

## **Appendix 9. Gartersnake Artificial Hibernacula Monitoring 2021**



**REPORT**

# Site C Wildlife Mitigation Structures

## *Snake Hibernacula Monitoring 2021*

Submitted to:

**BC Hydro**

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18113590-010-R-Rev2

19 January 2022



## Distribution List

e-copy: BC Hydro

e-copy: Blueberry River Enterprises

e-copy: Golder Associates Ltd.

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## 1.0 OVERVIEW

The broad mitigation objectives of BC Hydro's snake hibernacula program are to mitigate short-term effects on snake denning habitat due to construction of the Site Clean Energy Project (The Project). Specifically, the aspects of the wildlife monitoring program conducted by Blueberry River Enterprises (BRE) consisted of the installation and monitoring of six snake hibernacula installed along the north side of the Peace River between Fort St. John and Hudson's Hope, BC (Figure 1, Appendix A: Figures 2-5).

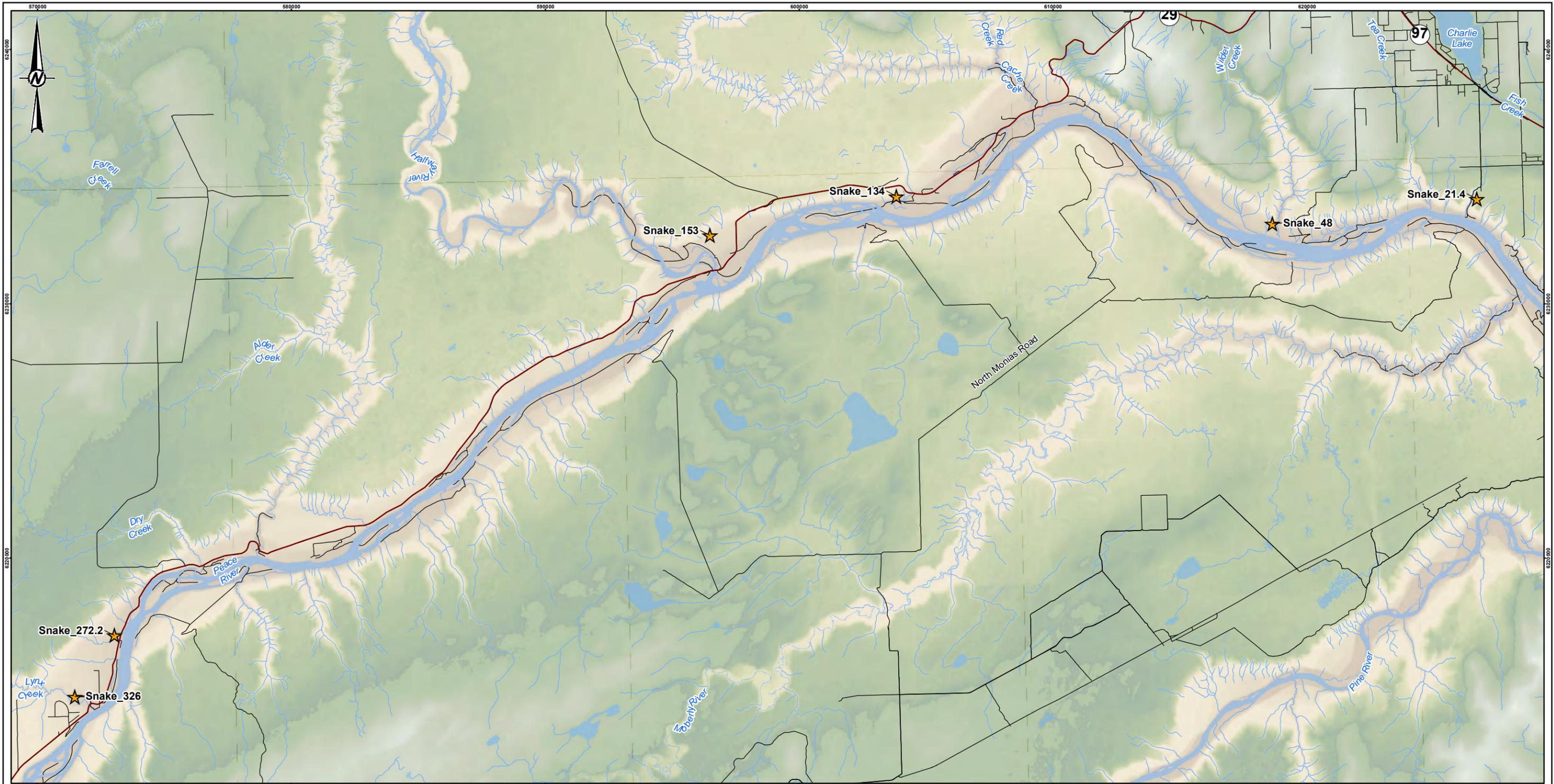
The requirements specific to snake hibernacula installation are detailed in the Construction Agreement between BC Hydro and Blueberry River Enterprises (BC Hydro Reference #686477). Golder Associates Ltd. (Golder) was contracted by BRE to provide technical expertise in support of the snake hibernacula monitoring program, and to lead field work in conjunction with BRE representatives. Mike Sarell, RPBio (Ophiuchus Consulting) was subcontracted by Golder as a Snake Technical Advisor to work on our team assisting with specific expertise relevant to the mitigation program. A total of six snake hibernacula were installed in the summer of 2020 as detailed in the Snake Hibernacula Installation Report (Golder 2020). The current report documents the results of snake hibernacula monitoring activities undertaken by BRE and Golder in 2021.

## 2.0 SNAKE HIBERNACULA DETAILS

The following details relating to installed snake hibernacula are summarized in Golder's 2020 installation report (Golder 2020) to provide background context and describe the configuration of the installed snake hibernacula.

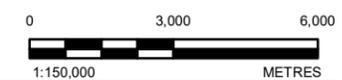
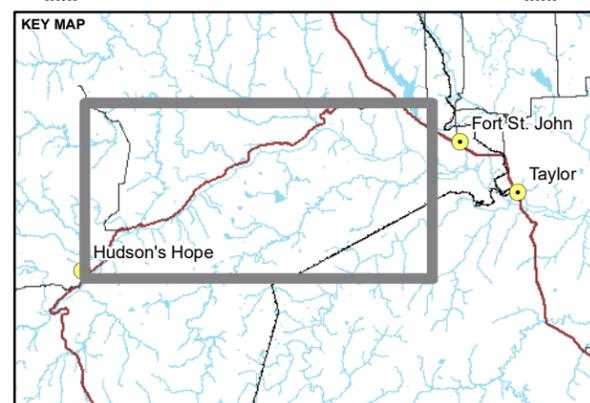
Snake hibernacula were installed by Kalmar, BRE's construction contractor, with guidance from the original Gartersnake Mitigation and Monitoring Workplan (Hilton et al. 2013) with advice and proposed field-refinement by Mike Sarell. The Scope of Services from BC Hydro (2017) asked that three artificial bank-style hibernacula and three mound-style hibernacula be installed. Upon review of site conditions, and at the recommendation of Mike Sarell, all installed snake hibernacula were bank-style designs. The original intent of installing mound-style hibernacula was largely a consequence of anticipated difficulties finding sufficient sites to locate an adequate number of preferred bank-style hibernacula at sloped sites (Sarell, pers. comm. 2020). Mound-style hibernacula, sited on level ground, have been used in England with success (Cresswell et al. 2008) but have not been tested in BC (Sarell, pers. comm. 2020). For the six artificial hibernacula sites planned, the crew were able to find an adequate number of sloped sites for the preferred bank style hibernacula to be implemented. Known and suspected hibernacula in the Peace are typically situated on warm aspect slopes, and therefore this was determined to be a suitable model to follow for implementation of this Project (Sarell, pers. comm. 2020).

The locations of installed snake hibernacula are shown in Figure 1 and Appendix A (Figures 2-5), with installation details summarized in Table 1.



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- LEGEND**
- ★ INSTALLED SNAKE HIBERNACULA LOCATION
  - HIGHWAY
  - ROAD
  - WATERCOURSE
  - WATERBODY



**REFERENCE(S)**

1. PRELIMINARY STABILITY IMPACT LINES AND GENERAL CLEARING AREAS OBTAINED FROM BC HYDRO.
2. TRANSPORTATION FEATURES OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. FISHER TYPE 1 DENNING STAND AND WATER BASE DATA OBTAINED FROM THE PROVINCE OF BRITISH COLUMBIA.

DATUM: NAD83 PROJECTION: UTM ZONE 10N

CLIENT  
BC HYDRO

PROJECT  
BRE WILDLIFE MITIGATION MONITORING PROGRAM

CONSULTANT	YYYY-MM-DD	2021-11-18
	DESIGNED	JS
	PREPARED	JP
	REVIEWED	TS
	APPROVED	IJ

<b>TITLE</b>			
<b>BRE SITE C MITIGATION SNAKE HIBERNACULA LOCATIONS</b>			
PROJECT NO.	CONTROL	REV.	FIGURE
18113590	1000	0	<b>1</b>

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

**Table 1: Snake Hibernacula Installation Details**

Hibernaculum Name	Installation Date	Easting / Northing (NAD 83) UTM Zone 10V	Distance to 'General Clearing Area'	Distance from trail/road (m)	Distance to drainage feature (m)	Nearby Habitat Features and Distance (m)	Nearby Installed Cover Features
Snake 21.4	14 July 2020	626695, 6234126	65.0 m (River/Stream – Intermittent)	200.8 m (Road unclassified)	574.4 m (Eastern Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Forested gully – 100 m west</li> <li>■ Forested habitat – 30 m east</li> </ul>	<ul style="list-style-type: none"> <li>■ 2 patio stones – 2 m east and 2 m west of entrance</li> </ul>
Snake 48	15 July 2020	618630, 6233149	159.0 m (Wilder Creek River/Stream – Definite)	149.6 m (Road unclassified)	91.4 m (Eastern Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Wilder Creek valley – 150 m east</li> <li>■ Forested habitat – 50 m south</li> </ul>	<ul style="list-style-type: none"> <li>■ 1 rock pile 3 m northeast of entrance</li> <li>■ 2 patio stones – 2 m east and 2 m west of entrance</li> </ul>
Snake 134	16 July 2020	603820, 6234237	52.9 m (River/Stream – Intermittent)	187.5 m (Trail)	85.0 m (Middle Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Forested gully – 30 m southeast</li> </ul>	<ul style="list-style-type: none"> <li>■ 1 patio stone at entrance with small rock pile</li> <li>■ 1 rock pile 3 m northeast of entrance</li> </ul>
Snake 153	16 July 2020	596484, 6232690	58.7 m (Flow Connectors – Inferred)	222.8 m (Trail)	545.9 m (Middle Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Silt bluffs – 700 m west</li> <li>■ Forested habitat – 50 m north and west</li> </ul>	<ul style="list-style-type: none"> <li>■ 2 patio stones at entrance with small rock pile</li> </ul>
Snake 272.2	17 July 2020	573017, 6216971	35.4 m (River/Stream – Definite)	105.9 m (Road unclassified)	54.7 m (Western Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Beaver lodge and dugout pond - 15 m east</li> <li>■ Forested habitat – 10 m north and south</li> </ul>	<ul style="list-style-type: none"> <li>■ 1 patio stone with three large rocks at entrance</li> </ul>
Snake 326	18 July 2020	571450, 6214558	106.3m (Lynx Creek River/Stream – Definite)	44.2 (Road unclassified)	118.6m (Western Reservoir Clearing)	<ul style="list-style-type: none"> <li>■ Buried vehicles - 30 m southeast</li> </ul>	<ul style="list-style-type: none"> <li>■ 2 patio stones 1 m east and 1 m west of the entrance and small rock pile</li> </ul>

### 3.0 2021 MONITORING SUMMARY

Monitoring activities in 2021 consisted of two rounds of site visits to assess occupancy as well as internal and surface hourly temperature monitoring via temperature loggers at each hibernaculum (Site Photos; Appendix B). The following subsections provide summaries of these monitoring activities and related results.

#### 3.1 Occupancy Monitoring

Two rounds of occupancy monitoring occurred in 2021, with round one occurring from 12-13 May and round two occurring from 10-11 June. Occupancy monitoring consisted of visual checks of the entrance and immediate area surrounding the hibernacula to look for individual snakes or snake sign (e.g., tracks, shed skins). Maintenance requirements for each hibernaculum were also assessed, with additional work consisting of gap filling and reinforcement of the hibernacula entrance completed during round two, where necessary.

Except for hibernaculum Snake 326 (Lynx Creek), snakes or snake sign were not observed during 2021 occupancy monitoring. On 13 May 2021, two male terrestrial gartersnakes (*Thamnophis elegans*) were observed at Snake 326 (Lynx Creek) under the left (western) cover tile (Appendix A, photo 7). On 11 June 2021, a total of four observations of at least two terrestrial gartersnakes were recorded, with one snake observed under the left (western) cover tile prior to flushing away from the hibernaculum. All other observations occurred in areas adjacent to the hibernaculum. Copies of field datasheets are found in Appendix C.

On 13 May 2021, Golder was notified by BC Hydro that a snake salvage was currently ongoing by Cantex and Ecofor Consulting Ltd. as part of construction of the Hudson's Hope Berm. BC Hydro indicated that salvaged snakes were being released at some of the installed hibernacula. Golder was provided data from this snake salvage for incorporation into this monitoring report (Cantex 2021). Snakes were salvaged from the Hudson's Hope Berm area between 30 April and 30 September 2021 (see Section 3.1.1).

Results of the occupancy monitoring are summarized in Table 2.

**Table 2: Results of the 2021 Snake Hibernacula Occupancy Monitoring Completed by Golder**

Hibernaculum Name	Date	Occupied	Snakes observed	Species	Comments
Snake 21.4 (Dam View)	12 May	No	No	-	Temperature logger data downloaded
	10 June	No	No	-	Gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 9 and 10)
Snake 48 (Wilder Creek)	12 May	No	No	-	Temperature logger data downloaded
	11 June	No	No	-	Gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 11 and 12)
Snake 134 (Watson Slough)	12 May	No	No	-	Temperature logger data downloaded
	10 June	No	No	-	Gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 13-14)

Hibernaculum Name	Date	Occupied	Snakes observed	Species	Comments
Snake 153 (Halfway River)	13 May	No	No	-	Temperature logger data downloaded
	10 June	No	No	-	Additional soil placed on hibernaculum to attempt to improve insulation; gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 15 and 16); adult western toad observed near hibernaculum entrance
Snake 272.2 (Peck's)	13 May	No	No	-	Temperature logger data downloaded; long-toed salamander observed near the entrance (Appendix B, photo 8)
	11 June	No	No	-	Additional soil placed on hibernaculum to attempt to improve its insulation (Appendix B, photos 19 and 20); gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 17 and 18)
Snake 326 (Lynx Creek)	13 May	No	Yes	Terrestrial gartersnake	2 snakes observed near hibernaculum entrance; temperature logger data downloaded
	11 June	No	Yes	Terrestrial gartersnake	A minimum of 2 individual snakes observed 4 times; additional soil placed on hibernaculum to attempt to improve its insulation (Appendix B, photos 23 and 24); gaps in hibernaculum entrance plugged using expanding insulating foam, rocks, and concrete/mortar/sand mixture (Appendix B, photos 21 and 22); adult western toad emerged from hibernaculum entrance (Appendix B, photo 30)

The optimal hibernation temperature range for snakes is suspected to be between 4-7 °C in the Peace Region (Sarell, pers. comm. 2017), with unsuitable conditions occurring if temperatures within the hibernacula drop below 0 °C (Gregory 1971), although gartersnakes have been observed to survive at least 'short' periods of subzero conditions (100% survival after 48 hrs at -1°C: Costanzo et al. 1988; 50% survival after 10 hrs at -2.5°C: Churchill and Storey 1992). During the first monitoring visit, it was confirmed that temperatures in the hibernacula did fall below freezing over the winter of 2020 during an extreme cold weather period (see Section 3.2); therefore, modifications to the hibernacula were proposed during the second monitoring visit.

Modifications to hibernacula consisted of reducing the number of gaps at all hibernaculum entrances and further insulating select hibernacula to reduce internal heat loss. Expanding insulating foam and additional rocks were used to fill gaps, which were then reinforced with a concrete, sand, and mortar mix (Appendix B, photos 15-18, 21 and 22). A small PVC tube had been installed for a temperature probe to be placed at the bottom of each hibernaculum. It is possible that this tube served as an opening for the incursion of cold air. As such, a piece of solid foam approximately 30 cm in length was inserted into the tube, and a cap was sealed on top of the PVC pipe with silicone (Appendix B, photos 25-28). Finally, three hibernacula, Snake 326 (Lynx Creek), Snake 153 (Halfway River), and Snake 272.2 (Peck's), had additional soil added on top, which was then seeded, to create additional insulation (Appendix B, photos 19, 20, 23, 24).

Snake use of the hibernacula could not be confirmed in 2020.

### 3.1.1 Hudson's Hope Berm Construction Snake Salvage

Snake salvages were completed from 30 April to 30 September 2021 by Ecofor Consulting Ltd. (Ecofor) in support of BC Hydro's berm construction in the Hudson Hope area. Golder understands that berm construction work intersected a previously unknown snake hibernaculum. Enclosure fencing was installed, and traps were set to capture snakes to relocate out of the active work area (Cantex 2021). A total of 95 gartersnakes were captured and relocated, 81 of which were relocated to three of the six installed hibernacula. In addition, 13 gartersnakes had emerged in the middle of the active construction site and were moved upstream of the berm outside of active construction where abundant rocks and cracks were present in the bank for shelter. Ecofor relocated 3 terrestrial gartersnakes to Snake 153 (Halfway River), 10 terrestrial gartersnakes to Snake 272.2 (Peck's), and 67 terrestrial gartersnakes and 1 common gartersnake (*Thamnophis sirtalis*) to Snake 326 (Lynx Creek; Table 3). It is unknown if relocated snakes remained at the release locations or dispersed from the relocation areas.

**Table 3: Ecofor Snake Salvage and Relocation to Installed Hibernacula**

Date of Salvage	Number Relocated	Species	Release Location Hibernaculum Name	
05-May-2021	3	Terrestrial Gartersnake	Snake 153 (Halfway River)	
06-May-2021	6	Terrestrial Gartersnake	Snake 326 (Lynx Creek)	
07-May-2021	1	Terrestrial Gartersnake		
08-May-2021	5	Terrestrial Gartersnake		
09-May-2021	5	Terrestrial Gartersnake		
10-May-2021	4	Terrestrial Gartersnake		
11-May-2021	2	Terrestrial Gartersnake		
12-May-2021	4	Terrestrial Gartersnake		
	1	Common Gartersnake		
13-May-2021	4	Terrestrial Gartersnake		
14-May-2021	7	Terrestrial Gartersnake		
17-May-2021	4	Terrestrial Gartersnake		
18-May-2021	1	Terrestrial Gartersnake		
19-May-2021	6	Terrestrial Gartersnake		
20-May-2021	4	Terrestrial Gartersnake		
21-May-2021	5	Terrestrial Gartersnake		
22-May-2021	4	Terrestrial Gartersnake		
23-May-2021	5	Terrestrial Gartersnake		
29-May-2021	1	Terrestrial Gartersnake		Snake 272.2 (Peck's)
31-May-2021	1	Terrestrial Gartersnake		
18-Jun-2021	1	Terrestrial Gartersnake		
21-Jun-2021	1	Terrestrial Gartersnake		
29-Aug-2021	1	Terrestrial Gartersnake		
30-Aug-2021	1	Terrestrial Gartersnake		
01-Sep-2021	1	Terrestrial Gartersnake		
29-Sep-2021	2	Terrestrial Gartersnake		
30-Sep-2021	1	Terrestrial Gartersnake		

## 3.2 Temperature Monitoring

Temperature monitoring was conducted at each hibernaculum to monitor the range of temperatures present, particularly if temperatures decreased below 0 °C where conditions may become unsuitable for hibernating snakes (Gregory 1971).

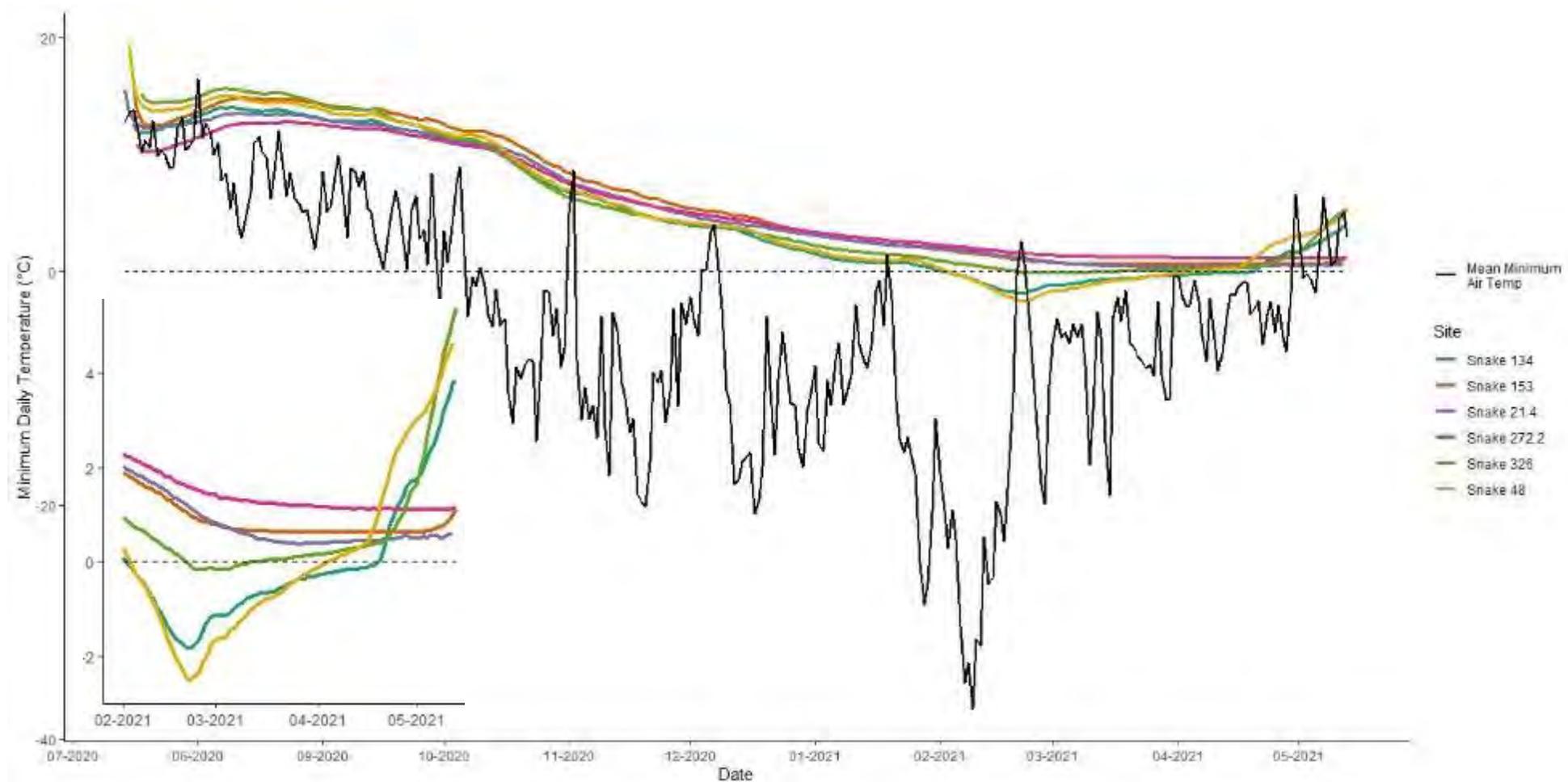
Temperature monitoring was conducted via two temperature loggers (HOBO USB Micro Station Logger with H21USB MicroStation Weatherproof datalogger [IP66]), which were deployed inside and outside of each of six hibernacula for a total of twelve temperature loggers to monitor both internal and surface temperatures. Monitoring commenced from 14-18 July 2020 and data were downloaded on 12-13 May 2021. Temperature loggers are still deployed and continue to monitor temperature. Hibernaculum Snake 48 was opportunistically visited on 14 October 2021 to verify that the logger remained in good working condition. No issues were noted at this location.

Minimum temperatures within the hibernacula decreased below 0 °C at three artificial hibernacula: Snake 48 (Wilder Creek), Snake 134 (Watson Slough), and Snake 326 (Lynx Creek). Temperatures fell below 0 °C at Snake 48 (Wilder Creek) and Snake 134 (Watson Slough) starting around early February 2021 and rose above 0 °C in early-April and mid-April 2021, respectively. At Snake 326 (Lynx Creek), temperatures fell below 0 °C in late-February 2021 and rose above 0 °C in mid-March 2021. The coldest surface temperatures at all six locations were experienced on 9 February 2021, with temperatures ranging from -35.4 °C to -39.8 °C, while coldest internal temperatures were experienced from February into May, depending on the location (Table 4; Graph 1). Notably, in April and May 2021, the same three hibernacula that had temperatures drop below freezing also had a rapid increase in hibernacula temperature, suggesting insufficient insulation at these locations.

While the internal temperature of only three hibernacula fell below 0 °C, loggers at all hibernacula recorded temperatures below 1.2 °C, below the 4-7 °C optimal hibernation temperature identified by Mike Sarell (pers. comm 2017). It is possible that snakes in the Peace Region are able to tolerate 'short' periods of subzero conditions (Costanzo et al. 1988, Churchill and Storey 1992). Regardless, efforts were made to further insulate hibernacula, including piling additional soil on and around three of the hibernacula (Snake 153, Snake 272.2 and Snake 326) and plugging gaps that could allow excess air circulation. There were constraints in the number of hibernacula able to be insulated with additional soil due to limitations of equipment and on-site soil availability. The success of these efforts will be revealed in the thermal data collected in the spring of 2022, which will help to inform further maintenance planning.

**Table 4: Minimum Temperatures and Days below 0°C Recorded at each Hibernaculum**

Hibernaculum Name	Minimum Internal Temperature (MIT)	Date of MIT	Minimum Surface Temperature Reading during MIT	Days below 0°C	Dates Range below 0°C
Snake 21.4 (Dam view)	0.38 °C	26-Mar-2021 / 27-Mar-2021	-11.94 °C / 0.38 °C	0	n/a
Snake 48 (Wilder Creek)	-2.51 °C	21-Feb-2021	4.19 °C	60	4-Feb-2021 to 4-Apr-2021
Snake 134 (Watson Slough)	-1.81 °C	20-Feb-2021 / 21-Feb-2021 / 22-Feb-2021	-0.40 °C / -1.81 °C / 3.41 °C	77	2-Feb-2021 to 19-Apr-2021
Snake 153 (Halfway River)	0.63 °C	18-Mar to 3-May 2021	-11.36 °C to 8.82 °C	0	n/a
Snake 272.2 (Peck's)	1.13 °C	12-Apr-2021 to 11-May-2021 (intermittent)	-9.30 °C to 7.77 °C	0	n/a
Snake 326 (Lynx Creek)	-0.14 °C	23-Feb-2021 to 5-Mar 2021 (intermittent)	-17.60 °C to 0.14 °C	9	2-Feb-2021 to 15-Mar-2021



**Graph 1: Daily minimum temperatures within all hibernacula (coloured lines) and mean daily minimum ground surface temperature recorded across sites (black) during the monitoring period, July 2020 to May 2021. A reference line (dashed) has been drawn at 0°C. Inset shows daily minimum hibernacula temperatures from 1 February to 12-13 May 2021.**

## 4.0 FUTURE MONITORING AND RECOMMENDATIONS

The 2022 and 2023 monitoring schedule and requirements as established in the Monitoring Agreement (BC Hydro Reference #686477) require the following monitoring activities to be conducted at snake hibernacula:

- Two occupancy surveys at each hibernaculum per year during spring emergence (April – June) with timing to be determined by environmental conditions each year. Based on observations of spring emergence in 2021, it is anticipated that the first two weeks of May could be the most suitable timing for future monitoring visits.
- Assessment of the condition of each hibernaculum.
- Continued ongoing temperature monitoring via remote temperature loggers and data download during the spring emergence surveys. Internal hibernacula temperature data is recommended to be compared between 2021 and 2022 to monitor how internal hibernacula temperatures responded to measures to further insulate the entrances completed in the spring of 2021. The results of monitoring will help inform further maintenance planning.

## 5.0 LIMITATIONS

This report has been prepared by Golder Associates Ltd., on behalf of Blueberry River Enterprises, for BC Hydro solely for the use of Blueberry River Enterprises and BC Hydro, in partial fulfilment of the terms and conditions of the Monitoring Agreement #686477. This report is limited to the field data, collected under the supervision of Golder, to assess occupancy of the snake hibernacula installed in 2020.

The findings and conclusions documented in this report have been prepared for specific application to this Project and have been developed in a manner consistent with the level of care normally exercised by environmental professionals currently practicing under similar conditions in the jurisdiction. Golder makes no other warranty, expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Golder accepts no responsibility for damages, if any suffered, by any third party as a result of decisions made or actions based on this report.

## 6.0 CLOSURE

We trust that this report provides sufficient information for your needs. If you have any questions, please do not hesitate to contact the undersigned.

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NM/JS/TMS/IJ/asd

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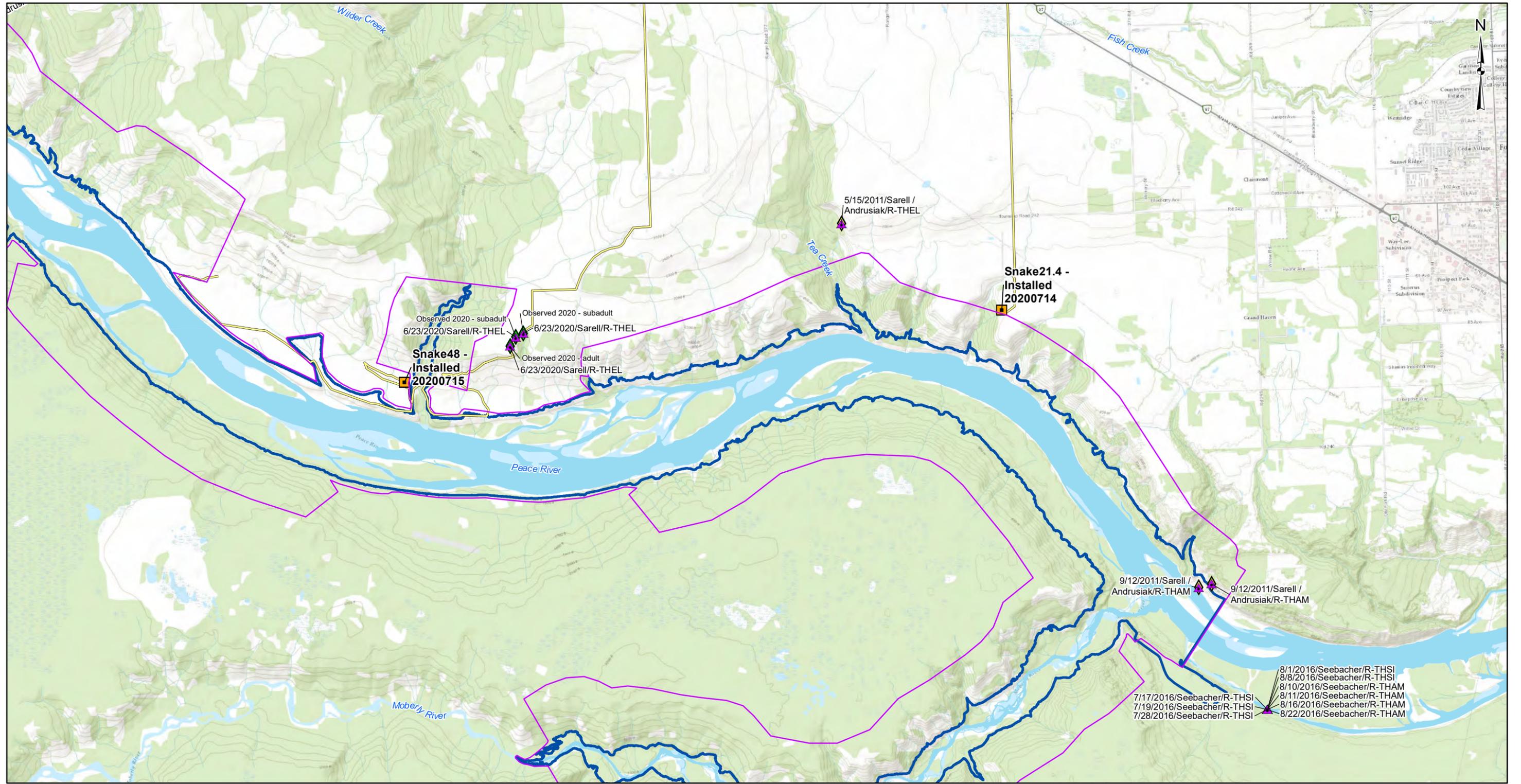
[https://golderassociates.sharepoint.com/sites/101442/deliverables/issued to client\\_for wp/18113590-010-r-rev2/18113590-010-r-rev2-re snake monitoring 19jan\\_22.docx](https://golderassociates.sharepoint.com/sites/101442/deliverables/issued%20to%20client_for/wp/18113590-010-r-rev2/18113590-010-r-rev2-re%20snake%20monitoring%2019jan_22.docx)

## 7.0 REFERENCES

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**APPENDIX A**

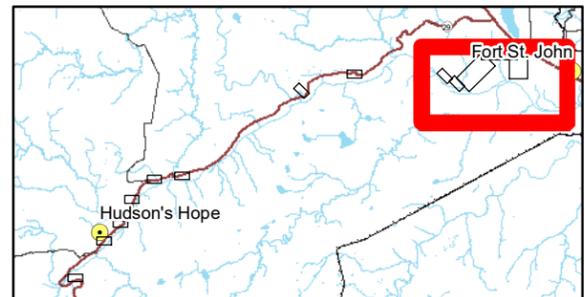
**Mapbook**



**Legend**

- Upper Limit of Proposed Reservoir (461.8 m)
- Preliminary Slope Stability Impact Line
- Installed Snake Hibernacula Locations 2020
- Snake Observation - 2020
- Historical BC Hydro Snake Observation
- Snake Observation

1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: Bing  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of January 2, 2018.



Species Code	Scientific Name	Common Name
R-THAM	<i>Thamnophis</i> sp.	Gartersnake sp.
R-THEL	<i>Thamnophis elegans</i>	Terrestrial Gartersnake
R-THIS	<i>Thamnophis sirtalis</i>	Common Gartersnake

Snake Hibernacula Monitoring Observations			
Round	Hibernacula	Species	Observed during Occupancy Monitoring
1	Snake 326	Terrestrial gartersnake	2
2	Snake 326	Terrestrial gartersnake	At least 2

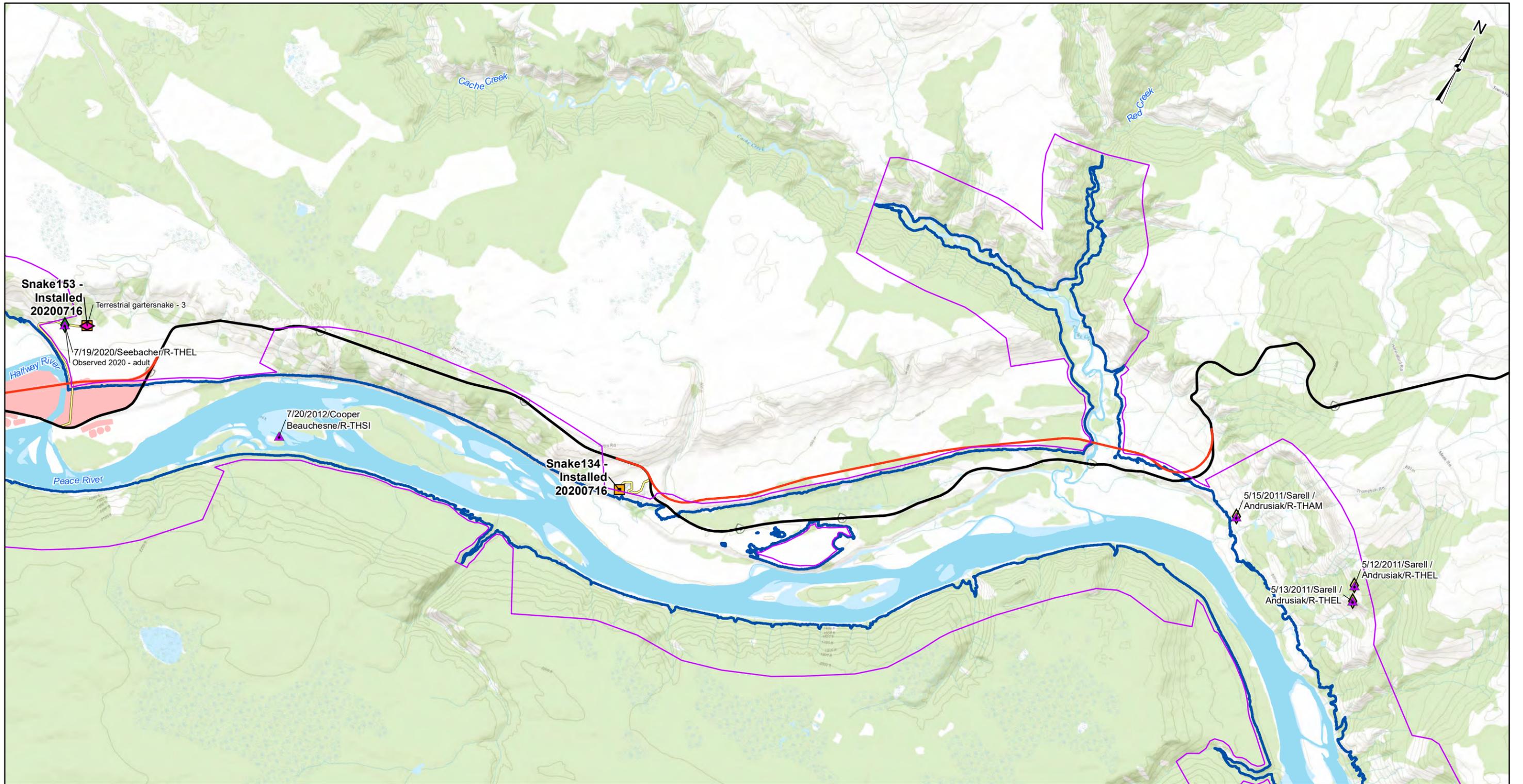
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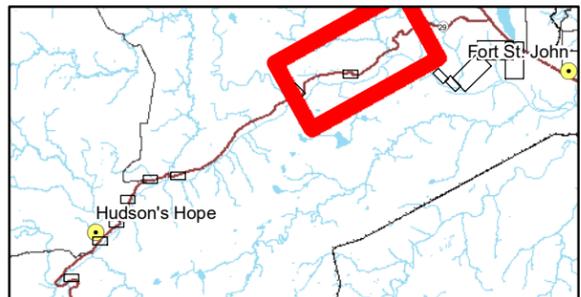
**Figure 2**  
**Snake Observations and Artificial Hibernacula (2020)**  
**(BRE Wildlife Mitigation Program)**

Date	Dec. 13, 2021	DWG NO	1016-N11-00921-1	R a
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Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.



Path: Y:\humbaby\CAD-GIS\Clients\BC\_Hydro\Site\_C199\_PROJECTS\1811359\02\_PROD\TOPO\DWG\Report\1016\_N11\_00921\_Site\_C\_Snake\_den\_installation\_2021.rvt.mxd



1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: Bing  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of January 2, 2018.

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**Legend**

- Upper Limit of Proposed Reservoir (461.8 m)
- Hwy 29 Re-Alignment Footprints
- Hwy 29 Re-Alignment Centerline
- Existing Hwy 29 Route
- Preliminary Slope Stability Impact Line
- Installed Snake Hibernacula Locations 2020
- ◆ Snake Observation - 2020
- ◆ Ecofor Salvage Release
- ◆ Historical BC Hydro Snake Observation
- ▲ Snake Observation

Species Code	Scientific Name	Common Name
R-THAM	<i>Thamnophis</i> sp.	Gartersnake sp.
R-THEL	<i>Thamnophis elegans</i>	Terrestrial Gartersnake
R-THIS	<i>Thamnophis sirtalis</i>	Common Gartersnake

Snake Hibernacula Monitoring Observations			
Round	Hibernacula	Species	Observed during Occupancy Monitoring
1	Snake 326	Terrestrial gartersnake	2
2	Snake 326	Terrestrial gartersnake	At least 2

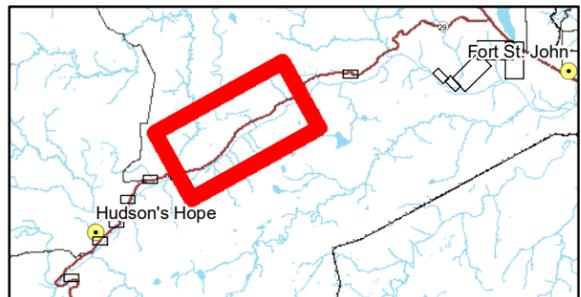
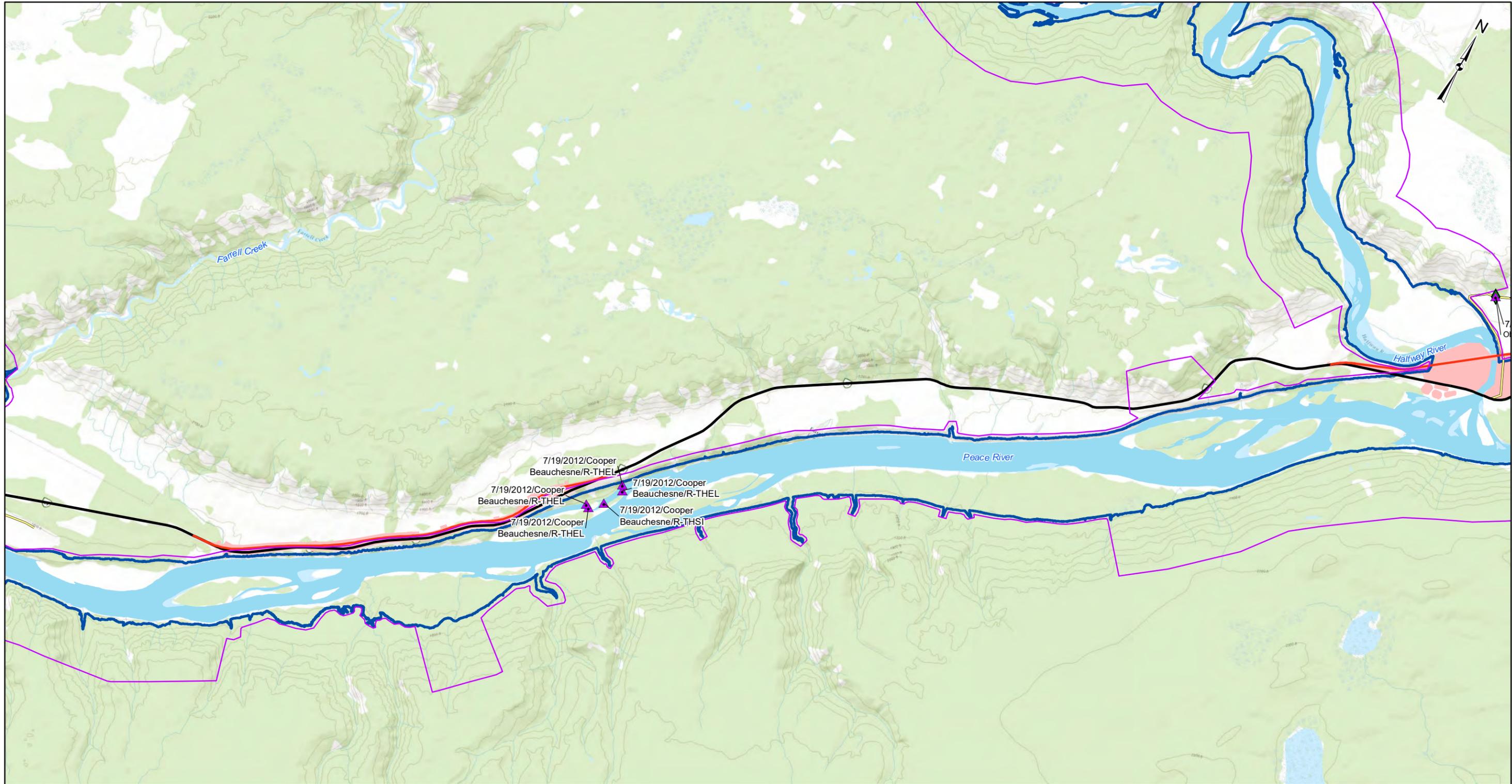
1:50,000 0 2,400 Meters



**Figure 3**  
**Snake Observations and Artificial Hibernacula (2020)**  
**(BRE Wildlife Mitigation Program)**

Date	Dec. 13, 2021	DWG NO	1016-N11-00921-2	R a
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Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.



1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: Bing  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of January 2, 2018.

- Legend**
- ▬ Upper Limit of Proposed Reservoir (461.8 m)
  - ▬ Hwy 29 Re-Alignment Footprints
  - ▬ Hwy 29 Re-Alignment Centerline
  - ▬ Existing Hwy 29 Route
  - ▬ Preliminary Slope Stability Impact Line
  - Installed Snake Hibernacula Locations 2020
  - ◆ Snake Observation - 2020
  - ◆ Ecofor Salvage Release
  - ▲ Snake Observation

Species Code	Scientific Name	Common Name
R-THAM	<i>Thamnophis</i> sp.	Gartersnake sp.
R-THEL	<i>Thamnophis elegans</i>	Terrestrial Gartersnake
R-THIS	<i>Thamnophis sirtalis</i>	Common Gartersnake

Snake Hibernacula Monitoring Observations			
Round	Hibernacula	Species	Observed during Occupancy Monitoring
1	Snake 326	Terrestrial gartersnake	2
2	Snake 326	Terrestrial gartersnake	At least 2

1:50,000 0 2,400 Meters



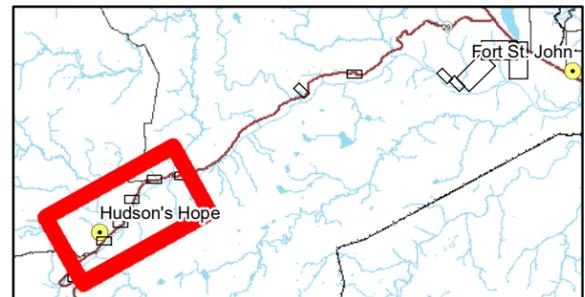
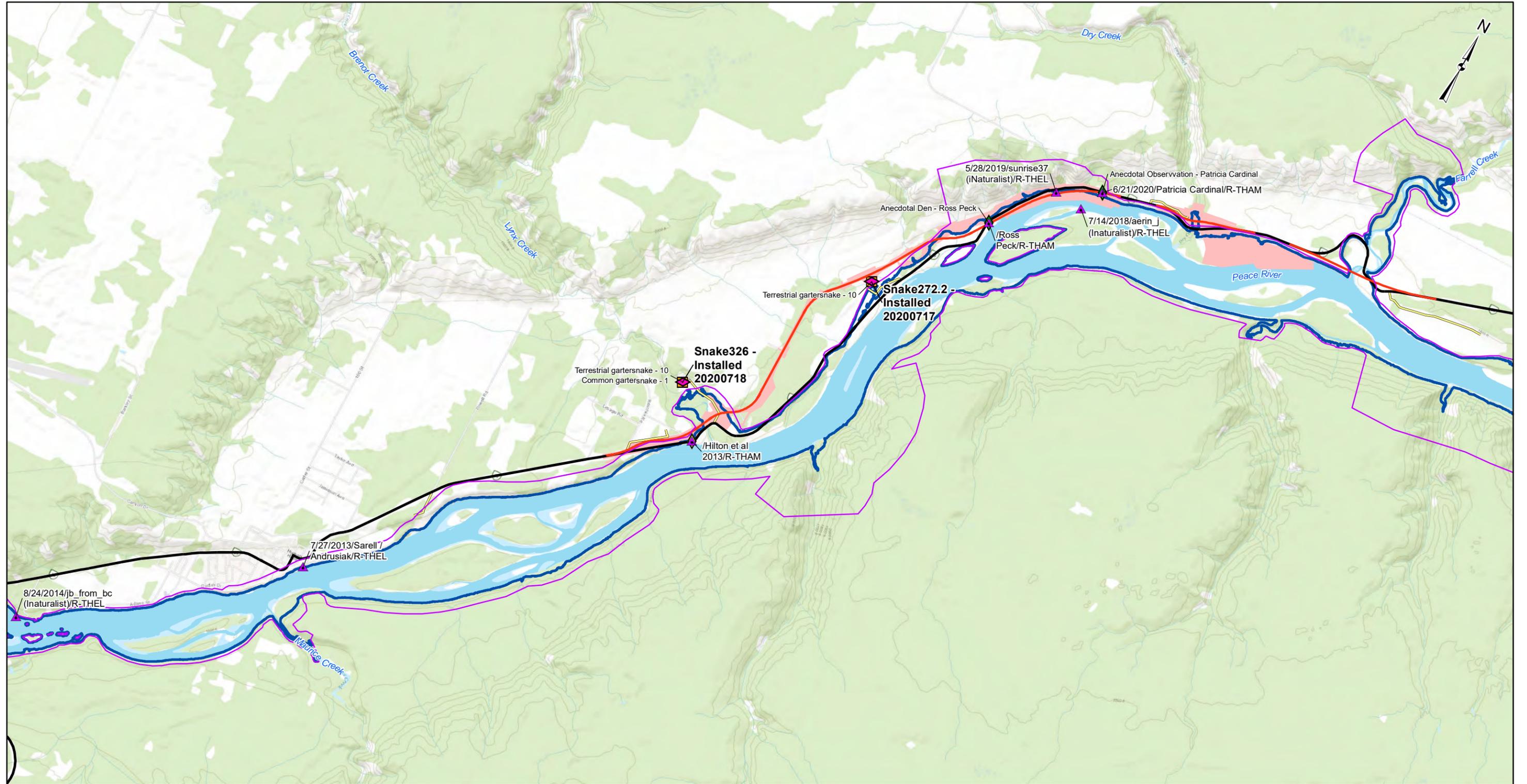
**Figure 4**  
**Snake Observations and Artificial Hibernacula (2020)**  
**(BRE Wildlife Mitigation Program)**

Date	Dec. 13, 2021	DWG NO	1016-N11-00921-3	R a
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Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: Y:\humbaby\CAD-GIS\client\BC\_Hydro\Site\_C199\_PROJECTS\1811359\02\_PRODUC\TOM\XDR\Report\1016\_N11\_00921\_Site\_C\_Snake\_den\_installation\_2021.rvt.mxd

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1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: Bing  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of January 2, 2018.

**Legend**

- ▬ Upper Limit of Proposed Reservoir (461.8 m)
- ▬ Hwy 29 Re-Alignment Footprints
- ▬ Hwy 29 Re-Alignment Centerline
- ▬ Existing Hwy 29 Route
- ▬ Preliminary Slope Stability Impact Line
- Installed Snake Hibernacula Locations 2020
- ◆ Snake Observation - 2020
- ◆ Ecofor Salvage Release
- ◆ Historical BC Hydro Snake Observation
- ▲ Snake Observation

Species Code	Scientific Name	Common Name
R-THAM	<i>Thamnophis</i> sp.	Gartersnake sp.
R-THEL	<i>Thamnophis elegans</i>	Terrestrial Gartersnake
R-THIS	<i>Thamnophis sirtalis</i>	Common Gartersnake

Snake Hibernacula Monitoring Observations			
Round	Hibernacula	Species	Observed during Occupancy Monitoring
1	Snake 326	Terrestrial gartersnake	2
2	Snake 326	Terrestrial gartersnake	At least 2

1:50,000 0 2,400 Meters



**Figure 5**  
**Snake Observations and Artificial Hibernacula (2020)**  
**(BRE Wildlife Mitigation Program)**

Date	Dec. 13, 2021	DWG NO	1016-N11-00921-4	R a
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Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: Y:\humbaby\CAD-GIS\Clients\BC\_Hydro\Site\_C199\_PROJECTS\18113590\02\_PROD\TOWNSHIP\1016\_N11\_00921\_Site\_C\_Snake\_den\_installation\_2021.rvt

**APPENDIX B**

**Photos**



**Photo 1: Snake 21.4 (Dam View) entrance on 12 May 2021.**



**Photo 2: Snake 48 (Wilder Creek) entrance on 12 May 2021.**



**Photo 3: Snake 134 (Watson Slough) entrance on 12 May 2021.**



**Photo 4: Snake 153 (Halfway River) entrance on 13 May 2021.**



**Photo 5: Snake 326 (Lynx Creek) entrance on 13 May 2021.**



**Photo 6: Snake 272.2 (Peck's) entrance on 13 May 2021.**



**Photo 7: Two terrestrial gartersnakes found near the entrance to Snake 326 (Lynx Creek) on 13 May 2021.**



**Photo 8: A long-toed salamander found near the entrance to Snake 272.2 (Peck's) on 13 May 2021.**



**Photo 9: Snake 21.4 (Dam View) entrance on 10 June 2021 prior to filling excess gaps.**



**Photo 10: Snake 21.4 (Dam View) entrance on 10 June 2021 after filling excess gaps.**



**Photo 11: Snake 48 (Wilder Creek) entrance on 10 June 2021 prior to filling excess gaps.**



**Photo 12: Snake 48 (Wilder Creek) entrance on 10 June 2021 after filling excess gaps.**



**Photo 13: Snake 134 (Watson Slough) entrance on 10 June 2021 prior to filling excess gaps.**



**Photo 14: Snake 134 (Watson Slough) entrance on 10 June 2021 after filling excess gaps.**



**Photo 15: Snake 153 (Halfway River) entrance on 11 June 2021 prior to filling excess gaps.**



**Photo 16: Snake 153 (Halfway River) entrance on 11 June 2021 after filling excess gaps and adding additional soil.**



**Photo 17: Snake 272.2 (Peck's) entrance on 11 June 2021 prior to filling excess gaps.**



**Photo 18: Snake 272.02 (Peck's) entrance on 11 June 2021 after filling excess gaps.**



**Photo 19: Snake 272.2 (Peck's) prior to addition of extra soil.**



**Photo 20: Snake 272.2 (Peck's) after addition of extra soil.**



**Photo 21: Snake 326 (Lynx Creek) entrance on 11 June 2021 prior to filling excess gaps.**



**Photo 22: Snake 326 (Lynx Creek) entrance on 11 June 2021 after filling excess gaps.**



**Photo 23: Snake 326 (Lynx Creek) prior to addition of extra soil.**



**Photo 24: Snake 326 (Lynx Creek) after addition of extra soil.**



**Photo 25:** Example of procedure to install extra insulation to the tube housing hibernaculum temperature logger. Tube cut close to ground level (11 June).



**Photo 26:** Example of procedure to install extra insulation to the tube housing hibernaculum temperature logger. Approximately 30 cm of foam added to top of tube (11 June).



**Photo 27:** Installation of extra insulation into the tube housing hibernaculum temperature logger. Insulating foam inserted into tube (11 June).



**Photo 28:** Installation of extra insulation to the tube housing hibernaculum temperature logger. Silicone sealant used to seal cap onto top of tube (11 June).



**Photo 29:** An adult western toad near the entrance of Snake 153 (Halfway River) on 10 June.



**Photo 30:** An adult western toad that emerged from Snake 326 (Lynx Creek) on 11 June.

**APPENDIX C**

**Field Data**

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	12 May 2021
Observers	TMS, MS, PC.

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	—
Air Temp (°C)	14°C
Ground Temp (°C)	Bib: 26/32/31 Patio: 34/33
UTM	10 U 626695, 6234126

Hibernacula Name	Snake 21.4 (Dam View)
Hibernacula Occupied?	Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown <input type="radio"/>
Start Time (24h)	10 <sup>00</sup>
End Time (24h)	



\*\*\* Reminder to rake sand at den entrance ✓

**Site Notes** Stay to edge of field while driving in, do not drive into site if wet, call Jim Sodergren at home 250-785-6548 or on his cell 250-262-8350 before monitoring for gate access code

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Snake sign
1) Cover tile 1	2	—
2) Cover tile 2	2	—
3) Rocks at entrance	0.5	—
4) Sand at entrance (tracks)	0.1	—
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #:  
 Black bear w 3 cuts on far bank, 3 dens across valley  
 VGSW, HETH

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

- some soil stuff ~0.5cm over lip onto bib.  
 - 2 ant colonies under patio stones (small / large)

**Temp Logger - Data Download Notes**

Battery - Good. - Downloaded data file, den did not get below zero.  
 - Push button start

## Snake Hibernacula Monitoring - 2021

Sheet \_\_\_ of \_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	12 May 2021
Observers	TMS, MS, PC

Field QA/QC by	
Cloud Cover	0 1 2 (3) 4 5
Wind	0 1 2 (3) 4 5
Precip	light rain / sun.
Air Temp (°C)	16°C
Ground Temp (°C)	Sandpit: 22/22/21    Patio: 25/25
UTM	10U 618630, 6233149

Den: 15



Hibernacula Name	Snake 48 (Wilder Creek)
Hibernacula Occupied?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Unknown <input type="checkbox"/>
Start Time (24h)	13:00
End Time (24h)	13:45

### Site Notes

48 hrs notice by telephone to: Owner at Ross and Deborah Peck 250.794.6269 and 250.261.0385, Mike Kroeher at 250.785.4956, Ray and Patty Hebert at 250.862.7657, Clay Peck 250-261-4815 and Katy Peck at 250.793.8222, and Blane Meek at 250-263-4174. Secondly Confirmation/Courtesy text Clay Peck - Cell 250-261-4815 to get gate code

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	2	None 
2) Cover tile 2	2	
3) Rock pile	3 to northeast	
4) Wilder Creek gully	150 m east	
5) Potential den past access gate	2 km by road	
6)		

### General Wildlife Observations (Fill out detail on WSI form)

Waypoint #: RWBL, deer scat, bear scat, Mike found deer antlers

### Hibernacula condition (e.g., temperature logger, repairs required etc)

Good condition, temp logger knocked off, put on with zap straps.

### Temp Logger - Data Download Notes

Good Battery, -2°C at coldest 7 April 2021  
4 Feb 2021 → 4 April 2021 below zero.

Cloud Cover Codes:	0 = clear/few clouds    1 = partly cloudy    2 = cloud/overcast    3 = fog    4 = drizzle    5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none    1 = drizzle    2 = rain    3 = sleet    4 = fog    5 = snow

## Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	12 May 2021
Observers	TMS, MS, PC

Field QA/QC by	
Cloud Cover	0 1 (2) 3 4 5
Wind	0 1 2 (3) 4 5
Precip	—
Air Temp (°C)	21.°C
Ground Temp (°C)	Sand: 38/34/25 Patio: 37
UTM	10U 603820, 6234237 Den: 20°C

Hibernacula Name	Snake 134 (Watson Slough)
Hibernacula Occupied?	Yes (No) Unknown
Start Time (24h)	15:45
End Time (24h)	16:30



**Site Notes**

Call XX before monitoring (None)

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	⊕
2) Rocks at entrance	0.5	
3) Rock pile	3 to northeast	
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #: Bear across river observed, horses in lower field

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

Good condition, grass seed growing.

**Temp Logger - Data Download Notes**

Good condition, Battery: GOOD, temp below zero for ~ 2 months. (2 Feb 2021 → 19 April 2021.)

Cloud Cover Codes:	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

## Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	13 May 2021
Observers	TMS, MS, PC

Field QA/QC by	
Cloud Cover	0 ① 2 3 4 5
Wind	0 ① 2 3 4 5
Precip	—
Air Temp (°C)	17°C
Ground Temp (°C)	Patio: 24/25 Sand: 31/33/35
UTM	10 U 596484, 6232690 Den: 16°C

Hibernacula Name	Snake 153 (Halfway River)
Hibernacula Occupied?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Unknown <input type="checkbox"/>
Start Time (24h)	10 <sup>00</sup>
End Time (24h)	10 <sup>20</sup>



### Site Notes

No issues for access

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	0.5	—
2) Cover tile 1	0.5	—
3) Rock pile at entrance	0.5	—
4) Silt bluffs	700 to west	
5)		
6)		

### General Wildlife Observations (Fill out detail on WSI form)

Waypoint #: CAGO, 2 kestrel, coyote scat at top.

\*Note, new access road and berm built into edge of agricultural field - berm piled to east.

### Hibernacula condition (e.g., temperature logger, repairs required etc)

Good, could use more soil on top of entrance, washed away?

### Temp Logger - Data Download Notes

Good battery life, coldest got to 0.6°C.

Cloud Cover Codes:	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

May 6 → 4 snakes.  
           → 2 snakes.

## Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	13 May 2021
Observers	TMS, MS, PC

Field QA/QC by	
Cloud Cover	0 1 2 (3) 4 5
Wind	0 1 (2) 3 4 5
Precip	—
Air Temp (°C)	19°C
Ground Temp (°C)	Patio: 44/45 °C Sand 51/47/46
UTM	10 U 571450, 6214558 Dan: 22

Hibernacula Name	Snake 326 (Lynx Creek)
Hibernacula Occupied?	(Yes) No Unknown
Start Time (24h)	12:30
End Time (24h)	18:30



### Site Notes

Please call Travis: 250-783-0529 or Steve: 250-783-0531 prior to access

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	2 THEL ♂ → See over for more detail. *
2) Cover tile 2	1	— ants.
3) Rock pile	0.5	—
4) Buried vehicles	30 to southeast	—
5)		
6)		

### General Wildlife Observations (Fill out detail on WSI form)

Waypoint #: RNSA tapping + calling.

### Hibernacula condition (e.g., temperature logger, repairs required etc)

Good, some soil moved away from horses on NE side of den, would be good to add more! Grass not growing well in den area due to horses - re-seed??

### Temp Logger - Data Download Notes

Good Battery condition, coldest -0.1°C between 20 Feb 2021 and 15 March 2021.

Cloud Cover Codes:	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

## Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	13 May 2021
Observers	TMS, MS, PC

Field QA/QC by	
Cloud Cover	0 1 2 (3) 4 5
Wind	0 1 2 3 (4) 5
Precip	—
Air Temp (°C)	19°C
Ground Temp (°C)	<del>19°C</del> Path: 43°C
UTM	10 U 573017, 6216971 37   36/35

Hibernacula Name	Snake 272.2 (Pecks)
Hibernacula Occupied?	Yes (No) Unknown
Start Time (24h)	14:30
End Time (24h)	15:10



Den: 15°C

**Site Notes** Please call both for Ross and Deborah prior to access: Ross: 250.261.0385 Deborah: 250.794.6269.

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	Longtoed salamander
2) Rocks at entrance	0.5	
3) Beaver lodge and dugout pond	15 m to east	Fresh beaver cutting.
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #: LAGO X 30, P1110.

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

Good, grass growing well.

**Temp Logger - Data Download Notes**

Good Battery, All good, coldest temp 1.1°C; did not go below zero.

<b>Cloud Cover Codes:</b>	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
<b>Wind Codes:</b>	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
<b>Precipitation Codes:</b>	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

# Snake Hibernacula Monitoring - 2021

Sheet      of     

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	10 Jun 21
Observers	JS/MS/PL

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	None
Air Temp (°C)	13.0°C
Ground Temp (°C)	15.3°C
UTM	10 U 626695, 6234126

Hibernacula Name	Snake 21.4 (Dam View)
Hibernacula Occupied?	Yes      No      Unknown
Start Time (24h)	9:30
End Time (24h)	



\*\*\* Reminder to rake sand at den entrance

**Site Notes**      Stay to edge of field while driving in, do not drive into site if wet, call Jim Sodergren at home 250-785-6548 or on his cell 250-262-8350 before monitoring for gate access code

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Snake sign
1) Cover tile 1	2    17.50C	
2) Cover tile 2	2    21.80C	
3) Rocks at entrance	0.5    23.00C	
4) Sand at entrance (tracks)	0.1    21.10C	
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #:

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

- ① Shorten Temp Logger pipe + fill with 14" foam strip
- ② Spray expanding foam into upper chambers of den entrance (see photos)
- ③ Apply concrete + rock fill to all upper + side openings (see photos)

**Temp Logger - Data Download Notes**

deferred

Cloud Cover Codes: <u>1</u>	0 = clear/few clouds    1 = partly cloudy    2 = cloud/overcast    3 = fog    4 = drizzle    5 = showers
Wind Codes: <u>2-3</u>	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes: <u>0</u>	0 = none      1 = drizzle      2 = rain      3 = sleet      4 = fog      5 = snow

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	11 June '21
Observers	JS/MS/PC

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	None
Air Temp (°C)	
Ground Temp (°C)	22.30C
UTM	10U 618630, 6233149

Hibernacula Name	Snake 48 (Wilder Creek)
Hibernacula Occupied?	Yes No <u>Unknown</u>
Start Time (24h)	9:46
End Time (24h)	



### Site Notes

48 hrs notice by telephone to: Owner at Ross and Deborah Peck 250.794.6269 and 250.261.0385, Mike Kroecker at 250.785.4956, Ray and Patty Hebert at 250.862.7657, Clay Peck 250-261-4815 and Katy Peck at 250.793.8222, and Blane Meek at 250-263-4174. Secondly Confirmation/Courtesy text Clay Peck – Cell 250-261-4815 to get gate code

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	2	30.70C
2) Cover tile 2	2	27.10C
3) Rock pile	3 to northeast	19.00C
4) Wilder Creek gully	150 m east	
5) Potential den past access gate	2 km by road	
6)		

### General Wildlife Observations (Fill out detail on WSI form)

Waypoint #:

Bald Eagle soaring directly above hibernacula.

### Hibernacula condition (e.g., temperature logger, repairs required etc)

- filled gaps in entrance w/ foam
- reinforced gaps w/ concrete/mortar/sand mix.
- cut den temp logger ~5cm above ground, inserted foam, sealed w/ silicone.

### Temp Logger - Data Download Notes

N/A

Cloud Cover Codes:	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

### SITE SKETCH

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	10/Jan/21
Observers	FC/MS/PC

Field QA/QC by	
Cloud Cover	0 1 2 3 <u>4</u> 5
Wind	0 1 <u>2</u> 3 4 5
Precip	light drizzle
Air Temp (°C)	
Ground Temp (°C)	16.0
UTM	10U 603820, 6234237

Hibernacula Name	Snake 134 (Watson Slough)
Hibernacula Occupied?	Yes No <u>Unknown</u>
Start Time (24h)	12:00
End Time (24h)	13:00



**Site Notes**  
Call XX before monitoring

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	25.0°C
2) Rocks at entrance	0.5	19.1°C
3) Rock pile	3 to northeast	15.3°C
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**  
Waypoint #:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Hibernacula condition (e.g., temperature logger, repairs required etc)**  
- filled gaps in entrance w/ expanding foam  
- reinforced cracks in entrance w/ concrete  
- cut den temp probe ~ 5cm above ground level, filled w/ foam to insulate

**Temp Logger - Data Download Notes**  
N/A.

**Cloud Cover Codes:** 0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers  
**Wind Codes:** 0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)  
**Precipitation Codes:** 0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

**SITE SKETCH**

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	10 June 21
Observers	JS/MS/PC

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	light drizzle
Air Temp (°C)	
Ground Temp (°C)	21.08
UTM	10 U 596484, 6232690

Hibernacula Name	Snake 153 (Halfway River)
Hibernacula Occupied?	Yes No <u>Unknown</u>
Start Time (24h)	11:00
End Time (24h)	<del>11:00</del> 15:40



**Site Notes**  
No issues for access

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	0.5	32.6 °C
2) Cover tile 1	0.5	33.1 °C
3) Rock pile at entrance	0.5	27.1 °C
4) Silt bluffs	700 to west	
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #:  
 Adult WETO @ entrance to hibernacula on arrival  
 Bald Eagle soaring near parking spot in corner of field.

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

- Sealed ~~the~~ gaps in entrance w/ expanding insulating foam
- filled gaps w/ extra rocks
- placed concrete to cover gaps, seal rocks together
- cut pipe for den temp logger, placed insulation + sealed w/ silicone.

**Temp Logger - Data Download Notes**

N/A  
 ↳ added some additional soil on top of den entrance from slightly upslope.

Cloud Cover Codes:	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
Wind Codes:	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
Precipitation Codes:	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

**SITE SKETCH**

\_\_\_\_\_

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	11 June 21
Observers	JS/MS/PC

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	None
Air Temp (°C)	
Ground Temp (°C)	23.4°C
UTM	10 U 573017, 6216971

Hibernacula Name	Snake 272.2 (Pecks)
Hibernacula Occupied?	Yes No <u>Unknown</u>
Start Time (24h)	15:15
End Time (24h)	17:00



**Site Notes** Please call both for Ross and Deborah prior to access: Ross: 250.261.0385 Deborah: 250.794.6269.

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	41.5°C
2) Rocks at entrance	0.5	36.1°C
3) Beaver lodge and dugout pond	15 m to east	
4)		
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #:  
 - 2 little brown nuthatches in green house. (MS spp. ID)  
 - beaver near lodge in pond

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

- filled gaps w/ expanding insulating foam.  
 - reinforced gaps w/ concrete/sand/mortar mix  
 - cut tube w/ den temp logger, inserted insulation, sealed w/ silicone.  
 - added additional soil, sealed

**Temp Logger - Data Download Notes**

N/A.

<b>Cloud Cover Codes:</b>	0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers
<b>Wind Codes:</b>	0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)
<b>Precipitation Codes:</b>	0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

**SITE SKETCH**

# Snake Hibernacula Monitoring - 2021

Sheet \_\_\_\_\_ of \_\_\_\_\_

Project Name	BRE Wildlife Mitigation
Project Number	18113590/4000/4003
Date (dd/mmm/yy)	11 June '21
Observers	JS/MS/PC

Field QA/QC by	
Cloud Cover	0 1 2 3 4 5
Wind	0 1 2 3 4 5
Precip	None
Air Temp (°C)	
Ground Temp (°C)	21.00C
UTM	10 U 571450, 6214558

Hibernacula Name	Snake 326 (Lynx Creek)
Hibernacula Occupied?	<input checked="" type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Unknown
Start Time (24h)	13:15
End Time (24h)	15:00



**Site Notes** Please call Travis: 250-783-0529 or Steve: 250-783-0531 prior to access

Cover Feature Type (e.g., rock pile, CWD)	Distance from Hibernacula (m)	Notes
1) Cover tile 1	1	38.7°C
2) Cover tile 2	1	39.6°C → 1 snake underneath.
3) Rock pile	0.5	28.3°C
4) Buried vehicles	30 to southeast	
5)		
6)		

**General Wildlife Observations (Fill out detail on WSI form)**

Waypoint #:

- Terrestrial garter beneath left cover tile. - flushed away from den
- WETO inside hibernacula entrance.
- Terrestrial observed on soil
- Terrestrial W of den
- Terrestrial on bare soil on den.

- # of snakes unknown  
to probably 2.

**Hibernacula condition (e.g., temperature logger, repairs required etc)**

- Sealed gaps in entrance w/ insulating foam.
- reinforced gaps w/ concrete / mortar / sand mix
- cut pipe w/ den temp logger, filled w/ insulation, sealed w/ silicone.
- piled additional soil on top of den. + seeded.

**Temp Logger - Data Download Notes**

N/A

**Cloud Cover Codes:** 0 = clear/few clouds 1 = partly cloudy 2 = cloud/overcast 3 = fog 4 = drizzle 5 = showers

**Wind Codes:** 0 = vertical smoke (<1 kph); 1 = smoke drifts (1-5 kph); 2 = wind felt on face, leaves rustle (6-11 kph); 3 = leaves/twigs in constant motion (12-19 kph); 4 = raises dust, small branches sway (20-28 kph); 5 = trees sway (29-38 kph)

**Precipitation Codes:** 0 = none 1 = drizzle 2 = rain 3 = sleet 4 = fog 5 = snow

**SITE SKETCH**



**[golder.com](http://golder.com)**

**Appendix 10. Cavity Nesting Mitigation and Monitoring Program –  
2021 Annual Report**

# MEMORANDUM

Date:	January 26, 2022
To:	BC Hydro
From:	Hemmera Envirochem Inc.
File:	989619-08
Re:	Cavity Nesting Mitigation and Monitoring Program – 2021 Annual Report

## 1.0 INTRODUCTION

BC Hydro assessed the potential effects of the Site C Clean Energy Project on Wildlife Resources in the Site C Environmental Impact Statement (EIS) using key species groups (BC Hydro 2013). Cavity nesting bird species were assessed in the EIS as part of the migratory birds (passerines [songbirds], northern flicker, and waterfowl) and raptors (hawks and owls) groups (BC Hydro 2016). In 2017, a mitigation and monitoring plan for cavity nesting birds was developed with input from the Vegetation and Wildlife Technical Committee, which is comprised of representatives of the Canadian Wildlife Service, the BC Ministry of Environment and Climate Change Strategy and the BC Ministry of Forests, Lands, Natural Resources Operations and Rural Development.

The purpose of the Cavity Nesting Mitigation and Monitoring Program is to mitigate habitat loss for cavity nesting species associated with Site C reservoir vegetation clearing, and to monitor the effectiveness of that mitigation (BC Hydro 2018). Mitigating the impacts of habitat loss for cavity nesting birds is focused on areas that will be retained (i.e., not cleared and not flooded) and currently have a low density of suitable trees for cavity nesting species (i.e., structural stage 4 [pole-sapling] or 5 [young forest] habitats<sup>1</sup> that have few large-diameter live trees or snags). Mitigation of habitat loss will be achieved using different measures depending on the time period for the effects for which they are intended to mitigate (i.e., short-, medium-, or long-term). Nest box installation for cavity nesting species provides short-term mitigation, the results of which are the focus of this memo.

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<sup>1</sup> Structural Stage 4 (pole-sapling forest): Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.  
Structural Stage 5 (young forest): Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions; from RIC (1998).

## 2.0 METHODS

### 2.1 Nest Box Construction

Cavity nesting birds differ in their habitat requirements and selection of cavities. Therefore, a variety of nest box designs were constructed to mitigate impacts on nesting habitat for cavity nesting birds due to activities associated with the Site C Clean Energy Project (**Figure 1**). Thirteen different nest box designs were constructed to accommodate 21 species of cavity nesting birds, with some box designs intended to support multiple species (BC Hydro 2018).



**Figure 1 Nest Box Designs Built for the Cavity Nesting Mitigation and Monitoring Program.**

### 2.2 Nest Box Installation

The selection of sites followed specifications described in the Cavity Nesting Species Mitigation and Monitoring Program (BC Hydro 2018). The selection of habitat and placement of nest boxes was guided based on information from James (1984) and Terrestrial Ecosystem Mapping data collected in 2016 along the anticipated reservoir. Boxes were placed on lands owned or leased by BC Hydro or on Crown land, in areas outside of planned clearing boundaries, above the high-water mark, and in areas of suitable but suboptimal habitat (i.e., areas of suitable age class but with a low number of cavity trees).

Box installation was specifically focussed on lower suitability habitat with a low proportion of potential cavity nesting trees (i.e., structural stages 4 to 5, but which have the greatest potential to develop into more suitable habitat over the short term (see **Figure 2** for an example of nest box installation). Additional information based on literature and expert knowledge were also considered for the installation of nest boxes:

- Proximity to a food source for all species (e.g., wetlands, water sources)
- Bird distribution and abundance information from Site C baseline studies in the area
- Known habitat associations
- Appropriate nest heights (**Table 1**)
- Density of nest boxes within an area (i.e., spacing between nest boxes) (**Table 1**).



**Figure 2** Nest box design ‘A,’ intended for black-capped chickadee (*Poecile atricapillus*), boreal chickadee (*Poecile hudsonicus*), red-breasted nuthatch (*Sitta canadensis*), white-breasted nuthatch (*Sitta carolinensis*), house wren (*Troglodytes aedon*), and brown creeper (*Certhia americana*).

**Table 1 Installation Guide Table Showing Minimum Distance Between Boxes and Height of Installation for the Different Types of Boxes Used in the Mitigation Plan**

Species Group	Common Name	Scientific Name	Minimum Spacing Between Boxes (m)	Nest Box Height (m)
<b>Passerines</b>	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
	red-breasted nuthatch	<i>Sitta canadensis</i>	50	1.5 - 4.5
	white-breasted nuthatch	<i>Sitta carolinensis</i>	300	1.5 - 6
	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
	house wren	<i>Troglodytes aedon</i>	30	1.5 - 3
	mountain bluebird	<i>Sialia currucoides</i>	90	1.2 – 1.8
<b>Waterfowl</b>	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>	1,000	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
<b>Raptors and Owls</b>	barred owl	<i>Strix varia</i>	1,000	4.5 - 9
	boreal owl	<i>Aegolius funereus</i>	150	≥3
	northern saw-whet owl	<i>Aegolius acadicus</i>	400-500	≥3
	northern pygmy-owl	<i>Glaucidium gnoma</i>	400-500	≥3
	northern hawk-owl	<i>Surnia ulula</i>	500-700	≥3
	American kestrel	<i>Falco sparverius</i>	500-800	3.5 – 6

### 2.3 Nest Box Monitoring and Maintenance

Nest boxes will continue to be monitored biennially through the Site C Clean Energy Project construction and the first ten years of operations (**Appendix A**). Boxes installed in 2017 were monitored in 2020 (Hemmera 2020) and will be monitored again in 2022 and every two years after that through the first 10 years of Project operations. Boxes installed in 2019 and 2020 were monitored in 2021 and will be monitored again in 2023.

Monitoring in 2021 was conducted by a qualified environmental professional in a manner that minimizes disturbance to active nests. Using the breeding period information provided in **Appendix B**, nest box visits were timed to coincide with nest stages in which the likelihood of detecting use is greatest (i.e., late incubation to early nestling stages).

Visits timed to coincide with nests at a stage with older nestlings are more likely to have their status determined, as parents are more likely to be feeding older nestlings more frequently. However, due to variation in brood timing within and among species, attempting to time surveys to coincide with the presence of older nestlings would increase the chance of arriving too late for direct observations of breeding activity for some nests. Therefore, a conservative estimate of the nesting window was applied to maximize the likelihood of observing active use and determining the species using each box.

During the monitoring work, surveyors approached the box discreetly, watching and listening for activity. When adults were attending a box, surveyors observed from a distance, recorded species, and attempted to determine stage (if nestlings were present, food delivery and fecal sac removal confirmed stage). If no use was evident from nest box observation, surveyors approached the nest box structure (tree or otherwise) and tapped lightly on it to elicit a response (Dudley and Saab 2003). If no bird appeared at the cavity entrance, a pole-mounted camera was used to examine the nest box contents. When 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, where possible, the species or genus occupying the box. For species with similar eggs and nests, it is only possible to identify to genus (e.g., goldeneye species [*Bucephala* sp.]).

During each nest box visit surveyors recorded the following data electronically:

- Date and time
- Coordinates
- Surveyors
- Weather conditions
- Nest box ID
- Detection methods:
  - Adult behaviour
  - Audible nestlings
  - Food delivery
  - Pole camera examination
- Is box being used
- Species detected
- Notes informing environmental context, such as disturbance in the area.

## Maintenance

Nest boxes have a 10 to 15-year lifespan with regular maintenance. Nest boxes in need of repair (e.g., broken or fallen boxes, loose lids or covers) were flagged during the monitoring season in 2020 and repaired during the monitoring period if feasible (e.g., not occupied, or salvageable). Maintenance and repair included replacing nesting material if necessary, and performing any replacement or repair of broken boxes.

### 3.0 RESULTS

#### 3.1 Nest Box Installation

Between 2017 and 2020, 268 nest boxes were installed on trees and structures on BC Hydro-owned and managed lands, and on private lands where permission was granted (**Table 2, Figure 3**). Twenty-one (21) boxes have been installed near the lower reservoir, 78 near the eastern reservoir, 38 near the middle reservoir and 131 near the western reservoir.

In 2017, a total of 97 nest boxes were installed on the north side of the Peace River. In 2019, 83 additional nest boxes were installed on the south side of the Peace River, and the remaining 88 nest boxes were installed in spring 2020 on the north and south sides of the Peace River, for a total of 171 nest boxes installed from 2019 to 2020. The locations of the 2020 nest boxes were selected based on areas not covered in previous installations (2017 and 2019) and complementing habitat and species assemblage within the proposed reservoir following the same criteria for habitat selection (see **Section 2.2**). The installation of new nest boxes was completed in 2020. Reinstallation of five boxes that were damaged or removed was completed in 2021. **Table 2** describes the target species, habitat type and number of boxes of each design installed to date.

**Table 2 Target Species, Habitat Preferences, and Total Number Nest Boxes Installed in 2017, 2019, and 2020**

Species Group	Habitat Preference	Box Type	Species Supported	Number of Boxes Installed to Date
Passerine	Prefer a variety of habitat types, from dry to wet forests and in most structural stages Brown creeper and nuthatches prefer more mature forested habitats  Swallows use wetland and cultivated field habitat Mountain bluebird require open field habitat	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	Need an unobstructed flight path from suitable forage habitat to nesting features	E1	bufflehead	8
		F	Barrow's goldeneye common goldeneye hooded merganser	48
		D / G	common merganser	18
Raptors and Owls	Typically found in mesic to moist forests smaller species found in younger forests  American kestrel requires open field habitat	E2	boreal owl northern saw-whet owl	27
		E3	American kestrel	17
		C	northern pygmy- owl	26
		B3	northern hawk-owl	20
		H	barred owl	3
<b>Total</b>				<b>268</b>

**Note:** 264 boxes were proposed to be installed (BC Hydro 2018)

**Nest Box Locations**

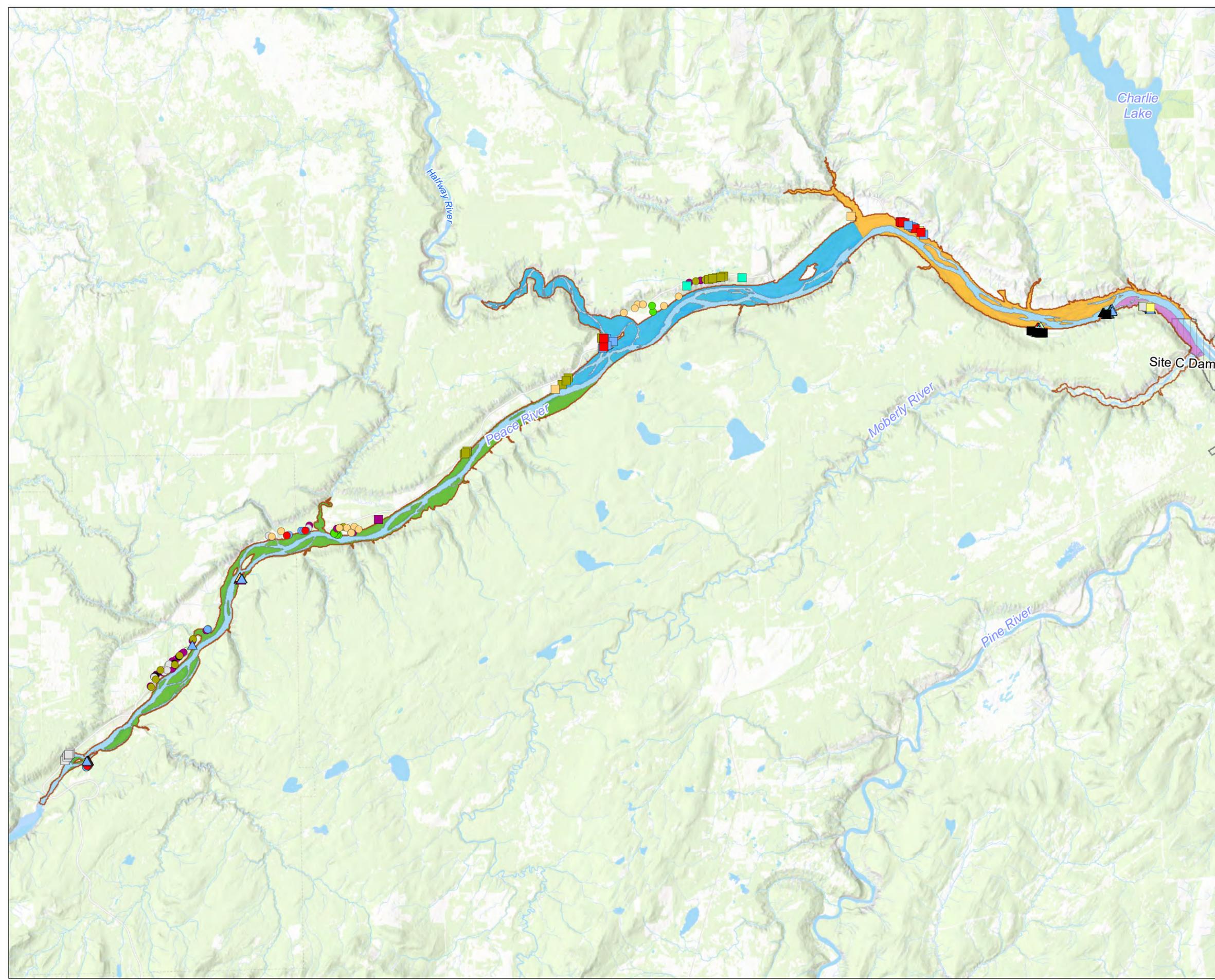
**Legend**

- Proposed Dam Site
- 5 Year Beach Line
- Eastern Reservoir
- Lower Reservoir
- Middle Reservoir
- Western Reservoir

**Nest Box Types**

2017 2019 2020

- |  |  |  |    |
|--|--|--|----|
|  |  |  | A  |
|  |  |  | A2 |
|  |  |  | B1 |
|  |  |  | B2 |
|  |  |  | B3 |
|  |  |  | BC |
|  |  |  | C  |
|  |  |  | D  |
|  |  |  | E1 |
|  |  |  | E2 |
|  |  |  | E3 |
|  |  |  | F  |
|  |  |  | G  |
|  |  |  | H  |

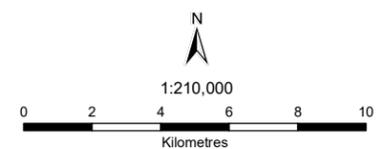


**Notes**

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

**Sources**

- Basemap: ESRI World Topographic Base



NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

## 3.2 Monitoring and Maintenance of Nest Boxes Installed in 2019 and 2020

### Monitoring

From May 17 to 22, 2021 monitoring was conducted for 62 nest boxes installed in 2019 and 85 nest boxes installed in 2020, for a total of 147 boxes monitored. An additional 10 nest boxes scheduled for monitoring in 2021 could not be found, and were presumably lost during vegetation clearing after a change in clearing boundaries or during inclement weather. The status of each box at the time of monitoring can be found in **Appendix C**.

Forty (40) boxes showed signs of use such as nesting material, feathers, or eggs present. Eggs were present in 6 boxes, presumed to be in the incubation stage. The locations of the six boxes containing eggs are mapped in **Figure 4**, **Figure 5**, and **Figure 6**. American kestrel (*Falco sparverius*) eggs were documented in two nest boxes, one in box E1-09 installed on a trembling aspen (*Populus tremuloides*) in an immature aspen forest, and one in box D-03 installed on a trembling aspen in a mixed young forest. The kestrel nests contained two (at D-03) or three (at E1-09; **Figure 7**) eggs each. Three boxes installed on trembling aspens in aspen forest contained duck eggs. Of these, one was occupied by goldeneye (F-49), the other two (F-26 and G-04) by cavity nesting ducks known to have whitish-coloured eggs (i.e., bufflehead [*Bucephala albeola*], common merganser [*Mergus merganser*], or hooded merganser [*Lophodytes cucullatus*]). A mixed-clutch was documented in nest box G-04 (**Figure 8**), where three eggs were suspected to belong to common merganser, the fourth to a smaller species such as hooded merganser or bufflehead. Passerine eggs were documented in nest box OWL-3, installed on a trembling aspen on a steep slope above a gully. Species or genus could not be identified for these eggs, which had characteristics matching several species (e.g., red-breasted nuthatch [*Sitta canadensis*]). Broken eggs were documented in two additional nest boxes (F-41 and F-21), not shown on Figures 4-6. Nesting outcome (i.e., success or failure) could not be determined without additional information (e.g., species, clutch size); broken eggs may have been a result of hatching or predation.

House wren (*Troglodytes aedon*) nesting activity was high, with nests or nest building documented in 14 boxes, which is more than a quarter of the boxes with evidence of use in 2021. Eggs were not documented in house wren nests. Dead rodents or rodent remains were observed in two boxes with large enough openings for raptors (i.e., F-39, E2-14), suggesting use by raptors for feeding.

Signs of rodent use, such as droppings, teeth marks, potential den sites, or squirrel caches, were observed at 14 boxes during monitoring. Old wasp or hornet nests were documented and removed in two boxes.

Locations of Nest Boxes with Eggs #1



Legend

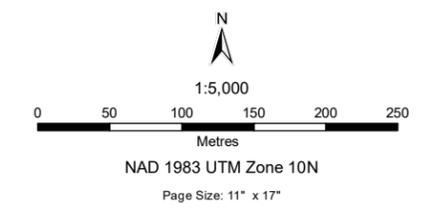
- 5 Year Beach Line
- Middle Reservoir
- Watercourse
- Waterbody
- Nest Boxes with Eggs - Species**
- American kestrel (*Falco sparverius*)
- Other Nest Boxes - Year Installed**
- 2020

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

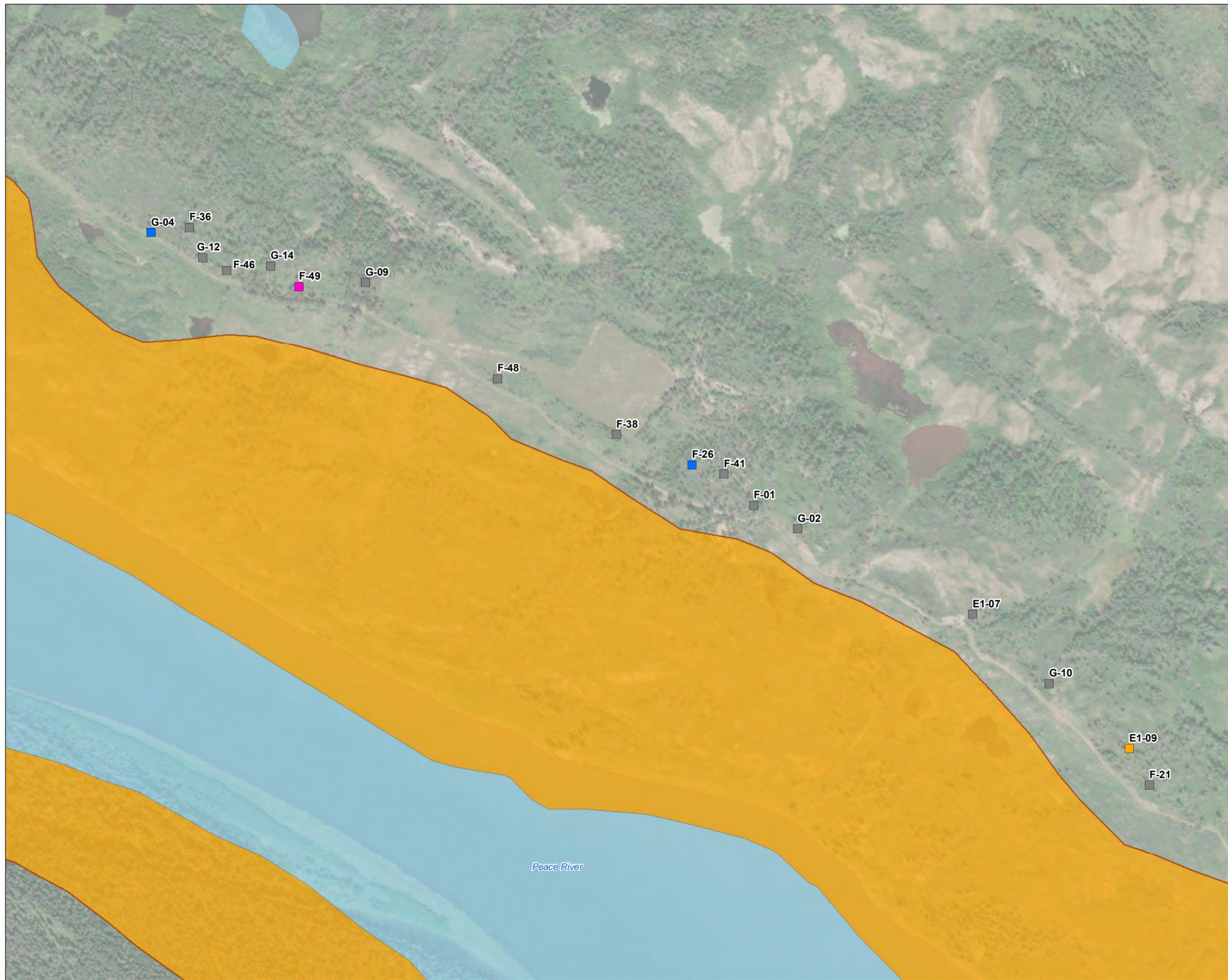
Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map



Path: S:\Geomatics\Project\898619\08\_cawp\_nestmed2021\Fig\_898619\_08\_CawpNest\_Eggs\_1\_211217.mxd

Locations of Nest Boxes with Eggs #2



Legend

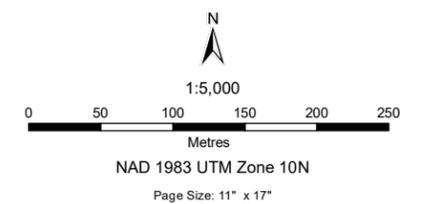
- 5 Year Beach Line
- Eastern Reservoir
- Watercourse
- Waterbody
- Nest Boxes with Eggs - Species**
- American kestrel (*Falco sparverius*)
- Duck species
- Goldeneye (*Bucephala* sp.)
- Other Nest Boxes - Year Installed**
- 2020

Notes

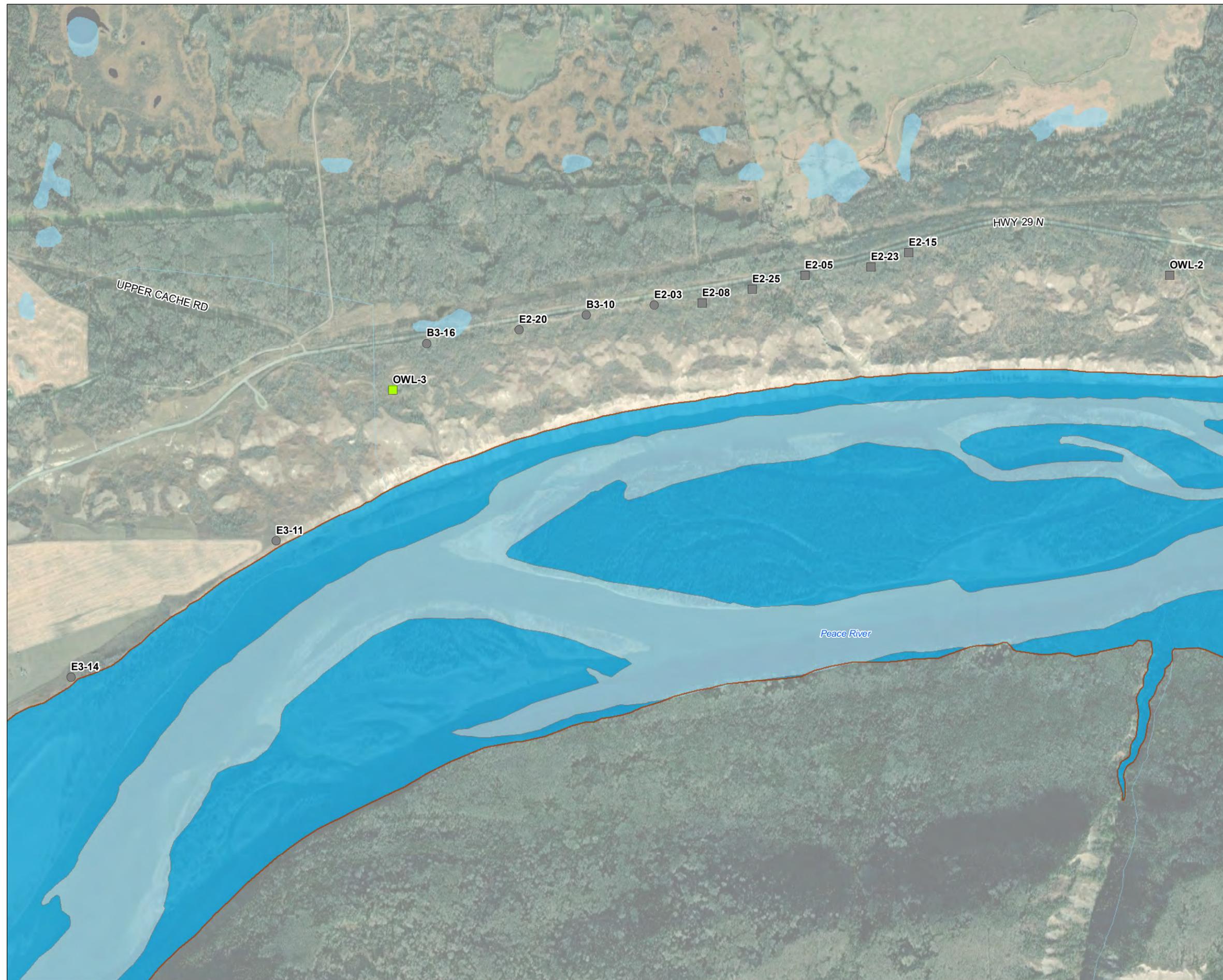
1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map



Locations of Nest Boxes with Eggs #3



Legend

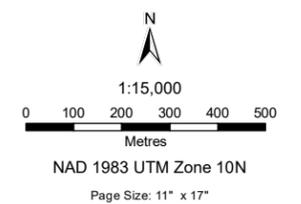
- 5 Year Beach Line
- Middle Reservoir
- Watercourse
- Waterbody
- Nest Boxes with Eggs - Species**
- Passerine species
- Other Nest Boxes - Year Installed**
- 2017
- 2020

Notes

1. Locations should be considered approximate.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map





**Figure 7** Example of American kestrel eggs documented in nest box E1-09.



**Figure 8** Mixed-clutch duck nest found in box G-04.

## Maintenance

Box maintenance in 2021 was completed simultaneously with monitoring from May 17 to 22 (**Appendix C**). Most maintenance completed comprised adding new wood shavings and minor repairs such as tightening screws and readjusting loose doors. Latching systems were installed at 122 nest boxes to secure the maintenance door from opening inadvertently or being accessed by predators. Detailed descriptions of maintenance completed can be found in **Appendix C**.

Two boxes sustained minor damage that did not affect their useability; these boxes were repaired. An additional two boxes appeared to have been struck by falling trees but were not damaged and left in place. A total of three boxes were unusable at the onset of monitoring. Of these, two that were impacted by falling trees were repaired and re-mounted, while the third was destroyed and could not be repaired.

Due to the updated linework for the Highway 29 realignment, two nest boxes (E3-08, scheduled for 2021 monitoring, and B3-13, scheduled for 2022 monitoring) were within 50 m of highway activities and were deactivated to prevent potential impact on nesting birds from work in the area. These boxes were assessed for occupancy, and when found to be unused, the entrances were blocked with a piece of wood to prevent birds from accessing the nest box. These boxes will be reactivated once BC Hydro confirms that Highway 29 road work in the area is complete. Another box (F-14) was relocated upslope due to its proximity to a boundary for logging activities.

## 4.0 DISCUSSION

Of the 171 boxes installed in 2019 and 2020, 144 were available for nesting at the onset of monitoring, 3 were unusable either due to damage from construction or falling trees, and 10 could not be found. The forestry team removed the remaining 14 boxes from areas where the clearing boundary was updated. Of the 144 available boxes, 51 were occupied or had evidence of use for nesting by birds in 2021 (i.e., nesting material, nests, or feathers), for an occupancy rate of 35%. This occupancy percentage is similar to other studies of artificial nests conducted on multiple species (Milligan and Dickinson 2016). When compared with data from 2020, 65 more nest boxes were available for use in 2021 and occupancy increased by 8% from 2020 to 2021. Rodent activity and wasp nests were observed in 10% of the available monitored nest boxes, likely precluding their use by target species. While one nest box installed in 2019 was deactivated during 2021 monitoring, it had been available at the onset of monitoring, thus it was considered available in the occupancy calculation.

Target species were documented with eggs in boxes intended for other species groups, a result commonly observed in studies of nest box use (e.g., Gauthier 1988; Bortolotti 1994). Both of the American kestrel clutches observed were laid in boxes intended for waterfowl (i.e., box types E1 and D in **Table 2**), while passerine eggs were laid in a box intended for owls. These observations indicate that boxes constructed for target species groups also provide opportunities to support species from other groups.

## 5.0 CLOSURE

This Work was performed in accordance with Contract No. 95055-08 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and BC Hydro, dated January 13, 2017 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

If there are any questions, please do not hesitate to contact the undersigned.

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# **APPENDIX A**

## **Monitoring and Maintenance Schedule**

**Table A Monitoring and Maintenance Schedule for Nest Boxes Installed in 2017, 2019, and 2020**

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
A-002	A	2017		X		X		X	
A-010	A	2017		X		X		X	
A-011	A	2017		X		X		X	
A-014	A	2017		X		X		X	
A-017	A	2017		X		X		X	
A-020	A	2017		X		X		X	
A-021	A	2017		X		X		X	
A-025	A	2017		X		X		X	
A2-35	A2	2017		X		X		X	
A2-36	A2	2017		X		X		X	
A2-37	A2	2017		X		X		X	
A2-44	A2	2017		X		X		X	
A2-45	A2	2017		X		X		X	
A2-51	A2	2017		X		X		X	
A2-55	A2	2017		X		X		X	
A2-58	A2	2017		X		X		X	
A2-59	A2	2017		X		X		X	
A2-62	A2	2017		X		X		X	
A2-66	A2	2017		X		X		X	
A2-72	A2	2017		X		X		X	
A2-74	A2	2017		X		X		X	
A2-75	A2	2017		X		X		X	
A2-76	A2	2017		X		X		X	
A2-79	A2	2017		X		X		X	
B1-01	B1	2017		X		X		X	
B1-02	B1	2017		X		X		X	
B1-03	B1	2017		X		X		X	
B1-06	B1	2017		X		X		X	
B2-03	B2	2017		X		X		X	
B2-06	B2	2017		X		X		X	
B3-02	B3	2017		X		X		X	
B3-03	B3	2017		X		X		X	
B3-05	B3	2017		X		X		X	
B3-06	B3	2017		X		X		X	

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
B3-07	B3	2017		X		X		X	
B3-10	B3	2017		X		X		X	
B3-11	B3	2017		X		X		X	
B3-12	B3	2017		X		X		X	
B3-13	B3	2017		X		X		X	
B3-14	B3	2017		X		X		X	
B3-16	B3	2017		X		X		X	
B3-17	B3	2017		X		X		X	
B3-20	B3	2017		X		X		X	
BC-01	BC	2017		X		X		X	
BC-02	BC	2017		X		X		X	
BC-03	BC	2017		X		X		X	
BC-05	BC	2017		X		X		X	
C-01	C	2017		X		X		X	
C-02	C	2017		X		X		X	
C-03	C	2017		X		X		X	
C-08	C	2017		X		X		X	
C-12	C	2017		X		X		X	
C-13	C	2017		X		X		X	
C-15	C	2017		X		X		X	
C-18	C	2017		X		X		X	
C-22	C	2017		X		X		X	
E1-02	E1	2017		X		X		X	
E1-05	E1	2017		X		X		X	
E2-01	E2	2017		X		X		X	
E2-02	E2	2017		X		X		X	
E2-03	E2	2017		X		X		X	
E2-06	E2	2017		X		X		X	
E2-10	E2	2017		X		X		X	
E2-13	E2	2017		X		X		X	
E2-17	E2	2017		X		X		X	
E2-20	E2	2017		X		X		X	
E2-21	E2	2017		X		X		X	
E2-27	E2	2017		X		X		X	
E2-28	E2	2017		X		X		X	

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
E3-01	E3	2017		X		X		X	
E3-02	E3	2017		X		X		X	
E3-02	E3	2017		X		X		X	
E3-03	E3	2017		X		X		X	
E3-04	E3	2017		X		X		X	
E3-05	E3	2017		X		X		X	
E3-05	E3	2017		X		X		X	
E3-07	E3	2017		X		X		X	
E3-09	E3	2017		X		X		X	
E3-11	E3	2017		X		X		X	
E3-12	E3	2017		X		X		X	
E3-13	E3	2017		X		X		X	
E3-14	E3	2017		X		X		X	
E3-15	E3	2017		X		X		X	
E3-16	E3	2017		X		X		X	
F-03	F	2017		X		X		X	
F-07	F	2017		X		X		X	
F-08	F	2017		X		X		X	
F-11	F	2017		X		X		X	
F-17	F	2017		X		X		X	
F-18	F	2017		X		X		X	
F-29	F	2017		X		X		X	
F-31	F	2017		X		X		X	
F-32	F	2017		X		X		X	
F-42	F	2017		X		X		X	
G-07	G	2017		X		X		X	
G-08	G	2017		X		X		X	
G-13	G	2017		X		X		X	
G-15	G	2017		X		X		X	
A-004	A	2019	X		X		X		X
A-006	A	2019	X		X		X		X
A-007	A	2019	X		X		X		X
A-013	A	2019	X		X		X		X
A-015	A	2019	X		X		X		X
A-016	A	2019	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
A-022	A	2019	X		X		X		X
A-024	A	2019	X		X		X		X
A-026	A	2019	X		X		X		X
A2-27	A2	2019	X		X		X		X
A2-28	A2	2019	X		X		X		X
A2-29	A2	2019	X		X		X		X
A2-30	A2	2019	X		X		X		X
A2-32	A2	2019	X		X		X		X
A2-33	A2	2019	X		X		X		X
A2-34	A2	2019	X*		X		X		X
A2-38	A2	2019	X		X		X		X
A2-39	A2	2019	X		X		X		X
A2-42	A2	2019	X		X		X		X
A2-46	A2	2019	X		X		X		X
A2-47	A2	2019	X		X		X		X
A2-53	A2	2019	X*		X		X		X
A2-56	A2	2019	X		X		X		X
A2-57	A2	2019	X*		X		X		X
A2-63	A2	2019	X*		X		X		X
A2-64	A2	2019	X*		X		X		X
A2-67	A2	2019	X		X		X		X
A2-68	A2	2019	X		X		X		X
A2-69	A2	2019	X		X		X		X
A2-80	A2	2019	X		X		X		X
B1-04	B1	2019	X		X		X		X
B1-05	B1	2019	X		X		X		X
B1-06b	B1	2019	X		X		X		X
B2-01	B2	2019	X		X		X		X
B2-02	B2	2019	X		X		X		X
B2-04	B2	2019	X		X		X		X
B2-05	B2	2019	X		X		X		X
B3-01	B3	2019	X		X		X		X
B3-04	B3	2019	X		X		X		X
B3-08	B3	2019	X		X		X		X
B3-15	B3	2019	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
B3-18	B3	2019	X		X		X		X
BC-04	BC	2019	X		X		X		X
C-21	C	2019	X		X		X		X
E2-11	E2	2019	X		X		X		X
E2-18	E2	2019	X		X		X		X
E2-26	E2	2019	X		X		X		X
F-02	F	2019	X		X		X		X
F-04	F	2019	X		X		X		X
F-05	F	2019	X		X		X		X
F-06	F	2019	X		X		X		X
F-10	F	2019	X		X		X		X
F-14	F	2019	X		X		X		X
F-15	F	2019	X		X		X		X
F-16	F	2019	X		X		X		X
F-19	F	2019	X		X		X		X
F-22	F	2019	X		X		X		X
F-23	F	2019	X		X		X		X
F-24	F	2019	X		X		X		X
F-25	F	2019	X		X		X		X
F-28	F	2019	X		X		X		X
F-30	F	2019	X		X		X		X
F-37	F	2019	X		X		X		X
F-39	F	2019	X		X		X		X
F-40	F	2019	X		X		X		X
F-47	F	2019	X		X		X		X
G-05	G	2019	X		X		X		X
OWL-2	H	2020	X		X		X		X
OWL-3	H	2020	X		X		X		X
A-001	A	2020	X		X		X		X
A-003	A	2020	X		X		X		X
A-005	A	2020	X*		X		X		X
A-009	A	2020	X		X		X		X
A-012	A	2020	X		X		X		X
A-018	A	2020	X		X		X		X
A2-31	A2	2020	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
A2-41	A2	2020	X		X		X		X
A2-48	A2	2020	X		X		X		X
A2-49	A2	2020	X		X		X		X
A2-50	A2	2020	X		X		X		X
A2-52	A2	2020	X		X		X		X
A2-61	A2	2020	X		X		X		X
A2-70	A2	2020	X		X		X		X
A2-81	A2	2020	X		X		X		X
B1-00	B1	2020	X		X		X		X
B3-09	B3	2020	X		X		X		X
B3-19	B3	2020	X		X		X		X
BC-01S	BC	2020	X		X		X		X
BC-02b	BC	2020	X		X		X		X
BC-03b	BC	2020	X		X		X		X
BC-04b	BC	2020	X		X		X		X
BC-NN	BC	2020	X		X		X		X
C-04	C	2020	X		X		X		X
C-05	C	2020	X		X		X		X
C-06	C	2020	X		X		X		X
C-09	C	2020	X		X		X		X
C-10	C	2020	X		X		X		X
C-11	C	2020	X		X		X		X
C-14	C	2020	X		X		X		X
C-16	C	2020	X		X		X		X
C-17	C	2020	X		X		X		X
C-19	C	2020	X		X		X		X
C-20	C	2020	X		X		X		X
C-23	C	2020	X		X		X		X
C-X1	C	2020	X		X		X		X
C-X2	C	2020	X		X		X		X
C-X3	C	2020	X		X		X		X
D-01	D	2020	X		X		X		X
D-02	D	2020	X		X		X		X
D-03	D	2020	X		X		X		X
E1-01	E1	2020	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
E1-03	E1	2020	X		X		X		X
E1-04	E1	2020	X		X		X		X
E1-07	E1	2020	X		X		X		X
E1-09	E1	2020	X		X		X		X
E2-04	E2	2020	X		X		X		X
E2-05	E2	2020	X		X		X		X
E2-07	E2	2020	X		X		X		X
E2-08	E2	2020	X		X		X		X
E2-12	E2	2020	X		X		X		X
E2-14	E2	2020	X		X		X		X
E2-15	E2	2020	X		X		X		X
E2-16	E2	2020	X		X		X		X
E2-19	E2	2020	X		X		X		X
E2-22	E2	2020	X		X		X		X
E2-23	E2	2020	X		X		X		X
E2-25	E2	2020	X		X		X		X
E2-27b	E2	2020	X		X		X		X
E3-01b	E3	2020	X		X		X		X
E3-08	E3	2020	X		X		X		X
F-01	F	2020	X		X		X		X
F-13	F	2020	X		X		X		X
F-21	F	2020	X		X		X		X
F-26	F	2020	X		X		X		X
F-27	F	2020	X		X		X		X
F-33	F	2020	X		X		X		X
F-34	F	2020	X		X		X		X
F-35	F	2020	X		X		X		X
F-36	F	2020	X		X		X		X
F-38	F	2020	X		X		X		X
F-41	F	2020	X		X		X		X
F-43	F	2020	X		X		X		X
F-45	F	2020	X		X		X		X
F-46	F	2020	X		X		X		X
F-48	F	2020	X		X		X		X
F-49	F	2020	X		X		X		X

Nest Box ID	Nest Box Type	Year Installed	Monitoring and Maintenance Schedule until 2027 (10 years after initial installation)						
			2021	2022	2023	2024	2025	2026	2027
G-01	G	2020	X		X		X		X
G-02	G	2020	X		X		X		X
G-04	G	2020	X		X		X		X
G-06	G	2020	X		X		X		X
G-09	G	2020	X		X		X		X
G-10	G	2020	X		X		X		X
G-12	G	2020	X		X		X		X
G-14	G	2020	X		X		X		X

**Notes:**

X indicates the scheduled year for monitoring and maintenance; no boxes were installed in 2019.

\* indicates boxes which could not be found in 2021, which were either missed during monitoring or destroyed during inclement weather. These boxes will be searched for again in 2023 to confirm their status.

# **APPENDIX B**

## **Breeding Periods for Survey Timing**

**Table B Species Specific Breeding Periods**

Species Group	Focal Species	Breeding Window Date Range <sup>1, 2</sup>	Late Incubation to Early Nestling Stages Date Range <sup>2, 3</sup>
<b>Passerines</b>	black-capped chickadee	Early March to early August	Mid-March to mid-July
	boreal chickadee	Mid-May to mid-July	Mid-May to mid-July
	brown creeper	Early April to late July	Early May to mid-June
	red-breasted nuthatch	Early April to late July	Mid-May to mid-June
	white-breasted nuthatch	Mid-April to early July	
	tree swallow	Mid-April to mid-September	Mid-May to mid-August
	violet-green swallow	Early April to late August	Early May to mid-July
	house wren	Mid-April to late August	Early May to mid-August
	mountain bluebird	Late March to early August	Mid-May to late July
<b>Waterfowl</b>	Barrow's goldeneye	Mid-March to late August	Early May to mid-July
	bufflehead	Mid-April to late August	Early June to mid-July
	common goldeneye	Early April to late August	Early May to mid-July
	common merganser	Early March to early September	Mid-April to late June
	hooded merganser	Late March to early October	Early May to early July
<b>Raptors and Owls</b>	barred owl	Mid-March to mid-August	Mid-April to late May
	boreal owl	Early April to mid-July	
	northern saw-whet owl	Early March to mid-August	Early April to mid-June
	northern pygmy owl	Mid-April to late August	Mid-May to mid-June
	northern hawk-owl	Mid-April to early August	
	American kestrel	Early April to late August	Early April to mid-July

**Notes:**

<sup>1</sup> the range of dates from egg-laying to fledging in BC for each focal species.

<sup>2</sup> information is based on Campbell et al. 1990a, 1990b, 1997.

<sup>3</sup> the range of dates when nests in BC are likely to be in the late incubation or early nestling stages.

# **APPENDIX C**

## **2021 Monitoring and Maintenance Results**

**Table C-1 2021 Monitoring and Maintenance Results**

Year Installed	Monitoring Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use (Y/N)	Box Species	Box Status	Maintenance Completed	Comments
2019	2021-05-17	A-006	A	Pole camera examination	No	-	Operational	Visual examination, latch installed, good nesting material.	
2019	2021-05-17	A-013	A	Visual inspection	No	-	Operational	Nesting material added, latch installed.	
2019	2021-05-17	A-026	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	A2-30	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	A2-38	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	Rodent droppings.
2019	2021-05-17	A2-39	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	Signs of predation, rodent activity, potential rodent den.
2019	2021-05-17	A2-42	A	Visual inspection	No	-	Operational	Nesting material added, latch installed.	Old hornet nest in door, rodent droppings inside.
2019	2021-05-17	A2-56	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	A2-67	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, no nesting material needed.	Chewing marks from rodents at the entrance.
2019	2021-05-17	A2-68	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	Chewing marks at the entrance.
2019	2021-05-17	A2-69	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-18	A-001	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-18	A-003	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, box door is nailed.	
2019	2021-05-18	A-004	A	Visual inspection	No	-	Operational	Visual inspection, latch installed. Nearby tree impacted tree on which box installed but box not damaged.	
2019	2021-05-18	A-007	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-18	A-009	A	Visual inspection	No	-	Operational	Visual inspection.	
2020	2021-05-18	A-012	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, no nesting material needed.	
2019	2021-05-18	A-015	A	Visual inspection	No	-	Operational	Visual inspection, latch installed.	
2019	2021-05-18	A-016	A	Visual inspection	No	-	Operational	Visually inspected. Latch added.	
2020	2021-05-18	A-018	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-18	A-022	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2019	2021-05-18	A-024	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2019	2021-05-18	A2-27	A	Visual inspection	Yes	House wren	Operational	Visual inspection, latch installed, no nesting material needed.	Old nest inside box, some chewing marks at the entrance
2019	2021-05-18	A2-28	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	Chewing marks at the entrance.
2019	2021-05-18	A2-29	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, no latch installed due to lost bits.	
2020	2021-05-18	A2-31	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-18	A2-32	A	Visual inspection	Yes	House wren	Operational	Visual inspection, no nesting material needed, latch installed.	Old stick nest inside box with feathers. Probably used last year. A few chewing marks at the entrance.
2019	2021-05-18	A2-33	A	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-18	A2-41	A	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Stick nest.
2019	2021-05-18	A2-46	A	Visual inspection	Yes	House wren	Operational	Visual inspection, latch installed, no nesting material needed.	Chewing marks at the entrance, several birds in the area (robins, kinglets, warblers, sparrows, ...) but no activity around the box

Year Installed	Monitoring Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use (Y/N)	Box Species	Box Status	Maintenance Completed	Comments
2019	2021-05-18	A2-47	A	Visual inspection	N/A	-	Operational	Box mounted, latch installed.	
2020	2021-05-18	A2-48	A	Visual inspection	Yes	House wren	Operational	Visual inspection, nesting material added, latch installed	Nesting material inside
2020	2021-05-18	A2-49	A	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Feathers and twigs. Chew marks on entrance.
2020	2021-05-18	A2-50	A	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Twigs
2020	2021-05-18	A2-52	A	Visual inspection	Yes	House wren	Operational	Visual inspection, latch installed.	Stick nest
2020	2021-05-18	A2-61	A	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Sticknest.
2020	2021-05-18	A2-70	A	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-18	A2-71	A	Visual inspection	Yes	-	Operational	Visual inspection, latch installed, nesting material added.	Old stick nest inside box,
2019	2021-05-18	A2-80	A	Visual inspection	N/A	-	Operational	Box found on the ground, probably hit by a tree, visual inspection, nesting material added, latch installed	
2020	2021-05-18	A2-81	A	Visual inspection	Yes	House wren	Operational	Visual inspection, latch installed.	Old nest inside box
2020	2021-05-18	B1-00	B	Visual inspection	No	-	Operational	Visual inspection, no nesting material needed. (creeper box without grooves (?))	
2019	2021-05-17	B1-04	B	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	B1-05	B	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2019	2021-05-17	B2-01	B	Visual inspection	No	-	Operational	Nesting material added, latch installed.	
2019	2021-05-17	B2-02	B	Visual inspection	No	-	Operational	Visually inspected.	
2019	2021-05-17	B2-04	B	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	B2-05	B	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-17	B3-01	B	Visual inspection	Yes	-	Operational	Latch installed, visual inspection.	Potential old nesting material
2019	2021-05-18	B3-04	B	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-19	B3-07	B	Pole camera examination	No	-	Operational	Visually inspected.	
2019	2021-05-17	B3-08	B	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-18	B3-09	B	Visual inspection	Yes	-	Operational	Visual inspection, latch installed, nesting material added.	Sticks inside
2019	2021-05-17	B3-15	B	Visual inspection	No	-	Operational	Nesting material added, latch installed.	Bite marks around the box.
2019	2021-05-17	B3-18	B	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-20	B3-19	B	Visual inspection	Yes	-	Operational	Visually inspected. Latch installed.	Grass, dry leaves and moss
2020	2021-05-18	BC-01s	BC	Visual inspection	No	-	Operational	Visual inspection, no nesting material needed.	
2020	2021-05-18	BC-03b	BC	Visual inspection	No	-	Operational	Visual inspection, nesting material added.	
2020	2021-05-18	BC-04b	BC	Visual inspection	No	-	Operational	Visual inspection, nesting material added, no latch needed.	
2020	2021-05-18	C-04	C	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-19	C-05	C	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-19	C-06	C	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-19	C-09	C	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-18	C-10	C	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Sticknest.
2020	2021-05-19	C-11	C	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2020	2021-05-18	C-14	C	Visual inspection	Yes	-	Operational	Visually inspected, latch installed, nesting material added.	Twigs present.

Year Installed	Monitoring Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use (Y/N)	Box Species	Box Status	Maintenance Completed	Comments
2020	2021-05-19	C-16	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-18	C-19	C	Visual inspection	No	-	Operational	Visually inspected, latch installed.	
2020	2021-05-19	C-20	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2019	2021-05-18	C-21	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-19	C-23	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-19	C-X1	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	Box was painted black.
2020	2021-05-19	C-X2	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	Birds in the area: GCKI, BCCH, woodpeckers
2020	2021-05-19	C-X3	C	Visual inspection	N/A	-	Operational	Visually inspected, latch installed, nesting material added. Face panel reattached	
2020	2021-05-21	D-01	D	Visual inspection	Yes	-	Operational	Visually inspected, latch installed, nesting material added.	Twigs, rudimentary nest.
2020	2021-05-21	D-02	D	Visual inspection	Yes	-	Operational	Visually inspected, latch installed	Moss, grass.
2020	2021-05-21	D-03	D	Visual inspection	Yes	American kestrel	Operational	Visually inspected, latch installed.	2 eggs approx 4cm long
2020	2021-05-20	E1-01	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-20	E1-03	E	Visual inspection	No	-	Operational	Visually inspected, latch installed.	
2020	2021-05-20	E1-04	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	E1-07	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed, nesting material added.	Dried grass, rudimentary nest.
2020	2021-05-22	E1-09	E	Visual inspection	Yes	American kestrel	Operational	Visually inspected, latch installed.	3 speckled yellow eggs approx 4cm long
2020	2021-05-20	E2-04	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-21	E2-05	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed, nesting material added.	Dried leaves
2020	2021-05-21	E2-07	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added. Fungus cached by squirrels was removed.	
2020	2021-05-21	E2-08	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Dry grass and leaves.
2019	2021-05-18	E2-11	E	Visual inspection	No	-	Operational	Visual inspection, nesting material added, no latch installed.	
2020	2021-05-20	E2-12	E	Visual inspection	No	-	Operational	Visually inspected, latch installed.	Shows evidence of use by rodents.
2020	2021-05-21	E2-14	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	Remains of mouse found inside.
2020	2021-05-21	E2-15	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-21	E2-16	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Old nest, not actively being used.
2019	2021-05-17	E2-18	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-20	E2-19	E	Visual inspection	No	-	Operational	Visually inspected, latch installed.	
2020	2021-05-20	E2-22	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed, nesting material added.	Center cleared of chips, evidence bird attempted to nest.
2020	2021-05-21	E2-23	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Dried grass, leaves and twigs.
2020	2021-05-21	E2-25	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Dry leaves, moss, owl feathers.
2019	2021-05-18	E2-26	E	Visual inspection	No	-	Operational	Visual inspection, no latch installed, nesting material added.	
2020	2021-05-21	E2-27b	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Grass, dry leaves. Several cracked panels, may need replacement.
2020	2021-05-21	E3-01b	E	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	E3-08	E	Visual inspection	No	-	Deactivated	Deactivated box, visual inspection, latch installed.	

Year Installed	Monitoring Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use (Y/N)	Box Species	Box Status	Maintenance Completed	Comments
2020	2021-05-22	F-01	F	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Feathers and bird scat
2019	2021-05-18	F-02	F	Visual inspection	Yes	-	Operational	Visual inspection, latch installed, no nesting material needed.	Moss sticks and branches inside (nesting signs)
2019	2021-05-17	F-04	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	One wasp, rodent droppings.
2019	2021-05-20	F-05	F	N/A	N/A	-	Not found	Destroyed by construction.	
2019	2021-05-18	F-06	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2019	2021-05-18	F-10	F	Visual inspection	Yes	-	Operational	Visual inspection, nesting material added, no latch installed.	Stick nest inside
2020	2021-05-20	F-13	E	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Grass and feathers.
2019	2021-05-20	F-13	F	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Feathers, grass, textiles.
2020	2021-05-17	F-14	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added, relocated upslope.	
2019	2021-05-18	F-15	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2019	2021-05-18	F-16	F	Visual inspection	No	-	Operational	Visual inspection, nesting material added, latch installed.	
2019	2021-05-18	F-19	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added.	
2020	2021-05-22	F-21	F	Visual inspection	Yes	-	Operational	Visual inspection, latch installed, nesting material added.	Feathers, cracked egg shell.
2019	2021-05-17	F-22	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, no nesting material needed.	
2019	2021-05-18	F-23	F	Visual inspection	No	-	Operational	Visual inspection, latch installed, nesting material added. Box not recorded on original file.	
2019	2021-05-18	F-24	F	Visual inspection	Yes	-	Operational	Visually inspected. Latch installed.	Dry leaves and twigs.
2019	2021-05-18	F-25	F	Visual inspection	No	-	Operational	Visual inspection, nesting material added, no latch installed.	
2020	2021-05-22	F-26	F	Visual inspection	Yes	Duck species	Operational	Visually inspected, latch installed.	4 white eggs, approximately 5 cm in length
2020	2021-05-21	F-27	F	Visual inspection	No	-	Operational	Visually inspected, latch installed.	
2019	2021-05-17	F-28	F	Pole camera examination	No	-	Operational	Nesting material added, latch installed.	
2019	2021-05-17	F-30	F	Visual inspection	No	-	Operational	Nesting material replaced, latch installed, door was cracked and fixed with wire.	
2020	2021-05-20	F-33	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-21	F-35	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	F-36	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2019	2021-05-18	F-37	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	F-38	F	Visual inspection	No	-	Operational	Visually inspected, latch installed.	
2019	2021-05-18	F-39	F	Visual inspection	Yes	-	Operational	Visual inspection, nesting material added, no latch.	Feathers and sticks inside. Dead rodent inside.
2019	2021-05-18	F-40	F	Visual inspection	Yes	-	Operational	Visual inspection, got hit by a tree but the box is still functional and attached to the tree. Latch installed. Nesting material added.	Old nesting material inside box
2020	2021-05-22	F-41	F	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Old nest, evidence of successful hatch. Two different types of feathers present, yellow and black/brown. Five white eggs, approximately 5 cm long.
2020	2021-05-20	F-43	F	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Moss, grass, leaves.
2020	2021-05-20	F-45	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	

Year Installed	Monitoring Date	Nest Box ID	Nest Box Type	Survey Method	Box in Use (Y/N)	Box Species	Box Status	Maintenance Completed	Comments
2020	2021-05-22	F-46	F	Visual inspection	Yes	-	Operational	Visually inspected, latch installed	Twigs, grass. Rudimentary nest.
2019	2021-05-18	F-47	F	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	No signs of use, chewing marks at the entrance and bottom.
2020	2021-05-22	F-48	F	Visual inspection	Yes	House wren	Operational	Visually inspected, latch installed.	Nesting material inside
2020	2021-05-22	F-49	F	Visual inspection	Yes	Goldeneye species	Operational	Visually inspected, latch installed.	3 eggs, greenish white 4-5 cm long.
2020	2021-05-20	G-01	G	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	G-02	G	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	
2020	2021-05-22	G-04	G	Visual inspection	Yes	Duck species	Operational	Visually inspected, latch installed.	4 whitish eggs, approximately 4cm long.
2019	2021-05-18	G-05	G	Visual inspection	Yes	-	Operational	Visually inspected.	Dry leaves and twigs. Old nesting material inside.
2020	2021-05-21	G-06	G	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Dry grass.
2020	2021-05-22	G-09	G	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Dry grass, bark, moss. Old nest.
2020	2021-05-22	G-10	G	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Feathers.
2020	2021-05-22	G-12	G	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Old nest, moss, feathers and grass.
2020	2021-05-22	G-14	G	Visual inspection	Yes	-	Operational	Visually inspected, latch installed.	Feathers present
2020	2021-05-18	BC-NN	BC	Visual inspection	No	-	Operational	Visual inspection, no nesting material needed, no latch needed.	
2020	2021-05-21	OWL-2	H	Visual inspection	No	-	Operational	Visually inspected, nesting material added.	
2020	2021-05-21	OWL-3	H	Visual inspection	Yes	Passerine species	Operational	Visually inspected.	2 white eggs with brown speckles approx 3cm long
2020	2021-05-18	C-17	C	Visual inspection	No	-	Operational	Visually inspected, latch installed, nesting material added.	

**Note:** N/A - box was not available for monitoring because it was damaged by clearing, livestock, winds, and probably vandalism, or deactivated to prevent their use during construction activities; '-' – species was not present and could not be identified.

**Table C-2 Nest Boxes Identified as Missing during 2021 Monitoring**

Nest Box ID	Nest Box Type	Year Installed	Monitored in 2021	Comments
A-005	A	2020	N	Not found, potentially missed during site visit or destroyed during inclement weather
A2-34	A2	2019	N	Not found, potentially missed during site visit or destroyed during inclement weather
A2-57	A2	2019	N	Not found, potentially missed during site visit or destroyed during inclement weather
A2-63	A2	2019	N	Not found, potentially missed during site visit or destroyed during inclement weather
A2-71	A2	2019	N	Not found, potentially lost during vegetation clearing
BC-02b	BC	2020	N	Not found, potentially missed during site visit or destroyed during inclement weather
E1-06	E1	2020	N	Not found, potentially lost during vegetation clearing
F-09	F	2019	N	Not found, potentially lost during vegetation clearing
F-12	F	2019	N	Not found, potentially lost during vegetation clearing
G-03	G	2019	N	Not found, potentially lost during vegetation clearing

**Appendix 11. Bald Eagle Nest Surveys – Summary for 2021**

# MEMORANDUM

Date:	December 21, 2021
To:	Brock Simons, Terrestrial Biodiversity Specialist, Site C Clean Energy Project
From:	Jason Brogan, M.Sc., R.P.Bio. Hemmera
File:	989619-05
Re:	Bald Eagle Nest Surveys – Summary 2021

## 1.0 INTRODUCTION

This memo summarizes the findings of the bald eagle (*Haliaeetus leucocephalus*) nest surveys on the Peace River conducted in May and June 2021. The purpose of the surveys was to document the status of known and newly constructed bald eagle nests along the Peace River, at wetlands near the Site C transmission line, and at artificial (mitigation) nesting structures. This is a continuation from the surveys that were completed in 2016 through 2020 (Hemmera 2016, 2018a, 2018b, 2019, 2021) and during baseline studies for the Site C Clean Energy Project (Keystone 2009).

Bald eagle nest surveys were conducted with two objectives:

1. Determine the status (active/not active) and productivity of known and newly constructed bald eagle nests in the study area (the Peace River between Hudson's Hope and the Alberta border, including areas encompassed by the Site C reservoir footprint); and
2. Provide the data to BC Hydro to inform Site C construction mitigation.

Data collected during this survey provide information on the spatial distribution, timing, and productivity of bald eagle nests in the study area.

## 2.0 METHODS

Surveys of bald eagle nests were conducted by helicopter on 12 and 28 May and 11 June 2021, with a two-person crew consisting of a crew lead and a technician, following methods outlined by the Resources Inventory Committee (RIC 2001). The study area is composed of the Peace River Valley from Hudson's Hope to the Alberta Border, as well as at natural wetlands adjacent to the Site C transmission line right-of-way.

Previously identified nest locations from past aerial surveys (Hemmera 2021) were visited. In addition to known nests, a search was conducted simultaneously for new nests, which were then added to the database with unique identification designations starting with both 10- and 11- for the 2021 surveys. Bald eagle nests reported by other crews working for BC Hydro were also visited. Nests that were known to be destroyed in 2019 (e.g., nest disintegrated, host tree failed naturally, or host tree was felled) were not visited in 2021, but searches were conducted in those areas for newly constructed nests.

The observations recorded at each known or new bald eagle nest (or stick nests constructed by other species) were the status of “active”, “inactive”, “not detected” or “tree gone”, or “unknown”, the associated species assigned to each nest, and the number of nestlings.

Status was determined by the presence of attending adults or evidence of nestlings. Productivity was estimated by counting the number of nestlings in each nest with the assumption that most nestlings reach fledging (Buehler 2021). Annual productivity was calculated as the sum of estimated productivity from active nests divided by the number of active nests. The following assumptions were used to determine nest status and productivity:

- Active nests included those with evidence of adults attending the nest during any one of the field surveys;
- The number of chicks in a nest at the last observation reflects the number fledged, except nests with three chicks which were only assumed to fledge two chicks; and
- No second clutches.

Nestlings grow quickly in the first days and weeks after hatching, resulting in large size differences between each sibling (Bortolotti 1986a). A third hatched chick is at a great disadvantage and will likely starve due to being out-competed by its larger siblings (Gerrard and Bortolotti 1988, as cited in Buehler 2021). In two-chick broods, both chicks generally survive (e.g., only two chicks from 37 two-chick broods in Saskatchewan died [(Bortolotti 1986b)]). Therefore, when calculating nest productivity, if two or three chicks were observed in a nest during the final survey round, it was assumed that two chicks survived and fledged.

Second clutches are not observed in natural bald eagle population of (Buehler 2021), likely due to the long duration of breeding, as speculated by Newton (2010). Exceptions are known 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.

Survey results were provided to BC Hydro in Excel (.csv) format, including applicable comments and coordinates for each nest.

Summary statistics were performed on the data. A Poisson regression was conducted on both total chicks, and active nests as a function of survey year to determine trends.

### 3.0 SURVEY RESULTS

A total of 55 potential bald eagle nests and 29 artificial nesting platforms were monitored in 2021 (**Appendix A**). None of the artificial nesting platforms were active. Of the 55 potential tree nests, 24 were active, 16 were inactive, one nest was not detected, and 14 of the host trees were gone (**Table 1**). The number of chicks observed at active nests ranged from one to three at the time of fledging, for a total of 37 assumed fledged chicks. The estimated bald eagle productivity for 2021 was 1.54 fledged chicks per active nest. One red tailed hawk (*Buteo jamaicensis*) was nesting in a previous bald eagle nest, Nest 608.

BC Hydro erected three artificial nesting structures in 2015 and an additional 26 structures in 2020. Of the 26 nesting structures erected in 2020, nest material was added by BC Hydro to seven and whole salvaged nests from nearby removed nest trees were placed in two of the nest structures. No evidence of bald eagle use of the artificial nesting structures was observed during the 2021 surveys. The artificial nesting structures are placed near the periphery of the future reservoir.

Bald eagle nesting activity data have been collected since 2016, with data sufficient for estimating nest productivity from 2017 onward. The average number of active nests was  $28.2 \pm 3.3$  SD. The average percent occupied nests was  $66.4 \pm 8.4$  standard deviation (SD) occupied nests. The average annual total chicks from 2017 to 2021 was  $38.6 \pm 5.1$  SD. The average number of young fledged per active nest was  $1.27 \pm 0.11$  SD.

Although the number of active nests appear to have declined over time, a Poisson regression demonstrated that the slope of that trend line is not statistically significant, with a coefficient of  $-0.075 \pm 0.06$  standard error (SE; p-value = 0.2). Poisson regression also did not show a statistically significant trend in the change in total chicks over time, with a coefficient of  $-0.005 \pm 0.05$  SE (p-value = 0.9) (**Figure 1**). A linear regression did not show a statistically significant change in the fledging success rate over time (i.e., young fledged per active nest; slope =  $0.08 \pm 0.08$  SE,  $R^2 = 0.26$ , p-value = 0.38).

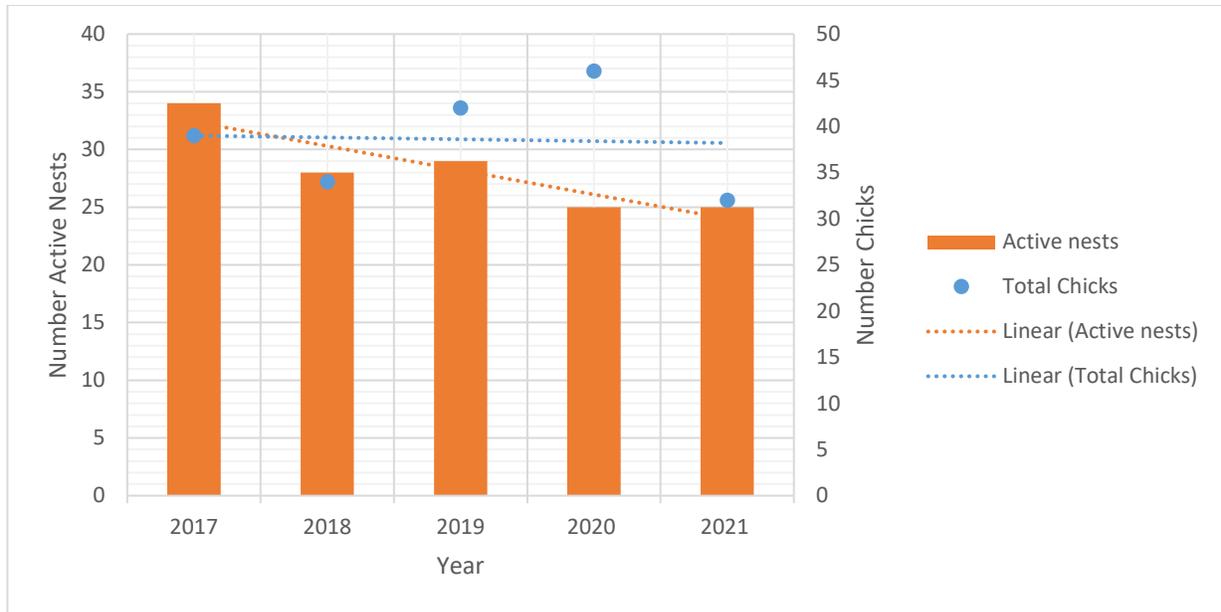
**Table 1 Bald Eagle Nest Activity and Productivity on the Peace River (2016-2021)**

Nest Status	2016	2017	2018	2019	2020*	2021
<b>Tree Nests</b>						
Active	NEI	34	28	29	25	25
Inactive	8	7	15	19	16	17
<b>Percent Active</b>	-	<b>83</b>	<b>65</b>	<b>60</b>	<b>61</b>	<b>60</b>
Not Detected/Tree Gone	-	18	4	6	11	15
Unknown	52	-	1	0	0	0
<b>Total Nests Surveyed</b>	<b>60</b>	<b>59</b>	<b>48</b>	<b>54</b>	<b>52</b>	<b>55</b>
<b>Estimated productivity (total chicks)</b>	<b>NEI</b>	<b>39</b>	<b>34</b>	<b>42</b>	<b>46</b>	<b>32</b>
<b>Estimated young fledged per active nest (fledging success rate)</b>	<b>NEI</b>	<b>1.15</b>	<b>1.21</b>	<b>1.45</b>	<b>1.84</b>	<b>1.28</b>
<b>Artificial Nesting Structures</b>						
Active	-	-	-	0	0	0
Inactive	-	-	-	3	3	29
<b>Total Structures Surveyed</b>	-	-	-	<b>3</b>	<b>3</b>	<b>29</b>
<b>Estimated productivity (total chicks)</b>	-	-	-	<b>0</b>	<b>0</b>	<b>0</b>
<b>Estimated young fledged per active nest (fledging success rate)</b>	-	-	-	<b>0</b>	<b>0</b>	<b>0</b>

**Note:** NEI = not enough information

“-“ indicates no data

\* Estimates of productivity (fledged per active nest) in 2020 were based on only two surveys rather than three and active nests may be an overestimate



**Figure 1** Active nests (red bars) and total fledged chicks (blue dots) from 2017 to 2021, Peace River, BC. A linear trend line is displayed for active nests (red dashed line) and total fledged chicks (blue dash line).



**Figure 2** Artificial nesting structure (Nest ID P32) for bald eagles and osprey, installed in 2015, as seen in 2021



**Figure 3** Artificial bald eagle nesting structure (Nest ID Eagle\_326), installed in 2020, as seen in 2021

## 4.0 DISCUSSION

The 2021 surveys represent the fifth year of estimating the annual productivity of bald eagles in the study area (2017 through 2021). The total number of fledged chicks in 2020 (46 chicks) was the greatest number observed since the beginning of the monitoring program, while the number of fledged chicks observed in 2021 was 32, below the average estimated number of chicks produced per year across survey years ( $38.6 \pm 5.1$  SD chicks per year). The cause of the increased chick production in 2020 is unknown and may have resulted from good weather during the breeding period, and/or reduced competition from other nesting pairs from the reduced number of active nests.

Bald eagle reproduction and productivity rates are generally regulated by nest availability and prey quality and abundance (Newton 1998; Elliott and Norstrom 1998). Although the change in the number of active nests over time has not been statistically significant (coefficient = -0.075, p-value = 0.2) as nesting trees have been lost or been removed, the number has decreased from 34 active nest trees in 2017 to 25 active nest trees in 2021 as forested habitat is cleared. From 2017 through 2021, on average,  $66\% \pm 8.4$  SD of nests have been active in a given year. Thirty-four active bald eagle nests were reported along the Peace River between Hudson's Hope and the Alberta border in 2011, although productivity was not reported (Hilton et al. 2013). Occupancy was similar at Williston Reservoir, with 60% of eagles nests occupied in 1995 (Booth B., Merkens M. Wood M. D. 1999). Despite the apparent (albeit not statistically significant) decline in the number of active nests, the total number of chicks fledged has stayed relatively unchanged over time (coefficient = -0.005, p-value = 0.9) (**Figure 1**), such that the number of fledged young per active nest (i.e., nest productivity) has shown an apparent increase that was not statistically significant (slope = 0.08,  $R^2 = 0.26$ ) from 1.15 chicks per active nest in 2017 to 1.24 in 2021.

The 29 artificial nesting structures erected in 2015 and 2020 have not been used by eagles to date. Three artificial nesting structures were placed around the planned reservoir footprint in 2015, which were designed to provide nesting substrates for both osprey (*Pandion haliaetus*) and bald eagle with an elevated platform (**Figure 2**). In late 2020, 26 additional nesting structures were erected, designed specifically for bald eagles with supports to hold a large cup nest (**Figure 3**). There has been no nesting activity observed at any of these structures yet. It's speculated that the structures are too far away from the current Peace River edge to be used by eagles while potential nest trees are still available closer to their foraging area. Both bald eagles and ospreys are known to use artificial nesting structures when natural nesting structures are limited (Bird et al. 1996; Hunter et al. 1997). It is anticipated that with the continued clearing of trees in the reservoir area, reducing the availability of natural nesting structures, intra-specific territoriality will increase, and the likelihood of artificial nesting structures being used will increase.

Surveys using the methods described here will continue in 2022 as per the commitments in the Site C Bald Eagle Mitigation and Monitoring Program (BC Hydro 2021).

## 5.0 CLOSURE

This Work was performed in accordance with BCO95055 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and BC Hydro (Client), dated 21 June 2016 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by BC Hydro. In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

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# **APPENDIX A**

## **Nest Survey Results for 2021**

### Nest Survey Results for 2021

Nest ID	Latitude	Longitude	Year First Detected*	Activity 2021	Nest Substrate
6	56.1378	-121.628	pre-2014	Active	Tree
8	56.18006	-121.526	pre-2014	tree gone	Tree
13	56.23497	-121.305	pre-2014	tree gone	Tree
22	56.13563	-120.641	pre-2014	Inactive	Tree
29	56.10791	-120.099	pre-2014	Active	Tree
38	56.10516	-120.442	pre-2014	Inactive	Tree
100	56.15796	-120.752	pre-2014	Active	Tree
101	56.15268	-120.742	pre-2014	tree gone	Tree
104	56.19497	-120.801	pre-2014	Inactive	Tree
127	56.23156	-121.337	pre-2014	Inactive	Tree
128	56.23103	-121.334	pre-2014	Active	Tree
132	56.16722	-121.572	pre-2014	tree gone	Tree
133	56.15651	-121.587	pre-2014	tree gone	Tree
138	56.09354	-121.812	pre-2014	Active	Tree
144	56.01341	-121.926	pre-2014	Inactive	Tree
146	56.0052	-121.96	pre-2014	Active	Tree
155	56.12454	-121.667	pre-2014	tree gone	Tree
203	55.99701	-121.721	pre-2014	Active	Tree
219	56.09443	-120.183	pre-2014	Active	Tree
222	56.0935	-120.35	pre-2014	Active	Tree
223	56.11221	-120.48	pre-2014	tree gone	Tree
224	56.11247	-120.482	pre-2014	Active	Tree
225	56.00347	-121.677	pre-2014	Inactive	Tree
600	56.03176	-121.893	2017	Inactive	Tree
601	56.09345	-121.812	2017	Inactive	Tree
602	56.11356	-121.77	2017	tree gone	Tree
607	56.1183	-120.545	2017	Active	Tree
608	56.14785	-120.709	2017	Inactive	Tree
610	56.05733	-121.116	2017	Active	Tree
611	56.00278	-121.68	2017	Inactive	Tree
701	56.05779	-121.112	2018	not detected	Tree
702	56.11453	-121.732	2018	Active	Tree
705	56.11264	-120.53	2018	tree gone	Tree
707	56.19025	-120.894	2018	tree gone	Tree
802	56.19521	-120.847	2019	Active	Tree
803	56.11214	-120.529	2019	Active	Tree

Nest ID	Latitude	Longitude	Year First Detected*	Activity 2021	Nest Substrate
804	56.13809	-120.02	2019	Active	Tree
805	56.06438	-121.095	2019	Inactive	Tree
806	56.13613	-120.643	2019	Active	Tree
901	56.22146	-121.07	2020	tree gone	Tree
902	56.22066	-121.06	2020	tree gone	Tree
903	56.04718	-121.863	2020	Inactive	Tree
904	56.20372	-121.472	2020	tree gone	Tree
1001	56.19021	-120.89	2021	Active	Tree
1100	55.99477	-121.657	2021	Inactive	Tree
1101	56.16626	-121.573	2021	Inactive	Tree
1102	56.10305	-120.255	2021	Active	Tree
1103	56.19153	-121.511	2021	Active	Tree
1105	56.24904	-121.146	2021	Active	Tree
1106	56.00555	-121.674	2021	Inactive	Tree
1107	56.155981	-121.589	2021	Active	Tree
1110	56.22109	-121.06	2021	Active	Tree
1108	56.20247	-121.473	2021	Active	Tree
1109	56.12386	-121.666	2021	Active	Tree
62c	56.19493	-120.849	pre-2014	tree gone	Tree
Eagle_134_West	56.24284	-121.326	2021	Inactive	Platform
Eagle_14.1	56.22483	-120.938	2021	Inactive	Platform
Eagle_142	56.24337	-121.394	2021	Inactive	Platform
Eagle_144	56.23522	-121.404	2021	Inactive	Platform
Eagle_147	56.23081	-121.414	2021	Inactive	Platform
Eagle_151	56.23171	-121.435	2021	Inactive	Platform
Eagle_153	56.22785	-121.451	2021	Inactive	Platform
Eagle_153_East	56.22949	-121.442	2021	Inactive	Platform
Eagle_167	56.25048	-121.506	2021	Inactive	Platform
Eagle_182C	56.18959	-121.516	2021	Inactive	Platform
Eagle_216B	56.1872	-121.525	2021	Inactive	Platform
Eagle_217	56.18436	-121.534	2021	Inactive	Platform
Eagle_246	56.1196	-121.701	2021	Inactive	Platform
Eagle_247 east	56.11782	-121.71	2021	Inactive	Platform
Eagle_249_East	56.11805	-121.721	2021	Inactive	Platform
Eagle_254_West	56.12484	-121.755	2021	Inactive	Platform
Eagle_257N	56.12191	-121.769	2021	Inactive	Platform
Eagle_258_East	56.12063	-121.777	2021	Inactive	Platform

Nest ID	Latitude	Longitude	Year First Detected*	Activity 2021	Nest Substrate
Eagle_326	56.07072	-121.854	2021	Inactive	Platform
Eagle_41.1A	56.21323	-121.064	2021	Inactive	Platform
Eagle_41.1B	56.21411	-121.076	2021	Inactive	Platform
Eagle_48	56.23015	-121.093	2021	Inactive	Platform
Eagle_49.1B	56.21772	-121.105	2021	Inactive	Platform
Eagle_49.2B	56.2156	-121.094	2021	Inactive	Platform
Eagle_75	56.25454	-121.185	2021	Inactive	Platform
Eagle_75.1	56.25009	-121.177	2021	Inactive	Platform
P32	56.24048	-121.13	2018	Inactive	Platform
P39	56.23498	-120.955	2018	Inactive	Platform
P47	56.23297	-121.1	2018	Inactive	Platform

**Notes:**

\*' - Year first observed for nests recorded before 2014 is not known as the Site C EIS does not provide this detail, but rather only that that BAEA nest surveys were conducted and the nests found in 2006, 2008, and 2011. Surveys were conducted in 2012, but no nests were detected.

Active – nest present and BAEA in area or using nest; Inactive – nest present but unused; Not Detected - nest not detected; Tree Gone - the nest tree is no longer standing

## **APPENDIX B**

### **Active Bald Eagle Nests and Assumed Productivity 2021**

Nest ID	Comments May 12	Comments May 28	Comments June 11	Estimated Productivity (if fledged)
6	Adult + 1 chick	Adult + 1 chick	Adult + 1 chick	1
29	Adult on nest	Adult + 1 chick	Adult + 1 chick	1
100	Adult + 2 chicks	1 chick	Adult + 1 chick	1
128	Adult + 2 chicks	Adult + 2 chicks	Adult + 2 chicks	2
138	Adult + 2 chicks	Adult + 2 chicks	2 chicks	2
146	Adult on nest	2 chicks	1 chick	1
203	Adult incubating	Adult + 2 chicks	Adult + 2 chicks	2
219	Adult on nest	Adult + 1 chick	Adult + 2 chicks	2
222	Adult + 2 chicks	Adult + 2 chicks	2 chicks	2
224	Adult + 1 chick	Adult + 1 chick	1 chick	1
607	Adult + 2 chicks	Adult + 1 chick	Adult + 1 chick	1
610	Adult incubating	Inactive	Inactive	0
702	2 chicks	Adult + 1 chick	2 chicks	2
802	Adult + 2 chicks	2 chicks	2 chicks	2
803	Adult + 1 chick	Adult + 2 chicks	Adult + 2 chicks	2
804	Adults+ 2 chicks	1 chick	Inactive	0
806	Adult + 1 chick	1 chick	Adult + 1 chick	1
1001	Adult + 2 chicks	Adult + 2 chicks	2 chicks	2
1002	Adult incubating	Inactive	Inactive	0
1003	Inactive	Adult + 1 chick	Inactive	0
1105	Adult nearby	Adult + 1 chick	1 chick	1
1107	Adult + 1 chick	Adult + 1 chick	2 adults + 1 chick	1
1108	Adult + 2 chicks	Adult + 2 chicks	Adult + 2 chicks	2
1109	Adult + 1 chick + 1 egg	Adult + 1 chick + 1 egg	Adult + 1 chick	1
1110	Adult + 2 chicks	2 chicks	2 chicks	2
<b>Total Chicks</b>				<b>32</b>

**Note:** Active – nest present and BAEA using nest; Inactive – nest present but unused

**Appendix 12. Ground-Nesting Raptor Monitoring 2021 Annual Report**



# Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2021 Annual Report



PRESENTED TO  
**BC Hydro and Power Authority**

NOVEMBER 4, 2021  
ISSUED FOR USE  
FILE: 704-ENW.PENW03042-02.GNRM

Saulteau EBA Environmental Services Joint Venture.  
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Vancouver, BC V6C 1N5 CANADA  
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# Site C Clean Energy Project Ground-Nesting Raptor Monitoring 2020 Annual Report

FILE: 704-ENW.PENW03042-02.GNRM  
November 4, 2021

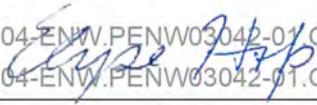
## PRESENTED TO

**Site C Clean Energy Project  
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## PRESENTED BY

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## LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of BC Hydro and Power Authority and their agents. Saulteau EBA Environmental Services Joint Venture does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than BC Hydro and Power Authority, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Saulteau EBA Environmental Services Joint Venture's Services Agreement. Saulteau EBA Environmental Services Joint Venture's Limitations on Use of This Document are provided in Appendix D of this report.

## EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground-nesting raptors (i.e., Short-eared Owl [*Asio flammeus*] and Northern Harrier [*Circus hudsonius*]) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2021. 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 2021 ground-nesting raptor surveys were conducted using two methods: (1) Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl, and (2) Autonomous Recording Units (ARUs) were established at select standwatch stations with the purpose of detecting Short-eared Owl through human-listening.

The ground-nesting raptor field surveys were completed within four cleared portions of the Site C construction headpond: Highway 29 near Watson Slough, Cache Creek, Bear Flats, and along the Peace River between the Halfway River and Moberly River. The surveys were conducted either through transects or through stationary standwatches. Ground-nesting raptor surveys were completed at each transect and standwatch station up to six times over May and June 2021 (three daytime visits and three evening surveys at select sites). The cleared portions near Bear Flats, Cache Creek, and Highway 29 were accessed on foot and the areas along the Peace River were accessed by boat.

ARUs were deployed at six stations throughout the survey area that were assessed as having the highest habitat potential for Short-eared Owl. These six stations were located along transects or at standwatch stations in the Bear Flats and Peace River survey areas in locations that had experienced between one to three growing seasons since clearing. The ARUs were retrieved after a month of recording and three audio recordings taken near sunset were randomly selected from separate nights at each station and analyzed and interpreted for Short-eared Owl through human listening.

No Short-eared Owls were detected during the field surveys or through human listening of the ARU recordings. Northern Harrier was observed twice within the Peace River area: once during the early June surveys (June 4 – June 8) and once during the late June surveys (June 18 – June 24). No behaviours suggestive of Northern Harrier nesting were observed. Surveys in 2022 will continue in all cleared areas within the construction headpond.

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## APPENDICES

- Appendix A Incidental Wildlife Observations
- Appendix B Survey Station History 2016 - 2021
- Appendix C Project Qualified Environmental Professionals
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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 BC Hydro and Power Authority’s (BC Hydro) Site C Clean Energy Project (“Site C”) in spring and summer 2021. The surveys were part of BC Hydro’s Ground-Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). Ground-nesting raptor surveys have occurred annually since 2016. This report describes the methods used to conduct the surveys and provides a summary of the results from 2021.

The Ground-Nesting Raptor Follow-up Monitoring Program is specifically focused on two ground-nesting raptor species: Short-eared Owl (*Asio flammeus*) and Northern Harrier (*Circus hudsonius*) (Table 1).

**Table 1: Species Covered in the Ground-Nesting Raptor Follow-up Monitoring Program**

Common Name	Scientific Name	BC List	COSEWIC <sup>1</sup> Status	SARA <sup>2</sup> Status
Short-eared Owl	<i>Asio flammeus</i>	Blue	Special Concern	Schedule 1 – Special Concern
Northern Harrier	<i>Circus hudsonius</i>	Yellow	-	-

<sup>1</sup> COSEWIC – Committee on the Status of Endangered Wildlife in Canada.

<sup>2</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.

## 2.0 METHODS

The 2021 ground-nesting raptor surveys were conducted using two methods:

1. Field surveys were conducted along transects and at standwatch stations to detect Northern Harrier and Short-eared Owl; and
2. Autonomous Recording Units (ARUs) were deployed at select standwatch stations as a pilot study to determine if acoustic recordings could be used to detect Short-eared Owl in late-evening hours when sites cannot be surveyed by human observers.

Surveys were conducted in cleared portions of the construction headpond between the dam site and the Halfway River. Surveys of the mitigation properties were conducted in 2016 and 2017. Use of the mitigation properties in their current conditions (i.e., in the absence of any land-use changes or habitat modification) by ground-nesting raptors has been well documented and further surveys would likely not provide new information. Surveys of the mitigation properties were therefore not conducted in 2021. Surveys of these areas will be performed again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications in the mitigation properties, whichever occur first.

### 2.1 Field Surveys

Surveys were conducted at 37 standwatch stations within the four areas outlined in Table 2 and on Figures 1 through 8 (see Appendix B for a full list of the standwatch stations surveyed in 2021 and the survey history of each station from 2016 – 2021):

- The Bear Flats area had a single transect with five standwatch stations located along its length (Figure 2).
- The Cache Creek area consisted of a single standwatch station (Figure 3). The Cache Creek transect could not be surveyed in 2021 due to active bridge construction that was underway. The construction prevented access to all five transect stations as well as to CCSW06. A single standwatch station, CCSW07, was newly established close to the abandoned station CCSW06 so that this area could continue to be surveyed.
- The Highway 29 area consisted of a single standwatch station, H29SW06 (Figure 3). H29SW01 was not surveyed this year, because this station had been established in an area that was outside of the ground-nesting raptor study area (i.e., outside of the headpond area).
- The Peace River area was the largest survey area, with five transects (for a total of 25 standwatch stations) between the Moberly River and Cache Creek and five standwatch stations located between Cache Creek and the Halfway River (Figures 3 to 8). No new survey stations were established within the Peace River area this year. The standwatch stations PRSW29, PRSW30, and PRSW36 were not surveyed this year because those stations had been established in areas outside of the ground-nesting raptor study area (i.e., outside of the headpond area).

Within these four areas, ground-nesting raptors were surveyed up to six times over May and June 2021 to capture earlier, middle, and later stages of their breeding season. The surveys were conducted using a combination of transects and stationary standwatches. The cleared Bear Flats, Cache Creek, Highway 29 areas were accessed by foot and the cleared Peace River areas were accessed by boat. Surveys were completed by two teams of two observers. Each team was composed of a biologist with raptor survey experience and an assistant (Appendix C).

Surveys were not conducted in the Moberly River area due to construction activity at the confluence with the Peace River and high water upstream making it inaccessible. The Lynx Creek survey area (LCSW01 and LCSW02) and Halfway River survey area (HRSW01) were not surveyed this year because those stations had been determined to be in areas outside of the ground-nesting raptor study area (i.e., outside of the construction headpond area).

**Table 2: 2021 Survey Areas with Dates and Times**

Survey Location	First Visit	Second Visit (Evening)	Third Visit	Fourth Visit (Evening)	Fifth Visit	Sixth Visit (Evening)
<b>Bear Flats</b>	May 6, 2021 09:00 – 11:29	May 6, 2021 20:39 – 21:30 (Only surveyed BFSW01 and BFSW02)	June 1, 2021 06:12 – 08:39	June 8, 2021 20:49 – 21:41 (Only surveyed BFSW01 and BFSW02)	June 24, 2021 06:45 – 09:28	June 24, 2021 20:54 – 21:50 (Only surveyed BFSW01)
<b>Cache Creek</b>	May 6, 2021 12:29 – 12:49	May 6, 2021 19:55 – 20:15	June 1, 2021 09:32 – 09:52	June 8, 2021 21:10– 21:30	June 24, 2021 07:02 – 07:22	June 24, 2021 22:02 – 22:22
<b>Highway 29</b>	May 6, 2021 12:55 – 13:15	May 6, 2021 19:30 – 19:50	June 1, 2021 09:36 – 09:56	June 8, 2021 20:40 – 21:00	June 24, 2021 06:34 – 06:54	June 24, 2021 22:03 – 22:23
<b>Peace River</b>	May 4, 2021 08:05 – 15:25 & May 5, 2021 07:29 – 15:38	No evening surveys conducted	June 2, 2021 06:54 – 15:07 & June 3, 2021 10:09 – 11:14	No evening surveys conducted	June 18, 2021 06:57 – 13:57 & June 19, 2021 09:17– 10:40	No evening surveys conducted

Northern Harrier are diurnal, and research suggests they are generally active between 05:30 and 21:30 (Smith et al. 2011). Short-eared Owl are a crepuscular species and optimal survey timing is in the evening just prior to civil twilight (Wiggins et al. 2006). While most surveys were conducted during daytime hours, three evening surveys were conducted at four select sites to enhance the possibility of detecting Short-eared Owl (the “evening” visit columns in Table 2). The evening surveys were limited to areas that could be safely accessed by truck due to the logistical and safety considerations that come with conducting surveys in cleared portions of the reservoir that require boat access. Evening surveys would require boating in very low light or dark conditions after surveys are complete, which would not be considered a safe work practice by BC Hydro.

### **2.1.1 Transect Survey Protocol**

The transect surveys were conducted by walking at a speed of 0.5 – 2 km/hr, looking and listening for birds. Surveyors stopped whenever required to confirm identification and record data. The walking transects were located only in cleared portions of the reservoir. Surveyors selected walking paths to ensure visual coverage of the entire portion of suitable habitat in each area. During the transect, surveyors stopped at each established standwatch station to complete a standwatch survey. From each standwatch station the surveyors had a view from the previous standwatch station to the next station in the transect. Adding these standwatches into the transect surveys allowed surveyors to observe areas for longer periods to increase the potential to observe bird activity and to monitor potential nesting behaviour for the purpose of locating ground-nesting raptor nests. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3; 12 – 19 km/hr), rain or fog, when bird activity and detectability are likely to be low. The order that the stations were visited was different on each of the survey days so that time of day varied between visits.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations (Appendix A). For Northern Harrier or Short-eared Owl observations, if a pair was observed or there was evidence of nesting behaviour, a nest search was conducted to attempt to locate any nest that might be present in the area. 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.

### **2.1.2 Standwatch Survey Protocol Without Transects**

Standwatch surveys in the absence of associated transects were conducted in cleared portions of the reservoir that (1) could not be visited by foot due to impassible terrain and/or (2) could not be linked with other standwatch stations to form a transect. Standwatches were conducted by observing from a stationary position for approximately 20 minutes.

Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 – 19 km/hr), rain or fog. The order that the stations were visited were different on each of the survey days.

Ground-nesting raptor observations were collected following the same protocol as described in Section 2.1.1 for transect surveys.

## 2.2 Autonomous Recording Unit Surveys

An ARU is a standalone audio recording device that can be deployed and left for a period of time to record vocalizations or other sounds. The audio recordings are analyzed and interpreted once the recording units have been retrieved. ARUs are a commonly used tool to survey birds (Shonfield and Bayne 2017). The benefit of using ARUs for bird surveys is that the units can be deployed during daylight hours in areas that cannot be easily or safely accessed in the evening/night (i.e. along the Peace River) when species such as Short-eared Owl are active, allowing for monitoring in areas that would otherwise be difficult to survey.

Short-eared Owl are not especially vocal (Wiggins et al. 2020) and surveys for this species are best conducted using visual ground surveys. However, ARUs could be a useful supplement to visual surveys if Short-eared Owl vocalizations can be reliably detected by a human listener in recordings. This would allow for listening of recordings at locations that could not otherwise be surveyed in evening hours.

To informally test the utility of ARUs for detecting Short-eared Owls and determine if ARUs could be a useful addition to supplement the ongoing visual ground surveys at Site C, an experimental trial was conducted in 2020 and 2021. ARUs were deployed at select standwatch stations with the intent that Short-eared Owl would be detected by visual survey and recordings could then be reviewed to identify Short-eared Owl vocalizations. Ideally, ARUs would be deployed at locations where Short-eared Owls are known to occur; however, previous surveys have not identified any Short-eared Owl in or adjacent to the reservoir area.

ARUs (Song Meter SM4 from Wildlife Acoustics Inc.) were deployed at six stations that were assessed as having the highest habitat potential for Short-eared Owl. These seven stations were located along transects or at standwatch stations in the Bear Flats and Peace River survey areas in locations that had experienced between one to three growing seasons since clearing (Table 3). These sites were abundant in low vegetation, grasses, shrubby regrowth, and had abundant coarse woody debris. A description of the habitat at each ARU survey station can be found in Section 3.1.

**Table 3. 2021 ARU Survey Station Locations**

ARU Survey Station	Location Reference	UTM Zone	UTM Easting	UTM Northing
PRSW03	Along Peace River Transect #1	10V	624355	6233276
PRSW07	Along Peace River Transect #2	10V	626626	6232622
PRSW12	Along Peace River Transect #3	10V	620711	6232634
PRSW23	Along Peace River Transect #4	10V	616002	6233032
PRSW26	Along Peace River Transect #5	10V	612217	6236472
BFSW03	Along the Bear Flats transect.	10V	612030	6237304

The ARUs were installed from May 4 to May 6, 2021 and were collected from June 18 to June 24, 2021. The ARUs were installed based on the deployment protocol of Lankau (2015). Each unit was mounted on a wooden stake or affixed to a tree approximately 1 m from the ground. The ARUs were set to record for 10 minutes every half hour each evening for the duration of deployment. The evening recordings were collected between 20:00 to 00:10 (i.e., midnight). The ARUs recorded 2-channel stereo, compressed W4V-8 files at 24 KHz.

To increase the probability of Short-eared Owl detection, recordings that could be selected for human listening were restricted to those taken as close to sunset (approximately 21:55 in June) as possible, when Short-eared Owls are likely to be most active. Three 10-minute recordings, taken at either 21:30 or 22:00, were randomly selected from each station for human listening, for a total of 18 recordings. The three recordings were selected from different

nights during the ARU deployment period. If a selected recording had persistent wind or rain, a new recording was randomly selected to avoid periods of low Short-eared Owl activity or decreased ability to detect sounds. The compressed W4V files were converted to uncompressed WAV files using the Kaleidoscope software (version 5.3.8) by Wildlife Acoustics. The uncompressed WAV files were then imported into Audacity (version 2.4.2) for human listening. The trained human listener played back each recording and was instructed to record Short-eared Owl calls, including barks, screams, bill snaps and male courtship hoots detected in 1-minute intervals; replay any section needed to accurately track and count Short-eared Owl detections; and estimate perceived distance to each individual (near, mid and far). Human listening was conducted by the same trained human listener for all recordings.

## 3.0 RESULTS

### 3.1 Habitat at Survey Areas

Habitat information for each survey station was noted during surveys to determine the quality of the cleared area as hunting and nesting habitat for ground-nesting raptors. Table 4, below, describes the habitat at each survey station. Photographs of the habitat at each station are presented on Figures 2-8.

**Table 4: Habitat at Peace River Standwatch Stations and Transects during the 2021 Surveys**

Transect or Survey Station	Cleared	Growing Seasons Since Clearing	Habitat
<b>Bear Flats Survey Area – Transect Only</b>			
Bear Flats Transect <ul style="list-style-type: none"> <li>▪ BFSW01</li> <li>▪ BFSW02</li> <li>▪ BFSW03</li> <li>▪ BFSW04</li> <li>▪ BFSW05</li> </ul>	Winter 2018/2019	2	The cleared area was experiencing vegetation regrowth with high percent cover (80-90%) of grasses, forbs and shrubs. Shrubs were approximately 1 m high. The cleared area is bounded by the Peace River to the south and by aspen forests growing on dry south-facing slopes to the north.
<b>Cache Creek Survey Area – Standwatch Only</b>			
CCSW07	Partial clearing in Winter 2016/2017  Partial clearing in Winter 2018/2019	4  2	Reestablished vegetation is dominated by grasses and patches of low shrubs (1.0 m in height). The area is oriented south towards Cache Creek, bounded by Highway 29 to the north and surrounded by deciduous riparian forests.
<b>Highway 29 Survey Area – Standwatch Only</b>			
H29SW06	Winter 2016/2017	4	Vegetation regrowth consists of a dense cover of grasses, weeds, forbs, and shrubs approximately 1 m tall with trembling aspen saplings growing to up to 2 m tall on the western side. The Peace River and riparian balsam poplar forest lies to the south.
<b>Peace River Survey Area – Transect and Standwatch</b>			
Peace River Transect #1 <ul style="list-style-type: none"> <li>▪ PRSW02</li> <li>▪ PRSW03</li> <li>▪ PRSW04</li> </ul>	Winter 2017/2018	3	A cleared and mulched bench in the river channel with thick herbaceous and shrubby regrowth (some greater than 1.0 m tall) covering 90% of the cleared area. It is bounded on the northern and southern sides by intact strips of open riparian forest between the cleared area and the Peace River.
Peace River Transect #2 <ul style="list-style-type: none"> <li>▪ PRSW05</li> <li>▪ PRSW06</li> <li>▪ PRSW07</li> <li>▪ PRSW08</li> </ul>	Winter 2017/2018	3	A cleared stretch of coniferous forest on a north-facing slope with abundant grass, herb and shrub regrowth (some greater than 1 m tall) covering 90% of the area. It is bounded to the south by the Peace River, and to the north and west by coniferous forest.



### **3.2 Transect Results**

Two Northern Harriers were observed along transects within the Peace River survey area (Table 5). During the second visit in early June, one Northern Harrier was observed along the Peace River Transect #5 at PRSW24. During the third visit in late June, one Northern harrier was observed along the Peace River Transect #2 at PRSW06. No Northern Harrier were observed at any of the stations during the first visit in early May. No nests or potential nests were observed along any of the transects surveyed.

### **3.3 Standwatch Results**

No Northern Harrier or Short-eared Owl were observed at any of the standwatch only stations.

### **3.4 Incidental Observations**

There were no incidental Northern Harrier or Short-eared Owl observed during any of the three visits.

### **3.5 ARU Survey Results**

Three 10-minute recordings from each of the six stations were analyzed through human listening, for a total of 18 recordings. No Short-eared Owls were detected through human listening.

**Table 5: Northern Harrier Observations during the May/June 2021 Field Surveys.**

Transect	Station	Date	Time	Count	Activity	Sex	Age Class	Observation Location			Comments <sup>1</sup>
								UTM Z	UTM E	UTM N	
<b>Observations from Transects</b>											
Peace River Transect #5	PRSW24	June 2, 2021	11:10	1	Flying	U	Adult	10V	613115	6235638	Observed NOHA <sup>1</sup> individual flying northwest approximately 500 m away at 140 degrees.
Peace River Transect #2	PRSW06	June 18, 2021	8:09	1	Flying	U	Adult	10V	626236	6232838	Observed NOHA flying approximately 500 m away at 200 degrees. Perched briefly in a few trees before flying east along treeline.

<sup>1</sup> NOHA = Northern Harrier

## 4.0 DISCUSSION

The 2021 ground-nesting raptor surveys detected Northern Harrier in and adjacent to the Project footprint. Northern Harriers were observed twice, once during the early June surveys, and once during the late June surveys. Both of these Northern Harrier observations occurred along the southern ridges and slopes of the Peace River, at the interface of cleared and forested areas. No behaviours suggestive of nesting were observed.

No Short-eared Owls were detected during the 2021 ground-nesting raptor surveys, which is consistent with the previous years' findings. No Short-eared Owls have been observed in or adjacent to the Project footprint since surveys began in 2016. The experimental use of ARUs to detect Short-eared Owl using audio recordings continues to be inconclusive since no Short-eared Owl were detected in 2020 or 2021. The ARU trial will be conducted again in 2022.

Areas surveyed within the headpond area in 2016 through 2021 will be surveyed again in 2022 in addition to any newly cleared areas within the headpond. Surveys in the headpond will continue until the reservoir has been filled. The first surveys in 2022 are expected to occur in the first week of May, consistent with previous years.

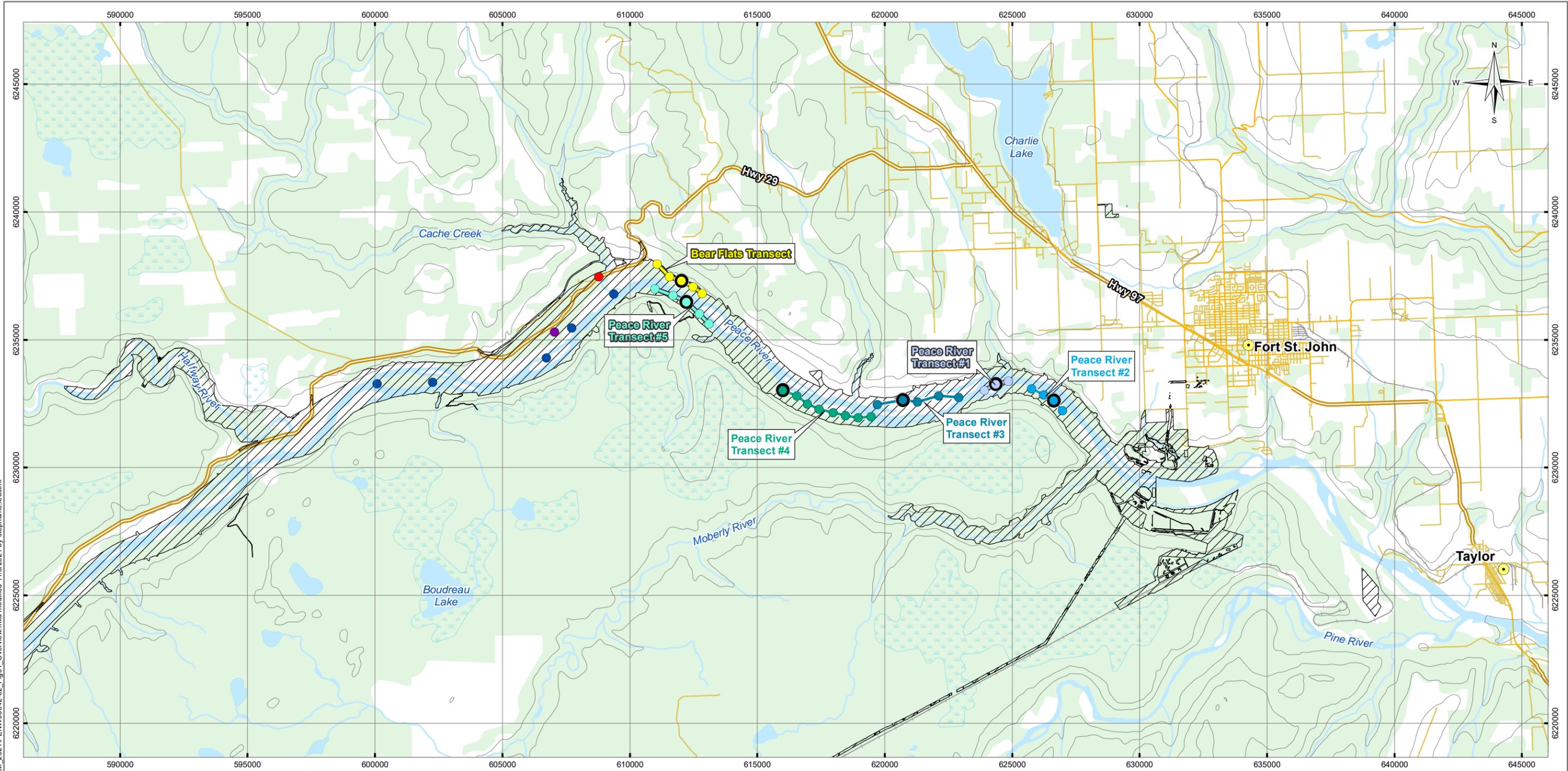
## 5.0 REFERENCES

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# FIGURES

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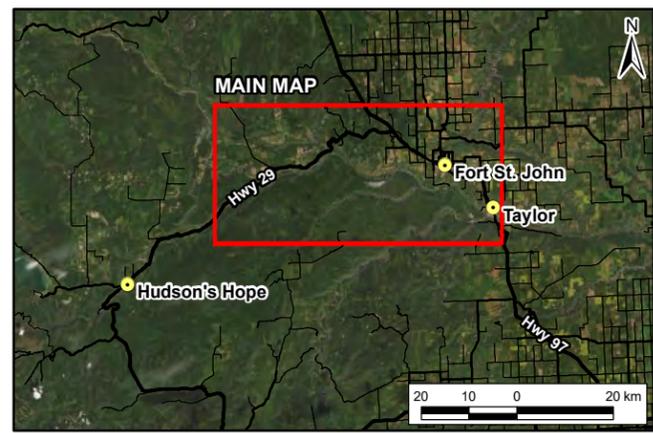
Figure 1	Project Overview
Figure 2	Bear Flats Transect Stations
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Figure 5	Peace River Transect #1 and Transect #2 Standwatch Stations
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Figure 7	Peace River Transect #4 Standwatch Stations
Figure 8	Peace River Transect #5 Standwatch Stations



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**LEGEND**

- |                           |                                    |                 |                            |                 |
|---------------------------|------------------------------------|-----------------|----------------------------|-----------------|
| Project Footprint         | <b>Transect Standwatch Station</b> | <b>Transect</b> | Populated Place            | Contour (100 m) |
| ARU Station               | Bear Flats                         | Bear Flats      | Highway                    | Watercourse     |
| <b>Standwatch Station</b> | Peace River #1                     | Peace River #1  | Main Road                  | Waterbody       |
| Cache Creek               | Peace River #2                     | Peace River #2  | Local Road                 | Wetland         |
| Highway 29                | Peace River #3                     | Peace River #3  | Resource/Recreational Road | Wooded Area     |
| Peace River               | Peace River #4                     | Peace River #4  | Railway                    |                 |
|                           | Peace River #5                     | Peace River #5  | Residential Area           |                 |



**NOTES**  
Base data source: CanVec 1:250,000 (2019).

**SITE C  
GROUND-NESTING RAPTOR MONITORING  
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**Project Overview**

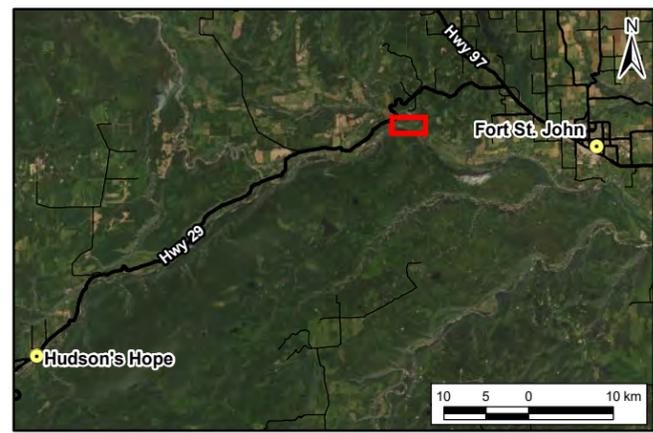
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**LEGEND**

- ARU Station
- Bear Flats Transect Standwatch Station
- Bear Flats Transect
- Project Footprint
- Highway
- Watercourse
- Waterbody



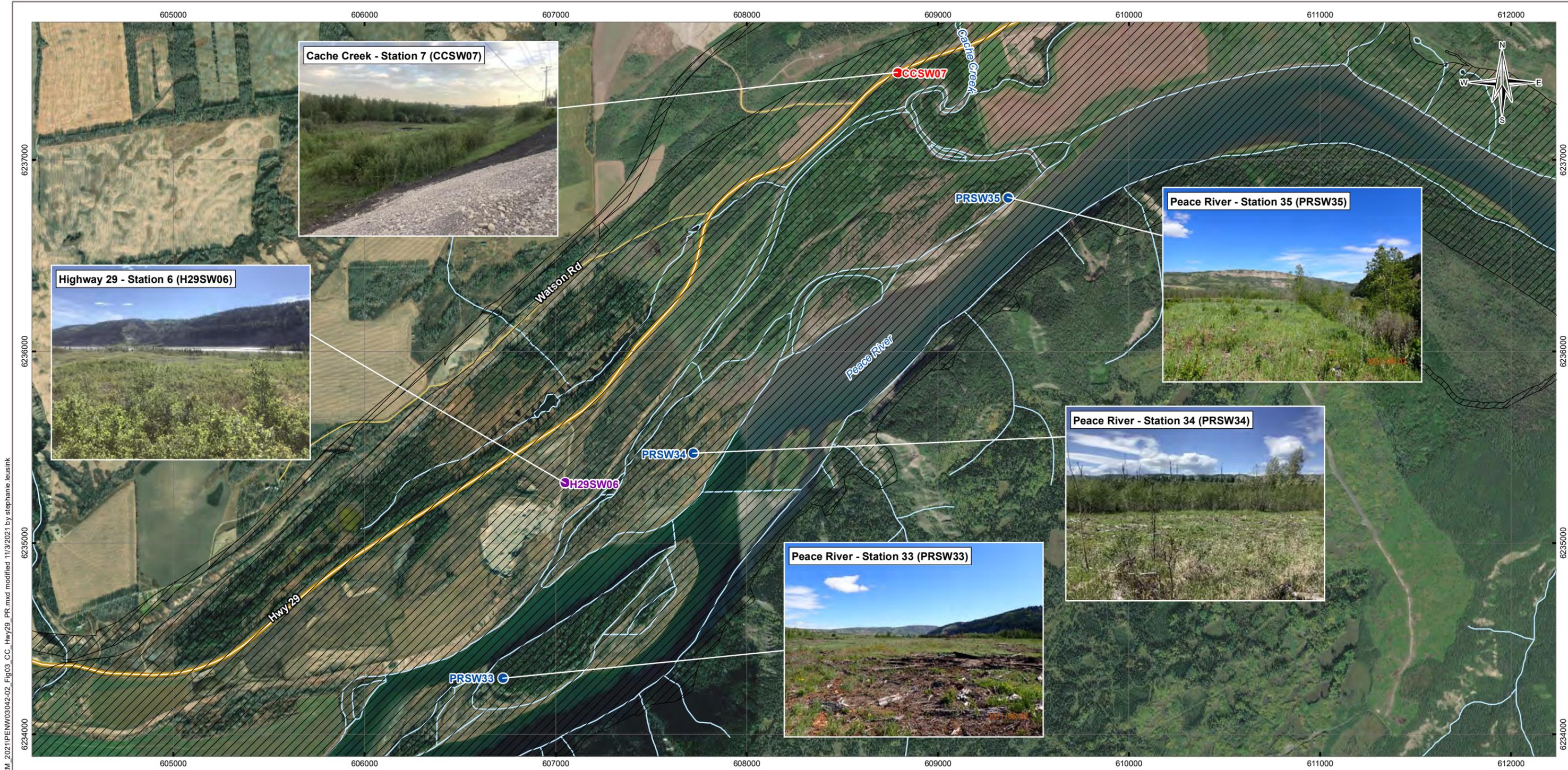
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 Imagery from ESRI; Maxar (2016).

**STATUS**  
 ISSUED FOR USE

**SITE C**  
**GROUND-NESTING RAPTOR MONITORING**  
**2021 ANNUAL REPORT**

**Bear Flats Transect Stations**

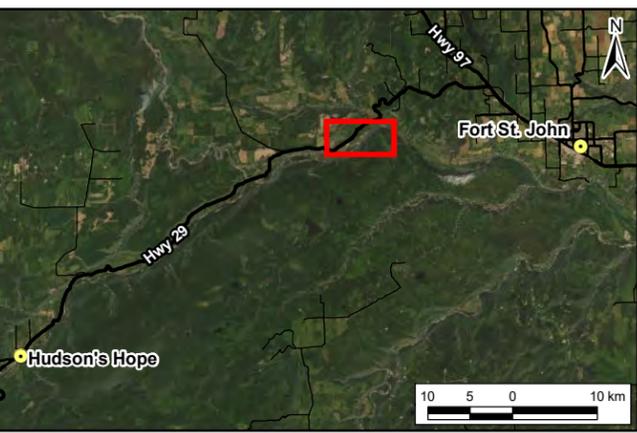
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				<b>TETRA TECH</b>	
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<b>DATE</b> November 3, 2021		<b>PROJECT NO.</b> ENW.PENW03042-02			



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**LEGEND**

- Cache Creek Standwatch Station
- Highway 29 Standwatch Station
- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- Watercourse
- Waterbody



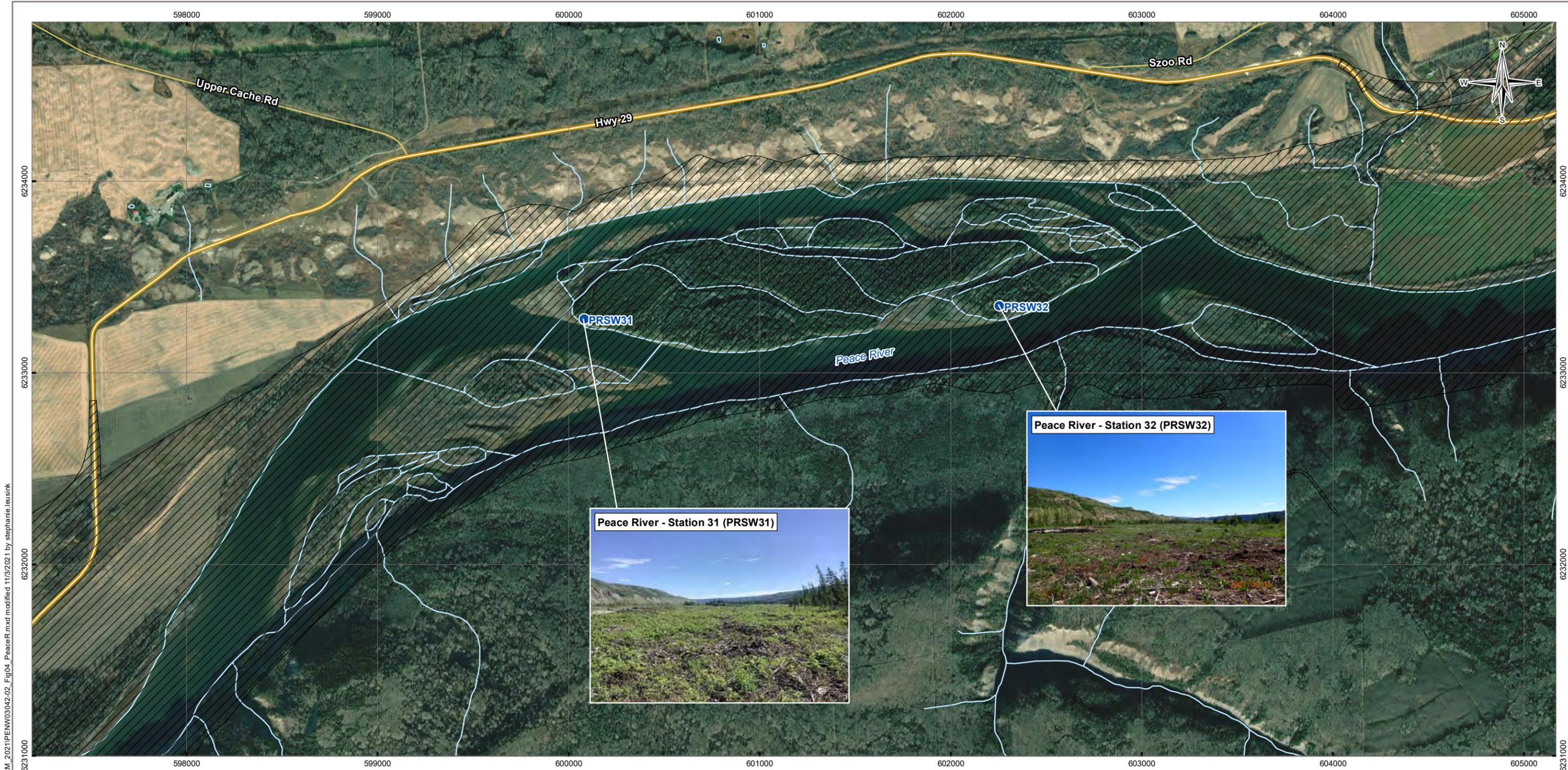
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 2021 ANNUAL REPORT**

**Cache Creek, Highway 29 and  
 Peace River Standwatch Stations**

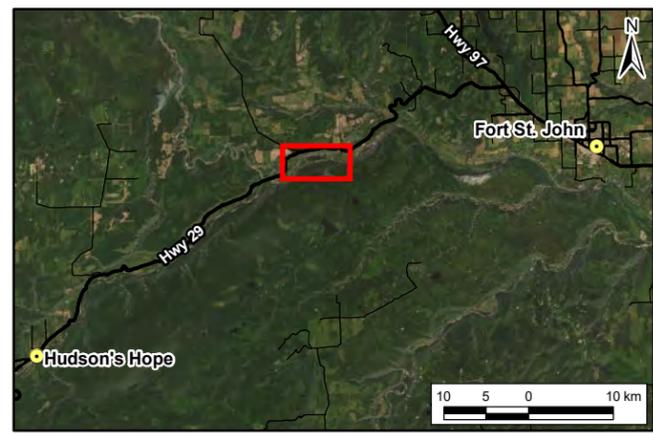
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400 200 0 400 Metres		
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**LEGEND**

- Peace River Standwatch Station
- Project Footprint
- Highway
- Local Road
- ~ Watercourse
- ☪ Waterbody



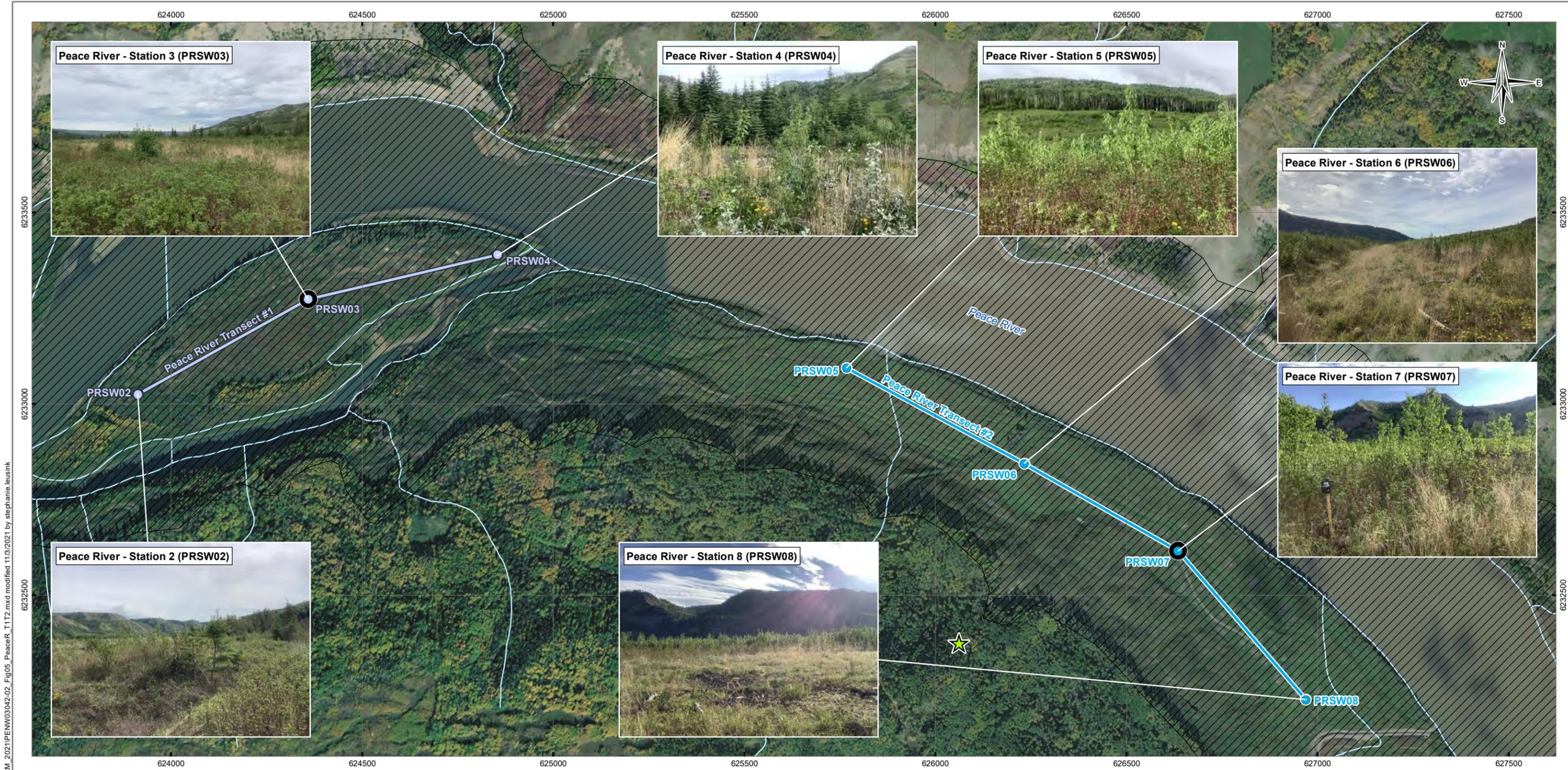
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 CanVec 1:50,000 (2019).  
 Imagery from ESRI; Maxar (2018).

**STATUS**  
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 GROUND-NESTING RAPTOR MONITORING  
 2021 ANNUAL REPORT**

**Peace River  
 Standwatch Stations**

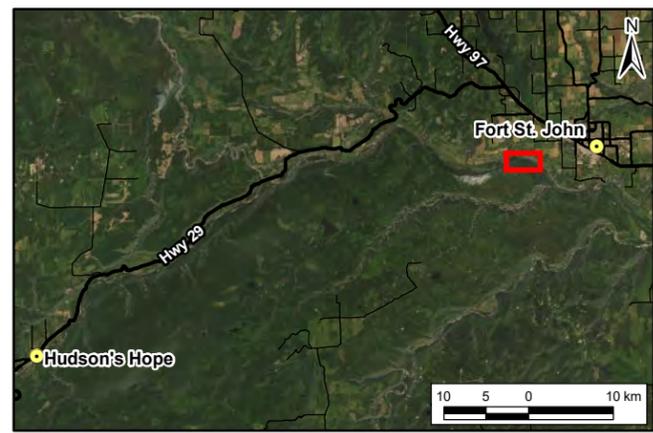
<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:20,000				
				<b>TETRA TECH</b>
<b>FILE NO.</b> PENW03042-02_Fig04_PeaceR.mxd				
<b>OFFICE</b> TI-VANC	<b>DWN</b> SL	<b>CKD</b> BB	<b>APVD</b> EH	<b>REV</b> 0
<b>DATE</b> November 3, 2021		<b>PROJECT NO.</b> ENW.PENW03042-02		
<b>Figure 4</b>				



Q:\Vancouver\GIS\ENVIRONMENTAL\ENW\ENW03042-02\Maps\GNRM\_2021\ENW03042-02\_Fig05\_PeaceR\_T1T2.mxd modified 11/3/2021 by stephanie.leusink

**LEGEND**

- Northern Harrier Observation
- ARU Station
- Peace River Transect #1 Standwatch Station
- Peace River Transect #2 Standwatch Station
- Peace River Transect #1
- Peace River Transect #2
- Project Footprint
- Watercourse
- Waterbody



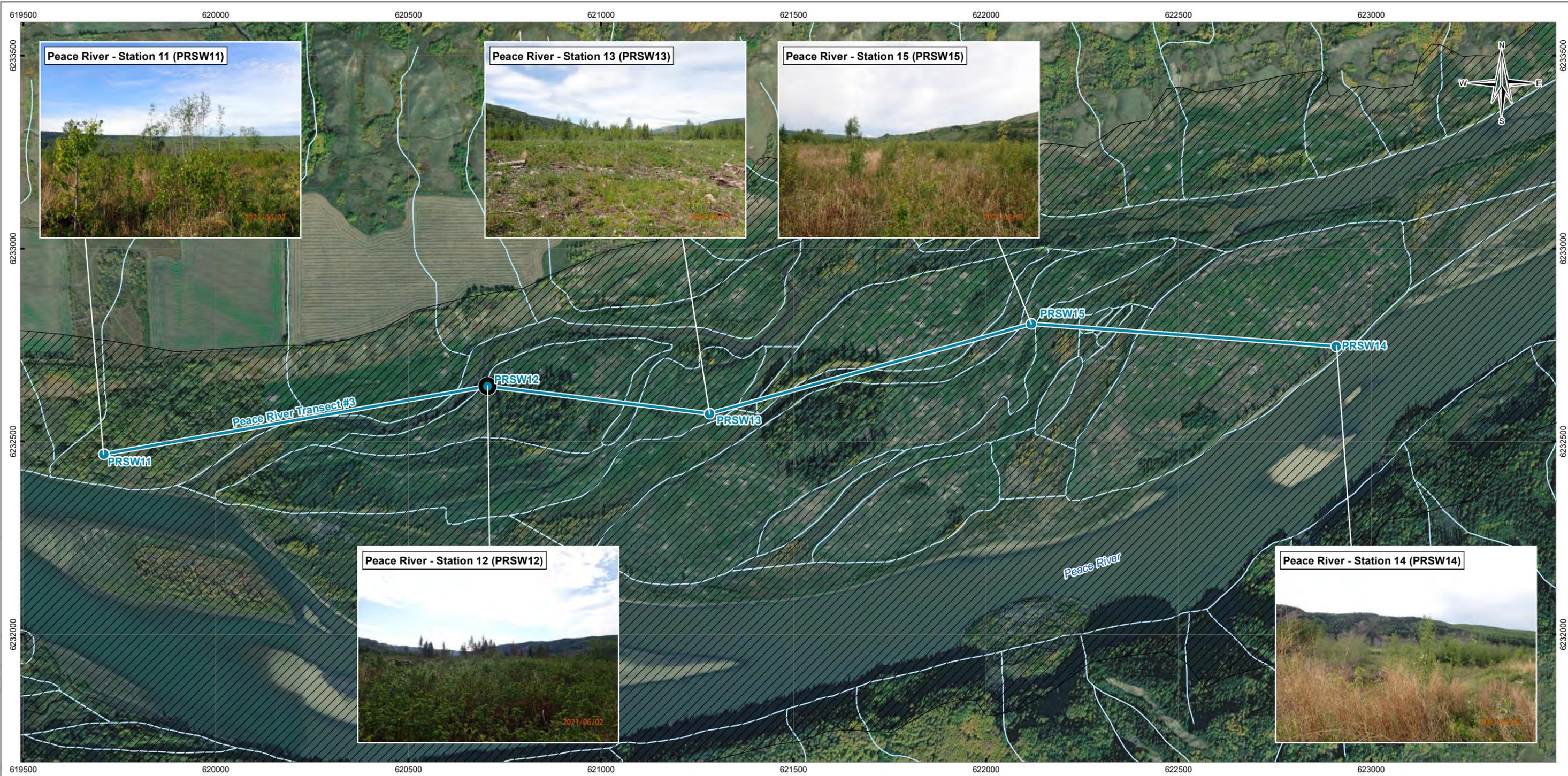
**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from ESRI; Maxar (2019).

**STATUS**  
 ISSUED FOR USE

**SITE C  
 GROUND-NESTING RAPTOR MONITORING  
 2021 ANNUAL REPORT**

**Peace River Transect #1 and  
 Transect #2 Standwatch Stations**

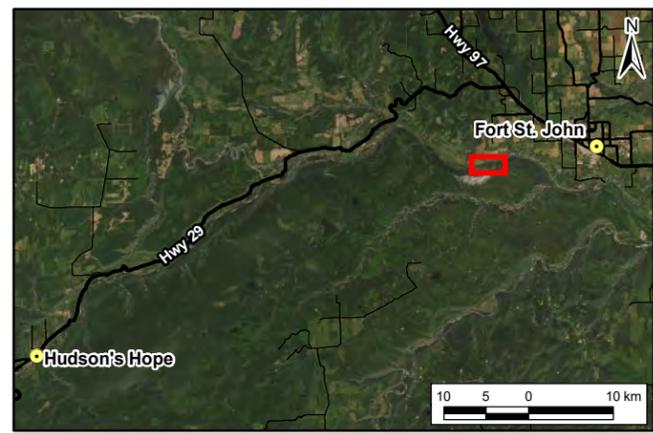
<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:10,000				
<b>FILE NO.</b> PENW03042-02_Fig05_PeaceR_T1T2.mxd				
<b>OFFICE</b> TI-VANC	<b>DWN</b> SL	<b>CKD</b> BB	<b>APVD</b> EH	<b>REV</b> 0
<b>DATE</b> November 3, 2021		<b>PROJECT NO.</b> ENW.PENW03042-02		
<b>Figure 5</b>				



Q:\Vancouver\GIS\ENVIRONMENTAL\ENW\IPENW03042-02\Maps\GNRM\_2021\ENW03042-02\_Fig06\_PeaceR\_T3.mxd modified 11/3/2021 by stephanie.leusink

**LEGEND**

-  ARU Station
-  Peace River Transect #3 Standwatch Station
-  Peace River Transect #3
-  Project Footprint
-  Watercourse
-  Waterbody

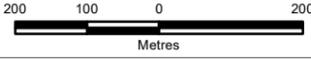


**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from ESRI; Maxar (2017/2019).

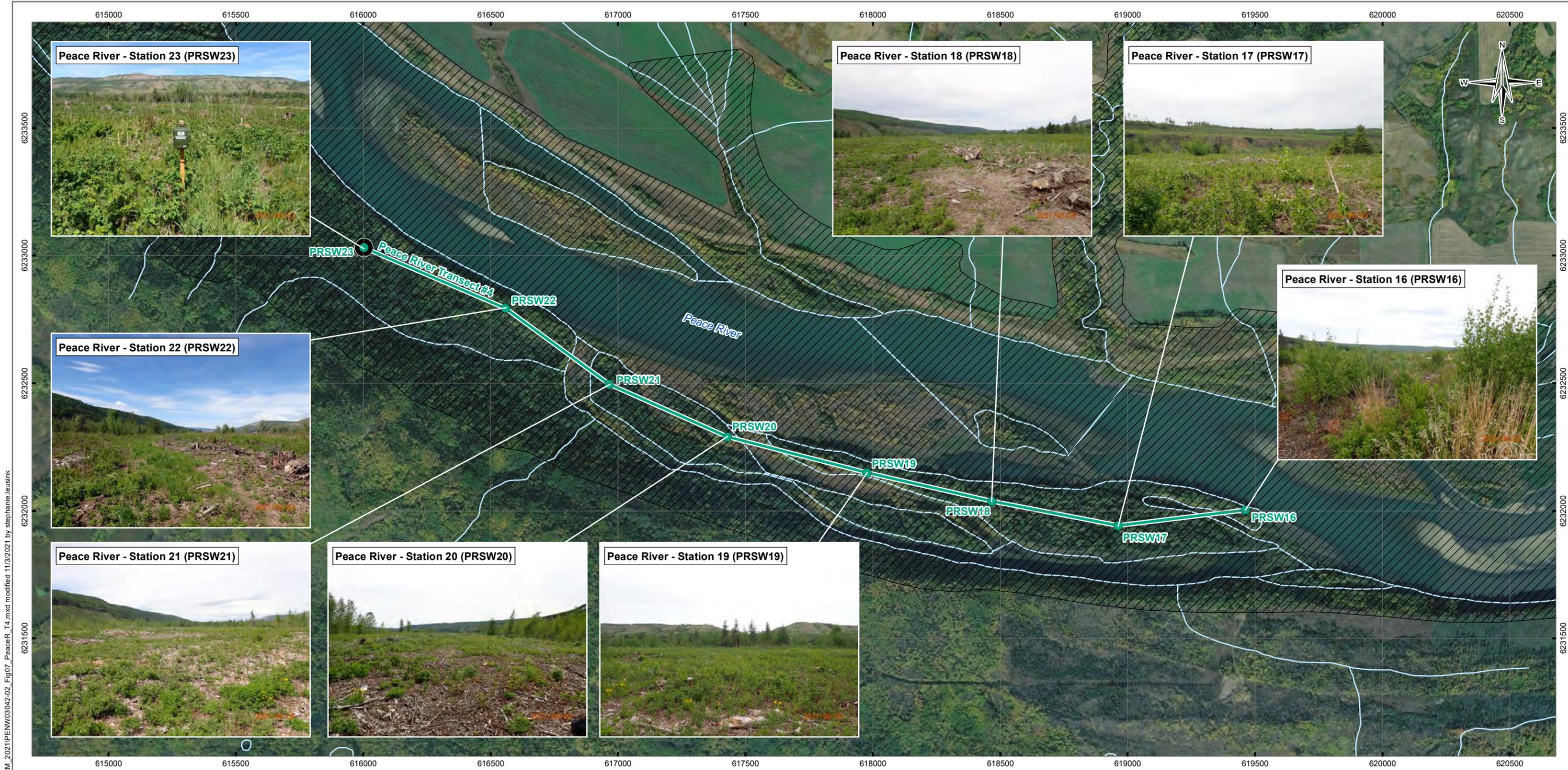
**STATUS**  
 ISSUED FOR USE

**SITE C  
 GROUND-NESTING RAPTOR MONITORING  
 2021 ANNUAL REPORT**

**Peace River Transect #3  
 Standwatch Stations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b>  Power smart
Scale: 1:10,000				
 Metres				
<b>FILE NO.</b> PENW03042-02_Fig06_PeaceR_T3.mxd				
<b>OFFICE</b> TI-VANC	<b>DWN</b> SL	<b>CKD</b> BB	<b>APVD</b> EH	<b>REV</b> 0
<b>DATE</b> November 3, 2021	<b>PROJECT NO.</b> ENW.PENW03042-02			
<b>Figure 6</b>				

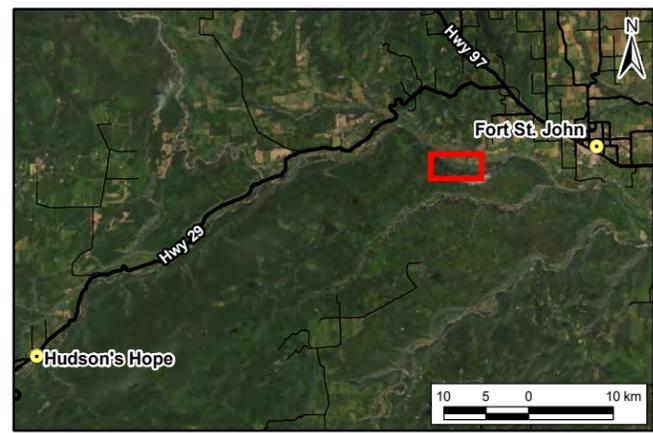




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**LEGEND**

- ARU Station
- Peace River Transect #4 Standwatch Station
- Peace River Transect #4
- Project Footprint
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from ESRI; Maxar (2017/2018).

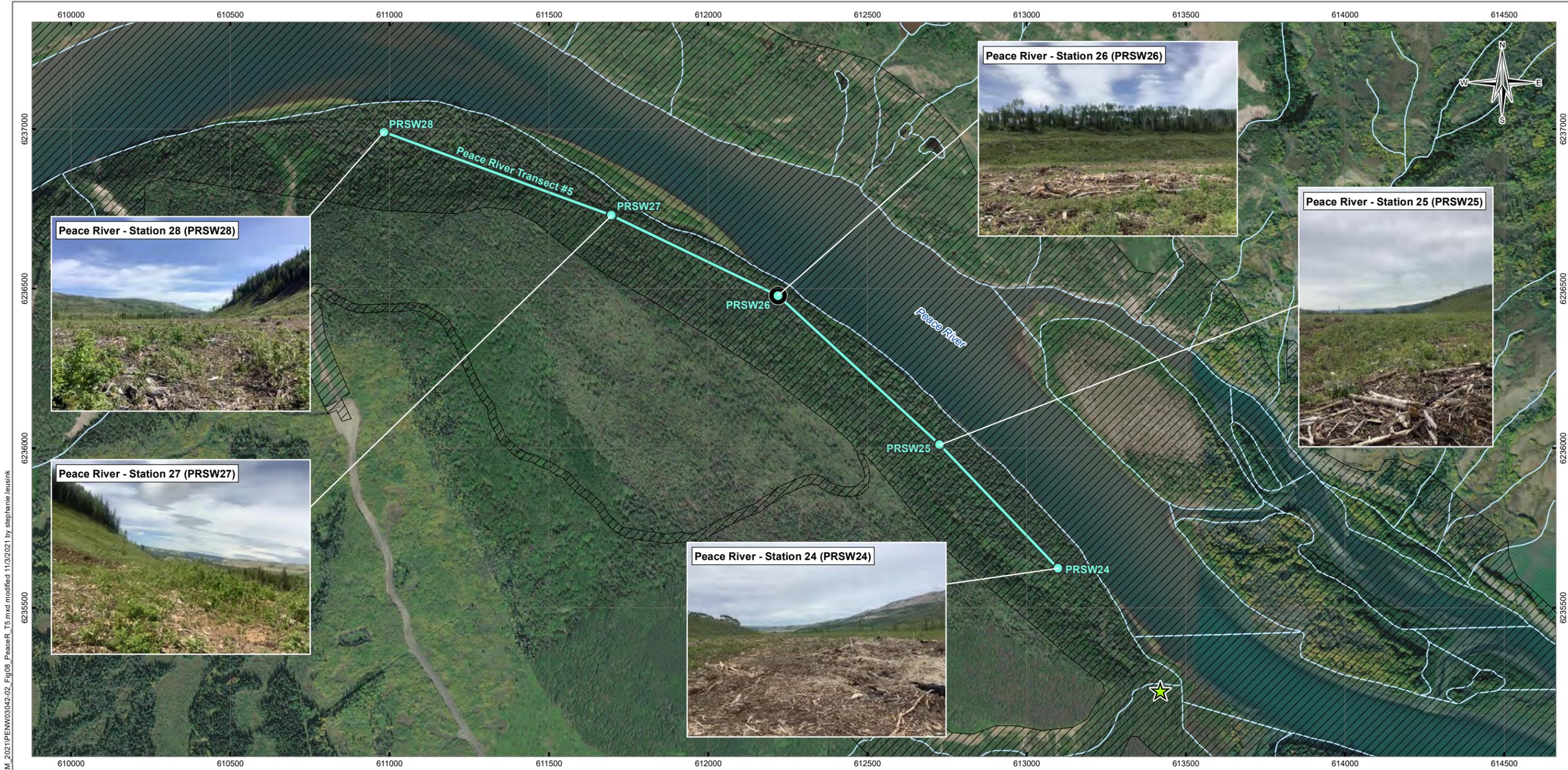
**STATUS**  
 ISSUED FOR USE

**SITE C**  
**GROUND-NESTING RAPTOR MONITORING**  
**2021 ANNUAL REPORT**

**Peace River Transect #4**  
**Standwatch Stations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:15,000 200 100 0 200 Metres				
<b>FILE NO.</b> PENW03042-02_Fig07_PeaceR_T4.mxd				
<b>OFFICE</b> TI-VANC	<b>DWN</b> SL	<b>CKD</b> BB	<b>APVD</b> EH	<b>REV</b> 0
<b>DATE</b> November 3, 2021	<b>PROJECT NO.</b> ENW.PENW03042-02			
<b>Figure 7</b>				

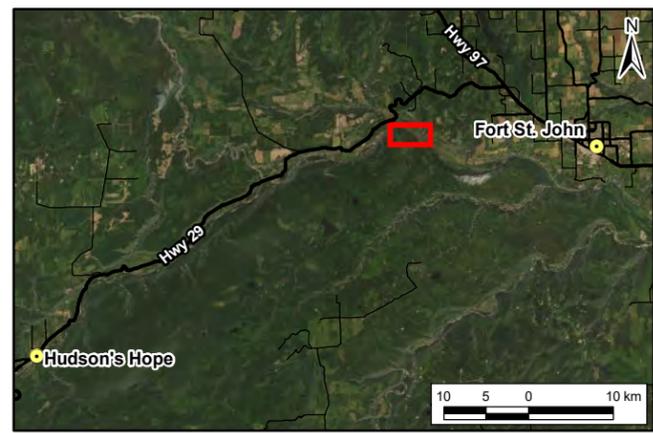




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**LEGEND**

- Northern Harrier Observation
- ARU Station
- Peace River Transect #5 Standwatch Station
- Peace River Transect #5
- Project Footprint
- Watercourse
- Waterbody



**NOTES**  
 Base data source:  
 CanVec 1:50,000 (2019).  
 Imagery from ESRI; Maxar (2017/2019).

**SITE C  
 GROUND-NESTING RAPTOR MONITORING  
 2021 ANNUAL REPORT**

**Peace River Transect #5  
 Standwatch Stations**

<b>PROJECTION</b> UTM Zone 10		<b>DATUM</b> NAD83		<b>CLIENT</b> <b>BC Hydro</b> Power smart
Scale: 1:12,000 				
<b>FILE NO.</b> PENW03042-02_Fig08_PeaceR_T5.mxd				
<b>OFFICE</b> TI-VANC	<b>DWN</b> SL	<b>CKD</b> BB	<b>APVD</b> EH	<b>REV</b> 0
<b>DATE</b> November 3, 2021		<b>PROJECT NO.</b> ENW.PENW03042-02		
<b>Figure 8</b>				

**STATUS**  
ISSUED FOR USE

# APPENDIX A

## INCIDENTAL WILDLIFE OBSERVATIONS

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

Common Name	Scientific Name	BC List	COSEWIC/SARA <sup>1</sup>	Number Observed			
				Bear Flats	Cache Creek	Hwy 29	Peace River
Great Horned Owl	<i>Bubo virginianus</i>	Yellow	-	-	-	-	1
Red-tailed Hawk	<i>Buteo jamaicensis</i>	Yellow	Not at Risk (May 1995)	-	-	-	1
Broad-winged Hawk	<i>Buteo platypterus</i>	Blue	-	-	-	-	1
Merlin	<i>Falco columbarius</i>	Yellow	Not at Risk (April 1985)	-	-	-	4
American Kestrel	<i>Falco sparverius</i>	Yellow	-	2	-	-	-
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Yellow	Not at Risk (May 1984)	6	3	-	16
Unknown Raptor	-	-	-	-	-	-	2

# **APPENDIX B**

## **SURVEY STATION HISTORY 2016 – 2021**

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Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year					
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021
Compensation Sites	Wilder Creek Lands	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
	Ruttledge Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
	Marl Fen Property	No	-	-	-	Surveyed	Surveyed	Not surveyed *	Not surveyed *	Not surveyed *	Not surveyed *
Highway 29	H29SW01	No	10	604838	6234918		Surveyed	Surveyed	Surveyed	Active Haul Road	Active Haul Road
	H29SW02	No	10	607633	6236693		Surveyed	Surveyed	Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.
	H29SW03	No	10	609150	6237937		Surveyed	Surveyed	Renamed CCSW05 and included in the CC Transect	Renamed CCSW05 and included in the CC Transect	Renamed CCSW05 and included in the CC Transect
	H29SW04	No	10	606078	6234708			Surveyed	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)	Active Construction (Gravel Pit)
	H29SW05	No	10	606918	6235242			Surveyed	Surveyed	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement	Disturbed by construction - soil piles, grading etc. Established H29SW06 nearby as replacement
	H29SW06	No	10	607050	6235314					Established to replace H29SW05	Surveyed
Peace River	PRSW01	No	10	623128	6232853		Surveyed	Surveyed	Surveyed	Redundant	Redundant
	PRSW02	Peace River Transect 1	10	623914	6233025		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW03		10	624359	6233273		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW04		10	624854	6233389		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW05	Peace River Transect 2	10	625768	6233094		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW06		10	626233	6232844		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW07		10	626635	6232616		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW08		10	626969	6232228		Surveyed	Surveyed	Surveyed	Surveyed	Surveyed
	PRSW09		10	627381	6231920		Surveyed	Surveyed	Active Construction	Active Construction	Active Construction
	PRSW10	No	10	617729	6232813				Surveyed	Redundant	Redundant
	PRSW11	Peace River Transect 3	10	619709	6232467				Surveyed	Surveyed	Surveyed
	PRSW12		10	620706	6232643				Surveyed	Surveyed	Surveyed
	PRSW13		10	621282	6232572				Surveyed	Surveyed	Surveyed
	PRSW14		10	622910	6232747				Surveyed	Surveyed	Surveyed
	PRSW15		10	622118	6232805				Surveyed	Surveyed	Surveyed
	PRSW16	Peace River Transect 4	10	619462	6232003				Surveyed	Surveyed	Surveyed
	PRSW17		10	618963	6231942				Surveyed	Surveyed	Surveyed
	PRSW18		10	618468	6232038				Surveyed	Surveyed	Surveyed
	PRSW19		10	617978	623215				Surveyed	Surveyed	Surveyed
	PRSW20		10	617429	6232291				Surveyed	Surveyed	Surveyed
	PRSW21		10	616965	6232496				Surveyed	Surveyed	Surveyed
	PRSW22		10	616559	6232794				Surveyed	Surveyed	Surveyed
	PRSW23		10	616002	6233031				Surveyed	Surveyed	Surveyed
	PRSW24	Peace River Transect 5	10	613099	6235624				Surveyed	Surveyed	Surveyed
	PRSW25		10	612727	6236012				Surveyed	Surveyed	Surveyed
	PRSW26		10	612220	6236478				Surveyed	Surveyed	Surveyed
	PRSW27		10	611697	6236730				Surveyed	Surveyed	Surveyed
	PRSW28		10	610982	6236991				Surveyed	Surveyed	Surveyed

Survey Area	Station	Accompanying Transect	UTM Coordinates			Survey Year					
			Zone	Easting	Northing	2016	2017	2018	2019	2020	2021
	PRSW29	No	10	597439	6231064					Surveyed	Not surveyed. Site not within Headpond Area.
	PRSW30	No	10	598178	6232247					Surveyed	Not surveyed. Site not within Headpond Area.
	PRSW31	No	10	600081	6233281					Surveyed	Surveyed
	PRSW32	No	10	602255	6233351					Surveyed	Surveyed
	PRSW33	No	10	606725	6234293					Surveyed	Surveyed
	PRSW34	No	10	607721	6235469					Surveyed	Surveyed
	PRSW35	No	10	609368	6236803					Surveyed	Surveyed
	PRSW36	No	10	598278	6232689					Surveyed - Called HRSW04 in the field.	Not surveyed. Site not within Headpond Area.
<b>Moberly River</b>	MRSW01	No	10	628328	6230312				Surveyed	Active Construction	Active Construction
<b>Bear Flats</b>	BFSW01	Bear Flats Transect	10	611077	6237965				Surveyed	Surveyed	Surveyed
	BFSW02		10	611561	6237465				Surveyed	Surveyed	Surveyed
	BFSW03		10	612031	6237301				Surveyed	Surveyed	Surveyed
	BFSW04		10	612483	6237076				Surveyed	Surveyed	Surveyed
	BFSW05		10	612839	6236812				Surveyed	Surveyed	Surveyed
<b>Cache Creek</b>	CCSW01	Cache Creek Transect	10	607653	6239245				Surveyed	No Access due to high water levels	Active Construction
	CCSW02 / CCSW02B		10	608345	6239034				Surveyed	Surveyed	Active Construction
	CCSW03		10	608729	6238798				Surveyed	Surveyed	Active Construction
	CCSW04		10	609093	6238402				Surveyed	Surveyed	Active Construction
	CCSW05		10	609318	6237699				Surveyed	Surveyed	Active Construction
	CCSW06	No	10	609057	6237557				Surveyed	Surveyed	Active Construction
	CCSW07	No	10	608790	6237457						Established to replace CCSW06
<b>Halfway River</b>	HRSW01 / HRSW01-2	No	10	595783	6231568				Surveyed	Surveyed	Not surveyed. Site not within Headpond Area.
	HRSW02	No	10	596262	6231237				Surveyed	Active Construction	Active Construction
	HRSW03	No	10	595800	6231049				Surveyed	Active Construction	Active Construction
<b>Lynx Creek</b>	LCSW01	No	10	571702	6214556					Surveyed	Not surveyed. Site not within Headpond Area.
	LCSW02	No	10	572132	6214265					Surveyed	Not surveyed. Site not within Headpond Area.

Footnotes:

General - Green cell indicates the site was surveyed. Red cell indicates the site was not surveyed

\* Surveys of the mitigation areas will be performed again when the reservoir has been inundated or when there are substantial land use changes or habitat modifications.

# APPENDIX C

## PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

---

<b>Name and Affiliation</b>	<b>Project Role</b>
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project Manager, Report Reviewer
Elyse Hofs, B.Sc., Dipl.T., B.I.T. Tetra Tech Canada Inc.	Field Data Collection, Data Entry, Report Author
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field Data Collection

# APPENDIX D

## 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.