence)		Full ownership of land is preferred - otherwise high degree of confidence that conservation allowances can be delivered	Legally secured for duration of offset commitment	Ideally a legally binding commitment, but at a minimum, government support	Legally binding conditions or common law contracts (e.g., protected area declaration, land donation, conservation agreements, retirement of development rights)	Formal establishment of management agreement or permit conditions.	Offsets should be permanently and securely secured (i.e., difficult to change .. For example, conservation covenants)  Offsets where permanently securing an offset is not possible looked at on a case-by-case basis, but size of offset will be increased to account for risk.	Offsets must be secured through legal, real estate and financial protections that ensure that offset is sustained for the duration of the impacts	Offsets legally established through voluntary legally binding permanent stewardship agreements	Offsets issued through long term land owner agreements. Offset activities should be reflected in the relevant government planning and decision-making processes and outputs.

Offset principle	Aspect	Environment Canada - Operational Framework for Use of Conservation Allowances (2012)	BC MOE - Procedures for Mitigating Impacts on Environmental Values (Environmental Mitigation Procedures) Version 1.0 May 27, 2014	IFC PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012)	South Africa - Draft National Biodiversity Offset Policy (2017)	Victoria's Native Vegetation Management (2017)	Australia Federal Government - Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012	US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2016)	NSW - Biodiversity Conservation Regulation (2017)	Business and Biodiversity Offsets Programme (BBOP) (2012)
<b>Technical risk</b>	<p>Technical risk a consideration for selecting the best practicable option for conservation allowances</p> <p>There must be a high probability of success</p> <p>Size of conservation allowance increases with degree of technical risk</p>	<p>The amount of offsetting needed to mitigate impacts will increase in accordance with the degree of uncertainty of the effectiveness of the offset measures</p>	<p>Must demonstrate credibility of offset. Incorporate external technical review where uncertainty of effectiveness of mitigation</p>	<p>Offset design must be risk-averse and cautious in the face of technical uncertainty</p>		<p>Offsets increase in scale depending on technical risk</p>	<p>Offsets increase in scale depending on technical risk</p> <p>Direct oversight of mitigation measures by USFWS to determine effectiveness</p>	<p>Regulator can revoke offset and require replacement if offset technically fails</p>	<p>Evidence is provided to substantiate the assumption that offset activities will result in the intended outcomes.</p> <p>The following can be used to address uncertainty: use a range of offset techniques and locations; increase offset ratios; bonds and insurance</p>	
<b>Functional habitat</b>	<p>Replacing ecological function is a specific objective of conservation allowances</p>	<p>Replacing ecological function is a specific objective of conservation allowances, although it may only be possible to use structural surrogates (e.g., patch size, connectivity)</p>	<p>Must demonstrate NNL/Net gain including required supporting ecological processes</p>	<p>Must maintain corridors and linkages even if it means doing a larger offset</p>	<p>Ecological function must be maintained for higher significance ecosystems and species ... flexibility for lower priority</p>	<p>The focus of offsets must be replacing ecological function - and the offset site must be equal or higher than that impacted</p>	<p>Offsets must target the recovery support function of affected critical habitat</p>		<p>Loss-gain accounting should include measures of ecosystem processes or function (dispersal, migration, pollination, ecosystem engineers, keystone species)</p>	

Offset principle	Aspect	Environment Canada - Operational Framework for Use of Conservation Allowances (2012)	BC MOE - Procedures for Mitigating Impacts on Environmental Values (Environmental Mitigation Procedures) Version 1.0 May 27, 2014	IFC PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012)	South Africa - Draft National Biodiversity Offset Policy (2017)	Victoria's Native Vegetation Management (2017)	Australia Federal Government - Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012	US Fish and Wildlife Service - Endangered Species Act Compensatory Mitigation Policy (2016)	NSW - Biodiversity Conservation Regulation (2017)	Business and Biodiversity Offsets Programme (BBOP) (2012)
<b>Cost-effectiveness</b>	Financial implications are a consideration when choosing the most practicable conservation allowance				Cost-effectiveness is achieved by considering/supporting as broad a range of offsets as possible through a competitive auction process	Market-based tools such as land brokering services and biodiversity banking schemes used to create a well-functioning market	Cost-effectiveness is achieved through the use of market-based programs such as conservation banking which generates competition among mitigation sponsors			

## **Appendix 6**

### **A Review of Landscape Conservation Planning for Application in Identifying Biodiversity Offsets Opportunities in the Peace River Basin Region**

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# Summary

BC Hydro is developing a vegetation and wildlife compensation accounting framework to track biological losses (habitat disturbance through dam construction) and gains (biodiversity offsets or compensation sites) associated with the Site C Clean Energy Project. The accounting framework incorporates international best practices with respect to biodiversity offsetting to the extent practicable in the region. This document advances BC Hydro's accounting framework by assembling landscape scale conservation plans and datasets that can be used to support the selection of the highest priority conservation sites in the region and facilitate the incorporation of landscape considerations into loss-gain accounting.

**Section 1** of this report summarizes the results of research and data collection. Existing biodiversity and conservation planning information for the Peace River Basin region relevant to supporting landscape conservation planning is described.

**Section 2** details the data gap analysis. After analyzing the coverage of available information, and identifying data gaps, practical recommendations are provided for how any data gaps can be overcome.

**Section 3** discusses next steps for BC Hydro to use the information reviewed in this document to support the selection of offset sites to meet its mitigation obligations.

**Appendices** provide data sources and references on landscape conservation planning and biodiversity offsets.

## ***Results and Recommendations***

There are currently two conservation planning initiatives with outputs that provide comprehensive coverage of the Peace River Basin region, three regional conservation plans that provide partial coverage, and several relevant spatial datasets, which would support the selection of the highest priority conservation sites in the region and facilitate the incorporation of landscape considerations into loss-gain accounting. Three regional conservation plans were completed that overlap with the western border of the Peace River Basin region in BC: a conservation area design was completed for the Muskwa-Kechika Management Area in 2004, a subsequent biodiversity conservation and climate change assessment was completed in 2012, and an ecoregional conservation plan was completed for the Central Interior in 2011. The ecoregional conservation plans were completed by the Nature Conservancy of Canada with partners at the BC government, University of BC, University of Northern BC, University of Alberta, The Nature Conservancy (US), other conservation organizations, NatureServe, consulting, and communities, and involved extensive expert review processes. The advantages of ecoregional conservation planning products are that they were developed with a broad range of partners who are also involved in implementing the recommendations, and they were heavily vetted through several expert review workshops. These conservation planning approaches are broadly described as systematic, spatial analyses combining fine-filter, coarse-filter, focal

species, and landscape connectivity. Global Forest Watch Canada's Atlas of Key Ecological Areas within Intact Forested Landscapes covers the Peace River Basin region in BC and AB – as does Ducks Unlimited Canada's Canadian Wetland Inventory. Nature Conservancy of Canada and Global Forest Watch Canada partnered to complete the Northern Alberta Conservation Atlas which covers the Peace River region in Alberta.

As well, the Fort St. John Land & Resource Management Plan (LRMP) area covers the Peace River Basin region in BC. It was completed in 1997, and an update was initiated by the BC government in 2019 with the intent to partner with interested First Nations, collaborate with local governments, and have extensive engagement with local communities, industry, stakeholders and the public. The main implementation actions coming out of this LRMP were the creation of the Muskwa-Kechika Management Area and designation of resource management zones.

BC Hydro can use the conservation plans and datasets identified in this report in two ways. First, this information can simply be referred to visually to identify priority sites. The advantage of this approach is that it uses available information and requires no additional GIS work. A disadvantage is that it can be difficult to evaluate, combine, or trade-off the results of the different plans and data layers presented here.

A second approach, which we prefer, would involve additional GIS work. The first step would be to create a "Tier 1" data layer by overlaying and "clipping" conservation planning and mapping datasets with comprehensive coverage of the Peace River Basin region:

- Atlas of Key Ecological Areas within Intact Forested Landscapes; and
- BC Ecological Proxy

The second step would be to create a "Tier 2" data layer by overlaying and "clipping" datasets with partial coverage of the Peace River Basin region:

- Conservation Area Design for the Muskwa-Kechika Management Area;
- Biodiversity Conservation and Climate Change Assessment for the Muskwa-Kechika Management Area;
- Central Interior Ecoregional Conservation Plan; and
- Northern Alberta Conservation Atlas (if considering the Alberta portion of the Peace River Basin region)

The third step would be to overlay supplemental datasets to complement the Tier 1 and 2 conservation planning and mapping layers:

- Canadian Wetland Inventory
- BC Conservation Data Centre data
- Other relevant species data, conservation plans, recovery plans
- LRMP data, local/finer-scale analyses and datasets

The output of this work would be a heterogeneous mapping utilizing all available conservation planning and datasets across the combined breeding ranges of the three warbler species in BC for which BC Hydro has explicit habitat compensation obligations, among non-wetland migratory birds more generally, due to a Federal Decision Statement condition for Site C. This would

support a more objective and systematic identification of offset sites compared to simply reviewing the plans and datasets individually.

Potential offset sites would then be assessed with regards to their feasibility, additionality, cost, permanence and other considerations in order to support the final selection and implementation of offsets.

## **1.0 Review of Landscape Conservation Planning Approaches**

BC Hydro's Vegetation and Wildlife Accounting Framework has two objectives:

- To provide a system for efficiently tracking measurable gains and losses in select vegetation and wildlife indicators chosen as measures for compensation to meet Federal Decision Statement (FDS) or Environmental Assessment Certificate (EAC) Project approval conditions associated with the Site C Clean Energy Project; and
- To provide a mechanism for communicating progress on compensation to regulators, stakeholders, and First Nations.

This report focuses on the two general information gaps relevant to BC Hydro's mitigation and compensation requirements associated with Site C: available landscape conservation planning, and how it can be applied with consideration of practical constraints. Best practices for biodiversity offsetting frameworks recognize the importance of conducting mitigation work within the context of a larger landscape conservation plan. This approach allows for the selection of the highest priority conservation sites in the region and facilitates the incorporation of landscape considerations into loss-gain accounting. This requires first identifying and evaluating the landscape-scale conservation planning that is available for the Peace River Basin region.

To better understand the landscape conservation context and how this information could be applied in a practical way in the Peace River Basin region, research and data collection of relevant existing biodiversity and conservation planning information, including a gap analysis, was undertaken. Existing biodiversity and conservation planning efforts were evaluated to understand their ability to be used to identify and evaluate potential offset opportunities. The results of the research and data collection, and gap analysis, supports the characterization of the conservation challenges and opportunities that exist within the region because of existing tenures, ownership, and other potentially important considerations for conservation planning.

### **1.1 Landscape Conservation Planning Approaches**

Measuring success at maintaining long-term ecological function and biodiversity in any region has proven difficult and elusive, but over the years the following four goals have become central to most landscape-level conservation planning approaches (Heinemeyer et al. 2004; Rumsey et al. 2004; Iachetti et al. 2006):

1. Represent, in a system of conserved and protected areas, all native ecosystem types and seral stages across their natural range of variation.
2. Maintain viable populations of all native species in natural patterns of abundance and distribution.
3. Maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions.
4. Design and manage the system to be resilient to short-term and long-term environmental change and to maintain the evolutionary potential of lineages.

Ecoregional conservation planning based on the work pioneered by The Nature Conservancy (TNC) in the 1970s, and Groves and Noss (Groves and The Nature Conservancy 2003; Noss et al. 1994; Noss 1987) over many decades identifies a conservation area network based on developing the following analyses:

- *Coarse-filter ecosystem representation analyses*: the coarse-filter approach hypothesizes that conservation of multiple, viable examples of all communities and ecological systems (i.e., coarse-filter targets) will also conserve most species that occupy them. This is a way to compensate for the lack of detailed information on numerous poorly studied invertebrates and other organisms.
- *Fine-filter (special elements) analyses*: fine-filter targets are species that we cannot assume will be captured by coarse-filter targets. Special efforts are required to ensure that fine-filter targets are represented in the conservation plan. These targets are typically rare or imperiled species, but they can also include wide-ranging species that require special consideration, or species that occur in other regions, but which have genetically important disjunct populations within the region of concern.
- *Focal species analyses*: focal species are selected based on their keystone or umbrella characteristics, and/or their sensitivity to potential development impacts.
- *Connectivity*: explicit consideration of connectivity across landscapes for the maintenance of demographic and genetic exchange between populations, as well as the maintenance of ecosystem and landscape processes.

This approach is implemented through the following process:

- Assemble information on the location of conservation targets.
- Assess existing conservation areas for their biodiversity values.
- Set conservation goals.
- Rate the suitability of each area for conservation.
- Develop a network of conservation areas.
- Refine the network of conservation areas through expert review.

## 1.2 Research and Data Collection

A thorough review of federal, BC and AB governments, conservation organizations, and academic sources found several landscape-level conservation plans and datasets that overlapped with the Peace River Basin region and the three species of warblers for which BC Hydro has an explicit compensation obligation, among that for non-wetland migratory birds more generally. Federal Decision Statement condition 10.3.4 requires “compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler”.

Two planning products provide comprehensive coverage of the entire area: The Atlas of Key Ecological Areas in Intact Forest Landscapes developed by Global Forest Watch Canada (2010) and the BC Ecological Proxy mapping developed by Holt and Kehm (2014). The

ecoregional plans conducted by the Nature Conservancy of Canada, The Nature Conservancy (US), and government partners cover portions of the western extent of the Boreal Plains ecoregion. The Conservation Atlas developed by the Nature Conservancy of Canada and Global Forest Watch Canada covers the Alberta side of the Peace. The Canadian Wetland Inventory mapping developed by Ducks Unlimited Canada, Environment Canada, the Canadian Space Agency, and the North American Wetlands Conservation Council, provides comprehensive, fine resolution coverage of the area for wetlands. Consideration of a combination of these complementary conservation plans and datasets serves to increase the robustness of selecting high-value conservation sites as compared to the use of a single information source. **Figures 1 and 2** show the boundaries of these conservation planning and mapping projects.

A summary of relevant conservation plans, atlases, and datasets are described in Table 1.

*Table 1. Summary of landscape-level conservation plans, mapping, and datasets overlapping with the Peace River Basin region.*

Coverage	Name	Key Values/Inputs/Analyses	Organization(s)	Reference(s)
Canada-wide	Key Ecological Areas in Intact Forest Landscapes	Ecological Values Index: <ul style="list-style-type: none"> <li>• Soil organic carbon</li> <li>• Net biome productivity</li> <li>• Wetlands</li> <li>• Lakes and rivers</li> <li>• Potential old growth</li> <li>• Species diversity (reptiles and amphibians, birds, mammals, trees)</li> <li>• Key focal species (woodland caribou)</li> </ul>	Global Forest Watch Canada	Lee et al. 2010
Canada-wide	Intact Forest Landscapes	<ul style="list-style-type: none"> <li>• Forest landscapes that remain ecologically intact (&gt;50,000 ha)</li> <li>• Remaining intact forest landscape fragments (5,000-50,000 ha for boreal ecozones; 1,000-50,000 ha for temperate ecozones)</li> </ul>	Global Forest Watch Canada	Lee et al. 2010
BC-wide	BC Ecological Proxy	<ul style="list-style-type: none"> <li>• Terrestrial ecosystems: Old and mature forest, grasslands</li> <li>• Intact large mammal predator-prey systems</li> <li>• Hydrologic/aquatic habitats: Rivers/lakes, wetlands</li> <li>• “Very rich” areas: Important Bird Areas, estuaries</li> </ul>	Tides Canada and Wilburforce Foundation	Holt and Kehm 2014a; 2014b

Coverage	Name	Key Values/Inputs/Analyses	Organization(s)	Reference(s)
		<ul style="list-style-type: none"> <li>Rare species and ecosystems</li> </ul>		
Northeast BC	Conservation Area Design for the Muskwa-Kechika Management Area	<ul style="list-style-type: none"> <li>Terrestrial systems</li> <li>Freshwater systems</li> <li>Terrestrial focal species: grizzly bear, gray wolf, mountain goat, northern caribou, moose, Rocky Mountain elk, Stone's sheep</li> <li>Aquatic focal species: bull trout, Arctic grayling</li> <li>Fine-filter analyses: 138 plant and animal targets; 17 special features (critical waterfowl habitat, swamps and marshes, marsh adjacent to lakes, marsh adjacent to streams or rivers, forested riparian, non-forested riparian, waterfalls, hot springs and mineral springs, grasslands, lakes with known occurrences of lake trout, caves and karst features, canyons, mineral licks, Important Bird Areas, 4 terrestrial ecological land unit types</li> <li>Permeability and connectivity analyses using Least-Cost Path analyses</li> <li>Human Impacts: human "footprint" – linear, point, and area features</li> <li>Identification of Primary Core Areas and Connectivity-Secondary Core Areas</li> <li>Supplementary sites</li> </ul>	Nature Conservancy of Canada; Round River Conservation Studies; Dovetail Consulting	Heinemeyer et al. 2004
Northeast BC	Muskwa-Kechika Management	<ul style="list-style-type: none"> <li>Enduring features: elevation, substrate, macro landform</li> </ul>	Yellowstone to Yukon	Yellowstone to Yukon

Coverage	Name	Key Values/Inputs/Analyses	Organization(s)	Reference(s)
	Area Biodiversity Conservation & Climate Change Assessment	<ul style="list-style-type: none"> <li>Primary productivity: wetlands &gt; 5 ha, large lakes, valley bottoms, and areas having a high number of Growing Degree Days (GDD). Areas outside wetlands, riparian areas or valley bottoms with annual GDD above 800 were used as the basis for determining locations of high productivity.</li> <li>Focal species models: focal species habitat suitability data from the MKMA CAD for moose, caribou, goat, and Rocky Mountain Bighorn sheep.</li> </ul>	Conservation Initiative	Conservation Initiative 2012
Central BC	Central Interior Ecoregional Conservation Plan	<ul style="list-style-type: none"> <li>Terrestrial systems</li> <li>Freshwater systems</li> <li>Species habitat models: grizzly bear; standardized occupancy maps for 10 vertebrate species</li> <li>Element occurrences</li> <li>Ecosystem services</li> <li>Bioclimatic envelopes</li> <li>Climate change</li> <li>Conservation value</li> <li>Vulnerability</li> </ul>	Nature Conservancy of Canada; BC Conservation Data Centre; University of Northern BC; University of BC; University of Alberta; University of Colorado, Boulder	(Iachetti 2011; T. G. F. Kittel et al. 2011; Chan et al. 2011; Rose 2011; Loos 2011; Horn 2011; Howard and Carver 2011; Kittel et al. 2011; Nielsen 2011; McNay et al. 2011)
Northwest AB	Northern Alberta Conservation Atlas	<ul style="list-style-type: none"> <li>Ecological Land Units: discrete abiotic systems combining substrate and landform</li> <li>Surficial geology</li> <li>Condition</li> <li>Diversity</li> <li>Ecological function</li> <li>Special features: Grizzly bear conservation areas; Woodland caribou; waterfowl and shorebirds</li> </ul>	Nature Conservancy of Canada; Global Forest Watch Canada	Nature Conservancy of Canada and Global Forest Watch Canada 2014

Coverage	Name	Key Values/Inputs/Analyses	Organization(s)	Reference(s)
Canada-wide	Canadian Wetland Inventory	<ul style="list-style-type: none"> <li>• Bog</li> <li>• Fen</li> <li>• Marsh</li> <li>• Swamp</li> <li>• Shallow open water</li> </ul>	Ducks Unlimited Canada; Environment Canada; Canadian Space Agency; North American Wetlands Conservation Council	Ducks Unlimited Canada 2019

**1.2.1. Intact Forested Landscapes and Key Ecological Areas**

Key ecological areas within Canada’s intact forest landscapes were mapped by Global Forest Watch Canada (Lee et al. 2010) and provides comprehensive spatial coverage of the Peace River Basin region. Intact forest landscapes are important for several reasons:

- Conservation value
- Ecosystem goods and services values
- Recreational, aesthetic, spiritual and heritage values
- Economic value

This analysis was developed and mapped in 1 km grid cells. Identifying key ecological areas within intact forest landscapes involved creating an Ecological Values Index based on the following:

- Forest landscapes that remain ecologically intact (>50,000 ha) and the remaining intact forest landscape fragments (5,000-50,000 ha for boreal ecozones; 1,000-50,000 ha for temperate ecozones) were initially selected as the primary units of analysis
- Seven key ecological values:
  - Soil organic carbon
  - Net biome productivity
  - Wetlands
  - Lakes and rivers
  - Potential old growth
  - Species diversity (reptiles and amphibians, birds, mammals, trees)
  - Key focal species (woodland caribou)

Each of the seven ecological values were ranked and then combined into a single conservation value by summing the overlaid grids (**Figure 3**).

**1.2.2 BC Ecological Proxy Mapping**

The ecological proxy map was created from combining nine different data layers. The map represents the coarse-filter or special ecological values with a focus on those that are important for climate change adaptation. The mapping combines datasets representing terrestrial ecosystems (older forests, grasslands), hydrologic/ aquatic habitats and linkages (rivers, lakes, wetlands), mapped ‘very rich’ areas (Important Bird Areas, estuaries), and locations of rare

ecosystems and species. Each of the nine datasets were scored and totals summed for every hectare of the province (**Figure 4**). The following thresholds were used to break the scores into consistent and interpretable results (Holt and Kehm 2014a; 2014b):

- “Fewer” = total scores between 0.2-0.9
- “Mid” = total scores between 1.0-1.9
- “More” = total scores 2.0-4.5

### **1.2.3. Ecoregional Conservation Planning**

Ecoregional conservation planning provides a regional scale, biodiversity-based context for implementing conservation efforts by identifying a portfolio of sites for conservation action with a goal of protecting representative biodiversity and ecologically significant populations. This approach has been pioneered since the 1970s by The Nature Conservancy (US) in partnership with the Nature Conservancy of Canada, other conservation organizations, and provincial, state, Indigenous, and federal governments.

Ecoregions are relatively large areas of land and water that contain geographically distinct assemblages of natural communities, with boundaries that are approximate. These natural communities share a large majority of their species, dynamics, and environmental conditions, and they function together effectively as a conservation unit at global and continental scales. Ecoregions are more effective at capturing the ecological and genetic variability of biodiversity than are political units (Groves and The Nature Conservancy 2003).

Two ecoregional conservation plans have been completed for areas adjacent and overlapping with the northern and western borders of the Peace River Basin region: a Conservation Area Design for the Muskwa-Kechika Management Area (MKMA CAD) that overlaps with the Northern Boreal Mountains, Taiga Plains, and Sub-Boreal Interior ecoregions; and an Ecoregional Conservation Plan for the Central Interior Ecoregion of BC (Heinemeyer et al. 2004; T. G. F. Kittel et al. 2011; Iachetti 2011; Rose 2011; Loos 2011; Horn 2011; Chanet et al. 2011; Howard and Carver 2011; G.M. Kittel et al. 2011; Nielsen 2011; McNay et al. 2011).

#### **1.2.3.1 Muskwa-Kechika Management Area Conservation Area Design**

The origins of the Muskwa-Kechika Management Area are in consensus recommendations coming from the Fort St. John (1997), Fort Nelson (1997), and Mackenzie Land and Resource Management Plans (2000). These planning processes proposed the establishment of the MKMA, the formation of an Advisory Board, and the establishment of a Trust Fund that would provide an overarching strategic and advisory perspective on wildlife and wilderness management. To inform discussions on the vision for the future of the Muskwa-Kechika Management Area, the MK Advisory Board initiated a Conservation Area Design to develop a regional assessment of conservation values across the MKMA. Led by the Nature Conservancy of Canada, Round River Conservation Studies, and Dovetail Consulting, the MKMA CAD had the following deliverables:

- A key conservation biology toolkit to assist in the ongoing planning and management issues, and a framework for developing direct links between regional and landscape-level objectives.
- A tool to provide strategic information to ongoing government planning processes.
- A dynamic modelling element that could examine changes to the landscape over time, whether through natural or human developments.

The MKMA CAD made use of three types of information to provide the foundation of the plan: focal species analyses, coarse-filter ecosystem analyses, and fine-filter special elements analysis. Connectivity across landscapes was explicitly considered for the maintenance of demographic and genetic exchange between wildlife populations. A human use analysis mapped linear, point, and area features associated with human developments in order to provide an index of landscape condition. This allowed for selection of less disturbed areas for conservation purposes.

The MKMA CAD used seven indicators that served as surrogates for the ecological values and condition of the study area, represented by a range of datasets and predictive models. These indicators included diversity across freshwater and terrestrial ecosystems determined by predictive models, habitat suitability for freshwater and terrestrial focal species determined by predictive models, occurrences and habitats for species of special concern determined from field data (fine-filter analysis), spatial data that characterized the extent and relative intensity of human uses, and modelled landscape permeability and connectivity. These components were represented using spatial vector models at 1:20,000, or as grid-based models with 50 m cells.

The CAD integrated the analytical components to describe the study area according to the following three classes (**Figure 5**):

- Primary Core Areas – areas necessary to represent a minimum of 30% of key conservation targets, including focal species habitat values, terrestrial and aquatic ecosystem diversity and selected fine-filters; and 60% core area for each terrestrial focal species
- Connectivity-Secondary Core Areas – areas identified to provide linkages between Primary Core Areas and increase overall representation of conservation targets.
- Supplementary Site – sites with coarse-filter or fine-filter values not captured in Primary Core Area and Connectivity-Secondary Core Areas due to their small size and isolation but needed to meet representation goals for rare targets.

The authors note that as a coarse-scale regional assessment, the MKMA CAD was not intended to offer detailed guidance for site-level or operational management of either protected areas or the landscape matrix. The MKMA CAD, like other regional conservation assessments, took a macroscopic view of the region, and is useful for the following functions:

- Highlighting areas of regional biological significance.
- Portraying the spatial pattern of high conservation value sites on a broad scale.
- Illuminating the landscape context of these sites.

- Assessing the conservation needs of wide-ranging (i.e., “regional-scale” and “coarse-scale”) species.
- Identifying priorities for further, more detailed, research at finer spatial resolution.

### **Muskwa-Kechika Management Area Biodiversity Conservation & Climate Change Assessment**

Subsequent to the MKMA CAD, a Muskwa-Kechika Management Area Biodiversity Conservation & Climate Change Assessment was completed in 2012 by the Yellowstone to Yukon Conservation Initiative (Yellowstone to Yukon Conservation Initiative, 2012). The project had the following objectives:

- Helping ensure that wilderness and wildlife goals of the MKMA were met.
- Identifying how well existing protected areas and management zones achieved broad conservation goals, and if necessary, recommend improvements in land use plans to increase the likelihood of meeting those goals.
- Enabling land managers within the greater MKMA ecosystem to employ precautionary strategies to maintain wildlife and ecosystems in the face of climate change.
- Providing conservation planners and managers with additional information against which to assess the potential impacts of developments proposed within the greater MKMA ecosystem.
- Identifying key wildlife habitat linkages within and outside the MKMA.
- Contributing to First Nations’ land use planning efforts in northern BC on lands in and adjacent to the MKMA.
- Informing any future review of existing land use plans in the greater MKMA ecosystem.

The main analysis in the assessment was the development of an “enduring features” model using data for elevation (grouped into nine classes to delineate altitude gradations in current ecological communities), substrate (bedrock and quaternary geology types categorized into ten groups), and macro landforms (slope and aspect combined into 23 landforms), which resulted in 1,648 unique combinations of enduring features classified into five categories in 90 m x 90 m data cells. The enduring features were categorized from most common to most rare based on the cumulative percent area covered by each combination. Primary productivity maps were also developed based on wetlands greater than 5 ha, large lakes, valley bottoms, and areas having a high number of Growing Degree Days (GDD) which were an indicator of total heat available for plants in the growing season. Areas outside wetlands, riparian areas or valley bottoms with annual GDD above 800 were used as the basis for determining locations of high productivity (**Figure 6**). The assessment used the focal species habitat suitability data from the MKMA CAD for moose, caribou, goat, and Rocky Mountain Bighorn sheep.

#### *1.2.3.2 Central Interior Ecoregional Conservation Plan*

The Central Interior Ecoregional Conservation Plan (CIECP) undertook analyses for terrestrial and freshwater coarse- and fine-filter targets, focal species, ecosystem services, bioclimatic envelopes and persistent climate corridors, and climate change vulnerability (Rose 2011; Chan,

Hoshizaki, and Klinkenberg 2011; T. G. F. Kittel et al. 2011; Horn 2011; G. M. Kittel et al. 2011; McNay, Sutherland, and Morgan 2011; Nielsen 2011; Howard and Carver 2011). Assessment products included these analyses, along with the following outputs:

- Terrestrial and freshwater portfolios of priority conservation areas and watersheds that show places of exceptional biological value and (or) the most likely places for conservation to succeed based on the current conditions or status
- Maps depicting the relative irreplaceability of all sites across the entire ecoregion
- The conservation value of all assessment units or watersheds, depicting a range of options for biodiversity conservation (**Figure 7**).

In partnership with the UBC Institute for Resources, Environment, & Sustainability, the CIECP undertook an analysis of ecosystem services in the study area through a spatially explicit, marginal economic values analysis for carbon storage, timber production, and the provision of recreational angling opportunities (Chan, Hoshizaki, and Klinkenberg 2011).

The CIECP looked at high-value conservation sites through a climate change and vulnerability lens (T. G. F. Kittel et al. 2011). It used a framework based on expert opinion to:

- Formulate qualitative scenarios of climatic and ecological change based on expected as well as less probable but plausible futures not tied to specific model projections.
- Synthesize established knowledge of the climate vulnerability of species and ecosystems of concern.
- Specify no-regrets climate adaptation strategies to reduce these vulnerabilities in conservation site selection.

Unlike other Ecoregional Conservation Plans completed by TNC and NCC and partners (for example, the Okanagan ECP, Willamette Valley-Puget Trough-Georgia Basin ECP, and Canadian Rocky Mountains ECP), the Central Interior Ecoregional Conservation Plan has so far not resulted in program areas being developed in the ecoregion or Natural Area Conservation Plans which identify specific properties and stewardship actions. The CIECP did support the BC Government during the mountain pine beetle outbreak in identifying “conservation uplift” areas where timber harvesting would not occur, and areas were protected for their biodiversity values.

#### 1.2.3.4 *Conservation Atlas for Northern Alberta*

The Nature Conservancy of Canada and Global Forest Watch Canada developed a Conservation Atlas for Northern Alberta (CANA), which covers all Peace River watersheds on the Alberta side (Nature Conservancy of Canada and Global Forest Watch Canada 2014). The CANA used available ecological datasets to map key ecological areas throughout Alberta’s north.

Ecological Land Units (ELU) were developed based on combining datasets for substrate and landform (referred to as “landscape facet”). Landscape facet is largely responsible for local variation in solar radiation, soil development, moisture availability, and susceptibility to wind and other disturbances. It is also tied to soil depth, texture, and nutrient availability – and combined with moisture, these are the primary edaphic controllers of plant productivity and species distributions. Ten landscape facets combining slope, aspect, landscape position, surface curvature, and a wetness index, were classified to reflect the major variation in ecological

processes in northern Alberta landscapes. Substrate and landscape facet were combined with ecodistrict data to build the ELUs. Ecodistricts are subdivisions of an ecoregion characterized by a distinctive assemblage of relief, landforms, geology, soil, vegetation, water bodies, and fauna. Mapped ecodistricts were used to divide the study area, and then subdivided by the intersection of substrate and landscape facets to produce the final ELU layer. The three ELU components were resampled to a 25 m resolution grid.

ELU grids were ranked in relation to the following ecological criteria:

- Condition - relative 'intactness' of the natural cover in an area was used as a surrogate for condition, by measuring the amount of natural cover immediately adjacent to an ELU cell. The average distance of roads from each ELU cell was assessed as a measure of disturbance and human accessibility. Ranking of condition was weighted to preferentially select ELUs with a high degree of natural cover and a low average distance to roads.
- Diversity – diversity potential was measured as the number of ELUs that neighbour each individual ELU polygon, with diversity greatest where the highest number of unique ELUs were located within the search distance at any given point within the ELU polygon.
- Ecological function – scores were assigned to each ecological system polygon based on the total area, with larger polygons receiving higher scores; shape was considered as the relative complexity of an ELU compared to a standard (square) shape of the same size; connectivity was used as a measure of the potential movement of organisms between habitats of the same type. Larger more compact patches with a greater degree of connectivity on the landscape were scored more highly. Also scored more highly were areas with greater amounts of wetlands and riparian areas; percent wetland cover was derived from DUC's Canadian Wetland Inventory dataset. All wetlands greater than 0.36 ha in size, combined with the organic component from the surficial geology dataset were included in the analysis. Percent wetland cover was derived from the total amount of wetland cover within a 1 km radius.
- Special features – are the unique features of conservation concern due to their risk or biological importance. These include priority species ranges or occurrences and the proximity to existing conservation areas. Proximity to existing conservation areas increases the probability of the presence and movement of wildlife as well as the influence of propagules dispersed from these areas. Sites closer to protected areas and conserved lands were scored more highly. Scores were assigned based on the count of the element occurrences (EOs) with areas having a greater number of overlapping EOs given a higher score. Grizzly bear Core and Secondary conservation areas were developed using a combined index of average linear access density within catchments and predicted realized habitat. For Woodland caribou herd ranges a combined index of herd status and caribou conservation zones consisting of herd buffer, intactness and permanent and temporary anthropogenic disturbances was developed. Waterfowl and shorebirds were selected as a result of the continental importance of Alberta's north for breeding waterfowl and shorebirds and for migration and stop-over habitat. A Ducks Unlimited Canada (DUC) dataset on distribution of waterfowl breeding pairs was used in the assessment. Waterfowl breeding pair densities were scored higher for densities >11 breeding pairs per square mile. For shorebirds the Important Bird Areas dataset was used.

Each ecological criterion was given a weighted score out of 100 based on the relative ecological importance within northern Alberta landscapes which was determined by expert opinion. The final score gave the “conservation value” of each cell relative to other ELU patches. The highest scoring cells were selected to represent core biodiversity conservation areas among all other cells of the same ELU type. The resulting maps of areas of relative conservation significance consist of priority conservation sites that conserve native ecological land units and occurrences of plant and animal species, nested within a matrix of semi-natural (**Figure 8**).

## **1.2.4 Other Relevant Land Use Planning, Mapping, and Datasets**

### **1.2.4.1 Canadian Wetland Inventory**

Ducks Unlimited Canada (DUC) has maintained a comprehensive wetlands inventory for Canada since 1979 using aerial photography and satellite imagery. The Canadian Wetland Inventory (CWI) was established in 2002 by DUC, Environment Canada, the Canadian Space Agency, and the North American Wetlands Conservation Council (Canadian Wetland Inventory Technical Committee 2016; Ducks Unlimited Canada 2019). The inventory uses detailed field data collected by helicopter to guide the classification of large-scale satellite images to map wetlands. The CWI helps to focus conservation, restoration and wetland monitoring programs, access changes in wetland abundance and classification in relation to climate change concerns, assist industry, governments, and conservation groups to develop land-use policies and protocols, and measure the performance of those policies and protocols towards landscape sustainability objectives.

The CWI defines and maps anthropogenic impact, shape, soil characteristics, and wetland systems for bogs, fens, marshes, swamps, and shallow/open water. The minimum mapping unit is 1 ha (**Figure 9**).

### **1.2.4.2 BC Government Land & Resource Management Planning**

The Fort St. John Land and Resource Management Plan (LRMP) was initiated in 1993 to ensure sustainable management of land, resources, water and ecosystems within the Fort St. John Timber Supply Area (TSA) and was published in October 1997. The plan was developed by the Fort St. John planning table comprised of private citizens, stakeholders (industrial sectors, environmental groups, etc.), and government agency representatives. First Nations did not participate in the LRMP (Fort St. John LRMP Working Group 1997).

The FSJ LRMP divides the planning area into 27 Resource Management Zones (RMZ). The Peace River Corridor RMZ, identified in the plan as a “Special Management – Major River Corridor”, contains major river valleys that have important fish and wildlife habitat, recreation, tourism, and scenic/visual quality values (Fort St. John LRMP Working Group 1997). The Peace River Corridor RMZ follows the Peace River Valley along the southern boundary of the Fort St. John Forest District from Farrell Creek, east to the Alberta boundary. The RMZ contains objectives for protecting or enhancing habitats for red and blue-listed species, maintaining high capability ungulate winter habitat (elk, deer, moose, caribou, mountain sheep, mountain goat), maintaining site-specific habitat, maintaining functioning and healthy ecosystems, maintaining fish habitat and water quality for priority fish species (bull trout, grayling, red and blue-listed

species), maintaining water quality in the Peace River, and managing visually sensitive areas within the Peace River Valley. The Dawson Creek LRMP (Dawson Creek LRMP Table 1999), and MacKenzie LRMP may also be relevant to the Peace River Basin assessment (Mackenzie LRMP Table 2000).

The B.C. government is working in collaboration with Blueberry River First Nations and other interested Treaty 8 First Nations on updating the Fort St. John LRMP. The LRMP update process is scheduled to run from April 2019-2021. Based on a questionnaire that was circulated in early 2019, consultant Urban Systems produced a “What We Heard” report<sup>14</sup>. Maintaining access to the land for all resource users, Indigenous needs and interests, ensuring First Nations have a partnering role, and maintaining biodiversity and protection for sensitive areas were all identified as priorities. The LRMP technical planning process started in June 2019 and public engagement workshops are scheduled for the fall 2019.

#### *1.2.4.3 Alberta Land Use Planning*

In Alberta, neither the Upper Peace Region nor the Lower Peace Region Land Use Framework processes have started (Government of Alberta 2008; fRI Research 2019). The Alberta Biodiversity Monitoring Institute (ABMI) tracks and maintains data on the Status of Human Footprint in Alberta for the Upper and Lower Peace Regions. The data collected is on human footprint types: agriculture, energy, forestry, human-created waterbodies, transportation, and urban/industrial.

#### *1.2.4.4 Y2Y Initiative*

The Yellowstone to Yukon Initiative has identified an area they have named the Peace River Break as particularly important for their objectives (Figure 11). The Peace River Break is in the northeast section of the province situated at the narrowest point of the Rocky Mountain range and is an important east-west linkage zone that enables wildlife to move between the Muskwa-Kechika Ecosystem and the Central Canadian Rocky Mountains and north-south between the mountain national parks and the Muskwa-Kechika Management area to the north (Yellowstone to Yukon 2019).

#### *1.2.4.5 First Nations Conservation Planning*

Twelve First Nations have traditional territories that include portions of the Peace River Basin, several of which belong to the Treaty 8 Tribal Association. The First Nations are the Tsay Keh Dene, Kwadacha, McLeod Lake, Blueberry River, Doig River, Fort Nelson, Prophet River, Halfway River, Saulteau, West Moberly, Nak’azdli, and Takla Lake.

### **Caribou Action Planning**

An Action Plan for the Klinse-Za Herd of Woodland Caribou has been developed by McNay et al. (2013) under contract with the West Moberly First Nation. The Action Plan focuses on

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<sup>14</sup> [https://engage.gov.bc.ca/app/uploads/sites/458/2019/07/2019-07-04-LRMP-What-We-Heard-Report\\_FINAL.pdf](https://engage.gov.bc.ca/app/uploads/sites/458/2019/07/2019-07-04-LRMP-What-We-Heard-Report_FINAL.pdf)

recovering a woodland caribou population that has greatly declined in terms of spatial distribution and numbers. This Action Plan was constructed to address the Klinse-Za herd and sufficient area surrounding it to encompass what is understood by Indigenous people to represent the historic extent of the herd prior to its decline. The population and distribution objectives for the Klinse-Za herd are for a stable or increasing population of at least 654 caribou distributed throughout their range, with connectivity to adjacent areas. The number of caribou chosen as the population objective is the weighted average population density of the northern caribou ecotype in British Columbia factored by the total amount of critical habitat calculated for the Klinse-Za herd Action Plan area.

Critical habitat necessary to meet population and distribution objectives for the Klinse-Za herd population was identified using a Bayesian modeling technique and traditional ecological knowledge of Elders was incorporated into the model. The model identifies habitat necessary for an animal to perform its life functions regardless of whether or not the habitat is currently being used due to the decline in population and distribution. Potential habitat was identified, which includes habitat used during four critical seasons: rut, winter, calving, and summer. Because of similarity in range conditions, results were grouped for rut with winter, and calving with summer. Three zones of caribou range were depicted: (1) low-elevation range, (2) high-elevation winter range, and (3) calving and summer range (McNay et al. 2013).

The strategies, approaches, and actions identified in the Action Plan were designed to stop the population decline and restore population numbers in the short term while ensuring effective protection of critical habitat in the short and long term. Because the Klinse-Za herd is unlikely to be self-sustaining at its current population size, and because of the high rate of recent population decline, emergency measures were proposed to stabilize the herd. The emergency measures took two approaches: (1) reducing caribou mortality, and (2) augmenting the population with adult caribou translocation.

The BC provincial government implemented experimental wolf reduction over a five-year period (2015-2019) within the South Peace region to address the rapid decline of Central Mountain caribou populations. These caribou herds have declined drastically in response to landscape changes that altered predator-prey dynamics and led to high rates of predation by wolves. The decrease in wolf abundance across the South Peace treatment area showed evidence that intensive wolf reduction had halted and reversed the declining trends of the Klinse-Za, Kennedy Siding, and Quintette caribou populations. The reduction of wolves during the fifth year is expected to elicit a positive population response but will not be measured until March 2020. As a result of wolf reduction, the South Peace caribou populations have increased by 49% from 166 individuals in 2016 to 247 individuals in 2019. The three herds combined had an average annual population growth rate of 15% following three years of wolf reductions and calf recruitment and adult female survival has increased in almost all cases in response to intensive wolf reductions (Bridger 2019).

The governments of Canada and BC fund most of the direct financial costs for implementing the Action plan. However, it may be possible for BC and Canada to offset some of these costs by requiring private sector stakeholders to contribute financially where their projects historically,

currently, or in the future will have adverse effects on caribou in the Action Plan area (McNay et al. 2013).

### **Tribal Parks and Indigenous Protected and Conserved Areas**

Indigenous Protected and Conserved Areas (IPCAs) aim to safeguard Indigenous rights—including the right to exercise free prior and informed consent—while also maintaining biodiversity and securing a space where communities can actively practice Indigenous ways of life (Plotkin et al. 2018).

K'ih Tsaa?dze Tribal Park was proclaimed by Doig River First Nation in 2011. It is a unique, world class example of highly productive, biologically diverse boreal ecosystems, including rare plant species. K'ih Tsaa?dze Tribal Park is located approximately 40 kilometres northeast of Fort St. John, consisting of 95,000 ha of land straddling the BC-Alberta border and containing old-growth spruce forest and wetlands - crucial habitat for caribou and grizzly bear (**Figure 12**).

K'ih tsaa?dze has long been a place of spiritual importance to the community members of Doig River. Doig River First Nation's objectives in establishing K'ih Tsaa?dze were to maintain traditional and contemporary cultural uses and to restore and maintain ecological integrity and biological diversity. The nation has negotiated logging deferrals with many of the companies operating within K'ih tsaa?dze's boundaries, and is currently in conversations with the provinces of BC and Alberta to explore co-governance models. Doig River First Nation intends to work directly with the governments of BC and AB to reach agreement on the development and implementation of an ecosystem-based conservation plan (EBCP) that protects and, where necessary, restores the natural ecological and cultural integrity within K'ih Tsaa?dze. The philosophy, principles and process for the K'ih Tsaa?dze EBCP will be developed during discussions between Doig River First Nation and the two provincial governments, but Doig River First Nation is developing a comprehensive engagement strategy for ensuring that interested and affected third parties are also part of the process.

## **2.0 Data Gap Analysis**

Available landscape conservation planning initiative outputs with comprehensive coverage of the entire Peace River Basin region and the ranges of the three warbler species (i.e., Canada Warbler, Cape May Warbler, and Bay-breasted Warbler), are the Key Ecological Values in Intact Forest Landscapes analyses and datasets, which cover all of Canada in 1 km grids, and the BC Ecological Proxy mapping which covers all of the region in the BC. Regional conservation plans covering portions of the Peace River Basin region in BC are the Muskwa-Kechika Management Area Conservation Area Design, subsequent MKMA Biodiversity Conservation & Climate Change Assessment, and Central Interior Ecoregional Plan. The Northern Alberta Conservation Atlas covers the AB portion of the Peace River.

There is an important distinction to note between these various conservation planning products and the approaches taken. These conservation planning approaches are split between (a) summarizing analyses, datasets, or map grids, and (b) systematic conservation planning to arrive at a network of conservation areas. While the inputs to each of these approaches are the

same or very similar, how they arrive at their outputs is different. The former approach derives outputs by summing up the inputs in a raster grid cell to produce an accounting of values on the landscape. This generally results in mapping that shows a range of scores for grid cells covering the study area. The latter approach applies rules to these inputs and uses tools like site-selection algorithms to select a network of conservation areas based on optimizing the solutions given practical constraints, such as minimizing the size of the network, selecting areas connected to protected areas, lumping conservation areas versus numerous separate areas, selecting larger areas over smaller areas, or selecting areas that have low human impacts. Table 2 separates the conservation planning, mapping, and datasets according to whether they fall into (a) summarizing or (b) systematic approaches.

*Table 2. Summary of conservation planning methods for determining outputs.*

Conservation Planning Approach	Conservation Plan/Atlas/Mapping Name	Method of Determining Outputs
	Key ecological values in intact forest landscapes	<ul style="list-style-type: none"> <li>• Developed and mapped in 1 km grid cells.</li> <li>• Created Ecological Values Index based on mapping forest landscapes.</li> <li>• Seven key ecological values ranked and then combined into a single conservation value by summing the overlaid grids.</li> </ul>
	BC Ecological Proxy	<ul style="list-style-type: none"> <li>• Combined nine different data layers representing terrestrial ecosystems (older forests, grasslands), hydrologic/ aquatic habitats and linkages (rivers, lakes, wetlands), mapped 'very rich' areas (Important Bird Areas, estuaries), and locations of rare ecosystems and species.</li> <li>• Nine datasets were scored and totals summed for every hectare of the province.</li> </ul>
Combining Inputs/Datasets	Muskwa-Kechika Management Area Biodiversity Conservation & Climate Change Assessment	<ul style="list-style-type: none"> <li>• "Enduring features" model mapped in 90 x 90 grids</li> <li>• Elevation, substrate, macro landforms</li> <li>• Grouped into 5 classes</li> <li>• Areas of high primary productivity mapped: compiled data on wetlands &gt; 5 ha, large lakes, valley bottoms, areas with high number of Growing Degree Days (GDD)</li> <li>• "Wilderness" maps created from compiling buildings, energy/transmission corridors, industrial areas, harvesting areas, transportation features - selectively edited, and buffered by 3.83 km</li> <li>• Wildlife connectivity modelling for four focal species</li> </ul>

Conservation Planning Approach	Conservation Plan/Atlas/Mapping Name	Method of Determining Outputs
	Conservation Atlas for Northern Alberta	<ul style="list-style-type: none"> <li>Each ecological criterion was given a weighted score out of 100 based on the relative ecological importance determined by expert opinion.</li> <li>Final score gave the “conservation value” of each cell relative to other ELU patches.</li> <li>The highest scoring cells were selected to represent core biodiversity conservation areas among all other cells of the same ELU type.</li> <li>Maps of areas of relative conservation significance consist of priority conservation sites that conserve native ecological land units and occurrences of plant and animal species.</li> </ul>
Systematic approach	Conservation Area Design for the Muskwa-Kechika Management Area	<ul style="list-style-type: none"> <li>Used Marxan, a site-selection software program</li> <li>Enabled the team to assemble and compare alternative conservation networks</li> <li>Overall objective is to minimize the cost of the network of conservation areas while ensuring that all conservation goals have been met.</li> <li>Marxan selects areas to meet goals for conservation targets while balancing objectives of efficiency, defined as the greatest number of goals met for the lowest cost or least amount of suitable land.</li> </ul>
	Central Interior Ecoregional Conservation Plan	

Table 3 summarizes the available conservation planning and mapping according to their ability to satisfy landscape conservation planning principles described in section 1.1.

*Table 3. Conservation plans and data for the Peace River Basin region measured against their ability to satisfy landscape conservation planning criteria.*

Landscape-level conservation planning approach	Key Ecological Values within Canada's Intact Forest Landscapes	BC Ecological Proxy	MKMA Conservation Area Design	MKMA Biodiversity Conservation & Climate Change Assessment	Central Interior Ecoregional Conservation Plan
Represent, in a system of protected areas, all native ecosystem types			X	X	X

<b>Landscape-level conservation planning approach</b>	<b>Key Ecological Values within Canada's Intact Forest Landscapes</b>	<b>BC Ecological Proxy</b>	<b>MKMA Conservation Area Design</b>	<b>MKMA Biodiversity Conservation &amp; Climate Change Assessment</b>	<b>Central Interior Ecoregional Conservation Plan</b>
and seral stages across their natural range of variation					
Maintain viable populations of all native species in natural patterns of abundance and distribution	X	X	X	X	X
Maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions	X	X	X	X	X
Design and manage the system to be resilient to short-term and long-term environmental change and to maintain the evolutionary potential of lineages	X		X	X	X
Fine-filter (special elements) analyses	X	X	X	X	X
Coarse-filter ecosystem representation analyses	X	X	X	X	X
Focal species analyses			X	X	X
Explicit consideration of connectivity across landscapes			X	X	X

A preliminary assessment of the amount of overlap between the Peace River Basin watersheds in BC and the conservation planning and mapping products was undertaken (Table 4). Every watershed has at least one of the conservation planning outputs present with some having 3 of the 4.

*Table 4. Overlapping conservation planning analyses and datasets in NE BC watersheds.*

<b>Watershed</b>	<b>Key Ecological Values in Canada's Intact Forest Landscapes</b>	<b>BC Ecological Proxy</b>	<b>Muskwa-Kechika Conservation Area Design</b>	<b>MKMA Biodiversity Conservation &amp; Climate Change Assessment</b>	<b>Central Interior Ecoregional Conservation Plan</b>
Murray River	x	x			x
Upper Peace River	x	x			
Lower Peace River	x	x			
Lower Beatton River	x	x			
Peace Arm	x	x			
Pine River	x	x			x
Lower Halfway River	x	x			x
Upper Halfway River	x	x	x	x	x
Ospika River	x	x	x	x	x
Parsnip Arm	x	x			x
Nation River	x	x			
Fox River	x	x			
Parsnip River	x	x			x
Kiskatinaw River	x	x			x
Smoky River	x	x			x

## **2.1 Data Availability and Gaps**

The research and data scan show that there is comprehensive conservation planning-related information that covers the Peace River Basin region and the ranges of the three warbler

species of concern (Canada, Cape May, and Bay-breasted)., With supplemental information and finer scale analyses, this available information would support identification and application of biodiversity offsets. It is important to put these information sources in context of when and where they were done and the importance of the ecological boundaries within which they were developed and completed. As noted in the previous section, the two conservation planning initiatives outputs covering the entire Peace River Basin region in BC (i.e., Key Ecological Areas in Intact Forest Landscapes and the BC Ecological Proxy) are different approaches to the systematic design of conservation area networks found in ecoregional planning.

Existing plans and datasets can be used in a variety of ways to support the selection of compensation sites. Ideally, the ecoregional plans surrounding and slightly overlapping the Peace River Basin region could be extended to create a seamless layer that covered the entire Peace. However, this would be a complex and time-consuming process. A less intensive, but still effective approach to inform planning would be to use GIS to combine existing conservation plans and datasets. Important data gaps between individual landscape conservation plans can be filled by combining all the aforementioned conservation datasets and element occurrence datasets from the CDC/NHIC to provide a comprehensive, but not homogenous, layer for mapping high-conservation value areas. A preliminary assessment that combines and overlays the Key Ecological Values in Canada's Intact Forest Landscapes, BC Ecological Proxy mapping, Central Interior Ecoregional Conservation Plan, and Muskwa-Kechika Conservation Area Design was undertaken. Depending on the timing of the ongoing Fort St. John LRMP landscape conservation planning process, its recent developments may also align with helping to satisfy landscape conservation planning principles for the purpose of offset planning for Site C.

These analyses and datasets can be supplemented with the Canadian Wetland Inventory (CWI) which covers all of Canada (with some areas still to be completed) and has a minimum 1 ha analysis unit. BC Conservation Data Centre data on species and ecosystems would provide further supplemental data to refine offsets site selection. Costs for using the CWI for broad scale analyses are prohibitive, but it may be useful for a closer desktop examination of selected focal areas.

A final approach is to simply visually inspect the conservation plans and data layers identified in this document in order to provide qualitative support for the identification of potential offset sites and to ensure ecological equivalence in landscape connectivity and conservation value.

### **3.0 Next steps**

This document has reviewed various conservation plans and datasets that can support the identification and evaluation of potential offset sites to meet BC Hydro's compensation obligations for impacts to upland migratory bird breeding habitat. We propose to continue this work in the following sequence:

**Step One** – confirm spatial boundaries for the selection of offset sites. We propose to identify and evaluate potential offset sites that fall within the combined breeding ranges of the three warbler species in BC for which BC Hydro has an explicit compensation obligation.

**Step Two** - identify priority potential sites either visually or through additional GIS analysis as described in Section 2.1. Our preferred approach is to conduct a modest amount of additional GIS work to combine all existing datasets across the BC breeding range of the three warbler species, giving greater weighting to conservation plans (e.g., Muskwa-Kechika Conservation Area Design) where they are available. This will yield heterogeneous map but one that utilizes available information to the greatest extent possible.

The mapping will then form the basis for identifying possible offset sites. Key considerations in the selection of potential offset sites include the following:

- Upland migratory breeding bird habitat value relative to that impacted by Site C (from Boreal Avian Modeling Project or other source)
- Landscape connectivity as indicated by patch size or similar landscape measure (e.g., Global Forest Watch Forest Intactness).
- Sites should maximize the overall conservation value for biodiversity that has been prioritized by conservation plans or datasets.

Given that some of the conservation plans and datasets were conducted years ago, potential offset sites identified in this Step will be subjected to a finer scale analysis using Google Earth and other available imagery to confirm their condition.

**Step Three** - assess offset potential. The portfolio of offset sites will then be evaluated using a variety of relevant criteria such as the following:

- Feasibility – for example, given the existing land tenure and existing resource rights, is there a feasible mechanism to implement a biodiversity offset at the site? Are there partners to help in implementation?
- Additionality – if it is feasible to implement an offset at the site, what would be the “additional” benefits for biodiversity values (in other words, which benefits would only accrue if the site were managed as an offset?).
- Cost – what would it cost to implement the offset?
- Cost effectiveness – what are the costs per unit of additional biodiversity benefits generated by the offset?
- Permanence – how secure are the likely gains in breeding bird habitat and other conservation values?

Ultimately, criteria will be combined such that offset performance can be measured in a semi-quantitative manner in terms of expected biodiversity value per unit cost. Information to assess offset potential in this Step can be obtained by talking directly with FLNRORD, MOE, forestry companies, First Nations, conservation groups, and others. Additionality will be assessed with the support of a timber supply model, which where appropriate will examine how changes to forest management influence forest composition and structure over time and thus provide a basis for measuring the benefits of each possible offset in terms of bird habitat value and other biodiversity indicators. Additional fieldwork may be needed to confirm breeding bird habitat value.

The output of this Step is a short list of viable offset opportunities capable of meeting BC Hydro’s mitigation obligations.

**Step Four** – implementation of offsets. The final step involves the implementation of the biodiversity offsets selected in Step Three. This involves among other considerations the provision of adequate financial resources for the purchase and management of the offsets, developing legal arrangements with partners for offset management, and the development of a monitoring program to confirm the efficacy of the offset over time.

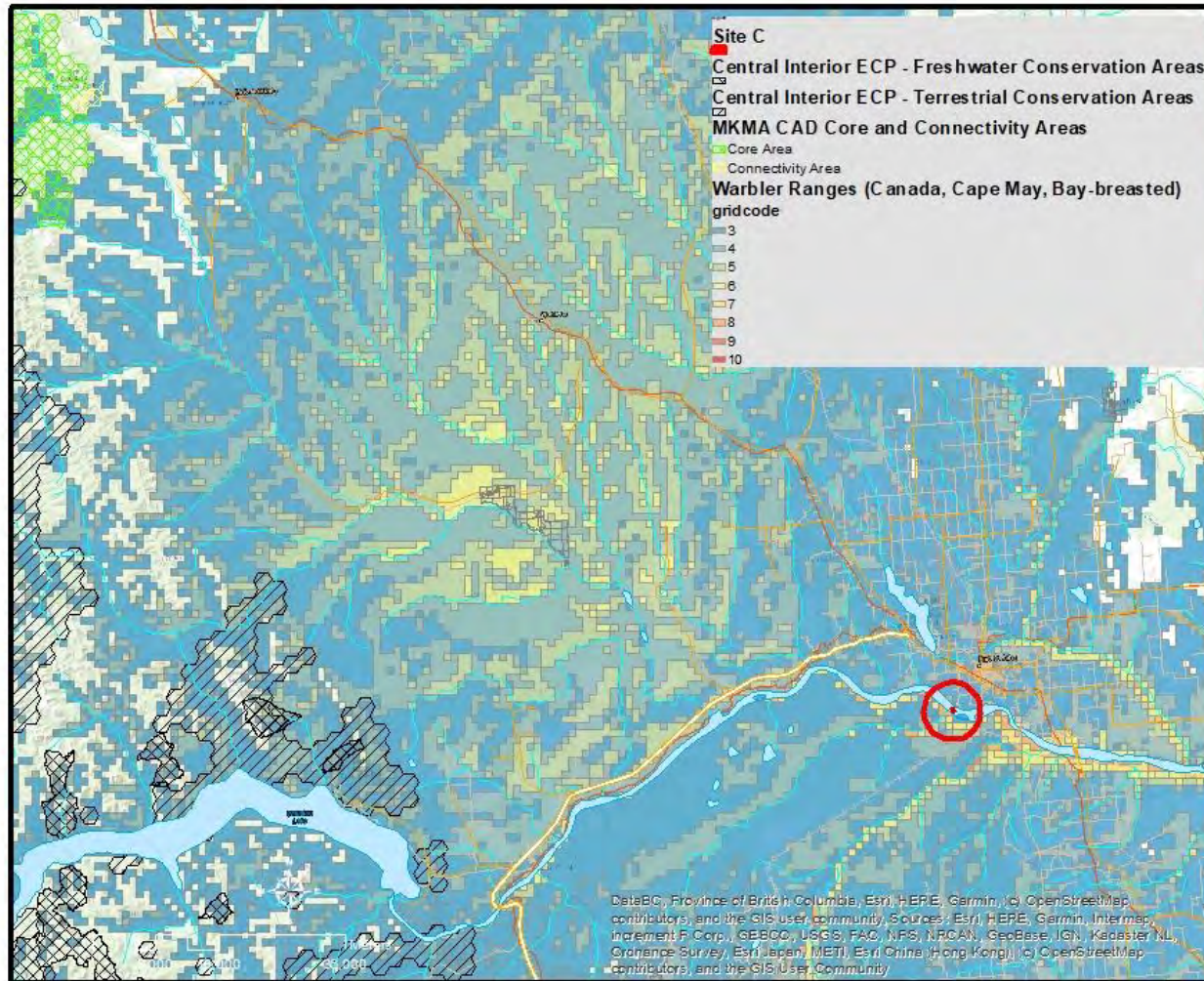


Figure 1. Ecoregional conservation planning boundaries (MKMA CAD, Central Interior ECP) overlain with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

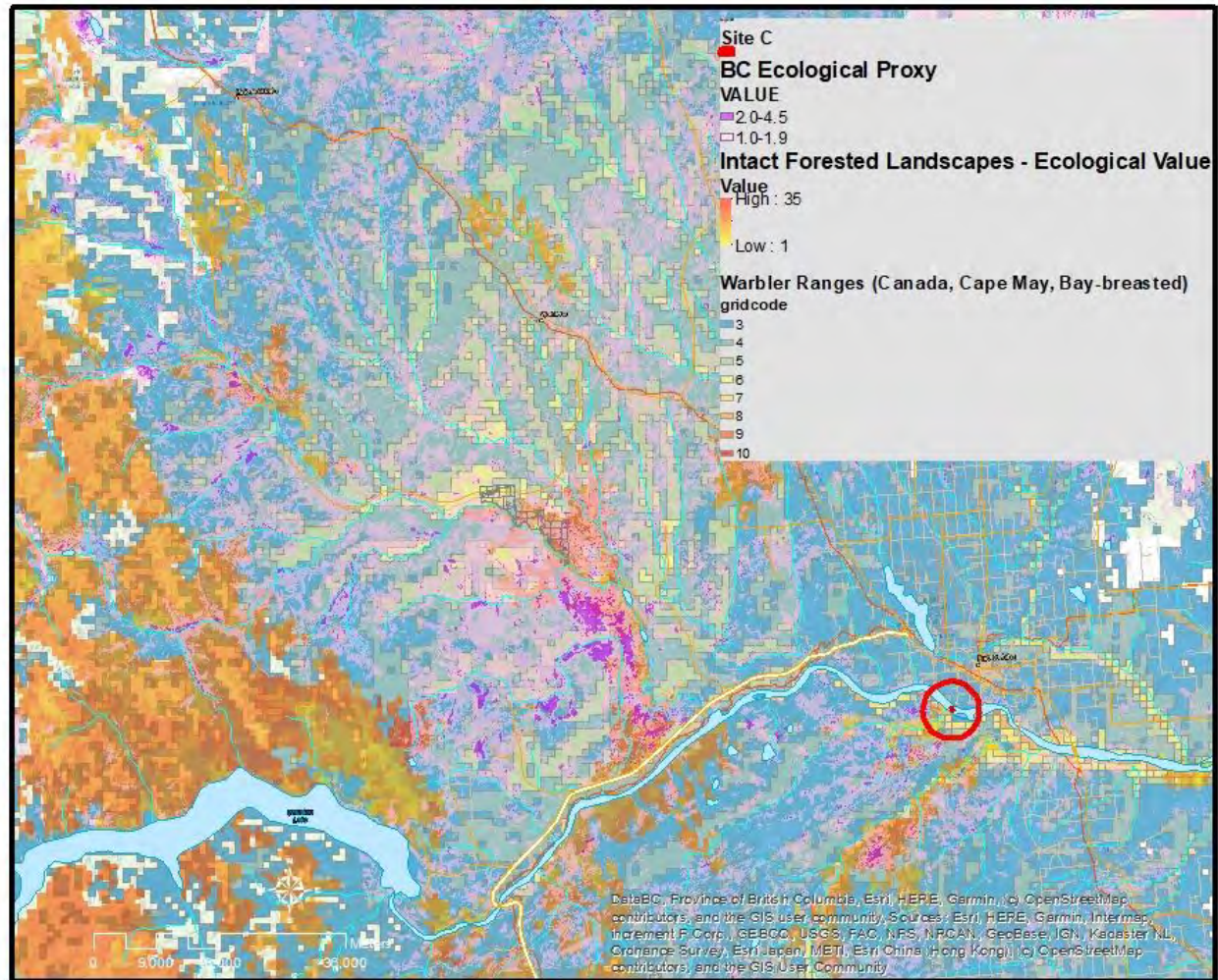


Figure 2. BC Ecological Proxy and Ecological Values in Intact Forest Landscapes mapping overlain with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

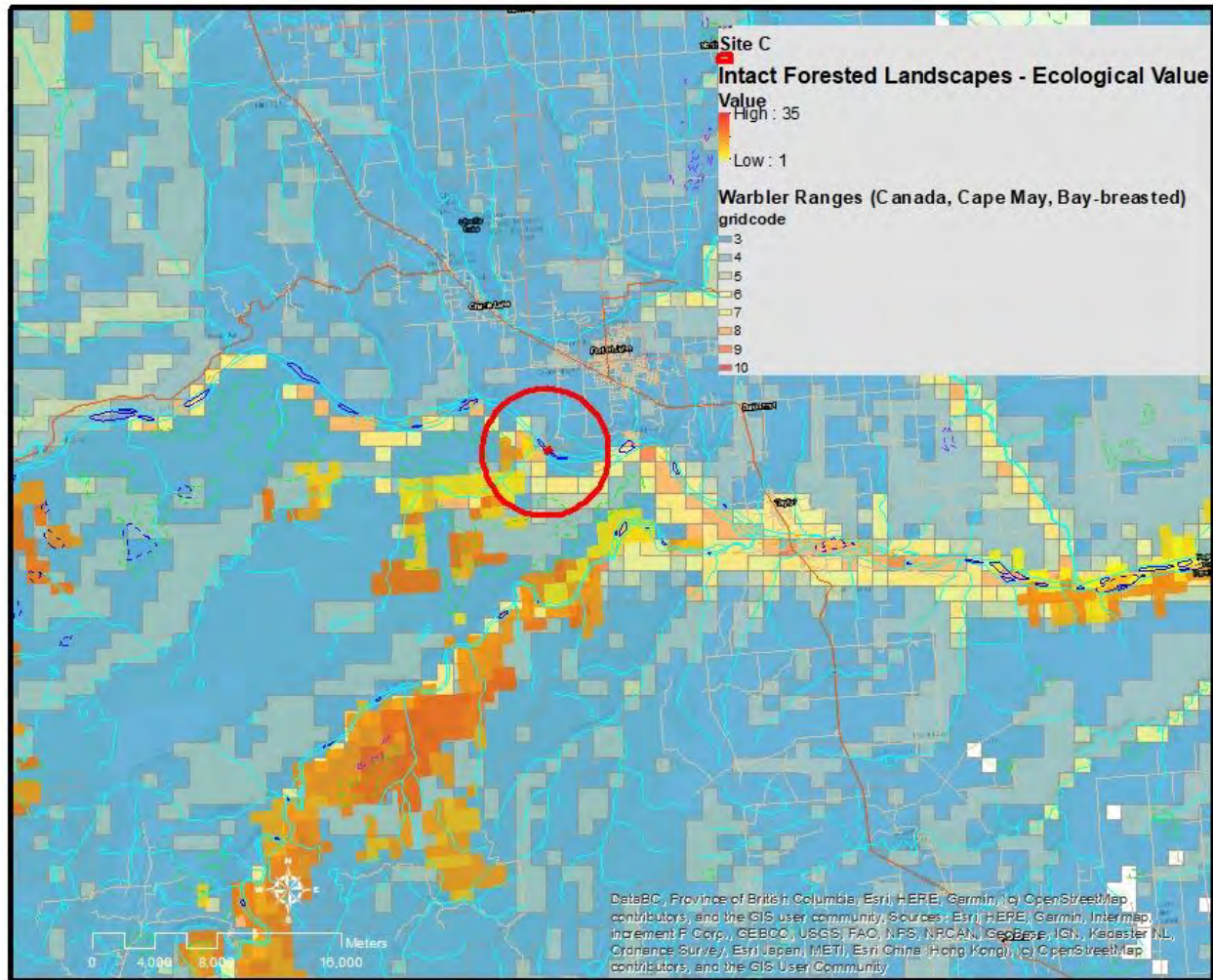


Figure 3. Key ecological values within Canada's intact forest landscapes overlap with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

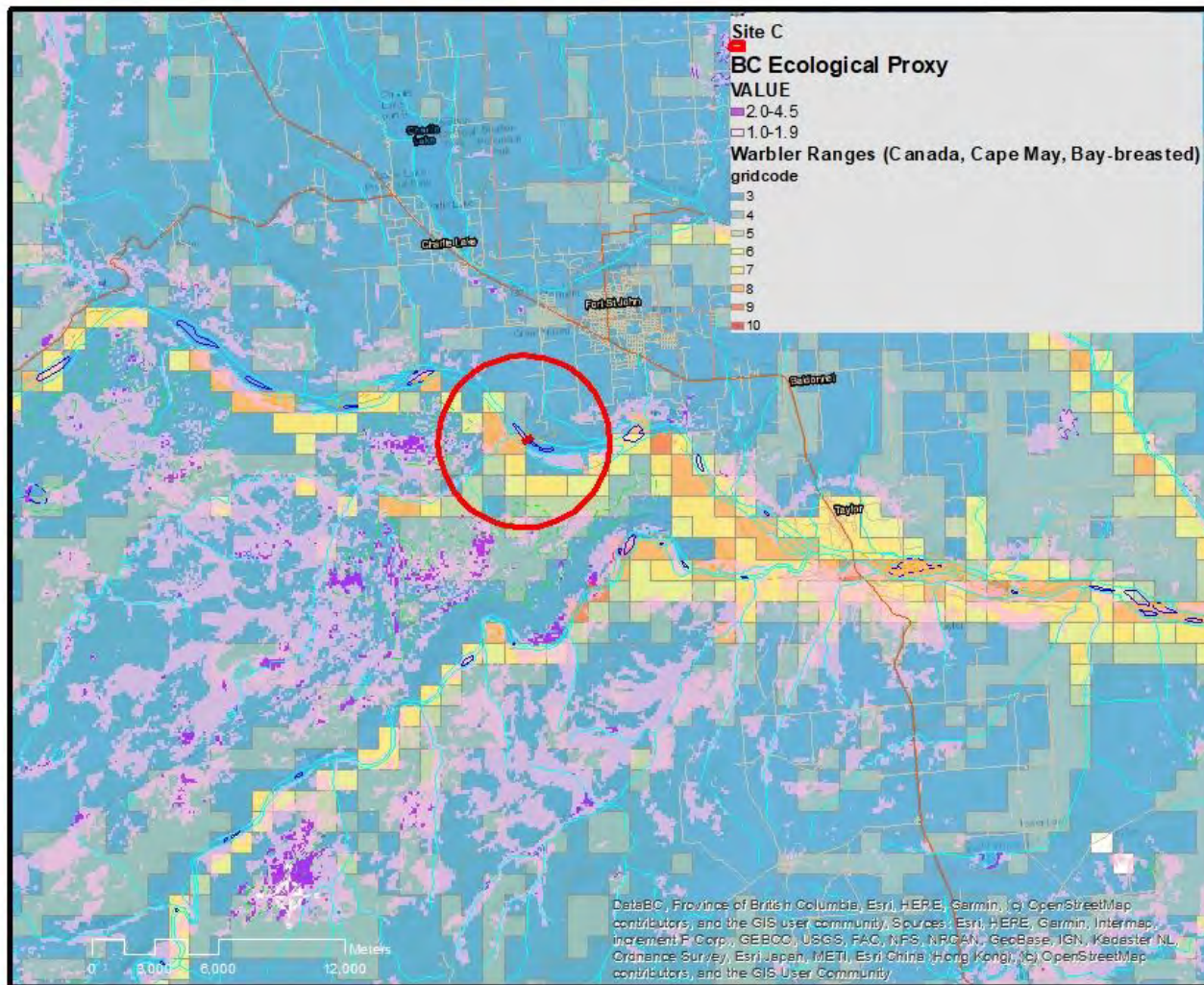


Figure 4. BC Ecological Proxy mapping overlain with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

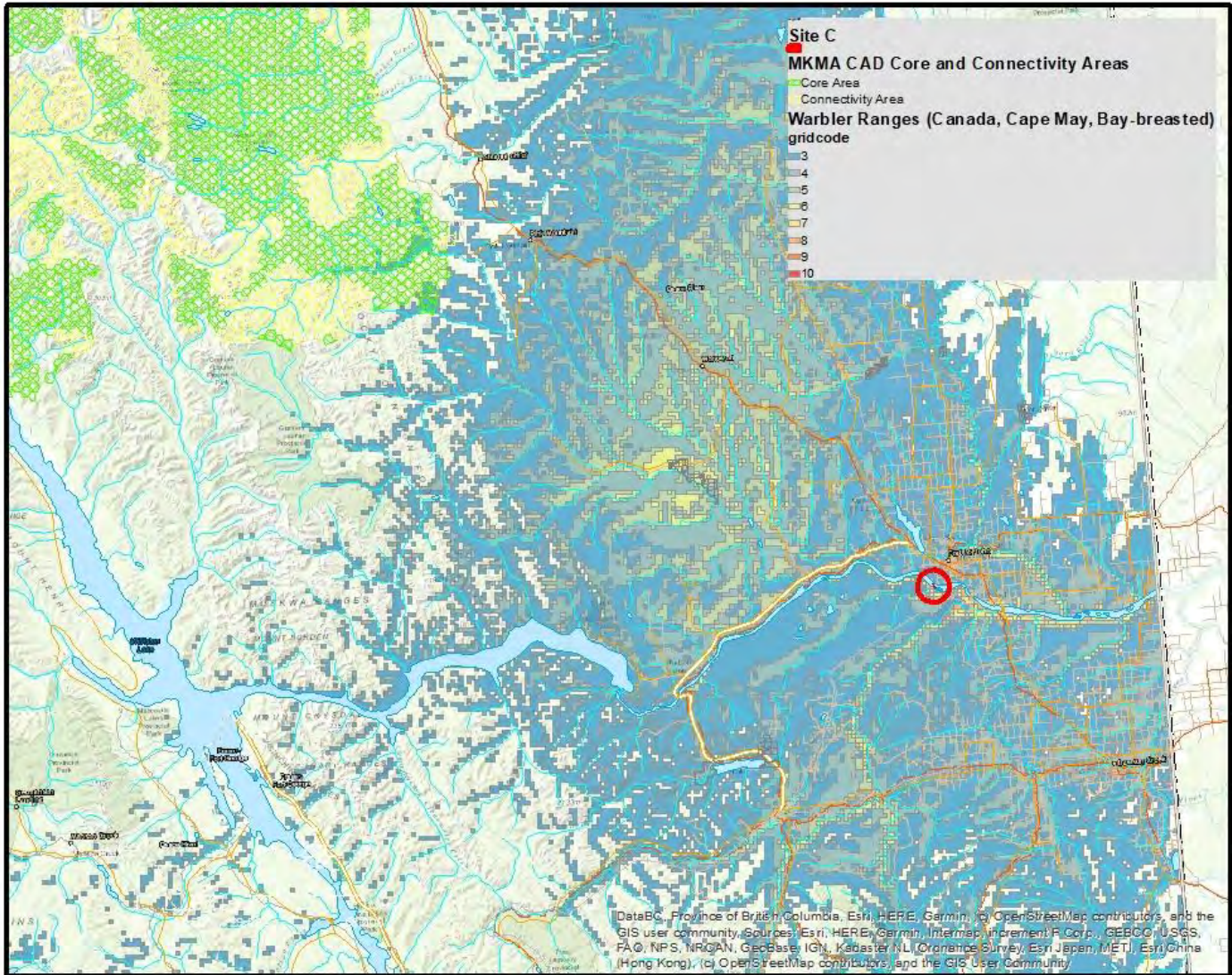


Figure 5. Muskwa-Kechika Management Area Conservation Area Design - Core and Connectivity Areas overlain with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler



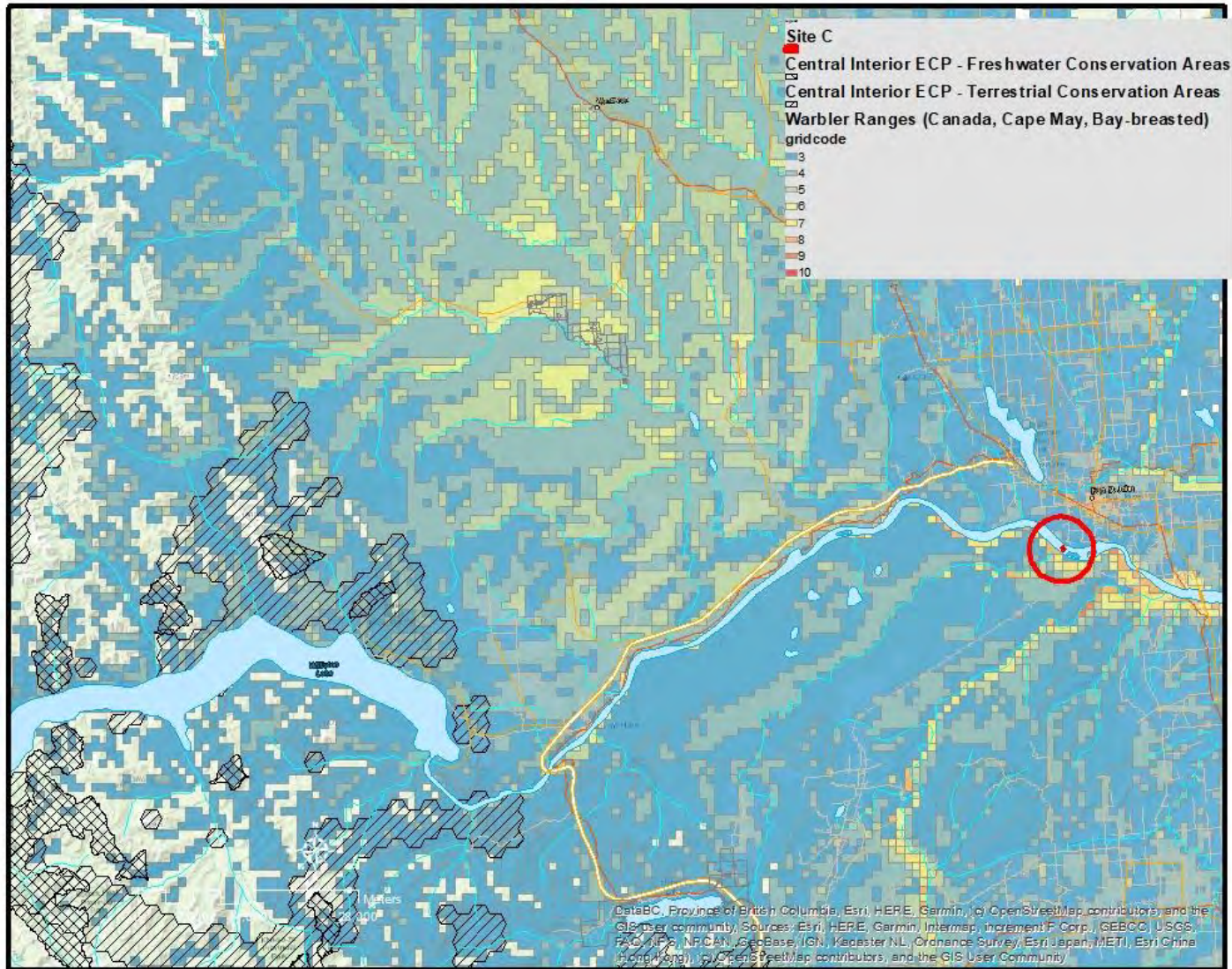


Figure 7. Central Interior Ecoregional Conservation Plan - Freshwater and Terrestrial Conservation Area Networks overlain with the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

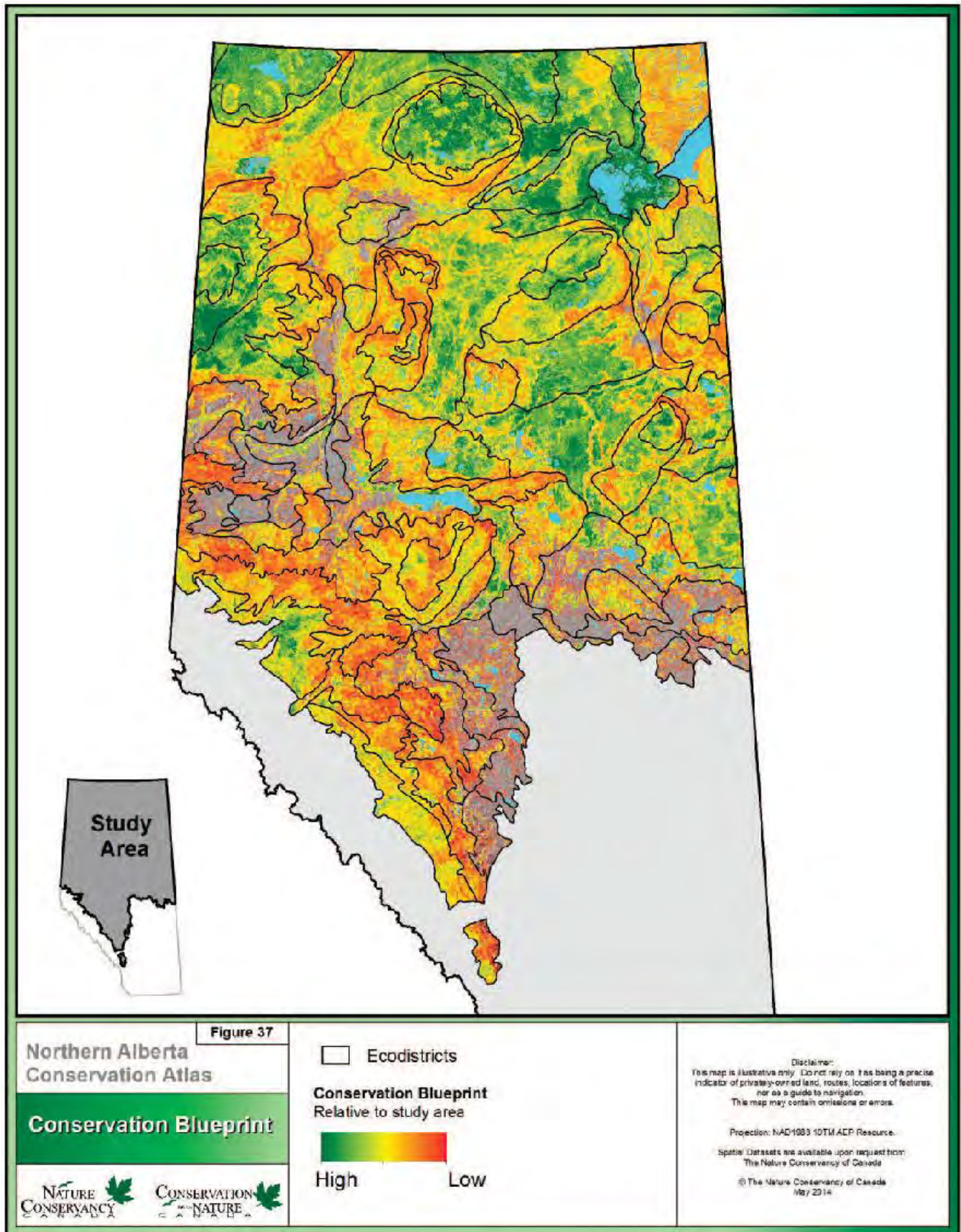
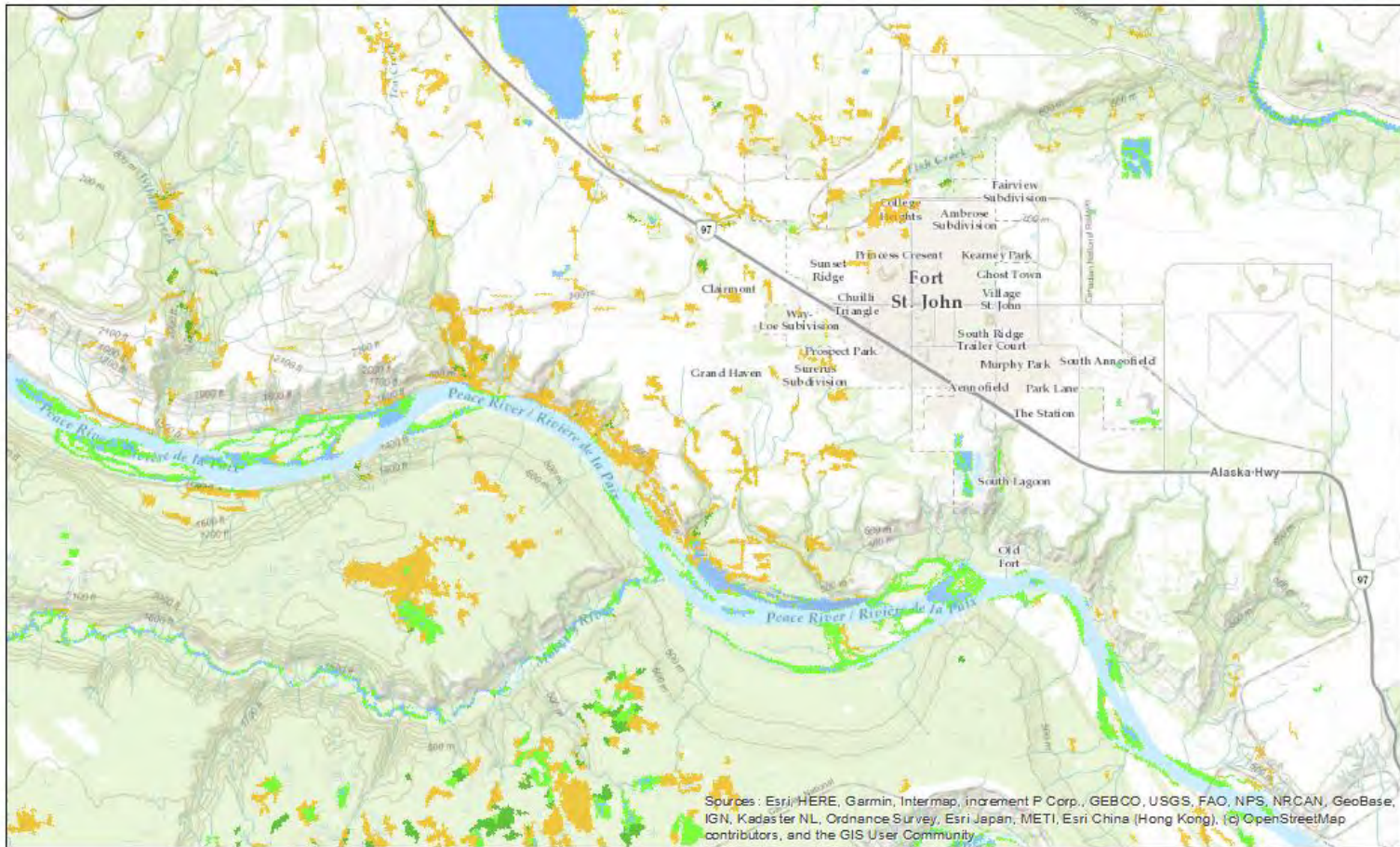


Figure 8. Northern Alberta Conservation Atlas (Nature Conservancy of Canada and Global Forest Watch Canada 2014).





## Canadian Wetland Inventory Status Map

### Wetland Classes

-  Bog \ Bog
-  Fen \ Fen
-  Marsh \ Marais
-  Swamp / Marécage
-  Shallow/Open Water / Eau peu profonde/étang

### CWI Inventory Status

-  Complete \ Near Complete
-  In Progress

0 2.75 5.5 11 Kilometers

Date: 12/11/2019



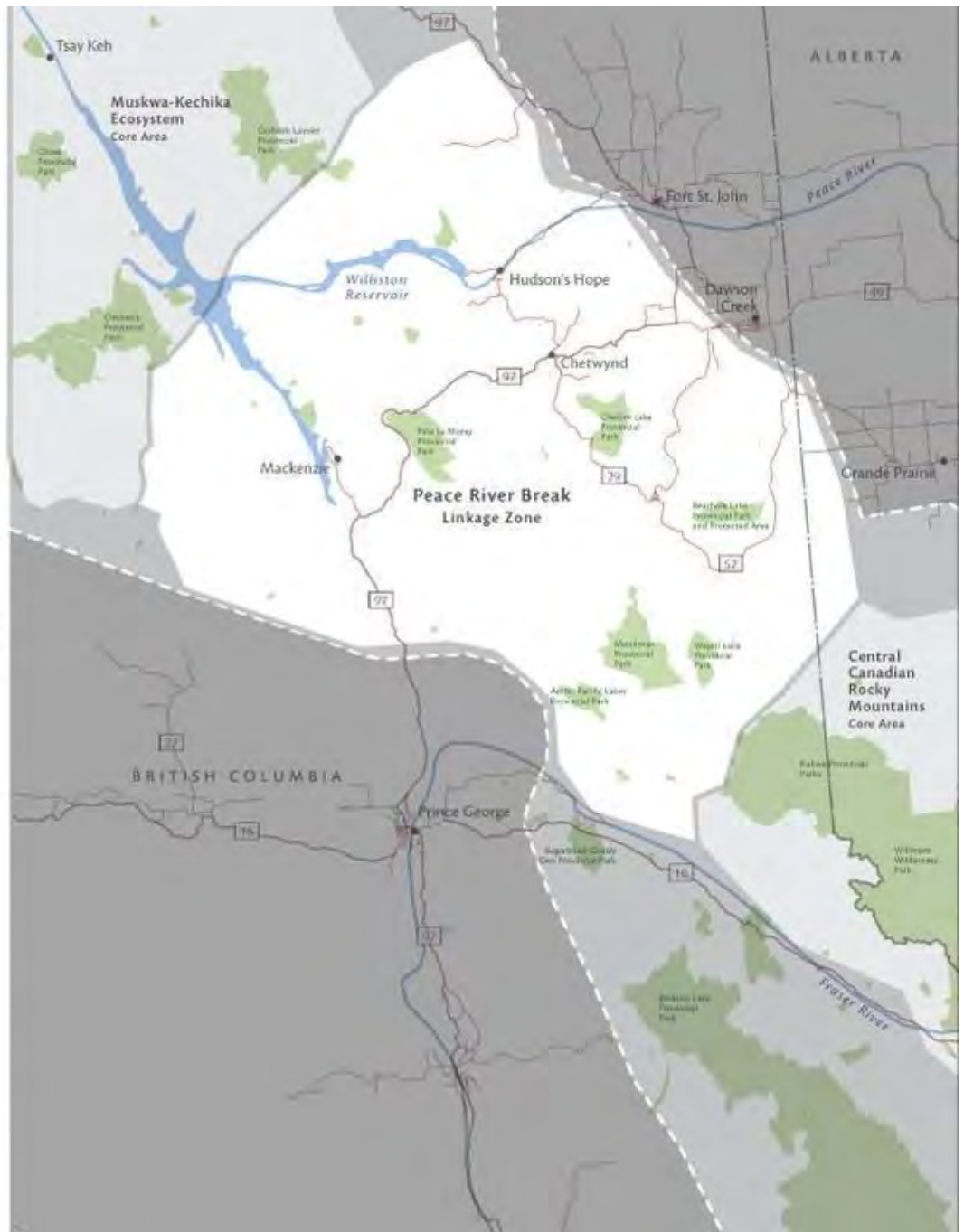
Figure 9. Sample of the Canadian Wetland Inventory in the Peace River region.

# Peace River Break

Linkage Zone

-  Priority Area
-  Yellowstone to Yukon Region
-  City
-  Highway
-  Political Boundary
-  River
-  Major Waterbody
-  National Park
-  Other Protected Area

40 kilometers  
25 miles





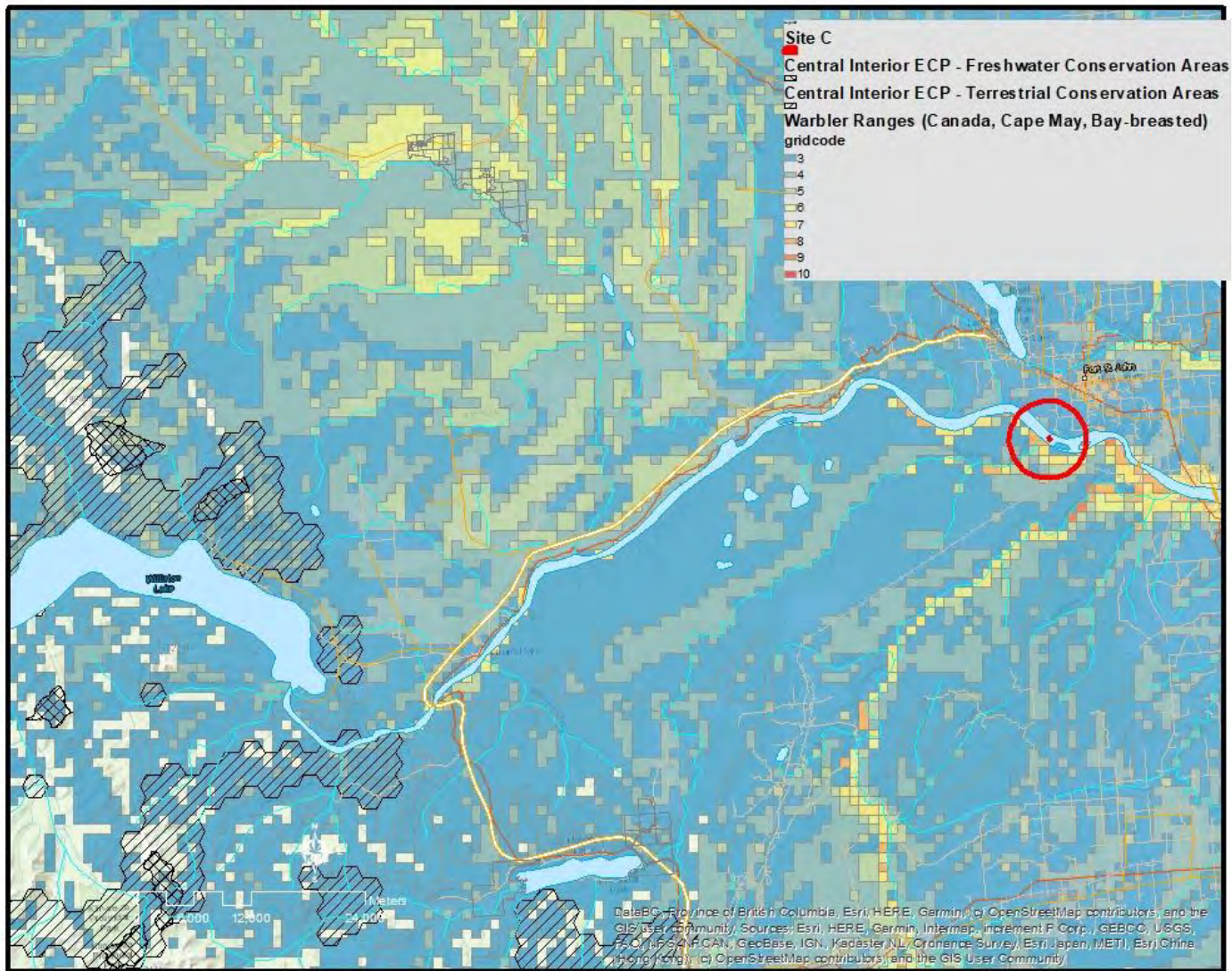


Figure 12. Central Interior ECP - Terrestrial and Freshwater conservation areas and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler in proximity to Site C.

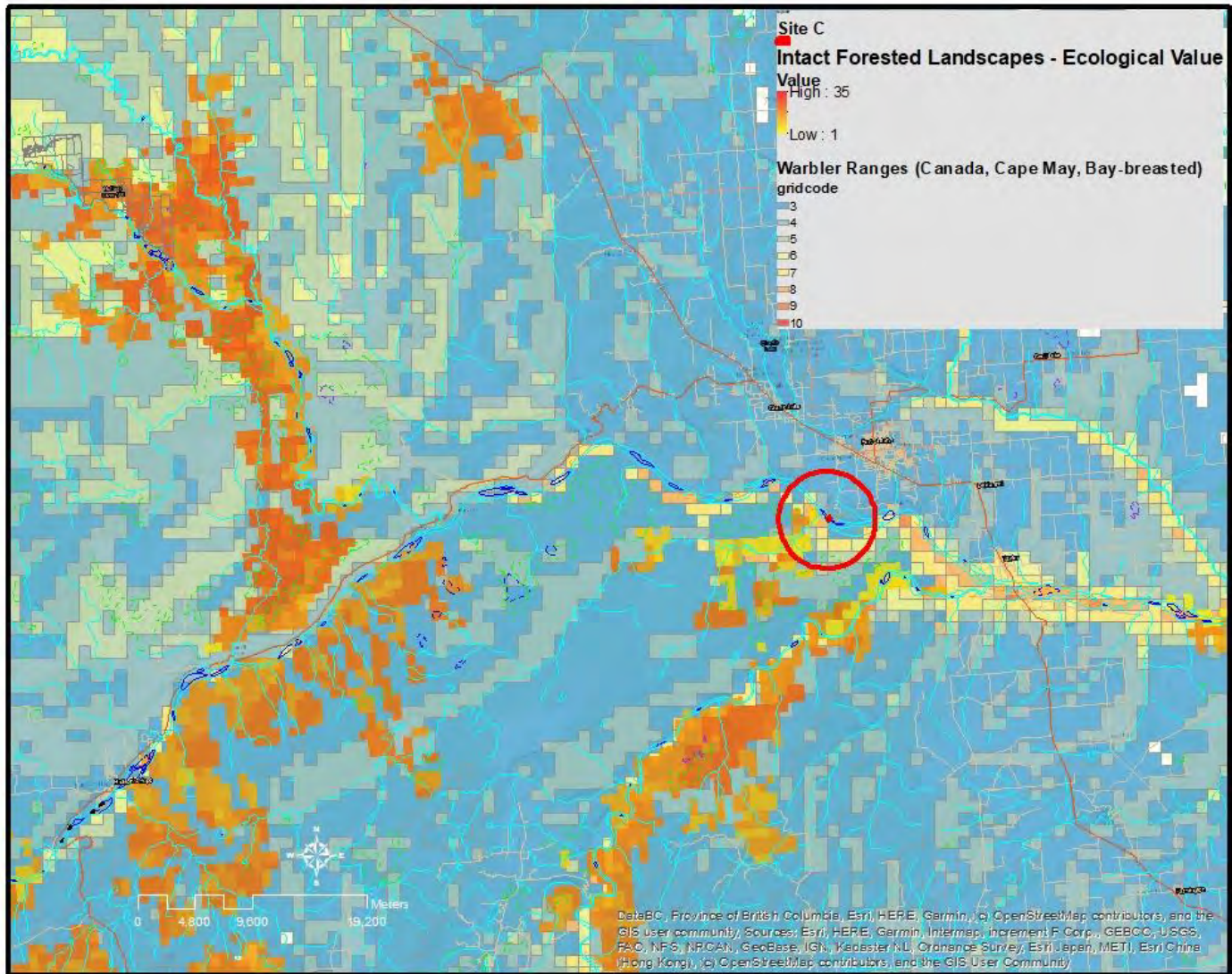


Figure 13. Key Ecological Values in Intact Forest Landscapes, BC Ecological Proxy mapping, and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler in proximity to Site C.

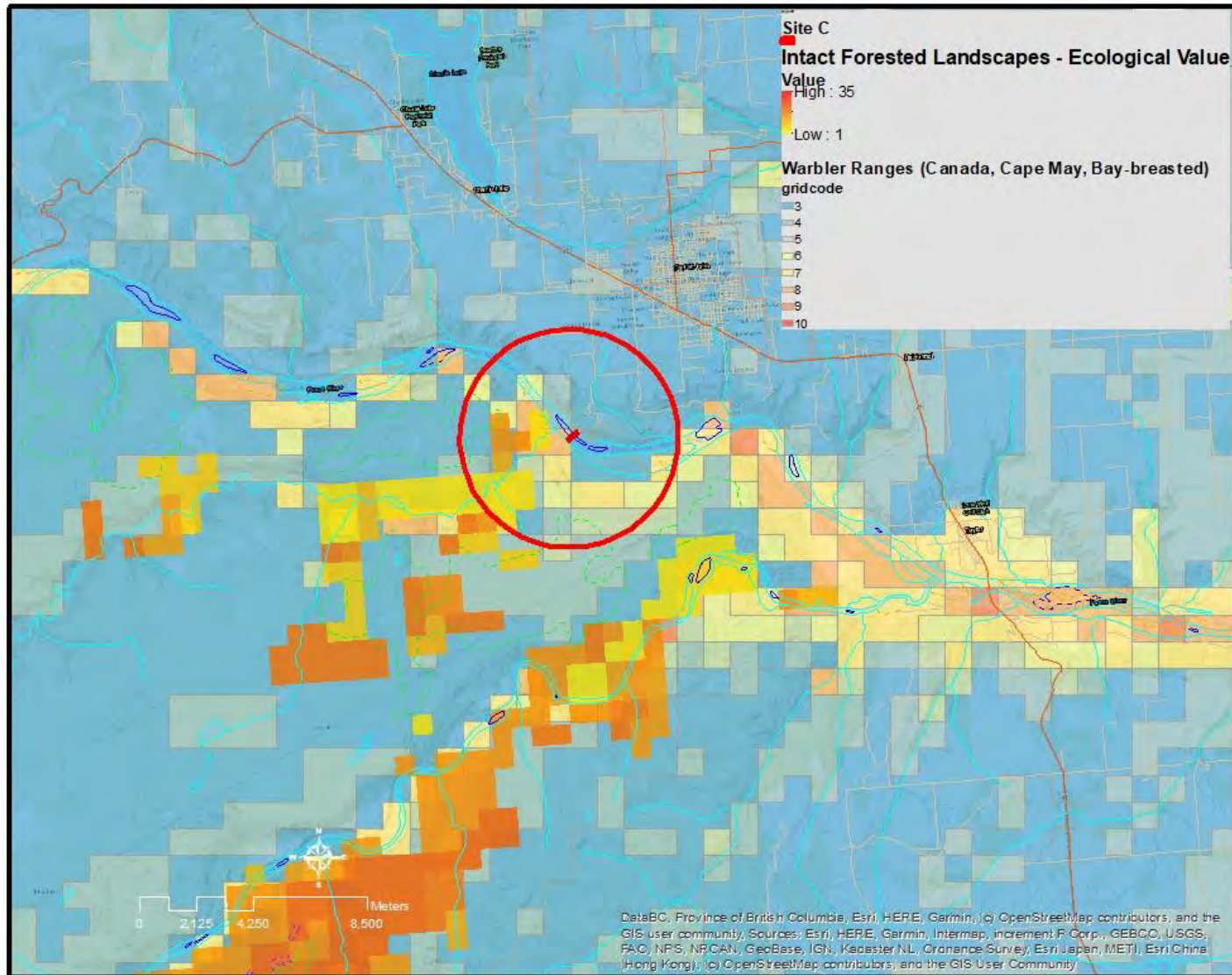


Figure 14. Key Ecological Values in Intact Forest Landscapes and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

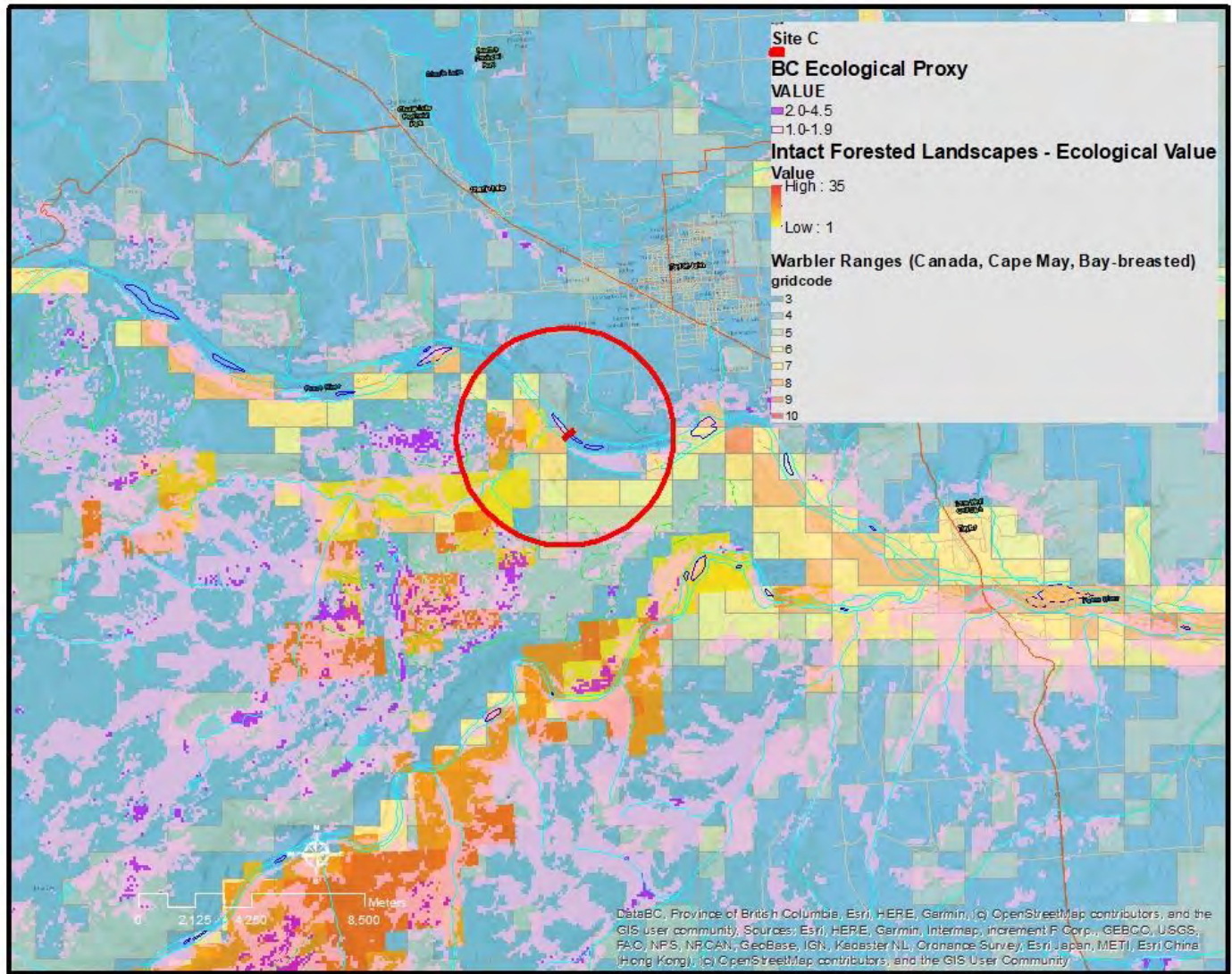


Figure 15. BC Ecological Proxy, Key Ecological Values in Intact Forest Landscapes, and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

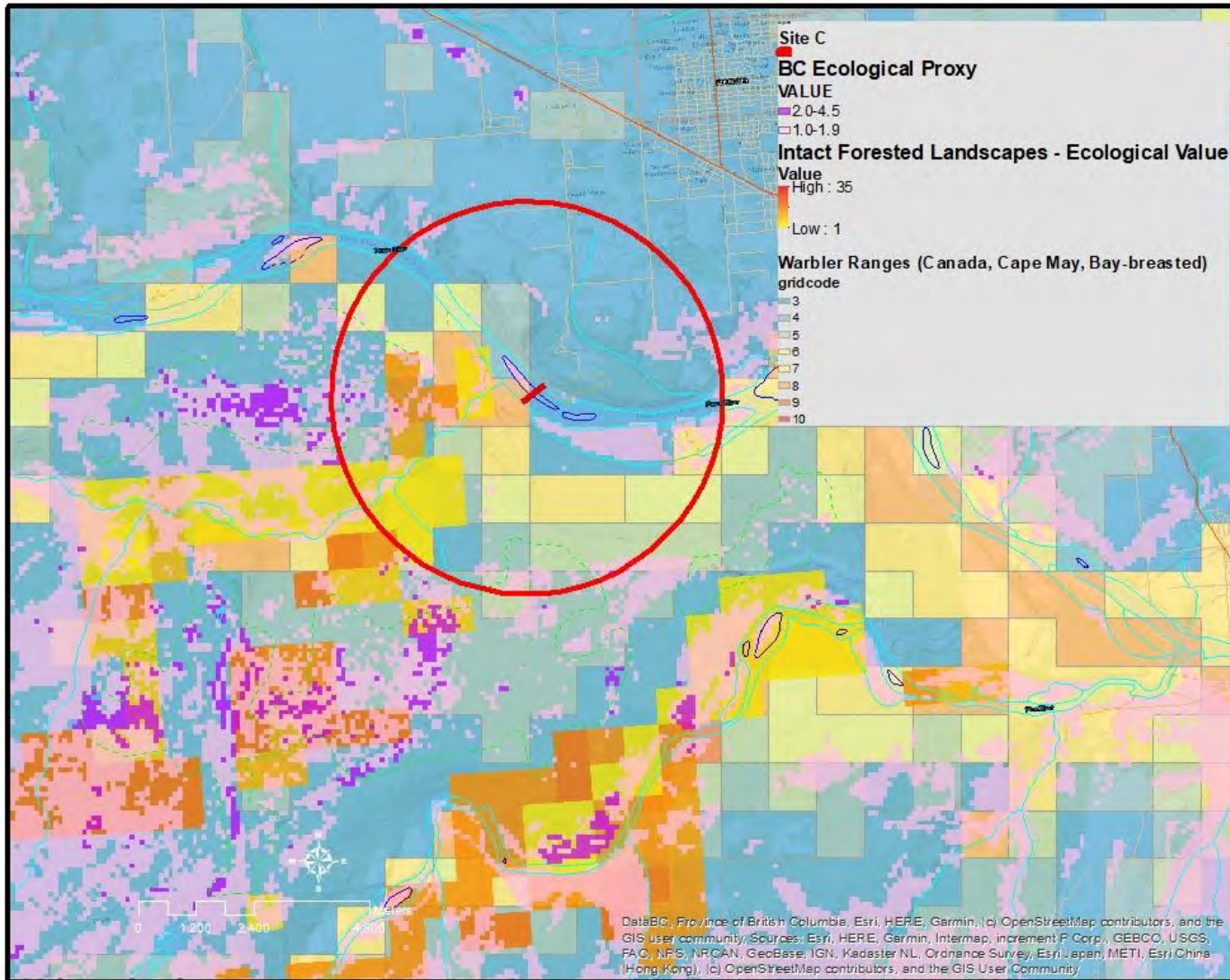


Figure 16. BC Ecological Proxy, Key Ecological Values in Intact Forest Landscapes, and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

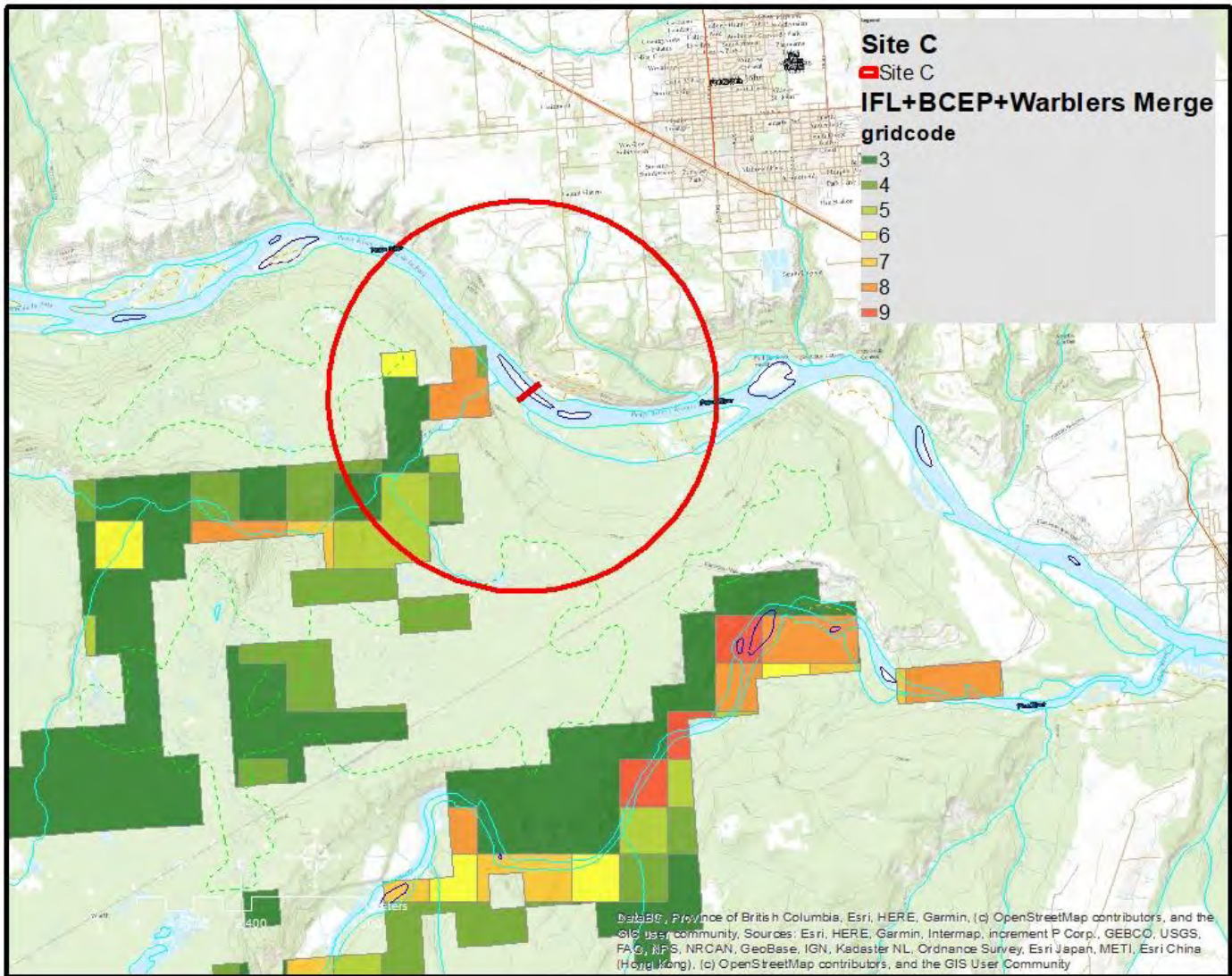


Figure 17. Merged BC Ecological Proxy, Key Ecological Values in Intact Forest Landscapes, and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

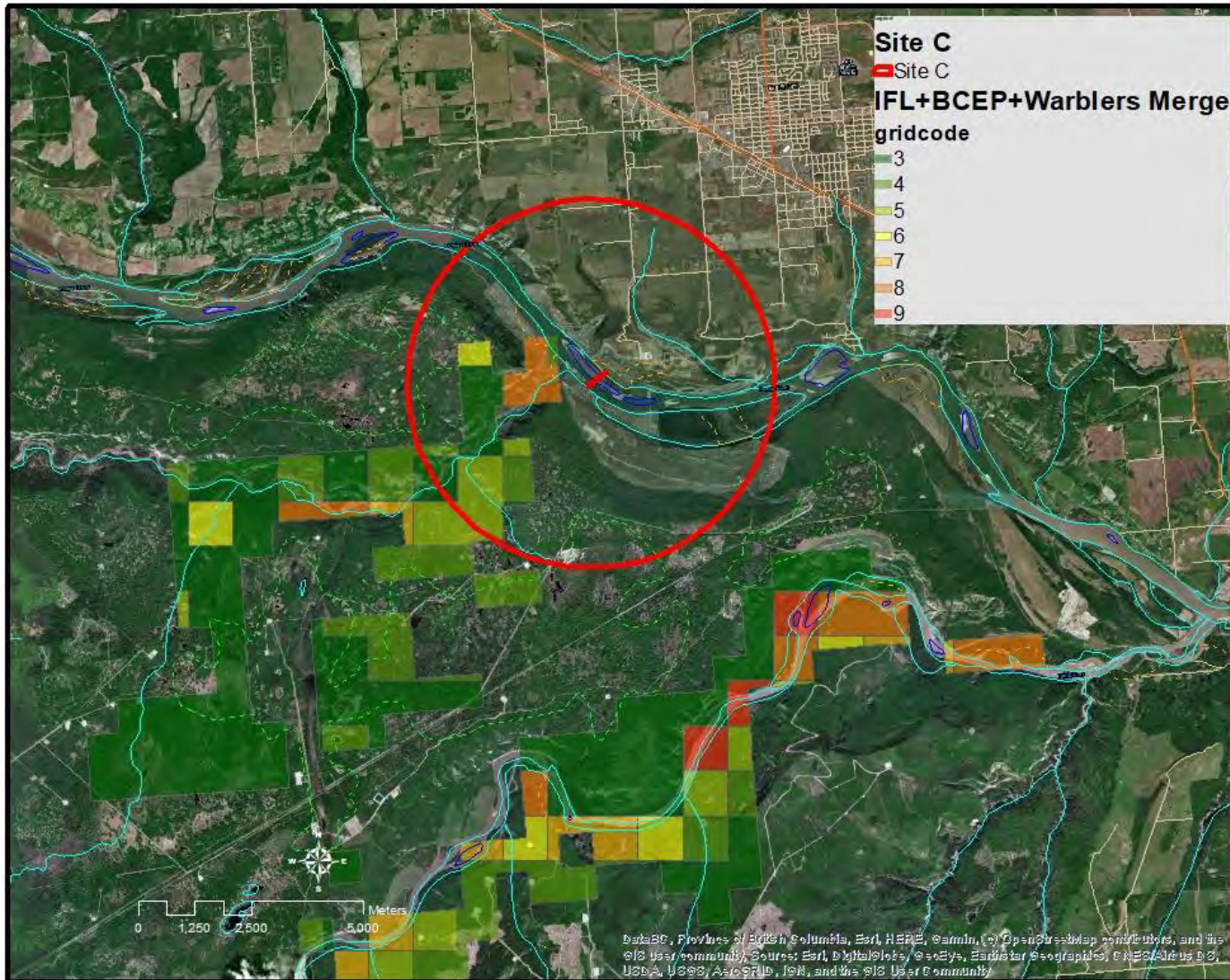


Figure 18. Merged BC Ecological Proxy, Key Ecological Values in Intact Forest Landscapes, and the ranges of Canada Warbler, Cape May Warbler, and Bay-breasted Warbler.

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## Appendix A. Data Sources

Data/Mapping	Location
BC Conservation Data Centre CDC iMap web mapping service	<ul style="list-style-type: none"> <li>• <a href="http://maps.gov.bc.ca/ess/hm/cdc/">http://maps.gov.bc.ca/ess/hm/cdc/</a></li> </ul>
BC Ecological Proxy	<ul style="list-style-type: none"> <li>• <a href="https://databasin.org/">https://databasin.org/</a></li> <li>• <a href="#">ArcGIS Online</a></li> </ul>
BC Government Data Catalogue	<ul style="list-style-type: none"> <li>• <a href="https://catalogue.data.gov.bc.ca/dataset?q=ECO&amp;download_audience=Public&amp;sort=score+desc%2C+record_publish_date+desc">https://catalogue.data.gov.bc.ca/dataset?q=ECO&amp;download_audience=Public&amp;sort=score+desc%2C+record_publish_date+desc</a></li> </ul>
Databasin.org	<ul style="list-style-type: none"> <li>• <a href="https://databasin.org/">https://databasin.org/</a></li> </ul>
Ducks Unlimited Canada: Canadian Wetland Inventory	<ul style="list-style-type: none"> <li>• <a href="http://maps.ducks.ca/cwi/">http://maps.ducks.ca/cwi/</a></li> </ul>
Global Forest Watch Canada: Key Ecological Values in Intact Forested Landscapes	<ul style="list-style-type: none"> <li>• <a href="https://databasin.org/">https://databasin.org/</a></li> <li>• <a href="#">ArcGIS Online</a></li> </ul>
Hectares BC	<ul style="list-style-type: none"> <li>• <a href="http://hectaresbc.org">hectaresbc.org</a></li> </ul>
Nature Conservancy of Canada	<ul style="list-style-type: none"> <li>• Muskwa-Kechika Management Area Conservation Area Design - <a href="http://support.natureconservancy.ca/pdf/blueprints/Muskwa_Kechika_Management_Area.pdf">http://support.natureconservancy.ca/pdf/blueprints/Muskwa_Kechika_Management_Area.pdf</a></li> <li>• Central Interior Ecoregional Conservation Plan - <a href="http://www.natureconservancy.ca/en/who-we-are/publications/conservation-blueprints/">http://www.natureconservancy.ca/en/who-we-are/publications/conservation-blueprints/</a></li> <li>• Northern Alberta Conservation Atlas - <a href="http://www.natureconservancy.ca/en/who-we-are/publications/conservation-blueprints/">http://www.natureconservancy.ca/en/who-we-are/publications/conservation-blueprints/</a></li> <li>• Contact: Brittany Dewar (Brittany.Dewar@natureconservancy.ca)</li> </ul>
The Status of Human Footprint in Alberta	<ul style="list-style-type: none"> <li>• <a href="https://abmi.ca/home/reports/2018/human-footprint/details.html?id=3">https://abmi.ca/home/reports/2018/human-footprint/details.html?id=3</a></li> </ul>

## **Appendix 20. Artificial Snake Hibernacula Monitoring Memo 2025 Update**



### Inter-office memo

To: Brent Matsuda  
Date: March 31, 2025

From: Jessica Brunet

CC: Arshad Khan

Subject: 2025 Snake Hibernacula Monitoring

---

#### **Background**

Two species of gartersnake, the Common Gartersnake (*Thamnophis sirtalis*) and the Western Gartersnake (also called Western Terrestrial Gartersnake; *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 Clean Energy Project (Project; BC Hydro, 2013). While neither is a provincial or federal species of concern, both are protected under the BC *Wildlife Act*.

The Environmental Impact Statement (EIS) for the Project (Volume 2, Section 14, page 14-14; Simpson et al. 2013) predicted a loss of 15% of suitable hibernation habitat in the local assessment area, as well as the loss of foraging habitat. Snake mortality was predicted to occur due to the alteration of habitats during construction activities (including blasting impacts on hibernacula), flooding, and the potential for mortality to individuals along roads. While these effects were determined to be not significant, BC Hydro committed to construct artificial snake hibernacula as habitat compensation and mitigation for the loss of snake hibernacula. These artificial hibernacula would be located on warm aspect slopes in open areas away from major roads (EIS, Volume 14, Table 14.15).

Further, the provincial Environmental Assessment Certificate (EAC) Condition 16 states that:

*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 compensation measures:*

- *Mitigation for the loss of snake hibernacula, artificial dens must be included during habitat compensation.*

As such, BC Hydro created a Gartersnake Mitigation and Monitoring Program (BC Hydro, 2018) which included the construction of artificial 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 completed in 2023 near Cache Creek. All seven hibernacula are located on the north side of the Peace River (WSP, 2024) upstream of the Site C dam.

As per EAC Condition 16, monitoring surveys are to begin the spring after installation of a hibernaculum and conducted twice a year for three years. Since 82.1 was completed in July 2023, monitoring would be required in 2024, 2025, and 2026. The monitoring for the other six hibernacula was completed in 2023, with details provided in WSP (2024).

This memo will summarize snake hibernacula monitoring and repairs conducted in 2025 at all seven hibernacula to support long-term monitoring of hibernacula effectiveness under the direction of BC Hydro. All were monitored in accordance with the Site C Gartersnake Mitigation and Monitoring Program plan.

### ***Snake Hibernaculum Monitoring (82.1)***

Upon hibernaculum construction completion in July 2023, temperature probes and a HOBO H21-USB datalogger were installed in September 2023 at this location.

Monitoring surveys were conducted by BC Hydro in 2024 (BC Hydro, 2025). In 2025, West Moberly-DWB Limited Partnership (DWB) was contracted to conduct hibernaculum monitoring at only this site. Snake monitoring surveys were conducted during the spring emergence window and fall pre-hibernation periods (see DWB 2026 in Appendix 1). One gartersnake, likely a Western Gartersnake (unconfirmed identification) was observed within approximately 15m west of the hibernaculum entrance on May 2, 2025. However, the snake was lost in the underbrush. There was no confirmation that it emerged from or entered the hibernaculum afterwards (Appendix 1).

Recorded temperature monitoring inside the hibernacula indicated a steady decrease throughout the winter of approximately 0.034°C per day reaching a minimum internal temperature of 4.45°C between March 25<sup>th</sup> to April 4<sup>th</sup> (Appendix 2). The hibernaculum remained above 0°C for the duration of the winter.

### ***Snake Hibernacula Repairs (21.4, 48, 82.1, 134, 153, 272.2, 326)***

In 2025, BC Hydro conducted site visits to all seven artificial snake hibernacula to assess the condition and functioning of installed temperature monitoring equipment (Appendix 3). The monitoring equipment was non-functional at six of the seven hibernacula with only 82.1 being functional. Temperature monitoring equipment was re-established at three of the six hibernacula (21.4, 134, 272.2) with upgrades conducted to better protect the equipment from water intrusion and wildlife damage. Temperature monitoring equipment at snake hibernaculum 82.1 also received upgrades to better protect the equipment from water intrusion and wildlife damage. The temperature monitoring stations at the three remaining hibernacula (48, 153, 326) were significantly damaged and will require further assessment.

Incidental snake observations were recorded during the site visits (Appendix 4). Notably, snakes were observed near hibernacula entrances in August 2025 which coincides with typical snake return timing to their hibernacula for overwintering. Camera traps were installed at four hibernacula to monitor for snake activity at the hibernacula entrances. Camera traps were opportunistically installed using the 30 second timelapse feature and manually screened due the complex nature of the habitat. Camera trap data is currently under review. Camera trap data recorded snakes entering and exiting snake hibernaculum 326. Representative site photographs were collected during site visits (Appendix 5).

### ***Future Considerations***

Snake hibernaculum 82.1 will continue to be monitored until the end of 2026. Snake surveys will continue to be conducted twice yearly to monitor for snake presence and collect temperature data from the hibernaculum.

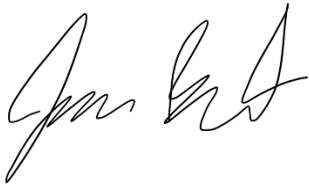
Long-term monitoring of all seven hibernacula require twice yearly visits to maintain the temperature monitoring equipment. Three of the hibernacula with currently damaged temperature monitoring equipment will require further assessment to determine if repairs are possible. Temperature probes installed during hibernacula creation that have since been damaged may no longer be retrievable or replaceable due to being embedded in the inner rock layers, so an alternative solution to monitoring inner hibernaculum temperature will need to be considered.

Relative humidity monitoring should also be considered during any subsequent upgrades. Historically, some of the hibernacula have reported freezing or near freezing temperatures for prolonged periods so would benefit from further insulation to make them thermally suitable for snake overwintering.

### ***Closure***

The 2025 monitoring and maintenance activities provided updated information on snake use of artificial hibernacula and the condition of installed temperature monitoring equipment. Monitoring under EAC Condition 16 applies only to hibernaculum 82.1 and will continue through 2026. BC Hydro will continue to maintain and monitor all seven hibernacula to support their long-term functionality.

We trust this memo provides sufficient information on the 2025 monitoring and maintenance activities conducted at the Site C artificial snake hibernacula, including monitoring completed at hibernaculum 82.1. Should you have any questions or require additional information, please contact the undersigned.



Prepared by:  
Jessica Brunet, RPBio  
Sr. Environmental Coordinator, BC Hydro



Reviewed by:  
Brent Matsuda, RPBio  
Sr. Environmental Coordinator, BC Hydro

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Simpson, K., T.K. Simpson, L. Simpson, L. Andrusiak, S. Hilton, M. Kellner, K. Klafki, I. Mattson and A. Creagh. 2013. Part 3 Amphibians and Reptiles. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

WSP. 2024. Site C Wildlife Mitigation Structures, Snake Hibernacula Monitoring 2023 Report. Submitted to BC Hydro by WSP Canada Inc., Fort St. John, BC.

## **Appendix 1 – Snake Activity Monitoring of Hibernaculum 82.1**



**West Moberly-DWB Limited Partnership**

# **HIGHWAY 29 CACHE CREEK SNAKE HIBERNACULUM 2025 ANNUAL REPORT**



**Prepared for:** BC Hydro and Power Authority

**Attn:** Brent Matsuda  
333 Dunsmuir St, 6th floor  
Vancouver, BC V6B 5R3



**Prepared by:** West Moberly-DWB Limited Partnership

Peace River Region  
7904-101 Avenue Fort St John, B.C. V1J 2A3  
250-785-1570 | [www.dwbconsulting.ca](http://www.dwbconsulting.ca)

**Date:** 2026-03-31 | **WM-DWB file:** W2422-437 | **Revisions:** 1



**OQM** | Organizational Quality  
Management Program

# Signature Page

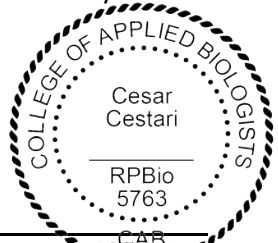
West Moberly-DWB Limited Partnership is pleased to submit this report for your review. This report has been prepared using sound technical and professional judgement, based on our knowledge and experience, applicable regulatory framework, industry best management practices, and current understanding of project conditions, design, and project setting.

REPORT TITLE: Highway 29 Cache Creek Snake Hibernaculum 2025 Annual Report

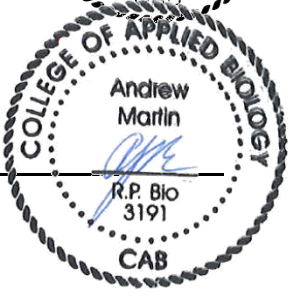
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REVISION: 1

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REVIEWED BY: Andrew Martin, RPBio



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DATE	VERSION	REVIEW TYPE <sup>1</sup>	REVIEWED BY (NAME, COMPANY)
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<sup>1</sup> Editorial Review: Reviewed for formatting, grammar, spelling, etc.  
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 Regulatory Review: Reviewed by regulatory agency (i.e., DFO) if necessary  
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- That by using the guidance in the report, the client will be approved by the contract holder for the applied works.

# Executive Summary

This report presents the results of the 2025 monitoring efforts at the Highway 29 Cache Creek artificial snake hibernaculum. A series of snake hibernacula were constructed as part of BC Hydro's habitat offsetting commitments associated with the Site C Project. The objective of the monitoring program is to evaluate occupancy and assess whether the structure is providing suitable overwintering conditions for gartersnakes.

Monitoring was conducted during spring emergence and fall pre-hibernation using visual encounter surveys and passive sand tracking at the entrance. A number of improvements were implemented at the snake hibernaculum in 2025, including an upgraded temperature logger, and rock armour and fencing to mitigate erosion and cattle trampling. During spring emergence, one snake was observed within 15 m of the hibernaculum entrance indicating possible occupancy. Continued monitoring will further evaluate occupancy patterns and overall suitability of the hibernaculum for gartersnake usage.

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## APPENDICES

APPENDIX A SNAKE HIBERNACULUM PHOTO LOG

## 1.0 INTRODUCTION

West Moberly-DWB Limited Partnership (WM-DWB) was retained by British Columbia Hydro and Power Authority (BC Hydro) to monitor a snake hibernaculum constructed to facilitate gartersnake (*Thamnophis* spp.) overwintering. This structure is part of a series of snake hibernacula developed by BC Hydro to offset the loss of natural overwintering habitat associated with the construction of the Site C Clean Energy Project (BC Hydro 2013; BC Hydro 2015).

Artificial snake hibernacula were first constructed along the north side of the Peace River in 2020 to mitigate anticipated habitat loss resulting from reservoir inundation, Highway 29 realignment, and associated infrastructure development. These structures were installed following habitat suitability assessments and consultation with snake ecology specialists to identify locations with favourable slope, substrate, and thermal characteristics suitable for overwintering snakes (Golder 2020; Hilton et al. 2013).

The hibernaculum is located in Cache Creek off of Highway 29, approximately 30 km west of Fort St. John, BC. The Cache Creek snake hibernaculum (Snake Den 82.1) was constructed in 2023 as part of BC Hydro's habitat compensation commitments under Environmental Assessment Certificate (EAC) #E14-02 for the Site C Clean Energy Project (EAO 2014). BC Hydro constructed a total of seven artificial snake hibernacula to offset the loss of natural overwintering habitat associated with Highway 29 realignment and reservoir development. Monitoring of the Cache Creek hibernaculum commenced in 2024 and is planned to continue annually through 2026 to evaluate effectiveness and occupancy, in accordance with EAC follow-up monitoring requirements. Initial monitoring conducted in September 2024 documented several gartersnakes in the vicinity of the hibernaculum; however, occupancy of the structure for overwintering could not be confirmed at that time (BC Hydro 2024a).

Artificial snake hibernacula are designed to provide suitable overwintering conditions, including stable thermal environments that remain above lethal freezing temperatures while allowing access to subterranean refugia. Temperature stability is a critical factor influencing overwinter survival of gartersnakes, as individuals rely on underground cavities that buffer extreme winter conditions. Monitoring of the artificial hibernaculum therefore includes evaluation of thermal conditions to help determine whether the structure is providing suitable overwintering habitat (Gregory 1984; Matsuda et al. 2006).

The Cache Creek hibernaculum was designed to provide overwintering habitat for gartersnakes known to occur in the Peace River region. Two gartersnake species are known to occur within the Peace River Valley, including the western gartersnake (*Thamnophis elegans*) and common gartersnake (*Thamnophis sirtalis*), both of which may be affected by habitat loss associated with Site C development (BC Hydro 2013). The western gartersnake is considered the most likely species to utilize the structure based on known regional distribution and previous observations near Site C hibernacula. However, additional gartersnake species may also utilize the structure if present in the surrounding area (Government of British Columbia 2023). The objective of this monitoring program was to determine the occupancy of the artificial snake hibernaculum through site visits conducted during expected periods of gartersnake movement, including spring emergence and fall ingress. Monitoring also aimed to assess whether the structure is providing suitable overwintering habitat and supporting BC Hydro's habitat offsetting objectives.

This report summarizes monitoring efforts conducted at the Cache Creek snake hibernaculum during 2025 field season.

## 2.0 METHODOLOGY

The monitoring was conducted to assess potential occupancy of the artificial snake hibernaculum and evaluate site conditions that may influence suitability for gartersnake overwintering (**Appendix A, Photo 1**). It consisted of visual encounter surveys focused on the hibernaculum entrance and surrounding habitat for a minimum of one hour per survey. Surveys were conducted during periods of expected snake movement, including spring emergence and fall ingress prior to hibernation. Surveying times ranged between 11:00 AM and 5:00 PM, aimed towards warmer and sunnier periods of the day.

The snake hibernaculum surveys were conducted during spring emergence period (April 14-15, and May 1-2, 2025) and prior to hibernation (September 8 and 11, 2025). It focused on habitat features typically associated with gartersnakes, including logs and rock piles. Similar survey approaches have been used during previous Site C snake hibernacula monitoring programs (Golder 2020; WSP 2023).

Snake observations were categorized based on proximity to the hibernaculum entrance. Confirmed occupancy included individuals observed entering or exiting the hibernaculum. Probable occupancy included individuals observed within close proximity to the entrance ( $\leq 20$  m), while possible occupancy included individuals observed within the surrounding habitat ( $\leq 50$  m). These criteria were developed to reflect typical emergence and basking behaviour observed near snake hibernacula (Gregory 1984; WSP 2023). A lack of encounters during surveys did not necessarily rule out usage of the hibernaculum, as gartersnakes are known to be cryptic and difficult to detect.

To supplement visual encounter surveys, passive monitoring techniques were implemented. Sand was placed at the hibernaculum entrance on May 1, 2025, to help identify snake movement and track activity at the entryway. In addition, plywood cover boards were placed around the hibernaculum to provide attractant cover objects and increase the likelihood of detecting snakes in the surrounding area (**Appendix A, Photo 2**).

Erosion and sediment control measures were also implemented to maintain suitable hibernaculum conditions. The slope immediately above the hibernaculum had experienced erosion due to cattle activity. On May 2, 2025, rocks from a nearby stockpile at the parking area were placed in a zig-zag pattern along the slope to improve stability and reduce sediment transport toward the hibernaculum entrance. Rock armouring was used to stabilize the slope and reduce erosion (**Appendix A, Photo 3**). Additionally, to further reduce disturbance from livestock, BC Hydro installed a livestock-exclusion fence around the hibernaculum during the summer of 2025 (**Appendix A, Photos 4 and 5**).

A temperature sensor (Onset HOBO Micro Station H21-USB) installed within the main hibernaculum cavity during construction was used to monitor thermal conditions (**Appendix A, Photo 6**). Temperature is a critical factor influencing overwinter survival of snakes, therefore artificial hibernacula must provide stable thermal conditions with an appropriate range for gartersnake hibernation (Gregory 1984). Temperature data were downloaded from the sensor during the spring emergence surveys to evaluate thermal conditions within the hibernaculum.

### 3.0 RESULTS

One gartersnake was observed during a visual encounter survey on May 2, 2025; the snake was found in the brush of a non-classified drainage about 15 m west of the hibernaculum entrance. The snake disappeared into a cavity below a root before a definitive identification could be achieved. However, its brown colouration and lighter longitudinal stripe appeared consistent with a western garter snake (*T. elegans*). The snake was an adult, and the precise size could not be determined.

During the first hibernaculum visit on the April 14, the external air temperature sensor was found to be damaged. WM-DWB downloaded the hibernaculum interior temperature logger data on May 1. The data was found to be erroneous, indicating an issue with the temperature sensor. An upgraded temperature logger was installed at the hibernaculum by BC Hydro over the summer. The upgraded logger box was locked during WM-DWB's September site visits. BC Hydro was contacted prior to the visit for access support but were not available within the available monitoring window; therefore, the data was not downloaded again by WM-DWB before the end of the season.

### 4.0 DISCUSSION

Observations of snakes in close proximity to hibernacula during spring emergence are commonly used as indicators of potential occupancy, as snakes often remain near overwintering sites prior to seasonal dispersal (Gregory 1984; Matsuda et al. 2006). Although the individual observed during the survey was not confirmed entering or exiting the hibernaculum, its proximity to the entrance suggests potential use of the structure or surrounding habitat.

When considered alongside the 2024 observations, the 2025 monitoring results suggest possible occupancy of the surrounding habitat and potential gradual adoption of the artificial hibernaculum. Artificial snake hibernacula may require multiple years before consistent occupancy is observed, as snakes often exhibit fidelity to established overwintering sites and may take time to locate and adopt newly constructed structures (Gregory 1984).

Monitoring of other Site C snake hibernacula provides additional context for interpreting these findings. Six artificial hibernacula constructed in 2020 along the north side of the Peace River were monitored between 2021 and 2023 to assess occupancy and effectiveness. Monitoring results indicated variable use among sites and years, with some hibernacula considered occupied in 2022, while no snake observations were observed at several sites during 2023. These results demonstrate that occupancy of artificial hibernacula may vary annually and that multiple years of monitoring are required to assess long-term effectiveness (BC Hydro 2024b).

Several improvements were implemented at the Cache Creek hibernaculum during the 2025 monitoring period, including rock armouring to reduce erosion and installation of a livestock-exclusion fence to reduce disturbance from cattle. These measures were intended to improve structural stability and reduce disturbance. Similar site protection measures have been implemented at other Site C hibernacula to maintain structural integrity and improve habitat suitability. Stable thermal conditions, reduced

sedimentation, and minimized disturbance are considered important factors influencing suitability of snake hibernacula and overwinter survival (Gregory 1984; Matsuda et al. 2006).

Although only one snake was observed during the 2025 monitoring period, the observation occurred during spring emergence and in close proximity to the hibernaculum entrance, which is consistent with potential occupancy. Given the relatively recent construction of the hibernaculum and the low density and cryptic nature of gartersnakes in the Peace River region, limited observations during early monitoring years are not unexpected. Continued monitoring will help determine whether the structure is being used for overwintering and evaluate long-term performance relative to BC Hydro's habitat offset objectives.

## 5.0 CONCLUDING SUMMARY

The Cache Creek snake hibernaculum was constructed in 2023 as part of BC Hydro's habitat offsetting commitments associated with the Site C Clean Energy Project. Monitoring of the structure began in 2024 and is planned to continue through 2026 to evaluate occupancy and effectiveness in providing suitable overwintering habitat for garter snakes.

Snake hibernaculum monitoring was conducted during the spring emergence period (April 14–15 and May 1–2, 2025) and prior to hibernation (September 8 and 11, 2025). Monitoring included visual encounter surveys, passive monitoring techniques, and evaluation of site conditions influencing habitat suitability. Additional measures implemented during the 2025 monitoring period included erosion control using rock armouring and installation of a livestock-exclusion fence to reduce disturbance and maintain structural stability.

During the 2025 monitoring period, one garter snake, likely a western terrestrial garter snake (*Thamnophis elegans*), was observed within 15 m of the hibernaculum entrance during spring emergence. Although occupancy of the hibernaculum was not confirmed, the proximity of the observation to the entrance suggests potential use of the structure or surrounding habitat.

When considered alongside observations made during 2024, the 2025 monitoring results suggest that the Cache Creek hibernaculum may be in the early stages of adoption. Artificial hibernacula often require multiple years before consistent occupancy is observed, particularly in regions where snake densities are low and natural overwintering habitat is limited (Gregory 1984).

Overall, the 2025 monitoring results indicate that the Cache Creek hibernaculum may be providing suitable habitat conditions for garter snakes. Continued monitoring through 2026 will help confirm occupancy and evaluate long-term performance of the structure relative to BC Hydro's habitat offsetting objectives for the Site C Clean Energy Project.

## 6.0 REFERENCES

- BC Hydro. 2013. *Site C Clean Energy Project Environmental Impact Statement. Volume 2: Assessment Methodology and Environmental Effects Assessment. Section 14: Wildlife Resources.*
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# APPENDIX A

## SNAKE HIBERNACULUM PHOTO LOG



**Photo 1.** View of the hibernaculum from below. 2025-09-11.



**Photo 2.** View of snake hibernaculum entrance with sand to monitor short term activity. 2025-05-01.



**Photo 3.** Rock armoring added by hand on the exposed slope above the hibernaculum. 2025-05-02.



**Photo 4.** Upgraded logger box, livestock-exclusion fencing, and cover objects at the hibernaculum. 2025-09-08.



**Photo 5.** Fence line leading east from the hibernaculum. 2025-09-11.



**Photo 6.** View of the logger box above the hibernaculum entrance prior to upgrades. Cover objects can be seen near the entrance in the NCD. 2025-05-02.

## **Appendix 2 – Temperature Monitoring of Hibernaculum 82.1**

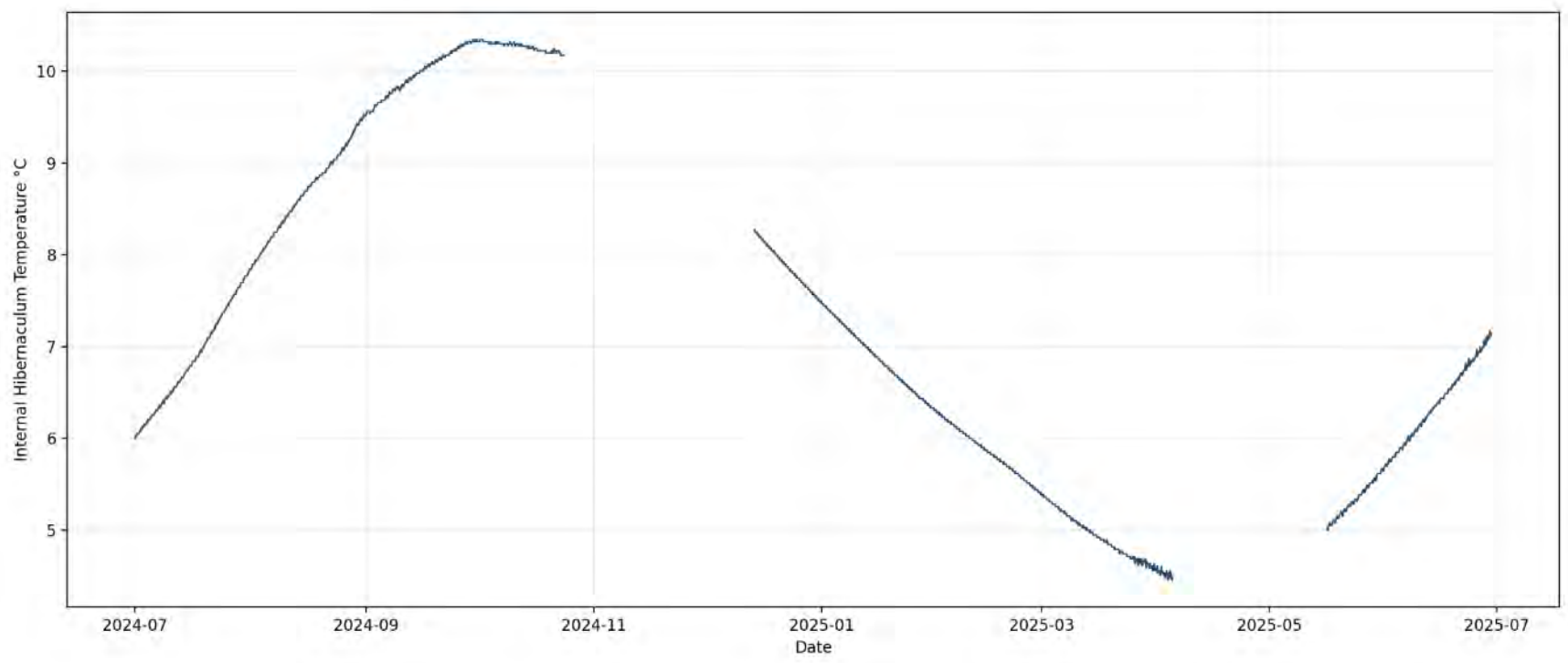


Figure 1. Snake hibernaculum 82.1 internal temperature recordings, July of 2024 to July of 2025.

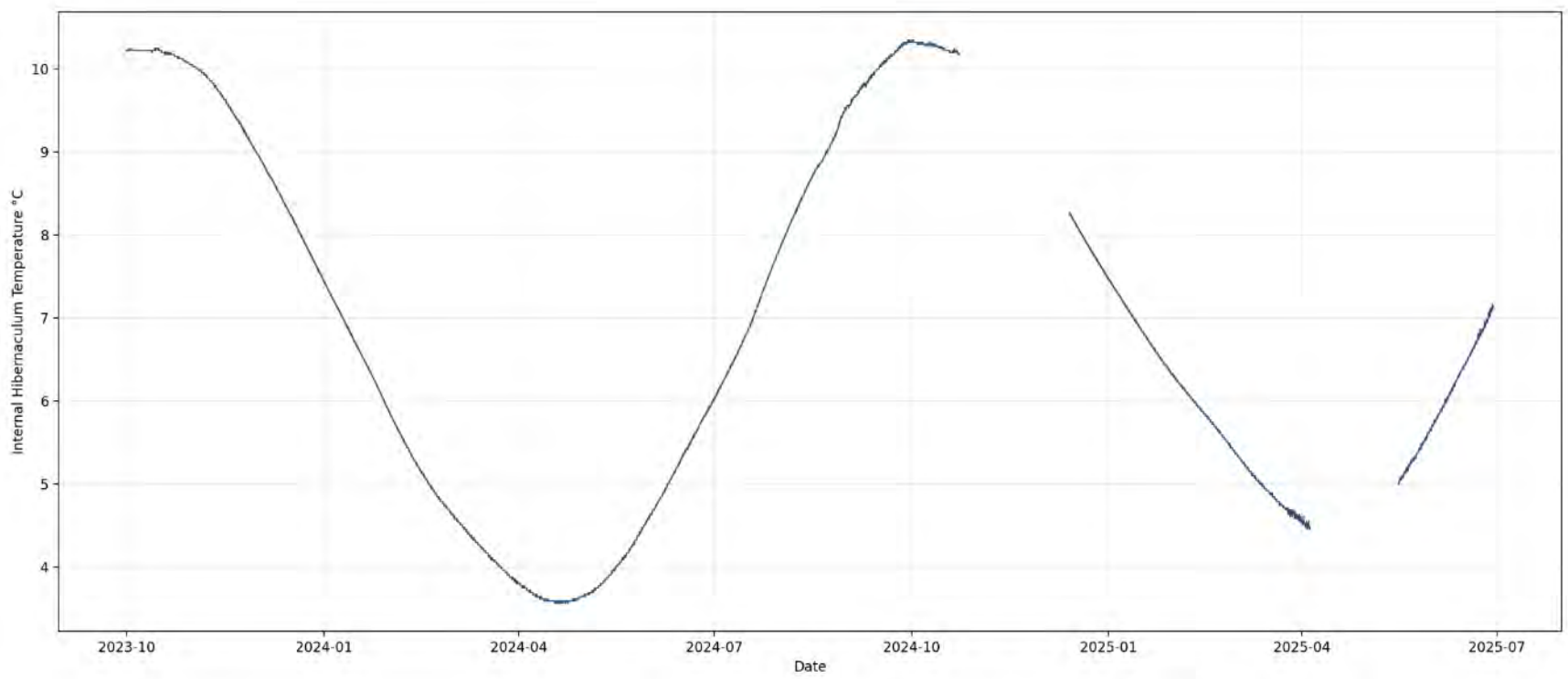


Figure 2. Snake hibernaculum 82.1 internal temperature recordings, October of 2023 to July of 2025.

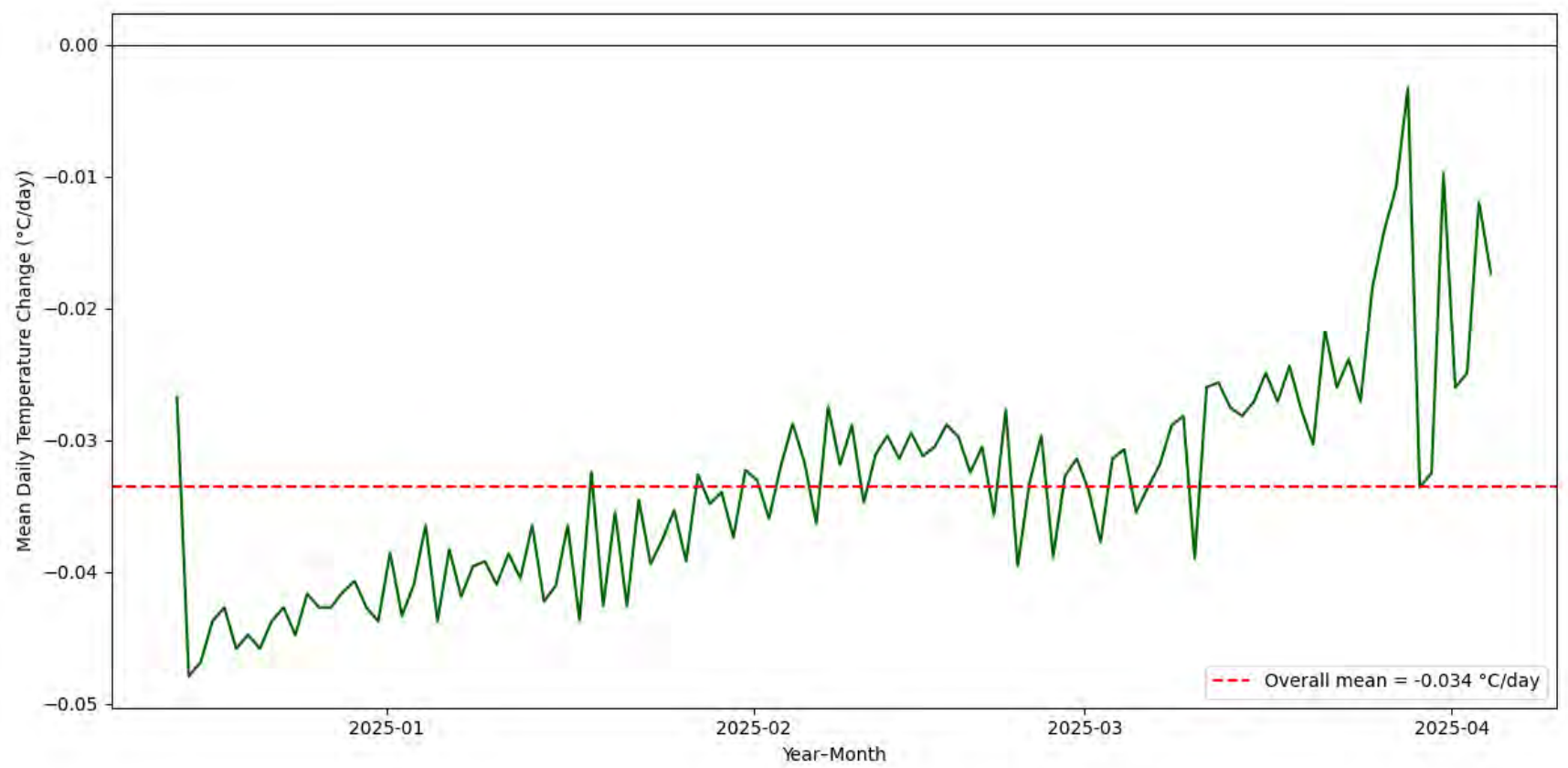


Figure 3. Snake hibernaculum 82.1 mean daily change in temperature during the winter (December to April).

## **Appendix 3 – Snake Hibernacula Assessment by BC Hydro**

Log of snake hibernacula temperature monitoring equipment repairs

Site Name	Equipment Functional Before Upgrade (Y/N)	Condition Before Upgrade	Upgrades Completed (Y/N)	Notes on Upgrades
21.4	N	HOBO H21-USB Micro Station corroded and non-functional. Internal and ambient temperature sensors were functional.	Y	Replaced HOBO H21-USB Micro Station. Reconnected internal and ambient temperature sensors. Installed weather-proofing and wire protection to prevent moisture intrusion and animal damage.
48	N	HOBO H21-USB Micro Station broken and non-functional. Internal and external temperature sensors severed (clean cuts likely due to farm machinery or vandalism).	N	Further assessment required to determine if the internal temperature sensor can be repaired.
82.1	Y	HOBO H21-USB Micro Station functional. Internal temperature sensor functional. Ambient temperature sensor broken.	Y	Replaced broken ambient temperature sensor. Installed weather-proofing and wire protection to prevent moisture intrusion and animal damage. Fencing installed surrounding the hibernaculum to prevent cattle from trampling the area. Fencing mesh size measured at 2 inches by 4 inches, sufficient to maintain snake access.
134	N	HOBO H21-USB Micro Station showed evidence of moisture intrusion. Batteries were replaced and the unit tested; station was functional and previously offline due to dead batteries. Internal and ambient temperature sensors functional.	Y	Installed weather-proofing and wire protection to prevent moisture intrusion and animal damage.
153	N	HOBO H21-USB Micro Station corroded and non-functional. Internal and external temperature sensors severed with chew marks evident on cables.	N	Further assessment required to determine if the internal temperature sensor can be repaired.
272.2	N	HOBO H21-USB Micro Station showed evidence of moisture intrusion. Batteries replaced and the unit tested; station was functional and previously offline due to dead batteries. Internal and ambient temperature sensors functional.	Y	Installed weather-proofing and wire protection to prevent moisture intrusion and animal damage.
326	N	HOBO H21-USB Micro Station corroded and non-functional. Internal and external temperature sensors severed (clean cuts likely due to farm machinery or vandalism).	N	Further assessment required to determine if the internal temperature sensor can be repaired.

## **Appendix 4 – BC Hydro Snake Observations**

Incidental snake observations by BC Hydro

Site Name	Incidental Snake Observations (Y/N)	Snake Observations	Camera Trapping (Y/N)	Camera Observations
21.4	Y	Arrived onsite at 17:30 on August 14, 2025. Direct sun exposure on hibernaculum and temperatures around 22°C. Three Western Gartersnakes noted near hibernaculum entrance.	Y	Camera installed between September 27 <sup>th</sup> and October 31 <sup>st</sup> . Camera fault prevent data collection during the middle of the day (10am-3pm). Half of the camera trap data is pending review.
48	Y	Arrived onsite at 18:00 on August 14, 2025. Direct sun on hibernaculum and temperatures around 22°C. Two snake sheds observed near the hibernaculum entrance.	N	N/A
82.1	Y	Arrived onsite at 13:00 on June 29, 2025. Western Gartersnake observed in the grass 50m west of the hibernaculum.	N	N/A
134	Y	Arrived onsite at 17:50 on August 19, 2025. Partial sun on the hibernaculum and temperatures around 20°C. Two Western Gartersnakes entered hibernaculum upon disturbance.  Arrived onsite at 13:30 on September 25, 2025. Cloudy conditions and temperatures around 14°C with wind. Two snake sheds observed in the rocks above the hibernaculum (observed when digging up the logger for repairs).	Y	Camera trapping conducted between September 25 <sup>th</sup> and October 17 <sup>th</sup> . Camera fault, timelapse data only collected for the first day.
153	Y	Arrived onsite at 14:50 on July 24, 2025. Direct sun on hibernaculum and temperatures around 20°C. Imminent incoming rainstorm. One Western Gartersnake observed under cement patio stone near hibernaculum entrance.	N	N/A
272.2	N	No snake observations during site visits. Site visits were completed later in the evening, and no direct sun exposure was noted during the visits. Snake basking unlikely.	Y	Camera trapping conducted between September 26 <sup>th</sup> and October 14 <sup>th</sup> . Data pending review.
326	Y	Arrived onsite at 16:00 on October 2, 2025. No direct sun at the hibernaculum entrance and temperatures around 14°C. Three snake sheds observed at the hibernaculum entrance.	Y	Camera trapping conducted between October 3 <sup>rd</sup> and October 26 <sup>th</sup> . Several Western Gartersnakes observed in and around the hibernaculum entrance.

## **Appendix 5 – BC Hydro Representative Site Photos**

Snake Hibernaculum 21.4

<p>Photo 1. Snake hibernaculum 21.4 aspect.</p>	<p>Photo 2. Snake hibernaculum 21.4 entrance.</p>	<p>Photo 3. Snake hibernaculum 21.4 entrance.</p>	<p>Photo 4. Snake hibernaculum temperature monitoring station, ambient temperature sensor broken, and data logger buried in the ground.</p>
<p>Photo 5. Snake hibernaculum 21.4 data logger, evidence of corrosion.</p>	<p>Photo 6. Temperature monitoring station repaired. Please note further wire protection installed after this photo.</p>	<p>Photo 7. Snake hibernaculum 21.4 entrance with camera trap.</p>	


**Snake Hibernaculum 48**

<p>Date &amp; Time: Thu, Aug 14, 2025 at 18:05:54 MST                  Position: +056.228394, -121.084431, (+15.60)                  Altitude: 1543ft (+15.60)                  Datum: WGS-84                  Azimuth/Bearing: 217.537W 3856mils True=11.3                  Elevation Angle: -17.0                  Horizon Angle: -02.6                  Zoom: 0.5X</p> 	<p>Date &amp; Time: Thu, Aug 14, 2025 at 18:04:43 MST                  Position: +056.228394, -121.084431, (+15.60)                  Altitude: 1543ft (+15.60)                  Datum: WGS-84                  Azimuth/Bearing: 217.537W 3856mils True=11.3                  Elevation Angle: -17.0                  Horizon Angle: -02.6                  Zoom: 0.5X</p> 	<p>Date &amp; Time: Thu, Aug 14, 2025 at 18:03:35 MST                  Position: +056.228394, -121.084431, (+15.60)                  Altitude: 1543ft (+15.60)                  Datum: WGS-84                  Azimuth/Bearing: 185.5815W 3856mils True=11.3                  Elevation Angle: -62.7                  Horizon Angle: -22.2                  Zoom: 2.0X</p> 	<p>Date &amp; Time: Thu, Aug 14, 2025 at 18:03:35 MST                  Position: +056.228394, -121.084431, (+15.60)                  Altitude: 1543ft (+15.60)                  Datum: WGS-84                  Azimuth/Bearing: 210.526W 3856mils True=11.3                  Elevation Angle: -85.7                  Horizon Angle: -33.7                  Zoom: 1.0X</p> 
<p>Photo 1. Snake hibernaculum 48 aspect.</p>	<p>Photo 2. Snake hibernaculum 48 entrance.</p>	<p>Photo 3. Snake hibernaculum 48 temperature monitoring cords severed.</p>	<p>Photo 4. Snake shed observed near hibernaculum entrance.</p>




**Snake Hibernaculum 82.1**

			
<p>Photo 1. Snake hibernaculum 82.1 after upgrades. Fence installed surrounding the hibernaculum.</p>	<p>Photo 2. Snake hibernaculum 82.1 data logger stored in weatherproof pelican case.</p>		

Snake Hibernaculum 134

			
<p>Photo 1. Snake hibernaculum 134 aspect.</p>	<p>Photo 2. Snake hibernaculum 134 entrance with camera trap.</p>	<p>Photo 3. Western Gartersnake near hibernaculum 134 entrance.</p>	<p>Photo 4. Western Gartersnake entering hibernaculum 134.</p>
			
<p>Photo 5. Snake hibernaculum 134 temperature monitoring station repaired. Please note conduit further buried with rocks. Further upgrades to wire protection required, including burial of conduit and permanent wire strain protection.</p>			

**Snake Hibernaculum 153**

 <p><small>Date &amp; Time: Thu, Jul 24, 2025 at 14:49:22 MST Position: 46°52'39.21" N, 121°44'36.56" W Altitude: 15970 m (52580 ft) Datum: WGS 84 Azimuth Bearing: 306° N (2° N) 827m (5150 ft) True Elevation Angle: 0.75° Horizon Angle: +30.2° Zoom: 0.5X</small></p>	 <p><small>Date &amp; Time: Thu, Jul 24, 2025 at 14:52:01 MST Position: 46°52'39.21" N, 121°44'37.03" W Altitude: 15970 m (52580 ft) Datum: WGS 84 Azimuth Bearing: 285° (33° W) 5067m (16624 ft) True Elevation Angle: -8.45° Horizon Angle: -35.0° Zoom: 1.34X</small></p>		
<p>Photo 1. Snake hibernaculum 153 entrance.</p>	<p>Photo 2. Snake hibernaculum 153 temperature monitoring cords chewed off.</p>	<p>Photo 3. Western Gartersnake observed near hibernaculum 153 entrance.</p>	

**Snake Hibernaculum 272.2**

			
<p>Photo 1. Snake hibernaculum 272.2 aspect.</p>	<p>Photo 2. Snake hibernaculum 272.2 entrance.</p>	<p>Photo 3. Snake hibernaculum 272.2 entrance with camera trap.</p>	<p>Photo 4. Snake hibernaculum 272.2 temperature monitoring station repaired.</p>

**Snake Hibernaculum 326**



Photo 1. Snake hibernaculum 326 aspect.



Photo 2. Snake hibernaculum 326 entrance.



Photo 3. Snake hibernaculum 326 data logger buried in the ground. Temperature sensor cords severed.



Photo 4. Snake shed observed near hibernaculum 326 entrance.



Photo 5. Snake hibernaculum 326 entrance with camera trap.



Photo 6. Snake hibernaculum 326 camera trap image with snake.



## **Appendix 21. 2025 Cavity-nesting Birds Annual Report**



# Site C Clean Energy Project Cavity-nesting Species Mitigation and Monitoring Program Nest Box Monitoring 2025 Annual Report



PRESENTED TO  
**British Columbia Hydro and Power Authority**

MARCH 30, 2026  
ISSUED FOR USE  
FILE: 704-ENW.PENW03042-02.CAVITY25.

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Suite 1000 – 10th Floor, 885 Dunsmuir Street  
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## Site C Clean Energy Project Cavity-nesting Species Mitigation and Monitoring Program: Nest Box Monitoring 2024 Annual Report

FILE: 704-ENW.PENW03042-02.CAVITY25  
March 30, 2026

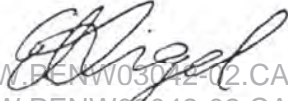
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## EXECUTIVE SUMMARY

In the spring of 2025, Saulteau EBA Environmental Services Joint Venture (SEES JV) completed monitoring and basic maintenance 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. Ausenco installed nest boxes in 2017, 2019, 2020, and 2022. This report describes the methods used to monitor nest boxes in 2025 and summarizes the results.

From June 10 to June 15, 2025, Tetra Tech Canada Inc. (Tetra Tech) monitored 155 nest boxes around the Site C Project footprint. We performed minimal maintenance of unused nest boxes, which involved replacing old debris with clean wood shavings when there were no signs of use, minor box structural repairs, and reattaching fallen boxes to a tree. Of the 155 nest boxes monitored, 135 (87%) were considered operational, and 65 (48%) of these showed signs of use. We found signs of use from an unknown species (rodent or bird) in 17 boxes, from an unknown rodent species in 6 boxes, and from an unknown bird species in 32 boxes. We also identified one box used by an unknown passerine species and two boxes used by an unknown waterfowl species, suspected to be Common Goldeneye. Seven nest boxes contained active nests: six were occupied by adult American Kestrels, and one by Northern Flying Squirrels. In total, we found evidence of three bird species using the nest boxes.

The 2025 nest box occupancy rate recorded by Tetra Tech (48%) 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, five of the six nest boxes with active American Kestrel nesting activity in 2025 were also used in previous years, indicating a tendency for birds to reuse established nest boxes.

Nest box monitoring conducted in 2025 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.

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Appendix A	Nest Box Monitoring and Maintenance Schedule – 2025
Appendix B	Nest Box Monitoring Results – 2025
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 2025, Saulteau EBA Environmental Services Joint Venture (SEES JV) conducted monitoring and basic maintenance 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”), which was established to satisfy conditions set out in the following three documents:

### **Environmental Assessment Certificate (EAC):**

- Issued by the British Columbia Provincial government, where conditions are listed in the Schedule B-Table of Conditions.
- EAC Condition 16 specifies that nest boxes for cavity-nesting waterfowl need to be established along the reservoir as a part of wetland mitigation and compensation.

### **Federal Decision Statement (FDS):**

- Issued by the Government of Canada, where conditions 10 and 11 require migration measures for effects on migratory birds, which include cavity-nesting birds.

### **Conditional Water Licence:**

- Program Area 10 of Schedule A of Conditional Water Licence 132990 and Conditional Water Licence 132991 require monitoring, mitigation, and compensation for effects to cavity-nesting species.

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), woodpeckers, cavity-nesting waterfowl, and cavity-nesting raptors (falcons, hawks, and owls). Short-term mitigation focuses on secondary-cavity-nesting birds and 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 2025.

## 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 2023). Of these species, 20 are obligate 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<sup>1</sup>.**

Species Group	Nesting Habitat Preference <sup>2</sup>	Box Type	Species Supported	Number of Boxes Installed to Date
Passerines	<ul style="list-style-type: none"> <li>Utilizes a variety of forested habitats, including deciduous and coniferous forests of most structural stages.</li> <li>Brown Creeper and Nuthatch species prefer older mature forests.</li> <li>House Wren utilize more open forested habitat.</li> <li>Mountain Bluebirds utilize open lowland and sagebrush habitats.</li> <li>Swallows utilize open and semi-open areas near water, including cultivated fields.</li> </ul>	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
Waterfowl	<ul style="list-style-type: none"> <li>Need a clear route from nesting areas to a watercourse.</li> <li>Bufflehead can utilize younger forests with smaller trees.</li> <li>Goldeneye require mature forest surrounding clear, cold water.</li> </ul>	E1	Bufflehead	11
		F	Barrow's Goldeneye Common Goldeneye Hooded Merganser	50
		D / G	Common Merganser	19
Raptors	<ul style="list-style-type: none"> <li>Utilize forests of various structural stages where smaller species are found in younger forests and larger species in older forests.</li> <li>American Kestrel requires nesting habitat adjacent to open fields for hunting.</li> </ul>	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
<b>Total</b>				<b>278</b>

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 the 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 2-2);

<sup>1</sup> From Ausenco (2024)

<sup>2</sup> Nesting habitat preferences for target bird species collected from the Audubon Guide to North American Birds (Audubon 2024).

- 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<sup>3</sup>.**

Species Group	Common Name	Scientific Name	Minimum Spacing Between Boxes (m)	Nest Box Height (m)
Passerines	Black-Capped Chickadee	<i>Poecile atricapillus</i>	150-200	1.5-4.5
	Boreal Chickadee	<i>Poecile hudsonicus</i>	150-200	1.5-3
	Brown Creeper	<i>Certhia americana</i>	150	1.0-10
	House Wren	<i>Troglodytes aedon</i>	30	1.5-3
	Mountain Bluebird	<i>Sialia currucoides</i>	90	1.2-1.8
	Red-Breasted Nuthatch	<i>Sitta canadensis</i>	50	1.5-4.5
	Tree Swallow	<i>Tachycineta bicolor</i>	10-30	1.5-1.8
	Violet-Green Swallow	<i>Tachycineta thalassina</i>	10-30	2.75-4.5
	White-Breasted Nuthatch	<i>Sitta carolinensis</i>	300	1.5-6
Waterfowl	Barrow's Goldeneye	<i>Bucephala islandica</i>	150-200	1.8-6
	Bufflehead	<i>Bucephala albeola</i>	50-150	1.5-3
	Common Goldeneye	<i>Bucephala clangula</i>	1000	1.8-9
	Common Merganser	<i>Mergus merganser</i>	100	2.4-5.2
	Hooded Merganser	<i>Lophodytes cucullatus</i>	30	1.8-7.6
Raptors	American Kestrel	<i>Falco sparverius</i>	500-800	3.5-6
	Barred Owl	<i>Strix varia</i>	1000	4.5-9
	Boreal Owl	<i>Aegolius funereus</i>	150	≥3
	Northern Hawk-Owl	<i>Surnia ulula</i>	500-700	≥3
	Northern Pygmy- Owl	<i>Glaucidium gnoma</i>	400-500	≥3
	Northern Saw-Whet Owl	<i>Aegolius acadicus</i>	400-500	≥3

A total of 278 nest boxes have been installed on trees and structures on BC Hydro-owned and managed lands, and on private lands where permission was granted (Figure 1). These nest boxes will be repaired and or replaced if damaged through the first 10 operating years of the Project. Nest boxes were strategically placed along the reservoir shoreline in areas determined to be most beneficial to each species group, while also considering the availability of land and suitable access for installation and future mitigation effectiveness monitoring. The locations include:

- 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

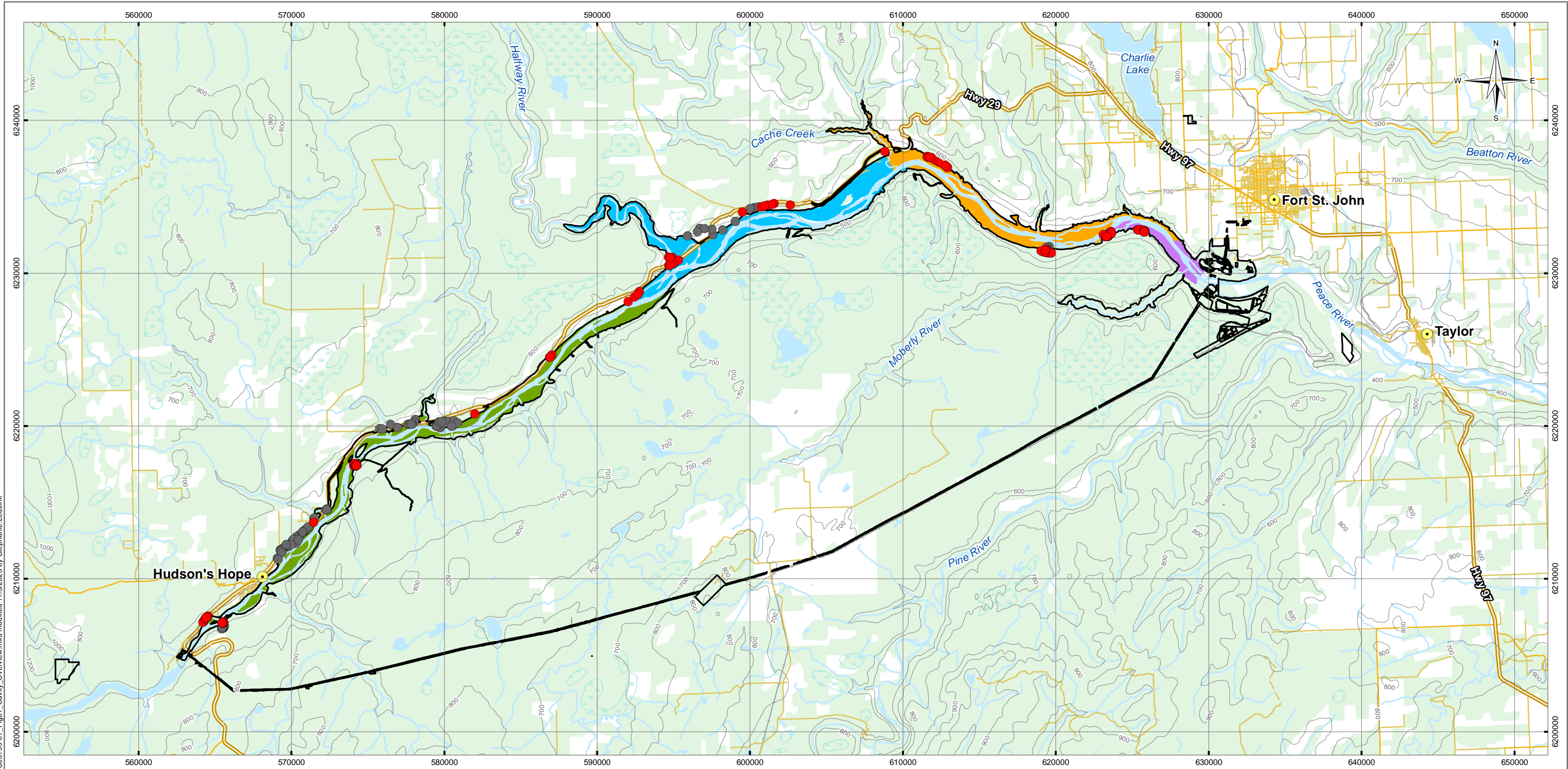
Now that the Site C reservoir has been filled, per one of the EAC conditions, BC Hydro will establish nest boxes for cavity-nesting waterfowl within riparian vegetation zones along the reservoir on BC Hydro-owned properties.

<sup>3</sup> From Ausenco 2024.

## 2.2 Nest Box Monitoring and Maintenance

Per the program, nest boxes are to be monitored once every two years throughout construction and through the first 10 operating years of the Project (Appendix A). Monitoring of nest boxes has been split into even and odd years, where approximately half of the 278 nest boxes are monitored in even-numbered years (e.g., 2020, 2022, etc.) and the remaining are monitored in odd-numbered years (e.g., 2021, 2023, etc.). A detailed breakdown of the monitoring history of nest boxes, along with a proposed monitoring schedule, is provided in Appendix A. In 2025, Tetra Tech monitored 155 nest boxes previously installed by Ausenco in 2019, 2020, and 2022 (Appendix A).

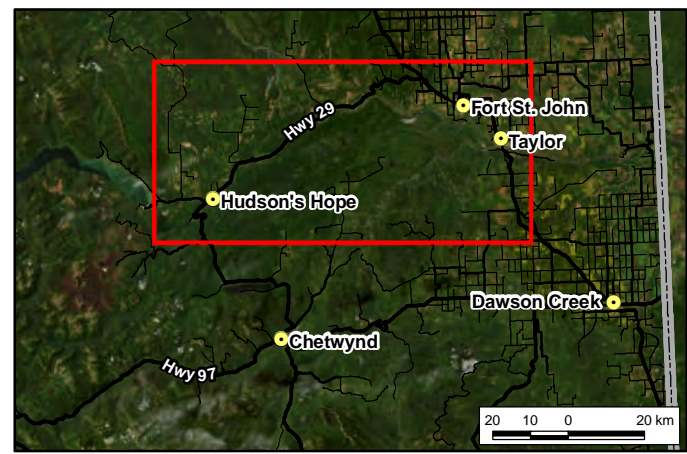
Nest box maintenance will vary from cleaning and minor repairs to full nest box replacement. Some songbirds prefer to nest in clean nest boxes instead of used nestboxes (Williams et al. 2020), so nest boxes were cleaned and had new wood shavings placed inside during monitoring activities, as long as there was no evidence of bird nesting activity. Nest boxes that had evidence of bird nesting were not cleaned. Nest boxes that require repairs (e.g., broken boxes) are noted during monitoring and will be repaired as a part of a future monitoring year. Per the program, Tetra Tech will replace nest boxes that have fallen or have been destroyed throughout the first 10 years of operations.



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**LEGEND**

- Project Footprint
- Populated Place
- Contour (100 m)
- Nest Box Locations**
- Monitored in 2025
- Highway
- Watercourse
- Not Monitored in 2025
- Main Road
- Waterbody
- Local Road
- Wetland
- Resource/Recreational Road
- Wooded Area
- Reservoir Section**
- Eastern
- Lower
- Middle
- Western
- Railway
- Residential Area



**NOTES**  
Base data source: CanVec 1:250,000.

**SITE C CLEAN ENERGY PROJECT  
NEST BOX MONITORING REPORT 2025**

**Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> BC Hydro Power smart	
Scale: 1:250,000					
<b>FILE NO.</b> BIOS03193-01_Fig01_Cavity_Overview.mxd					
<b>OFFICE</b> Tl-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0	<b>TETRA TECH</b>
<b>DATE</b> MARCH 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01			

**STATUS**  
ISSUED FOR USE

**Figure 1**

## 3.0 METHODS

### 3.1 Nest Box Monitoring

A team of two qualified environmental professionals (QEPs; Appendix C) conducted nest box monitoring from June 10 to 15, 2025. We chose these monitoring dates because they aligned with the late-incubation to early-nestling period of the target species, which typically occurs from early June to mid-June (Appendix C of BC Hydro 2023). Monitoring during this life stage provided the greatest likelihood of detecting individuals using the nest boxes. The sequence in which we visited nest boxes was based on logistical considerations, including distance from the Site C work camp and the required method of access (e.g., truck, boat, or foot).

The methods that we used to monitor nest boxes were intended to minimize disturbance to active nests and were consistent with previous efforts conducted by Tetra Tech and Auesnco. During monitoring, 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, attempting to determine the nesting stage based on behaviour. If no use was evident from nest box observation, we approached the nest box structure and tapped lightly on it to elicit 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 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 to inform the environmental context.

### 3.2 Nest Box Maintenance

Maintenance activities were limited to relatively simple box repairs and cleaning, which included removing old debris and replacing it with clean wood shavings. If there was uncertainty about whether a nest box was actively being used by birds (i.e., presence of obvious bird nesting material), we did not perform maintenance work. We used a small ladder to access nest boxes for maintenance and minor repairs. When a nest box was found to have significant damage or to be destroyed, the condition was documented so the box could be repaired during a future monitoring event.

## 4.0 RESULTS

Tetra Tech monitored 155 of the 278 nest boxes in 2025 (Figure 1 & Figures 2a-l, Appendix B). One nest box (B3-16), installed in 2022, was monitored for the first time this year. Four nest boxes could not be located and are presumed to have been destroyed or removed due to reservoir construction or flooding. Of the 151 nest boxes that could be found, ten were destroyed or irreparably damaged, four were not operational but were subsequently repaired (e.g., Photos 1 and 2), two needed to be reactivated (e.g., Photo 3), and 135 were operational (Table 4-1, Figures 2a-l; Appendix B).

During monitoring, we repaired and maintained nest boxes to the best extent possible with basic tools and repair materials. We conducted major box repairs (e.g., reattachment to trees) to three nest boxes, minor repairs to one reactivated box, and replaced nesting material in 14 nest boxes. The status of each box at the time of monitoring is presented in Appendix B.

**Table 4-1: Status of nest boxes surveyed in 2025**

Nest Box Status	Number of Nest Boxes
Irreparably Damaged	4
Destroyed	6
Gone/Missing	4
Operational	135
Reactivated	2
Repaired	4
<b>Total</b>	<b>155</b>



**Photo 1:** View of nest box A-016 found fallen on the ground and needing to be reattached to a new tree.



**Photo 2:** View of nest box A-016 after being reattached to a birch tree adjacent to where box was found on the ground.



**Photo 3:** View of nest box E3-08 before it was reactivated.



**Photo 4:** View of Northern Flying Squirrels found using nest box E2-15.

Signs of use were observed in 65 of the 135 operational boxes (48%), including 41 with evidence of bird activity and seven with signs of rodent use (Figures 2a-l, Table 4-2; Photos 4-8). Feathers were present in seven boxes (5%), and seven boxes (six bird, one rodent) contained nests with eggs or young.

The presence of ambiguous nesting materials limited our ability to identify the species using a nest box. For example, 17 nest boxes displayed signs of use, but we could not identify whether it was from a bird or rodent species (Appendix B). We inferred species use in three boxes based on nest materials and surrounding habitat. We suspect that Common Goldeneye (*Bucephala clangula*) used nest boxes F-02 and F-36. These two nest boxes were lined with light downy feathers (Photo 6), suggesting that they were occupied by nesting waterfowl species. Eggshells matching the size and colour of Common Goldeneye were found at the base of one of the nest box trees (Photo 7). Common Goldeneye have been documented in past Ausenco reports (Ausenco 2024) to use nest boxes and are well documented to utilize nest boxes in other areas when available (Sonerud 2021). Another nest box (A2-68) was lined with many smaller feathers, likely from a passerine bird (Photo 8). Tree Swallows (*Tachycineta bicolor*) are documented to use abundant feather lining in their nests and do not form a tight cup (Winkler 1993). It is possible that a Tree Swallow was using this nest box.

Adult American Kestrels (*Falco sparverius*) were the most identified species using nest boxes. Kestrels were observed to be using six nest boxes (Figure 2c & Figures 2f-g). Five of these contained eggs, and one had a deceased adult. We observed three American Kestrel eggs in nest box E1-09, five eggs in nest box E2-14 (Photo 5), three eggs in nest box F-21, one egg in nest box F-33, and six eggs in nest box F-35. Nest box E2-15 contained an adult Northern Flying Squirrel (*Glaucomys sabrinus*), with two young (Photo 4). Two nest boxes (F-02 and F-36; Photo 6) were lined with downy feathers, indicating waterfowl use. One nest box (B1-05) contained a grass cup nest, typical of a passerine species. Finally, one nest box (A2-68) was lined with small to medium-sized feathers likely from a passerine species.

**Table 4-2: Wildlife species identified to be using operational nest boxes in 2025**

Species Using Nest Box	Number of Nest Boxes
American Kestrel	6
Bumblebee	1
Northern Flying Squirrel	1
Unknown Bird Species	32
Unknown Passerine (suspected Tree Swallow)	1
Unknown Rodent Species	6
Unknown Species	17
Unknown Waterfowl (suspected Common Goldeneye)	2
Wasp/Hornet	2
<b>Total</b>	<b>68</b>



**Photo 5:** View of American Kestrel eggs observed within nest box E2-14.



**Photo 6:** View of down lined nest box, suspected to be used by Common Goldeneye (nest box F-36).

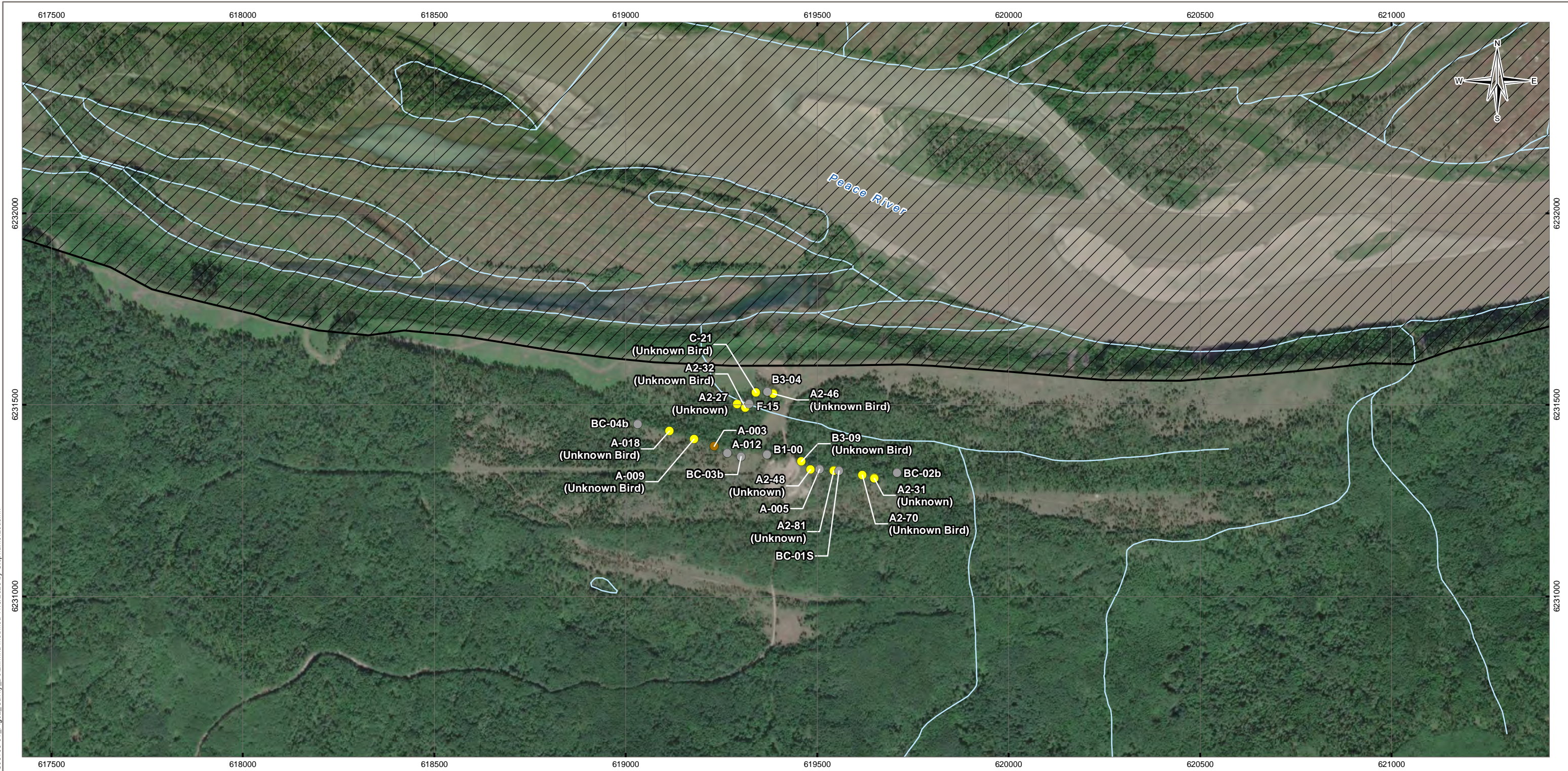


**Photo 7:** View of eggshell at the base of nest box F-36. Eggshell suspected to be from Common Goldeneye.



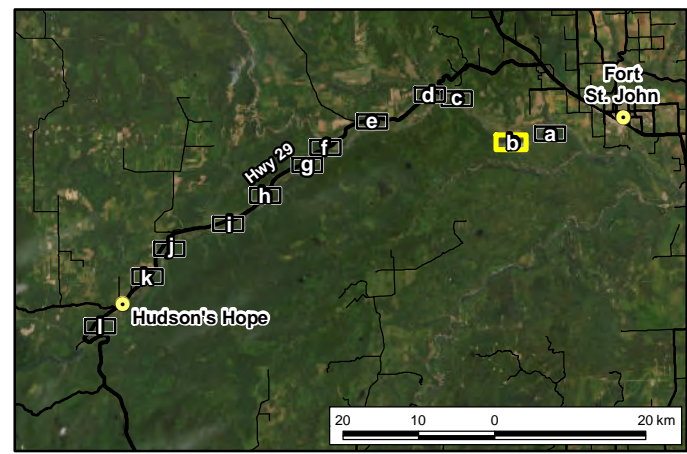
**Photo 8:** View of feather and bark-lined floor of nest box A2-68.





**LEGEND**

- Nest Box - Used
- Nest Box - Repaired
- Nest Box - Not Used
- Project Footprint
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from ESRI; Vantor (2023)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

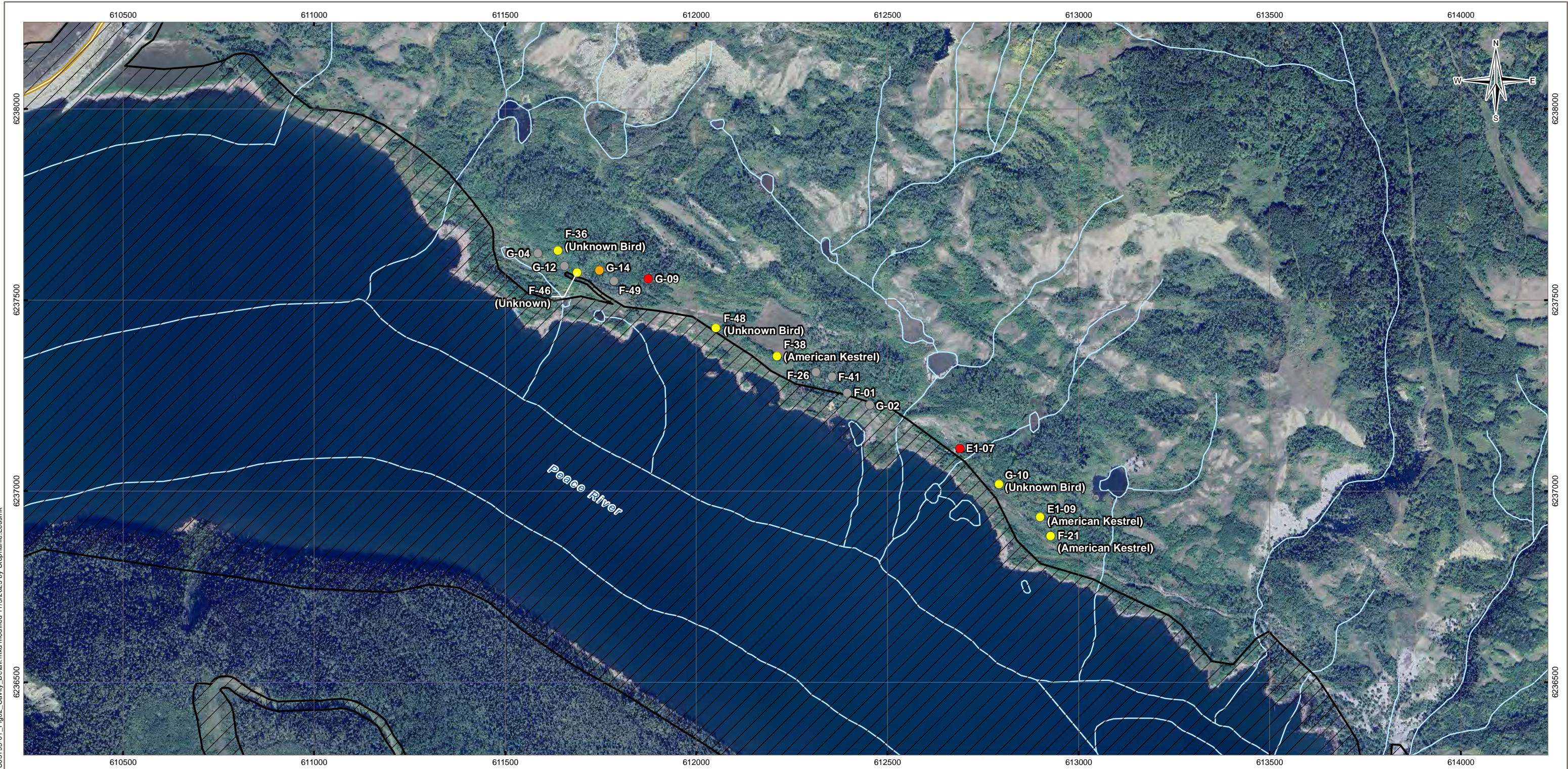
**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10	<b>DATUM</b> NAD83	<b>CLIENT</b> <b>BC Hydro</b> Power smart			
Scale: 1:10,000 200 100 0 200 Metres					
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd					
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0	<b>CLIENT</b> <b>TETRA TECH</b>
<b>DATE</b> March 30, 2026	<b>PROJECT NO.</b> ENW.BIOS03193-01				

**Figure 2b**

**STATUS**  
ISSUED FOR USE

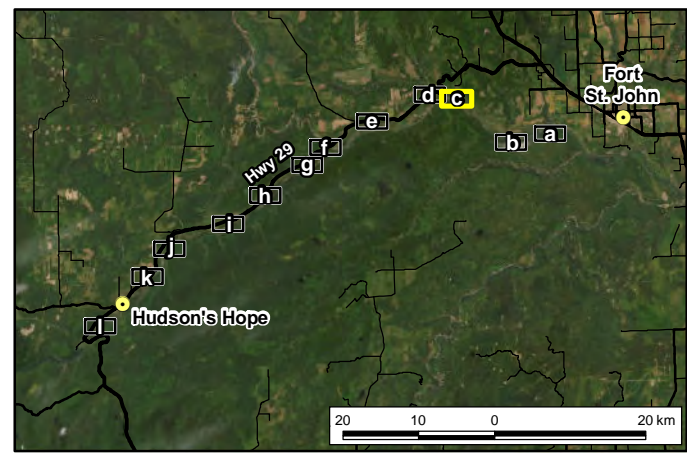
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**LEGEND**

- Nest Box - Used
- Nest Box - Repairs Required
- Nest Box - Confirmed Destroyed
- Nest Box - Not Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



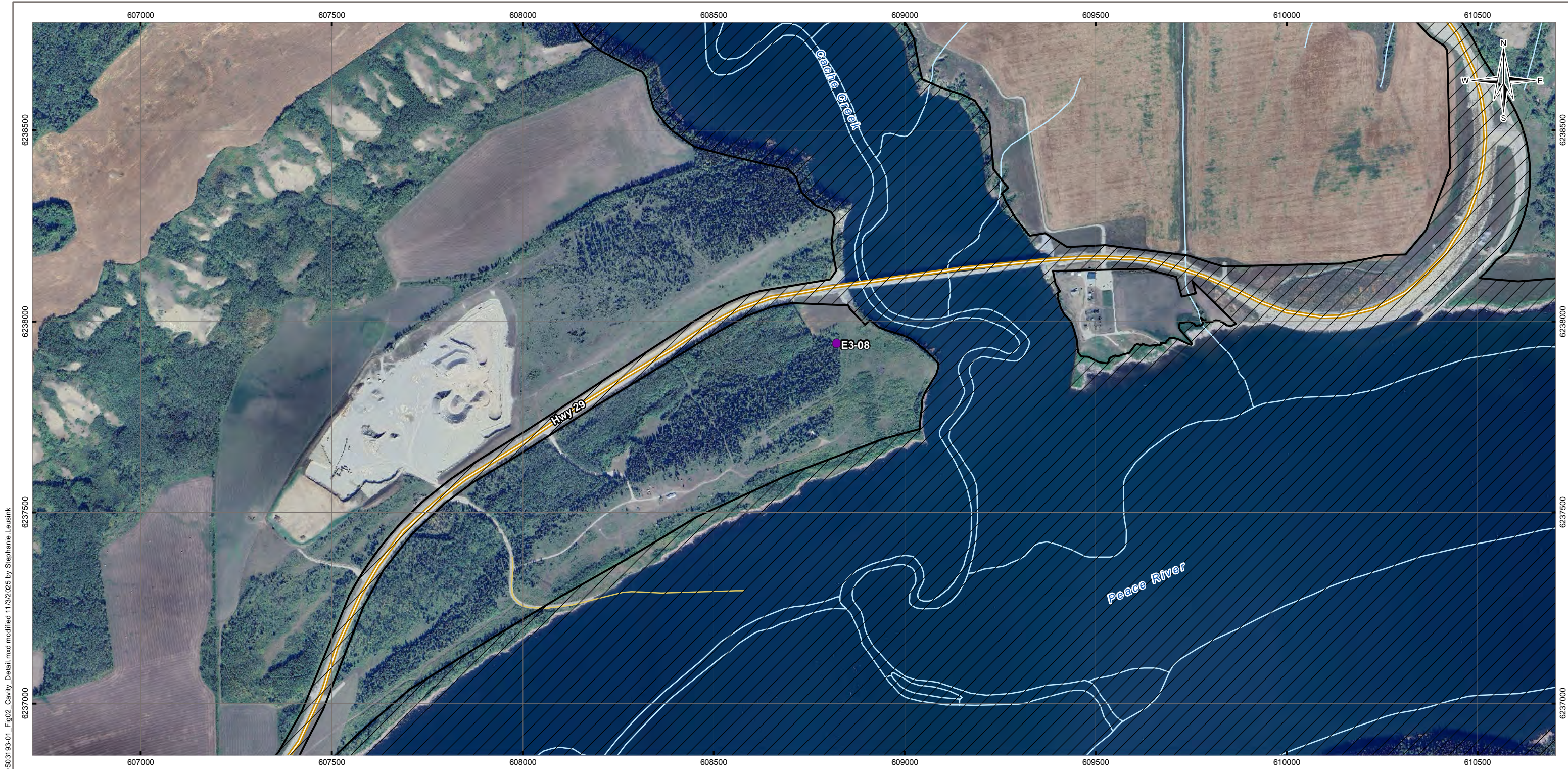
**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2025)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> BC Hydro Power smart	
Scale: 1:10,000				TETRA TECH	
200 100 0 200 Metres					
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd					
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0	<b>Figure 2c</b>
<b>DATE</b> March 30, 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01			

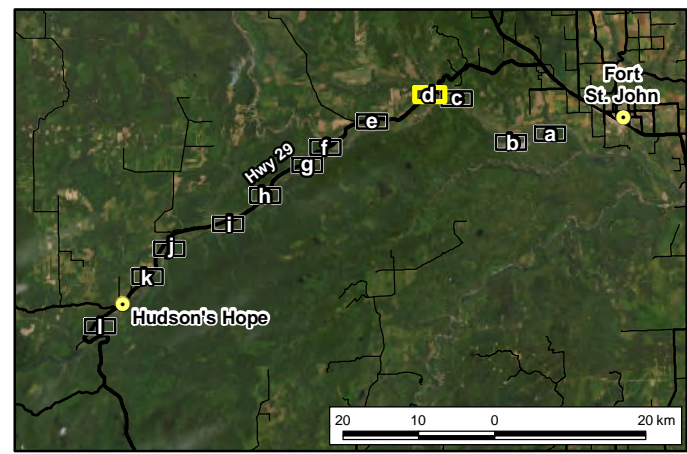
**STATUS**  
ISSUED FOR USE



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**LEGEND**

- Nest Box - Reactivated
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2025)

**STATUS**  
 ISSUED FOR USE

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:10,000				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026	<b>PROJECT NO.</b> ENW.BIOS03193-01			



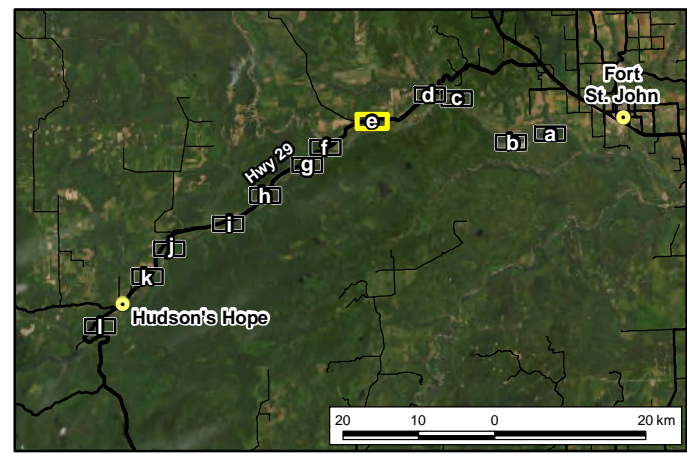
**Figure 2d**



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**LEGEND**

- Nest Box - Used
- Nest Box - Repaired
- Nest Box - Suspected Destroyed
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2025)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:10,000				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01		



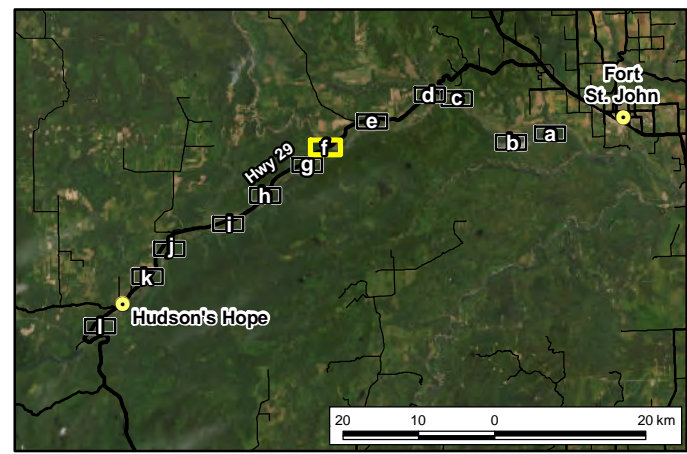
**Figure 2e**

**STATUS**  
ISSUED FOR USE



**LEGEND**

- Nest Box - Used
- Nest Box - Repairs Required
- Nest Box - Confirmed Destroyed
- Nest Box - Not Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2025)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart	
Scale: 1:10,000					
				<b>TETRA TECH</b> 	
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd					
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0	<b>Figure 2f</b>
<b>DATE</b> March 30, 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01			

**STATUS**  
ISSUED FOR USE

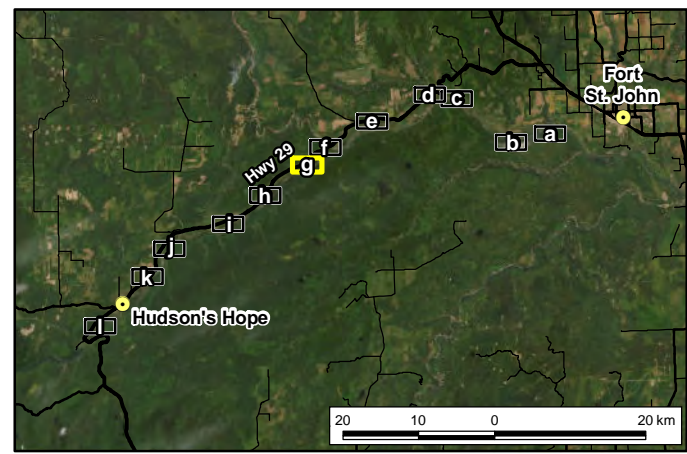
G:\ENVIRONMENTAL\BIOS03193-01\GIS\Maps\CAVITY\_2025\BIOS03193-01\_Fig02\_Cavity\_Detail.mxd modified 11/3/2025 by Stephanie Leusink



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**LEGEND**

- Nest Box - Used
- Nest Box - Confirmed Destroyed
- Project Footprint
- Highway
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2023/2025)

**STATUS**  
 ISSUED FOR USE

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10	<b>DATUM</b> NAD83	<b>CLIENT</b> <b>BC Hydro</b> Power smart		
Scale: 1:10,000				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026	<b>PROJECT NO.</b> ENW.BIOS03193-01			

**TETRA TECH**

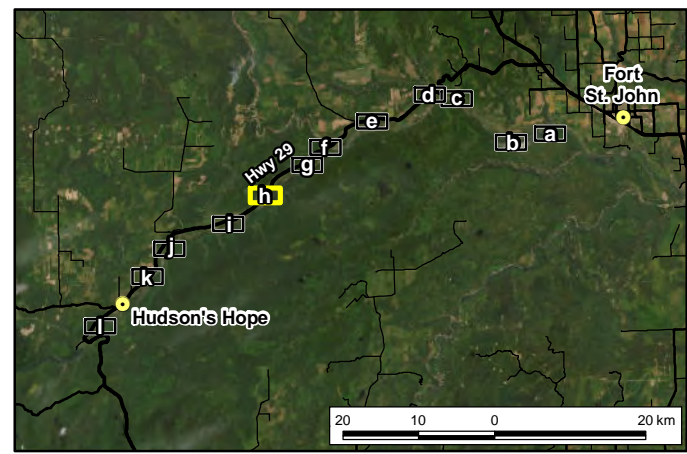
Figure 2g



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**LEGEND**

- Nest Box - Not Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2023)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:10,000				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01		
<b>Figure 2h</b>				

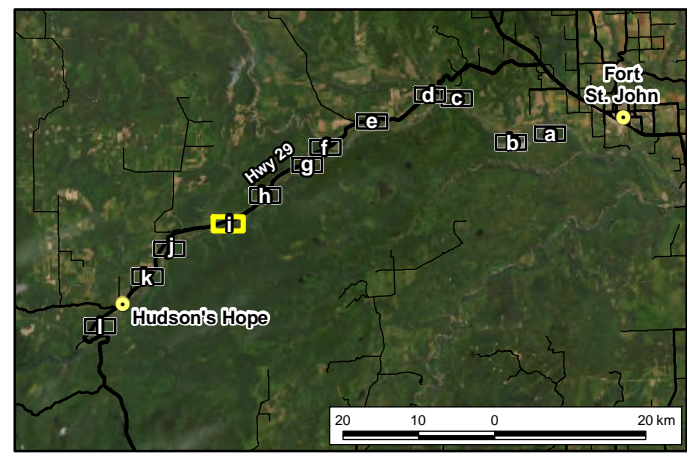
**STATUS**  
ISSUED FOR USE



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**LEGEND**

- Nest Box - Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from ESRI; Vantor (2024)

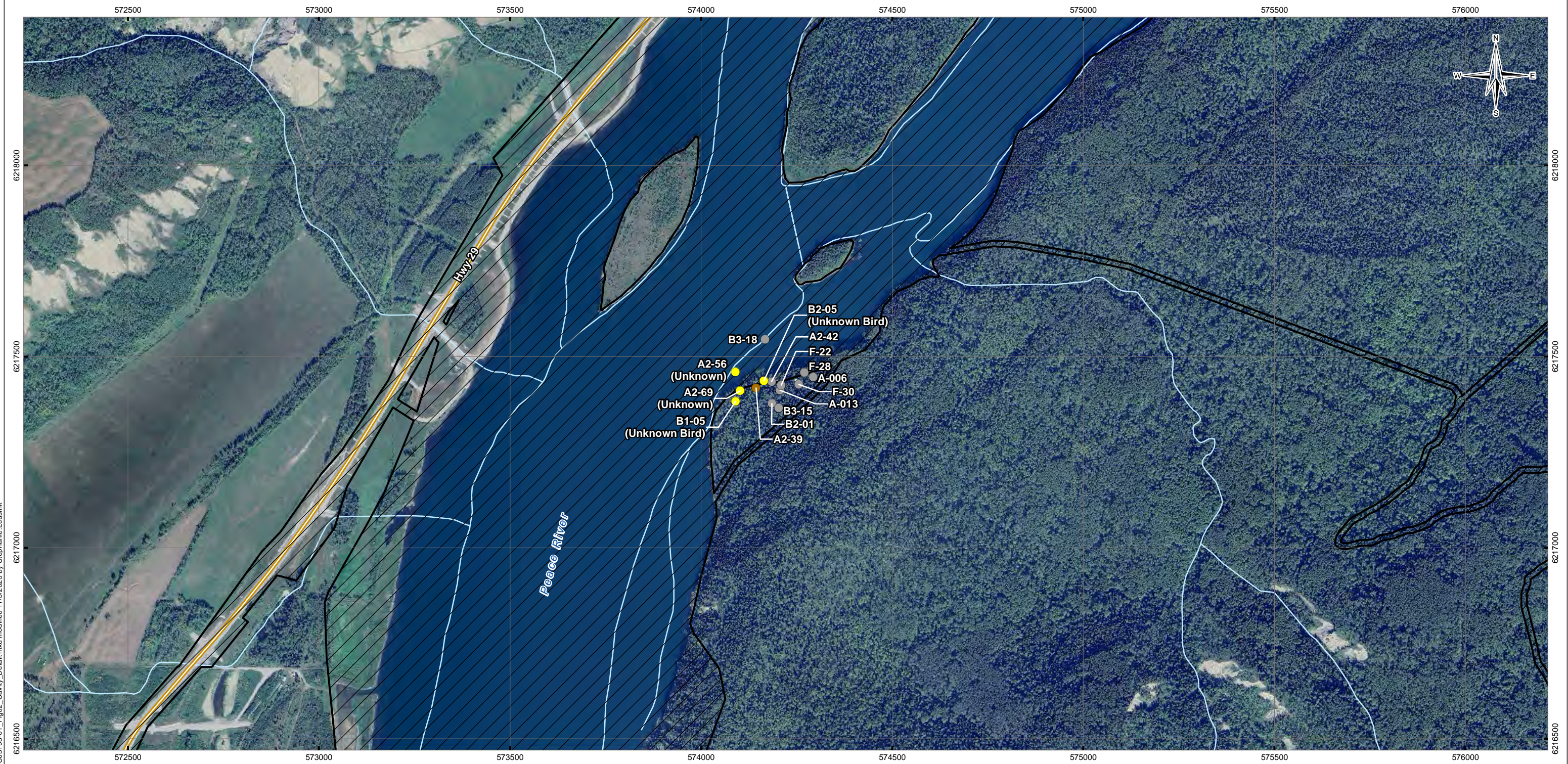
**STATUS**  
 ISSUED FOR USE

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10	<b>DATUM</b> NAD83	<b>CLIENT</b> 
Scale: 1:10,000 		
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd		
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB
<b>DATE</b> March 30, 2026	<b>APVD</b> ED	<b>REV</b> 0
<b>PROJECT NO.</b> ENW.BIOS03193-01		<b>Figure 2i</b>

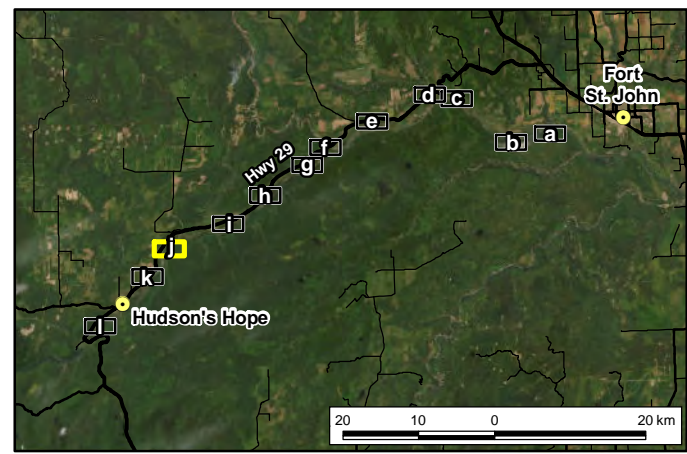




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**LEGEND**

- Nest Box - Used
- Nest Box - Repaired
- Nest Box - Not Used
- Project Footprint
- Highway
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Goole Earth Pro; Airbus (2025)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:10,000				
 Metres				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026	<b>PROJECT NO.</b> ENW.BIOS03193-01			



**Figure 2j**

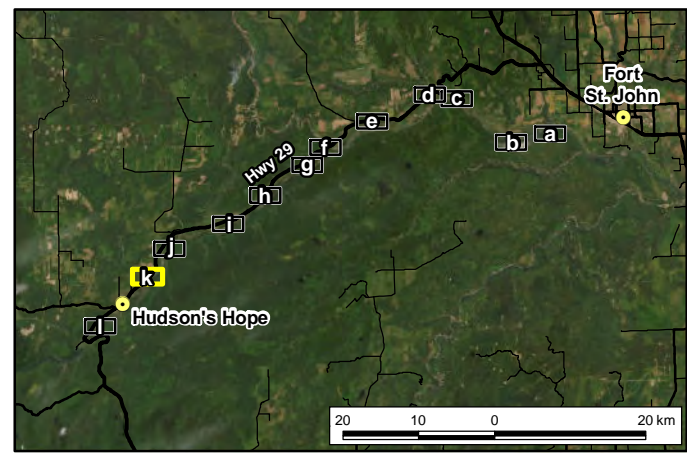
**STATUS**  
ISSUED FOR USE



G:\ENVIRONMENTAL\BIOS\03193-01\GIS\Maps\CAVITY\_2025\BIOS03193-01\_Fig02\_Cavity\_Detail.mxd modified 11/23/2025 by Stephanie Leusink

**LEGEND**

- Nest Box - Confirmed Destroyed
- Project Footprint
- Highway
- Local Road
- ~ Watercourse
- ~ Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from ESRI; Vantor (2024)

**STATUS**  
 ISSUED FOR USE

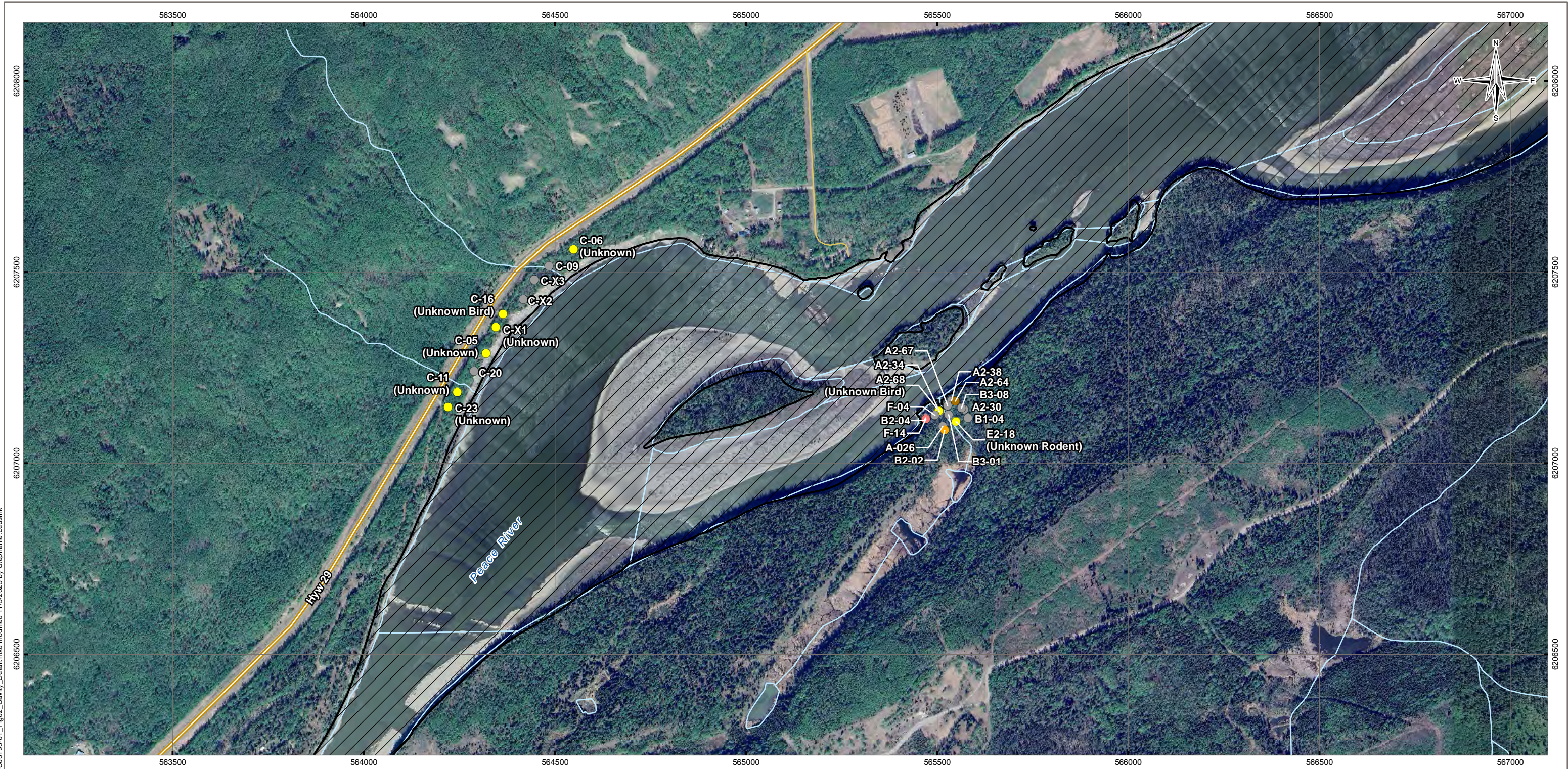
**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10	<b>DATUM</b> NAD83			
Scale: 1:10,000				
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd				
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0
<b>DATE</b> March 30, 2026	<b>PROJECT NO.</b> ENW.BIOS03193-01			

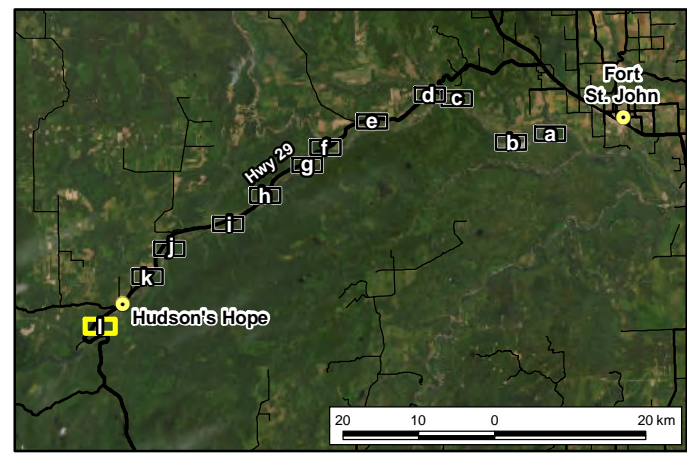


**Figure 2k**



**LEGEND**

- Nest Box - Used
- Nest Box - Repairs Required
- Nest Box - Repaired
- Nest Box - Suspected Destroyed
- Nest Box - Not Used
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019)  
 Imagery from Google Earth Pro; Airbus (2023)

**SITE C CLEAN ENERGY PROJECT  
 NEST BOX MONITORING REPORT 2025**

**2025 Nest Box Locations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> BC Hydro Power smart	
Scale: 1:10,000					
<b>FILE NO.</b> BIOS03193-01_Fig02_Cavity_Detail.mxd					
<b>OFFICE</b> Tt-VANC	<b>DWN</b> SL	<b>CKD</b> MRB	<b>APVD</b> ED	<b>REV</b> 0	<b>Figure 2I</b>
<b>DATE</b> March 30, 2026		<b>PROJECT NO.</b> ENW.BIOS03193-01			

**STATUS**  
ISSUED FOR USE

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## 5.0 DISCUSSION

Occupancy rates of nest boxes have generally increased since the program began in 2020. Reported occupancy rose from 27% in 2020 (Hemmera 2020) to 31% in 2021 (Hemmera 2022a), 42% in 2022 (Hemmera 2022b), and 55% in 2023 (Ausenco 2024), before decreasing slightly to 49% in 2024 (Tetra Tech 2025). In 2025, we recorded a nest box occupancy rate of 48%. These occupancy rates are consistent with those reported from other studies. For example, Thompson et al. (2023) found occupancy rates between 1% and 78% across a North American and European meta-analysis, and Milligan and Dickinson (2016) reported occupancy rates below 50% for artificial nest structures in California oak woodlands. These results support the conclusion that the Site C nest boxes are providing supplemental nesting habitat for cavity-nesting species at rates consistent or better than other studies.

Many nest boxes had ambiguous nesting materials, which created uncertainty about species use and the recency of use. As described in the methods, we removed debris and replaced it with fresh wood shavings only when we could confirm rodent use or when the material was so decayed that it clearly no longer reflected active nesting. Rodents typically create grass-dominated nests, but several boxes contained mixed materials (e.g., bark, grass, leaves, and other fragments), making it difficult to determine species use. Our monitoring approach allows us to confirm use but not nesting success or fledging outcomes. As a result, we rely on occupancy as the most practical and conservative indicator of whether the program continues to provide functional habitat for cavity-nesting birds.

The Project includes 14 nest box designs intended to support 20 target secondary cavity-nesting bird species (Table 2-2). However, nest box use is rarely limited to only target species, with many studies documenting high use by non-target species. For example, Lindenmayer et al. (2016) found that regionally common species frequently dominate nest box occupancy. During 2025 monitoring, American Kestrels were found to be using the E1, E2, and F-type nest boxes. Notably, E1 and E2 boxes were designed for other species but share structural similarities with E3 boxes, which were specifically intended for kestrels. The use of F-type boxes—originally designed for waterfowl—by kestrels further highlights the adaptability of these birds and that boxes will provide nesting habitat for non-target species. These observations demonstrate that nest boxes can and will provide nesting opportunities for a range of species, including those not initially targeted by the design, if they are placed in suitable habitat and are of suitable size.

American Kestrels remained the most frequently recorded species using nest boxes in 2025, with confirmed use of six boxes. Other studies in managed boreal forest areas elsewhere in Canada show that kestrels often benefit disproportionately from artificial nest box programs and may occupy nest boxes more frequently than natural cavities (Bortolotti 1994). Five of these six nest boxes with active American Kestrel use were also occupied by kestrels in previous years (Ausenco 2024). For example, the E1-09 box had an active kestrel nest in 2021, 2023, and again in 2025 (Hemmera 2022a Ausenco 2024). This evidence suggests that once birds establish the use of a nest box, they display strong nest site fidelity in subsequent years.

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) are recommended to take place in future monitoring cycles to ensure nest boxes remain usable for target species.

## 6.0 REFERENCES

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# APPENDIX A

## NEST BOX MONITORING AND MAINTENANCE SCHEDULE – 2025

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**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	
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
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

**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
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
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	
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	
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	

**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
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
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
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	
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

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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
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	
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	
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
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

**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
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
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
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

## NEST BOX MONITORING RESULTS – 2025

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**Appendix B: 2025 Nest Box Monitoring Results**

Nest Box ID	2025 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
A-001	2025-06-12	A	NA	NA	NA	Gone/Missing	NA	Could not find box, suspected destroyed.
A-003	2025-06-12	A	Visual	NA	NA	Repaired	Major box repairs	Box found on a tree that had fallen. Removed and attached the box to a nearby tree.
A-004	2025-06-11	A	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
A-005	2025-06-12	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-006	2025-06-14	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-007	2025-06-11	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-009	2025-06-12	A	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Rodent chew marks at entrance hole. Bear claw marks on tree box is affixed to. Old stick nest visible in bottom of box
A-012	2025-06-12	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A-013	2025-06-14	A	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
A-015	2025-06-11	A	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
A-016	2025-06-12	A	Visual	No	NA	Repaired	Major box repairs	Box found on the ground. Reattached box to paper birch
A-018	2025-06-12	A	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Box densely packed with sticks
A-022	2025-06-12	A	Pole Camera Examination	Yes	Wasp/Hornet	Operational	Clean/add wood shavings	Box contained an inactive wasp nest.
A-024	2025-06-12	A	Pole Camera Examination	No	NA	Operational	Minor box repairs	Repaired top of nest box.
A-026	2025-06-10	A	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A2-27	2025-06-12	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Box densely packed with sticks. Rodent chew marks at entrance hole.
A2-28	2025-06-11	A2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A2-29	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Rodent	Operational	Clean/add wood shavings	Bottom of the box contained shredded wasp or hornet nest remnants. Rodent chew marks at entrance hole.
A2-30	2025-06-10	A2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A2-31	2025-06-12	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Lichen and bark observed in bottom of nest box. Rodent chew marks at entrance hole.
A2-32	2025-06-12	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Box densely packed with sticks.
A2-33	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Loose stick nest. No longer in use. Rodent chew marks at entrance hole
A2-34	2025-06-10	A2	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	No nesting material or signs of use.
A2-38	2025-06-10	A2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A2-39	2025-06-14	A2	Visual	No	NA	Repaired	Major box repairs	Box found on tree that had fallen. Reattached to new tree. Rodent chew marks at entrance hole of box.
A2-41	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Box has loosely packed large sticks and was overgrown with tent caterpillars.
A2-42	2025-06-14	A2	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
A2-46	2025-06-12	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Box densely packed with sticks
A2-47	2025-06-12	A2	Pole Camera Examination	Yes	Bumblebee	Operational	Clean/add wood shavings	Rodent chew marks at entrance hole. Box being actively used by Bumblebees.
A2-48	2025-06-12	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Loose sticks scattered along bottom of nest box. Rodent chew marks at entrance hole
A2-49	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Rodent	Operational	Clean/add wood shavings	Loose sticks, grass and overgrown with tent caterpillars. Rodent chew marks at entrance hole
A2-50	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Loose stick nest. No longer in use.
A2-52	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Box densely packed with sticks
A2-53	2025-06-12	A2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
A2-56	2025-06-14	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Grasses bark and lichen observed in next box. Rodent chew marks at entrance hole.
A2-57	2025-06-11	A2	Pole Camera Examination	No	NA	Operational	None	Active bumblebee nest within rodent nest. Grasses and bark strips present in bottom of box.
A2-61	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Box densely packed with sticks
A2-63	2025-06-12	A2	Pole Camera Examination	No	NA	Operational	Clean/add wood shavings	Rodent chew marks at entrance hole.
A2-64	2025-06-10	A2	NA	NA	NA	Repairs Required	NA	Major repairs needed. Nest box fallen off of tree and missing bottom.
A2-67	2025-06-10	A2	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
A2-68	2025-06-10	A2	Pole Camera Examination	Yes	Tree Swallow	Operational	None	Many feathers packed into the bottom of the box along with some bark. Suspected to be Tree Swallow nest.
A2-69	2025-06-14	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Grasses and small bark strips scattered along bottom of box
A2-70	2025-06-12	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Sticks and grasses present along with some small feathers.
A2-80	2025-06-11	A2	Pole Camera Examination	Yes	Unknown Bird	Operational	Clean/add wood shavings	Loose sticks and box overgrown with tent caterpillars. Rodent chew marks at entrance hole.
A2-81	2025-06-12	A2	Pole Camera Examination	Yes	Unknown	Operational	None	Rodent chew marks at entrance hole. Sticks scattered along bottom of box.
B1-00	2025-06-12	B1	Pole Camera Examination	No	NA	Operational	None	Squirrel observed in tree near box but box does not show signs of use.
B1-04	2025-06-10	B1	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B1-05	2025-06-14	B1	Pole Camera Examination	Yes	Mountain Bluebird	Operational	None	Grasses and leaves packed into a cup nest. Suspected to be a Mountain Bluebird nest.
B1-06b	2025-06-11	B1	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B2-01	2025-06-14	B2	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
B2-02	2025-06-10	B2	Pole Camera Examination	No	NA	Repairs Required	None	Nest box has fallen off of tree and needs to be reattached.
B2-04	2025-06-10	B2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B2-05	2025-06-14	B2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Leaves bark and lichen in nest box. Rodent chew marks at entrance hole
B3-01	2025-06-10	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-04	2025-06-12	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-08	2025-06-10	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-09	2025-06-12	B3	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Packed with grasses, some small black feathers scattered along bottom of box.
B3-15	2025-06-14	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-16	2025-06-12	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-18	2025-06-14	B3	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
B3-19	2025-06-10	B3	Pole Camera Examination	Yes	Unknown Rodent	Operational	Clean/add wood shavings	Loosely scattered nest of grass. Expcted to be a rodent nest
BC-01S	2025-06-12	BC	Visual	No	NA	Operational	None	No nesting material or signs of use.
BC-02b	2025-06-12	BC	Visual	No	NA	Operational	None	No nesting material or signs of use.
BC-03b	2025-06-12	BC	Visual	No	NA	Operational	None	No nesting material or signs of use.
BC-04	2025-06-12	BC	NA	NA	NA	Gone/Missing	NA	Could not find box, suspected destroyed.
BC-04b	2025-06-12	BC	Visual	No	NA	Operational	None	No nesting material or signs of use.
BC-NN	2025-06-12	BC	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-04	2025-06-11	C	Pole Camera Examination	Yes	Wasp/Hornet	Operational	None	Active wasp or hornet nest
C-05	2025-06-10	C	Pole Camera Examination	Yes	Unknown	Operational	None	Loosely scattered nest of grass
C-06	2025-06-10	C	Pole Camera Examination	Yes	Unknown	Operational	None	Many green leaves scattered in bottom of nest box
C-09	2025-06-10	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-10	2025-06-11	C	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Box densely packed with sticks
C-11	2025-06-10	C	Pole Camera Examination	Yes	Unknown	Operational	None	Bark loosely scattered through the bottom of the box.
C-14	2025-06-11	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-16	2025-06-10	C	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Tight bark strip nest.
C-17	2025-06-11	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-19	2025-06-11	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-20	2025-06-10	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-21	2025-06-12	C	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Grasses packed into the bottom of the box.
C-23	2025-06-10	C	Pole Camera Examination	Yes	Unknown	Operational	None	Grass and bark in nest box, loosely scattered
C-X1	2025-06-10	C	Pole Camera Examination	Yes	Unknown	Operational	None	Bark strips present along bottom of box.
C-X2	2025-06-10	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
C-X3	2025-06-10	C	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
D-01	2025-06-13	D	Pole Camera Examination	No	NA	Operational	None	Small bark strips scattered along the bottom of the box.
D-02	2025-06-13	D	Pole Camera Examination	Yes	Unknown Bird	Operational	None	One large feather in bottom of box along with grasses, moss, and leaves.
D-03	2025-06-13	D	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Bark scattered along bottom of box
E1-01	2025-06-14	E1	Pole Camera Examination	Yes	NA	Operational	None	No nesting material or signs of use.
E1-03	2025-06-13	E1	Visual	No	NA	Repairs Required	NA	Box broken - back panel split down middle. Sides crumbling. Roof unaligned
E1-04	2025-06-14	E1	Pole Camera Examination	Yes	Unknown	Operational	None	Grass scattered along bottom of nest
E1-07	2025-06-14	E1	NA	NA	NA	Not Operational	NA	Box found destroyed
E1-09	2025-06-15	E1	Pole Camera Examination	Yes	American Kestrel	Operational	None	3 large American Kestrel eggs with cracked and damaged shells. Possibly predated.

**Appendix B: 2025 Nest Box Monitoring Results**

Nest Box ID	2025 Monitoring Date	Nest Box Type	Survey Method	Evidence of Use	Species Using Box	Box Status	Maintenance Completed	Comments
E2-04	2025-06-13	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
E2-05	2025-06-14	E2	Pole Camera Examination	Yes	Unknown	Operational	None	Sticks and leaves present in the bottom of the box
E2-07	2025-06-13	E2	Pole Camera Examination	Yes	Unknown	Operational	None	Small sticks scattered along the bottom of the box
E2-08	2025-06-14	E2	Visual	NA	NA	Repaired	Major box repairs	Box broken and fallen on ground. Repaired best as possible but should be replaced. Evidence of past owl nesting in the box.
E2-11	2025-06-11	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
E2-12	2025-06-13	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
E2-14	2025-06-13	E2	Pole Camera Examination	Yes	American Kestrel	Operational	None	5 American Kestrel eggs.
E2-15	2025-06-14	E2	Pole Camera Examination	Yes	Northern Flying Squirrel	Operational	None	Flying squirrel with at least 2 young.
E2-16	2025-06-13	E2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Scattered grasses and lichen along the bottom of the nest box
E2-18	2025-06-10	E2	Pole Camera Examination	Yes	Unknown Rodent	Operational	None	Scat from unknown species, suspected rodent.
E2-19	2025-06-13	E2	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
E2-22	2025-06-14	E2	Pole Camera Examination	Yes	Unknown Rodent	Operational	None	Bottom of box packed with grasses.
E2-23	2025-06-14	E2	Pole Camera Examination	Yes	Unknown	Operational	None	Leaves, grass and lichen scattered in bottom of box
E2-25	2025-06-14	E2	Pole Camera Examination	Yes	Unknown	Operational	None	Grasses and lichen scattered through bottom of nest box
E2-26	2025-06-11	E2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Grasses and sticks scattered throughout the bottom of the nest box.
E2-27b	2025-06-13	E2	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Ball of grasses and lichen in bottom of box.
E3-01b	2025-06-13	E3	NA	No	NA	Destroyed	None	Box found destroyed.
E3-08	2025-06-15	E3	Pole Camera Examination	Yes	Unknown Rodent	Reactivated	Other	Reactivated and cleaned out old rodent nest
F-01	2025-06-15	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-02	2025-06-11	F	Pole Camera Examination	Yes	Common Goldeneye	Operational	None	Light downy feathers and grasses packed into the bottom of box. Suspected Common Goldeneye nest.
F-04	2025-06-10	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-05	2025-06-10	F	NA	NA	NA	Destroyed	NA	Box found destroyed.
F-06	2025-06-11	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Leaves scattered along bottom of box
F-10	2025-06-11	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-13	2025-06-14	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-14	2025-06-10	F	NA	NA	NA	Gone/Missing		Could not find box, suspected destroyed.
F-15	2025-06-12	F	Pole Camera Examination	No	NA	Operational	None	Rodent chew marks at entrance hole
F-16	2025-06-11	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Lichen and grasses loosely packed along bottom of box
F-19	2025-06-12	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-21	2025-06-15	F	Pole Camera Examination	Yes	American Kestrel	Operational	None	3 American Kestrel eggs. Adult male near box
F-22	2025-06-14	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-23	2025-06-11	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-24	2025-06-12	F	Pole Camera Examination	No	NA	Repaired	Minor box repairs	Minor door repairs conducted.
F-25	2025-06-11	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-26	2025-06-15	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-27	2025-06-13	F	Pole Camera Examination	No	Unknown Bird	Operational	None	Small bark strips and select small sticks scattered along the bottom of the box.
F-28	2025-06-14	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-30	2025-06-14	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-33	2025-06-14	F	Pole Camera Examination	Yes	American Kestrel	Operational	None	1 American Kestrel egg
F-34	2025-06-13	F	NA	NA	NA	Destroyed	N/A	Box found destroyed.
F-35	2025-06-13	F	Pole Camera Examination	Yes	American Kestrel	Operational	None	6 American Kestrel eggs. Female American Kestrel observed outside of box.
F-36	2025-06-15	F	Pole Camera Examination	Yes	Common Goldeneye	Operational	None	Bottom of the box packed with downy feathers. Egg shells similar in size and colour for Common Goldeneye observed at bottom of nest box tree.
F-37	2025-06-11	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-38	2025-06-15	F	Pole Camera Examination	Yes	American Kestrel	Operational	Clean/add wood shavings	Dead American Kestrel found in box. Removed and cleaned box.
F-39	2025-06-11	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
F-40	2025-06-11	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Bark strips scattered along bottom of box
F-41	2025-06-15	F	Pole Camera Examination	No	NA	Operational	None	Front panel has been damaged by possible animal trying to get in. Screen is damaged. Claw marks on tree.
F-43	2025-06-14	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Bark and scattered sticks
F-45	2025-06-14	F	NA	NA	NA	Destroyed	N/A	Found destroyed
F-46	2025-06-15	F	Pole Camera Examination	Yes	Unknown	Operational	None	Packed grasses in the bottom of the box
F-47	2025-06-11	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Lichen and grasses loosely packed along bottom of box
F-48	2025-06-15	F	Pole Camera Examination	Yes	Unknown Bird	Operational	None	A few scattered sticks in bottom of box
F-49	2025-06-15	F	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
G-01	2025-06-13	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
G-02	2025-06-15	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
G-04	2025-06-15	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
G-05	2025-06-11	G	Pole Camera Examination	No	NA	Operational	None	No nesting material or signs of use.
G-06	2025-06-13	G	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Grasses packed into a loose nest in bottom of box
G-09	2025-06-13	G	NA	NA	NA	Destroyed	N/A	Box found destroyed.
G-10	2025-06-15	G	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Downy feathers scattered along the floor of the nest box. Some species of waterfowl likely using nest box.
G-12	2025-06-15	G	Pole Camera Examination	No	NA	Operational	None	Grasses packed into the bottom of the box.
G-14	2025-06-15	G	NA	NA	NA	Repairs Required	NA	Missing bottom. Major repairs needed
OWL-2	2025-06-15	OWL	Pole Camera Examination	Yes	Unknown Bird	Operational	None	Grasses, leaves and bark in bottom of nest box. Downy feathers observed.
OWL-3	2025-06-14	OWL	NA	NA	NA	Gone/Missing	N/A	Could not find box, suspected destroyed.

# APPENDIX C

## PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

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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

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# LIMITATIONS ON USE OF THIS DOCUMENT

## NATURAL SCIENCES

### 1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of Saulteau EBA Environmental Services Joint Venture's (SEES JV) Client (the "Client") as specifically identified in the SEES JV Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). SEES JV does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by SEES JV.

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### 1.2 ALTERNATIVE DOCUMENT FORMAT

Where SEES JV submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed SEES JV's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by SEES JV shall be deemed to be the original. SEES JV will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of SEES JV's Instruments of Professional Service shall not, under any circumstances, be altered by any party except SEES JV. SEES JV's Instruments of Professional Service will be used only and exactly as submitted by SEES JV.

Electronic files submitted by SEES JV have been prepared and submitted using specific software and hardware systems. SEES JV makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

### 1.3 STANDARD OF CARE

Services performed by SEES JV 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 SEES JV.

### 1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with SEES JV 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 SEES JV to properly provide the services contracted for in the Contract, SEES JV has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

### 1.5 INFORMATION PROVIDED TO SEES JV BY OTHERS

During the performance of the work and the preparation of this Professional Document, SEES JV may have relied on information provided by third parties other than the Client.

While SEES JV endeavours to verify the accuracy of such information, SEES JV 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 SEES JV 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 exploration, investigation, and assessment.

SEES JV 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.



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### 1.7 ENVIRONMENTAL ISSUES

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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.

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### 1.8 NOTIFICATION OF AUTHORITIES

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SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV 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 SEES JV in its reasonably exercised discretion.

## **Appendix 22. 2025 Bald Eagle Nest Surveys Annual Report**



**Attention:**

Brent Matsuda  
Senior Environmental Coordinator, BC Hydro  
Site C Clean Energy Project

**Re: Bald Eagle Nest Monitoring 2025 Annual Report**

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**EXECUTIVE SUMMARY**

In 2025, West Moberly–DWB Limited Partnership completed three rounds of aerial bald eagle (*Haliaeetus leucocephalus*) nest surveys along the Peace River corridor, from Peace Canyon Dam to the Alberta border, including natural tree nests and artificial nesting platforms installed as mitigation for nest removal associated with reservoir filling for the Site C Clean Energy Project (the Project).

Approximately 900 km of aerial survey coverage was completed across the three 2025 monitoring flights. A total of 39 natural tree nests were observed, of which 37 were confirmed as potential bald eagle nests available for the nesting season. Of these, 29 nests (78.4%) were active in 2025. A total of 38 chicks were estimated to have fledged, resulting in a fledging success rate of 1.31 young per active nest. Forty-three artificial nesting platforms were also monitored. One platform (Eagle\_41.1B) was active during early surveys but did not produce a confirmed fledgling.

The 2025 results indicate an increase in both the number of active nests and total fledged young compared to 2024, and performance above the multi-year average between 2017–2024. Monitoring objectives were achieved, and data was successfully collected to inform BC Hydro’s Site C wildlife mitigation program.

**1.0 INTRODUCTION**

This memo summarizes the findings of bald eagle nest surveys conducted by West Moberly-DWB Limited Partnership (WM-DWB) in April, May and June 2025. The purpose of the surveys was to document the status of known and new bald eagle nests along the Peace River between the Peace Canyon Dam and the British Columbia (BC) – Alberta border, at wetlands near the Site C transmission line, and at artificial bald eagle mitigation nesting structures. The 2025 work is a continuation of the surveys completed in 2016 through 2024 (Hemmera 2016, 2018a, 2018b, 2019, 2021, 2022; Ausenco 2022, 2023; WM-DWB 2024) and during baseline studies for the Project (Keystone 2009). Formatting and text from previous annual reporting (WM-DWB 2024) has largely been retained at the request of BC Hydro for consistency; however, data has been updated to summarize the results of the 2025 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 operational 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 Project and reservoir fill resulted in the removal of some bald eagle nest trees. The BC Ministry of Forests Lands and Natural Resource Operations, now the BC Ministry of Water, Land, and Resource Stewardship, initially issued Eagle Nest Permit FJ14-154018 on July 6, 2015 under the BC *Wildlife Act* allowing BC Hydro to remove bald eagle nests in Peace Region Management Units 7-31 through 7-35 (BC Hydro 2021). A new permit (FJ24-896316) was re-issued January 21, 2025, expiring March 31, 2030. However, no nests were removed in 2025 and none are expected to be removed now that reservoir fill has completed. To mitigate the past nest removals, 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 installed. Most are basket-style installations with some flat, wooden platforms. Artificial nest platforms were placed 200 to 600 m from the Site C reservoir shoreline which were intended to appeal to nesting bald eagles once reservoir fill was complete (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 Project footprint since 2016 to document eagle occupancy of natural nests and artificial nest platforms. 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, though the timing of nesting activities including egg-laying, incubation, hatching, and fledging can be quite variable.

## 2.0 METHODS

### 2.1 Aerial surveys

Three rounds of bald eagle nest surveys were conducted by helicopter on April 29, May 17, and June 21, 2025, 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 included the Peace River Valley from the Peace Canyon Dam near Hudson’s Hope to the BC - Alberta Border, as well as natural wetlands adjacent to the Site C transmission line right-of-way.

The estimated linear distance flown per survey (excluding transiting time and fueling) was approximately 300 km, resulting in an estimated total survey distance 900 km across the three 2025



monitoring flights. An estimated total of 5.5–6.0 helicopter hours occurred across all three 2025 surveys.

During surveys, two observers were positioned on the left side of the aircraft following pilot instructions. The front observer had visibility to both sides, and the pilot assisted with nest detection on the right, minimizing gaps in coverage. Survey routes were informed by known bald eagle nest locations. Previously identified nest locations from past aerial surveys (WM-DWB 2024) were visited. In addition to known nests, a search was simultaneously conducted for new nests, particularly during the first nest survey of the season prior to leaf-out. 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 2025, but searches were conducted in those areas for newly constructed nests. All BC Hydro artificial platform nest installations were also visited in 2025.

During the survey, each observer scanned outward from the helicopter to approximately 200 m laterally, aided by binoculars / camera when required. Between known nesting locations, particularly during the April survey prior to leaf out, observers spent additional survey effort focused on riparian cottonwood stands, large trembling aspen, conifer trees and snags, reservoir shoreline edges, and known historic nest locations to try and detect additional nests. When a known or new nest was identified, the pilot reduced speed and adjusted position to allow confirmation of nest contents, adult attendance, and chick age class where visible. While the helicopter approached nests from a safe distance (typically 30 – 50 m distance), the Qualified Environmental Professional (QEP) used a Canon 7D Mark II camera equipped with a Canon Ultrasonic L-series 100-400 mm image stabilizing zoom lens to help assess nest status, nesting species, and number of eggs or nestlings. This technique allows for a greater distance to be maintained from the nest and for observers to spend less time at each nest, reducing disturbance while accurately collecting productivity and observational data. The Canon 7D Mark II takes georeferenced photos, with location data updated every second. This allows the QEP to easily review photos post-survey and confirm the accuracy of field observations. The QEP assistant helped with the survey under the direction of the crew lead and recorded observations. Nest data was also collected electronically by the QEP and paper data forms and electronic data were reconciled post-survey and verified with the photo record.

## **2.2 Nest status and productivity**

Observations recorded at each known or new bald eagle nest or stick nests constructed by other species included: (1) nest status (“active”, “inactive”, “unknown”), (2) bird species observed, and (3) 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 (i.e., number of fledglings) 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 of the three annual 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. Using criteria from Bortolotti (1984), only those nestlings that were estimated at least 17 days old (with darker grey plumage) during the first survey in April 29, 2025 and/or 35 days old (with darker or brown mottled plumage) during the second survey in May 17, 2025 are considered potential fledglings.
- No eagles attempted second clutches.

Simple summary statistics (i.e., nests active, estimated fledged chicks per active nest) were calculated for this annual report. Survey results were reported to BC Hydro following each survey including applicable comments and coordinates for each nest observed.

### 3.0 RESULTS

In 2025, surveyors visited 39 natural tree nests. Two of these were corvid species nests. The remaining 37 tree nests were bald eagle nests, meaning they remained standing and in acceptable condition. Twenty-nine of the 37 bald eagle nests species were active. Observers also monitored 43 artificial nesting platforms (**Appendix A**). In total, 82 nests (natural and artificial) were monitored.

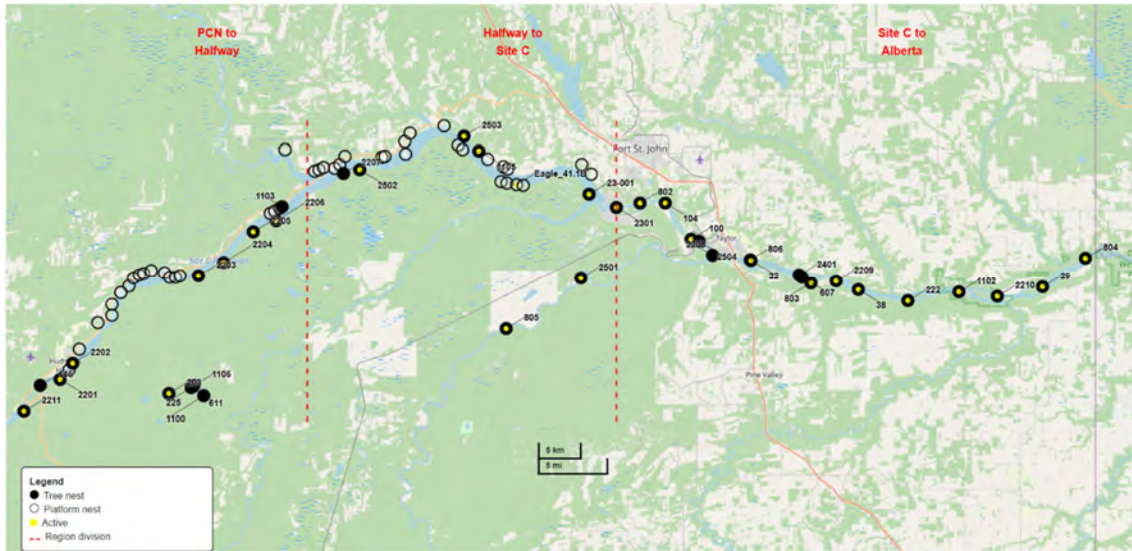
Four of the bald eagle nest trees were newly detected during 2025 (i.e., nest 2501 – 2504) and three previously known nest trees were not detected (, i.e., nests 607, 806, and 2207). In these cases, the tree likely blew down or snapped. In addition, during the third (and last) survey on June 21, 2025, two of the nesting trees (nests 146 and 2201) detected in the initial survey on April 29, 2025, were no longer present. Nest 2201 was considered to have successfully fledged as the chicks observed during second survey (May 17, 2025) were in an advanced stage of development (**Appendix B**).

The first recorded use of an artificial nesting platform by a bald eagle along the Site C corridor occurred in 2024. Artificial nest platform *Eagle\_41.1B* with a relocated bald eagle nest, located on the south side of the Peace River across from Wilder Creek (between Site C and Cache Creek), continued to be used in 2025. An incubating adult was observed there during the first survey on April 29, and a grey chick was present during the second survey on May 17. However, the platform was considered inactive during the third survey, with no adult nearby. As the chick had not yet reached fledging age during the second survey, the nest was presumed to have failed.

Of the 37 potential bald eagle tree nests surveyed in 2025, 29 (78.4%) were used by bald eagles, defined as nests where eggs, an incubating adult or chicks were observed during at least one visit (**Figure 1**). The remaining eight tree nests were either inactive or occupied by other species (**Table 1**). A total of 38 chicks were presumed fledged, with each active nest producing one or two chicks. The estimated fledging success for 2025 was 1.31 fledged chicks per active nest (**Appendix B**).



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**Figure 1.** Map showing tree nests (black dots) and artificial nesting platform (white dots) by region. Active nests in 2025 are highlighted with central yellow points in the black dots.



**Table 1.** Bald eagle Nest Status and Productivity 2016 – 2024.

Nest Status	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>Natural Nesting Structures</b>										
Inactive (incl. non-eagle use)	8	7	15	19	16	17	18	9	13	8
Active (bald eagle use)	-	34	28	29	25	25	19	24	21	29
Percent active (%)	-	83	65	60	61	60	51	73	62	78
Not detected/Tree gone	-	18	4	6	11	15	0	5	0	5
Unknown	52	-	1	0	0	0	0	0	0	0
Total tree nests surveyed	60	59	48	54	52	57	37	38	34	42
Estimated productivity (total number of chicks)	NEI	39	34	42	46	32	22	28	31	38
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	1.31
Nest Status	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>Artificial Nesting Structures</b>										
Active	-	-	-	0	0	0	0	0	1	1
Inactive	-	-	-	3	3	29	29	30	42	42
Total Structures Surveyed	-	-	-	3	3	29	29	30	43	43
Estimated productivity (total chicks)	-	-	-	0	0	0	0	0	1	0
Estimated young fledged per active nest (fledging success rate)	-	-	-	0	0	0	0	0	1	0

Note: NEI = not enough information  
 “-“ indicates no data

Data from 2025 indicate an increase in the total number of fledged chicks in natural nests compared to 2024 (**Table 1**). The 2025 total (n = 38) is above the 2017–2024 average of 34 chicks. The highest productivity observed over the monitoring period occurred in 2020, with 46 fledged chicks, followed by a sharp decline to just 22 in 2022 (Table 1, Figure 3). The 2025 results indicate an upward trend.

Fledging success of natural nests peaked at 1.84 chicks per active nest in 2020 but declined to 1.16 and 1.17 in 2022 and 2023, respectively. It rose again in 2024 to 1.48—the second-highest rate observed since monitoring began in 2017—and above the 2017–2023 average of 1.32. In 2025, fledging success declined slightly to 1.31 (**Figure 2**). For historical context, surveys conducted in 1995 and 1997 around the Williston Reservoir, approximately 188 km upstream of Site C, recorded an average fledging rate of just 0.78 chicks per active nest—significantly lower than values observed along the Peace River corridor in this study (Merkens et al. 1997; Booth et al. 1999).



The number of active bald eagle nests peaked in 2017 with 34, then declined to a low of 19 in 2022. In 2025, this number increased to 29—surpassing the 2017–2024 average of 26 active tree nests (Figure 3).

When analyzing nesting activity by region along the Peace River corridor (see Figure 1), a decline in both the number and proportion of active nests was observed in the Peace Canyon Dam to Halfway River section up to 2023. However, a recovery trend showed in 2024 and 2025 (Figure 4A). Although nest tree removal in the Halfway River to Site C Dam region has reduced the number of available nests since 2017, occupancy of the remaining nests has increased annually, reaching full (100%) occupancy in 2024 and slightly decreasing to 90% in 2025 (Figure 4B). Downstream of the Site C Dam, both the number of nests and their occupancy have shown a slight but steady increase since 2017 (Figure 4C).

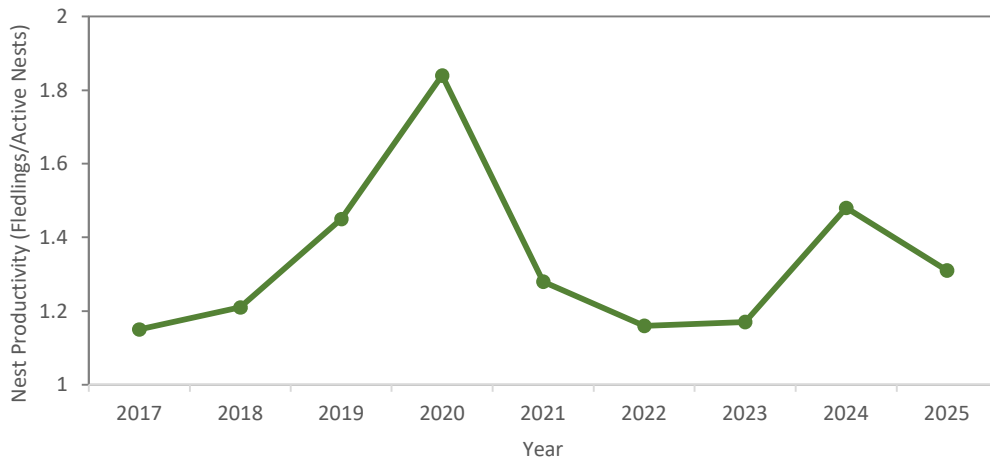


Figure 2. Annual bald eagle nest fledging success rate from 2017 to 2025.

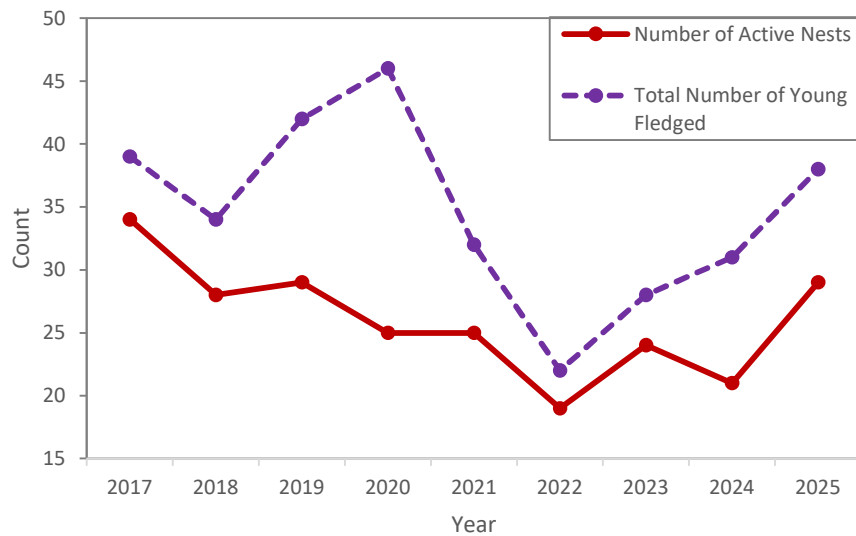
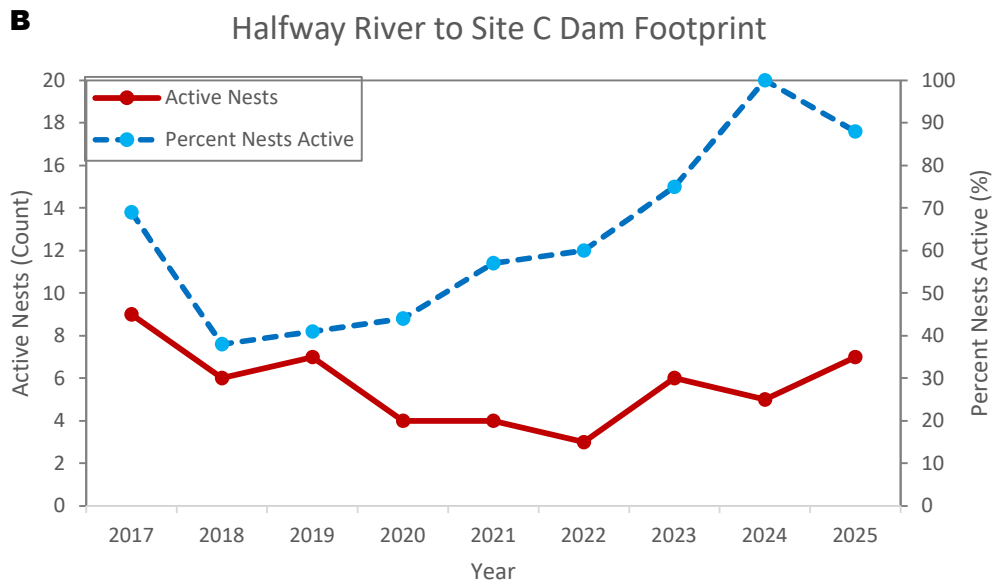
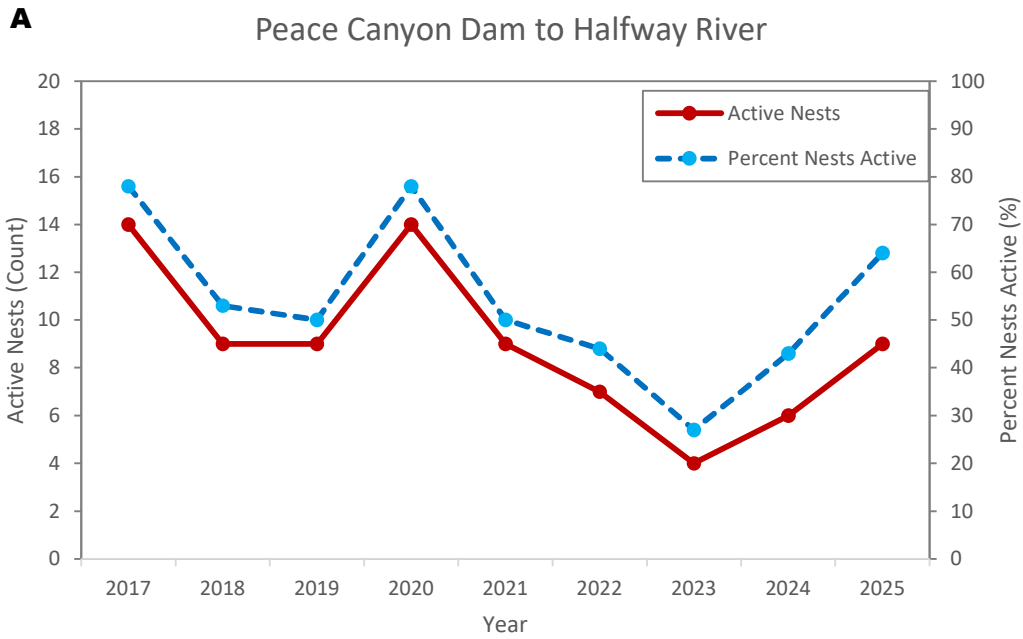
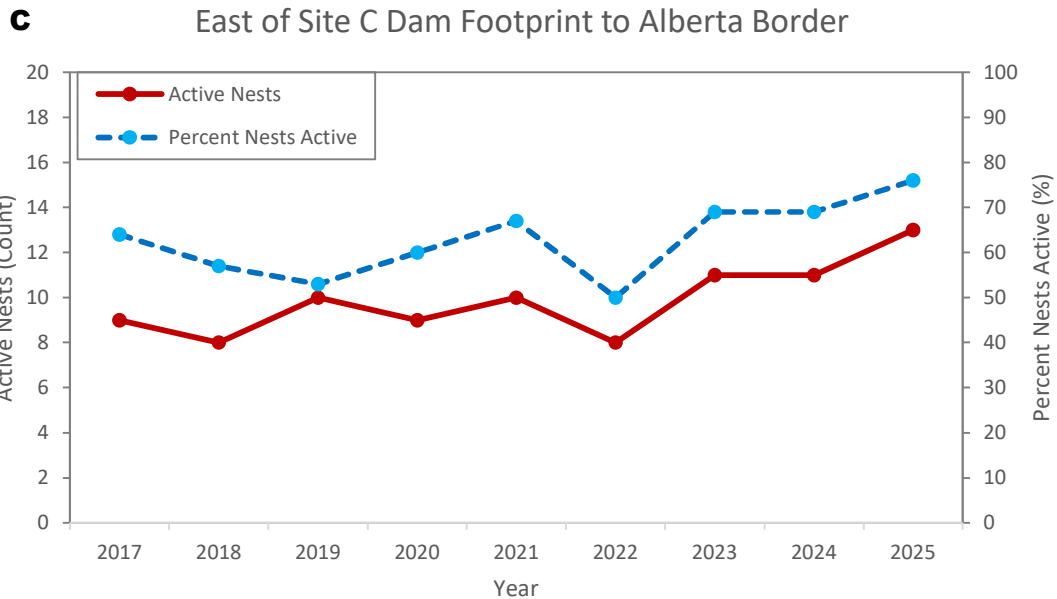


Figure 3. Number of active bald eagle nests and total number of young fledged per year from 2017 to 2025.



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**Figure 4.** 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.

#### 4.0 DISCUSSION

When compared to prior years, the 2025 nesting season stands out as a year of relative recovery and stabilization. The number of active nests ( $n = 29$ ), % of active nests or occupancy (78%), and fledged chicks ( $n = 38$ ) were higher than in most years since 2017, particularly when contrasted with the depressed values observed in 2021–2022 when the permitted removal of bald eagle nesting trees was most active (see Figure 2). Productivity in 2025 (1.31 fledglings per active nest) aligns well with the better-performing years in the dataset. These findings suggest that, despite ongoing habitat pressures and nest loss, bald eagles continue to maintain relatively high breeding success locally.

Nesting patterns showed variation within the three sections of the study area (i.e., Peace Canyon Dam to Halfway River, Halfway River to Site C, and Site C to Alberta). Nest activity and availability in the Peace Canyon Dam to Halfway River section declined through 2023 but began to recover in 2024–2025 (see Figure 4A). Occupancy (or % of active nests) of remaining nests ranged from 27% in 2023 to 64% in 2025. Historically, this area has been most impacted by nest tree removal 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 raptor nests is influenced by many factors, including environmental conditions, disease, human activity, and available nesting habitat (Gende *et al.* 1997; Travisky and Beauvais 2004). In the Halfway River to Site C Dam section, while the number of nest trees decreased due to removals, occupancy of remaining surveyed nests reached 100% in 2024 and remained high (90%) in 2025—indicating strong competition for remaining nesting habitat annually surveyed (see Figure 4B). Downstream of the Site C Dam, occupancy rate of



76% has shown a slow but steady increase since 2017, reinforcing the importance of this area as a potential refuge for bald eagles nesting in the study area (see Figure 4C). Tracking nest availability, occupancy, and productivity is essential to understanding the effects of the Site C Dam on local bald eagle populations. Occupancy values are calculated as the proportion of active nests relative to the number of nests surveyed within each section and year. Because the number of surveyed nests vary annually, these values should be interpreted with caution. Nevertheless, they provide a useful temporal indication of nest use by bald eagles relative to the total number of available nests surveyed within each area.

The use of artificial platform nesting structures by bald eagles in the region is still rare. The first use of an artificial nesting platform by bald eagles within the Site C corridor occurred in 2024. This basket-style nest was the only structure that contained a relocated bald eagle nest indicating that there may be a preference for using a relocated nest than building on an empty platform. In 2025, the same nest was active with one nestling, but it was considered unproductive as there was no evidence of fledging completion. While artificial nesting platforms can function as valuable conservation tools in landscapes where natural nest trees have been lost or degraded (Watts et al. 2006), bald eagles continue to show a marked preference for natural trees. Such trees provide essential features, including high visibility for territorial surveillance, structural stability to support large nests, and partial canopy cover that offers protection from environmental stressors like wind, precipitation, and direct sunlight (Watts et al. 2006; Andrew and Mosher 1982).

Among the various techniques of nest structure builds documented, the most effective approach combines a sturdy artificial platform with the transfer of previously used natural nests or the incorporation of natural nest materials into the new structure (Bortolotti et al. 1988; Marion et al. 1992). This method yields higher occupancy rates and greater reproductive success than the installation of clean or empty platforms alone. Numerous studies have shown that bald eagles exhibit strong site fidelity, often returning to the same nest year after year and adding material to it continuously (Watts et al. 2006; Buehler 2000). This behavior makes the transfer of an existing nest particularly effective, as it retains familiar olfactory, visual, and structural cues that may facilitate acceptance by the original breeding pair or other territorial eagles (Bortolotti et al. 1988; Watts & Duerr 2010).

Platforms can also be strategically placed to enhance reproductive success, for example, by situating them close to reliable food sources and in areas with low human disturbance. Moreover, they can reduce competition among pairs in densely occupied areas or promote recolonization in regions where bald eagles have historically declined. In some documented cases, eagles have shown high fidelity to platforms once they successfully raise young there, indicating their potential to become long-term nesting sites (Andrew & Mosher 1982).

## **CONCLUDING SUMMARY**

The 2025 monitoring program was designed to:

1. Determine the status (active/inactive) and productivity of known and newly constructed bald eagle nests within the study area; and
2. Provide monitoring data to BC Hydro to inform Site C operational mitigation requirements.



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Both objectives were achieved.

Three helicopter surveys were conducted in April, May, and June 2025 following established RIC (2001) protocols. Survey effort was approximately 900 km covered across the three monitoring events. Known nests were revisited, newly constructed nests were identified, and artificial platforms were assessed. Nest status and productivity were determined using standardized criteria, including age-based productivity assumptions consistent with established literature.

Results demonstrate that bald eagle nesting activity in 2025 was comparatively strong relative to recent years. The number of active natural nests ( $n = 29$ ) exceeded the 2017–2024 average ( $n = 26$ ), and total fledged young ( $n = 38$ ) was above the recent multi-year mean. Fledging success (1.31 young per active nest) remained within the upper range observed during the monitoring period and indicates stable reproductive output.

Regional analysis suggests partial recovery in areas previously affected by nest tree removal, particularly upstream of the Halfway River and within the Site C footprint, where occupancy rates of remaining nests remained high. Downstream areas continued to show gradual increases in both nest numbers and occupancy.

Artificial nesting platforms continue to show limited uptake, with only one platform active in 2025 with no confirmed fledging success. However, the continued use of this platform (Eagle\_41.1B) for a second consecutive year suggests potential for long-term adaptation.

Overall, the 2025 monitoring results indicate that bald eagle reproductive performance within the study area remains stable and resilient despite habitat alterations associated with Site C reservoir development. The monitoring program successfully met its objectives and continues to provide critical data to support adaptive management and regulatory compliance.



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## 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 2025



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Row ID	Nest ID	Latitude	Longitude	First Detected	2025 Activity	Species	Nest Substrate
1	22	56.13563	-120.64073	pre-2014	Active	bald eagle	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	Tree gone	bald eagle	Tree
7	203	55.99701	-121.72124	pre-2014	Active	bald eagle	Tree
8	222	56.09350	-120.34967	pre-2014	Active (fledged)	bald eagle	Tree
9	225	56.00347	-121.67735	pre-2014	Inactive (other)	bald eagle	Tree
10	607	56.11830	-120.54547	2017	Not detected	-	Tree
11	611	56.00278	-121.67980	2017	Inactive	common raven	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	Not detected	-	Tree
17	1100	55.99477	-121.65667	2021	Inactive	bald eagle	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



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Row ID	Nest ID	Latitude	Longitude	First Detected	2025 Activity	Species	Nest Substrate
23	2202	56.02804	-121.89961	2022	Active (fledged)	bald eagle	Tree
24	2203	56.11968	-121.66675	2022	Active (fledged)	bald eagle	Tree
25	2204	56.13295	-121.62031	2022	Active (fledged)	bald eagle	Tree
26	2205	56.16553	-121.56509	2022	Active (fledged)	bald eagle	Tree
27	2206	56.17717	-121.52208	2022	Active	bald eagle	Tree
28	2207	56.22567	-121.39790	2022	Not detected	-	Tree
29	2208	56.14070	-120.71230	2022	Inactive	bald eagle	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	Active	bald eagle	Tree
35	23-001	56.20447	-120.94126	2023	Active	bald eagle	Tree
36	2501	56.11760	-120.95634	2025	Active	bald eagle	Tree
37	2502	56.22959	-121.36773	2025	Active	bald eagle	Tree
38	2503	56.26360	-121.17428	2025	Active	bald eagle	Tree
39	2504	56.15543	-120.73726	2025	Inactive	bald eagle	Tree
40	82.1	56.27494	-121.21140	2024	Inactive	-	Artificial
41	115.2	56.26696	-121.27370	2024	Inactive	-	Artificial
42	118.1	56.2583	-121.28423	2024	Inactive	-	Artificial
43	126	56.24313	-121.32064	2024	Inactive	-	Artificial
44	262	56.11707	-121.78712	2024	Inactive	-	Artificial



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Row ID	Nest ID	Latitude	Longitude	First Detected	2025 Activity	Species	Nest Substrate
45	268	56.10175	-121.81059	2024	Inactive	-	Artificial
46	272.2	56.08980	-121.82769	2024	Inactive	-	Artificial
47	276	56.07811	-121.82767	2024	Inactive	-	Artificial
48	351.1	56.04266	-121.88782	2024	Inactive	-	Artificial
49	397	56.02166	-121.90713	2024	Inactive	-	Artificial
50	Eagle 249	56.12294	-121.72933	2024	Inactive	-	Artificial
51	Eagle_134 _West	56.24284	-121.32593	2021	Inactive	-	Artificial
52	Eagle_14.1	56.22483	-120.93805	2021	Inactive	-	Artificial
53	Eagle_142	56.24337	-121.39449	2021	Inactive	-	Artificial
54	Eagle_144	56.23522	-121.40398	2021	Inactive	-	Artificial
55	Eagle_147	56.23081	-121.41371	2021	Inactive	-	Artificial
56	Eagle_151	56.23171	-121.43510	2021	Inactive	-	Artificial
57	Eagle_153	56.22785	-121.45057	2021	Inactive	-	Artificial
58	Eagle_153 _East	56.22949	-121.44242	2021	Inactive	-	Artificial
59	Eagle_167	56.25048	-121.50582	2021	Inactive	-	Artificial
60	Eagle_182 C	56.18959	-121.51610	2021	Inactive	-	Artificial
61	Eagle_216 B	56.18720	-121.52462	2021	Inactive	-	Artificial
62	Eagle_217	56.18436	-121.53404	2021	Inactive	-	Artificial
63	Eagle_246	56.11960	-121.70063	2021	Inactive	-	Artificial
64	Eagle_247 East	56.11782	-121.70977	2021	Inactive	-	Artificial
65	Eagle_249 _East	56.11805	-121.72080	2021	Inactive	-	Artificial
66	Eagle_254 _West	56.12484	-121.75518	2021	Inactive	-	Artificial



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Row ID	Nest ID	Latitude	Longitude	First Detected	2025 Activity	Species	Nest Substrate
67	Eagle_257_N	56.12191	-121.76874	2021	Inactive	-	Artificial
68	Eagle_258_East	56.12063	-121.77700	2021	Inactive	-	Artificial
69	Eagle_268	56.10171	-121.81042	2021	Inactive	-	Artificial
70	Eagle_326	56.07072	-121.85407	2021	Inactive	-	Artificial
71	Eagle_41.1_A	56.21323	-121.06435	2021	Inactive	-	Artificial
72	Eagle_41.1_B	56.21411	-121.07576	2021	Active	bald eagle	Artificial
73	Eagle_48	56.23015	-121.09307	2021	Inactive	-	Artificial
74	Eagle_49.1_B	56.21773	-121.10538	2021	Inactive	-	Artificial
75	Eagle_49.2_B	56.21560	-121.09437	2021	Inactive	-	Artificial
76	Eagle_75	56.25455	-121.18467	2021	Inactive	-	Artificial
77	Eagle_75.1	56.25009	-121.17684	2021	Inactive	-	Artificial
78	Gates Island	56.10869	-121.79515	2021	Inactive	-	Artificial
79	p32	56.24048	-121.12966	2018	Inactive	-	Artificial
80	p39	56.23498	-120.95523	2018	Inactive	-	Artificial
81	p47	56.23297	-121.10032	2018	Inactive	-	Artificial
82	Peaceview	56.24593	-121.28262	2024	Inactive	-	Artificial



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## APPENDIX B

### Active Bald Eagle Nests and Assumed Productivity 2025



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Row ID	Nest ID	Survey 1 April 29, 2025	Survey 2 May 17, 2025	Survey 3 June 21, 2025	Total Chicks Fledged
1	22	Adult incubating	2 grey chicks with adult	2 dark chicks adult perched nearby	2
2	29	Adult incubating other adult perched nearby	2 grey feathered chicks with adult	2 dark chicks in nest standing	2
3	38	Adult incubating	1 chick with adult in the nest	2 dark chicks standing in nest	2
4	100	Adult and at least one grey chick	2 grey chicks with adult in nest	2 mottled chicks in nest adult perched nearby	2
5	104	Adult incubating	1 grey chick with adult in nest	1 dark chick at edge of nest. Adult perched nearby	1
6	222	2 grey chicks under adult	2 grey chicks no adult	1 dark feathered chick	1
7	802	3 grey chicks with adult, other adult perched nearby	3 grey chicks with adult in nest	3 dark chicks	3
8	803	3 grey chicks with adult	3 grey chicks. Adult nearby	3 mottled chicks. Adult nearby	3
9	804	Adult on nest incubating	2 grey chicks with adult	2 dark chicks with adult	2
10	805	Adult on nest	2 grey chicks. Adults nearby	1 chick with flight feathers	1
11	1102	1 grey chick with adult.	3 grey chicks	3 mottled chicks	3
12	1105	Adult incubating	1 chick. Adult nearby	1 chick	1
13	1106	Adult incubating	1 white chick with adult	No chick or adult	1
14	2201	1 grey chick. Adult attending. Other adult nearby	2 grey chicks. Two adults nearby	nest not detected	2
15	2202	Adult incubating	2 grey chicks. Adult nearby	2 mottled chicks	2
16	2203	Adult incubating	2 grey chicks with adult	1 mottled chick	1
17	2204	Adult incubating	1 white chick with adult. Other adult nearby	1 dark chick	1
18	2205	2 white chicks with adult	1 dark chick with adult	No chick or adult	1
19	2209	1 gray chick with adult. Other adult nearby	2 grey chicks	1 dark chick. Adult nearby	1
20	2210	2 grey chicks with adult. Other adult flying nearby	2 grey chicks	2 dark chicks. Adult nearby	2



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Row ID	Nest ID	Survey 1 April 29, 2025	Survey 2 May 17, 2025	Survey 3 June 21, 2025	Total Chicks Fledged
21	2211	2 grey chicks with adult	2 dark chicks with adult	2 dark chicks	2
22	2301	Adult incubating	1 egg, 1 grey chick with adult. Other adult nearby	1 dark chick	1
23	2401	Adult incubating. Other adult nearby	2 grey chicks with adult	1 dark chick with adult	1
24	23-001	Adult incubating	Adult incubating	1 grey chick	1
25	2502	2 eggs with adult. Other adult nearby	1 white chick with adult	Adult nearby	1
26	2503	1 chick with 2 adults	1 grey chick with adult	1 mottled chick. Adult hundred meters upstream	1
				Estimated total fledged chicks*	38

\* nests with three chicks were assumed to fledge two chicks (Gerrard and Bortolotti 1988, as cited in Buehler 2021).