BC Hydro
Power smart

Vegetation and Wildlife Mitigation and Monitoring Plan 2018 Annual Report

Site C Clean Energy Project

March 29, 2019

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1.0 Introduction

The Vegetation and Wildlife Mitigation and Monitoring Plan Annual Plan describes the measures that will be used to mitigate the adverse effects of the Site C Clean Energy Project (the Project) on vegetation and ecological communities and wildlife resources during the construction and operation of the Project. The Plan was developed in accordance with the conditions of the Project's provincial Environmental Assessment Certificate (EAC #14-02, or 'the EAC') and Federal Decision Statement (FDS) issued for the Project in 2014. The draft and first revision of the VWMMP was submitted to regulatory agencies and Aboriginal Groups for review and feedback on October 17, 2014, and April 7, 2015, respectively. The final VWMMP was submitted to the same recipients on June 5, 2015, and is posted on the Site C Project website at: https://www.sitecproject.com/sites/default/files/Veg_and_Wildlife_Mit_and_Mon_Plan.pdf.

The purpose of this annual report is to describe the mitigation and monitoring measures that set out in the VWMMP that were implemented between January 1, 2018 and December 31, 2018.

2.0 Objective and Scope

The objective of the Vegetation and Wildlife Mitigation and Monitoring Plan Annual Report (the Report) is to describe the mitigation and monitoring measures implemented in 2018 to meet the requirements of FDS conditions 9, 10, 11, 16 and 18 and EAC conditions 9 to 12, 14 to 16, 19, 21, 23, and 24. These conditions, and where they are addressed in the Vegetation and Wildlife Mitigation and Monitoring Plan (VWMMP), past annual reports, or the current Report, are listed in Tables 1 and 2 below.

Note that the requirements of Environmental Assessment Certificate (EAC) conditions 8 and 13 (for Vegetation and Ecological Communities), and conditions 17, 18, 20, and 22 (for Wildlife Resources) are fully addressed in the CEMP and/or the Vegetation Clearing and Debris Management Plan. Therefore, those conditions are not addressed in this report.

Requirements of FDS condition 16.3.1 and parts of EAC conditions 9 and 15 were fulfilled in 2015, with results reported in the 2015 Annual Report, and are not addressed in this report:

- FDS Condition 16.3.1 - Field work to verify the modeled results for surveyed species at risk and determine habitat effects for those species (Section 6.4.1 of the 2015 Annual Report).
- EAC Condition 9 - Surveys of existing invasive species populations prior to construction. (Section 7.1.1 of the 2015 Annual Report).
- EAC Condition 9 - Rare and Sensitive community identification (Section 7.1.3 of the 2015 Annual Report)
- EAC Condition 15 - Verification of modelled results (Section 7.3.1 of the 2015 Annual Report).

Requirements of FDS condition 9.9.1 were fulfilled in 2016, with results reported in the 2016 Annual Report, and are not addressed in this report:

- FDS Condition 9.9.1 – Conducting a risk assessment for bird collisions under the current transmission line design (Section 6.1.3 of 2016 Annual Report).

Table 1. Federal Decision Statement Conditions and Relevant Annual Report Sections

FDS Condition	Condition	Annual Report Section
9.	Disturbance and destruction of migratory birds	Section 6.1 Federal Decision Statement Condition 9
9.1	The Proponent shall ensure that the Designated Project is carried out in a manner that avoids mortality and disturbance of migratory birds and their nests.	Section 6.1.1 Condition 9.1
9.2	The Proponent shall prepare and submit to the Agency an annual schedule, describing the location and timing for construction and reservoir filling activities, 90 days prior to initiating any of these activities.	Section 6.1.2 Condition 9.2
9.3	The Proponent shall develop, in consultation with Environment Canada, a plan to monitor and mitigate potential disturbance of breeding migratory birds in and adjacent to the Project Activity Zone, including the area immediately downstream of the dam where risks to migratory bird nests could occur, during construction, reservoir filling and operation.	Section 6.1.3 Condition 9.3
9.9	The Proponent shall address potential risks of bird collisions with the transmission line, in consultation with Environment Canada, by:	
9.9.1	conducting a risk assessment for bird collisions under the current transmission line design;	2016 Annual Report (Section 6.1.3)
9.9.2	determining if additional mitigation measures could be implemented to reduce the risk of bird collisions;	Section 6.1.4 Condition 9.9.2
10	Non-wetland migratory bird habitat	Section 6.2 Federal Decision Statement Condition 10
10.3	The plan shall include:	
10.3.1	non-wetland migratory bird habitat baseline conditions for habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact;	Section 6.2.1 Condition 10.3.1
10.3.2	migratory bird abundance, distribution and use of non-wetland habitat;	Section 6.2.2 Condition 10.3.2
10.3.4	compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler;	Section 6.2.3 Condition 10.3.4
10.3.5	an analysis of the effects of any compensation measures identified in condition 10.3.4 on the current use of lands and resources for traditional	Section 6.2.4 Condition 10.3.5

FDS Condition	Condition	Annual Report Section
	purposes by Aboriginal peoples; and	
10.3.6	an approach to monitor and evaluate the effectiveness of the mitigation or compensation measures to be implemented and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory bird habitat, including migratory bird use of that habitat.	Section 6.2.5 Condition 10.3.6
11	Wetlands used by migratory birds and for current use of lands and resources for traditional purposes	Section 6.3 Federal Decision Statement Condition 11
11.1	The Proponent shall mitigate the potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes by Aboriginal people.	Section 6.3.1 Condition 11.1
11.2	The Proponent shall develop, in consultation with Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups, a plan that addresses potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes.	Section 6.3.2 Condition 11.2
11.3	The Proponent shall, in developing the plan, describe how the mitigation hierarchy and the objective of no net loss of wetland functions were considered.	Section 6.3.3 Condition 11.3
11.4	The plan shall include:	
11.4.1	baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use	Section 6.3.4 Condition 11.4.1
11.4.2	mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost;	Section 6.3.5 Condition 11.4.2
11.4.3	an approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data;	Section 6.3.6 Condition 11.4.3
11.4.4	compensation measures to address the	Section 6.3.7 Condition 11.4.4

FDS Condition	Condition	Annual Report Section
	unavoidable loss of wetland areas and functions supporting migratory birds, species at risk, and the current use of lands and resources by Aboriginal people in support of the objective of full replacement of wetlands in terms of area and function	
11.8	The Proponent shall commence the implementation of the compensation measures specified in condition 11.4.4 no later than five years from the initiation of construction.	Section 6.3.8 Condition 11.8
11.9	The Proponent shall implement each component of the plan and provide to the Agency an analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and at the end of year 1, 2, 3, 5, 10, 15, 20 and 30 of operation.	Section 6.3.9 Condition 11.9
16	Species at risk, at-risk and sensitive ecological communities and rare plants	Section 6.4 Federal Decision Statement Condition 16
16.1	The Proponent shall ensure that potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants are addressed and monitored.	
16.2	The Proponent shall develop, in consultation with Environment Canada, a plan setting out measures to address potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants.	
16.3	The plan shall include:	
16.3.1	field work to verify the modeled results for surveyed species at risk and determine the habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact for those species, including the Short-eared Owl, the Western Toad and the Myotis Bat species	2015 Annual Report (Section 6.4.1)
16.3.2	surveys to determine whether the rare plant species potentially facing extirpation in the Project Activity Zone are found elsewhere in the region	2017 Annual Report (Section 6.4.1; Section 7.2.1; Appendix 9)
16.3.3	measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;	Section 6.4.1 Condition 16.3.3
16.3.4	conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation;	Section 6.4.2 Condition 16.3.4

FDS Condition	Condition	Annual Report Section
16.3.5	an approach to avoiding or minimizing the use of herbicides and pesticides in areas that could impact species at risk, at-risk and sensitive ecological communities and rare plants;	2017 Annual Report (Section 6.4.4)
16.3.6	an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and	Section 6.4.3 Condition 16.3.6
16.3.7	an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the Designated Project.	Section 6.4.4 Condition 16.3.7

Table 2. Environmental Assessment Certificate Conditions and Relevant Annual Report Sections

EAC Condition	Condition	Plan Reference[(a)]
VEGETATION AND ECOLOGICAL COMMUNITIES		
9	The EAC Holder must develop a Vegetation and Invasive Plant Management Plan to protect ecosystems, plant habitats, plant communities, and vegetation with components applicable to the construction phase.	Section 7.1 EAC Condition 9
	The Vegetation and Invasive Plant Management Plan must include at least the following:	
	Invasive Species	
	• Surveys of existing invasive species populations prior to construction.	2015 Annual Report (Section 7.1.1)
	• Invasive plant control measures to manage established invasive species populations and to prevent invasive species establishment.	Section 7.1.1 Invasive Plant Control
	Rare Plants and Sensitive Ecosystems	
	• The EAC Holder must expand its modelling, including completing field work, to improve	2015 Annual Report (Section 7.1.3)

EAC Condition	Condition	Plan Reference[a]
	identification of rare and sensitive plant communities and aid in delineation of habitats that may require extra care, 90 days prior to any Project activities that may affect these rare or sensitive plant communities	
	• The EAC Holder must, with the use of a QEP, complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission lines. These pre- construction surveys must target rare plants as defined in Section 13.2.2 of the EIS —including vascular plants, mosses, and lichens.	Section 7.1.2 Inventory Areas Not Already Surveyed
	• The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE using provincial data collection standards.	Section 7.1.3 Spatial Database of Known Rare Plant Occurrences
	• The EAC Holder must implement construction methods to reduce the impact to rare plants, maximize use of existing access corridors, and construct transmission towers and temporary roads away from wetlands and known rare plant occurrences.	Section 7.1.4 Rare plant avoidance
	• Protect known occurrences of Tufa seeps, wetlands and rare plants located adjacent to construction areas. Install signage and flagging where necessary, as determined by the QEP, to indicate the boundaries of the exclusion area.	Section 7.1.5 Protect tufa seeps, wetlands and rare plants located adjacent to construction areas
	• The EAC Holder will engage the services of a Rare Plant Botanist during construction to design and implement an experimental rare plant translocation program in consultation with MOE using the BC MOE's Guidelines for Translocation of Plant Species at Risk in BC (Maslovat, 2009).	Section 7.1.6 Experimental rare plant translocation program
10	The EAC Holder must fund or undertake directly with the use of a Rare Plant Botanist the following, during construction:	2017 Annual Report (Section 7.2)
	• Targeted surveys in the RAA (as defined in the amended EIS) to identify occurrences of the 18 directly affected rare plant species (as defined in the amended EIS), and rare plant species identified	2017 Annual Report (Section 7.2.1 and Appendix 9)

EAC Condition	Condition	Plan Reference[(a)]
	by the MOEs Conservation Framework requiring additional inventories	
	• A study focused on clarifying the taxonomy of Ochroleucus bladderwort (*Utricularia ochroleuca*), including field, herbaria, and genetic work in consultation with FLNR and the MOE (BC Conservation Data Centre).	2017 Annual Report (Section 7.2.2 and Appendix 10)
11	EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes:	Section 7.3 EAC Condition 11
	• Assistance (financial or in-kind) to the managing organization of suitable habitat enhancement projects in the RAA (RAA as defined in the amended EIS).	Section 7.3.1 Habitat Enhancement Projects in the RAA
	• Direct purchase of lands in the RAA and manage these lands and suitable existing properties owned by the EAC Holder to enhance or retain rare plant values where opportunities exist.	Section 7.3.2 Direct purchase of lands in the RAA to enhance or retain rare plant values
	The EAC Holder must engage with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.	Section 7.3.3 Engaging with FLNRORD, MOE and Indigenous Groups
12	The EAC Holder must develop a Wetland Mitigation and Compensation Plan.	Section 7.4 EAC Condition 12
	The Wetland Mitigation and Compensation Plan must include an assessment of wetland function lost as a result of the Project that is important to migratory birds and species at risk (wildlife and plants). The Wetland Mitigation and Compensation Plan must be developed by a QEP with experience in wetland enhancement, maintenance and development.	Section 7.4.1 Wetland Mitigation and Compensation
	The Wetland Mitigation and Compensation Plan must include at least the following:	
	• Information on location, size and type of wetlands affected by the Project	Section 7.4.1.1 Information on location, size and type of wetlands affected by the Project
	• If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;	2017 Annual Report (Section 7.3.1.2)
	• Stormwater management will be designed to control runoff and direct it away from work areas	2017 Annual Report (Section 7.3.1.3)

EAC Condition	Condition	Plan Reference[a]
	where excavation, spoil placement, and staging activities occur.	
	• Develop, with the assistance of a hydrologist, site-specific measures prior to construction to reduce changes to the existing hydrologic balance and wetland function during construction of the Jackfish Lake Road and Project access roads and transmission line.	2017 Annual Report (Section 7.3.1.4)
	• All activities that involve potentially harmful or toxic substances, such as oil, fuel, antifreeze, and concrete, must follow approved work practices and consider the provincial BMP guidebook Develop with Care (BC Ministry of Environment 2012 or as amended from time to time).	2017 Annual Report (Section 7.3.1.5)
14	The EAC Holder must develop a Vegetation and Ecological Communities Monitoring and Follow-up Program for the construction phase and first 10 years of the operations phase. The Vegetation and Ecological Communities Monitoring and Follow-up Program must be developed by a QEP. The Vegetation and Ecological Communities Monitoring and Follow-up Program must include at least the following:	Section 7.5 Condition 14
	• Definition of the study design for the rare plant translocation program (see condition 9).	7.5.1 Definition of the study design for the Experimental Rare Plant Translocation Program
	• Plan for following-up monitoring of any translocation sites to assess the survival and health of translocated rare plant species, under the supervision of a Rare Plant Botanist.	7.5.2 Plan for monitoring translocations
	• Measurement criteria, including vegetation growth, persistence of rare plants and establishment / spread of invasive plant species, and associated monitoring to document the effectiveness of habitat enhancement and possible compensation programs.	7.5.3 Measurement criteria for effectiveness monitoring of habitat enhancement and compensation programs
WILDLIFE RESOURCES		
15	The Wildlife Management Plan must be developed by a QEP.	Section 4.0 Qualified Professionals
	The Wildlife Management Plan must include at least the following:	
	• Field work, conducted by a QEP, to verify the	2015 Annual Report (Section

EAC Condition	Condition	Plan Reference[a]
	modelled results for surveyed species at risk and determine, with specificity and by ecosystem, the habitat lost or fragmented for those species. The EAC Holder must use these resulting data to inform final Project design and to develop additional mitigation measures, as needed, as part of the Wildlife Management Plan, in consultation with Environment Canada and FLNR.	7.3.1)
	• Measures to avoid, if feasible, constructing in sensitive wildlife habitats. If avoiding sensitive wildlife habitats is not feasible, condition 16 applies.	Section 7.6.1 Measures to avoid, if feasible constructing in sensitive wildlife habitats
	• If sensitive habitats, such as wetlands, are located immediately adjacent to any work site, buffer zones must be established by a QEP to avoid direct disturbance to these sites.	Section 7.6.2 Setback buffers to avoid direct impacts to sensitive habitats
	• Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.	Section 7.6.3 Mitigation of adverse effects to wildlife and wildlife habitat
	• Protocol to ensure that lighting is focused on work sites and away from surrounding areas to manage light pollution and disturbance to wildlife. If lighting cannot be directed away from surrounding areas, the EAC Holder must ensure additional mitigation measures are implemented to reduce light pollution, including light shielding.	Section 7.6.4 Protocol to ensure that lighting is focused on work sites
	• A mandatory environmental training program for all workers so that they are informed that hunting in the vicinity of any work site/Project housing site is strictly prohibited for all workers. The EAC Holder must ensure that all workers are familiar with the Wildlife Management Plan.	Section 7.6.5 Environmental training of workers
16	If loss of sensitive wildlife habitat or important wildlife areas cannot be avoided through Project design or otherwise mitigated, the EAC Holder must implement the following measures, which must be described in the Vegetation and Wildlife Mitigation and Monitoring Plan.	Section 7.7 EAC Condition 16
	The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation measures:	
	• Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.	2017 Annual Report (Section 7.7.1)
	• Establishment of nest boxes for cavity-nesting	Section 7.7.1 Nest boxes for

EAC Condition	Condition	Plan Reference[a]
	waterfowl developed as part of wetland mitigation and compensation plan, and established within riparian vegetation zones established along the reservoir on BC Hydro-owned properties.	cavity-nesting waterfowl
	• A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into new bridge designs located within the Peace River valley.	Section 7.7.2 A design for bat roosting habitat in HWY 29 bridges
	• Following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats.	Section 7.7.3 Creation of hibernating and roosting sites for bats VWMMP Section 8.7.6
	• Creation of natural or artificial piles of coarse woody debris dispersed throughout the disturbed landscape to maintain foraging areas and cold-weather rest sites, and arboreal resting sites, for the fisher population south of the Peace River.	Section 7.7.4 Resting sites for fisher
19	The EAC Holder must use reasonable efforts to avoid and reduce injury and mortality to amphibians and snakes on roads adjacent to wetlands and other areas where amphibians or snakes are known to migrate across roads including locations with structures designed for wildlife passage	Section 7.8 EAC Condition 19
21	The EAC Holder must ensure that measures implemented to manage harmful Project effects on wildlife resources are effective by implementing monitoring measures detailed in a Vegetation and Wildlife Mitigation and Monitoring Plan.	Section 7.9 EAC Condition 21
	The Vegetation and Wildlife Mitigation and Monitoring Plan must be developed by a QEP.	Section 4.0 Qualified Professionals
	The Vegetation and Wildlife Mitigation and Monitoring Plan must include at least the following:	
	• Monitor Bald Eagle nesting populations adjacent to the reservoir, including their use of artificial nest structures.	Section 7.9.1 Monitoring of Bald Eagle nesting populations
	• Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.	Section 7.9.2 Monitoring waterfowl and shorebird populations
	• Survey songbird and ground-nesting raptor populations during construction and operations	Section 7.9.3 Survey songbird and ground-nesting raptor populations
	• Require annual reporting during the construction phase and during the first 10 years of operations to	Section 7.9.4 Annual reporting beginning 180 days following

EAC Condition	Condition	Plan Reference[a]
	EAO, beginning 180 days following commencement of construction.	commencement of construction
23	The EAC Holder must maintain current knowledge of Project effects on the status of listed species by tracking updates for species identified by the Province, the Committee on the Status of Endangered Wildlife in Canada, and the *Species at Risk Act.*	Section 7.10 Status of listed species

(a) VWMMP: Vegetation and Wildlife Mitigation and Monitoring Plan. Submitted to FLNRORD, MOE and the Environmental Assessment Office on June 5, 2015.

3.0 Consultation

Consultation regarding the development and implementation of individual programs conducted in 2018 is provided below.

3.1 Canadian Wildlife Services

In 2018 BC Hydro continued to consult with the Canadian Wildlife Service (CWS) during plan development and implementation. Consultation with CWS in 2018 continued with regard to the Wetland Function Assessment (WFA), the Wetland Monitoring Program, the Downstream Vegetation Monitoring Plan, and various migratory bird monitoring plans (e.g., songbirds, woodpeckers, common nighthawk, and waterbirds). Consultation occurred primarily through the Vegetation and Wildlife Mitigation and Monitoring Technical Committee (VWTC), to which CWS, BC Hydro, and provincial agencies belong. The VWTC was established by the Comptroller of Water Rights under Conditional Water Licences 132990 and 132991 (see Section 3.2).

3.2 Consultation with the Province

The VWTC was established by the Comptroller of Water Rights under Conditional Water Licences 132990 and 132991 (see Section 3.2) to provide ongoing engagement between BC Hydro, Ministry of Environment (MOE) and Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) with respect to the implementation of vegetation and wildlife mitigation and monitoring programs. The province requested that the VWTC be formed as a sub-committee of the existing BC and BC Hydro joint Fish / Hydro Management Committee. Environment Canada joined the committee in July of 2016.

The VWTC met in person or via conference call twelve (12) times between January and December 2018 to address the Program Areas laid out in Schedule A of Conditional Water Licenses 132990 and 132991. Table 3 summarizes the status of each Program Area discussed as of December 31, 2018.

Table 3. Status of Schedule A Program Areas as of December 31, 2018.

Program Area	Status as of December 1, 2018
Completed	
1. Ungulates	Complete
2.2. Wetlands and Riparian Habitat: Downstream Vegetation Monitoring	Complete
4. Bats	Complete
5.1. Snakes – Downstream Monitoring	Complete
5.2. Snakes – Hibernacula Mitigation and Monitoring	Complete
6.1. Amphibians – Downstream Monitoring	Complete
6.2 Amphibians – Migration Mitigation	Complete
7. Eagles	Complete
8.3 Breeding and Migratory Birds – Common	Complete

Program Area	Status as of December 1, 2018
Nighthawk	
9. Ground Nesting Raptors	Complete
10. Cavity Nesting Species	Complete
11.2. Rare Plants – Regional Surveys	Complete
12. Sharp-tailed Grouse	Complete
13. Lighting Effects	Complete
14. Carnivore Den Sites	Complete
15. Other Raptors	Complete
16. Other Species at Risk	Complete
In Progress	
2.1. Wetlands and Riparian Habitat: Wetland Function Assessment	In progress
3. Fisher	In progress
8.1. Breeding and Migratory Birds - Songbirds	In progress
8.2. Breeding and Migratory Birds – Waterbirds	In progress
8.4. Breeding and Migratory Birds – Woodpeckers	In progress
8.5. Breeding and Migratory Birds – Nest Monitoring	In progress
11.1. Rare Plants - Translocation	In progress

4.0 Qualified professionals

The Qualified Professionals involved in the development and implementation of vegetation and wildlife mitigation and monitoring programs in 2018 are listed in Table 4.

Table 4. Qualified Professionals involved in development and implementation of programs in 2018

Qualified Professional	Area of Work
Brock Simons, M.Sc., R.P.Bio. BC Hydro	Vegetation and Wildlife
Lisette Ross, M.Sc., P.Biol., Native Plant Solutions	Wetland Function Assessment, Wetland Monitoring Program
Lynn Dupuis, M.Sc.,P.Biol., Native Plant Solutions	Wetland Function Assessment, Wetland Monitoring Program
Llwellyn Armstrong, M.Sc., Ducks Unlimited Canada	Statistician - Wetland Function Assessment Wetland Monitoring Program
Melissa Mushanski, M.Sc., Native Plant Solutions	Wetland Monitoring Program
Justin Vitt, Native Plant Solutions	GIS – Wetland mapping, Wetland Monitoring Program
Susan Witherly, M.Sc., Ducks Unlimited Canada	GIS – Wetland mapping

Qualified Professional	Area of Work
Natasha Bush, B.Sc. P.Ag., EcoLogic Consultants Ltd.	Experimental Rare Plant Translocation, Wetland Monitoring Program, and Hwy 29
Dan McAllister, M.Sc., P.Ag., EcoLogic	Experimental Rare Plant Translocation, Wetland Monitoring Program and Hwy 29
Jamie Fenneman, Ph.D. R.P.Bio., Ecologic	Experimental Rare Plant Translocation and Wetland Monitoring Program
Ryan Durand, M.Sc. R.P.Bio., EcoLogic	Experimental Rare Plant Translocation, Wetland Monitoring Program and Hwy 29
Jason Jones, Ph.D. R. P. Bio., P. Biol., EcoLogic	Experimental Rare Plant Translocation, Songbird and Raptor Monitoring, Woodpecker Monitoring, Fisher Mitigation, Wetland Monitoring Program and Hwy 29
Holly Buehler, M.Sc., EcoLogic	Experimental Rare Plant Translocation, Wetland Monitoring Program and Hwy 29
Randy Krichbaum, M.Sc., P.Biol., R.P.Bio.- Eagle Cap Consulting Ltd.	Pre-construction Rare Plant Surveys and Experimental Rare Plant Translocation
Margaret Krichbaum, B.Sc.- Eagle Cap	Pre-construction Rare Plant Surveys and Experimental Rare Plant Translocation
Jeff Matheson M.Sc., R.P.Bio., P.Biol.	Experimental Rare Plant Translocation, Regional Rare Plant Surveys.
Claudio Bianchini, R.P. Bio., Bianchini Biological Services	Breeding bird and raptor monitoring
Todd Heakes, Tetra Tech Canada Inc.	Breeding bird and raptor monitoring
Kerrith McKay, McKay Environmental Consulting Ltd.	Breeding bird and raptor monitoring
Elyse Hofs, B.Sc., Dipl.T., Tetra Tech Canada Inc.	Breeding bird and raptor monitoring
Charlie Palmer, M.Sc., P.Biol., R.P.Bio, Hemmera Envirochem Inc.	Cavity nesting bird mitigation, waterbird monitoring, Portage Mountain bat monitoring, bald eagle monitoring
Ashleigh Ballevona, B.Sc., R.P.Bio, Hemmera	Bald eagle data management
Beth Boyce, B.Sc., EPt	Bald eagle data management
Brian Paterson, B.Sc., R.P.Bio, Hemmera	Bald eagle monitoring field lead, Portage Mountain bat data detector downloads, waterbird monitoring
Kyle Routledge, B.Sc., R.P.Bio, Hemmera	Waterbird monitoring field lead, cavity nesting bird mitigation field lead
Toby St. Clair, M.Sc., Hemmera	Waterbird monitoring field lead, western toad and gartersnake monitoring
Felix Martinez-Nunez, M.Sc., R.P.Bio, Hemmera	Waterbird monitoring field lead, Portage Mountain bat monitoring field lead and acoustic analyst
Jay Brogan M.Sc., R.P.Bio., Hemmera	Waterbird monitoring field lead, western toad and gartersnake monitoring
David Clegg, A.Ag., Hemmera	Western toad mitigation road surveys
Jared Hobbs, M.Sc., R.P.Bio, Hemmera	Gartersnake monitoring plan

Qualified Professional	Area of Work
Dan Webster, B.Sc., P.Ag., R.P.Bio., P.Biol., Eco-Web Ecological Consulting Ltd.	Portage Mountain bat monitoring, bald eagle monitoring
Kyle Brown, Eco-Web Ecological Consulting Ltd.	Western toad mitigation road surveys
Sigrid Moe, R.B. Tech., Eco-Web Ecological Consulting Ltd.	Western toad mitigation road surveys, Portage Mountain bat detector downloads
Jodi Fleming, B.Sc., P.Ag., BIT, Eco-Web Ecological Consulting Ltd.	Portage Mountain bat monitoring, western toad and gartersnake monitoring

5.0 Structure and Content

The mitigation and monitoring measures discussed in this report are organized into two parts: Section 6.0 describes those mitigation and monitoring measures that were implemented to meet the requirements of the Federal Decision Statement (FDS) conditions; Section 7.0 describes those measures that were implemented to meet the requirements of the Environmental Assessment Certificate (EAC) conditions. Cross-references are provided in Section 7.0 where information provided to meet the EAC conditions is the same as that provided for the FDS conditions.

Several of the programs outlined in the Vegetation and Wildlife Mitigation Plan were not implemented in 2018. Table 5 below outlines which programs were not implemented, and when they will be implemented and reported in annual reports.

Table 5. Summary of programs not implemented in 2018

Condition Number	Program to be Implemented	Planned Implementation Year	Planned Inclusion in Annual Report
FDS 9.3	Nest Monitoring	2021	2021
FDS 10.3.3	Littoral zone enhancements	2019	2019
	Riparian plantings	TBD	TBD
FDS 16.3.6	Wetlands and Riparian Habitat: Downstream Vegetation Monitoring	2019	2019
EAC 16	Construction of artificial snake hibernacula	2019	2019
EAC 21	Monitor amphibian use of migration crossing structures	TBD	TBD

6.0 Implementation of Mitigation and Monitoring Measures – Federal Decision Statement Conditions

Conditions 9, 10, 11, and 16 of the FDS, respectively, set out the mitigation and monitoring requirements for the disturbance and destruction of migratory birds, non-wetland migratory bird habitat, wetlands used by migratory birds and for current use of lands and resources for traditional purposes, and species at risk, at-risk and sensitive ecological communities and rare plants (Table 1).

6.1 Federal Decision Statement Condition 9: Migratory Bird Mitigation and Monitoring

This section of the annual report summarizes the programs conducted in 2018 in accordance with the requirements of FDS condition 9, shown below.

9. Disturbance and destruction of migratory birds
9.1. The Proponent shall ensure that the Designated Project is carried out in a manner that avoids mortality and disturbance of migratory birds and their nests.
9.2. The Proponent shall prepare and submit to the Agency an annual schedule, describing the location and timing for construction and reservoir filling activities, 90 days prior to initiating any of these activities.
9.3. The Proponent shall develop, in consultation with Environment Canada, a plan to monitor and mitigate potential disturbance of breeding migratory birds in and adjacent to the Project Activity Zone, including the area immediately downstream of the dam where risks to migratory bird nests could occur, during construction, reservoir filling and operation.
9.4. The plan shall include measures to undertake construction, reservoir filling and operation in a manner that avoids or minimizes the risk of disturbance and mortality to migratory birds and their nests.
9.5. The Proponent shall, in preparing the plan, consult:
9.5.1. Environment Canada's policy on Incidental Take of Migratory Birds in Canada; and
9.5.2. Environment Canada's avoidance guidelines on General Nesting Periods of Migratory Birds in Canada.
9.6. The Proponent shall submit to the Agency and Environment Canada a draft copy of the plan for review 90 days prior to initiating construction.
9.7. The Proponent shall submit to the Agency the final plan a minimum of 30 days prior to initiating construction. When submitting the final plan, the Proponent shall provide to the Agency an analysis that demonstrates how it has appropriately considered the input, views or information received from Environment Canada.
9.8. The Proponent shall implement the plan and provide to the Agency an analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and for the first five years of operation.
9.9. The Proponent shall address potential risks of bird collisions with the transmission line, in consultation with Environment Canada, by:
9.9.1. conducting a risk assessment for bird collisions under the current transmission line design;
9.9.2. determining if additional mitigation measures could be implemented to reduce the risk of bird collisions; and
9.9.3. implementing any additional mitigation measures (e.g. line marking and diversions), to minimize impacts.

6.1.1 Condition 9.1

This section summarizes actions taken in accordance with the following requirement of Condition 9.1: *The Proponent shall ensure that the Designated Project is carried out in a manner that avoids mortality and disturbance of migratory birds and their nests.*

In accordance with Condition 9.1, BC Hydro has, where feasible, given Project requirements and constraints, scheduled vegetation clearing outside of the migratory bird nesting period. The Project occurs within Zone B5, for which ECCC describes a general nesting period for migratory birds of 19 April to 29 August[1]. BC Hydro developed Section 4.17 of the CEMP to address the requirements of Condition 9.1 and EAC Condition 17, and provided an outline of the nest survey protocol in Section 3.5.1 of the Vegetation Clearing and Debris Management Plan.

BC Hydro developed a pre-clearing nesting activity survey methodology, which outlines specific field procedures to be followed to determine the likelihood that migratory bird nests within are present in areas scheduled to be cleared. The protocol also describes the approach for determining appropriate situation and species-specific disturbance setback buffers to be applied around locations where nests are likely to be present.

In 2018, pre-clearing nesting activity surveys were completed between April and August along the planned Highway 29 realignment, as well as and various other locations where small-scale clearing was occurring. If active or suspected nest areas were identified, then protective buffers were established around the nest area, as determined by a Qualified Environmental Professional (QEP).

After each area was surveyed, a free-to-work survey report was produced. The report maps the area surveyed and indicates which areas were free-to-work, any conditions placed on work activities, location of buffered nests and the expiry date of the free-to-work period.

6.1.2 Condition 9.2

This section summarizes actions taken in accordance with the following requirement of Condition 9.2: *The Proponent shall prepare and submit to the Agency an annual schedule, describing the location and timing for construction and reservoir filling activities, 90 days prior to initiating any of these activities.*

An initial construction schedule was submitted to CEAA on 17 October 2014. The most recent revised construction schedule, updated on 24 October 2018, can be found in Appendix 1.

6.1.3 Condition 9.3

This section summarizes actions taken in accordance with the following requirement of Condition 9.3: *The Proponent shall develop, in consultation with Environment Canada, a plan to monitor and mitigate potential disturbance of breeding migratory birds in and adjacent to the Project Activity Zone, including the area immediately downstream of the dam where risks to migratory bird nests could occur, during construction, reservoir filling and operation.*

6.1.3.1 Songbird surveys

The songbird monitoring program is focussed on passerines (songbird perching birds), hummingbirds, swifts, doves, kingfisher, and pigeons (all members of the orders Passeriformes, Apodiformes, Columbiformes, and Coraciiformes), which are collectively referred to as songbirds. Songbird baseline surveys were conducted in 2006, 2008, 2011 and 2012 in support of the EIS. Surveys were again conducted in 2016, 2017 and 2018 as part of the monitoring

[1] https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html#_zoneB_calendar

program. The Breeding Bird Follow-up Monitoring – Songbirds 2018 Annual Report can be found in Appendix 2.

6.1.3.2 Common nighthawk surveys

Common Nighthawk is designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Threatened under Schedule 1 of the Species at Risk Act (SARA), and listed as Yellow (secure) in British Columbia. Common nighthawk surveys were conducted in 2010 and 2012 in support of the EIS. Surveys are again occurring over two years, with approximately half occurring in 2018 and half in 2019 as part of the monitoring program. The Common Nighthawk Follow-up Monitoring 2018 Annual Report can be found in Appendix 3.

6.1.3.3 Woodpecker surveys

Woodpecker surveys were conducted in 2010 in support of the EIS. Woodpecker surveys are being completed in the project footprint within the Peace River valley and in the BC Hydro proposed mitigation properties over a two-year period (2018 and 2019) as part of the monitoring program. The Breeding Bird Follow-up Monitoring – Woodpeckers 2018 Annual Report can be found in Appendix 4.

6.1.3.4 Waterbird surveys

The waterbirds survey program is focussed on shorebirds, marsh birds, waterfowl, and other birds associated with aquatic and wetland habitats (collectively known as ‘waterbirds’). Waterbirds surveys were conducted in the Peace River and adjacent wetlands in 2006 and 2008 and 2012 through 2014. Those waterbird surveys were conducted using fixed-wing aircraft and twin-engine helicopter surveys and, to a lesser extent, ground and boat surveys. No shorebirds were documented during helicopter and fixed-wing aircraft surveys between 2012 and 2014 because of the difficulty detecting small birds using aerial surveys. As a result, methods were adapted in 2017 to continue the use of fixed-wing aircraft for aerial surveys, and to add ground, river boat, unmanned aerial vehicle and autonomous recording unit survey methods. As aerial surveys have been shown to make identifying most waterbirds to the species level, it is expected that the aerial component of waterbird surveys will be discontinued and not applied in 2018. The Waterbirds Follow-up Monitoring 2018 Annual Report can be found in Appendix 5.

6.1.4 Condition 9.9.2

This section summarizes actions taken in accordance with the following requirement of Condition 9.9.2: *The Proponent shall address potential risks of bird collisions with the transmission line, in consultation with Environment Canada, by determining if additional mitigation measures could be implemented to reduce the risk of bird collisions.*

A risk assessment for bird collisions with the transmission line was included in Section 6.1.3 of the 2016 VWMMP Annual Report. Since that time, changes have been incorporated in the transmission line design that further reduce the risk of bird collisions:

- Phase to phase spacing is more than 12 meters, preventing any electrocution hazard that exists on distribution lines;

- Conductor size is approximately 1.25" diameter, therefore easier for birds to see. Each phase of the conductor will be configured in a square-shaped bundle of four, with spacing of 0.5 meters between each conductor, thus further increasing visibility for birds.
- There are no shield wires on most of the line. Shield wires are smaller in diameter and harder for birds to see, and will only be installed in the last kilometer of each end of the line.
- Water crossings of the Peace and Moberly rivers will have marker spheres on them, which will increase visibility for birds.
- Guy wires on the structures are relatively low to the ground, as they connect to the tower at 2/3 the height of the tower. The lower height of the guy wires will reduce risk to birds. The bottom of the guy wires are marked with bright yellow plastic guards, which will increase their visibility, and further reduce risk to birds.

The transmission line has not yet been constructed, but once constructed the mitigations implemented will be documented in the appropriate VWMMP Annual Report.

6.2 Federal Decision Statement Condition 10: Non-Wetland Migratory Bird Habitat Mitigation and Monitoring

This section of the annual report summarizes the applicable components of the VWMMP implemented to fulfill FDS condition 10 in 2018 in accordance with the requirements of FDS condition 10.8. For context, the complete requirements of FDS condition 10 are shown below.

10. Non-wetland migratory bird habitat

10.1. The Proponent shall mitigate the potential effects of the Designated Project on non- wetland migratory bird habitat.

10.2. The Proponent shall develop, in consultation with Environment Canada, a plan that addresses potential effects of the Designated Project on non-wetland migratory bird habitat.

10.3. The plan shall include:

10.3.1. non-wetland migratory bird habitat baseline conditions for habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact;

10.3.2. migratory bird abundance, distribution and use of non-wetland habitat;

10.3.3. measures to mitigate the changes in aquatic and riparian-related food resources and other habitat features associated with a change from a fluvial to a reservoir system;

10.3.4. compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler;

10.3.5. an analysis of the effects of any compensation measures identified in condition
10.3.4 on the current use of lands and resources for traditional purposes by Aboriginal peoples; and

10.3.6. an approach to monitor and evaluate the effectiveness of the mitigation or compensation measures to be implemented and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory bird habitat, including migratory bird use of that habitat.

10.4. The Proponent shall submit to the Agency and Environment Canada a draft copy of the plan for review:

10.4.1. for conditions 10.3.1, 10.3.2, 10.3.3 and 10.3.6, 90 days prior to initiating construction;

and

10.4.2. for conditions 10.3.4 and 10.3.5, 90 days prior to implementing any component of the compensation plan.

10.5. The Proponent shall submit to the Agency the final plan:

10.5.1. for conditions 10.3.1, 10.3.2, 10.3.3 and 10.3.6, a minimum of 30 days prior to initiating construction; and

10.5.2. for conditions 10.3.4 and 10.3.5, a minimum of 30 days prior to implementing any component of the compensation plan.

10.6. When submitting each component of the final plan, the Proponent shall provide to the Agency an analysis that demonstrates how it has appropriately considered the input, views or information received from Environment Canada.

10.7. The Proponent shall commence the implementation of the compensation measures specified in condition 10.3.4 no later than five years from the initiation of construction.

10.8. The Proponent shall implement each component of the plan and provide to the Agency an analysis and summary of the implementation of the applicable component of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and at the end of year 1, 2, 3, 5, 10, 15, 20 and 30 of operation.

6.2.1 Condition 10.3.1

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.1: *The plan shall include non-wetland migratory bird habitat baseline conditions for habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact.*

The collection of data on non-wetland migratory bird habitat baseline conditions is done through implementation of the migratory bird monitoring plans, for which the results of 2018 surveys are summarized in Section 6.1.3 in relation to FDS Condition 9.3 (monitor and mitigate potential disturbance of breeding migratory birds).

6.2.2 Condition 10.3.2

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.2: *The plan shall include migratory bird abundance, distribution and use of non-wetland habitat.*

The collection of data on non-wetland migratory bird abundance, distribution and use of non-wetland habitat is done through implementation of the migratory bird monitoring plans, for which the results of 2018 surveys are summarized in Section 6.1.3 in relation to FDS Condition 9.3 (monitor and mitigate potential disturbance of breeding migratory birds).

6.2.3 Condition 10.3.4

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.4: *The plan shall include compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler.*

BC Hydro continues to manage three properties (Marl Fen, Rutledge and Wilder Creek) that were retained (in part) to provide habitat for non-wetland migratory birds. Management plans for those properties were included in the 2015 annual report. No new properties were added to the program in 2018.

6.2.4 Condition 10.3.5

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.4: *The plan shall include an analysis of the effects of any compensation measures identified in condition 10.3.4 on the current use of lands and resources for traditional purposes by Aboriginal peoples.*

BC Hydro has not been made aware of any current use of its fee simple lands for traditional purposes by Aboriginal peoples. The purchase and retention, by BC Hydro, of fee simple lands is not expected to affect current use of lands and resources for traditional purposes by Aboriginal people. Access to fee simple lands is controlled by the owner, or, in the case of BC Hydro, the leaseholder of lands leased by BC Hydro.

6.2.5 Condition 10.3.6

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.6: *The plan shall include an approach to monitor and evaluate the effectiveness of the mitigation or compensation measures to be implemented and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory bird habitat, including migratory bird use.*

An approach to monitor the effectiveness of mitigation and compensation measures and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory birds is done within the migratory bird monitoring plans. The 2018 results of the implementation of those plans are summarized in Section 6.1.3 in relation to FDS Condition 9.3 (monitor and mitigate potential disturbance of breeding migratory birds).

6.3 Federal Decision Statement Condition 11

This section of the annual report summarizes the components of the VWMMP implemented to fulfill FDS condition 11 in 2018 in accordance with the requirements of FDS condition 11.9. For context, the complete requirements of FDS condition 11 are shown below.

11.	**Wetlands used by migratory birds and for current use of lands and resources for traditional purposes**
11.1	The Proponent shall mitigate the potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes by Aboriginal people.
11.2.	The Proponent shall develop, in consultation with Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups, a plan that addresses potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes.
11.3.	The Proponent shall, in developing the plan, describe how the mitigation hierarchy and the

objective of no net loss of wetland functions were considered.

11.4. The plan shall include:

11.4.1. baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use;

11.4.2. mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost;

11.4.3. an approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data;

11.4.4. compensation measures to address the unavoidable loss of wetland areas and functions supporting migratory birds, species at risk, and the current use of lands and resources by Aboriginal people in support of the objective of full replacement of wetlands in terms of area and function; and

11.4.5. an analysis of the effects of any compensation measures identified in condition 11.4.4 on the current use of lands and resources for traditional purposes by Aboriginal peoples.

11.5. The Proponent shall submit to the Agency, Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups a draft copy of the plan for review:

11.5.1. for conditions 11.4.1, 11.4.2 and 11.4.3, 90 days prior to initiating construction; and

11.5.2. for conditions 11.4.4 and 11.4.5, 90 days prior to implementing any component of the compensation plan.

11.6. The Proponent shall submit to the Agency the final plan:

11.6.1. for conditions 11.4.1, 11.4.2 and 11.4.3, a minimum of 30 days prior to initiating construction; and

11.6.2. for conditions 11.4.4 and 11.4.5, a minimum of 30 days prior to implementing any component of the compensation plan.

11.7. When submitting each component of the final plan, the Proponent shall provide to the Agency an analysis that demonstrates how it has appropriately considered the input, views or information received from Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups.

11.8. The Proponent shall commence the implementation of the compensation measures specified in condition 11.4.4 no later than five years from the initiation of construction.

11.9. The Proponent shall implement each component of the plan and provide to the Agency an analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and at the end of year 1, 2, 3, 5, 10, 15, 20 and 30 of operation.

6.3.1 Condition 11.1

This section summarizes actions taken in accordance with the following requirement of Condition 11.1: *The Proponent shall mitigate the potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes by Aboriginal people.*

The CEMP (Section 4.5) states that riparian habitat is to be protected by retaining "a 15 m machine-free riparian buffer from the Ordinary High Water Mark of watercourses and waterbodies during clearing, except where worker safety prohibits manual tree falling and vegetation removal methods, and as addressed in a site specific prescription prepared and endorsed by a QEP". The CEMP (Section 4.5) also requires that lay-down and material storage areas be located "at least 15 m from the Ordinary High Water Mark".

The location and boundaries of wetland habitats near construction areas are field trothed, their boundaries flagged and coordinates recorded using GPS. This information was also used when determining the location of access roads that will be used to construct the transmission line. Mitigation for loss of wetland habitat is discussed in Section 6.3.2.

6.3.2 Condition 11.2

This section summarizes actions taken in accordance with the following requirement of Condition 11.2: *The Proponent shall develop, in consultation with Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups, a plan that addresses potential effects of the Designated Project on wetland habitat used by migratory birds, species at risk and for current use of lands and resources for traditional purposes.*

Potential effects of Site C on wetland habitat are being addressed within a wetland compensation plan, which has the objective of no net loss of wetland functions. Please refer to In 2018 BC Hydro revised the Wetland Function Assessment (WFA) in response to comments from CWS, FLNRORD and MOE. A revised version of the WFA was distributed to the VWTC on 18 April 2018.

BC Hydro continues to manage the Marl Fen property, which was retained (in part) to protect the marl fen that makes up part of the property. The management plan for that property was included in the 2015 annual report. In 2017, with support by Ducks Unlimited, BC Hydro identified a good candidate wetland for restoration on private land and has been working with the landowner and the Agricultural Land Commission (ALC) to secure an appropriate covenant to the title and commence restoration activities. In 2018, at the suggestion of Indigenous Groups, BC Hydro has been focussing efforts on finding opportunities for wetland protection and enhancement on BC Crown lands, so that benefits can be realized for use of those lands and resources for traditional purposes. A candidate site has been identified, and planning for wetland enhancement at the site is ongoing.

A wetland monitoring program has been developed through consultation with and review by MoE, FLNRORD, and CWS by way of the VWTC. Based on the requirements for wetland monitoring described in FDS Condition 11, a monitoring program must be informative enough to allow for:

- Collection of baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project;
- An evaluation of change to baseline wetland conditions due to the Project;
- Selection of compensation measures for loss of wetland areas and functions, including reclamation, improvement, creation and protection; and,
- Flexibility in the monitoring program to allow for further refinement in the characterization of baseline and affected wetlands, as data become available.

The monitoring program includes direct measures of groundwater quality and quantity, surface water quality and quantity, vegetation cover, structure and diversity, and rare plant occurrence.

Wetland monitoring also includes wetland delineation to help evaluate and improve wetland mapping. Further data on biotic structure and diversity, and migratory bird and species at risk abundance, density, diversity and use will be gathered through focussed monitoring plans (e.g., see Section 6.1.3 for details on spring and fall waterfowl and shorebird surveys conducted in 2018). Baseline data regarding current use of wetlands for traditional purposes by Aboriginal people have been gathered by the BC Hydro Indigenous relations team through groundtruthing with FN groups, who will also gather and compile data regarding changes to use of wetlands for traditional purposes.

The priority for the wetland monitoring program in 2018 was to sample wetland habitats for which baseline data may be insufficient, and which are likely to soon be impacted by clearing or construction activities. The wetland monitoring program annual report for 2018 is in Appendix 6. The wetland monitoring program is currently being revised to incorporate field learnings and data gathered to focus the program for 2019.

6.3.3 Condition 11.4.3

This section summarizes actions taken in accordance with the following requirement of Condition 11.2: *The Proponent shall, in developing the plan, describe how the mitigation hierarchy and the objective of no net loss of wetland functions were considered.*

The mitigation framework has three main steps, as outlined in the Environment Canada's Operational Framework for Use of Conservation Allowances (2012):

- Avoid proposed impacts;
- Minimize proposed impacts; and
- Address any residual environmental effects that cannot be avoided or sufficiently minimized with the use of conservation allowances.

Measures to avoid where feasible, and to minimize impacts to wetlands where avoidance is not feasible, are described in the CEMP and the Site C Vegetation Clearing and Debris Management Plan. For residual impacts to wetlands, BC Hydro is working to create, restore and enhance wetlands with the objective of no net loss of wetland functions. Determining the residual impacts to wetland functions, and the appropriate amount and type of wetlands to develop as conservation allowances, will be done through application of the Wetland Function Assessment, combined with application of the wetland monitoring program (see Section 6.3.2 above). The wetland monitoring program is designed to measure residual impacts to wetlands due to Site C, as well as to measure positive changes to wetland functions as a result of BC Hydro's efforts to create, restore and enhance wetlands.

6.3.4 Condition 11.4.1

This section summarizes actions taken in accordance with the following requirement of Condition 11.4.1: *The plan shall include baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use.*

Considerable baseline data on the biogeochemical, hydrological and ecological functioning of wetlands and associated riparian habitat were collected during baseline surveys for the EIS, and subsequent surveys of wetlands likely to be impacted by the transmission line RoW. See Section 6.3.2 for a description of the full wetland monitoring program that was implemented in 2018.

6.3.5 Condition 11.4.2

This section summarizes actions taken in accordance with the following requirement of Condition 11.4.2: *The plan shall include mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost*.

Wetland function will be maintained for wetlands that will not be permanently lost through timing of works (e.g. winter to minimize ground disturbance), maintenance of hydrology through the installation of culverts during road construction (see Section 7.5.1.2), and approaches to minimize impacts to wetlands through careful construction practices (see Section 6.3.1). The wetland monitoring program and Wetland Function Assessment tool were designed together to identify impacts to wetlands and wetland functions, which will then inform quantitative wetland compensation objectives (see Section 6.3.2).

6.3.6 Condition 11.4.3

This section summarizes actions taken in accordance with the following requirement of Condition 11.4.3: *The plan shall include an approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data*.

See section 6.3.2 for discussion the plan for monitoring and evaluating changes to baseline conditions, as defined in condition 11.4.1, and for identifying improvements based on monitoring data.

6.3.7 Condition 11.4.4

This section summarizes actions taken in accordance with the following requirement of Condition 11.4.4: *The plan shall include compensation measures to address the unavoidable loss of wetland areas and functions supporting migratory birds, species at risk, and the current use of lands and resources by Aboriginal people in support of the objective of full replacement of wetlands in terms of area and function*.

Please see Section 6.3.2 for details on the wetland mitigation program and the Wetland Function Assessment tool.

6.3.8 Condition 11.8

This section summarizes actions taken in accordance with the following requirement of Condition 11.8: *The Proponent shall commence the implementation of the compensation measures specified in condition 11.4.4 no later than five years from the initiation of construction.*

Please refer to Section 6.3.2 for details on implementation of the compensation measures in 2015, the first year of construction, and ongoing implementation.

6.3.9 Condition 11.9

This section summarizes actions taken in accordance with the following requirement of Condition 11.9: *The Proponent shall implement each component of the plan and provide to the Agency an analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and at the end of year 1, 2, 3, 5, 10, 15, 20 and 30 of operation*.

This annual report represents an analysis and summary of the implementation of the plan, as well as amendments made to the plan through the ongoing development of component mitigation and monitoring plans based on survey results and consultation with CWS, FLNRORD and MOE.

6.4 Federal Decision Statement Condition 16

This section of the annual report summarizes the programs as implemented in 2018 in accordance with the requirements of FDS condition 16.6.

For context, the complete requirements of FDS condition 16 are shown below.

16. Species at risk, at-risk and sensitive ecological communities and rare plants

16.1. The Proponent shall ensure that potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants are addressed and monitored.

16.2. The Proponent shall develop, in consultation with Environment Canada, a plan setting out measures to address potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants.

16.3. The plan shall include:

- 16.3.1. field work to verify the modeled results for surveyed species at risk and determine the habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact for those species, including the Short-eared Owl, the Western Toad and the Myotis Bat species;
- 16.3.2. surveys to determine whether the rare plant species potentially facing extirpation in the Project Activity Zone are found elsewhere in the region;
- 16.3.3. measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;
- 16.3.4. conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation;
- 16.3.5. an approach to avoiding or minimizing the use of herbicides and pesticides in areas that could impact species at risk, at-risk and sensitive ecological communities and rare plants;
- 16.3.6. an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and
- 16.3.7. an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the

	Designated Project.
16.4.	The Proponent shall submit to the Agency and Environment Canada a draft copy of the plan for review 90 days prior to initiating construction.
16.5.	The Proponent shall submit to the Agency the final plan a minimum of 30 days prior to initiating construction. When submitting the final plan, the Proponent shall provide to the Agency, an analysis that demonstrates how it has appropriately considered the input, views or information received from Environment Canada.

6.4.1 Condition 16.3.3

This section summarizes actions taken in accordance with the following requirement of Condition 16.3.3: *The plan shall include measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants.*

In 2018 the following measures were implemented to mitigate effects on species at risk and at-risk and sensitive ecological communities and rare plants:

- Completion of pre-construction rare plant surveys focussed on Highway 29 corridors, and proposed access roads into the eastern reservoir clearing areas. (Section 6.4.1.1)
- Completion of amphibian dispersal mitigation and salvages (Section 6.4.1.2)
- Implementation of protection measures for wetland and riparian areas, in which rare plant occurrences are generally concentrated, in the CEMP (See Section 6.3.1).
- The Environmental Features Map was updated with the 2018 rare plant data on 12 October, 2018 and posted in the data room for contractors to access for planning purposes.
- Further development and implementation of the Experimental Rare Plant Translocation program in consultation with MOE, FLNRORD and CWS (Section 7.1.6).
- Avoidance of hibernacula and suspected maternity roosts at Portage Mountain. The 2017 Annual Report described how impacts to hibernacula at Portage Mountain will be avoided. Monitoring of bat activity at Portage Mountain began in 2017 for evaluating the effectiveness of mitigation (Section 6.4.3).

6.4.1.1 Pre-construction rare plant surveys

Pre-construction rare plant surveys were conducted in 2018 in areas of the planned Project footprint not previously surveyed. The resultant data served as inputs to the final design of access roads, as well as to provide information for potential propagule sources for the Experimental Rare Plant Translocation Program (see Section 7.1.6). The first season of pre-construction surveys was completed in the summer and fall of 2015, and those surveys have been ongoing in each year since. The 2018 pre-construction rare plant survey report, which includes methods and results from surveys conducted in 2015-2018, is Appendix 7.

6.4.1.2 Amphibian dispersal mitigation and salvage

Mitigation for minimizing the impacts of the Project on amphibians and amphibian habitat is required of contractors and specified in part in Section 4.17 of the CEMP. Those mitigations include the following:

- Limit vegetation clearing and avoid road construction in identified amphibian breeding and migration areas, where feasible;
- If construction is required adjacent to any identified amphibian breeding and migration areas, implement appropriate barriers and set-back buffers around the sites in accordance with aquatic and riparian protection measures (i.e., retain a 15 m machine-free riparian buffer from the Ordinary High Water Mark of watercourses and waterbodies during clearing, except where worker safety prohibits manual tree falling and vegetation removal methods, and as addressed in a site specific prescription prepared and endorsed by a QEP [see Section 4.5 of the CEMP]; avoid where feasible, including through the use of disturbance setback buffers);
- Install crossing structures for amphibians and snakes to avoid and reduce injury and mortality to amphibians on roads that cross or are immediately beside wetland or other areas where amphibians or snakes are known to migrate across roads in accordance with Section 8.8 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Notify BC Hydro of such installations within 5 days of installation;
- Implement amphibian salvage and relocation procedures as required. Amphibian salvages could be required when avoidance of areas containing metamorphosing tadpoles cannot be avoided, when mass migration events cross access roads, or prior to the destruction of wetlands supporting amphibians (Wildlife Act Permit FJ16-226024, expires December 31, 2023).

It is necessary for each contractor's QEP to conduct amphibian breeding and migration area surveys in advance of ground disturbing activities and alongside active construction roads, where and when appropriate, to determine appropriate mitigation. Revision 5 of the CEMP includes an explicit requirement for each Contractor and its QEP to follow the Western Toad Management Procedure wherever western toads may exist. The Western Toad Management Procedure was developed through extensive consultation with FLNRORD, MoE and CWS within the VWTC, and can be found in Appendix 6 of the 2017 Annual Report. This procedure was finalized June 26, 2017, and since that time has been required for inclusion in all contractors' EPPs for works that could impact amphibians. Appropriate amphibian mitigation is monitored by BC Hydro site Environmental Monitors and the Independent Environmental Monitor against commitments within EPPs to determine and enforce compliance.

The Western Toad Management Procedure is applicable during construction on access roads, the transmission line, and areas within 250 m of wetlands. It requires daily surveys of all access roads and work sites during the 'core dispersal period' of June 1 to August 15. During the 'caution dispersal periods' of April 1 to May 31 and August 16 to September 30, the protocol requires a minimum of weekly surveys, as well as surveys before travelling to site and before any work commences. The protocol includes a stop work procedure at access roads or construction sites if dispersing toads are confirmed within 20 m of those areas, as well as a requirement for installing temporary barrier fences to prevent toads from being exposed to an increased mortality risk. Trapped toads are then to be translocated safely across work areas in the direction of their dispersal.

6.4.2 Condition 16.3.4

This section summarizes actions taken in accordance with the following requirement of Condition 16.3.4: *The plan shall include conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation*.

The propagule collection phase of an Experimental Rare Plant Translocation program was developed in consultation with MOE, FLNRORD and CWS. Collection of seeds began in 2017 and continued in 2018 (see Section 7.1.6).

6.4.3 Condition 16.3.6

This section summarizes actions taken in accordance with the following requirement of Condition 16.3.6: *The plan shall include an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants.*

6.4.3.1 Migratory Bird Monitoring

Please see Section 6.1.3 for a summary of migratory bird surveys conducted in 2018. These monitoring programs are designed to meet a number of objectives, including to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of predictions made during the environmental assessment regarding migratory bird species at risk. Numerous migratory species that have been observed in those surveys are provincially and / or federally listed.

6.4.3.2 Ground Nesting Raptor Surveys

Ground nesting raptor surveys were conducted in 2018 to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of predictions made during the environmental assessment on ground nesting raptors, such as short-eared owl (see Section 7.9.3.2). Short-eared owl is provincially Blue-listed and federally listed as Special Concern on Schedule 1 of SARA.

6.4.3.3 Bat Mitigation Monitoring at Portage Mountain

To avoid destroying the hibernacula at Portage Mountain that are being used by little brown myotis and northern myotis, BC Hydro redesigned the quarry to the eastern edge of the License of Occupation area. This relocation achieved a 300 m no activity / no access buffer around the 16 documented hibernacula. To avoid disturbance to hibernating bats, BC Hydro has also prohibited blasting at Portage Mountain between September 15 and May 15 (see Section 4.2 of the CEMP); this window was established based on data collected at the hibernacula in 2013 and in consultation with bat biologists. This mitigation is summarized in Section 7.7.3 of this annual report and is described in detail in Appendix 8 of the 2016 Annual Report.

To prevent damaging rock structures associated with the hibernacula, the BC MoE[2] recommends noise levels during blasting be kept below certain thresholds at the hibernacula (see Section 7.7.3). BC Hydro conducted noise modelling for blasting at Portage Mountain, which predicted that noise levels at the hibernacula would be below those thresholds.

BC Hydro evaluated the accuracy of noise modelling predictions at the hibernacula by monitoring noise during test blasting at Portage Mountain Quarry in August of 2018. That monitoring found that blasting within the re-designed quarry boundaries is not likely to exceed

[2] BC MoE. 2016. Best Management Practices Guidelines for Bats in British Columbia. Chapter 2: Mine Developments and Inactive Mine Habitats. 68 pp.

the thresholds for noise and vibration defined within the BC MOE Best Management Practices Guidelines for Bats in British Columbia. All measurements for hibernacula locations demonstrated an air overpressure of less than 150 decibels, a shock wave less than 15 p.s.i., and peak particle velocity (PPV) less than 15 mm/second.

In addition, BC Hydro is conducting year-round monitoring of bat use at Portage Mountain, with the following objectives:

- confirm that the bat species previously recorded at Portage Mountain remain present during quarry operations;
- evaluate any changes in the use of hibernacula at Portage Mountain through bat activity recorded during the winter and spring-emergence periods;
- evaluate and changes in the use of Portage Mountain by bats by comparing bat activity to previously recorded spring to fall bat activity; and
- emergence counts with bioacoustic surveys to help determine whether maternity roosts are present, and to evaluate the efficacy of spatial setback mitigation from suspected maternity roosts.

6.4.3.4. Western Toad and Gartersnake Monitoring

The Western Toad and Gartersnake Monitoring Program was developed to identify and describe impacts to western toad and gartersnake in wetlands downstream of Site C, and implemented in 2018. Western toad is federally listed as Special Concern under COSEWIC, SARA Schedule 1 – Special Concern, but is considered not at risk in BC. The 2018 annual report of this program is in Appendix 8.

6.4.3.4. Wetland Function Assessment and Wetland Monitoring

The Wetland Function Assessment has been developed to characterize the impacts of the Project on wetlands in general, and specifically the ecological functions that wetlands provide. A wetland monitoring program implemented in 2018 to monitor and evaluate the effectiveness of wetland mitigation measures and to verify the accuracy of the predictions made during the environmental assessment (see Section 6.3.2).

6.4.4 Condition 16.3.7

This section summarizes actions taken in accordance with the following requirement of Condition 16.3.7: *The plan shall include an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the Designated Project.*

The Conservation Data Center revised its ranking of species at risk in 2018. The following documents were reviewed to identify changes to rankings of species documented in the LAA during baseline surveys[3]:

[3] Ministry of Environmental Protection and Sustainability. 2018. Recent Data Changes. https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/conservation-data-centre-updates. Accessed: 14 March 2019.

- 2018 BC Conservation Status Rank Review and Changes: Vascular and Non-Vascular Plants
- 2018 BC Conservation Status Rank Review and Changes: Invertebrate and Vertebrate Animals

Species listed on Schedules 1, 2 and 3 of the federal Species at Risk Act (SARA) were reviewed to determine if any species occurring in the Project area had been added or had their rankings changed.

Provincially species are assigned to lists based on their Provincial conservation status. Species on the red and blue-lists are considered species at risk. Species on the yellow and unknown lists are not considered species at risk. A summary of the lists are provided below and can be accessed at http://www.env.gov.bc.ca/atrisk/help/list.htm:

- **Red-list:** Includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.
- **Blue-list:** Includes any indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened.
- **Yellow-list:** Includes species that are apparently secure and not at risk of extinction. Yellow-listed species may have red- or blue-listed subspecies.
- **Unknown**: Includes species or subspecies for which the Provincial Conservation Status is unknown due to extreme uncertainty (e.g., S1S4). It will also be 'Unknown' if it is uncertain whether the entity is native (Red, Blue or Yellow), introduced (Exotic) or accidental in B.C. This designation highlights species where more inventory and/or data gathering is needed

6.4.4.1 Rare Plants

In 2018 the conservation status of 28 species with potential to occur in the Site C Project area changed (Table 6). All changes for previously listed species represented reductions in conservation status, largely due to the results of regional rare plant surveys (see Section 7.2.1 and Appendix 9 of the 2017 Annual Report) showing that rare plants identified during Site C baseline surveys are not as rare as previously believed. Creeping sulphur (*Fulgensia subbracteata*) was added to the list, and is ranked as Red-listed.

Table 6. 2018 BC Conservation Status Rank for Plants Occurring in and around the Site C Project Area

Scientific Name	Common Name	2017 Status	2018 Status
Antennaria neglecta	field pussytoes	Blue	Yellow
Avenula hookeri	spike-oat	Blue	Yellow
Botrychium crenulatum	dainty moonwort	Blue	Yellow
Calamagrostis montanensis	plains reedgrass	Blue	Yellow
Carex heleonastes	Hudson Bay sedge	Blue	Yellow
Epilobium halleanum	Hall's willowherb	Blue	Yellow
Geum triflorum var. triflorum	old man's whiskers	Red	Yellow
Glyceria pulchella	slender mannagrass	Blue	Yellow
Lempholemma polyanthes	mourning phlegm	Blue	Yellow
Leptogium intermedium	fourty-five vinyl	Blue	Yellow
Leptogium tenuissimum	birdnest vinyl	Red	Yellow
Malaxis brachypoda	white adder's-mouth orchid	Blue	Yellow
Phaeophyscia kairamoi	five o'clock shadow	Blue	Yellow
Potentilla pulcherrima	pretty cinquefoil	Red	Yellow
Silene drummondii var. drummondii	Drummond's campion	Blue	Yellow
Sphenopholis intermedia	slender wedgegrass	Blue	Yellow
Stuckenia vaginata	sheathing pondweed	Blue	Yellow
Usnea cavernosa	pitted beard	Blue	Yellow
Fulgensia subbracteata	creeping sulphur	[not tracked]	Red
Artemisia herriotii	Herriot's sage	Red	Blue
Carex sprengelii	Sprengel's sedge	Red	Blue
Chrysosplenium iowense	Iowa golden-saxifrage	Red	Blue
Drosera linearis	slender-leaf sundew	Red	Blue
Pedicularis parviflora	small-flowered lousewort	Red	Blue
Penstemon gracilis	slender penstemon	Red	Blue
Polypodium sibiricum	Siberian polypody	Red	Blue

Scientific Name	Common Name	2017 Status	2018 Status
Ranunculus rhomboideus	prairie buttercup	Red	Blue
Rorippa calycina	persistent-sepal yellowcress	Red	[not tracked]

6.4.4.2 Wildlife

The SARA status listings for wildlife species likely to occur within the Site C Project area did not change in 2018. In addition, no recovery strategies for federally listed species likely to occur within the Site C Project Area were released in 2018.

In 2018, the BC Conservation Data Centre (CDC) listing did not change for any wildlife species that occur in the LAA. However, the rank for Cape May warbler (*Setophaga tigrina*; provincially Blue-listed) changed from S3B (Vulnerable) to S3S4B (Apparently Secure).

7.0 Mitigation and Monitoring Measures-Environmental Assessment Certificate Conditions

Conditions 9 to 12, 14 to 16, 19, 21, 23, and 24 of the Environmental Assessment Certificate, respectively, set out the mitigation and monitoring requirements for the Project's effects on vegetation and ecological communities and wildlife resources.

7.1 EAC Condition 9

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 9.

For context, the complete requirements of Condition 9 are shown below.

EAC Condition 9

The EAC Holder must develop a Vegetation and Invasive Plant Management Plan to protect ecosystems, plant habitats, plant communities, and vegetation with components applicable to the construction phase.

The Vegetation and Invasive Plant Management Plan must be developed by a QEP.

The Vegetation and Invasive Plant Management Plan must include at least the following:

Invasive Species

- Surveys of existing invasive species populations prior to construction.
- Invasive plant control measures to manage established invasive species populations and to prevent invasive species establishment.

Rare Plants and Sensitive Ecosystems

- The EAC Holder must expand its modelling, including completing field work, to improve identification of rare and sensitive plant communities and aid in delineation of habitats that may require extra care, 90 days prior to any Project activities that may affect these rare or sensitive plant communities
- The EAC Holder must, with the use of a QEP, complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission

lines. These pre- construction surveys must target rare plants as defined in Section 13.2.2 of the EIS —including vascular plants, mosses, and lichens.

- The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE using provincial data collection standards.
- The EAC Holder must implement construction methods to reduce the impact to rare plants, maximize use of existing access corridors, and construct transmission towers and temporary roads away from wetlands and known rare plant occurrences.
- The EAC Holder must implement construction methods to reduce the impact to rare plants, maximize use of existing access corridors, and construct transmission towers and temporary roads away from wetlands and known rare plant occurrences.
- Protect known occurrences of Tufa seeps, wetlands and rare plants located adjacent to construction areas. Install signage and flagging where necessary, as determined by the QEP, to indicate the boundaries of the exclusion area.
- The EAC Holder will engage the services of a Rare Plant Botanist during construction to design and implement an experimental rare plant translocation program in consultation with MOE using the BC MOE's Guidelines for Translocation of Plant Species at Risk in BC (Maslovat, 2009).

The EAC Holder must provide this draft Vegetation and Invasive Plant Management Plan to Environment Canada, FLNR, MOE, and Aboriginal Groups for review a minimum of 90 days prior to construction and operation phases.

The EAC Holder must file the final Vegetation and Invasive Plant Management Plan with EAO, Environment Canada, FLNR, MOE, and Aboriginal Groups, a minimum of 30 days prior to construction and operation phases.

The EAC Holder must develop, implement and adhere to the final Vegetation and Invasive Plant Management Plan, and any amendments, to the satisfaction of EAO.

7.1.1 Invasive Plant Control

Refer to Section 4.15 of CEMP and the Invasive Weed Mitigation and Adaptive Management Plan (IWMAMP). Numerous invasive plant control measures for the Project continued in 2018:

- invasive plant removal through hand pulling;
- on-going inventories of invasive plant locations;
- extensive hydroseeding of exposed slopes across the Project area;
- regular vehicle inspections and cleaning through various methods so that vehicles are clean and free of dirt and invasive plants when transitioning between sites and into the Project area;
- In 2018, BC Hydro utilized the Main Civil Works contractor's onsite wash station to keep vehicles free of dirt and invasive plants. Use of that wash station will continue until a permanent wash station is constructed. Procurement is ongoing for a permanent wash station, which is planned to be installed in 2019.
- An Invasive Species Management Contractor was sourced by BC Hydro in 2018. That contractor will provide specialized support invasive species management support on the dam site, transmission line, reservoir, Hwy 29 realignment and other off-site locations through 2024.

7.1.2 Inventory areas not already surveyed

This section summarizes actions taken in accordance with the following requirement of Condition 9*: The EAC Holder must, with the use of a QEP, complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission lines. These pre- construction surveys must target rare plants as defined in Section 13.2.2 of the EIS —including vascular plants, mosses, and lichens.*

Please see Section 6.4.1.1 for pre-construction rare plant surveys conducted in areas not already surveyed. Rare plant location data collected in 2018 was used to update the Environmental Features Map for contractors to access in their planning so that impacts to rare plants could be mitigated.

7.1.3 Spatial database of known rare plant occurrences

This section summarizes actions taken in accordance with the following requirement of Condition 9*: The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE using provincial data collection standards.*

The Site C Environmental Features Database and Environmental Features Map was updated with the 2018 rare plant data on 12 October 2018 and posted in the data room for contractors to access in their planning.

The 2018 rare plant data was submitted to Jennifer Penny, Program Botanist at the BC Conservation Data Center, MOE, on 11 January 2018.

Voucher specimens were submitted to the Herbarium at the University of British Columbia in the fall of 2018.

7.1.4 Rare plant avoidance

This section summarizes actions taken in accordance with the following requirement of Condition 9*: The EAC Holder must implement construction methods to reduce the impact to rare plants, maximize use of existing access corridors, and construct transmission towers and temporary roads away from wetlands and known rare plant occurrences.*

General mitigation to minimize impacts to wetlands, where rare plants are often concentrated is described in Section 6.3.1.

Rare plant location data collected in 2018 were used to update the Environmental Features Map for BC Hydro and contractors to access in their planning so that impacts to known occurrences of rare plants could be mitigated.

The way in which BC Hydro fulfilled this part of Condition 9 during the transmission line design phase was described in the 2015 annual report. Tower types selected are capable of supporting longer spans of conductor than those originally planned, which will reduce the overall number of towers required. Tower pad placement has been adjusted to minimize impacts to wetlands within engineering constraints. As a result, the total number of towers has been reduced from 433 in the conceptual design down to 409 in the current design. The number of wetlands impacted was 102 in the conceptual design, and is 64 in the current design. Occurrences of rare plants have been avoided through transmission line design and tower placement to the degree feasible.

Further practices for avoidance of rare plant occurrences are described in Section 4.15 of the CEMP. All known rare plant occurrences are stored in the Site C Environmental Features Database and displayed on the Environmental Features Map (see Section 7.1.3). Contractors are required to avoid impacting rare plant occurrences, where feasible. Where complete avoidance is not feasible, contractors are required to employ measures to reduce adverse effects, such as by timing construction activities in winter months and frozen ground conditions, placing ramps or matts over occurrences to reduce soil compaction, use rubber-tired equipment, and implement designated travel routes to and from work sites. Additional mitigation for rare plant occurrences that cannot be avoided is through the Experimental Rare Plant Translocation program, through which rare plant propagules are being collected, propagated, out-planted and monitored (see Sections 7.1.6, 7.5.1 and 7.5.2).

7.1.5 Protect tufa seeps, wetlands and rare plants located adjacent to construction areas

This section summarizes actions taken in accordance with the following requirement of Condition 9*: Protect known occurrences of Tufa seeps, wetlands and rare plants located adjacent to construction areas. Install signage and flagging where necessary, as determined by the QEP, to indicate the boundaries of the exclusion area.*

In accordance with the CEMP, a wetland on the north bank of the dam construction site was established as a work avoidance zone, within which no construction activity will be permitted. This zone will be maintained throughout construction.

Within the transmission right of way Riparian Vegetation Management Areas/Machine Free Zones have been established around wetlands. Within this zone clearing will be carried out by either hand-falling or having machines reach in from the edge of the RVMA (machines are not allowed to enter the RVMA). No burning, mulching or chipping is allowed within an RVMA. Vegetation with a normal mature height less than 3 m and conifers less than 2m will not be removed from the RVMA.

7.1.6 Experimental Rare Plant Translocation Program

This section summarizes actions taken in accordance with the following requirement of Condition 9: *The EAC Holder will engage the services of a Rare Plant Botanist during construction to design and implement an experimental rare plant translocation program in consultation with MOE using the BC MOE's Guidelines for Translocation of Plant Species at Risk in BC (Maslovat, 2009).*

A field program was conducted in 2018, as part of Site C Project's Experimental Rare Plant Translocation Program. Field activities conducted in 2018 were propagule collection, ex-situ propagation, and the first year of translocation implementation. A technical memorandum summarizing the results and recommendations arising from the

2018 field program can be found in Appendix 9.

7.3 EAC Condition 11

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 11.

For context, the complete requirements of Condition 11 are shown below.

EAC Condition 11

EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes:

- Assistance (financial or in-kind) to the managing organization of suitable habitat enhancement projects in the RAA (RAA as defined in the amended EIS).
- Direct purchase of lands in the RAA and manage these lands and suitable existing properties owned by the EAC Holder to enhance or retain rare plant values where opportunities exist.

The EAC Holder must engage with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.

7.3.1 Habitat Enhancement Projects in the RAA

This section summarizes actions taken in accordance with the following requirement of Condition 11: *EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes assistance (financial or in-kind) to the managing organization of suitable habitat enhancement projects in the RAA (RAA as defined in the amended EIS).*

Habitat enhancement activities to compensate for the loss of rare and sensitive habitats and for protecting occurrences of rare plants are being conducted through Ducks Unlimited for wetland compensation activities (Section 6.3.2), and Ecologic Consultants through the Saulteau-EBA Environmental Services Joint Venture for the Rare Plant Translocation Program (Section 7.1.6).

7.3.2 Direct purchase of lands in the RAA to enhance or retain rare plant values

This section summarizes actions taken in accordance with the following requirement of Condition 11: *EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes direct purchase of lands in the RAA and manage these lands and suitable existing properties owned by the EAC Holder to enhance or retain rare plant values where opportunities exist.*

In 2014 BC Hydro purchased the Marl Fen property, located outside Hudson's Hope. This property supports several rare plant species. This property is being managed to maintain rare plants along with other wildlife and vegetation values. Results of surveys documenting species that occur within the property are provided in the 2015 Annual Report for the VWWMP.

7.3.3 Engaging with FLNRORD, MOE and Indigenous Groups

This section summarizes actions taken in accordance with the following requirement of Condition 11: *The EAC Holder must engage with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.*

BC Hydro continues to engage in the development of the compensation program for the loss of rare and sensitive habitats and to protect occurrences of rare plants through the VWTC. BC Hydro continues to engage with Indigenous Groups through ongoing communications, such as direct requests for assistance in identifying appropriate wetland compensation opportunities. In addition, BC Hydro engages with Indigenous Groups through regularly scheduled permitting forums, and a wetland and rare plant focussed environmental forum that was held in Fort St. John on 13 November 2018.

7.4 EAC Condition 12

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 12.

Details regarding the Wetland Mitigation and Compensation Plan and wetland mapping are described in Section 7.4.1 and 7.4.1.1, respectively. Additional details regarding maintaining hydrological balance at wetlands, sedimentation barriers, stormwater management, implementation of approved work practices and Develop with Care are presented in Section 7.3 of the 2017 VWMMP Annual Report.

For context, the complete requirements of Condition 12 are shown below.

EAC Condition 12

The EAC Holder must develop a Wetland Mitigation and Compensation Plan. The Wetland Mitigation and Compensation Plan must include an assessment of wetland function lost as a result of the Project that is important to migratory birds and species at risk (wildlife and plants). The Wetland Mitigation and Compensation Plan must be developed by a QEP with experience in wetland enhancement, maintenance and development.

The Wetland Mitigation and Compensation Plan must include at least the following:

- Information on location, size and type of wetlands affected by the Project;
- If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;
- Stormwater management will be designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur.

Develop, with the assistance of a hydrologist, site-specific measures prior to construction to reduce changes to the existing hydrologic balance and wetland function during construction of the Jackfish Lake Road and Project access roads and transmission line.

- All activities that involve potentially harmful or toxic substances, such as oil, fuel, antifreeze, and concrete, must follow approved work practices and consider the provincial BMP guidebook Develop with Care (BC Ministry of Environment 2012 or as amended from time to time).

- A defined mitigation hierarchy that prioritizes mitigation actions to be undertaken, including but not limited to:
    - Avoid direct effects where feasible;
    - Minimize direct effects where avoidance is not feasible;
    - Maintain or improve hydrology where avoidance is not feasible;
    - Replace like for like where wetlands will be lost, in terms of functions and compensation in terms of area;
    - Improve the function of existing wetland habitats; and
    - Create new wetland habitat

The EAC Holder must monitor construction and operation activities that could cause changes in wetland functions.

The EAC Holder must provide this draft Wetland Mitigation and Compensation Plan to Environment Canada, FLNR, MOE, Aboriginal Groups, Peace River Regional District and District of Hudson's Hope for review a minimum of 90 days prior to any activity affecting the wetlands.

The EAC Holder must file the final Wetland Mitigation and Compensation Plan with EAO, Environment Canada, FLNR, MOE, Peace River Regional District, District of Hudson's Hope and Aboriginal Groups, a minimum of 30 days prior to any activity affecting the wetlands.

The EAC Holder must develop, implement and adhere to the final Wetland Mitigation and Compensation Plan, and any amendments, to the satisfaction of EAO.

7.4.1 Wetland Mitigation and Compensation Plan

Condition 12 requires: *The EAC Holder must develop a Wetland Mitigation and Compensation Plan. The Wetland Mitigation and Compensation Plan must include an assessment of wetland function lost as a result of the Project that is important to migratory birds and species at risk (wildlife and plants). The Wetland Mitigation and Compensation Plan must be developed by a QEP with experience in wetland enhancement, maintenance and development.*

Please see Section 6.3.2 for a summary of wetland mitigation plan development for 2018.

7.4.1.1 Information on location, size and type of wetlands affected by the Project

This section summarizes actions taken in accordance with the following requirement of Condition 12: *Information on location, size and type of wetlands affected by the Project.*

Three spatial datasets are available that describe the location, size and type of wetlands that may be affected by the Project: TEM habitat mapping; detailed wetland mapping; and the Maple Leaf Forestry dataset. The TEM was generated in and around the Project Activity Zone (PAZ), including the Peace River, the transmission line, and other sites within the PAZ. Polygons in the TEM were produced at a 1:20,000 scale, delineated using aerial photography, characterized with aerial photography combined with Vegetation Resources Inventory (VRI) forest cover mapping, and ground-truthed using field sampling. The TEM was used to generate estimates of wetland area to be affected by construction in the PAZ in the EIS; however, because up to three wetland types (and potentially more than three wetlands) can be found within a TEM polygon, the TEM habitat mapping's usefulness for characterizing wetlands that may be affected is limited.

Detailed wetland mapping was created by BC Hydro to be a finer scale wetland mapping inventory than the TEM data. Within a TEM polygon, wetland boundaries were delineated using aerial photos that were either at a 1:5,000 or 1:15,000 scale. This allowed for greater detail to delineate the wetland edge. The detailed wetland mapping was completed along the transmission line corridor and the Peace River. It was delineated by first identifying all TEM polygons classified as wetland habitat. Using large scale aerial photographs, the boundaries of any wetland that fell within a TEM wetland polygon were then delineated and the habitat type of the TEM wetland polygon was assigned to the newly delineated wetland(s). In some cases the TEM wetland was divided up into several smaller wetlands while in others the edge of the TEM wetland was only modified based on the higher detail aerial photographs used. Also, in some cases, wetlands have been delineated outside of TEM wetland polygons. A Field Truthing Required (FTR) label was assigned to any wetland where wetland classification needed refining. Because the detailed wetland mapping polygons follow wetland edge, this GIS dataset is useful for characterizing wetlands that may be affected.

In October 2017 Maple Leaf Forestry Ltd. conducted an assessment and classification of wetlands impacted by the transmission line RoW. This consisted of field visits to identify all the wetlands in the RoW, categorize them into a wetland type, and delineate the boundaries of the wetland. Wetlands were categorized into the same wetland types as in the TEM while also classified into a Wetland Riparian Class of the Forest Practices and Planning Regulation (FPPR) under the Forest and Range Practices Act (FRPA). All wetlands in the transmission line were classified as W1, W3, W5, or a non-classified wetland. The Wetland Riparian Class was used to identify the minimum riparian management area width, riparian reserve zone width and riparian management zone width for the wetland. Because the Maple Leaf Forestry dataset has field-verified wetland edges and type, there is a greater level of accuracy associated with this dataset; however, wetland mapping and characterization was only conducted along the transmission line RoW, and therefore its usefulness for characterizing wetlands that may be affected by the Project is limited.

Although each dataset has its limitations, the TEM, detailed and Maple Leaf wetland habitat mapping can be used in association with each other. Additional wetland delineation was done in 2018 through the wetland monitoring program (Section 6.3.2).

7.5 EAC Condition 14

This section of the annual report summarizes the programs as implemented in 2018 in accordance with the requirements of Condition 14.

For context, the complete requirements of Condition 14 are shown below.

EAC Condition 14

The EAC Holder must develop a Vegetation and Ecological Communities Monitoring and Follow-up Program for the construction phase and first 10 years of the operations phase. The Vegetation and Ecological Communities Monitoring and Follow-up Program must be developed by a QEP.

The Vegetation and Ecological Communities Monitoring and Follow-up Program must include at least the following:

- Definition of the study design for the rare plant translocation program (see condition 9).
- Plan for following-up monitoring of any translocation sites to assess the survival and health of translocated rare plant species, under the supervision of a Rare Plant Botanist.
- Measurement criteria, including vegetation growth, persistence of rare plants and establishment / spread of invasive plant species, and associated monitoring to document the effectiveness of habitat enhancement and possible compensation programs.

The Vegetation and Ecological Communities Monitoring and Follow-up Program reporting must occur annually during construction and the first 10 years of operations, beginning 180 days following commencement of construction.

7.5.1 Definition of the study design for the Experimental Rare Plant Translocation Program

As outlined in the VWMPP, the study design for the Experimental Rare Plant Translocation Program will follow a five step approach, as outlined in Maslovat (2009)[4]. The goals of the experimental rare plant translocation program are to contribute to:

1. the viability of target rare plant species through propagule collection, propagation, and out-planting; and
2. the field of plant translocation based on the findings from the seeding, propagation, out-planting, management, and monitoring measures.

The primary objective of the ERPT is to establish new or augment extant populations of target rare plant species using established and where necessary experimental techniques.

The secondary objectives of the ERPT program are to:

1. support the conservation of the target species by promoting a self-sustaining population;
2. maintain local genetic diversity of target species;
3. re-establish individuals of target species in high-risk areas into secure, analogous habitat; and
4. produce a secondary supply of viable plant stock in the case that supplementing translocated populations is required.

There are four strategies that will be employed in achieving the goals and objectives of the program:

1. Translocate rare plant species through plant salvage, collection of vegetative propagules and/ or seeds from populations that will or may be lost (e.g., lost due to the creation of the reservoir).

[4] Maslovat, C. 2009. Guidelines for translocation of plant species at risk in British Columbia. British Columbia Ministry of Environment, Victoria, BC.

2. Document the survival of the translocated rare plants through population monitoring at re-location sites.

3. Manage translocated populations for seven years after translocation to maximize plant survival and fitness.

4. Improve the theory and practice of rare plant translocation, and increase knowledge of the biology and ecology of targeted rare plant species.

The results of the study will be made publically available, as part of the annual Vegetation and Wildlife Mitigation and Monitoring Program report, so that learnings are accessible to others, thereby adding to the relevant knowledge base and improving the theory/practice of rare plant translocation.

The program at its current state of development consists of four main phases over seven years of study (2016 to 2022):

1. **Literature review and program development (2016-2017).** The literature review and program development is underway and will continue throughout the duration of the ERPT program. A review of existing guidance, methodologies, and results of previous rare plant translocation projects worldwide is ongoing. The lessons learned through these studies and analyses are being used to inform the structure and methods of the ERPT program.

2. **Propagule collection (2017 to 2020).** The standards for collecting and storing propagules for ex-situ conservation (e.g., timing, sampling, labelling, cleaning, processing, stratification, sowing, and provenance) are being refined for this program and incorporate guidance outlined in Maslovat (2009) and by the European Native Seed Conservation Network (2009)[5]. The program is designed to collect seeds and cuttings or whole plants and to characterize the site conditions at the source locations. The level of risk to each plant population is being used to prioritize sites for the collection program and will be used for future collection activities, as appropriate. The level of risk is determined based on the expected clearing date, rarity of the plant, and predicted propagule collection timing. Propagule collection is occurring throughout the growing season and takes into consideration local plant phenology and propagation. Field teams are conducting multiple site visits to collect seeds on a number of occasions as appropriate based on seed availability and readiness.

3. **Ex-situ propagation (2017 and 2021).** This phase of the ERPT Program involves the evaluation of methods and implementation of seed cleaning, drying, storage, stratification, and ex-situ propagation for each individual taxon. Depending on the species and seed type, seeds are either being dried or cleaned following collection to ensure maximum viability. Cleaning includes the removal of waste material from the seed itself and includes the use of sieves, hand separation, and water baths and drying, as appropriate. Stratification is conducted as needed, whereby seeds are treated with cold or moist heat to simulate natural germination conditions. Many (but not all) seeds require stratification to break seed dormancy and permit germination. Some seeds also require a pre-treatment, such as mechanical or acid scarification, to weaken the seed

[5] ENSCONET. 2009a. Seed Collecting Manual for Wild Species. Main editors: Royal Botanic Gardens (UK) & Universidad Politécnica de Madrid (Spain). Edition 1: 17 March 2009.

coat prior to stratification. Seeds that do not require stratification are being stored until spring. Propagation methods for asexual and sexual propagation for each species are being investigated in the context of the ecological conditions observed at the source populations.

4. **Translocation implementation (2018 and 2021).** The detailed methods for translocation implementation are being refined based on data collected during field activities. Translocation implementation includes preparation at pre-translocation sites and seeding and/or planting at recipient sites. Efforts will be made to determine if any site preparation (for intact habitats) or site engineering (for restoration sites) is required before translocation and to identify if habitat manipulation after the translocation will be required. Recipient sites will be prepared as necessary prior to the translocation, including invasive plant species removal (and implementation of steps to minimize introduction during the translocation process), soil amendment, and sculpting microcatchments. The specific timing windows for planting will be determined based on the plant phenology, the development stage of the propagated plants, and the local weather and soil moisture conditions. Initial out-planting occurred in September 2018, with follow up planting planned for spring 2019. Additional planting is planned tol occur in the fall and spring of 2020 and will incorporate the key findings from previous planting efforts. Some stock will be withheld from planting as insurance should inclement conditions negatively affect the initial out-planting stock.

5. **Post-translocation care, maintenance and monitoring (2018-2022).** Post-translocation care, maintenance, and monitoring will commence immediately after each translocation event is completed. Post-translocation plant care and site management will assess the health and establishment of the translocated populations and to identify and address any factors affecting the survival or health of the translocated plants. The first four years of follow-up site visits and data collection (i.e., short-term monitoring) will inform the frequency and level of effort of post-translocation care and additional long-term monitoring in subsequent years. Translocated populations that are achieving identified targets will still require long-term monitoring but may require less frequent follow-up visits than populations that are not achieving key metrics and thus require more active management. Monitoring the success or failure of the methods will assist in identifying opportunities for improvement within an adaptive management framework. Importantly, this information can also help to inform other translocation projects, thereby improving the overall success of translocation efforts.

7.5.2 Plan for monitoring translocations

Experimental Rare Plant Translocation Program monitoring will document a suite of parameters designed to evaluate the efficacy of translocation methods in relation to the stated objectives of the program. All actions associated with the translocation (see Section 7.5.1) will be fully documented to retain as much information as possible on the pathway of a given plant (e.g., from seed collection to planting) to facilitate post-hoc assessments of success. Specifically, the monitoring program will measure, document, and evaluate the following:

1. the efficacy of the methods used to 1) characterize donor and recipient sites, 2) collect and store plant propagules, 3) conduct ex-situ propagation; and 4) translocate the rare plant species from the host site to the recipient sites;

2. the efficacy of the techniques used for managing the translocated plant propagules (e.g. site preparation, watering, weeding, fertilizing (e.g. Carlsen et. al 2011; Rynear et. al. 2013);

3. the survival of the translocated rare plant species through monitoring of population size, extent, threats, resilience, and persistence (Pavlik 1996; Vallee et al. 2004, Maslovat 2009, Weeks et al. 2011); and

4. the success of follow up procedures applied to address any declines in survival or fitness of the translocated plants.

7.5.3 Measurement criteria for effectiveness monitoring of habitat enhancement and compensation programs

Please see Section 7.5.2 for how the effectiveness of the rare plant translocation program will be measured.

7.6 EAC Condition 15

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 15.

For context, the complete requirements of Condition 15 are shown below.

EAC Condition 15

The EAC Holder must develop a Wildlife Management Plan. The Wildlife Management Plan must be developed by a QEP.

The Wildlife Management Plan must include at least the following:

- Field work, conducted by a QEP, to verify the modelled results for surveyed species at risk and determine, with specificity and by ecosystem, the habitat lost or fragmented for those species. The EAC Holder must use these resulting data to inform final Project design and to develop additional mitigation measures, as needed, as part of the Wildlife Management Plan, in consultation with Environment Canada and FLNR.
- Measures to avoid, if feasible, constructing in sensitive wildlife habitats. If avoiding sensitive wildlife habitats is not feasible, condition 16 applies.
- If sensitive habitats, such as wetlands, are located immediately adjacent to any work site, buffer zones must be established by a QEP to avoid direct disturbance to these sites.
- Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.
- Protocol to ensure that lighting is focused on work sites and away from surrounding areas to manage light pollution and disturbance to wildlife. If lighting cannot be directed away from surrounding areas, the EAC Holder must ensure additional mitigation measures are implemented to reduce light pollution, including light shielding.
- A mandatory environmental training program for all workers so that they are informed that hunting in the vicinity of any work site/Project housing site is strictly prohibited for all workers.

The EAC Holder must ensure that all workers are familiar with the Wildlife Management Plan.

The EAC Holder must submit this draft Wildlife Management Plan to Environment Canada, FLNR, MOE and Aboriginal Groups for review a minimum of 90 days prior to the commencement of construction.

The EAC Holder must file the final Wildlife Management Plan with EAO, Environment Canada, FLN, MOE and Aboriginal Groups, a minimum of 30 days prior to commencement of construction.

The EAC Holder must develop, implement and adhere to the final Wildlife Management Plan, and any amendments, to the satisfaction of EAO.

7.6.1 Measures to avoid, if feasible constructing in sensitive wildlife habitats

This section summarizes actions taken in accordance with the following requirement of Condition 15: *Measures to avoid, if feasible, constructing in sensitive wildlife habitats. If avoiding sensitive wildlife habitats is not feasible, condition 16 applies.*

Measures to avoid impacts to sensitive wildlife habitats are described in Section 4.17 of Revision 4 of the CEMP:

- Avoid construction activity within Important Wildlife Areas, including designated setback buffers determined by a QEP, where feasible:
  - wetlands;
  - snake hibernacula;
  - bat hibernacula;
  - sharp-tailed grouse leks;
  - beaver lodges, dams and food caches;
  - active furbearer and large carnivore den sites;
  - active bird nests (see Section 6.1.1);
  - mineral licks;
  - habitat used by ungulates for winter range; and
  - amphibian breeding sites and migration routes.
- Except within the dam site area, on designated access roads and during clearing, construction activities are prohibited within 15 m of the Ordinary High Water Mark of streams or wetlands, unless the activity was described in the EIS and is accepted by BC Hydro;
- Guidance to minimize impacts to raptor nests;
- Protocol for conducing sharp-tailed grouse lek monitoring and a decision tree for various lek activity scenarios to minimize impacts to sharp-tailed grouse leks (see also Appendix 7 of the 2016 Annual Report); and
- Measures for minimizing impacts to amphibian breeding and migration areas (see also Section 6.4.1.2).

7.6.2 Setback buffers to avoid direct impacts to sensitive habitats

This section summarizes actions taken in accordance with the following requirement of Condition 15*: If sensitive habitats, such as wetlands, are located immediately adjacent to any work site, buffer zones must be established by a QEP to avoid direct disturbance to these sites*

As described in Section 7.5.1, Revision 4 of the CEMP (Section 4.17) specifies that construction activity is to be avoided within Important Wildlife Areas, including designated setback buffers determined by a QEP, where feasible.

Procedures for determining appropriate situation and species-specific disturbance setback buffers to be applied around locations where bird nests are likely to be present are discussed in Section 6.1.1 (migratory birds) and described in Appendix 1 (migratory birds, sharp-tailed grouse, bald eagle and other raptors).

7.6.3 Mitigation of adverse effects to wildlife and wildlife habitat

This section summarizes actions taken in accordance with the following requirement of Condition 15*: Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.*

Much mitigation of adverse effects to wildlife is discussed in Sections 7.6.1 and 7.6.2. Section 6.4.1.2 provides a summary of mitigation applied to minimize adverse impacts to amphibians. Revision 4 of the CEMP (Section 4.17) specifies that, where feasible, vegetation clearing will take place during Peace Region terrestrial wildlife least-risk windows. Least risk timing windows for wildlife are described in Table 5 of the CEMP.

Where clearing outside of least-risk timing windows cannot be avoided, pre-clearing surveys are conducted, with disturbance setback buffers determined by a QEP.

7.6.4 Protocol to ensure that lighting is focused on work sites

This section summarizes actions taken in accordance with the following requirement of Condition 15*: Protocol to ensure that lighting is focused on work sites and away from surrounding areas to manage light pollution and disturbance to wildlife. If lighting cannot be directed away from surrounding areas, the EAC Holder must ensure additional mitigation measures are implemented to reduce light pollution, including light shielding.*

Section 4.17 of Revision 4 of the CEMP requires contractors to focus lighting on work sites and away from surrounding areas to minimize light. CEMP requirements are audited by site Environmental Monitors and the Independent Environmental Monitor to determine and enforce compliance.

7.6.5 Environmental training of workers

This section summarizes actions taken in accordance with the following requirement of Condition 15*: A mandatory environmental training program for all workers so that they are informed that hunting in the vicinity of any work site/Project housing site is strictly prohibited for all workers. The EAC Holder must ensure that all workers are familiar with the Wildlife Management Plan.*

All workers are required to attend both a BCH orientation and a contractor specific orientation(s) prior to starting work on-site. A component of these training sessions is environmental training for workers. Completion of these sessions required prior to the issuance of site access cards.

7.7 EAC Condition 16

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 16.

For context, the complete requirements of Condition 16 are shown below.

EAC Condition 16

If loss of sensitive wildlife habitat or important wildlife areas cannot be avoided through Project design or otherwise mitigated, the EAC Holder must implement the following measures, which must be described in the Vegetation and Wildlife Mitigation and Monitoring Plan.

The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation measures:

- Compensation options for wetlands must include fish-free areas to manage the effects of fish predation on invertebrate and amphibian eggs and larvae and young birds.
- Mitigation for the loss of snake hibernacula, artificial dens must be included during habitat compensation.
- Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.
- Establishment of nest boxes for cavity-nesting waterfowl developed as part of wetland mitigation and compensation plan, and established within riparian vegetation zones established along the reservoir on BC Hydro-owned properties.
- A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into new bridge designs located within the Peace River valley.
- Following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats.
- Creation of natural or artificial piles of coarse woody debris dispersed throughout the disturbed landscape to maintain foraging areas and cold-weather rest sites, and arboreal resting sites, for the fisher population south of the Peace River.

The EAC Holder must provide this draft Vegetation and Wildlife Mitigation and Monitoring Plan to Environment Canada, FLNR, MOE, and Aboriginal Groups for review a minimum of 90 days prior to the commencement of construction.

The EAC Holder must file the final Vegetation and Wildlife Mitigation and Monitoring Plan with EAO, Environment Canada, FLNR MOE, and Aboriginal Groups, a minimum of 30 days prior to commencement of construction.

The EAC Holder must develop, implement and adhere to the final Vegetation and Wildlife Mitigation and Monitoring Plan, and any amendments, to the satisfaction of EAO.

7.7.1 Nest boxes for cavity-nesting waterfowl

In 2017, 269 nest boxes were constructed for cavity nesting bird species. Of these, 76 nest boxes were constructed for waterfowl; 9 for bufflehead, 49 for Barow’s goldeneye, common goldeneye or hooded merganser; and 18 for common merganser. Also in 2017, 96 nest boxes were installed on the north side of the Peace River on trees and structures on BC Hydro owned and managed lands, and private lands where permission was granted. Of those, 16 nest boxes were designed to be suitable for waterfowl; two for bufflehead, 10 for Barow’s goldeneye, common goldeneye or hooded merganser; and four for common merganser. No nest boxes were installed in 2018, as further implementation is being held until additional mitigation areas are identified.

7.7.2 A design for bat roosting habitat in HWY 29 bridges

This section summarizes actions taken in accordance with the following requirement of Condition 16: *A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into new bridge designs located within the Peace River valley.*

During baseline surveys bats were documented using the Farrell Creek, Halfway River and Cache Creek bridges as night roosts. These three (3) bridges and the bridge at Lynx Creek will be inundated by the reservoir. New bridges will be constructed at these locations.

BC Hydro had previously reached an agreement with the Ministry of Transportation and Infrastructure to install bat roost structures on newly constructed bridges along re-aligned sections of Highway 29 to offset the losses of night roosts on existing bridges. However, on 25 October 2018, BC Hydro received notification from Kathryn Graham, Regional Manager, Environmental Services, MOTI, that MOTI no longer supports the placement of bat roosting boxes on bridges. Therefore, the bat boxes cannot be integrated into the designs of any new bridges, including the planned Farrell Creek, Halfway River, Cache Creek and Lynx Creek bridges.

7.7.3 Creation of hibernating and roosting sites for bats

This section summarizes actions taken in accordance with the following requirement of Condition 16: *Following rock extraction at Portage Mountain, creation of hibernating and roosting sites for bats.*

To avoid destroying the hibernacula at Portage Mountain that are being used by little brown myotis and northern myotis, BC Hydro moved the quarry to the eastern edge of the License of Occupation area. This relocation achieved a 300 m no activity/no access buffer around the 16 documented hibernacula. This mitigation is described in detail in Appendix 8 of the 2016 Annual Report.

In February of 2016 the BC Ministry of Environment released Best Management Practices Guidelines for Bats in British Columbia “Bat BMPs”[6]. These guidelines recommend a 100 m buffer be established around the core area of bat habitat, which for Portage Mountain is defined as all the hibernacula entrances documented. Within this 100 m no activities that modify the above or below ground habitat are allowed. The guidelines also recommend a 1 km special management zone, within which blasting activities are permitted if the following can be achieved:

- No blasting to occur between October and May;
- Blasting must be conducted within the following parameters (to avoid damage to the rock structures associated with the hibernacula):
    - the sound concussion is less than 150 dB;
    - the shock wave is less than 15 p.s.i; and
    - the peak particle velocity is less than 15 mm/s.

[6] BC MoE. 2016. Best Management Practices Guidelines for Bats in British Columbia. Chapter 2: Mine Developments and Inactive Mine Habitats. 68 pp.

To avoid disturbance to hibernating bats, BC Hydro has also prohibited blasting at Portage Mountain between September 15 and May 15 (see Section 4.2 of the CEMP); this window was established based on data collected at the hibernacula in 2013 and in consultation with bat biologists (see the 2016 Annual Report).

For planned activities at Portage Mountain Quarry, noise modelling was conducted, from which it was determined that at 300m:

- the sound concussion would be 120 dB (below BMP limit of 150 dB);
- the shock wave would be 0.002 p.s.i (1 kPa) and (below BMP limit of 15 p.s.i (104 kPa); and
- the peak particle velocity would be 2.84 mm/s (below BMP limit of 15 mm/s).

As described in Section 6.4.3.3, BC Hydro evaluated the accuracy of noise predictions at the hibernacula by monitoring noise during test blasting at Portage Mountain Quarry in August of 2018. Also as described in Section 6.4.3.3, BC Hydro is conducting year round monitoring of bat use at Portage Mountain.

Through the broader Site C bat mitigation and monitoring program, BC Hydro is constructing and installing bat roosting boxes in suitable habitat near the future reservoir and dam site. In 2018, 60 bat roost boxes were constructed and installed.

7.7.4 Resting sites for fisher

This section summarizes actions taken in accordance with the following requirement of Condition 16: *Creation of natural or artificial piles of coarse woody debris dispersed throughout the disturbed landscape to maintain foraging areas and cold-weather rest sites, and arboreal resting sites, for the fisher population south of the Peace River.*

Twenty-five (25) coarse woody debris (CWD) piles for fisher were created within the dam site area in 2016. An additional 31 CWD piles were created for fisher along the transmission line in 2018. Signs were also installed at existing CWD piles indicating that they were designated fisher habitat to prevent their inadvertent disturbance by construction activities.

In addition to CWD piles, BC Hydro is also constructing and installing fisher den boxes to help mitigate the loss of denning habitat due to reservoir clearing. In 2018, BC Hydro installed 10 den boxes on the south side of the Peace River near the Moberly River.

7.8 EAC Condition 19

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 19.

For context, the complete requirements of Condition 19 are shown below.

EAC Condition 19
The EAC Holder must use reasonable efforts to avoid and reduce injury and mortality to amphibians and snakes on roads adjacent to wetlands and other areas where amphibians or snakes are known to

migrate across roads including locations with structures designed for wildlife passage

The EAC Holder must consult with Environment Canada, FLNR and MOE with regard to the size and number of the proposed structures prior to construction.

Appropriate amphibian mitigation is monitored by BC Hydro site Environmental Monitors and the Independent Environmental Monitor against commitments within EPPs to determine and enforce compliance. Amphibian mitigation activities are summarized in Section 6.4.1.2.

Work sites are being regularly monitored during the spring and summer for western toad migration and dispersal, as per the Western Toad Management Procedure. Western toad movement patterns have not yet resulted in mass movements across access roads such that specific structures designed for amphibian passage have been required.

7.9 EAC Condition 21

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 21.

For context, the complete requirements of Condition 21 are shown below.

EAC Condition 21

The EAC Holder must ensure that measures implemented to manage harmful Project effects on wildlife resources are effective by implementing monitoring measures detailed in a Vegetation and Wildlife Mitigation and Monitoring Plan. The Vegetation and Wildlife Mitigation and Monitoring Plan must be developed by a QEP.

The Vegetation and Wildlife Mitigation and Monitoring Plan must include at least the following:

- Monitor Bald Eagle nesting populations adjacent to the reservoir, including their use of artificial nest structures.
- Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.
- Monitor amphibian use of migration crossing structures installed along Project roads.
- Survey songbird and ground-nesting raptor populations during construction and operations.
- Survey the distribution of western toad and garter snake populations downstream of the Site C dam to the Pine River.
- Require annual reporting during the construction phase and during the first 10 years of operations to EAO, beginning 180 days following commencement of construction.

The EAC Holder must provide this draft Vegetation and Wildlife Mitigation and Monitoring Plan to FLNR, MOE, Environment Canada and Aboriginal Groups for review a minimum of 90 days prior to the commencement of construction.

The EAC Holder must file the final Vegetation and Wildlife Mitigation and Monitoring Plan must with EAO, FLNR, MOE, Environment Canada and Aboriginal Groups a minimum 30 days prior to the commencement of construction.

The EAC Holder must develop, implement and adhere to the final Vegetation and Wildlife Mitigation and Monitoring Plan, and any amendments, to the satisfaction of EAO.

7.9.1 Monitoring of Bald Eagle nesting populations

Known bald eagle nest locations along the Peace River and at natural wetlands adjacent to the Site C transmission line right-of-way were surveyed by helicopter over three days in May and June 2018. In 2018, 48 bald eagle nests were surveyed and 44 were observed. Of the 44 nests observed, seven bald eagle nests were newly identified in 2018; six were identified as bald eagle nests during the surveys and one was reported as a bald eagle nest by a third party. A summary of the methods and results of bald eagle nest monitoring in 2018 is presented in Appendix 10.

7.9.2 Monitoring waterfowl and shorebird populations

This section summarizes actions taken in accordance with the following requirement of Condition 21: *Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.*

A summary of the waterbird survey program for 2018 is presented in Section 6.1.3.4 and Appendix 3.

7.9.3 Survey songbird and ground-nesting raptor populations during construction and operations

This section summarizes actions taken in accordance with the following requirement of Condition 21: *Survey songbird and ground-nesting raptor populations during construction and operations.*

7.9.3.1 Songbirds

A summary of the songbird monitoring program for 2018 is presented in Section 6.1.3.1 and Appendix 2.

7.9.3.2 Ground nesting raptors

Ground nesting raptor surveys in 2018 were conducted at two cleared portions of the Site C reservoir along the Peace River and Highway 29 (Bear Flats area). Ground nesting raptor surveys were completed three times over May and June 2018 through stationary standwatches. No ground nesting raptors or their nests were observed at any of the cleared portions of the footprint along the Peace River or Highway 29. The ground nesting raptor monitoring 2018 annual report can be found in Appendix 11.

7.9.4 Annual reporting beginning 180 days following commencement of construction

This section summarizes actions taken in accordance with the following requirement of

Condition 21: *Require annual reporting during the construction phase and during the first 10 years of operations to EAO, beginning 180 days following commencement of construction.*

Submission of this report satisfies the requirement this portion of Condition 21 for 2018 during the construction phase of the Site C Clean Energy Project.

7.10 Status of listed species

This section of the annual report summarizes the programs implemented in 2018 in accordance with the requirements of Condition 23. For context, the complete requirements of Condition 23 are shown below.

EAC Condition 23
The EAC Holder must maintain current knowledge of Project effects on the status of listed species by tracking updates for species identified by the Province, the Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act. Should the status of a listed species change for the worse during the course of the construction of the Project due to Project activities, the EAC Holder, must work with Environment Canada FLNR and MOE to determine if any changes to the associated management plans or monitoring programs are required to mitigate effects of the Project on affected listed species.

7.10.1 Rare Plants

Please see Section 6.4.4.1 for a summary of ranking changes to rare plants

7.10.2 Wildlife

Please see Section 6.4.4.2 for a summary of ranking changes to wildlife.

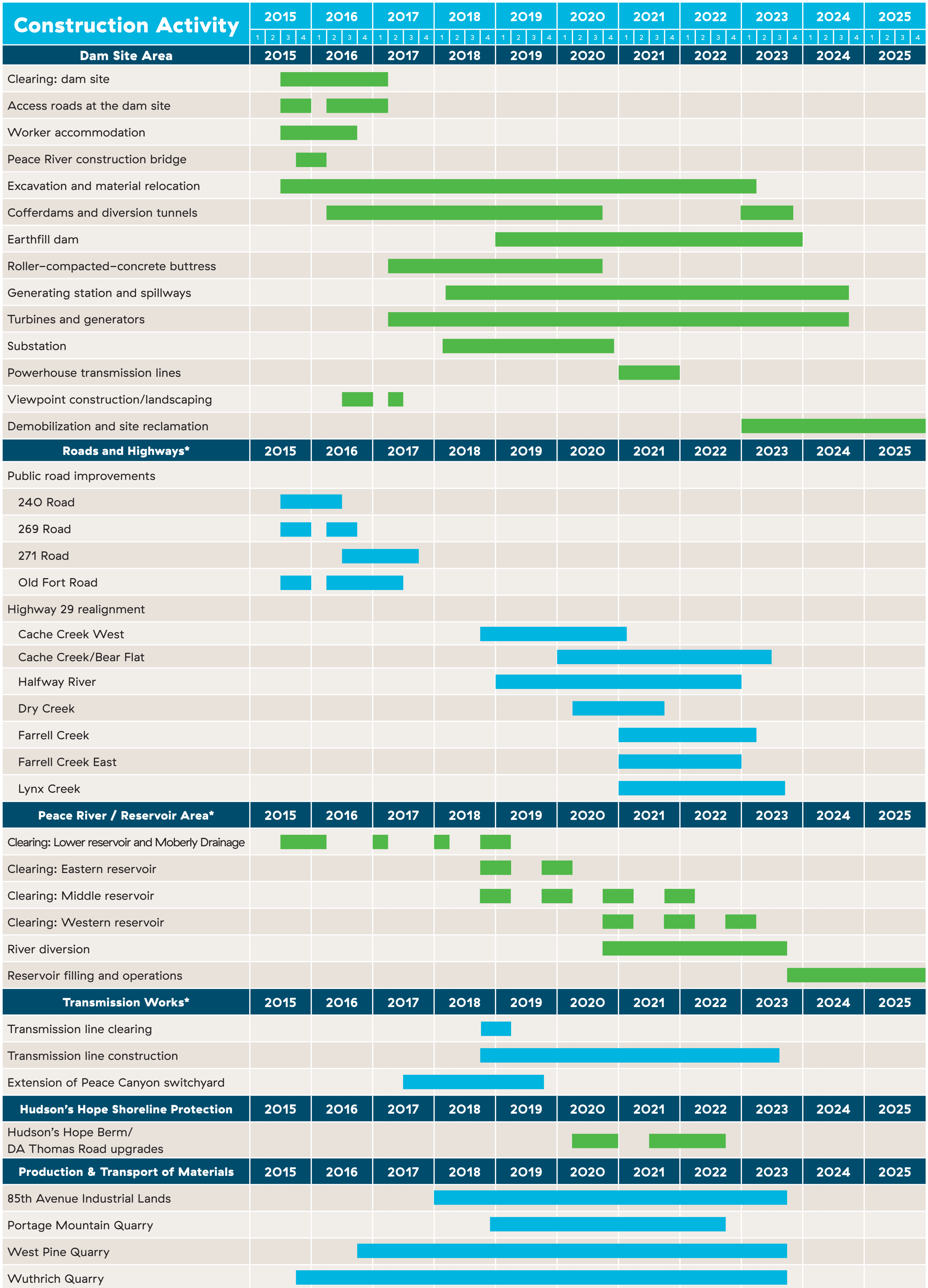
Appendices

Appendix 1. Site C Clean Energy Project Construction Schedule

Site C Construction Schedule

October 2018

BCH18-1060



The construction schedule is indicative only and subject to change. The purpose of the schedule is to illustrate the general sequence of construction activities, but the dates and schedule may change.

* Timelines do not include site preparation or wood disposal.

BC Hydro
Power smart

Appendix 2. Breeding Bird Follow-up Monitoring – Songbirds 2018 Annual Report

Site C Clean Energy Project
Breeding Bird Follow-up Monitoring - Songbirds
2018 Annual Report

PRESENTED TO
BC Hydro and Power Authority

MARCH 22, 2019
ISSUED FOR USE
FILE: 704-ENV.VENV03095-01.SONG-2018

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Site C Clean Energy Project Breeding Bird Follow-Up Monitoring - Songbirds 2018 Annual Report

FILE: 704-ENV.VENV03095-01.SONG-2018
March 22, 2019

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EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed breeding bird point count surveys in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program. The breeding birds monitoring program is focussed on passerines (songbird perching birds), hummingbirds, swifts, doves, kingfisher, and pigeons (all members of the orders *Passeriformes*, *Apodiformes*, *Columbiformes*, and *Coraciiformes*), which are collectively referred to as songbirds. Songbird baseline surveys were conducted in 2006, 2008, 2011 and 2012. Surveys were again conducted in 2016, 2017, and 2018 as part of the monitoring program. This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

Surveys were conducted June 1 to June 29, 2018 at 115 stations in and around the project footprint. Each station was surveyed two times in order to maximize the detection of early and late breeders. Birds were surveyed using unlimited radius point counts. The geographic focus of surveys in 2018 was the reservoir from east of Hudson's Hope to the Halfway River. Surveys were also conducted in select locations downstream of the dam to the Pine River and in the Cache Creek area.

A total of 1,847 songbirds of 64 songbird species were recorded during the point count surveys in 2018. Five species listed under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the *Species at Risk Act* (SARA) and/or British Columbia's Red and Blue lists were observed during the surveys.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed breeding bird point count surveys in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program (Volume 2, Section 14 in BC Hydro 2013). This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

The breeding birds monitoring program is focussed on passerines (songbird perching birds), hummingbirds, swifts, doves, kingfisher, and pigeons (all members of the orders *Passeriformes*, *Apodiformes*, *Columbiformes*, and *Coraciiformes*), which are collectively referred to as songbirds. Songbird baseline surveys were conducted in 2006, 2008, 2011 and 2012. Surveys were again conducted in 2016, 2017, and 2018 as part of the monitoring program.

2.0 METHODS

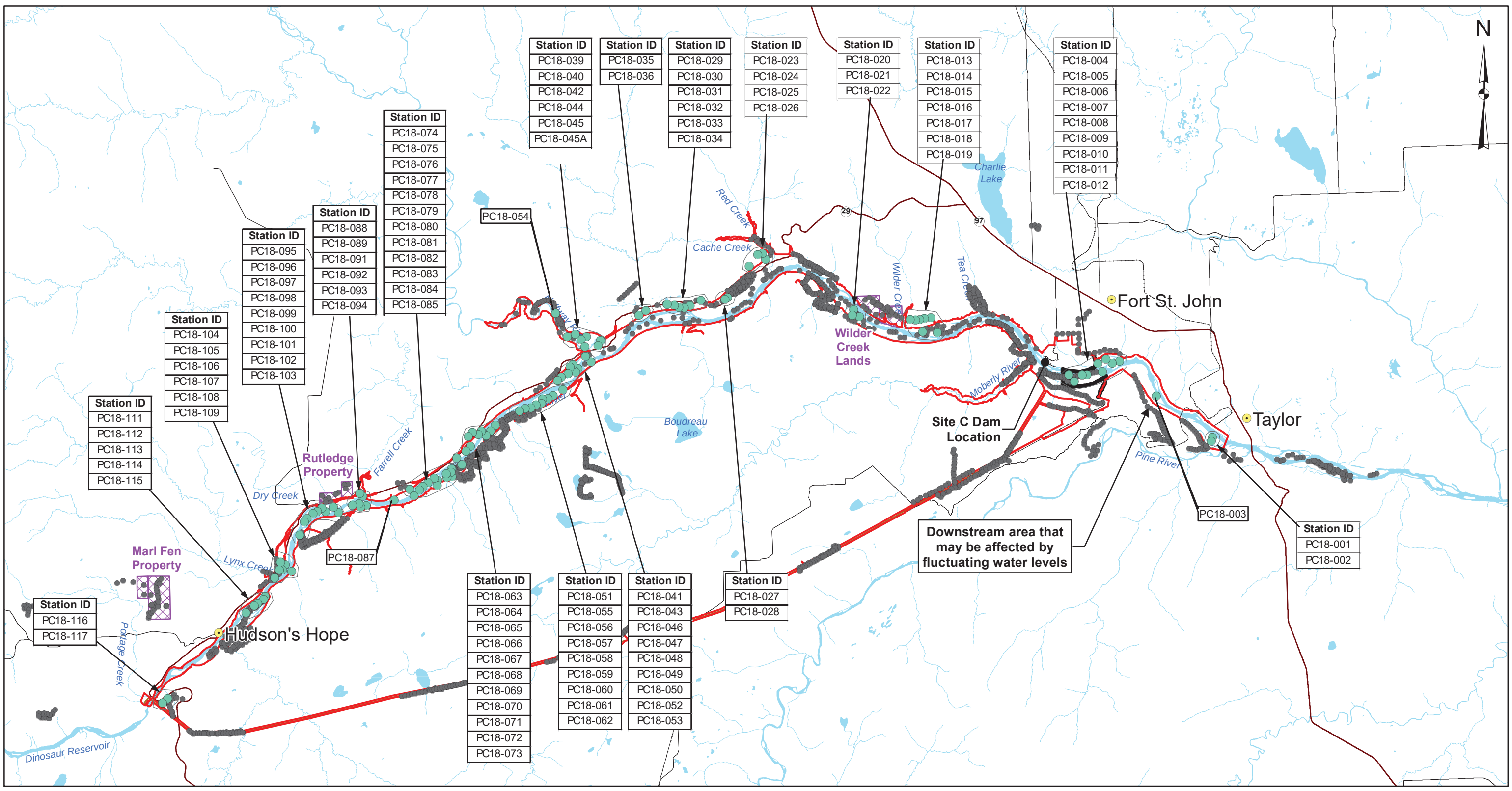
2.1 Survey Area

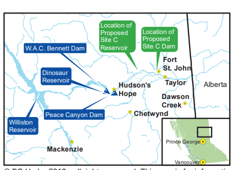
Songbird surveys were conducted in and around the project footprint and in the BC Hydro proposed mitigation properties (Figure 1). The footprint is primarily composed of the dam, generating station and spillways, reservoir, transmission line and construction access roads. Songbird monitoring is also occurring in areas along the Peace River between the dam and the confluence with the Pine River that could be affected by fluctuating water levels.

2.2 Survey Station Locations

Station locations were selected based on areas and habitats in and around the footprint that had not received sampling in the past, habitat for rare species, and habitats likely to have high bird abundance and species richness. Terrestrial Ecosystem Mapping (TEM) developed for the EIS (Hilton et al., 2013) was used as the habitat base map. To identify habitats for priority sampling, the number of past surveys were tallied by ecosystem unit (i.e., a combination of site series and structural stage) to determine those units with few or no past surveys.

The geographic focus of surveys in 2018 was the reservoir from east of Hudson's Hope to the Halfway River. Surveys were also conducted in select locations downstream of the dam to the Pine River and in the Cache Creek area. Station coordinates, dates of visits and ecosystem units are listed in Appendix A. Station locations are shown in Figure 1.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.
5. Figure prepared by Tetra Tech Canada.

Legend

- Songbird Survey Location
- 2006-2017 Songbird Survey Location
- Songbird Monitoring Study Area
- Potential Mitigation Property
- Proposed Transmission Corridor
- Highway
- Other Road
- Railway
- Provincial Boundary

1:275,000

0 10 km

BC Hydro TETRA TECH

Breeding Bird Follow-up Monitoring - Songbirds

Figure 1:
Locations of Songbird Surveys in 2018

Date	November 21, 2018	DWG NO	1016-C14-08895-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: W:\Projects\VAN\14942\VENV03095-01\GIS\Maps\2018\BreedingBird_2018\BB_Songbirds_1016_C14_08895-1_R0.mxd

2.3 Bird Surveys

Birds were surveyed using point count methods consistent with those used in past surveys and with those recommended by the Resources Information Standards Committee (RISC 1999). However, beginning in 2017 the precise survey protocol was modified in two ways. The 2017 and 2018 point count surveys were conducted as unlimited radius point counts (instead of the 100m fixed-radius conducted previously) with distance-to-detection intervals set at 0-50 m, 51-100 m and >100 m. The unlimited radius distance allows for greater potential for species detection during surveys. The detection distance intervals have two benefits: 1) allow for comparison to the baseline 100 m fixed-radius point count data and 2) allow for distance-based estimates of absolute abundance if that analytical approach is utilized in the future. Second, each point-count survey was conducted over ten minutes (instead of the 5-minute survey period conducted previously) and bird detections were recorded in three intervals: 0-3 minutes, 3-5 minutes and 5-10 minutes. The longer survey period allows for more numerous bird detections. The three time intervals allow for comparison to the 5-minute point count baseline data and allows for time-of-detection estimates of absolute abundance if that analytical approach is utilized in the future.

Point counts were conducted June 1 to June 29. Point counts took place from sunrise to approximately four hours after sunrise. At each station, the surveyor waited one minute upon arriving, then commenced the 10-minute survey period and recorded all birds seen and/or heard. Data were recorded on a standardized data form.

Each station was surveyed (visited) two times in order to maximize the detection of early and late breeders. The results of the visits at each station were pooled using maximum detection (i.e., the largest number of each species found over both surveys at the station). This approach assumes that repeat observations of a species after the first visit are the same individuals, plus new individuals if a greater number is detected.

Incidental observations were recorded when non-songbird species were observed during surveys, or when any bird species were observed outside of survey stations (e.g. when surveyors were traveling between stations) or survey periods (e.g. before or after daily observations have started/finished). For each incidental observation of a rare species, date, time, GPS location, gender, behavior and habitat was recorded. Observations of birds other than songbirds will be collected in a database to contribute to other mitigation and monitoring plans, such as the ground-nesting raptor, woodpecker, Common Nighthawk, waterbird and cavity-nesting species plans.

2.4 Collection of Habitat Data

Habitat data were collected at 114 of the 115 stations. One of the stations could not be revisited to collect habitat data due to changing water levels that prohibited boat access. Habitat data for this station will be collected in 2019, if accessible. Data were recorded using the Ministry of Forests and Range's Site Visit (SIVI) Form and included all plot fields, the site features field, the stand attributes field, and a partial vegetation list (Appendix A)[1]. Soil attribute data were not collected. Data on dead standing trees were recorded. The number of dead standing trees >15 cm diameter at breast height were recorded within a 11.3 m radius of the plot centre according to the decay class. In addition, the number of dead standing trees >15 cm diameter at breast height within 50 m of plot centre of any decay class were estimated. Classification of each station was completed according to the TEM units defined in the EIS (Hilton *et al.*, 2013a).

[1] Starting in 2018, the BC Ministry of Forests and Range and BC Ministry of Environment's Site Visit form (SIVI, FS1333) will be used for habitat data collection in place of the Ground Inspection Form used in 2017. The same data will be collected.

3.0 RESULTS AND DISCUSSION

The number of stations surveyed in each ecosystem unit (Map Code/Site Series and Structural Stage) is provided in Table 1.

Table 1: Number of Songbird Point Count Stations Surveyed in Each Ecosystem Unit

Bird Habitat Category	Map Code	Ecosystem Name	Herbaceous	Shrub	Pole/sapling	Young forest	Mature forest	Old forest	Total
Cultivated field	CF	Cultivated Field	1	-	-	-	-	-	**1**
Coniferous-mature forest	AM	SwAt – Step moss	-	-	-	-	1	2	**3**
	SH	Sw – Currant – Horsetail	-	-	-	-	8	2	**10**
	SO	Sw – Currant – Oak fern	-	-	-	-	2	1	**3**
Coniferous-young forest	AM	SwAt – Step moss	-	-	-	7	-	-	**7**
	LL	Pl – Lingonberry – Velvet-leaved blueberry	-	-	-	2	-	-	**2**
	SH	Sw – Currant – Horsetail	-	-	-	3	-	-	**3**
	SO	Sw – Currant – Oak fern	-	-	-	1	-	-	**1**
Coniferous-shrub	LL	Pl – Lingonberry – Velvet-leaved blueberry	-	1	-	-	-	-	**1**
	SO	Sw – Currant – Oak fern	-	2	-	-	-	-	**2**
Deciduous-mature forest	AM:ap	$At – Creamy peavine	-	-	-	-	7	-	**7**
	SC:ab	$At – Black Twinberry	-	-	-	-	1	-	**1**
	SH:ac	$Ac – Cow parsnip	-	-	-	-	6	1	**7**
	SW:as	$At – Soopolallie	-	-	-	-	1	-	**1**
Deciduous-young forest	AM:ap	$At – Creamy peavine	-	-	-	8	-	-	**8**
	SH:ac	$Ac – Cow parsnip	-	-	2	1	-	-	**3**
	SW:as	$At – Soopolallie	-	-	1	3	-	-	**4**
Deciduous-shrub	AM:ap	$At – Creamy peavine	-	3	-	-	-	-	**3**
	AS	SwAt – Soopolallie	-	7	-	-	-	-	**7**
	LL:ak	$At – Kinnikinnick	-	2	-	-	-	-	**2**
	SH:ac	$Ac – Cow parsnip	-	1	-	-	-	-	**1**
Riparian-mixed mature forest	Fm02	ActSw – Red-osier dogwood	-	-	-	-	12	2	**14**
Riparian-mixed young forest	Fm02	ActSw – Red-osier dogwood	-	-	1	1	-	-	**2**
Riparian-mixed shrub	Fm02	ActSw – Red-osier dogwood	-	4	-	-	-	-	**4**
Wetland-riparian	WH	Willow – Horsetail – Sedge – Riparian Wetland	2	12	-	-	-	-	**14**
Wetland-willow	WW	Willow – Sedge – Wetland	4	-	-	-	-	-	**4**
		Total	**7**	**32**	**4**	**26**	**38**	**8**	**115**

A total of 1,847 songbirds of 64 songbird species were recorded during the point count surveys in 2018 (Table 2). Five species listed under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the *Species at Risk Act* (SARA) and/or British Columbia's Red and Blue lists were observed during the surveys (Table 2). The songbird species observed are provided in Table 3. Other bird species were recorded as incidental observations and are provided in Appendix C. Birds observed before or after 10-minute point-count surveys were recorded as incidentals in Appendix C as well.

Table 2: Point Count Survey Summary for 2018

Metric	Result
Number of survey stations	115
Number of point counts	226
Number of bird species detected	86
Number of songbird species detected	64
Number of rare songbird species detected	5
Number of songbirds detected (based on maximum count over the two surveys at each station)	1847
Mean songbird species per station (standard deviation in parentheses)	11.5 (3.2)
Mean songbird max count per station (standard deviation in parentheses)	16.2 (4.6)

Table 3: Songbird Species Observed During the 2018 Point Count Surveys

Common Name	Scientific Name	BC List	COSEWIC	SARA	Total Detections[1]	Total Maximum Count[2]
Rufous Hummingbird	*Selasphorus rufus*	Yellow	-	-	**1**	**1**
Belted Kingfisher	*Megaceryle alcyon*	Yellow	-	-	**1**	**1**
Olive-sided Flycatcher	*Contopus cooperi*	Blue	Threatened	Schedule 1 Threatened	**2**	**2**
Western Wood-Pewee	*Contopus sordidulus*	Yellow	-	-	**26**	**20**
Alder Flycatcher	*Empidonax alnorum*	Yellow	-	-	**44**	**32**
Least Flycatcher	*Empidonax minimus*	Yellow	-	-	**106**	**75**
Dusky Flycatcher	*Empidonax oberholseri*	Yellow	-	-	**5**	**5**
Pacific-slope Flycatcher	*Empidonax difficilis*	Yellow	-	-	**7**	**6**
Eastern Phoebe	*Sayornis phoebe*	Yellow	-	-	**1**	**1**
Blue-headed Vireo	*Vireo solitarius*	Yellow	-	-	**11**	**11**
Warbling Vireo	*Vireo gilvus*	Yellow	-	-	**20**	**20**
Red-eyed Vireo	*Vireo olivaceus*	Yellow	-	-	**268**	**186**
Gray Jay	*Perisoreus canadensis*	Yellow	-	-	**7**	**7**
Blue Jay	*Cyanocitta cristata*	Yellow	-	-	**6**	**6**
Black-billed Magpie	*Pica hudsonia*	Yellow	-	-	**28**	**27**
American Crow	*Corvus brachyrhynchos*	Yellow	-	-	**31**	**29**
Common Raven	*Corvus corax*	Yellow	-	-	**104**	**89**
Black-capped Chickadee	*Poecile atricapillus*	Yellow	-	-	**7**	**7**
Boreal Chickadee	*Poecile hudsonicus*	Yellow	-	-	**4**	**4**
Red-breasted Nuthatch	*Sitta canadensis*	Yellow	-	-	**23**	**20**
Brown Creeper	*Certhia americana*	Yellow	-	-	**2**	**2**
House Wren	*Troglodytes aedon*	Yellow	-	-	**22**	**21**

Table 3: Songbird Species Observed During the 2018 Point Count Surveys

Common Name	Scientific Name	BC List	COSEWIC	SARA	Total Detections[1]	Total Maximum Count[2]
Golden-crowned Kinglet	*Regulus satrapa*	Yellow	-	-	**11**	**10**
Ruby-crowned Kinglet	*Regulus calendula*	Yellow	-	-	**20**	**15**
Swainson's Thrush	*Catharus ustulatus*	Yellow	-	-	**138**	**97**
Hermit Thrush	*Catharus guttatus*	Yellow	-	-	**67**	**53**
American Robin	*Turdus migratorius*	Yellow	-	-	**89**	**74**
Varied Thrush	*Ixoreus naevius*	Yellow	-	-	**1**	**1**
Gray Catbird	*Dumetella carolinensis*	Yellow	-	-	**8**	**8**
Cedar Waxwing	*Bombycilla cedrorum*	Yellow	-	-	**36**	**30**
Purple Finch	*Haemorhous purpureus*	Yellow	-	-	**6**	**5**
White-winged Crossbill	*Loxia leucoptera*	Yellow	-	-	**40**	**39**
Pine Siskin	*Spinus pinus*	Yellow	-	-	**6**	**6**
Evening Grosbeak	*Coccothraustes vespertinus*	Yellow	-	-	**3**	**3**
Ovenbird	*Seiurus aurocapilla*	Yellow	-	-	**131**	**86**
Northern Waterthrush	*Parkesia noveboracensis*	Yellow	-	-	**5**	**5**
Black-and-white Warbler	*Mniotilta varia*	Yellow	-	-	**11**	**11**
Tennessee Warbler	*Oreothlypis peregrina*	Yellow	-	-	**4**	**4**
Orange-crowned Warbler	*Oreothlypis celata*	Yellow	-	-	**21**	**19**
MacGillivray's Warbler	*Geothlypis tolmiei*	Yellow	-	-	**1**	**1**
Mourning Warbler	*Geothlypis philadelphia*	Yellow	-	-	**6**	**5**
Common Yellowthroat	*Geothlypis trichas*	Yellow	-	-	**18**	**14**
American Redstart	*Setophaga ruticilla*	Yellow	-	-	**117**	**93**
Magnolia Warbler	*Setophaga magnolia*	Yellow	-	-	**29**	**26**
Bay-breasted Warbler	*Setophaga castanea*	Red	-	-	**3**	**3**
Yellow Warbler	*Setophaga petechia*	Yellow	-	-	**136**	**105**
Yellow-rumped Warbler	*Setophaga coronata*	Yellow	-	-	**96**	**73**
Black-throated Green Warbler	*Setophaga virens*	Blue	-	-	**14**	**10**
Canada Warbler	*Cardellina canadensis*	Blue	Threatened	Schedule 1 Threatened	**5**	**5**
Wilson's Warbler	*Cardellina pusilla*	Yellow	-	-	**11**	**11**
Chipping Sparrow	*Spizella passerina*	Yellow	-	-	**64**	**50**
Clay-colored Sparrow	*Spizella pallida*	Yellow	-	-	**50**	**34**
Vesper Sparrow	*Pooecetes gramineus*	Yellow	-	-	**12**	**10**
Savannah Sparrow	*Passerculus sandwichensis*	Yellow	-	-	**2**	**1**
Fox Sparrow	*Passerella iliaca*	Yellow	-	-	**4**	**3**
Song Sparrow	*Melospiza melodia*	Yellow	-	-	**45**	**33**
Lincoln's Sparrow	*Melospiza lincolnii*	Yellow	-	-	**25**	**19**
Swamp Sparrow	*Melospiza georgiana*	Yellow	-	-	**7**	**5**
White-throated Sparrow	*Zonotrichia albicollis*	Yellow	-	-	**244**	**156**
Dark-eyed Junco	*Junco hyemalis*	Yellow	-	-	**36**	**32**
Western Tanager	*Piranga ludoviciana*	Yellow	-	-	**83**	**64**
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Yellow	-	-	**35**	**32**

Table 3: Songbird Species Observed During the 2018 Point Count Surveys

Common Name	Scientific Name	BC List	COSEWIC	SARA	Total Detections[1]	Total Maximum Count[2]
Red-winged Blackbird	*Agelaius phoeniceus*	Yellow	-	-	**16**	**10**
Brewer's Blackbird	*Euphagus cyanocephalus*	Yellow	-	-	**1**	**1**
Brown-headed Cowbird	*Molothrus ater*	Yellow	-	-	**9**	**9**
Baltimore Oriole	*Icterus galbula*	Blue	-	-	**1**	**1**
Unknown Passerine Species	-	-	-	-	**2**	**2**
Unknown Warbler Species	-	-	-	-	**1**	**1**
				Total	**2,396**	**1,847**

[1] The total number of detections over both surveys at all stations.

[2] The greater number of each species found over both surveys at a station, totaled over all stations.

4.0 REFERENCES

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Assessment. Volume 2 – Assessment Methodology and Environmental Effects Assessment.

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

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British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment. 2010. Field manual for describing terrestrial ecosystems. 2nd ed. BCMFR Research Branch and BCMOE Resource Inventory Branch, Victoria, B.C. (Reprint with updates 2015).

Resources Inventory Committee. 1999. Inventory Methods for Forest and Grassland Songbirds. Version 2.0. Standards for Components of British Columbia’s Biodiversity No. 15. BC Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria, BC.

APPENDIX A
SITE VISIT FORM USED TO COLLECT HABITAT DATA

British Columbia
The Best Place on Earth
Ministry of Forests and Range

SITE VISIT FORM

PROJECT ID

Plot No.	**Plot Type**	Grnd ☐	Visual ☐	Note ☐	Other ☐	Date YY - MM - DD
Surveyors		Map Polygon No.				Plot Photo

Plot Location

FS Region/ District	East	North	UTM Zone
NTS Map.	Lat.	Long.	Accur. (+/- m)

Plot Representing

BGC	SS	SMR	SNR	Map Label

Site Features	Elevation	Slope %	Aspect	Surface Shape ST ☐ CC ☐ CV ☐

Crest ☐	Upper ☐	Mid ☐	Lower ☐	Toe ☐	Level ☐	Dep. ☐	Gully ☐	Flood Plain? ☐

Expose. Type ☐ insolation ☐ wind ☐ snow ☐ water spray ☐ misc.
☐ n/a ☐ frost ☐ cold air ☐ salt spray ☐ air toxicity ______________

Site Disturb. ☐ fire ☐ site prep. ☐ terrain ☐ soil dist. ______________
☐ n/a ☐ harvest ☐ planted ☐ biotic ☐ other ______________

Stand Attributes	Stand Age ________ Est. ☐ Mea. ☐	Stand Ht. ________ Est. ☐ Mea. ☐	Canopy Composition

Struct. Stage	1a ☐	1b ☐	2a ☐	2b ☐	2c ☐	2d ☐	3a ☐	3b ☐	4 ☐	5 ☐	6 ☐	7a ☐	7b ☐

Success Status	NV ☐	PS ☐	YS ☐	MS ☐	OS ☐	YC ☐	MC ☐	OC ☐	DC ☐

Terrain	Texture	Surficial Material	S. Expression	Geo. Process	Rock Types
1					1
2					2

Rooting Zone	Drainage	☐ X	☐ R	☐ W	☐ M	☐ I	☐ P	☐ V

Humus/Organic Form ☐ Mor ☐ Moder ☐ Mull ☐ Fibric ☐ Mesic ☐ Humic

Humus Thickness ________ cm	Ah? ☐ Ae? ☐ ________ cm	Estimated Soil Depth ________ cm
R.Z. Soil Texture ________	R.Z.Coarse Fragment % ________	Estimated Rooting Depth ________ cm
Gleying or Mottling ☐ n/a ________ cm	Seepage ☐ n/a ________ cm	Restrict.Layer ☐ n/a ________ cm

Restrict. Type ☐ **C**ement ☐ **P**an ☐ **K**ompact ☐ **L**ithic ☐ **W**ater ☐ **X** Chem. ☐ **Z** Permafrost

SPP. LIST	COMP. ☐ PART. ☐	% COVER BY LAYER	TREE (A)	SHRUB (B)	HERB (C)	MOSS / LICHEN (D)	Associated Full Cruise Card ? ☐ No ☐ Yes

COL.	TREES & SHRUBS	A1	A2	A3	A	B1	B2	B	COL.	HERB LAYER (C)	%

COL.	MOSS / LICHEN / SEEDLING (D)	%

Notes/Diagram

Tree Mensuration

SPP.	dbh	Ht.	BH Age	Path. Y/N	Notes

FS 1333 HRE 2010/03

APPENDIX B
2018 POINT COUNT STATIONS

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–001	Peace River	10V, 641736, 6224602	8-Jun-18	21-Jun-18	Fm02	09	5	Balsam poplar/white spruce – Red-osier dogwood (Young forest)
PC18–002	Peace River	10V, 641639, 6224309	8-Jun-18	21-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–003	Peace River	10V, 637580, 6227667	8-Jun-18	21-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–004	Peace River	10V, 634857, 6230209	8-Jun-18	21-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–005	Peace River	10V, 634316, 6230071	8-Jun-18	21-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–006	Peace River	10V, 633838, 6230382	8-Jun-18	21-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–007	Peace River	10V, 633602, 6229458	8-Jun-18	21-Jun-18	Fm02	09	3	Balsam poplar/white spruce – Red-osier dogwood (Shrub)
PC18–008	Peace River	10V, 633235, 6230059	8-Jun-18	21-Jun-18	WH	00	2	Willow – Horsetail – Sedge – Riparian Wetland (Herbaceous)
PC18–009	Peace River	10V, 632443, 6229247	8-Jun-18	21-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–010	Peace River	10V, 632072, 6229213	8-Jun-18	21-Jun-18	Fm02	09	3	Balsam poplar/white spruce – Red-osier dogwood (Shrub)
PC18–011	Peace River	10V, 631488, 6228735	8-Jun-18	21-Jun-18	AM	01	7	White spruce/trembling aspen – Step moss (Old forest)
PC18–012	Peace River	10V, 631099, 6229226	8-Jun-18	21-Jun-18	SH	07	7	White Spruce – Currant – Horsetail (Old forest)
PC18–013	Peace River	10V, 621366, 6232348	9-Jun-18	28-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–014	Peace River	10V, 620869, 6233454	5-Jun-18	18-Jun-18	WW	00	2	Fuzzy–spiked Wildrye – Wolf–willow (Herbaceous)
PC18–015	Peace River	10V, 620389, 6233405	5-Jun-18	18-Jun-18	WW	00	2	Fuzzy–spiked Wildrye – Wolf–willow (Herbaceous)
PC18–016	Peace River	10V, 620271, 6232422	10-Jun-18	28-Jun-18	Fm02	09	3	Balsam poplar/white spruce – Red-osier dogwood (Shrub)
PC18–017	Peace River	10V, 620050, 6223306	5-Jun-18	18-Jun-18	AS	00	3	White spruce/trembling aspen – Soopolallie (Shrub)
PC18–018	Peace River	10V, 619745, 6233286	5-Jun-18	18-Jun-18	AS	00	4	White spruce/trembling aspen – Soopolallie (Pole/Sapling)
PC18–019	Peace River	10V, 619336, 6233333	5-Jun-18	18-Jun-18	WW	00	2	Fuzzy–spiked Wildrye – Wolf–willow (Herbaceous)

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–020	Peace River	10V, 615585, 6233526	10-Jun-18	29-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–021	Peace River	10V, 615145, 6234065	10-Jun-18	29-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–022	Peace River	10V, 615060, 6233634	10-Jun-18	29-Jun-18	SH:ac	$07	7	Balsam poplar – Cow parsnip (Old forest)
PC18–023	Cache Creek	10V, 608639, 6237777	6-Jun-18	18-Jun-18	LL	02	5	Lodgepole pine – Lingonberry – Velvet-leaved blueberry (Young forest)
PC18–024	Cache Creek	10V, 608388, 6238236	6-Jun-18	18-Jun-18	LL	02	5	Lodgepole pine – Lingonberry – Velvet-leaved blueberry (Young forest)
PC18–025	Cache Creek	10V, 608058, 6238140	6-Jun-18	18-Jun-18	LL	02	3	Lodgepole pine – Lingonberry – Velvet-leaved blueberry (Shrub forest)
PC18–026	Cache Creek	10V, 607416, 6237266	6-Jun-18	18-Jun-18	SW:as	$03	5	Trembling aspen – Soopallalie (Young forest)
PC18–027	Watson's Slough	10V, 605811, 6234955	5-Jun-18	19-Jun-18	SH	07	5	White Spruce – Currant – Horsetail (Young forest)
PC18–028	Watson's Slough	10V, 605636, 6234839	5-Jun-18	19-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–029	Highway 29	10V, 603837, 6234750	5-Jun-18	19-Jun-18	AS	00	3	White spruce/trembling aspen – Soopolallie (Shrub)
PC18–030	Highway 29	10V, 603047, 6234343	5-Jun-18	19-Jun-18	WW	00	2	Fuzzy–spiked Wildrye – Wolf–willow (Herbaceous)
PC18–031	Highway 29	10V, 602606, 6234195	5-Jun-18	19-Jun-18	AS	00	4	White spruce/trembling aspen – Soopolallie (Pole/Sapling)
PC18–032	Highway 29	10V, 602191, 6234235	5-Jun-18	19-Jun-18	SW:as	$03	5	Trembling aspen – Soopallalie (Young forest)
PC18–033	Highway 29	10V, 601873, 6234393	5-Jun-18	19-Jun-18	SW:as	$03	4	Trembling aspen – Soopallalie (Pole/Sapling)
PC18–034	Highway 29	10V, 601330, 6234433	5-Jun-18	19-Jun-18	SW:as	$03	5	Trembling aspen – Soopallalie (Young forest)
PC18–035	Highway 29	10V, 599755, 6233984	6-Jun-18	19-Jun-18	AS	00	3	White spruce/trembling aspen – Soopolallie (Shrub)
PC18–036	Highway 29	10V, 599236, 6233634	6-Jun-18	23-Jun-18	AS	00	3	White spruce/trembling aspen – Soopolallie (Shrub)
PC18–039	Halfway River	10V, 596396, 6231752	7-Jun-18	20-Jun-18	Fm02	09	4	Balsam poplar/white spruce – Red-osier dogwood (Pole/Sapling)
PC18–040	Halfway River	10V, 596215, 6231397	7-Jun-18	20-Jun-18	AS	00	3	White spruce/trembling aspen – Soopolallie (Shrub)
PC18–041	Peace River	10V, 595694, 6230172	1-Jun-18	22-Jun-18	SH:ac	$07	4	Balsam poplar – Cow parsnip (Pole/Sapling)

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–042	Halfway River	10V, 595356, 6232030	7-Jun-18	20-Jun-18	SH:ac	$07	3	Balsam poplar – Cow parsnip (Shrub)
PC18–043	Peace River	10V, 595279, 6230599	1-Jun-18	22-Jun-18	SH:ac	$07	4	Balsam poplar – Cow parsnip (Pole/Sapling)
PC18–044	Halfway River	10V, 592246, 6231303	7-Jun-18	20-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–045	Halfway River	10V, 594965, 6231844	7-Jun-18	20-Jun-18	CF	–	2	Cultivated field (including pastures) (Herbaceous)
PC18–045A	Halfway River	10V, 593941, 6232041	7-Jun-18	20-Jun-18	Fm02	09	7	Balsam poplar/white spruce – Red-osier dogwood (Old forest)
PC18–046	Peace River	10V, 594721, 6229684	1-Jun-18	22-Jun-18	AM	01	6	White spruce/trembling aspen – Step moss (Mature forest)
PC18–047	Peace River	10V, 594556, 6229423	1-Jun-18	22-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–048	Peace River	10V, 594362, 6229991	1-Jun-18	22-Jun-18	SO	05	3	White Spruce – Currant – Oak fern (Shrub)
PC18–049	Peace River	10V, 594143, 6229802	1-Jun-18	22-Jun-18	SO	05	3	White Spruce – Currant – Oak fern (Shrub)
PC18–050	Peace River	10V, 594007, 6229312	1-Jun-18	22-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–051	Peace River	10V, 593615, 6228118	1-Jun-18	22-Jun-18	SO	05	7	White Spruce – Currant – Oak fern (Old forest)
PC18–052	Peace River	10V, 593484, 6229059	1-Jun-18	22-Jun-18	SO	05	6	White Spruce – Currant – Oak fern (Mature forest)
PC18–053	Peace River	10V, 593220, 6228795	1-Jun-18	22-Jun-18	SO	05	6	White Spruce – Currant – Oak fern (Mature forest)
PC18–054	Halfway River	10V, 593080, 6233773	7-Jun-18	20-Jun-18	Fm02	09	7	Balsam poplar/white spruce – Red-osier dogwood (Old forest)
PC18–055	Peace River	10V, 592878, 6227675	1-Jun-18	22-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–056	Peace River	10V, 592512, 6227464	1-Jun-18	22-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–057	Peace River	10V, 592093, 6227434	1-Jun-18	22-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–058	Peace River	10V, 592015, 6227088	1-Jun-18	22-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–059	Peace River	10V, 591624, 6226994	1-Jun-18	22-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–060	Peace River	10V, 591241, 6226776	1-Jun-18	22-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–061	Peace River	10V, 590804, 6226730	1-Jun-18	22-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–062	Peace River	10V, 590387, 6226544	1-Jun-18	22-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–063	Peace River	10V, 588600, 6225499	2-Jun-18	24-Jun-18	SH	07	7	White Spruce – Currant – Horsetail (Old forest)
PC18–064	Peace River	10V, 588259, 6225083	2-Jun-18	24-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–065	Peace River	10V, 587929, 6224733	2-Jun-18	24-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–066	Peace River	10V, 587587, 6225065	2-Jun-18	24-Jun-18	WH	00	2	Willow – Horsetail – Sedge – Riparian Wetland (Herbaceous)
PC18–067	Peace River	10V, 587349, 6224786	2-Jun-18	24-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–068	Peace River	10V, 586907, 6224966	6-Jun-18	23-Jun-18	LL:ak	$02	3	Trembling aspen – Kinnikinnick (Shrub)
PC18–069	Peace River	10V, 586759, 6223928	2-Jun-18	24-Jun-18	SH	07	5	White Spruce – Currant – Horsetail (Young forest)
PC18–070	Peace River	10V, 586593, 6124664	6-Jun-18	23-Jun-18	LL:ak	$02	3	Trembling aspen – Kinnikinnick (Shrub)
PC18–071	Peace River	10V, 586436, 6223566	2-Jun-18	24-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–072	Peace River	10V, 686129, 6222571	2-Jun-18	24-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–073	Peace River	10V, 585733, 6223075	2-Jun-18	23-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–074	Peace River	10V, 585389, 6221705	2-Jun-18	24-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–075	Peace River	10V, 585373, 6222250	2-Jun-18	24-Jun-18	SC:ab	$05	6	Trembling aspen – Black Twinberry (Mature forest)
PC18–076	Peace River	10V, 585318, 6221991	2-Jun-18	24-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–077	Peace River	10V, 565006, 6221593	2-Jun-18	24-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–078	Peace River	10V, 584969, 6221906	2-Jun-18	24-Jun-18	SH:ac	$07	5	Balsam poplar – Cow parsnip (Young forest)
PC18–079	Peace River	10V, 584352, 6221414	3-Jun-18	24-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–080	Peace River	10V, 584289, 6221041	3-Jun-18	24-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–081	Peace River	10V, 584084, 6221563	2-Jun-18	24-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–082	Peace River	10V, 583619, 6221219	3-Jun-18	24-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–083	Peace River	10V, 583251, 6220959	3-Jun-18	24-Jun-18	SH	07	5	White Spruce – Currant – Horsetail (Young forest)
PC18–084	Peace River	10V, 582999, 6220683	3-Jun-18	25-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–085	Peace River	10V, 585894, 6220283	3-Jun-18	25-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–086	Peace River	10V, 582279, 6220736	3-Jun-18	25-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–087	Peace River	10V, 581101, 6219958	3-Jun-18	27-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–088	Peace River	10V, 579024, 6219527	3-Jun-18	27-Jun-18	SH	07	6	White Spruce – Currant – Horsetail (Mature forest)
PC18–089	Peace River	10V, 578769, 6220220	6-Jun-18	23-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–091	Peace River	10V, 578638, 6219427	3-Jun-18	27-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–092	Peace River	10V, 578574, 6220431	6-Jun-18	23-Jun-18	AM:ap	$01	3	Trembling aspen – Creamy peavine (Shrub)
PC18–093	Peace River	10V, 578495, 6219682	3-Jun-18	27-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–094	Peace River	10V, 578043, 6219572	3-Jun-18	27-Jun-18	AM	01	5	White spruce/trembling aspen – Step moss (Young forest)
PC18–095	Peace River	10V, 576992, 6219018	3-Jun-18	27-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–095A	Peace River	10V, 594547, 6232230	Not surveyed	20-Jun-18	SO	05	5	White Spruce – Currant – Oak fern (Young forest)
PC18–096	Peace River	10V, 576615, 6219430	Not surveyed	27-Jun-18	Fm02	09	3	Balsam poplar/white spruce – Red-osier dogwood (Shrub)
PC18–097	Peace River	10V, 576023, 6219085	3-Jun-18	27-Jun-18	AM	01	7	White spruce/trembling aspen – Step moss (Old forest)
PC18–098	Peace River	10V, 575755, 6219366	3-Jun-18	27-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–099	Peace River	10V, 575433, 6219122	3-Jun-18	27-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)
PC18–100	Peace River	10V, 575091, 6218943	3-Jun-18	27-Jun-18	AM:ap	$01	5	Trembling aspen – Creamy peavine (Young forest)

Table B1: Songbird Point Count Stations Surveyed in 2018

Station	Location Ref	Geographic Coordinates (UTM)	First Visit	Second Visit	Map Code	Site Series	Structural Stage	Ecosystem (Site Series / Structural Stage)
PC18–101	Peace River	10V, 574660, 6218572	3-Jun-18	27-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–102	Peace River	10V, 574477, 6218333	3-Jun-18	27-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–103	Peace River	10V, 574115, 6217365	11-Jun-18	27-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–104	Peace River	10V, 573520, 6214675	11-Jun-18	27-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–105	Peace River	10V, 573047, 6215156	6-Jun-18	23-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–106	Peace River	10V, 572836, 6214784	6-Jun-18	23-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–107	Peace River	10V, 572701, 6215360	6-Jun-18	23-Jun-18	AM:ap	$01	6	Trembling aspen – Creamy peavine (Mature forest)
PC18–108	Peace River	10V, 572608, 6214790	6-Jun-18	23-Jun-18	SW:as	$03	6	Trembling aspen – Soopallalie (Mature forest)
PC18–109	Peace River	10V, 572254, 6214184	Not surveyed	23-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–111	Peace River	10V, 571549, 6212812	11-Jun-18	27-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–112	Peace River	10V, 571439, 6212595	11-Jun-18	27-Jun-18	SH:ac	$07	6	Balsam poplar – Cow parsnip (Mature forest)
PC18–113	Peace River	10V, 571000, 6212316	11-Jun-18	27-Jun-18	Fm02	09	6	Balsam poplar/white spruce – Red-osier dogwood (Mature forest)
PC18–114	Peace River	10V, 570733, 6212123	11-Jun-18	27-Jun-18	WH	00	3	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)
PC18–115	Peace River	10V, 570138, 6211594	11-Jun-18	27-Jun-18	WH	00	4	Willow – Horsetail – Sedge – Riparian Wetland (Pole/Sapling)
PC18–116	Peace River	10V, 564330, 6205240	11-Jun-18	23-Jun-18	AM:ap	$01	3	Trembling aspen – Creamy peavine (Shrub)
PC18–117	Peace River	10V, 563939, 6204917	11-Jun-18	23-Jun-18	AM:ap	$01	3	Trembling aspen – Creamy peavine (Shrub)

APPENDIX C
INCIDENTAL BIRD OBSERVATIONS

Table C.1: Incidental Observations of Birds Recorded Outside of Point Count Surveys and Birds Recorded During Point Counts that are not Songbirds

Common Name	Scientific Name	BC List	COSEWIC	SARA	Total Count[1]
Canada Goose	*Branta canadensis*	Yellow	-	-	68
Trumpeter Swan	*Cygnus buccinator*	Yellow	-	-	9
Mallard	*Anas platyrhynchos*	Yellow	-	-	1
Ruffed Grouse	*Bonasa umbellus*	Yellow	-	-	10
Sora	*Porzana carolina*	Yellow	-	-	3
Killdeer	*Charadrius vociferus*	Yellow	-	-	3
Wilson's Snipe	*Gallinago delicata*	Yellow	-	-	6
Spotted Sandpiper	*Actitis macularius*	Yellow	-	-	15
Northern Goshawk	*Accipiter gentilis*	Yellow	-	-	2
Great Horned Owl	*Bubo virginianus*	Yellow	-	-	3
Barred Owl	*Strix varia*	Yellow	-	-	2
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Yellow	-	-	40
Downy Woodpecker	*Picoides pubescens*	Yellow	-	-	1
Hairy Woodpecker	*Picoides villosus*	Yellow	-	-	8
American Three-toed Woodpecker	*Picoides dorsalis*	Yellow	-	-	14
Northern Flicker	*Colaptes auratus*	Yellow	-	-	19
Pileated Woodpecker	*Dryocopus pileatus*	Yellow	-	-	4
American Kestrel	*Falco sparverius*	Yellow	-	-	1
Dusky Flycatcher	*Empidonax oberholseri*	Yellow	-	-	1
Red-breasted Nuthatch	Sitta canadensis	Yellow	-	-	1
Hermit Thrush	*Catharus guttatus*	Yellow	-	-	1
Gray Catbird	*Dumetella carolinensis*	Yellow	-	-	2
Cedar Waxwing	*Bombycilla cedrorum*	Yellow	-	-	1
White-winged Crossbill	*Loxia leucoptera*	Yellow	-	-	1
Yellow-rumped Warbler	*Setophaga coronata*	Yellow	-	-	1
Black-throated Green Warbler	*Setophaga virens*	Blue	-	-	1
White-throated Sparrow	*Zonotrichia albicollis*	Yellow	-	-	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Yellow	-	-	1
Unknown Duck Species	-	-	-	-	3
Unknown Raptor Species	-	-	-	-	1
Unknown Swallow Species	-	-	-	-	2
Unknown Woodpecker Species	-	-	-	-	15
	Total				**241**

[1] The total number of detections over both surveys at all stations.

APPENDIX D
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report author
Camille Roberge, B.Sc., E.Pt.	Data entry, report author
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection
Todd Heakes Tetra Tech Canada Inc.	Field data collection
Kerrith McKay, M.Sc. McKay Environmental Consulting Ltd.	Field data collection

APPENDIX E
LIMITATIONS ON THE USE OF THIS DOCUMENT

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”).

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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.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by SEES JV in its reasonably exercised discretion.

Appendix 3. Common Nighthawk Follow-up Monitoring 2018 Annual Report

Site C Clean Energy Project
Common Nighthawk Follow-up Monitoring
2018 Annual Report

PRESENTED TO

BC Hydro and Power Authority

MARCH 22, 2019
ISSUED FOR USE
FILE: 704-ENV.VENV03095-01.NIGHTHAWK

Saulteau EBA Environmental Services Joint Venture.
14940 – 123 Avenue
Edmonton, AB T5V 1B4 CANADA
Tel 780.451.2121 Fax 780.454.5688

Site C Clean Energy Project Breeding Bird Follow-Up Monitoring – Common Nighthawk
2018 Annual Report

FILE: 704-ENV.VENV03095-01.Nighthawk
March 22, 2019

PRESENTED TO

Site C Clean Energy Project
BC Hydro and Power Authority
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Environmental Scientist

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of Common Nighthawk (*Chordeiles minor*; CONI) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project in the spring and summer of 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program. This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

CONI surveys are being completed in the reservoir footprint and in the BC Hydro proposed mitigation properties. Surveys are occurring over two years with approximately half occurring in 2018 and half in 2019. The focus of surveys in 2018 was the eastern reservoir, from the Halfway River east to the Site C dam.

CONI were surveyed using Autonomous Recording Units (ARUs) in combination with point counts. Fifteen ARUs were used for audio recording. The ARUs were initially deployed at 15 stations for seven days and then rotated to 15 new stations three additional times to survey all 60 stations. ARUs were left to record for at least seven days between June 1 and July 4, 2018. ARU recordings were analyzed in two ways: human listening and automated detection. Two 10-minute recordings were randomly selected for each station for human listening. The listener recorded the number of calls and wing booms and estimated the total number of individual CONI. Automated detection of CONI calls for all recordings at a station was completed using computer software to visualize, isolate, sort and identify vocalizations in sound recordings. The results of the automated detections were validated by a human listener.

Human-conducted point counts were conducted at 13 locations within the footprint that could be accessed by vehicle and foot. An audio recording was collected using the station ARU and corresponded to the exact time period the point count was conducted.

CONI were identified at 53 of the 59 surveys stations. Human listening and automated detection (with validation) of ARU recordings identified CONI at the same proportion of stations; however there were differences in the stations at which CONI were identified. There were three stations where CONI were detected in ARU recordings by automated detection and not by human listening; the reverse was true at two stations. CONI were detected by point counts at 7 of 13 stations. When comparing point counts with human listening of ARU recordings for the same survey period, human listening of ARU recordings detected more CONI than point counts (13 versus 11) over all stations.

The data collected in 2018 represents only half of the CONI data to be collected as part of the monitoring program. After the remainder of the data has been collected in 2019, further analysis and summary of both the 2018 and 2019 data will be conducted. Two observations were made based on analysis of the data collected in 2018:

- Automated detection has been shown to be valuable to flag candidate CONI detections, but validation is important.
- For the determination of station occupancy, the results underscore the benefit multiple approaches as each survey approach detected CONI at stations when other approaches had not.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of Common Nighthawk (*Cordeiles minor*) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in the spring and summer of 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program (Volume 2, Section 14 in BC Hydro 2013). Common Nighthawk is designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Threatened under Schedule 1 of the Species at Risk Act (SARA), and listed as Yellow (secure) in British Columbia. The monitoring program for Common Nighthawk is described in the Common Nighthawk program plan (BC Hydro 2017). This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

2.0 METHODS

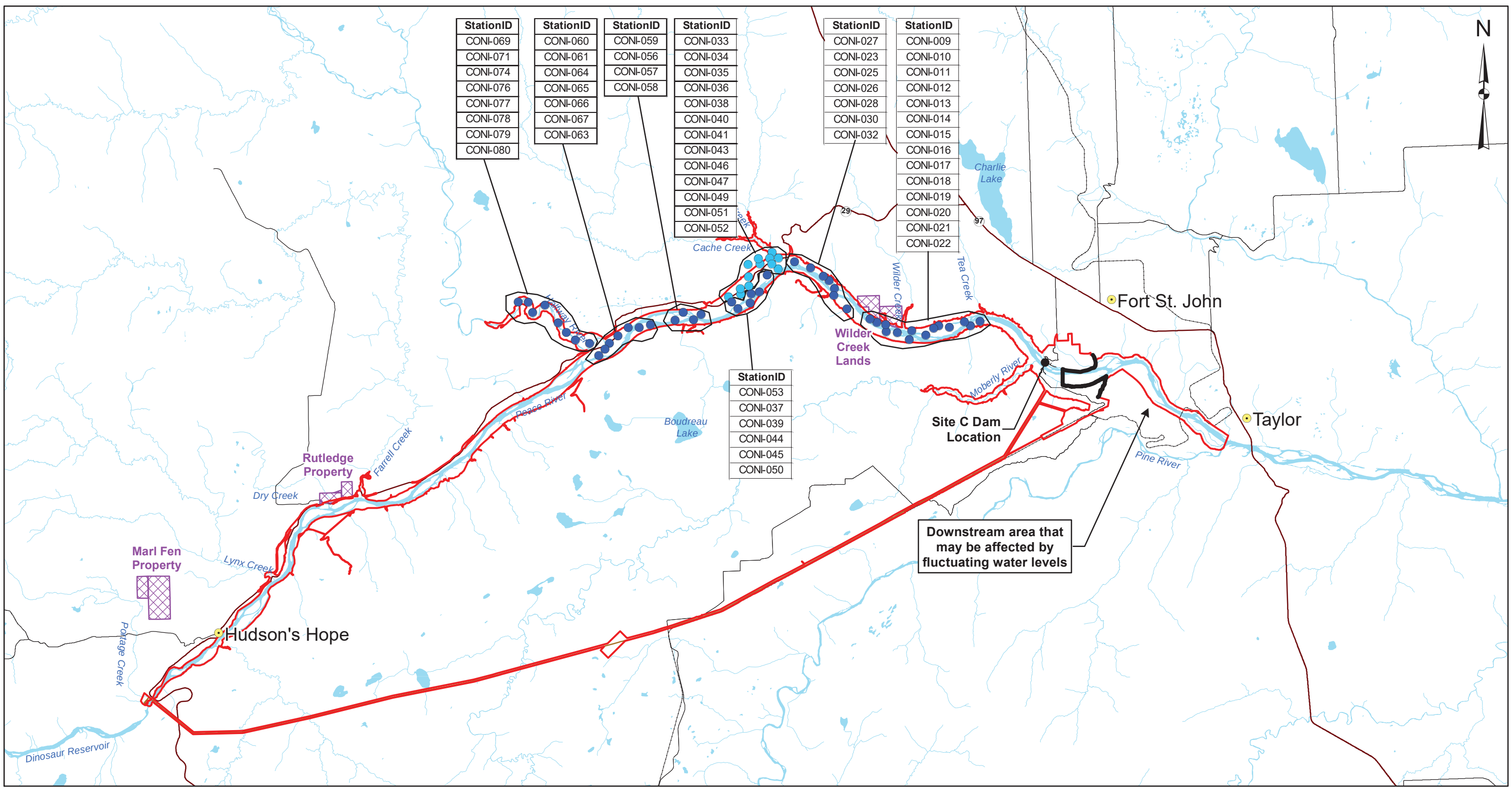
2.1 Approach

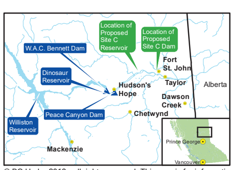
Common Nighthawk (from here on referred to as CONI) were surveyed using Autonomous Recording Units (ARUs) in combination with point counts. An ARU is a standalone audio recording unit installed and left for a period of time to record bird vocalizations or other sounds. The audio recordings are analyzed and interpreted at a later date once the recording units have been retrieved. ARUs are becoming a common approach for surveys of birds and have been used for CONI. The benefit of using ARUs for CONI surveys is that the units can be deployed during daylight hours in areas that cannot be safely accessed in the evening/night (i.e. along the Peace River), allowing for monitoring in areas of the footprint that could not otherwise be surveyed. ARUs also allow for longer periods of data collection, increasing the potential for detection of species of interest.

2.2 Survey Area and Station Locations

CONI surveys are being completed in the reservoir footprint and in the BC Hydro proposed mitigation properties (Figure 1). Surveys are occurring over two years with approximately half occurring in 2018 and half in 2019. After these two years of surveys, it is expected that most of the suitable habitat within the project footprint and the mitigation properties will be surveyed. Ongoing monitoring after that point will focus on any remaining areas not surveyed, the mitigation properties and on those areas that have been reclaimed or restored.

The focus of surveys in 2018 was the eastern reservoir, from the Halfway River east to the Site C dam. Survey stations were located within suitable habitat for CONI (Table 1). Survey stations were often placed in the centre of a homogenous habitat type but that was not always possible given the heterogeneity and complexity of the Peace River valley and the detection radius of the ARUs (i.e., at least 200 m or much more in open habitats). Sixty survey stations were planned for 2018; however, only 59 were surveyed due to a non-functioning ARU (Figure 1).





Legend

- Common Nighthawk Survey Location - Autonomous Recording Unit + Point Count Survey
- Common Nighthawk Survey Location - Autonomous Recording Unit Survey
- Songbird Monitoring Study Area
- Potential Mitigation Property
- Proposed Transmission Corridor
- Highway
- Other Road
- Railway
- Provincial Boundary

1:275,000

0 — 10 km

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.
5. Figure prepared by Tetra Tech Canada.

BC Hydro — TETRA TECH

Breeding Bird Follow-up Monitoring
Common Nighthawk

Figure 1:
Locations of Common Nighthawk Surveys in 2018

Date	November 21, 2018	DWG NO	1016-C14-08896-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\2018\BreedingBird_2018\BB_Nighthawks_1016_C14_08896-1_R0.mxd

Table 1. Number of CONI survey stations by ecosystem unit (map code and structural stage).

Ecosystem Unit[1]	Number of Survey Stations
$Ac – Cow parsnip (Old forest) [2]	1
$Ac – Cow parsnip (Pole/sapling) [2]	2
$Ac – Cow parsnip (Shrub)	1
$At - Creamy peavine (Mature forest) [2]	1
$At - Creamy peavine (Pole/sapling) [2]	1
$At - Creamy peavine (Shrub)	2
$At - Kinnikinnick (Herb)	5
$At - Kinnikinnick (Shrub)	1
$At - Soopolallie (Shrub)	2
ActSw - Red-osier dogwood (Shrub)	8
ActSw - Red-osier dogwood (Young forest) [2]	1
Cultivated field (including pastures) (Herb)	7
Gravel bar	3
Sedge Wetland (Herb)	2
Sedge Wetland (Shrub)	1
Willow – Horsetail – Sedge – Riparian Wetland (Herb)	5
Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	16
Total	**59**

[1] Ac = balsam poplar; At = trembling aspen; Sw – white spruce. $ denotes seral association.
[2] The forested sites are actually complexes with a mosaic of forest and open habitats.

2.3 Autonomous Recording Units

2.3.1 Data Collection

Fifteen ARUs (Song Meter SM4 from Wildlife Acoustics Inc.) were used for audio recording. The ARUs were initially deployed at 15 stations for seven days and then rotated to 15 new stations three additional times to survey all 60 stations[1]. ARUs were left to record for at least seven days per station between June 1 and July 4, 2018. Recordings collected beyond the first seven days at a station were not used in subsequent analyses. The ARUs were installed based on the deployment protocol of Lankau (2015). Each unit was mounted on a wooden stake approximately 1 m from the ground. The ARUs were set to record for 10 minutes every hour on the hour for each day of deployment. Recordings from times when CONI are typically less active were not analyzed but kept for potential use in other monitoring programs. The ARUs recorded 2-channel stereo, uncompressed WAV files at 24 KHz.

[1] One ARU was found to be defective during the first deployment and only 14 stations were therefore surveyed in the first session. The defective ARU was replaced in time for the second deployment session.

2.3.2 Analysis

ARU recordings were analyzed in two ways: human listening and automated detection. Human listening allows for detection of both the CONI foraging call ("peent") and the low frequency, non-vocal display sound (wing booms) but is time-intensive since playback analysis is in real-time and prohibits listeneing to all recordings. Automated detection (use of computer software trained to recognize a vocalization) has the benefit of analyzing many recordings without human intervention, though is limited to the CONI foraging call because low-frequency sounds are more difficult for automated recognition. Automated recognition is also imperfect and requires validation.

Human Listening

Two 10-minute recordings were randomly selected from each station for human listening. Recordings made within two hours of sunset were considered for analysis (22:00 and 23:00)[2]. During the point counts it was noted that CONI activity decreased sharply after midnight. The two recordings for human listening were selected from different nights. If a selected recording had persistent rain, a new recording was selected in order to avoid periods of low CONI activity or decreased ability to detect sounds.

The process for human listening was based on the protocols in Lankau et. al (2015) and Wild Research (2015). Recordings were played and analysed using Audacity® (Audacity Team, 2018). The trained human listener played back each recording and noted all CONI calls and wing booms in 1-minute intervals. The listener replayed any section needed in order to accurately track and count CONI detections. The number of individual CONI were estimated based on overlapping calls or calls so close together that it was apparent that more than one individual was present. This approach is conservative, and the number of CONI detected at a station is likely an underestimate. An estimate of perceived distance to each individual was also recorded (near, mid and far).

Automated Detection

Automated detection of CONI calls was completed using Kaleidoscope Pro (Version 5; Wildlife Acoustics Inc.), a software application used to visualize, isolate, sort and identify vocalizations in sound recordings. Kaleidoscope uses signal detection and cluster analysis to group similar vocalizations based on their spectral characteristics. A species-specific classifier is developed using training data manually selected by a human listener. This classifier is then applied to new audio recordings to isolate similar vocalizations as those in the training data. A CONI classifier was developed using 201 manually identified CONI calls from 10 randomly selected 10-minute audio recordings. In order for the classifier to differentiate CONI vocalizations from other detected vocalizations, 403 non-CONI vocalizations were also identified. The classifier was then applied to all station recordings made at 22:00 and 23:00. The audio recordings were processed using the following parameters:

- Frequency range: 1000 – 12000 Hz.
- Minimum and maximum length of detection: 0.1 – 2 seconds.
- FFT Window: 5.33 ms
- Maximum distance from cluster center to include outputs in cluster: 1.0.

All other parameters were set according to the software developer's recommendations. The ARUs have two microphones corresponding to left and right channel. Both channels were included in the automated detection in order to maximize the potential for detection of CONI. However, it does mean that detections are double-counted

[2] During the survey period (June 1 to July 4), sunset ranged from 21:39 to 21:55.

when recorded on both channels. Actual unique detections may therefore be as low as one-half of the reported detections.

The results of the automated detections were validated for each station in the following way:

- Potential CONI detections (hits) were reviewed (by ear and/or visual inspection of the spectrogram) until the first true-positive detection was encountered; and
- For stations that had no confirmed CONI hits, the first 100 isolated vocalizations in non-CONI clusters were reviewed to determine if any were false-negatives.

2.4 Point Count Surveys

Human-conducted point counts were conducted at 13 locations within the footprint that could be accessed by vehicle and foot. The point count surveys were completed between sunset and nautical twilight, a survey window of approximately two hours. The surveys were conducted as unlimited radius point counts with distance-to-detection intervals set at 0-50 m, 51-100 m and >100 m. Each point-count survey was conducted over 10 minutes and the first detection of a bird was recorded in one of three intervals: 0-3 minutes, 3-5 minutes and 5-10 minutes. An audio recording was collected using the station ARU and corresponded to the exact time period the point count was conducted.

Surveys were not conducted in inclement weather conditions (i.e., wind speed > Beaufort 3, steady rain, temperature < 7 ^{o}C). UTM coordinates (NAD 83), survey start and end time, and weather conditions (i.e., wind, cloud cover, precipitation, and temperature) were recorded for each station. When CONI were detected, surveyors recorded the detection type (i.e. visual, foraging call or wing boom) and time, the activity, the number heard/seen, and the estimated distance and direction to the initial detection location. All field data were recorded on standard point count survey forms. Incidental observations of other wildlife were recorded during surveys and while in the field.

2.5 Collection of Habitat Data

Ecosystem attributes were recorded for each survey station. These data were recorded on a Site Visit form (SIVI; British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment 2010) (Appendix B) and included all site and vegetation fields with the exception of soil characteristics.

The site ecosystem attributes combined with other mapped terrain, topographic or landscape features (e.g., distance to water) can be used at a later date to further describe and define attributes associated with observations that are more detailed than exist with the TEM ecosystem classification of map code/site series and structural stage.

3.0 RESULTS AND DISCUSSION

CONI were identified at 53 of the 59 surveys stations (Table 2). Human listening and automated detection (with validation) of ARU recordings identified CONI at the same proportion of stations however there are differences in the stations at which CONI were identified (Table 3). There were three stations where CONI were detected by automated detection and not by human listening of ARU recordings; the reverse was true at two stations.

Table 2. Summary of the results of the Common Nighthawk surveys using human listening, automated detection and point counts.

Survey Approach	Number of Stations with CONI Detections	Proportion of Stations with CONI Detections
Human Listening of ARU Recordings	49 of 59	83%
Automated Detection of ARU Recordings	49 of 59	83%
Point Counts	7 of 13	54%
Combined	53 of 59	89%

Of the six point count stations where no CONI were reported, five had CONI reported by human listening and automated detection of ARU recordings. It is important to note that the survey effort by human listening of ARU recordings (two 10-minute surveys on different days at each station) is twice that of the point counts (one 10-minute survey).

Table 3. Results of the Common Nighthawk surveys using human listening, automated detection and point counts.

Survey Station	Ecosystem Unit	ARU Deployment Date	Human Listening of ARU Recordings (HL)							Automated Detection of ARU Recordings (AD)			Point Counts (PC)	Result and Comparison
			Recording 1			Recording 2			Maximum Number of CONI[1]	Number of Detections[2]	Mean Detections per 10-min	Validation	Number of CONI [3]	
			Calls	Wing Booms	Number of CONI	Calls	Wing Booms	Number of CONI						
CONI-009	Willow – Horsetail – Sedge – Riparian Wetland (Herb)	2018-06-09	216	16	2	503	31	4	4	2,441	349	True positive hits	-	CONI detected - agreement
CONI-010	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	255	22	2	110	24	3	3	309	44	True positive hits	-	CONI detected - agreement
CONI-011	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	209	18	2	49	2	2	2	780	111	True positive hits	-	CONI detected - agreement
CONI-012	ActSw - Red-osier dogwood (Shrub)	2018-06-09	0	0	0	50	0	1	1	777	111	True positive hits	-	CONI detected - agreement
CONI-013	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	5	4	1	4	7	1	1	121	17	True positive hits	-	CONI detected - agreement
CONI-014	Willow – Horsetail – Sedge – Riparian Wetland (Herb)	2018-06-09	46	2	1	112	9	2	2	271	39	True positive hits	-	CONI detected - agreement
CONI-015	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	0	0	0	307	27	3	3	831	119	True positive hits	-	CONI detected - agreement
CONI-016	$At - Creamy peavine (Pole/sapling)	2018-06-09	49	12	1	12	0	1	1	54	8	True positive hits	-	CONI detected - agreement
CONI-017	Willow – Horsetail – Sedge – Riparian Wetland (Herb)	2018-06-09	0	0	0	67	0	1	1	7	1	True positive hits	-	CONI detected - agreement
CONI-018	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	399	26	3	177	12	2	3	1,830	261	True positive hits	-	CONI detected - agreement
CONI-019	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-09	270	10	3	71	0	2	3	687	98	True positive hits	-	CONI detected - agreement
CONI-020	$At - Creamy peavine (Mature forest)	2018-06-09	61	0	1	59	14	1	1	273	39	True positive hits	-	CONI detected - agreement
CONI-021	ActSw - Red-osier dogwood (Shrub)	2018-06-09	72	17	2	319	23	2	2	263	38	True positive hits	-	CONI detected - agreement
CONI-022	ActSw - Red-osier dogwood (Shrub)	2018-06-09	118	9	2	323	39	3	3	1,224	175	True positive hits	-	CONI detected - agreement
CONI-023	Willow – Horsetail – Sedge – Riparian Wetland (Herb)	2018-06-27	0	0	0	0	0	0	0	58	8	No true positive hits	-	CONI detected - agreement
CONI-025	ActSw - Red-osier dogwood (Young forest)	2018-06-27	223	14	3	331	49	3	3	517	74	True positive hits	-	CONI detected - agreement
CONI-026	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-27	53	1	2	89	2	1	2	167	24	True positive hits	-	CONI detected - agreement
CONI-027	ActSw - Red-osier dogwood (Shrub)	2018-06-09	591	37	4	730	68	4	4	1,085	155	True positive hits	-	CONI detected - agreement
CONI-028	$At - Creamy peavine (Shrub)	2018-06-27	187	23	2	324	16	3	3	624	89	True positive hits	-	CONI detected - agreement
CONI-030	$At - Soopolallie (Shrub)	2018-06-27	0	0	0	0	0	0	0	97	14	No true positive hits	-	CONI not detected
CONI-032	$At - Creamy peavine (Shrub)	2018-06-27	0	0	0	0	0	0	0	14	2	No true positive hits	-	CONI not detected
CONI-033	Cultivated field (including pastures) (Herb)	2018-06-01	22	4	1	0	0	0	1	56	8	True positive hits	1	CONI detected - agreement
CONI-034	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-01	5	0	1	0	0	0	1	61	9	No true positive hits	0	CONI detected - HL found CONI, AD and PC did not
CONI-035	ActSw - Red-osier dogwood (Shrub)	2018-06-01	132	6	2	1	0	1	2	123	18	True positive hits	1	CONI detected - agreement
CONI-036	$At - Kinnikinnick (Herb)	2018-06-01	31	0	1	282	15	2	2	1,587	227	True positive hits	1	CONI detected - agreement
CONI-037	$Ac – Cow parsnip (Pole/sapling)	2018-06-27	9	0	1	116	6	2	2	506	72	True positive hits	-	CONI detected - agreement
CONI-038	$At - Kinnikinnick (Herb)	2018-06-01	20	20	3	237	17	2	3	422	60	True positive hits	1	CONI detected - agreement
CONI-039	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-27	31	1	1	193	2	3	3	294	42	True positive hits	-	CONI detected - agreement

Survey Station	Ecosystem Unit	ARU Deployment Date	Human Listening of ARU Recordings (HL)							Automated Detection of ARU Recordings (AD)			Point Counts (PC)	Result and Comparison
			Recording 1			Recording 2			Maximum Number of CONI[1]	Number of Detections[2]	Mean Detections per 10-min	Validation	Number of CONI [3]	
			Calls	Wing Booms	Number of CONI	Calls	Wing Booms	Number of CONI						
CONI-040	$At - Kinnikinnick (Herb)	2018-06-01	6	20	3	83	6	1	3	567	81	True positive hits	1	CONI detected - agreement
CONI-041	ActSw - Red-osier dogwood (Shrub)	2018-06-01	0	0	0	144	5	2	2	298	43	True positive hits	3	CONI detected - agreement
CONI-043	$At - Kinnikinnick (Herb)	2018-06-01	10	1	2	167	4	2	2	84	12	True positive hits	0	CONI detected - HL and AD found CONI, PC did not
CONI-044	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-27	1	0	1	250	13	3	3	643	92	True positive hits	-	CONI detected - agreement
CONI-045	$Ac – Cow parsnip (Old forest)	2018-06-27	89	13	2	231	23	3	3	755	108	True positive hits	-	CONI detected - agreement
CONI-046	Sedge Wetland (Shrub)	2018-06-01	0	0	0	150	5	1	1	224	32	True positive hits	0	CONI detected - HL and AD found CONI, PC did not
CONI-047	$At - Kinnikinnick (Herb)	2018-06-01	9	0	1	21	6	1	1	74	11	True positive hits	1	CONI detected - agreement
CONI-049	$At - Kinnikinnick (Shrub)	2018-06-01	1	0	1	90	2	2	2	532	76	True positive hits	0	CONI detected - HL and AD found CONI, PC did not
CONI-050	ActSw - Red-osier dogwood (Shrub)	2018-06-27	529	24	4	323	9	4	4	1,416	202	True positive hits	-	CONI detected - agreement
CONI-051	Sedge Wetland (Herb)	2018-06-01	240	0	2	36	10	1	2	293	42	True positive hits	2	CONI detected - agreement
CONI-052	Sedge Wetland (Herb)	2018-06-01	0	0	0	0	0	0	0	70	10	True positive hits	0	CONI detected – AD found CONI, HL and PC did not
CONI-053	Cultivated field (including pastures) (Herb)	2018-06-01	0	1	1	61	7	1	1	108	15	True positive hits	-	CONI detected - agreement
CONI-056	Cultivated field (including pastures) (Herb)	2018-06-27	225	11	2	114	3	2	2	378	54	True positive hits	-	CONI detected - agreement
CONI-057	$Ac – Cow parsnip (Pole/sapling)	2018-06-27	312	14	2	324	23	3	3	1,444	206	True positive hits	-	CONI detected - agreement
CONI-058	Willow – Horsetail – Sedge – Riparian Wetland (Herb)	2018-06-27	73	5	2	122	2	2	2	83	12	True positive hits	-	CONI detected - agreement
CONI-059	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	511	36	3	521	23	4	4	1611	230	True positive hits	-	CONI detected - agreement
CONI-060	Gravel bar	2018-06-19	249	4	2	204	10	2	2	386	55	True positive hits	-	CONI detected - agreement
CONI-061	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	333	17	3	370	24	4	4	1,892	270	True positive hits	-	CONI detected - agreement
CONI-063	$Ac – Cow parsnip (Shrub)	2018-06-27	16	0	1	19	0	1	1	40	6	True positive hits	-	CONI detected - agreement
CONI-064	$At - Soopolallie (Shrub)	2018-06-19	0	0	0	0	0	0	0	31	4	True positive hits	-	CONI detected - AD found CONI, HL did not
CONI-065	Cultivated field (including pastures) (Herb)	2018-06-19	0	0	0	0	0	0	0	56	8	True positive hits	-	CONI detected - AD found CONI, HL did not
CONI-066	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	48	7	2	48	0	1	2	111	16	True positive hits	-	CONI detected - agreement
CONI-067	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	6	1	1	110	9	1	1	346	49	True positive hits	-	CONI detected - agreement
CONI-069	Cultivated field (including pastures) (Herb)	2018-06-19	41	0	1	0	0	0	1	56	8	True positive hits	-	CONI detected - agreement
CONI-071	Gravel bar	2018-06-19	0	0	0	30	1	1	1	62	9	True positive hits	-	CONI detected - agreement
CONI-074	Gravel bar	2018-06-19	2	0	1	0	0	0	1	12	2	No true positive hits	-	CONI detected - agreement
CONI-076	Cultivated field (including pastures) (Herb)	2018-06-19	0	0	0	0	0	0	0	17	2	No true positive hits	-	CONI not detected
CONI-077	ActSw - Red-osier dogwood (Shrub)	2018-06-19	0	0	0	2	0	1	1	7	1	No true positive hits	-	CONI detected - HL found CONI, AD did not

Survey Station	Ecosystem Unit	ARU Deployment Date	Human Listening of ARU Recordings (HL)							Automated Detection of ARU Recordings (AD)			Point Counts (PC)	Result and Comparison
			Recording 1			Recording 2			Maximum Number of CONI[1]	Number of Detections[2]	Mean Detections per 10-min	Validation	Number of CONI [3]	
			Calls	Wing Booms	Number of CONI	Calls	Wing Booms	Number of CONI						
CONI-078	Cultivated field (including pastures) (Herb)	2018-06-19	0	0	0	0	0	0	0	18	3	No true positive hits	-	CONI not detected
CONI-079	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	0	0	0	0	0	0	0	32	5	No true positive hits	-	CONI not detected
CONI-080	Willow – Horsetail – Sedge – Riparian Wetland (Shrub)	2018-06-19	0	0	0	0	0	0	0	6	1	No true positive hits	-	CONI not detected

[1] This is the maximum of the estimated number of CONI over the two recordings.

[2] This is the mean number of detections from the left and right channel at each station.

[3] Note that only 1 10-minute point count survey was conducted compared to the human listening where two 10-minute recordings were analyzed.

The completion of point counts and human listening of ARU recordings at the same sites for the same time period (duration and exact time of day) provide an opportunity to more accurately compare the rate of CONI detection between the two survey methods (Table 4). Human listening of ARU recordings detected more CONI than point counts (13 versus 11) over all stations. There were four stations where human listening of ARU recordings detected more CONI than by point count; the reverse was true for two stations.

Table 4. Results and comparison of human listening and point counts conducted for the same time period.

Survey Station	Human Listening of ARU Recordings (HL)			Point Count (PC)	Relative Abundance Comparison
	Calls	Wing Booms	Number of CONI	Number of CONI	
CONI-033	105	0	2	1	HL > PC
CONI-034	0	2	1	0	HL > PC
CONI-035	209	4	2	1	HL > PC
CONI-036	273	12	1	1	HL = PC
CONI-038	123	5	2	1	HL > PC
CONI-040	187	7	1	1	HL = PC
CONI-041	323	1	2	3	PC > HL
CONI-043	0	0	0	0	HL = PC
CONI-046	0	0	0	0	HL = PC
CONI-047	153	0	1	1	HL = PC
CONI-049	0	0	0	0	HL = PC
CONI-051	138	0	1	2	PC > HL
CONI-052	0	0	0	0	HL = PC
Total	**-**	**-**	**13**	**11**	**HL > PC**

There was one station (CONI-034) where CONI were detected by human listening but were not detected during the point count. The two human listening wing boom detections were faint and far away and the difference in detection may have been due to:

- Other sounds masking the wing booms during the point count;
- A moment of inattention or distraction during the point count; or
- The benefit of visual recognition from the spectrogram during human listening.

The data collected in 2018 represents only half of the CONI data to be collected as part of the monitoring program. After the remainder of the data has been collected in 2019, further analysis and summary of both the 2018 and 2019 data will be conducted. Based on the data collected in 2018, the following two observations are made.

- Automated detection has been shown to be valuable to flag candidate detections, but validation is important. The CONI classifier identified CONI hits at all stations, though 10 of those stations had no true positive hits. A new classifier will be developed after the 2019 data collection with the intent of improving automated detection, however there will always be misidentifications.
- For the determination of station occupancy, the results underscore the benefit of multiple approaches as each survey approach detected CONI at stations when other approaches had not.

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APPENDIX A
SITE VISIT FORM USED TO COLLECT HABITAT DATA

BRITISH COLUMBIA
The Best Place on Earth
Ministry of Forests and Range

SITE VISIT FORM

PROJECT ID

Plot No.	Plot Type: Grnd ☐ Visual ☐ Note ☐ Other ☐	Date YY - MM - DD
Surveyors	Map Polygon No.	Plot Photo

Plot Location

FS Region/ District	East	North	UTM Zone
NTS Map.	Lat.	Long.	Accur. (+/- m)

Plot Representing

BGC	SS	SMR	SNR	Map Label

Site Features	Elevation	Slope %	Aspect	Surface Shape: ST ☐ CC ☐ CV ☐

Crest ☐ Upper ☐ Mid ☐ Lower ☐ Toe ☐ Level ☐ Dep. ☐ Gully ☐ Flood Plain? ☐

Expose. Type ☐ insolation ☐ wind ☐ snow ☐ water spray ☐ misc.
☐ n/a ☐ frost ☐ cold air ☐ salt spray ☐ air toxicity ____________

Site Disturb. ☐ fire ☐ site prep. ☐ terrain ☐ soil dist. ____________
☐ n/a ☐ harvest ☐ planted ☐ biotic ☐ other ____________

Stand Attributes	Stand Age ________ Est. ☐ Mea. ☐	Stand Ht. ________ Est. ☐ Mea. ☐	Canopy Composition

Struct. Stage	1a	1b	2a	2b	2c	2d	3a	3b	4	5	6	7a	7b
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Success Status	NV	PS	YS	MS	OS	YC	MC	OC	DC
	☐	☐	☐	☐	☐	☐	☐	☐	☐

Terrain	Texture	Surficial Material	S. Expression	Geo. Process	Rock Types
1					1
2					2

Rooting Zone Drainage ☐ X ☐ R ☐ W ☐ M ☐ I ☐ P ☐ V

Humus/Organic Form ☐ Mor ☐ Moder ☐ Mull ☐ Fibric ☐ Mesic ☐ Humic

Humus Thickness ________ cm	Ah? ☐ Ae? ☐ ________ cm	Estimated Soil Depth ________ cm
R.Z. Soil Texture ________	R.Z.Coarse Fragment % ________	Estimated Rooting Depth ________ cm
Gleying or Mottling ☐ n/a ________ cm	Seepage ☐ n/a ________ cm	Restrict.Layer ☐ n/a ________ cm

Restrict. Type ☐ **C**ement ☐ **P**an ☐ **K**ompact ☐ **L**ithic ☐ **W**ater ☐ **X** Chem. ☐ **Z** Permafrost

SPP. LIST	COMP. ☐ PART. ☐	% COVER BY LAYER	TREE (A) ☐	SHRUB (B) ☐	HERB (C) ☐	MOSS / LICHEN (D) ☐	Associated Full Cruise Card ? ☐ No ☐ Yes

COL.	TREES & SHRUBS	A1	A2	A3	**A**	B1	B2	**B**

COL.	HERB LAYER (C)	%

COL.	MOSS / LICHEN / SEEDLING (D)	%

Notes/Diagram

Tree Mensuration

SPP.	dbh	Ht.	BH Age	Path. Y/N	Notes

FS 1333 HRE 2010/03

APPENDIX B
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report author
Camille Roberge, B.Sc., E.Pt. Tetra Tech Canada Inc.	Field data collection, data entry
Elyse Hofs, B.Sc., Dipl.T. Tetra Tech Canada Inc.	Field data collection, data entry, analysis, report co-author
Todd Heakes Tetra Tech Canada Inc.	Field data collection
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection
Kerrith McKay, M.Sc. McKay Environmental Consulting Ltd.	Field data collection

APPENDIX C
LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

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1.5 INFORMATION PROVIDED TO SEES JV BY OTHERS

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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.

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This Professional Document is based solely on the conditions presented and the data available to SEES JV at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

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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.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by SEES JV in its reasonably exercised discretion.

Appendix 4. Breeding Bird Follow-up Monitoring – Woodpeckers 2018 Annual Report

Site C Clean Energy Project
Breeding Bird Follow-up Monitoring - Woodpeckers
2018 Annual Report

PRESENTED TO
BC Hydro and Power Authority

MARCH 22, 2019
ISSUED FOR USE
FILE: 704-ENV.VENV03095-01WOODPECKERS

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Site C Clean Energy Project Breeding Bird Follow-Up Monitoring Woodpeckers
2018 Annual Report

FILE: 704-ENV.VENV03095-01. Woodpeckers
March 22, 2019

PRESENTED TO

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Senior Biologist

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture completed woodpecker surveys in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project in spring and summer 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program. This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

Woodpecker surveys are being completed in the project footprint within the Peace River valley and in the BC Hydro proposed mitigation properties over a two-year period (2018 and 2019). Surveys in 2018 were focused on the middle and eastern reservoir, from the Halfway River east to the dam site.

Woodpecker survey stations were pre-selected to represent the range of forested habitats previously mapped in the project footprint. Woodpeckers were surveyed using unlimited radius point counts with call-playback. At each station, observers played commercially obtained woodpecker recordings over a speaker to elicit a response from any individuals in the area. After a one-minute initial listening period, calls for seven woodpecker species were played at each station. Playbacks for each individual species consisted of up to 20 seconds of calls followed by 30 seconds of silence, during which time observers looked and listened for a response. That sequence was repeated twice for each species. Woodpecker detections were recorded as either spontaneously calling or call-playback response. Each station was surveyed two times in the month of June to maximize the detection of woodpeckers.

Woodpecker surveys were conducted at 101 survey stations in 2018. There were 240 woodpecker detections over both survey rounds at all stations. All seven species of woodpecker known to occur in the Peace River area were detected. Yellow-bellied Sapsucker was the most-frequently observed (n=81). Black-backed Woodpecker was the least-frequently observed (n=2). More than half of the detections were responses to the playback of their recorded calls or drumming.

Woodpecker surveys in 2019 will focus on the reservoir west of the Halfway River (the western reservoir) and in habitats that were not well-sampled in 2018.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed woodpecker surveys in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2018. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program (Volume 2, Section 14 in BC Hydro 2013). The monitoring program for woodpeckers is more fully described in the woodpecker program plan (BC Hydro 2018a).

Seven woodpecker species are known to occur in the Peace River valley (Table 1). None of the woodpecker species are considered species at risk (i.e., not listed as Red or Blue in BC, nor listed under the Committee on the Status of Endangered Wildlife in Canada [COSEWIC] or the Species at Risk Act [SARA]).

Table 1: Woodpecker Species Known to Occur in the Peace River Valley

Common Name	Scientific Name	BC List	COSEWIC	SARA
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Yellow	-	-
Downy Woodpecker	*Dryobates pubescens*	Yellow	-	-
Hairy Woodpecker	*Dryubates villosus*	Yellow	-	-
American Three-toed Woodpecker	*Picoides dorsalis*	Yellow	-	-
Black-backed Woodpecker	*Picoides arcticus*	Yellow	-	-
Northern Flicker	*Colaptes auratus*	Yellow	-	-
Pileated Woodpecker	*Dryocopus pileatus*	Yellow	-	-

The objectives of woodpecker surveys are to:

1. Determine the distribution and relative abundance of woodpeckers within habitat expected to be lost or otherwise affected by the project to verify the predictions made in the EIS. This information, together with the existing baseline woodpecker data, will be used to more precisely identify and quantify the species that are currently present within the project footprint and whose habitat will be lost or affected as a result of the project.

2. Identify habitat associations and habitat attributes used by woodpeckers to help identify areas for offsetting impacts. Species-habitat relationships will be used to help determine appropriate compensation for non-wetland migratory bird habitat.

3. Conduct effectiveness monitoring to determine the degree to which mitigation areas offset impacts to woodpeckers and their habitat and determine further woodpecker mitigation requirements.

This report describes the methods used to conduct the 2018 surveys and provides a summary of the results.

2.0 METHODS

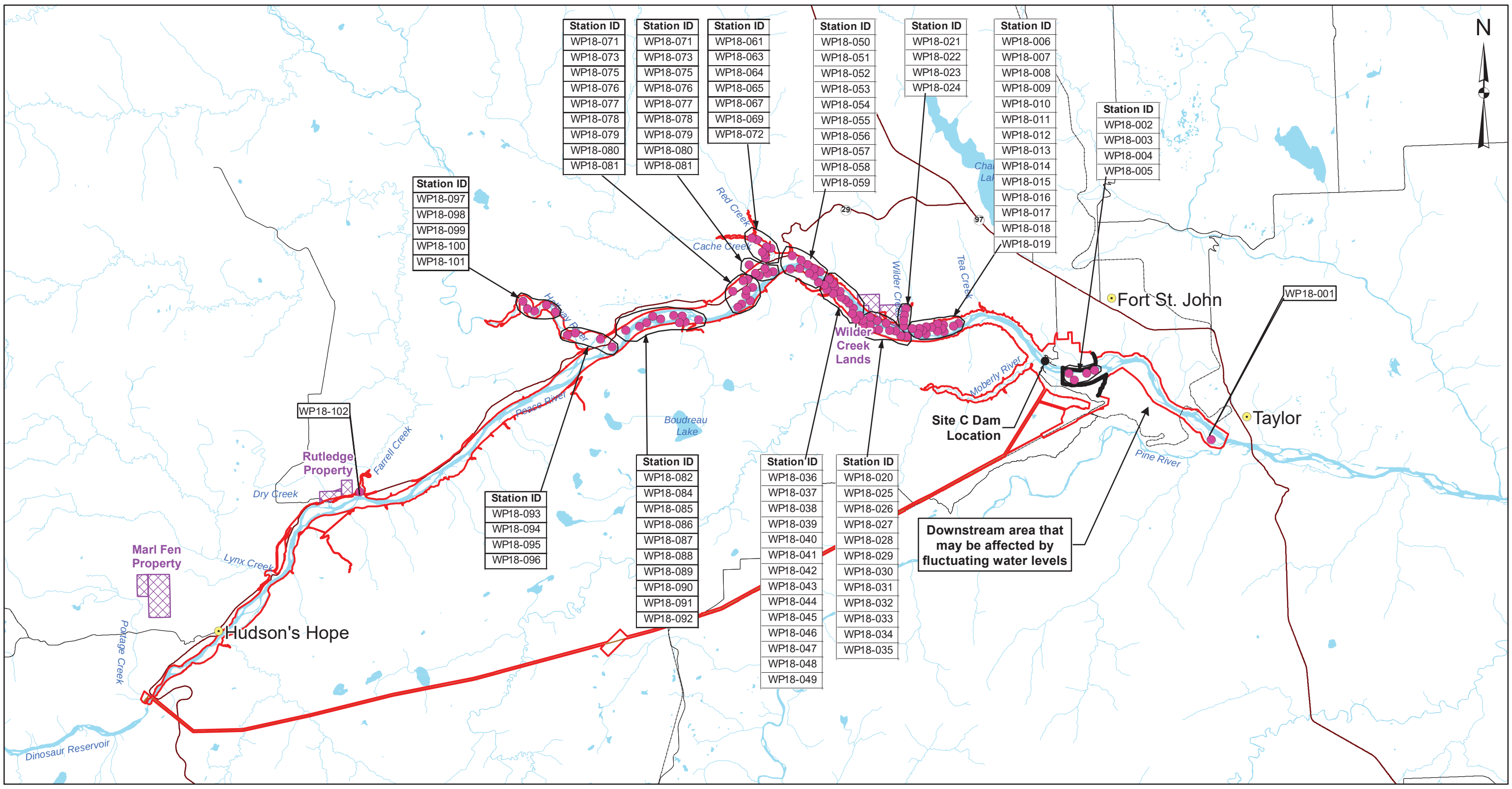
2.1 Survey Area

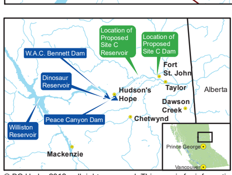
Woodpecker monitoring is occurring within the Peace River valley project footprint and in the BC Hydro proposed mitigation properties (Figure 1). The footprint is primarily composed of the dam, generating station and spillways, reservoir, transmission line and construction access roads, as well as the areas along the river between the dam and the confluence with the Pine River that could be affected by fluctuating water levels. Woodpecker surveys are occurring over a two-year period (2018 and 2019). Surveys in 2018 were focused on the middle and eastern reservoir, from the Halfway River east to the dam site and at select locations downstream of the dam to the Pine River.

2.2 Survey Station Locations

Survey station locations were stratified by habitat type. Terrestrial Ecosystem Mapping (TEM) developed for the EIS (Hilton et al., 2013) was used as the primary habitat base. Thirty-eight ecosystem types (site series/map codes) and seven structural stages were mapped in the Project footprint. Site series/map codes and structural stages were mapped together to form ecosystem units; 95 ecosystem units were mapped in the footprint, 73 of which could support woodpeckers. The TEM units provide fine-scale habitat mapping; however, there are too many to effectively stratify sampling and it was not be feasible to achieve an adequate number of samples in each of the 73 units for analysis. To address this, an intermediate-scale habitat classification was developed by combining similar ecosystem units based on dominant vegetation and stand age to form 21 habitat classes. The fine-scale TEM ecosystem units are nested within the intermediate-scale habitat classes to form a hierarchical classification system. Both levels were used to stratify and track sampling. The habitat classes were used to stratify and establish sampling targets. Within each habitat class, the goal was to sample the range of ecosystem units found in each class. Completed woodpecker surveys were tracked by the actual ecosystem unit documented at the survey station[1].

[1] For more details on the sampling plan, see the woodpecker sampling plan memo dated July 12, 2018 (BC Hydro 2018b).





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.
5. Figure prepared by Tetra Tech Canada.

Legend

- Woodpecker Survey Location
- Songbird Monitoring Study Area
- Potential Mitigation Property
- Proposed Transmission Corridor
- Highway
- Other Road
- Railway
- Provincial Boundary

1:275,000

0 10 km

BC Hydro TETRA TECH

Breeding Bird Follow-up Monitoring - Woodpeckers

Figure 1:
Locations of Woodpecker Surveys in 2018

Date	November 21, 2018	DWG NO	1016-C14-08894-1	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

2.3 Woodpecker Surveys

Call-playback surveys were used to survey woodpeckers. Surveys were completed in June, between sunrise and approximately 10 AM on each survey day. Call playback stations were placed no closer than 400 m apart. At each station, observers played commercially obtained woodpecker recordings over a speaker (FoxPro NX4 game caller) to elicit a response from any individuals in the area. After a one-minute initial listening period, calls for all seven woodpecker species were played at each station. Calls and territorial drums for each selected species were played consecutively, starting with the smallest woodpecker and ending with the largest. Playbacks for each individual species consisted of up to 20 seconds of calls followed by 30 seconds of silence, during which time observers looked and listened for a response. That sequence was repeated twice for each species. The same sequence of woodpecker calls was played during each survey at each station even when spontaneous calls were heard.

Many of the woodpecker call-playback surveys were conducted at the same location and time as songbird point counts for logistical efficiency. For those surveys, the woodpecker survey was conducted after the songbird point count.

Surveys were not done in inclement weather conditions (i.e., wind speed > Beaufort 3, steady rain, temperature < 7ºC). UTM coordinates (NAD 83), station start and end time, and weather conditions (i.e., wind, cloud cover, precipitation, and temperature) were recorded for each call station. When a woodpecker was detected, surveyors recorded the species, sex and age class (if possible), the activity, the number heard/seen, and the estimated distance (0-50 m, 50-100 m or >100 m) and direction to the initial detection location. Woodpecker detections were recorded as either spontaneously calling or as a call-playback response:

- Spontaneously calling - a woodpecker calling, drumming or observed during the initial 1-min listening period or at other times during the survey except during or after its own call or drum being played; or
- Call playback response – a woodpecker calling, drumming or observed when its own call or drum was being played or in the listening interval after.

All field data were recorded on standard forms for call-playback surveys. Incidental observations of other wildlife were recorded during surveys and while in the field.

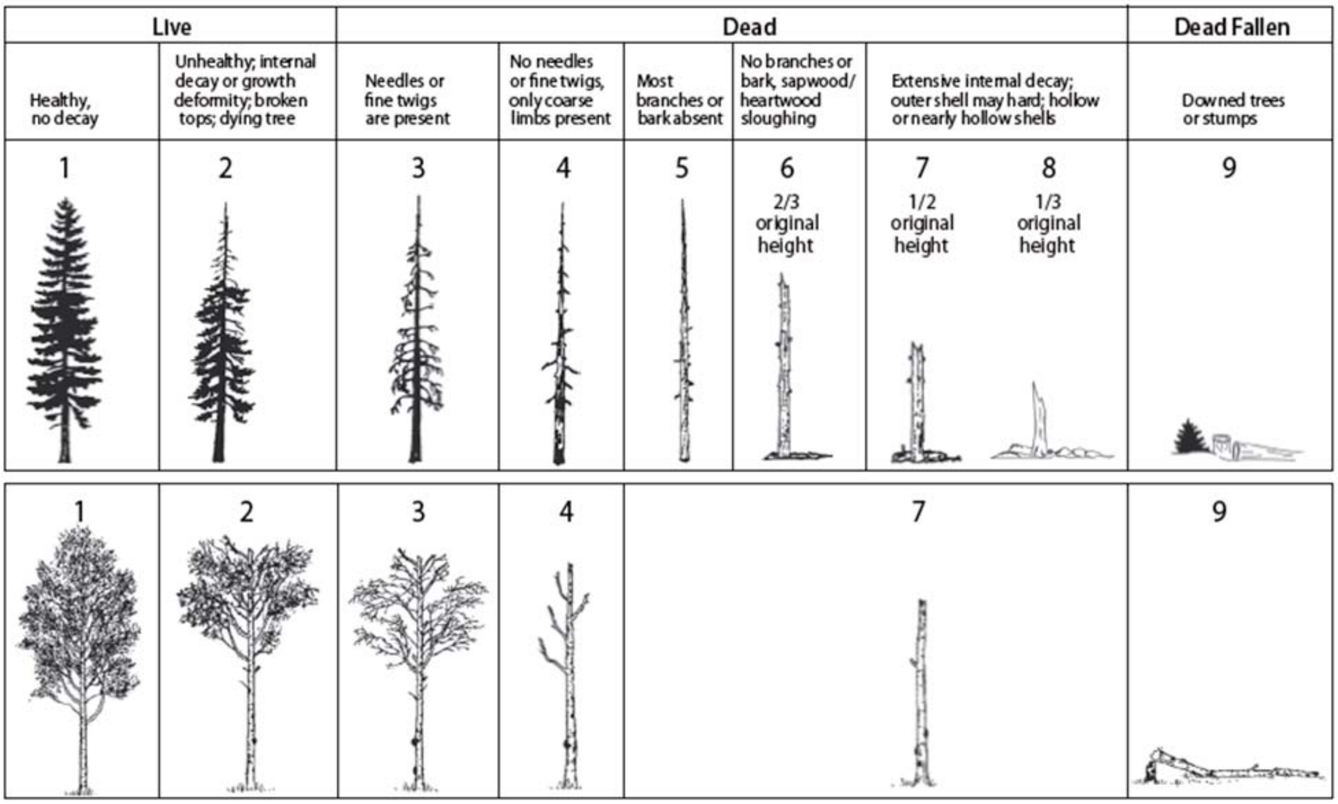
Any woodpecker nests observed while completing call-playback and songbird surveys were recorded. Data on tree height, tree species, diameter at breast height and decay class were recorded along with woodpecker species, nest height and cavity size.

Each station was surveyed two times per year. The results of the visits at each station were pooled using maximum detection (i.e., the greater number of each species found over both surveys at the station). This approach assumes that repeat observations of a species after the first visit are the same individuals, plus new individuals if a greater number is detected.

2.4 Collection of Habitat Data

Ecosystem attributes were recorded for each station and for any identified nest tree not near a station. These data were recorded on a Site Visit form (SIVI; British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment 2010) and included all site and vegetation fields with the exception of soil characteristics. In addition to the SIVI form attributes, data on dead standing trees were recorded. The number of dead standing trees >15 cm diameter at breast height were recorded within a 11.3 m radius of the plot centre according to the decay class (Figure 2). In addition, the number of dead standing trees >15 cm diameter at breast height within 50m of plot centre of any decay class were estimated.

Figure 2: Tree Decay Class Codes



Source: British Columbia Ministry of Forests and Range and British Columbia Ministry of Environment (2010)

3.0 RESULTS AND DISCUSSION

Woodpecker surveys were conducted at 101 locations in 2018 (Figure 1 and Appendix B). No survey stations were in the dam site area, the lower Moberly River, and the Peace River valley from the dam site west to Tea Creek and Tea Island, because these areas were predominantly cleared in 2016/2017. Attempts were made to access the portion of the Moberly River that has not yet been cleared (the upper portion of the Moberly River valley within the footprint) however high water levels and fast water flows prevented safe boat access. The number of stations surveyed in each ecosystem unit (Map Code/Site Series and Structural Stage) and according to the broader Bird Habitat Category is provided in Table 2.

Table 2: Number of Survey Stations Listed by Bird Habitat Category, Map Code and Structural Stage

Bird Habitat Category	Map Code	Ecosystem Name	Shrub	Pole/sapling	Young forest	Mature forest	Old forest	Total
Coniferous-mature forest	AM	SwAt - Step moss				3	1	**4**
	SH	Sw - Currant – Horsetail				1	3	**4**
	SO	Sw - Currant - Oak fern				1		**1**
Coniferous-young forest	LL	Pl - Lingonberry - Velvet-leaved blueberry			2			**2**
	SO	Sw - Currant - Oak fern			1			**1**
Deciduous-mature forest	AM:ap	$At - Creamy peavine				5	1	**6**
	SC:ab	$At – Black Twinberry				3	1	**4**
	SH:ac	$Ac – Cow parsnip				12	4	**16**
	SW:as	$At - Soopolallie				3		**3**
Deciduous-young forest	AM:ap	$At - Creamy peavine		1	4			**5**
	SH:ac	$Ac – Cow parsnip		4	4			**8**
	SW:as	$At - Soopolallie			1			**1**
Deciduous-shrub	AM:ap	$At - Creamy peavine	3					**3**
	SH:ac	$Ac – Cow parsnip	5					**5**
	SW:as	$At - Soopolallie	2					**2**
Fen/bog-treed	BT	Sb - Labrador tea – Sphagnum				1		**1**
Riparian-mixed mature forest	Fm02	ActSw - Red-osier dogwood				11	1	**12**
Riparian-mixed young forest	Fm02	ActSw - Red-osier dogwood		4	5			**9**
Riparian-mixed shrub	Fm02	ActSw - Red-osier dogwood	9					**9**
Wetland-riparian	WH	Willow – Horsetail – Sedge – Riparian Wetland	4					**4**
Wetland-shrub	WS	Willow – Sedge – Wetland	1					**1**
		Total	**24**	**9**	**17**	**40**	**11**	**101**

There were 240 woodpecker detections over both surveys at all stations. All seven species of woodpecker known to occur in the Peace River area were detected. The 240 detections represent a conservative estimate of 205 individual woodpeckers detected when the detections are pooled over both surveys using maximum detection. Of the 205 individuals counted, 20 could not be identified to the species level (11%). Other bird species were recorded as incidental observations and are provided in Appendix C. Yellow-bellied Sapsucker was the most frequently observed (n=61), while only two Black-backed Woodpeckers were recorded. Hairy Woodpecker and Pileated Woodpecker called spontaneously equally or more often than they responded to their species' call-playback, while the rest of the species responded more often than they called spontaneously. No woodpecker nests were observed.

Table 3: Woodpeckers Observed during the 2018 Surveys

Common Name	Woodpecker Detections[1]			Total Detections[3]	Total Maximum Count[4]
	Spontaneously Calling	Call Playback Response	NA[2]		
Yellow-bellied Sapsucker	32	49	-	**81**	**61**
Downy Woodpecker	5	9	1	**15**	**12**
Hairy Woodpecker	18	18	1	**37**	**35**
American Three-toed Woodpecker	12	19	1	**32**	**29**
Black-backed Woodpecker	0	2	-	**2**	**2**
Northern Flicker	17	20	3	**40**	**33**
Pileated Woodpecker	8	5	-	**13**	**13**
Unknown woodpecker species	-	-	20	**20**	**20**
Total	**92**	**122**	**26**	**240**	**205**

[1] The total number of detections over both surveys at all stations.

[2] Call type was written as NA (not available) when call type (i.e. spontaneously or call playback response) was uncertain.

[3] The total number of detections over both surveys at all stations.

[4] The greater number of each species found over both surveys at a station, totaled over all stations.

Woodpecker surveys in 2019 will focus on the reservoir west of the Halfway River (the western reservoir). For habitats that cannot be sufficiently sampled within the footprint due to small area, small patch sizes or footprint clearing, nearby locations outside the footprint may be surveyed in future years to supplement data collected inside the footprint. Data from stations outside the footprint will allow for inferences about woodpecker relative abundance and distribution in habitats within the footprint based on habitat associations.

Woodpecker habitat associations will be analyzed after the second year of data collection is complete in 2019.

4.0 REFERENCES

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APPENDIX A
SITE VISIT FORM USED TO COLLECT HABITAT DATA

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SITE VISIT FORM

PROJECT ID

Plot No.	Plot Type: Grnd ☐ Visual ☐ Note ☐ Other ☐	Date YY - MM - DD
Surveyors	Map Polygon No.	Plot Photo

Plot Location

FS Region/ District	East	North	UTM Zone
NTS Map.	Lat.	Long.	Accur. (+/- m)

Plot Representing

BGC	SS	SMR	SNR	Map Label

Site Features	Elevation	Slope %	Aspect	Surface Shape: ST ☐ CC ☐ CV ☐

Crest ☐ Upper ☐ Mid ☐ Lower ☐ Toe ☐ Level ☐ Dep. ☐ Gully ☐ | Flood Plain? ☐

Expose. Type ☐ insolation ☐ wind ☐ snow ☐ water spray ☐ misc.
☐ n/a ☐ frost ☐ cold air ☐ salt spray ☐ air toxicity ________

Site Disturb. ☐ fire ☐ site prep. ☐ terrain ☐ soil dist. ________
☐ n/a ☐ harvest ☐ planted ☐ biotic ☐ other ________

Stand Attributes	Stand Age ________ Est. ☐ Mea. ☐	Stand Ht. ________ Est. ☐ Mea. ☐	Canopy Composition

Struct. Stage: 1a ☐ 1b ☐ 2a ☐ 2b ☐ 2c ☐ 2d ☐ 3a ☐ 3b ☐ 4 ☐ 5 ☐ 6 ☐ 7a ☐ 7b ☐

Success Status: NV ☐ PS ☐ YS ☐ MS ☐ OS ☐ YC ☐ MC ☐ OC ☐ DC ☐

Terrain	Texture	Surficial Material	S. Expression	Geo. Process	Rock Types
1					1
2					2

Rooting Zone Drainage ☐ X ☐ R ☐ W ☐ M ☐ I ☐ P ☐ V

Humus/Organic Form ☐ Mor ☐ Moder ☐ Mull ☐ Fibric ☐ Mesic ☐ Humic

Humus Thickness ________ cm	Ah? ☐ Ae? ☐ ________ cm	Estimated Soil Depth ________ cm
R.Z. Soil Texture ________	R.Z.Coarse Fragment % ________	Estimated Rooting Depth ________ cm
Gleying or Mottling ☐ n/a ________ cm	Seepage ☐ n/a ________ cm	Restrict.Layer ☐ n/a ________ cm

Restrict. Type ☐ **C**ement ☐ **P**an ☐ **K**ompact ☐ **L**ithic ☐ **W**ater ☐ **X** Chem. ☐ **Z** Permafrost

SPP. LIST	COMP. ☐ PART. ☐	% COVER BY LAYER	TREE (A)	SHRUB (B)	HERB (C)	MOSS / LICHEN (D)	Associated Full Cruise Card ? ☐ No ☐ Yes

COL.	TREES & SHRUBS	A1	A2	A3	A	B1	B2	B	COL.	HERB LAYER (C)	%	COL.	MOSS / LICHEN / SEEDLING (D)	%

Notes/Diagram

Tree Mensuration

SPP.	dbh	Ht.	BH Age	Path. Y/N	Notes

FS 1333 HRE 2010/03

APPENDIX B

2018 WOODPECKER SURVEY STATIONS

Table B.1: Locations where Woodpecker Call Playback Surveys were Conducted in 2018

Station	UTM Zone	UTM Easting	UTM Northing	Map Code	Ecosystem Name	Structural Stage	Bird Habitat Category	First Survey	Second Survey
WP18-001	10	641639	6224309	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-08	2018-06-21
WP18-002	10	633002	6229458	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-08	2018-06-21
WP18-003	10	632417	6229230	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-08	2018-06-21
WP18-004	10	631488	6228735	AM	SwAt - Step moss	Old forest	Coniferous-mature forest	2018-06-08	2018-06-21
WP18-005	10	631099	6229226	SH	Sw - Currant – Horsetail	Old forest	Coniferous-mature forest	2018-06-08	2018-06-21
WP18-006	10	622925	6232926	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-05	2018-06-28
WP18-007	10	622555	6232738	SH	Sw - Currant – Horsetail	Old forest	Coniferous-mature forest	2018-06-05	2018-06-28
WP18-008	10	621857	6232323	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-05	2018-06-22
WP18-009	10	621810	6232833	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-05	2018-06-28
WP18-010	10	621689	6232556	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-05	2018-06-28
WP18-011	10	621362	6232894	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-05	2018-06-28
WP18-012	10	621366	6232348	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-09	2018-06-28
WP18-013	10	620935	6232637	SH:ac	$Ac – Cow parsnip	Old forest	Deciduous-mature forest	2018-06-09	2018-06-28
WP18-014	10	620529	6232153	WH	Willow – Horsetail – Sedge – Riparian Wetland	Shrub	Wetland-riparian	2018-06-10	2018-06-22
WP18-015	10	620530	6232670	SH:ac	$Ac – Cow parsnip	Young forest	Deciduous-young forest	2018-06-09	2018-06-28
WP18-016	10	620271	6232422	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-10	2018-06-28
WP18-017	10	620013	6232570	SH:ac	$Ac – Cow parsnip	Young forest	Deciduous-young forest	2018-06-10	2018-06-28
WP18-018	10	619957	6232152	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-05	2018-06-22
WP18-019	10	619501	6232556	AM:ap	$At - Creamy peavine	Pole/sapling	Deciduous-young forest	2018-06-05	2018-06-28
WP18-020	10	619089	6231954	AM:ap	$At - Creamy peavine	Old forest	Deciduous-mature forest	2018-06-05	2018-06-23
WP18-021	10	619041	6234009	SH:ac	$Ac – Cow parsnip	Young forest	Deciduous-young forest	2018-06-09	2018-06-22
WP18-022	10	618930	6233543	Fm02	ActSw - Red-osier dogwood	Young forest	Riparian-mixed young forest	2018-06-09	2018-06-22

Table B.1: Locations where Woodpecker Call Playback Surveys were Conducted in 2018

Station	UTM Zone	UTM Easting	UTM Northing	Map Code	Ecosystem Name	Structural Stage	Bird Habitat Category	First Survey	Second Survey
WP18-023	10	618874	6232727	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-09	2018-06-22
WP18-024	10	618864	6233150	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-09	2018-06-22
WP18-025	10	618646	6232004	AM:ap	$At - Creamy peavine	Mature forest	Deciduous-mature forest	2018-06-05	2018-06-23
WP18-026	10	618268	6232370	WH	Willow – Horsetail – Sedge – Riparian Wetland	Shrub	Wetland-riparian	2018-06-05	2018-06-22
WP18-027	10	617820	6232407	WH	Willow – Horsetail – Sedge – Riparian Wetland	Shrub	Wetland-riparian	2018-06-05	2018-06-22
WP18-028	10	617576	6232945	AM:ap	$At - Creamy peavine	Mature forest	Deciduous-mature forest	2018-06-05	2018-06-18
WP18-029	10	617020	6232467	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-05	2018-06-22
WP18-030	10	616897	6233118	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-05	2018-06-18
WP18-031	10	616446	6332443	SC:ab	$At – Black Twinberry	Mature forest	Deciduous-mature forest	2018-06-05	2018-06-23
WP18-032	10	616369	6233374	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-05	2018-06-18
WP18-033	10	616393	6232805	SH	Sw - Currant – Horsetail	Mature forest	Coniferous-mature forest	2018-06-05	2018-06-23
WP18-034	10	615844	6232810	SC:ab	$At – Black Twinberry	Mature forest	Deciduous-mature forest	2018-06-07	2018-06-28
WP18-035	10	615847	6233185	SH	Sw - Currant – Horsetail	Old forest	Coniferous-mature forest	2018-06-07	2018-06-28
WP18-036	10	615585	6233526	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-10	2018-06-29
WP18-037	10	615317	6233228	SC:ab	$At – Black Twinberry	Old forest	Deciduous-mature forest	2018-06-07	2018-06-29
WP18-038	10	615117	6234060	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-10	2018-06-29
WP18-039	10	615062	6233655	SH:ac	$Ac – Cow parsnip	Old forest	Deciduous-mature forest	2018-06-10	2018-06-29
WP18-040	10	614793	6234423	AM	SwAt - Step moss	Mature forest	Coniferous-mature forest	2018-06-07	2018-06-29
WP18-041	10	614549	6234686	AM	SwAt - Step moss	Mature forest	Coniferous-mature forest	2018-06-07	2018-06-07
WP18-042	10	614210	6234883	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-07	2018-06-29
WP18-043	10	614139	6235318	Fm02	ActSw - Red-osier dogwood	Pole/sapling	Riparian-mixed young forest	2018-06-06	2018-06-20
WP18-044	10	613742	6235636	Fm02	ActSw - Red-osier dogwood	Young forest	Riparian-mixed young forest	2018-06-06	2018-06-20

Table B.1: Locations where Woodpecker Call Playback Surveys were Conducted in 2018

Station	UTM Zone	UTM Easting	UTM Northing	Map Code	Ecosystem Name	Structural Stage	Bird Habitat Category	First Survey	Second Survey
WP18-045	10	613635	6235919	Fm02	ActSw - Red-osier dogwood	Pole/sapling	Riparian-mixed young forest	2018-06-06	2018-06-20
WP18-046	10	613635	6235134	WH	Willow – Horsetail – Sedge – Riparian Wetland	Shrub	Wetland-riparian	2018-06-06	2018-06-20
WP18-047	10	613328	6236197	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-06	2018-06-18
WP18-048	10	613161	6235423	AM:ap	$At - Creamy peavine	Mature forest	Deciduous-mature forest	2018-06-06	2018-06-29
WP18-049	10	613003	6235785	AM	SwAt - Step moss	Mature forest	Coniferous-mature forest	2018-06-06	2018-06-20
WP18-050	10	612686	6236761	AM:ap	$At - Creamy peavine	Mature forest	Deciduous-mature forest	2018-06-10	2018-06-20
WP18-051	10	612552	6235999	SW:as	$At - Soopolallie	Mature forest	Deciduous-mature forest	2018-06-06	2018-06-29
WP18-052	10	612218	6236450	SW:as	$At - Soopolallie	Mature forest	Deciduous-mature forest	2018-06-06	2018-06-20
WP18-053	10	612211	6236997	SW:as	$At - Soopolallie	Shrub	Deciduous-shrub	2018-06-10	2018-06-20
WP18-054	10	611867	6236644	AM:ap	$At - Creamy peavine	Young forest	Deciduous-young forest	2018-06-10	2018-06-29
WP18-055	10	611744	6237305	SW:as	$At - Soopolallie	Shrub	Deciduous-shrub	2018-06-10	2018-06-20
WP18-056	10	611259	6237635	AM:ap	$At - Creamy peavine	Shrub	Deciduous-shrub	2018-06-10	2018-06-20
WP18-057	10	611156	6236994	SO	Sw - Currant - Oak fern	Mature forest	Coniferous-mature forest	2018-06-10	2018-06-29
WP18-058	10	610608	6237961	AM:ap	$At - Creamy peavine	Young forest	Deciduous-young forest	2018-06-03	2018-06-24
WP18-059	10	610461	6236966	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-10	2018-06-29
WP18-060	10	609194	6236762	SH:ac	$Ac – Cow parsnip	Shrub	Deciduous-shrub	2018-06-03	2018-06-21
WP18-061	10	609036	6238518	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-03	2018-06-21
WP18-062	10	608770	6236650	SH:ac	$Ac – Cow parsnip	Pole/sapling	Deciduous-young forest	2018-06-03	2018-06-21
WP18-063	10	608698	6238604	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-03	2018-06-21
WP18-064	10	608639	6237777	LL	Pl - Lingonberry - Velvet-leaved blueberry	Young forest	Coniferous-young forest	2018-06-06	2018-06-18
WP18-065	10	608567	6238059	SC:ab	$At – Black Twinberry	Mature forest	Deciduous-mature forest	2018-06-02	2018-06-18
WP18-066	10	608571	6237001	SH:ac	$Ac – Cow parsnip	Shrub	Deciduous-shrub	2018-06-03	2018-06-21
WP18-067	10	608388	6238236	LL	Pl - Lingonberry - Velvet-leaved blueberry	Young forest	Coniferous-young forest	2018-06-06	2018-06-18
WP18-068	10	608162	6236483	SH:ac	$Ac – Cow parsnip	Pole/sapling	Deciduous-young forest	2018-06-03	2018-06-29

Table B.1: Locations where Woodpecker Call Playback Surveys were Conducted in 2018

Station	UTM Zone	UTM Easting	UTM Northing	Map Code	Ecosystem Name	Structural Stage	Bird Habitat Category	First Survey	Second Survey
WP18-069	10	607989	6239142	Fm02	ActSw - Red-osier dogwood	Pole/sapling	Riparian-mixed young forest	2018-06-03	2018-06-21
WP18-070	10	607888	6236654	SH:ac	$Ac – Cow parsnip	Shrub	Deciduous-shrub	2018-06-03	2018-06-24
WP18-071	10	607685	6235599	SH:ac	$Ac – Cow parsnip	Shrub	Deciduous-shrub	2018-06-12	2018-06-29
WP18-072	10	607597	6239258	Fm02	ActSw - Red-osier dogwood	Mature forest	Riparian-mixed mature forest	2018-06-21	Not surveyed
WP18-073	10	607477	6234613	SH:ac	$Ac – Cow parsnip	Old forest	Deciduous-mature forest	2018-06-12	2018-06-29
WP18-074	10	607416	6237266	SW:as	$At - Soopolallie	Young forest	Deciduous-young forest	2018-06-06	2018-06-18
WP18-075	10	607302	6236178	SW:as	$At - Soopolallie	Mature forest	Deciduous-mature forest	2018-06-03	2018-06-24
WP18-076	10	607154	6235037	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-03	2018-06-24
WP18-077	10	606970	6236096	WS	Willow – Sedge – Wetland	Shrub	Wetland-shrub	2018-06-03	2018-06-24
WP18-078	10	606856	6234373	Fm02	ActSw - Red-osier dogwood	Old forest	Riparian-mixed mature forest	2018-06-12	2018-06-29
WP18-079	10	606572	6234119	Fm02	ActSw - Red-osier dogwood	Shrub	Riparian-mixed shrub	2018-06-12	2018-06-29
WP18-080	10	606212	6235316	BT	Sb - Labrador tea – Sphagnum	Mature forest	Fen/bog-treed	2018-06-03	2018-06-24
WP18-081	10	607214	6235407	AM:ap	$At - Creamy peavine	Shrub	Deciduous-shrub	2018-06-03	2018-06-24
WP18-082	10	603660	6233206	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-11	2018-06-29
WP18-084	10	602661	6233041	AM:ap	$At - Creamy peavine	Mature forest	Deciduous-mature forest	2018-06-12	2018-06-29
WP18-085	10	602464	6233469	Fm02	ActSw - Red-osier dogwood	Young forest	Riparian-mixed young forest	2018-06-11	2018-06-28
WP18-086	10	602239	6232979	AM:ap	$At - Creamy peavine	Young forest	Deciduous-young forest	2018-06-12	2018-06-29
WP18-087	10	601823	6233491	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-11	2018-06-28
WP18-088	10	600857	6233244	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-11	2018-06-28
WP18-089	10	600271	6233456	Fm02	ActSw - Red-osier dogwood	Young forest	Riparian-mixed young forest	2018-06-11	2018-06-28
WP18-090	10	599832	6232981	Fm02	ActSw - Red-osier dogwood	Young forest	Riparian-mixed young forest	2018-06-11	2018-06-28
WP18-091	10	599287	6232721	SH:ac	$Ac – Cow parsnip	Young forest	Deciduous-young forest	2018-06-11	2018-06-28
WP18-092	10	598260	6232430	SH:ac	$Ac – Cow parsnip	Shrub	Deciduous-shrub	2018-06-11	2018-06-28

Table B.1: Locations where Woodpecker Call Playback Surveys were Conducted in 2018

Station	UTM Zone	UTM Easting	UTM Northing	Map Code	Ecosystem Name	Structural Stage	Bird Habitat Category	First Survey	Second Survey
WP18-093	10	597266	6231178	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-11	2018-06-28
WP18-094	10	596396	6231752	Fm02	ActSw - Red-osier dogwood	Pole/sapling	Riparian-mixed young forest	2018-06-07	2018-06-30
WP18-095	10	594547	6232230	SO	Sw - Currant - Oak fern	Young forest	Coniferous-young forest	2018-06-07	2018-06-20
WP18-096	10	593936	6232047	SH:ac	$Ac – Cow parsnip	Old forest	Deciduous-mature forest	2018-06-07	2018-06-20
WP18-097	10	593059	6233754	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-07	2018-06-20
WP18-098	10	592405	6234286	SH:ac	$Ac – Cow parsnip	Mature forest	Deciduous-mature forest	2018-06-07	2018-06-20
WP18-099	10	591515	6233829	SH:ac	$Ac – Cow parsnip	Pole/sapling	Deciduous-young forest	2018-06-07	2018-06-20
WP18-100	10	590979	6234003	AM:ap	$At - Creamy peavine	Young forest	Deciduous-young forest	2018-06-07	2018-06-20
WP18-101	10	590642	6234575	SH:ac	$Ac – Cow parsnip	Pole/sapling	Deciduous-young forest	2018-06-07	2018-06-20
WP18-102	10	578574	6220431	AM:ap	$At - Creamy peavine	Shrub	Deciduous-shrub	2018-06-11	2018-06-27

APPENDIX C

INCIDENTAL BIRD OBSERVATIONS

Table C.1: Incidental Observations of Birds Recorded Outside of Surveys and Birds Recorded During Surveys that are not Woodpeckers

Common Name	Scientific Name	BC List	COSEWIC	SARA	Number of Detections
Canada Goose	*Branta canadensis*	Yellow	-	-	3
Ruffed Grouse	*Bonasa umbellus*	Yellow	-	-	1
Common Nighthawk	*Chordeiles minor*	Yellow	Special Concern	Threatened	2
Wilson's Snipe	*Gallinago delicata*	Yellow	-	-	1
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	-	-	1
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	-	-	1
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Yellow	-	-	1
Hairy Woodpecker	*Picoides villosus*	Yellow	-	-	1
American Three-toed Woodpecker	*Picoides dorsalis*	Yellow	-	-	1
Pileated Woodpecker	*Dryocopus pileatus*	Yellow	-	-	2
Olive-sided Flycatcher	*Contopus cooperi*	Blue	Special Concern	Threatened	9
Alder Flycatcher	*Empidonax alnorum*	Yellow	-	-	5
Least Flycatcher	*Empidonax minimus*	Yellow	-	-	12
Pacific-slope Flycatcher	*Empidonax difficilis*	Yellow	-	-	1
Warbling Vireo	*Vireo gilvus*	Yellow	-	-	1
Red-eyed Vireo	*Vireo olivaceus*	Yellow	-	-	9
Black-billed Magpie	*Pica hudsonia*	Yellow	-	-	2
American Crow	*Corvus brachyrhynchos*	Yellow	-	-	1
Common Raven	*Corvus corax*	Yellow	-	-	1
Tree Sparrow	*Tachycineta bicolor*	Yellow	-	-	1
Black-capped Chickadee	*Poecile atricapillus*	Yellow	-	-	1
Boreal Chickadee	*Poecile hudsonicus*	Yellow	-	-	2
Red-breasted Nuthatch	*Sitta canadensis*	Yellow	-	-	8
Ruby-crowned Kinglet	*Regulus calendula*	Yellow	-	-	1
Swainson's Thrush	*Catharus ustulatus*	Yellow	-	-	16
Hermit Thrush	*Catharus guttatus*	Yellow	-	-	1
American Robin	*Turdus migratorius*	Yellow	-	-	3
White-winged Crossbill	*Loxia leucoptera*	Yellow	-	-	3
Ovenbird	*Seiurus aurocapilla*	Yellow	-	-	6
Black-and-white Warbler	*Mniotilta varia*	Yellow	-	-	1
Common Yellowthroat	*Geothlypis trichas*	Yellow	-	-	2
American Redstart	*Setophaga ruticilla*	Yellow	-	-	1
Yellow Warbler	*Setophaga petechia*	Yellow	-	-	2
Black-throated Gray Warbler	*Setophaga nigrescens*	Yellow	-	-	2
Black-throated Green Warbler	*Setophaga virens*	Blue	-	-	2
Canada Warbler	*Cardellina canadensis*	Blue	Threatened	Threatened	2
Chipping Sparrow	*Spizella passerina*	Yellow	-	-	3
Clay-colored Sparrow	*Spizella pallida*	Yellow	-	-	2

Table C.1: Incidental Observations of Birds Recorded Outside of Surveys and Birds Recorded During Surveys that are not Woodpeckers

Common Name	Scientific Name	BC List	COSEWIC	SARA	Number of Detections
Song Sparrow	*Melospiza melodia*	Yellow	-	-	2
White-throated Sparrow	*Zonotrichia albicollis*	Yellow	-	-	21
Western Tanager	*Piranga ludoviciana*	Yellow	-	-	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Yellow	-	-	3
Red-winged Blackbird	*Agelaius phoeniceus*	Yellow	-	-	2
Brewer's Blackbird	*Euphagus cyanocephalus*	Yellow	-	-	15
Baltimore Oriole	*Icterus galbula*	Blue	-	-	1

APPENDIX D
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report author
Camille Roberge, B.Sc., E.Pt. Tetra Tech Canada Inc.	Field data collection, data entry, report author
Elyse Hofs, B.Sc., Dipl.T. Tetra Tech Canada Inc.	Field data collection, data entry
Todd Heakes Tetra Tech Canada Inc.	Field data collection
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection
Kerrith McKay, M.Sc. McKay Environmental Consulting Ltd.	Field data collection

APPENDIX E
LIMITATIONS ON THE USE OF THIS DOCUMENT

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").

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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.

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This Professional Document is based solely on the conditions presented and the data available to SEES JV at the time the data were collected in the field or gathered from available databases.

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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.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

SEES JV professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by SEES JV of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by SEES JV in its reasonably exercised discretion.

Appendix 5. Waterbird Migration Follow-up Monitoring Program – 2018

Site C Vegetation and Wildlife Waterbird Migration Follow-up Monitoring Program – 2018

Prepared for:

BC Hydro
Site C Clean Energy Project
1055 Dunsmuir Street
PO Box 49260, BC V7X 1V5

Project No. 398-173.09

Prepared by:

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March 26, 2019

EXECUTIVE SUMMARY

Waterbird surveys were conducted on the Peace River and transmission line portions of the Site C Clean Energy Project study area in 2017 and 2018. Ground (i.e., on-foot), river boat, unmanned aerial vehicle (UAV), and autonomous recording unit (ARU) survey methods were used to obtain location-specific records of waterbird abundance and habitat associations. Survey results will be used to assess Project-related changes in waterbird abundance, density, and diversity, as per the objectives of the Waterbird Migration Follow-up Monitoring Program.

This report details the results of surveys conducted in 2017 and 2018. Descriptive statistics present the results relative to monitoring objectives. Survey results from 2017 and 2018 are pooled for data analysis where detection rates and survey timing are comparable due to similar survey methods; however, not all data collected in 2017 could be pooled because of changes to methods in 2018 that will continue to be employed for future monitoring. Following an independent analysis of the 2017 survey data and approach by Native Plant Solutions/Ducks Unlimited, a consensus was reached between BC Hydro and Environment and Climate Change Canada (ECCC) to adjust survey methods in 2018 to account for potential biases in waterbird detection rates across wetlands (e.g., cease aerial surveys, which underrepresented shorebirds and reduced detection accuracy) and to encompass a broader period for fall migration (i.e., extend surveys into mid-late October).

Results presented herein describe variation in waterbird abundance, density and diversity within and between seasons (during three and four survey periods within spring migration [April 1 – May 30] and fall migration [August 1 – October 30], respectively) as well as across habitat types and study areas. These descriptive statistics are determined based on cumulative counts of all waterbird species, and for seven foraging guilds comprised of species with similar morphology and foraging strategies: Large dabblers, dabbling ducks, benthic feeding divers, piscivorous divers, shorebirds, gulls and surface feeding terns, and marsh birds.

On the Peace River between Hudson's Hope and the Alberta Border, a total of five and six surveys were conducted during waterbird migrations in spring and fall, respectively. Results were compiled based on pooling the data from 2017 and 2018 surveys that were conducted using the same methods. Peak waterbird abundance during spring surveys occurred in the early survey period (April 1 – 15), with 3,179 birds observed on average across the Peace River study area. Mean waterbird abundances recorded in early spring were higher than any other period in the spring or fall. During fall, the highest waterbird abundances were recorded within the early-middle survey period (August 15 – September 14: 1,606 birds). The most abundant species guild was large dabblers, followed by dabbling ducks and gulls. Across Peace River habitat types, the greatest densities of waterbirds were recorded in Island (18.79 birds/km) and Off-channel (15.76 birds/km) reaches during spring, and in Confluence (48.63 birds/km) reaches during fall. The relatively high waterbird densities observed during fall were largely driven by high numbers (i.e., large flocks) of gulls. There were a total of 43 species of birds observed along the Peace River during 2018 surveys and 47 across 2017 and 2018 surveys. The highest diversity of waterbird species was recorded in the spring, specifically, during the middle-spring survey period (36 species; Shannon-Weiner Index: 1.80).

Wetlands along the Project transmission line route on the Moberly Plateau were surveyed during four and six survey events over the course of spring (April 27 - May 17) and fall (August 6 - October 19), respectively, during 2018. A total of 31 wetland stations were surveyed in 2018, encompassing all wetland habitat types considered potentially suitable for use by waterbirds: open water, sedge, willow sedge, tamarack sedge and Labrador tea-sedge. Surveys in 2018 (100 m transects, stationary standwatch, and aerial UAV surveys) detected a total of 34 species across wetland types. Open water stations surveyed by standwatch methods in 2017 (six stations, 24 species) provided comparable data, which was pooled for analysis with 2018 data to determine average densities within each survey period. Results for other stations are based on survey data from only 2018. The greatest densities of waterbirds were detected on open water wetlands within late spring and through late-middle fall (6.04-7.56 birds/hectare). Dabbling ducks were the most abundant waterbirds across all wetland types and survey methods. Species diversity was highest within open water habitats as observed during standwatches (29 species in 2018), followed by vegetated wetland habitats (14 species) as observed during transects. Species diversity in wetland habitats was highest during the late-spring migration periods. Lower waterbird densities and diversity during the early spring (April) and late fall (October) were apparently influenced by freezing conditions associated with relatively limited use of wetlands by waterbirds. Bioacoustics monitoring in 2017 and 2018 using ARU detected sora (*Porzana carolina*) at seven of seven sites, and yellow rail (*Coturnicops noveboracensis*) at one of seven sites, where the species was detected for the first time during this monitoring program in 2018.

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1.0 INTRODUCTION

This report describes the results of the 2017 and 2018 Waterbird Migration Follow-up Monitoring Program surveys for shorebirds, marsh birds, waterfowl, and other birds associated with aquatic and wetland habitats (collectively known as 'waterbirds'). This program is being conducted to fulfill, in part, the requirements and conditions set forth in the Site C Clean Energy Project's Provincial Environmental Assessment Certificate (EAC) (Condition 21) and the Federal Decision Statement (FDS) (Conditions 10.2 10.3, 11.3 and 11.4).

1.1 Background

In the Site C Environmental Impact Statement (EIS), BC Hydro assessed the potential effects of the Site C Clean Energy Project (the Project) on Wildlife Resources using key species groups, including shorebirds, marsh birds, and waterfowl (BC Hydro 2013). Effects of the Project on these waterbirds were assessed in terms of habitat alteration and fragmentation, disturbance and displacement, and mortality (BC Hydro 2013).

The EIS assessed the residual effect of the Project on waterfowl and shorebirds as high magnitude because of the anticipated extent of river and back channel habitat loss (i.e., habitat alteration and fragmentation). The duration and geographic extent of the effect is dependent on waterbird use of the reservoir and wetlands created through habitat compensation. There was low confidence in the characterization of this expected use, because use will depend on the success of vegetation establishment along the boundaries of the reservoir, the extent of ice formation in the reservoir, the use of nest boxes, and the use of nesting habitat in artificial and created wetlands (BC Hydro 2013).

BC Hydro coordinated baseline studies of waterbirds in the Peace River and adjacent wetlands in 2006, 2008 and 2012 through 2014. Baseline waterbird studies employed fixed-wing aircraft and twin-engine helicopter surveys and, to a lesser extent, ground and boat surveys (Simpson and Andrusiak 2009, BC Hydro 2013, Churchland et al. 2015). The Vegetation and Wildlife Technical Committee (VWTC) reviewed the summary of baseline studies for waterbirds and noted that no shorebirds were documented during helicopter and fixed-wing aircraft surveys between 2012 and 2014. The lack of shorebird observations during aerial surveys prompted the VWTC to request that a follow-up monitoring program better suited to detecting small birds be developed to provide a more complete assessment of waterbird use of the Peace River during spring and fall migration periods. Such a program was developed in conjunction with the VWTC, and this report provides the summary results from waterbird surveys conducted in 2017 and 2018.

1.2 Monitoring Objectives

The objective of the follow-up monitoring program is to address uncertainties regarding the effects of the Project (i.e., change from river valley to reservoir and changes in flow regime) on waterbirds that use habitat along and surrounding the Peace River (including wetland and non-wetland areas). Data collected will be used to help satisfy the monitoring requirements of the FDS and EAC, by evaluating the effectiveness of mitigation and compensation measures for waterbirds, and to verify the accuracy of the predictions made in the EIS regarding waterbirds and their habitat. The specific objectives are to:

1. Assess changes in waterbird wetland and non-wetland habitat on the Peace River and the transmission line route from Project construction through to the first 10 years of Project operations to assess Project-related impacts relative to those predicted in the EIS (EIS Volume 2; Appendix R-Section 4.1);

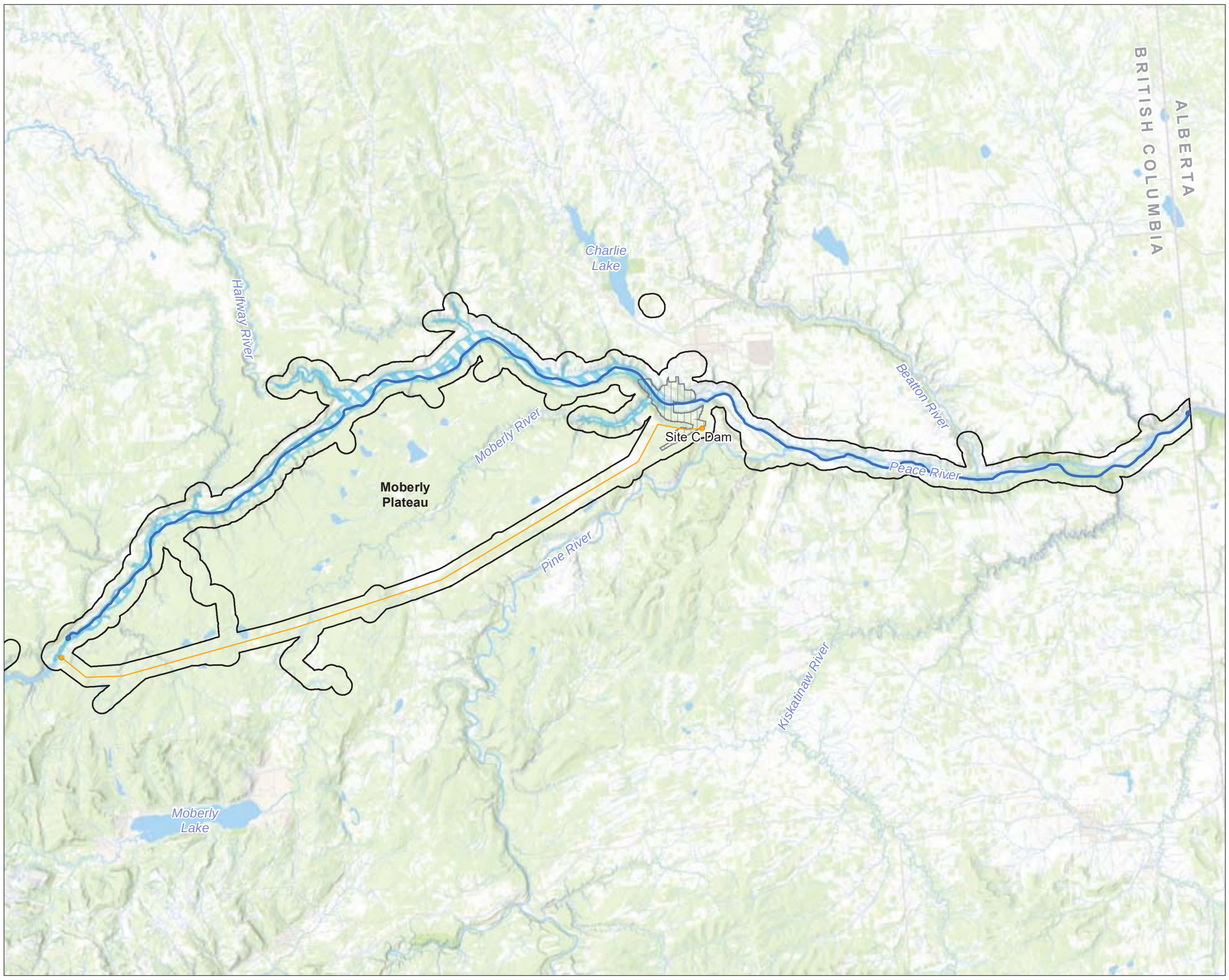
2. Document changes in waterbird relative abundance and diversity across habitats (Peace River and wetlands) during the first 10 years of Project operations relative to pre-reservoir and transmission line (2017-2019) conditions to assess Project-related impacts relative to those predicted in the EIS (EIS Volume 2; Appendix R- Section 4.1); and
3. Monitor waterbird use of natural and created compensatory wetland features from Project construction through to the first 10 years of Project operations to evaluate the effectiveness of mitigation and compensation measures.

The monitoring program will improve the understanding of baseline conditions for waterbirds and allow a robust assessment of Project-related changes in habitat and habitat use by waterbirds. This report contains data from 2017 and 2018 using methods designed to provide improved species identification and to detect shorebirds and other small waterbirds. As such, analyses of change compared to data collected in prior years using aerial survey methods are not possible. Comparisons to data from boat surveys conducted in 2006 and 2008 may be possible in future analyses but would be complicated by inconsistencies in the historical and updated boat survey methods and timing. Descriptive statistics and mapping of the 2017 and 2018 data show their utility for future analyses of change to assess any changes in abundance and/or re-distribution of waterbirds from impacted habitat to adjacent wetlands, both natural and created.

1.3 Study Area and Temporal Scope

The study area for the Waterbird Migration Follow-up Monitoring Program comprises the Peace River between Hudson's Hope and the Alberta border, and wetland habitat on the Moberly Plateau within 2 km of the Project transmission line local assessment area (**Figure 1**). Additional wetland habitat within the Moberly Plateau that was surveyed from fixed-wing aircraft during 2017 was not surveyed in 2018 because species identification was seldom possible from the elevations required for flight safety, and access from the ground is limited. Sites with newly enhanced and created compensation wetlands with waterbird habitat will be included in the study area as they are identified.

Waterbird survey data were collected in 2017 and 2018 and will be collected each year through the Project construction period and for the first 10 years of Project operations, as per EAC Condition 21. The monitoring program is focused on spring and fall migration periods because the greatest numbers and diversity of waterbirds are present in the study area during those periods (Simpson and Andrusiak 2009, Hilton et al. 2013). In 2017, surveys of the Peace River, and wetland habitats adjacent to the Project transmission line were conducted during three survey periods within each of the spring (April/May) and fall (August/September) migrations to document early, middle, and late migrants in each season. In 2018, following recommendations from Environment and Climate Change Canada (ECCC) and Native Plant Solutions / Ducks Unlimited (NPS/DU), fall surveys of the Peace River were extended into October and a fourth survey period was included to obtain additional data on late migrating waterbird species (e.g., merganser [*Mergus*] and goldeneye [*Bucephala*] species). During the spring, Peace River surveys started earlier than wetland surveys along the transmission line to document waterbirds using the river before upland wetlands thawed. Prior to thawing, wetlands along the transmission line are unavailable for waterbird foraging use and waterbirds primarily use habitat along the Peace River. During the fall, river and transmission line surveys were conducted concurrently.



Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Study Areas of the Waterbird Monitoring Program on the Peace River and Moberly Plateau

Legend

- Site C LAA
- Proposed Dam Site
- Proposed Reservoir
- Wetlands Survey Adjacent to Transmission Line Right of Way
- Peace River Boat Survey Transect
- Provincial Border

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

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2.0 MONITORING METHODS

Survey methods to meet the objectives of the waterbird monitoring program were developed using guidance from Resource Inventory Standards Committee (RISC) protocols, with review from the VWTC and subsequent input from ECCC and Native Plant Solutions. The survey methods employed during the 2018 field program are described in the following sections. Rationale for the methods is presented in the workplan (BC Hydro 2018).

Baseline surveys conducted for waterfowl between 2006 and 2014 were designed to assess species within the orders Anseriformes (i.e., ducks, geese, and swans), Procellariiformes (i.e., loons), and Podicipediformes (i.e., grebes). Surveys in 2015 and 2016 (Mushanski et al 2015 and 2016, Hemmera 2016) using the same methods expanded the focus to include Charadriiformes (e.g., snipe, sandpipers, phalaropes, plovers, gulls, terns, avocets), Gruiformes (e.g., rails), and Pelecaniformes (e.g., bitterns). The Waterbird Migration Follow-up Monitoring Program conducted in 2017 and 2018 was designed to survey the full range of waterbirds present in the study area.

Differences in site accessibility and detection constraints across habitat types require multiple survey methods for the Peace River and wetlands adjacent to the Project transmission line. The Peace River was surveyed by boat along the mainstem of the river and within any channels accessible by boat. Unmanned aerial vehicle (UAV) surveys were used to survey areas of the river that were either too shallow or otherwise obstructed from boat access. Wetlands along the Project transmission line were surveyed using fixed length (100 metre) transects in all vegetated habitat, standwatch (20 minute) stationary surveys in open water habitat with unobstructed lines of sight, and UAV surveys (5 hectares) in wetlands with areas of open water where lines of sight were obstructed from the ground (e.g., high vegetation). Autonomous recording units (ARU) were used within wetland habitats along the Project transmission line to monitor species not easily detected with visual surveys. For example, the likelihood of detecting marsh birds is highest in the half hour between sunset and complete darkness (Conway 2011), which is a time of day that is difficult to survey due to safety concerns.

All waterbirds and all provincially or federally-listed species observed were recorded during waterbird surveys. The time and precise (UTM) location of waterbird observations using time-referenced waypoints, along with species, number of individuals, habitat characteristics, and distance measures from observation locations were recorded. The distribution of habitat types across the study area was derived from available terrestrial ecosystem mapping (TEM) data and satellite imagery to categorise wetland and river reach types. Potential impacts to waterbirds will be measured in terms of changes in relative abundance and diversity across habitat and river reach types (BC Hydro 2018).

Within the subsequent sections, the following terminology is used to define the temporal scope of survey efforts:

- **Survey Day** – Survey effort in a given day, which covers only a portion of the transmission line route wetlands or Peace River study areas.
- **Survey Event** – A group of survey days, which together encompass the entire Peace River or all wetlands within transmission line route study area
- **Survey Period** – A period of time which encompasses a defined period of spring or fall migration, typically encompassing the peak migration of one or more species groups (i.e., foraging guilds).

2.1 Habitat Assessment

Prior to field surveys, the area of wetland habitat types within the Peace River Valley and Moberly Plateau study areas were summarized in 2017 from existing TEM data using ARCGIS Desktop (v.10.5.1) software (Hemmera 2018). The most widespread wetland habitat types in the study area are Labrador tea-sedge and tamarack-sedge (Table 1, **Figure 5**). Sedge and open water were less widespread, and willow-sedge was the least common wetland habitat type. Habitat parameters for which data were collected with waterbird observations are described for each survey method in **Sections 2.2** and **2.3.** Habitat data specific to the transmission line wetland survey stations are presented in **Section 4.2.**

Table 1 Area of wetland habitat types in the Peace River Valley and Moberly Plateau study area

Habitat Type	Area (ha)
Labrador tea-sedge	7,243
Tamarack-sedge	4,749
Cultivated field	3,845
Sedge	1,782
Open water	1,535
Willow-sedge	720
Non-forested floodplain wetlands	440

Water discharge data can help to explain variation in water flow and depth within the Peace River, which may influence waterbird abundance and distribution. Hourly waterflow data were obtained from BC Hydro and summarized using SigmaPlot (v.12.5) to illustrate the frequency of flow rates at a representative site along the Peace River within the Control and Impact treatment areas. Flow rate data were then linked to the waterbird database using Microsoft Access to provide an estimated flow rate for each waterbird record specific to the treatment area in which birds were observed. The flow rate record from the nearest hour was assigned to each waterbird record based on the time of observation in the field. Frequency distributions of flow rates at the time of waterbird observations were generated from the resulting dataset, using SigmaPlot to determine if data were recorded during a representative distribution of water flow rates including the full range of water regimes. Following subsequent years of data collection, flow rate data will also be used as a habitat variable in models describing waterbird distribution on the Peace River.

2.2 Peace River Waterbird Surveys – Boat and UAV

2.2.1 Study Design

The Peace River surveys assess the relative abundance and diversity of waterbirds using riverine and backchannel habitat in the Peace River valley. Native Plant Solutions (Ducks Unlimited) conducted a power analysis of the 2017 waterbird monitoring data to determine the number of surveys within and across years required to detect a 50% change in waterbird abundance (NPS 2018). Given variability observed in waterbird numbers across survey periods, a similar level of effort was recommended for 2018. Thus, five surveys were conducted for the spring and six surveys were conducted in the fall with shorter spacing between spring surveys to account for higher variance during that season and a shorter migration period. Surveys from 2017 and 2018 will provide measures of within and between season variability as well as initial estimates of inter-annual variance which will be refined following subsequent years of data collection.

To assess the relative abundance and diversity of waterbirds along the Peace River, a before-after-control-impact (BACI) design is being used to distinguish between background and Project-related changes in waterbird relative abundance and diversity. Areas surveyed to assess impacts are: (i) the Site C reservoir from the Peace Canyon Dam to the Project site (impact from inundation; **Figure 2**), (ii) the Peace River from the Site C dam to the Pine River confluence with the Peace River (impact from change in flow regime; **Figure 3**), and (iii) the Peace River from the Pine River confluence to the Alberta border (control; **Figure 4**). Below the confluence of the Peace and Pine rivers, Project-related changes in flow regime will be negligible relative to inputs from the Pine River.

The before condition for the BACI design will be that which exists prior to reservoir filling, which is planned to occur in fall 2023. Impacts are expected once the reservoir has been filled. The river diversion period (planned to occur fall 2020 to fall 2023) will be baseline conditions because water volumes and flow rates will be mostly un-changed outside of the immediate construction area and small headpond during this period.

The total length of river within the study area is 146.5 kilometres (km), 82.1 km in the Inundation Impact area (**Figure 2**), 18.0 km in the Flow Impact area (**Figure 3**), and 46.5 km in the Control area (**Figure 4**), . Four reach types were delineated across the Peace River study area using recent aerial photographs to characterize areas dominated by similar habitat as one of the following: Off-channel, Mainstem, Island and Confluence habitats. All four reach types were present in the Inundation Impact and Control areas; however, Island reaches are absent from the Flow Impact area.

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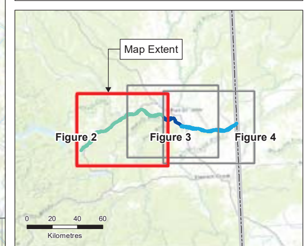
2018 Report
Site C, Peace River, BC

Inundation Impact Area on the Peace River



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Notes

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

Sources

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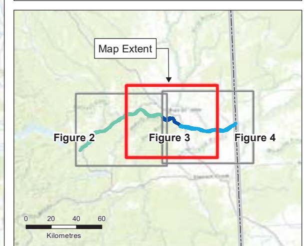
Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Flow Regime Change Impact Area on the Peace River



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

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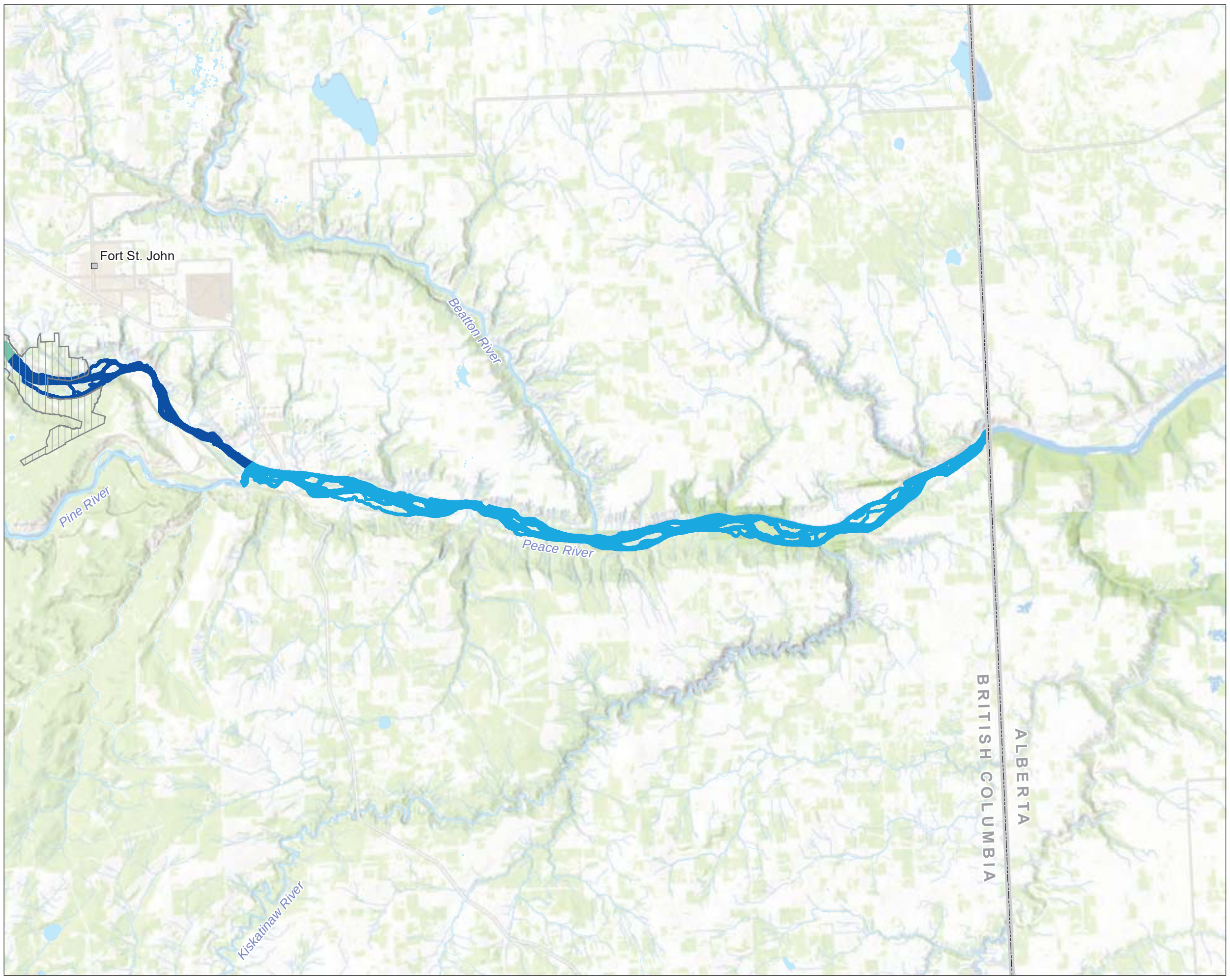
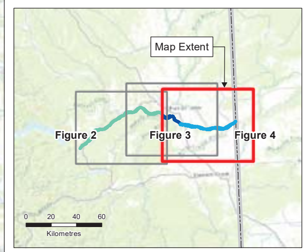
Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Control Area on the Peace River





Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Notes

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BC hydro

2.2.2 Survey Methods

Boat surveys followed a modified version of the “Floating Rivers in Rafts or Kayaks” methods described in *Inventory Methods for Riverine Birds* (RIC 1998*a*) and *Inventory Methods for Waterfowl and Allied Species* (RIC 1999). Surveys took place in daylight hours between 07:00 and 18:00 over the length of the Peace River, from just below the Peace Canyon Dam to the Alberta border using a jet boat (Peace River Boat Survey Transect; **Figure 1**). Surveys required two days to cover this 146.5 km section of river. For each survey, the upstream portion of the river was surveyed on the first day and the downstream portion of the river was surveyed the second day. Boat surveys allowed visual coverage of the river, shoreline, nearshore areas, exposed sandbanks, gravel bars, and mudbanks/flats. Surveyors circled around islands and observed up backchannels wherever water levels were high enough for boat access. The boat survey was conducted at a consistent speed (i.e., 30-40 km/hour) except when low water levels required faster speeds to prevent the boat from getting stuck on the river bed. Also, speeds were slowed when multiple flocks of waterbirds were observed to improve the accuracy of species identification and abundance estimates. Surveys were conducted by biologists trained in waterbird identification. Two observers focused their respective survey efforts on opposite shores to the center of the river and communicated bird movements to prevent double counting birds. The observers scanned the river from the front of the boat using the naked eye to detect birds and binoculars for species identification. Data were recorded using electronic data forms immediately following each observation using map-based spatial software. Surveyors took care to ensure that only one surveyor was entering data at any given time so at least one observer was available to search. Surveys were not conducted during sustained inclement weather conditions that would result in a reduced ability to detect waterbirds (i.e., wind speeds greater than 3 on the Beaufort scale [>10 km/h], any rain or fog that resulted in poor visibility [<1 km], <1.5 metre (m) waves [no whitecaps]); as per RISC standards (RIC 1999).

Field crews recorded the following information for each individual or flock of waterbirds observed:

- UTM coordinates
- Date and time (hour and minute)
- Species
- Number of Individuals
- Habitat type (gravel bar, open river, riverbank, terrestrial)
- Current (none, slow, moderate, fast)
- Distance to disturbance (Not disturbed, <50 m, 50-<100 m, 100-<200 m, 200-400 m, >400 m)

UAV surveys recorded birds in areas that could not be accessed by boat (e.g., shallow water), with a camera displaying a live video to surveyors on the ground. To minimize any disturbance to waterfowl, the UAV was deployed at least 100 m from any observed birds, sudden movements were avoided, and any observations requiring close investigation involved approaching individuals at angles not steeper than 20° (Vas et al. 2015). UAV surveys were standardized by flying at a consistent height, speed and camera angle, whenever possible. The location of UAV observations was determined by recording a survey site ID at the beginning of each video and cross-checking satellite imagery with landscape features (e.g., islands and channels) within the site. Species were identified from raw video footage, or with still frames and video at 2 to 4 times magnification when necessary. All species found on the UAV video footage were recorded, with the information bulleted above collected, in addition to the height of the UAV at the time of observation.

During the fall of 2018, surveyors recorded GIS tracks of the boat survey route as part of broader efforts to assess waterbird detection rates (i.e., incomplete detection) across the monitoring program. Tracks were used in conjunction with the coordinates of waterbirds, recorded on iPads in the field, to determine the approximate perpendicular distance from the boat survey route to each record. These data can be used to assess and account for the extent to which detection rates decrease with distance from observers (i.e., distance sampling). Additionally, a third observer recorded species during one spring and two fall surveys in 2018 to help assess surveyor observability / incomplete detection.

2.3 Transmission Line Wetland Surveys – Transect, Standwatch, UAV and ARU

2.3.1 Study Design

To assess the relative abundance and diversity of waterbirds using wetland habitats adjacent to the Project transmission line route, surveys were conducted by walking fixed-length transects (100 m) of vegetated habitat, stationary surveys of open water habitat with clear lines of sight, recording aerial video (UAV) of open water habitat with surrounding vegetation, and by recording acoustic data using ARU. Accessible wetlands (stations) found to contain suitable waterbird habitat in 2017 were surveyed again in 2018 in addition to several wetlands identified as potentially suitable which were further west along the transmission line route. Surveys were allocated across a target of 30 wetland stations including all wetland types in which waterbirds were expected to occur. One survey was conducted at each station over three survey days to comprise a single survey of all stations in the study area. Four surveys were conducted in the spring, following thaw, and six surveys were conducted in the fall. Wetland survey effort was standardized either by length (100 m transects), time (20-minute standwatch surveys), or area (5 ha UAV survey polygons). The transmission line wetland surveys are not subject to a BACI design (BC Hydro 2018) because potential control sites on the plateau are not accessible and the before condition does not exist on much of the already-cleared transmission line. Instead the study is designed to compare relative abundances across each habitat type before and after Project operations. While survey methods vary across wetland habitat types, and do not provide directly comparable estimates of abundance, before and after results will be comparable within each habitat type.

For species of marsh birds not easily detected using diurnal standwatch, transect, or UAV survey methods (e.g., yellow rail [*Coturnicops noveboracensis*]), field studies employed acoustic monitoring using ARU (Song Meter 3, Wildlife Acoustics Inc. Maynard, Massachusetts, USA). ARUs are designed to record acoustic data for long periods of time. These data can be filtered for target species with known call signatures and are therefore well suited for detecting rare species (e.g., American bittern [*Botaurus lentiginosus*]) and species that are less active during daylight hours when other survey methods were employed. ARU were programmed to record audio data during time periods when the target species are most active (dusk and dawn in the case of yellow rail and American bittern), for a minimum of three nights during the peak vocalization period (i.e., from May to July [Conway 2011]) at seven survey sites during 2017 and 2018. Sora (*Porzana carolina*) was detected regularly and at a variety of stations during wetland surveys in 2017. American bittern was not detected during 2017 monitoring and has only been recorded within the Peace Region on a few occasions. Yellow rail was not detected in 2017, but there are several recent records of the species within the Project study area (Hilton et al. 2013). Thus, in 2018, bioacoustic monitoring with ARU targeted the area of the Moberly Plateau where yellow rail has historically been recorded most often (**Figure 5**).

2.3.2 Survey Methods

Surveys in each of the wetland types during the 2017 monitoring program confirmed waterbirds' use of three wetland habitat types: sedge (SE), open water (OW), willow-sedge (WS) and found little evidence of use of cultivated fields (CF) (**Table 2**); however, insufficient information was collected on Labrador tea-sedge (BT) and tamarack-sedge (TS) during 2017 surveys. Survey efforts along wetlands adjacent to the transmission line route in 2018 were consequently focused on SE, OW, WS, BT, and TS habitat.

Two crews, each consisting of a biologist and a field technician, completed the surveys during daylight hours between 07:00 and 20:00. Biologists were experienced in visual and vocalization identification of wetland bird species and were trained in vegetation and structural stage identification for wetland habitat characterization. Surveys were not conducted during sustained inclement weather such as high winds (i.e., >3 on the Beaufort scale) or moderate to heavy precipitation.

Fixed length transect surveys of 100 m length were conducted in 2018 within sedge, willow-sedge, tamarack–sedge, and Labrador tea–sedge habitats along the transmission line. This method is considered appropriate given the lack of visibility (from the ground or air) within these wetland types, and the consistency with which the method can be applied. Wetlands with at least twenty percent coverage of such vegetated wetland types were surveyed with one to three transects. Where multiple wetland types were present within wetland stations, transects were conducted within distinct habitat types to provide data specific to each wetland type. Transects were generally straight but followed slightly meandering routes where necessary to stay within habitat types.

Stationary standwatch surveys of 20-minute duration were conducted in 2017 and 2018 at wetlands with open water habitat and small lakes with clear lines of sight. This method is considered most appropriate for these habitats given that visual lines of sight from ground-level provide efficient visual detection of waterbirds on the water's surface across large areas. Wetlands in which open-water was the dominant habitat type were surveyed by this method with a single 20-minute survey. Where necessary, the 20-minute survey was divided into two 10-minute segments at two vantage points, while being cautious to avoid double-counting birds. The same vantage points were used to survey open-water wetland stations during each survey event.

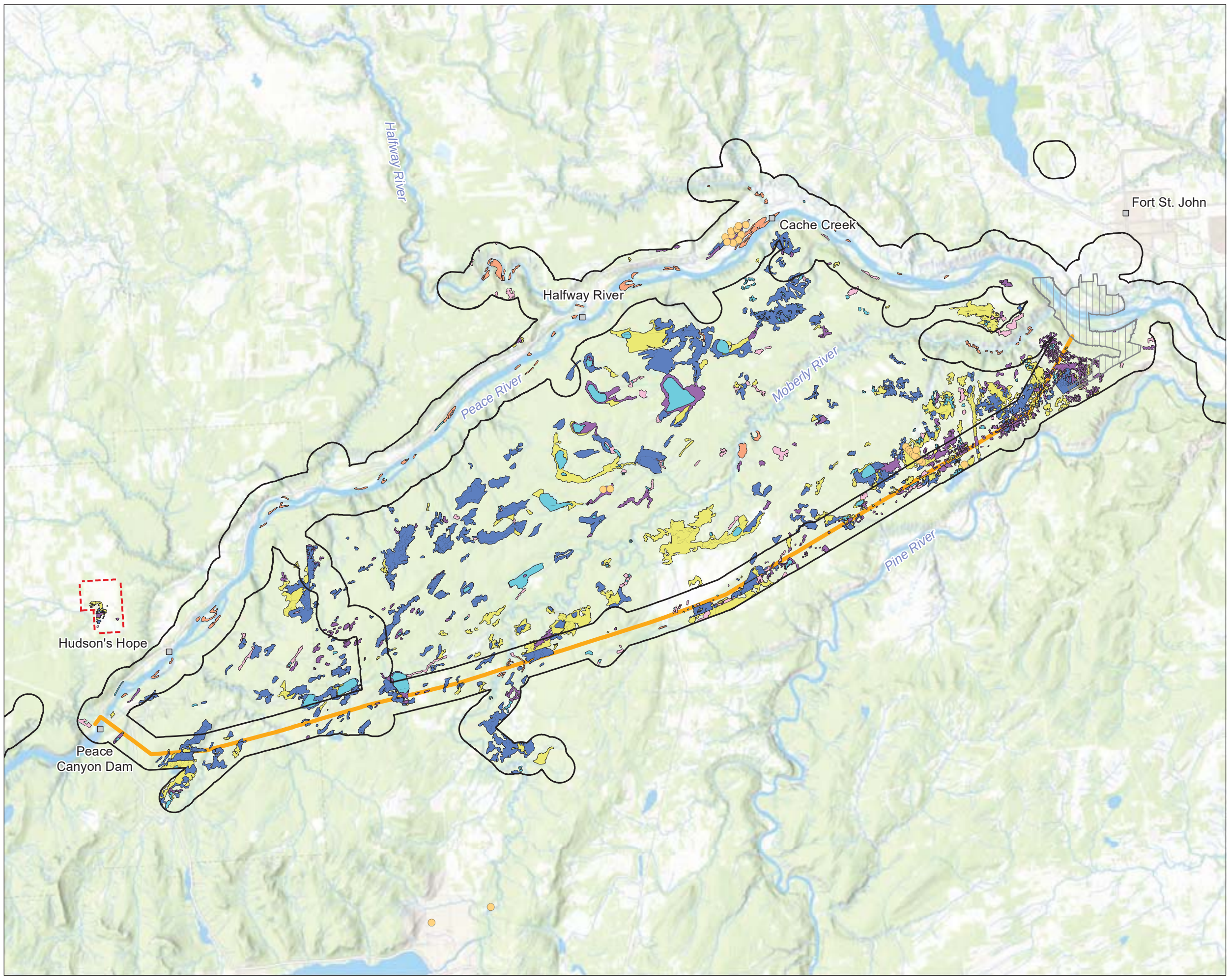
UAV surveys encompassing a maximum area of five hectares were conducted in 2018 at wetlands with open water habitat where vegetation obscured lines of sight from the ground level, but not from an aerial perspective. No other survey method was able to effectively assess waterbird abundances in such habitat, where open water areas were surrounded by sedges and cattails. UAV surveys of such wetlands focused effort on areas of open water within wetland station polygons. Efforts were made to provide still video footage at a low angle for all waterbirds observed to allow for species identification upon review of the footage. UAV surveys were restricted to 10-minutes but were of variable duration given the variety in the area of open water habitat across stations and survey dates.

Many of the wetland stations surveyed in 2017 and 2018 monitoring program were comprised of a mosaic of wetland types and varied seasonally in the depth and extent of open water. The survey methods described above were applied to habitat whenever it was present within a wetland station. Consequently, multiple survey methods were often used at a wetland station in a single day (e.g., UAV and Transect surveys at a wetland dominated by sedge habitat, but also containing extensive open water habitat). Additionally, survey methods varied seasonally at wetland stations that were flooded in the spring (standwatch or UAV surveys), but where vegetation was exposed in the fall (transect surveys). Station conditions (e.g., flooded, saturated, dry) and the resulting survey method employed to obtain the best estimate of relative abundance were recorded during each survey given differences in detection constraints under such variable conditions. Survey results were only compared across stations that were surveyed with the same methods.

Standwatch surveys were repeated at some wetland stations following the same methods to provide preliminary estimates of detection rate (i.e., to obtain a measure of the number of birds not observed during a typical survey). Transect and UAV surveys were repeated at some wetland stations as well, but transect surveys at these stations typically disturbed and altered abundances leading to reduced numbers during repeated surveys. Consequently, repeated surveys at stations surveyed by transect were not considered informative of detection rates, and distance to disturbance was recorded instead.

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Wetland Habitat Types and Historic Yellow Rail Detections in and Adjacent to the Peace River Valley and Transmission Line Route



Legend

- Site C LAA
- Proposed Dam Site
- Marl Fen Property - BC Hydro Wetland Compensation Site
- Transmission Line Right-of-Way
- Historic YERA observations from eBird and Baseline Studies

Wetland Types

- Labrador-tea – sedge (BT)
- Non-forested floodplain wetland (WH)
- Sedge (SE)
- Shallow open water (OW)
- Tamarack-sedge (TS)
- Willow sedge (WS)

Notes

1. OW has been used as the idientfier for Shallow Open Water wetland field locations; however, please note that the wetland classification also includes LA and PD habitat codes.
2. Locations should be considered approximate.
3. 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

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Table 2 Wetland habitat types suitable for waterbirds adjacent to the Project transmission line route

Habitat type	Characteristics	Waterbirds expected?
Open water (OW)	Open water with no (or limited) emergent vegetation including shallow open water (<2m depth), as well as ponds, and lakes transitioning or connected to wetlands.	Yes, waterbirds are abundant in open water habitat
Tamarack-sedge (TS)	Fen with tamarack dominated overstorey	Yes, provided there is low density overstory vegetation (Twedt et al. 1998) that allows predator detection (Plauny 2000)
Sedge (SE)	Uniform sedge (*Carex* sp) flat low area, typically wetted and often with standing water. Often surrounding or bordering open water habitats.	Yes, provided there is low density overstory vegetation
Labrador tea-sedge (BT)	Labrador tea dominated peat bogs	No, waterbirds not anticipated to occur in peat bogs (Eifrig 1911).
Willow-sedge (WS)	Sedge (*Carex* sp.) meadow with scattered willows/scrub birch. Often bordering SE habitat in slightly elevated and areas with less standing water than SE habitat.	Yes, when willows are in low densities
Cultivated field (CF)	Only considered if wetted and/or water source or wetland occurs within 100 m	Only when flooded. Few waterbirds noted in 2017 and 2018. No longer considered potential habitat.

The following information was recorded at each wetland survey station:

- UTM coordinates;
- Date;
- Start and end time of survey;
- Proportion of each habitat type within the wetland or survey station; and
- Approximate water depth within each habitat type.

The following information was recorded for each survey waterbird or flock observed during surveys:

- UTM coordinates;
- Date and time (Hour and minute);
- Species;
- Number of individuals;
- Habitat type in which the bird was observed;
- Water depth where the bird was observed;
- Behavior; and
- Distance from the observer.

The area of habitat types within each surveyed wetland, as a percentage of the total area, were recorded based on visual estimation from the ground and aerial imagery when available from UAV surveys. These data were used to determine the dominant and sub-dominant habitat within each wetland station. For the purposes of this study, dominant was considered the most common habitat type, and sub-dominant was the next most widespread wetland type at the station, assuming at least twenty percent coverage of the wetland station on average. In cases where the no other wetland type comprised at least twenty percent of the station, the dominant wetland type was also considered as the sub-dominant type.

The presence of marsh birds was monitored with Song Meters SM3 ARU (Wildlife Acoustics, Inc., Maynard, Massachusetts, USA). ARU provide comparable and potentially greater detection rates for yellow rail as compared to call playback methods (Bayne et al. 2014), and reduce safety hazards associated with accessing and working in remote areas at night. ARU were deployed during the breeding period in 2017, from May 18 to June 27, and in 2018 from July 4 to July 23 in suitable nesting habitat for yellow rail and American bittern (i.e., open marsh or pond edges with emergent vegetation, tall grasses, rushes and bulrushes [Goldade et al. 2002, Bayne et al. 2014]). All ARU were fitted with omnidirectional SMM-A1 microphones recording at a sample rate of 16 kHz and gain of 0 dB. The microphones were installed approximately 2 m above ground and were set up to record acoustic data from 30 minutes before dusk to 30 minutes after dawn. Dusk and dawn recording times are recognized automatically by the internal GPS and clock of the ARU, which accurately detects the time zone where the ARU is recording. Data for the number of nights that ARU were deployed was recorded, and results were assessed as present or not detected at each monitoring station.

3.0 DATA MANAGEMENT AND ANALYSIS

Waterbird records from all surveys were compiled in a Microsoft Access database. Data were reviewed to check for anomalous records, and questionable species identification or count data were queried with field staff. Once data were compiled, quality assurance measures were applied to confirm that values were logical and any outlying records (e.g., high counts, rare species) were verified with field staff.

The total number of waterbirds detected by each survey method is reported for each season and survey period. Totals are described in terms of relative abundance because they represent the number of waterbirds detected across temporal and spatial scales, rather than true abundance, which requires estimates of detection rates to determine the proportion of birds not detected. Distance and repeated survey data were collected (as described in **Section 2.2.2** and **2.3.2**) to provide measures of detection rates and true abundance in subsequent analyses (e.g., analyses of Project related effects), but the scope of this report is limited to descriptive statistics of raw survey data. Relative abundance data are also summarised by species guilds defined by method of foraging: dabbling ducks (small waterfowl that feed primarily on aquatic vegetation), large dabblers (large waterfowl [e.g., geese and swans] that feed primarily on vegetation), piscivorous divers (diving birds that forage on fish), benthic feeding divers (small waterfowl and sea ducks that feed primarily on benthic invertebrates), gulls and surface-feeding terns (small to large size birds that forage on fish and insects near the water's surface, and occasionally garbage), shorebirds (plovers and sandpipers that feed primarily on or near the shoreline), and unidentified waterbirds. Birds that were not identified to species were recorded to the most specific taxonomic level possible. A full list of species observed and the guilds to which they are assigned is presented in **Appendix A**. Gulls and surface-feeding terns are hereafter referred to simply as gulls, except in the single case where black tern (*Chlidonias niger*) was observed.

Waterbird diversity is presented as species richness (i.e., number of species), species evenness (i.e., the relative abundance of different species), and the Shannon-Weiner Index (SWI). Species evenness is presented with values ranging from zero to one, where values tending towards one represent more even proportions of species and values tending towards zero represent communities dominated by fewer species. The SWI is a measure of diversity that considers both species richness and evenness. Communities possessing many individuals of a few species receive lower SWI values (minimum 0) than communities with the same number of species but more even abundances across species.

3.1 Peace River Waterbird Surveys – Boat and UAV

Waterbird data were summarized to provide mean relative abundance and diversity across sections of the Peace River that will be differentially affected by the Project (i.e., treatment areas), seasons, and survey periods. Relative abundance data were also summarized by river reach categories by calculating summary statistics for all sections of the river with the same contiguous habitat features. Four reach types were identified within the study area based on review of satellite imagery:

- Mainstem (reaches where the river consists of one large channel);
- Island (reaches where the river is split relatively evenly around islands);
- Off-channel (reaches where a small portion of the river runs around islands, or where there are backchannels and/or bodies of water that are only connected to the river during high flows); and
- Confluence (reaches where major tributaries such as the Pine, Beatton, Halfway and Moberly rivers join the Peace River).

To control for variation in relative abundance due to the size of a reach rather than habitat type, data are summarized in terms of number of individuals observed per km of river (i.e., density by river length) as per RISC standards (RIC 1999).

To assess for potential Project-related effects to the relative abundance and diversity of waterbirds, the Peace River study will employ a BACI model. The BACI model will be used to assess changes in waterbird abundance and diversity before reservoir filling and Project-operations as compared to after, while accounting for background (i.e., natural) variation in the area. Variables of interest considered in a standard BACI model are Treatment (control/impact) and Period (before/after). The model is defined as follows:

$$Abundance = Treatment\ (control|impact) + Period(before|after) + Treatment * Period$$

This model tests for Project-related changes in relative abundance, density or diversity indices depending on which is included as the dependent variable on the left-hand side of the equation. The interaction term (*Treatment * Period*) is known as the BACI effect and is the term that represents Project-related effects. The BACI effect compares changes in means at control and impact sites, occurring between before and after periods (Schwarz 2015). If changes are similar at control and impact sites between the before and after periods, the interaction effect is not likely to be statistically significant. If there is a relatively larger decline or increase in abundance/diversity at the impact site as compared to the control site, then a Project-related effect could be statistically significant.

Once additional years of survey data are obtained, the BACI model will be adapted to include additional factors to account for variation in the data unrelated to the Project (e.g., season, year) which will increase the power of analyses to assess for Project-related effects. The model will also consider habitat characteristics (e.g., reach type, flow) to define their relationship with waterbird abundance and diversity. Inclusion of such additional explanatory variables increases the power of BACI analyses to detect Project related effects. The model to be applied following future years of monitoring is expected to be as follows:

$$\begin{aligned} &Abundance\ (or\ Diversity\ or\ Density) \\ &\quad = Treatment\ (control|impact) + Period(before|after) + Habitat\ Type \\ &\quad + Survey\ Event\ (or\ Survey\ Period) + Season + Year + Treatment * Period \end{aligned}$$

Analyses employing a BACI model statistical framework will be conducted using R statistical software (adapted Ime4 package [Schwarz 2015]).

A power analysis based on the BACI model can also be conducted to provide the expected likelihood of detecting Project-related effects for a given allocation of survey effort, provided that variance can be defined or estimated for factors in the model (NPS 2018). It is possible to calculate statistical power by defining the number of events (n), detected variance across survey events (d), and the significance level (typically α=0.05) (Cohen 1988, Champely 2017). It is also possible to find the optimal (n) number of surveys for a desired power and variance level and to expand the power analysis to include additional factors. These estimates will be refined in subsequent years and, through the power analysis, will support determination of the number of survey years and events per year required to detect certain thresholds of Project-related change.

Variance estimates are provided for factors where the data support these statistics; survey event, survey period, and habitat type. These statistics provide preliminary indications of how to optimize survey efforts in future years. Power to detect significant differences between treatment levels and to define relationships of waterbird abundance and diversity with habitat factors will be improved by allocating more effort at temporal and spatial scales where the greatest variation occurs.

3.2 Transmission Line Wetland Surveys – Transect, Standwatch, UAV and ARU

Data from 2017 and 2018 surveys were summarized to provide estimates of relative abundance and diversity for each survey. These estimates were compared across survey periods, seasons, and years. The number of birds observed within each habitat type was presented per unit of survey effort. For transect surveys, the number of birds observed within sedge, willow-sedge, tamarack-sedge, and Labrador tea-sedge during each survey were determined per transect conducted in each habitat type. The mean number of birds within each foraging guild observed per transect was calculated for each wetland type. Data collected from standwatch surveys were used to provide estimates of density at stations with permanent open water, and an average estimate of density was calculated across all these stations for each foraging guild. A separate average density was calculated for standwatch data from seasonally flooded areas. Waterbirds in seasonally flooded habitat are best surveyed by the same method as permanent waterbodies, but these areas contain different vegetation (e.g., sedges instead of purely aquatic vegetation) and, thus, are a distinct habitat type. Seasonally flooded areas and sub-dominant open water areas (typically surveyed by UAV) are also subject to larger fluctuations in the area of open water as compared to permanent open water wetlands. To avoid biased estimates of density in such areas, the number of birds within flooded, open water habitat within the 5 ha wetland station polygon is used to as the measure of waterbird density. This equates to total abundance of waterbirds in open water habitat within wetland stations and is the metric used to assess relative abundance of waterbirds in UAV surveys as well.

Acoustic data were downloaded and analyzed using a cluster analysis method in Kaleidoscope Pro (Wildlife Acoustics, Inc.) followed by manual verification. Cluster analysis groups bird songs with similar parameters such as minimum and maximum frequency range of the song, duration of the song and inter-syllable gap. Reference songs of sora, yellow rail and American bittern were obtained from the Cornell Laboratory of Ornithology (Macauley Library), and characteristics for several songs from each of these species were matched to the groups of songs from the cluster analysis. Recorded songs suspected to be of sora, yellow rail or American bittern were aurally verified and checked against the reference calls from the Macaulay Library.

4.0 RESULTS

Results for the monitoring program from both 2017 and 2018 provide an overview of the data collected. The overview summarizes habitat data as well as waterbird abundance and diversity indices within habitat types, seasons, and, where possible, survey period. Statistical comparisons and modeling planned for subsequent years of data collection are discussed in **Section 5.0**.

4.1 Peace River Waterbird Surveys – Boat and UAV

The Peace River study area was surveyed during five survey events in the spring and six survey events in the fall over 11 and 12 days, respectively (**Table 3**). Due to rain and wind speeds that exceeded survey standards (**Section 2.2.2**), half of the river was not surveyed during the second survey event of the early spring period in 2017. The first survey in the middle survey period of spring 2018 was not completed as scheduled because ice from the Pine River broke into the Peace River and delayed the survey until May 1.

Table 3 Peace River survey timing; migratory waterbird monitoring program, 2017 and 2018

Survey Period	2017 Survey Dates	2018 Survey Dates
Spring		
Early (Apr 1 – Apr 14)	Apr 5, Apr 6; Apr 12*	Apr 13, Apr 14
Middle (Apr 15 – May 6)	Apr 26, Apr 27; May 3, May 4	Apr 25, Apr 26, May 1**; May 5, May 6
Late (May 7 – May 30)	May 10, May 11; May 14, May 15	May 10, May 11; May 18, May 19
Fall		
Early (Aug 1 - Aug 14)	Aug 8, Aug 9; Aug 14, Aug 15	Aug 4, Aug 5
Early-Middle (Aug 15 – Sept 14)	Aug 22, Aug 23; Aug 28, Aug 29	Aug 20, Aug 21; Sep 4, Sep 5
Late-Middle (Sept 15 – Oct 14)	Sep 21, Sep 22; Sep 27, Sep 28	Sep 20, Sep 21; Oct 4, Oct 5
Late (Oct 15 – Oct 30)	No surveys	Oct 15, Oct 16

*Second day of survey event not completed due to inclement weather

**Third day required to complete survey event due to interruption from ice flow out of the Pine River

All four reach types are present in the Inundation Impact and Control areas; however, Island reaches are absent from the Flow Impact area (**Table 4**). Off-channel, Mainstem, and Island reaches are present in roughly equivalent lengths across the study area; however, the proportion of these reach types varies across treatment areas. Island reaches comprise most of the Inundation Impact (54%) treatment area, whereas Off-channel reaches comprise most of the Flow Impact (47%) and Control (42%) treatment areas. Confluence reaches comprise a relatively small proportion of total river length (8.4 km) but occur relatively evenly across treatment areas (**Table 4**).

Table 4 Categories, number, and length of river reaches within the Peace River study area

Treatment Area	Off-channel		Island		Mainstem		Confluence	
	Reaches (no.)	Length (km)	Reaches (no.)	Length (km)	Reaches (no.)	Length (km)	Reaches (no.)	Length (km)
Control	5	11.4	8	25.0	5	7.9	2	2.1
Flow Impact	4	8.5	0	0.0	4	6.1	2	3.4
Inundation Impact	13	34.6	5	15.9	16	28.7	2	2.9
Total	22	54.5	13	40.9	25	42.7	6	8.4

Peace River discharge data for treatment areas from Hudson's Hope (Inundation Impact area), Old Fort (Flow Impact area), and Taylor (Control area) were used to assess the representativeness of surveys relative to the water regime during spring and fall migration periods. Discharge rates during surveys were similar to those recorded over the spring and fall migration for both years; the surveys encompass the range of discharges that occurred during those periods (**Figure 6**, **Figure 7**, **Figure 8**).

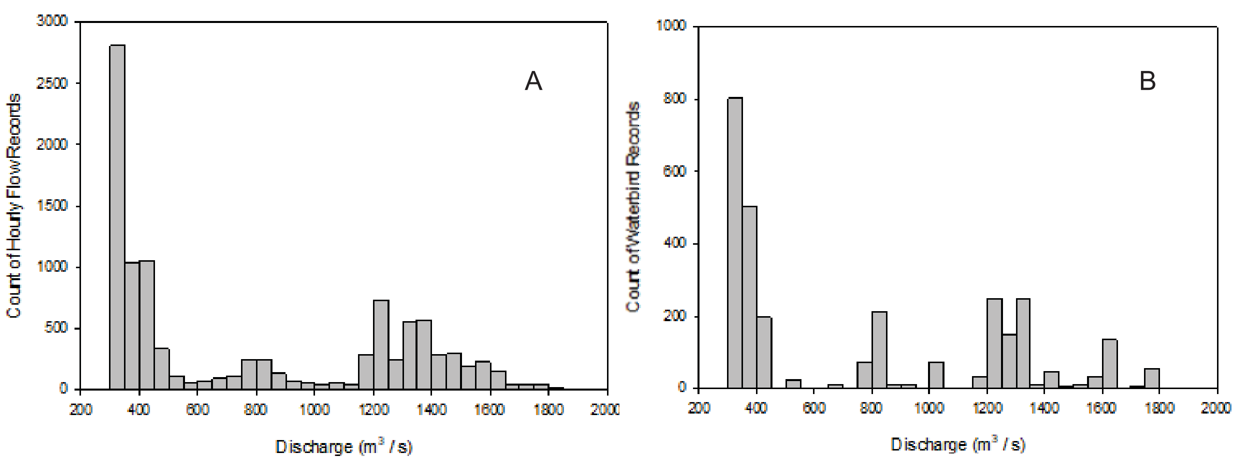


Figure 6 Frequency distribution of hourly Peace River discharge (flow rate) records at Hudson's Hope in the Inundation Impact area (A) and frequency of waterbirds observed relative to discharge rates (B) during April 1 to October 31, 2017 and 2018.

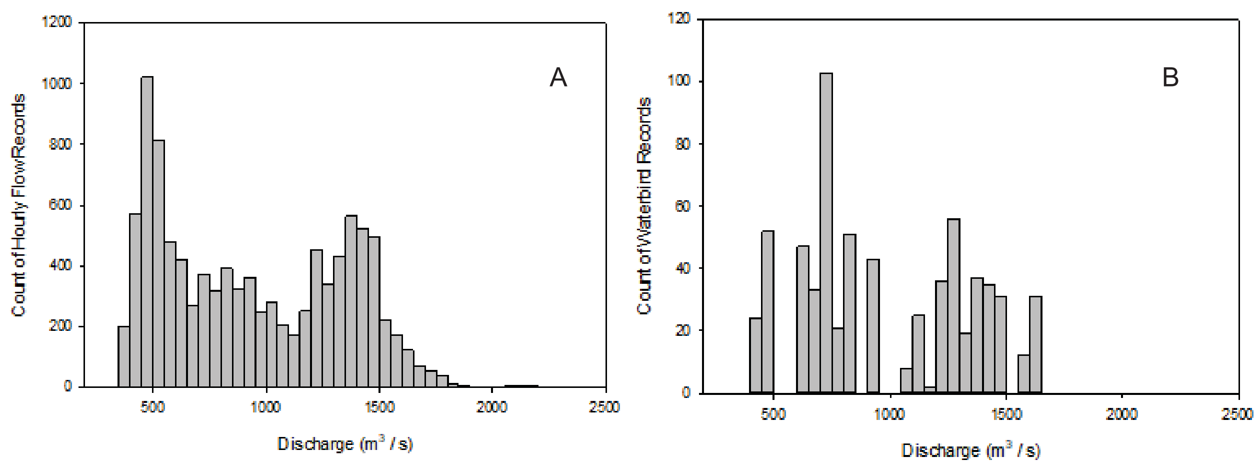


Figure 7 Frequency distribution of hourly Peace River discharge (flow rate) records at Old Fort in the Flow Impact area (A), and frequency of waterbirds observed relative to discharge rates (B) during April 1 to October 31, 2017 and 2018.

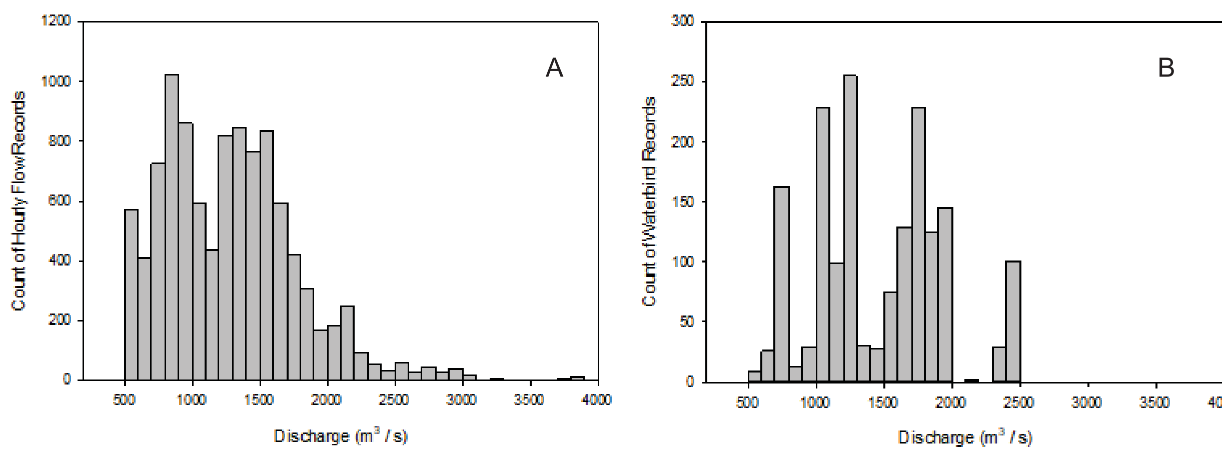


Figure 8 Frequency distribution of hourly Peace River discharge (flow rate) records at Taylor in the Control area (A), and frequency of waterbirds observed relative to discharge rates (B) during April 1 to October 31, 2017 and 2018.

4.1.1 Relative Abundance and Density

Waterbirds were observed along the entirety of the Peace River study area in spring and fall of 2018 (see location figures in **Appendix B – Figures B-1 to B-4**). There were a total of 22,053 individual waterbirds observed in 2018, with 43 species identified (**Appendix A**). Total waterbird abundances compiled for 2017 and 2018 were highest during the early survey period in both seasons and were higher in spring than in fall (**Table 5**). Abundances of waterfowl (i.e., benthic feeding divers, dabbling ducks, large dabblers, and piscivorous divers) were highest in the early and middle spring periods, while gulls and shorebirds were most abundant in early fall. Large dabblers, primarily Canada goose (*Branta canadensis*), were the most abundant waterbird overall. Dabbling ducks were the second most abundant waterbird with most observations in the mid-spring. The third most-abundant guild of birds was gulls, with many found in the early fall (**Table 5**).

Table 5 Mean relative abundance of waterbird foraging guilds per survey, spring and fall 2017 and 2018 data compiled

Foraging Guild	Spring Survey Periods			Fall Survey Periods				Total of Means
	Early	Middle	Late	Early	Early Middle	Late Middle	Late	
Benthic Feeding Divers	136	272	29	5	2	8	6	458
Dabbling Ducks	714	796	420	122	198	172	101	2,523
Gulls	1	15	31	657	774	526	78	2,082
Large Dabblers	1,856	621	515	175	462	719	798	5,146
Piscivorous Divers	253	106	45	33	34	22	46	539
Shorebirds	3	3	94	147	76	2	0	325
Unknown Waterbirds	218	259	140	30	60	88	40	835
Total	3,181	2,072	1,274	1,169	1,606	1,537	1,069	

Note: Survey period dates are presented in Table 3.

Overall waterbird relative densities varied across reach types and treatment areas, and reflected the influence of the more abundant guilds (i.e., large dabblers and dabbling ducks in spring, gulls and large dabblers in fall; **Table 5**).

During spring, overall waterbird densities were highest in Island reaches, with 18.79 birds/km (**Table 6, Figure 9, Figure 10, Figure 11**). In the fall, waterbird densities in Confluence reaches (48.63 birds/km) were at least six-fold higher than those of other reach types; however, this density was primarily attributed to one guild, gulls (42.01 birds/km) (**Table 7, Figure 12, Figure 13, Figure 14**). In the spring, Confluence reaches hosted the lowest waterbird densities (6.76 birds/km), while Island reaches had the lowest density in the fall (3.86 birds/km). Overall waterbird densities were higher during spring as compared to fall in all reach types except Confluence reaches.

In the spring, the density of waterbirds was similar across treatment areas. The lowest density of waterbirds was found in the Flow Impact area (12.49 birds/km) and the highest density of waterbirds was found in the Control area (13.83 birds/km) (**Table 6, Figure 9, Figure 10, Figure 11**). In the fall, the Flow Impact area had the highest density of waterbirds (32.75 birds/km), mostly due to high numbers of gulls in the Confluence reaches of the Peace River between the dam site and the Pine River (**Table 7, Figure 12, Figure 13, Figure 14**).

Population densities of each waterbird foraging guild were consistently high in specific habitat types across seasons:

- Dabbling ducks – Off-channel habitat and Island habitat
- Gulls - Confluence habitat
- Large dabblers – Off-channel and Island habitat
- Shorebirds – Island habitat
- Piscivorous Divers and Benthic divers – no clear preference

The distribution of waterbirds across treatment areas varied by foraging guild (**Table 6, Table 7**). In the spring, dabbling ducks and large dabblers were the most abundant waterbirds and were found in the highest densities within Control and Inundation Impact areas, respectively (both 5.92 birds/km). In the fall, the most abundant guild was gulls, which were primarilly found in the Flow Impact area (24.82 birds/km).

Table 6 Density (birds/km) of spring migrant waterbirds in the Peace River study area by river reach category and treatment area, 2017 and 2018 data compiled

Foraging Guild	River Reach Category				Treatment Area		
	Off-channel	Island	Mainstem	Confluence	Inundation Impact	Flow Impact	Control
Benthic Feeding Divers	1.23	1.26	0.60	0.32	1.42	0.88	0.32
Dabbling Ducks	4.98	6.20	2.13	1.57	3.23	4.96	5.92
Gulls	0.10	0.05	0.14	0.60	0.10	0.36	0.08
Large Dabblers	6.44	8.15	2.69	3.31	5.92	4.29	5.68
Piscivorous Divers	0.86	0.87	0.53	0.68	1.02	0.58	0.36
Shorebirds	0.23	0.48	0.14	0.13	0.22	0.31	0.34
Unidentified Waterbirds	1.92	1.78	0.51	0.15	1.60	1.11	1.12
Total	**15.76**	**18.79**	**6.74**	**6.76**	**13.51**	**12.49**	**13.83**

Note: Densities are calculated as means across all fully completed surveys in spring, 2017 and 2018 (n = 10). Data from incomplete survey events are excluded.

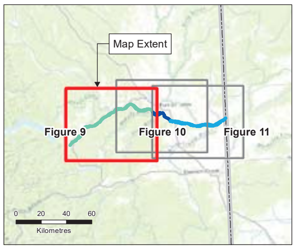
Table 7 Density (birds/km) of fall migrant waterbirds in the Peace River study area by river reach category and treatment area, 2017 and 2018 data compiled

Foraging Guild	River Reach Category				Treatment Area		
	Off-channel	Island	Mainstem	Confluence	Inundation Impact	Flow Impact	Control
Benthic Feeding Divers	0.05	0.02	0.03	0.05	0.04	0.08	0.00
Dabbling Ducks	2.29	0.70	0.09	0.63	1.47	1.61	0.27
Gulls	2.55	0.09	2.54	42.01	1.81	24.82	0.18
Large Dabblers	5.44	1.86	1.94	5.77	2.94	4.25	4.01
Piscivorous Divers	0.20	0.35	0.12	0.03	0.20	0.14	0.26
Shorebirds	0.38	0.78	0.22	0.07	0.35	0.25	0.63
Unidentified Waterbirds	1.04	0.07	0.00	0.06	0.37	1.59	0.02
Total	**11.94**	**3.86**	**4.93**	**48.63**	**7.18**	**32.75**	**5.37**

Note: Densities are calculated as means across all surveys completed in fall, 2017 and 2018 (n = 12).

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Density (birds/km) of Spring Migrant Waterbirds in Reaches of the Inundation Impact Area (2017-2018)



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 30
- >30 - 70
- >70 - 100
- >100 - 180

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
3. Waterbird count values were classified using approximate Quantile Breaks.

Sources

- Basemap: ESRI World Topographic Base

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Kilometres

NAD 1983 UTM Zone 10N

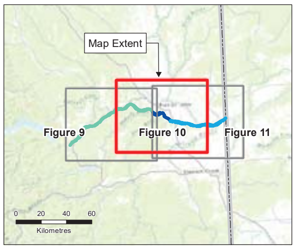
Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure 9

Hemmera An Ausenco Company BC hydro

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Density (birds/km) of Spring Migrant Waterbirds in Reaches of the Flow Impact Treatment Area (2017-2018)



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 30
- >30 - 70
- >70 - 100
- >100 - 180

Notes

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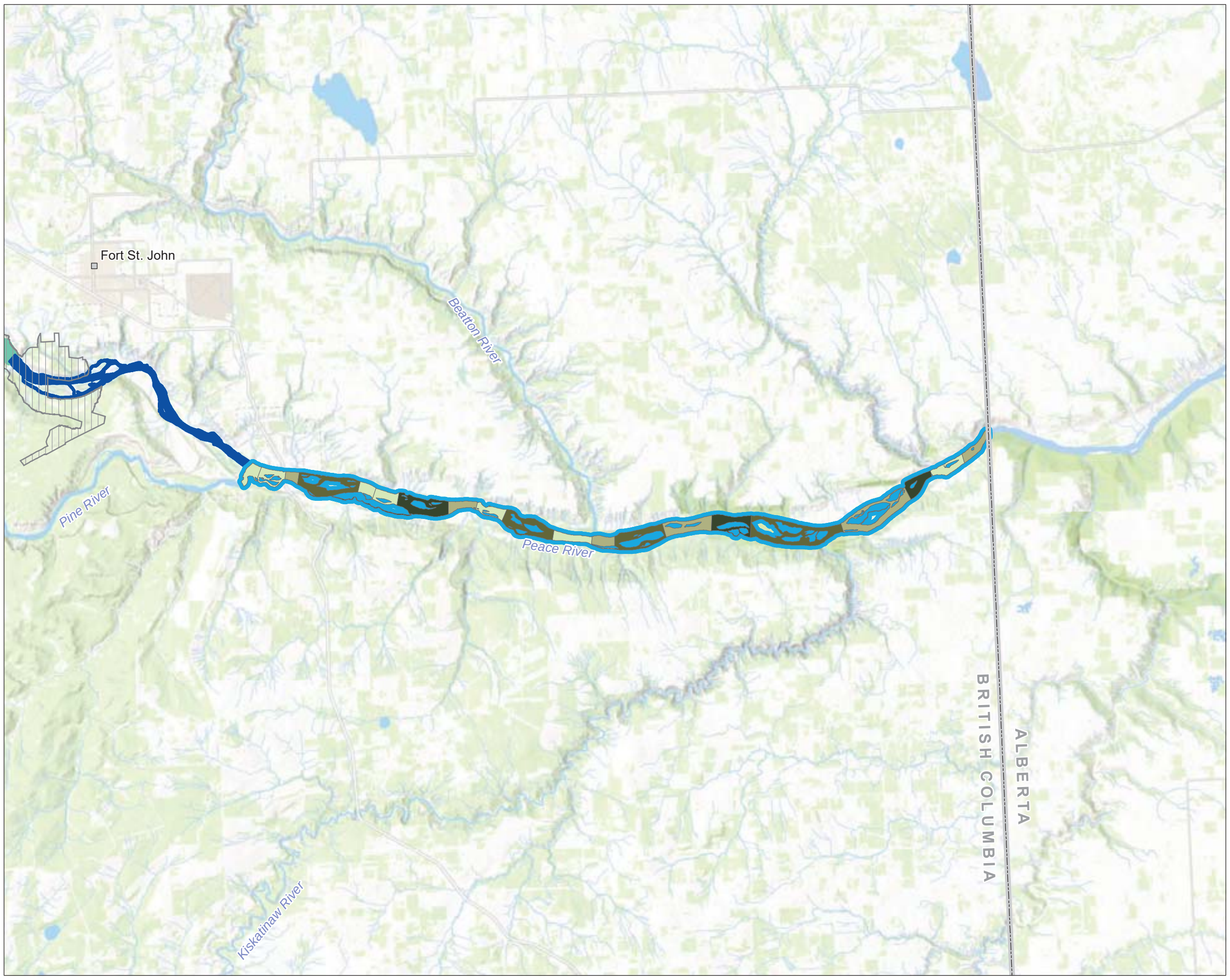
989619-07	Production Date: Dec 14, 2018	Figure 10

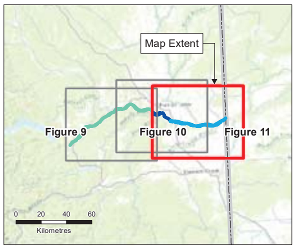
Hemmera
An Ausenco Company

BC hydro



Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Density (birds/km) of Spring Migrant Waterbirds in Reaches of the Control Treatment Area (2017-2018)



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 30
- >30 - 70
- >70 - 100
- >100 - 180

Notes

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3. Waterbird count values were classified using approximate Quantile Breaks.

Sources

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Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure 11

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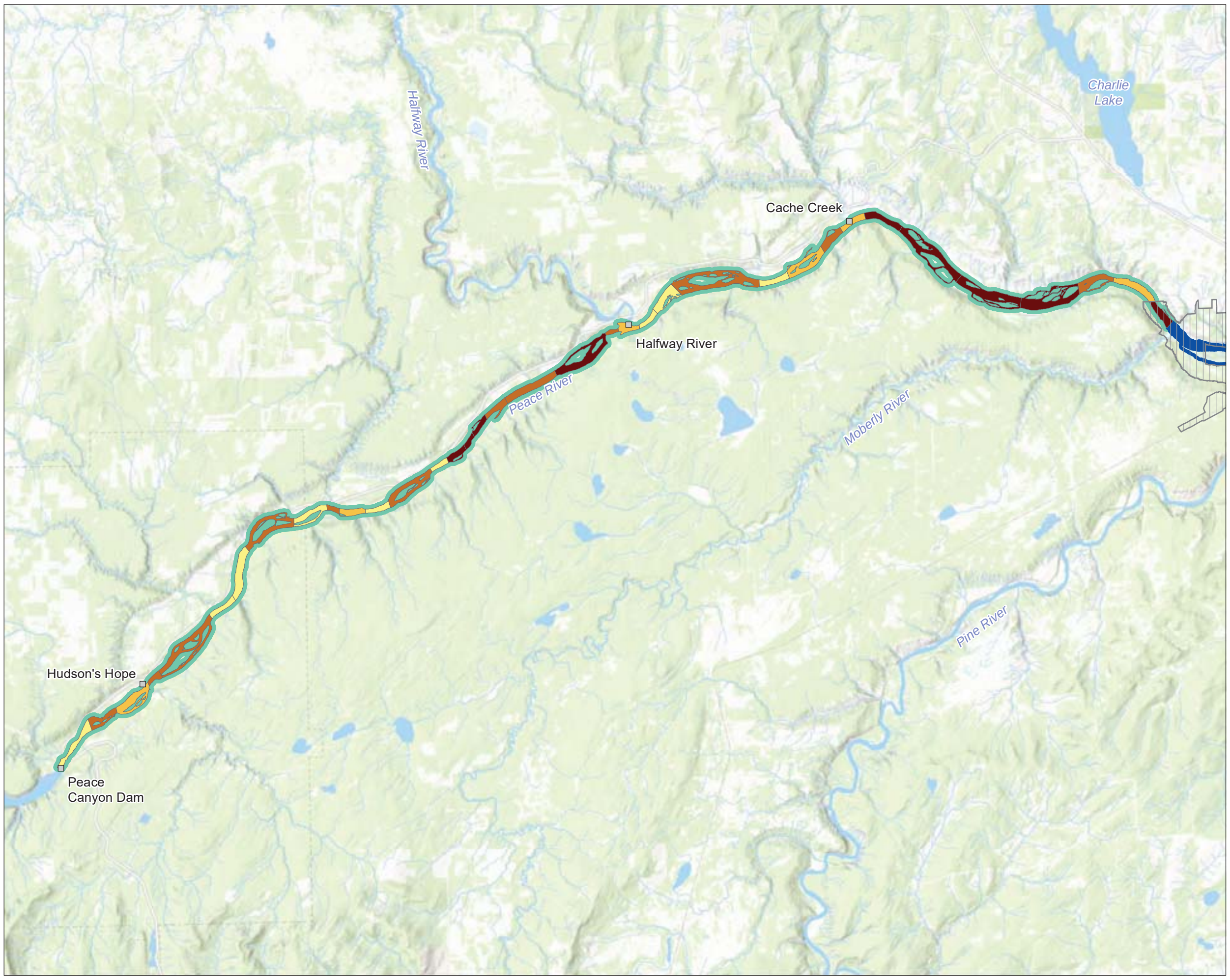
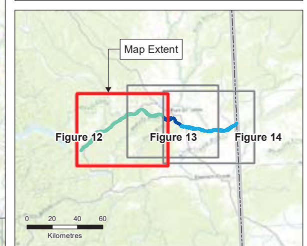


Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Density (birds/km) of Fall Migrant Waterbirds in Reaches of the Inundation Impact Area (2017-2018)



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 10
- >10 - 20
- >20 - 70
- >70 - 1000

Notes

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3. Waterbird count values were classified using approximate Quantile Breaks.

Sources

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Kilometres

NAD 1983 UTM Zone 10N

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989619-07	Production Date: Dec 14, 2018	Figure 12

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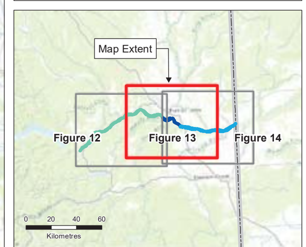
Migratory Waterbird Follow-up Monitoring Program
2017 Report
Site C, Peace River, BC

Density (birds/km) of Fall Migrant Waterbirds in Reaches of the Flow Impact Treatment Area



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 10
- >10 - 20
- >20 - 70
- >70 - 1000

Notes

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3. Waterbird count values were classified using approximate Quantile Breaks.

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989619-07	Production Date: Dec 14, 2018	Figure 13

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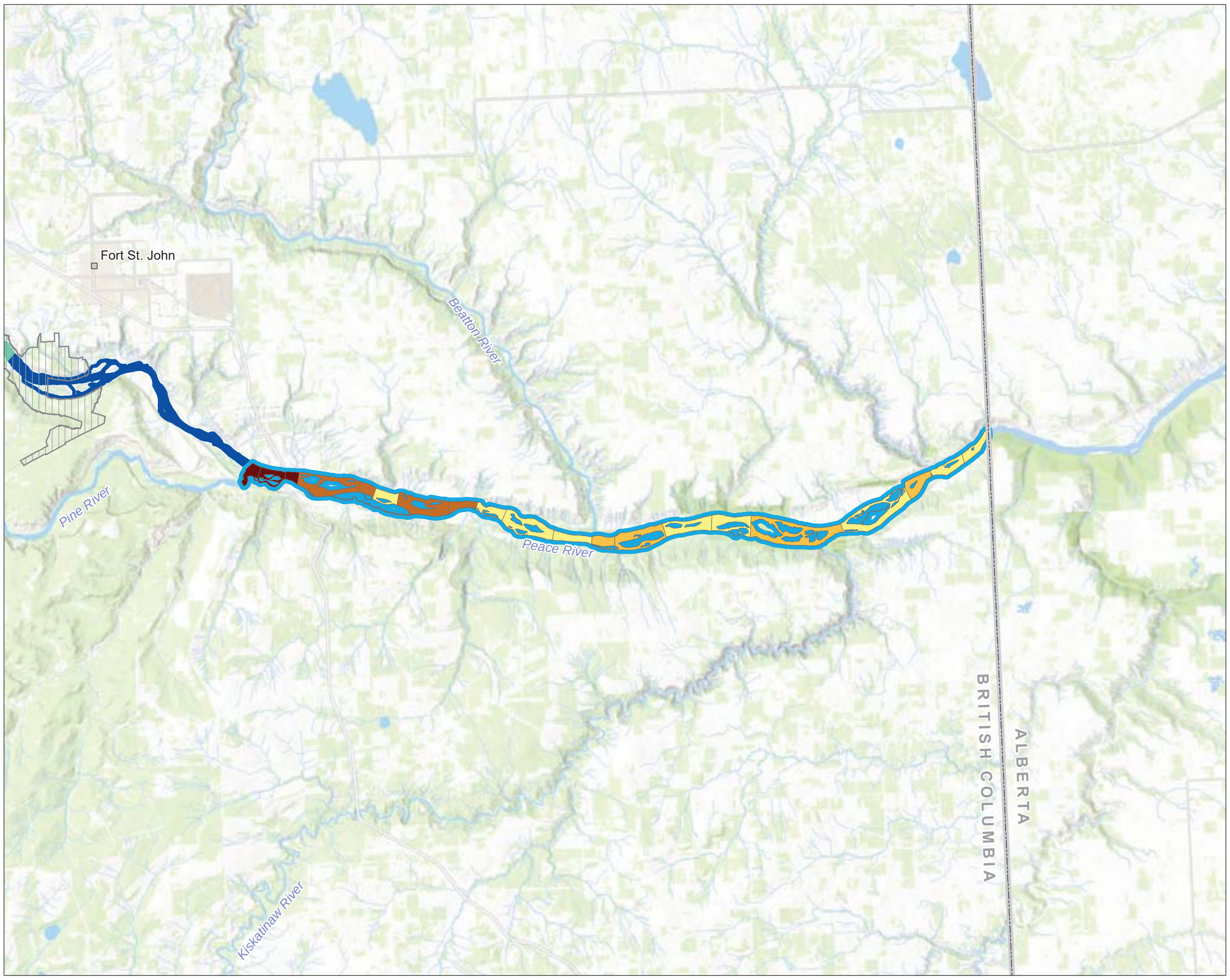
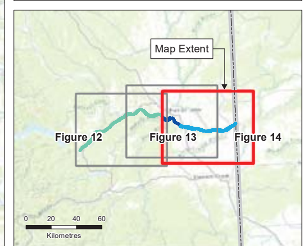
Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Density (birds/km) of Fall Migrant Waterbirds in Reaches of the Control Treatment Area (2017-2018)





Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Waterbird Count per 1 km

- 0 - 10
- >10 - 20
- >20 - 70
- >70 - 1000

Notes

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3. Waterbird count values were classified using approximate Quantile Breaks.

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NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure 14

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BC hydro

4.1.2 Diversity

A total of 48 waterbird species were detected across the 2017 and 2018 waterbird surveys of the Peace River (**Table 8; Appendix A**). Dabbling ducks were the most species rich foraging guild observed during both the spring (14 species) and fall (ten species), with 14 species documented in total. Despite higher species richness observed in spring (44) as compared to fall (37), total seasonal diversity as described by the SWI, was similar during the spring and fall migrations (SWI = 1.72 and 1.71, respectively). Across survey periods, the highest species richness and SWI were observed during the middle and late spring (**Table 8**).

Table 8 Diversity of waterbird foraging guilds observed across survey periods on the Peace River during spring and fall migration, 2017 and 2018 data compiled

Foraging Guild	Spring species richness by survey period			Spring Total	Fall species richness by survey period				Fall Total	*2017-2018 Total*
	Early	Middle	Late		Early	Early-Middle	Late-Middle	Late*		
Benthic Feeding Divers	3	7	6	**7**	2	2	2	3	**5**	**8**
Dabbling Ducks	6	12	11	**14**	6	6	9	5	**10**	**14**
Gulls	1	3	5	**5**	4	5	6	2	**6**	**6**
Large Dabblers	3	2	2	**3**	1	2	2	2	**2**	**3**
Piscivorous Divers	2	8	7	**10**	2	6	7	3	**9**	**10**
Shorebirds	1	4	3	**5**	4	4	2	0	**5**	**6**
Total Species Richness	**16**	**36**	**34**	**44**	**19**	**25**	**28**	**15**	**37**	**47**
Species Evenness	**0.44**	**0.50**	**0.50**	**0.46**	**0.54**	**0.49**	**0.48**	**0.33**	**0.47**	**0.49**
Shannon-Weiner Index	**1.22**	**1.80**	**1.77**	**1.72**	**1.59**	**1.58**	**1.59**	**0.90**	**1.71**	**1.91**

Note: Individual birds not identified to species are excluded from calculations of species evenness by Shannon-Weiner Index.

* The late fall survey period was added in 2018, data are therefore based on one survey.

Due to unequal river reach lengths (i.e., unequal survey effort) across river reach habitat categories and treatment areas in the Peace River study area (**Table 4**), diversity indices cannot be compared directly across reach types or areas. However, diversity statistics were calculated for spring and fall in both 2017 and 2018 to assess temporal variability, and to provide a baseline for comparison to future survey years (**Table 9**, **Table 10**).

Off-channel habitat was the only habitat type to have equal species richness (33 species) between seasons, while the spring hosted greater species richness in all other habitats. Species richness across habitats in the spring averaged 27 species (range 16-33 species), while in the fall the species richness averaged 24 (range 14-33 species; **Table 9**, **Table 10**). The greater diversity observed in the spring across habitats is further shown by the SWI results, which averaged 1.78 (range 1.62-1.88), while in the fall SWI averaged 1.50 (range 1.31-1.59; **Table 9**, **Table 10**).

Higher species richness in the spring as compared to the fall was also observed in all treatment areas in 2017 and 2018. Overall, species richness in the spring averaged 30 species (range 23-37 species), and the fall average was 25 species (range 20-34 species; **Table 9**, **Table 10**). The SWI in spring averaged 1.85 (range 1.75-2.04) and the fall average was 1.41 (range 0.96-1.79; **Table 9**, **Table 10**). In the Inundation Impact area, however, there was lower SWI in the spring (1.75 vs 1.79) despite higher species richness as the distribution of abundances was less even (**Table 9**, **Table 10**).

Table 9 Diversity of spring migrant waterbirds in the Peace River study area by river reach habitat category and treatment area, 2017 and 2018 data compiled

Foraging Guild	Species richness by river reach habitat category				Species richness by treatment area		
	Off-channel	Island	Mainstem	Confluence	Inundation Impact	Flow Impact	Control
Benthic Feeding Divers	6	6	4	3	6	4	5
Dabbling Ducks	11	11	8	4	11	8	11
Gulls	4	3	4	4	5	4	3
Large Dabblers	3	2	2	1	3	2	2
Piscivorous Divers	6	8	5	3	8	2	7
Shorebirds	3	3	2	1	4	3	2
Total Species Richness	**33**	**33**	**25**	**16**	**37**	**23**	**30**
Species Evenness	**0.54**	**0.50**	**0.57**	**0.58**	**0.48**	**0.65**	**0.52**
Shannon-Weiner Index	**1.88**	**1.76**	**1.84**	**1.62**	**1.75**	**2.04**	**1.77**

Note: Diversity statistics are calculated with all data from fully completed surveys in spring, 2017 and 2018 (n = 10). Data from the incomplete survey events are excluded.

Table 10 Diversity of fall migrant waterbirds in the Peace River study area by river reach habitat category and treatment area, 2017 and 2018 data compiled

Foraging Guild	Species richness by river reach habitat category				Species richness by treatment area		
	Off-channel	Island	Mainstem	Confluence	Inundation Impact	Flow Impact	Control
Benthic Feeding Divers	4	3	2	1	4	3	1
Dabbling Ducks	10	7	4	4	10	6	5
Gulls	5	5	6	5	6	5	5
Large Dabblers	2	2	2	1	2	2	2
Piscivorous Divers	7	5	6	2	8	2	4
Shorebirds	5	3	2	1	4	2	3
Total Species Richness	**33**	**25**	**22**	**14**	**34**	**20**	**20**
Species Evenness	**0.45**	**0.49**	**0.50**	**0.50**	**0.51**	**0.50**	**0.32**
Shannon-Weiner Index	**1.59**	**1.57**	**1.54**	**1.31**	**1.79**	**1.48**	**0.96**

Note: Diversity statistics are calculated with all data from fully completed surveys in fall, 2017 and 2018 (n = 12).

4.1.3 Variance Estimates and Power Analysis

Variance estimates (e.g., standard error) are provided in the results of the power analysis of 2018 data conducted by Native Plant Solutions (**Appendix E**). Estimates of variance were determined across and within seasons, as well as across years for all foraging guilds and were used to inform the power analysis. As variance increases, the statistical power to detect change is reduced. Thus, in addition to estimates of standard error provided in **Appendix E**, variances are reflected in the number of years required to detect changes of the specified magnitudes.

The survey effort required to detect a 50% change in relative abundance during spring was lowest for large dabblers and greater for dabbling ducks, piscivorous divers, benthic feeding divers, shorebirds and gulls; these latter guilds had high variability between 2017 and 2018 observations. In fall, the survey effort required to detect a 50% change in relative abundance was lowest for shorebirds, with increasing survey effort required to detect change in piscivorous divers, large dabblers, dabbling ducks, gulls and benthic feeding divers due to the higher data variability for those species. For all foraging groups except gulls and shorebirds, abundance data variability was greater in the fall, resulting in increased survey duration requirements to detect change, relative to spring. Estimates of inter-annual variability are expected to decrease following subsequent years of data collection.

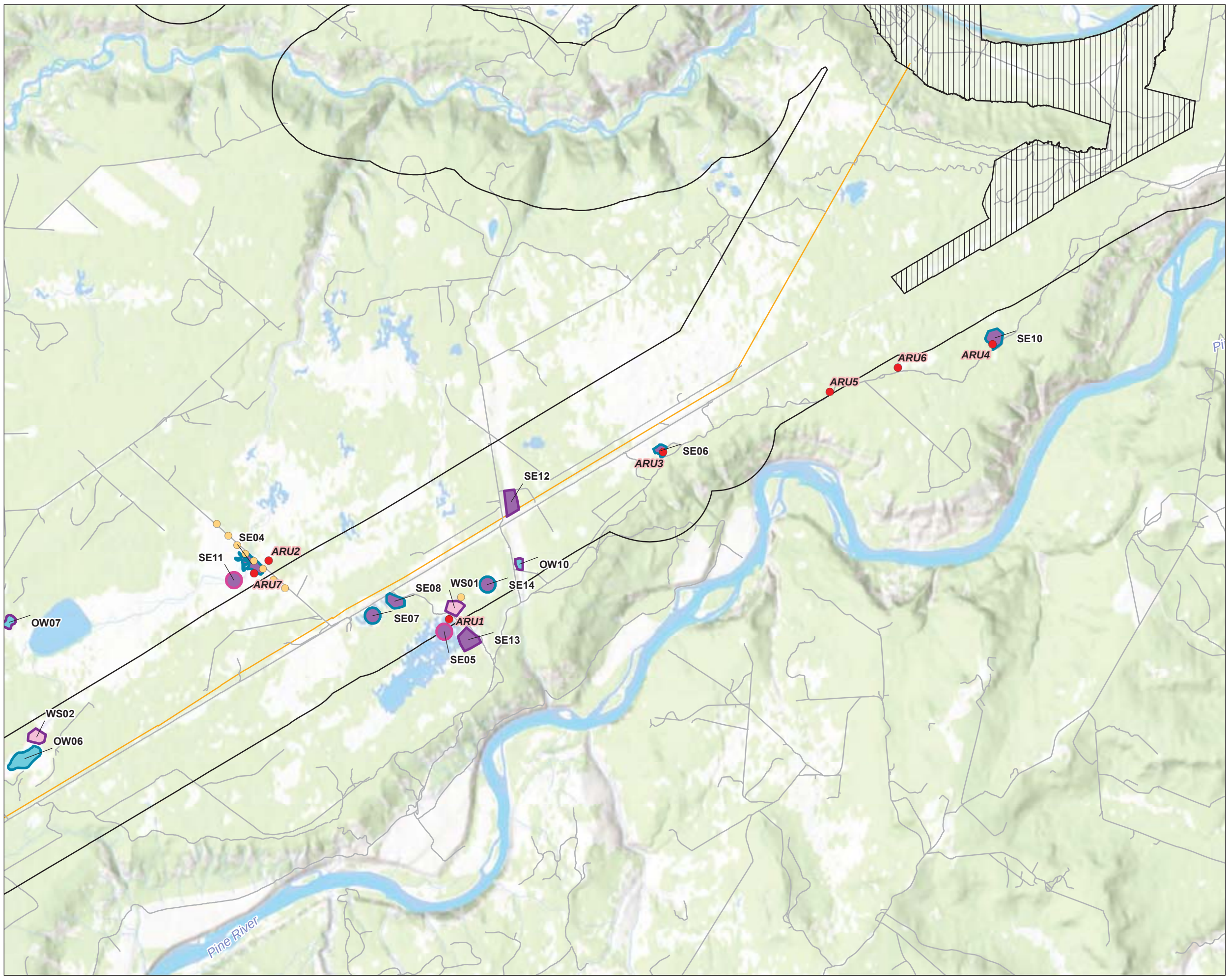
4.2 Transmission Line Wetland Surveys – Transect, Standwatch, UAV, and ARU

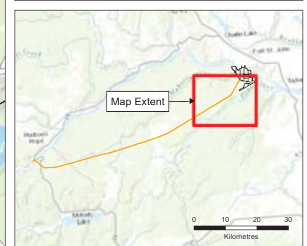
Surveys were conducted at 31 wetlands (survey stations) along the transmission line route during the spring (April 27 to May 17, 2018) and fall (August 6 to October 19, 2018) migrations (**Table 12**, **Figures 15 - 17**). Wetland surveys in 2018 included six stations surveyed by standwatch (open water habitat with clear lines of sight in all seasons), 12 stations with open water areas surveyed by UAV, and 25 stations with vegetated wetlands surveyed by transects (**Appendix C**). The six stations surveyed by standwatch were surveyed by the same method in 2017 and 2018, providing comparable data that have been compiled into the results for open water surveys. Photos of each station showing aerial views or representative habitat are provided in **Appendix E**. In 2018, wetland surveys were conducted over a total of 30 days (12 days in spring and 18 days in fall) within suitable wetland habitat types for waterbirds (**Tables 1-2** and **19**). No transmission line wetlands were visited in the early spring survey period in either 2017 or 2018 because those wetlands were frozen and unavailable for waterbird foraging during that period (**Table 11**). On survey days when wetland stations were frozen, surveys were conducted when possible, but otherwise recorded as zero abundance given that waterbirds were not observed within completely frozen wetlands during any survey or incidentally.

Wetland stations were visited a total of 271 times across survey periods in 2018 (**Table 13, Appendix C**). All of the five wetland types identified as suitable habitat for waterbirds (**Table 1** and **Table 2**) following the 2017 monitoring program were sampled: open water, sedge, willow-sedge, tamarack-sedge, and labrador tea-sedge. The wetland types most commonly dominant within wetland stations were sedge (14) and open water (8), while tamarack-sedge (2), willow-sedge (3) and Labrador tea-sedge (4) were dominant less frequently (**Appendix C**). Given that incidental observations of cultivated fields during the 2017 field program found little evidence of use by waterbirds, no cultivated fields were surveyed in 2018.

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Wetland Survey Stations and ARU Monitoring Locations on the Transmission Line Route (East)





Legend

- Site C LAA
- Proposed Dam Site
- Access / Service Road
- Transmission Line Right-of-Way
- Bioacoustic Monitoring Station
- Historic YERA observations from eBird and Baseline Studies

Survey Station - Dominate Wetland Types

- Sedge (SE)
- Shallow open water (OW)
- Willow sedge (WS)

Survey Station - Sub-dominant Wetland Types

- Sedge (SE)
- Shallow open water (OW)
- Willow sedge (WS)

Notes

1. OW has been used as the idientfier for Shallow Open Water wetland field locations; however, please note that the wetland classification also includes LA and PD habitat codes.
2. Locations should be considered approximate.
3. 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

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Kilometres

NAD 1983 BC Environment Albers

Page Size: 11" x 17"

989619-07	Production Date: Dec 6, 2018	Figure 15

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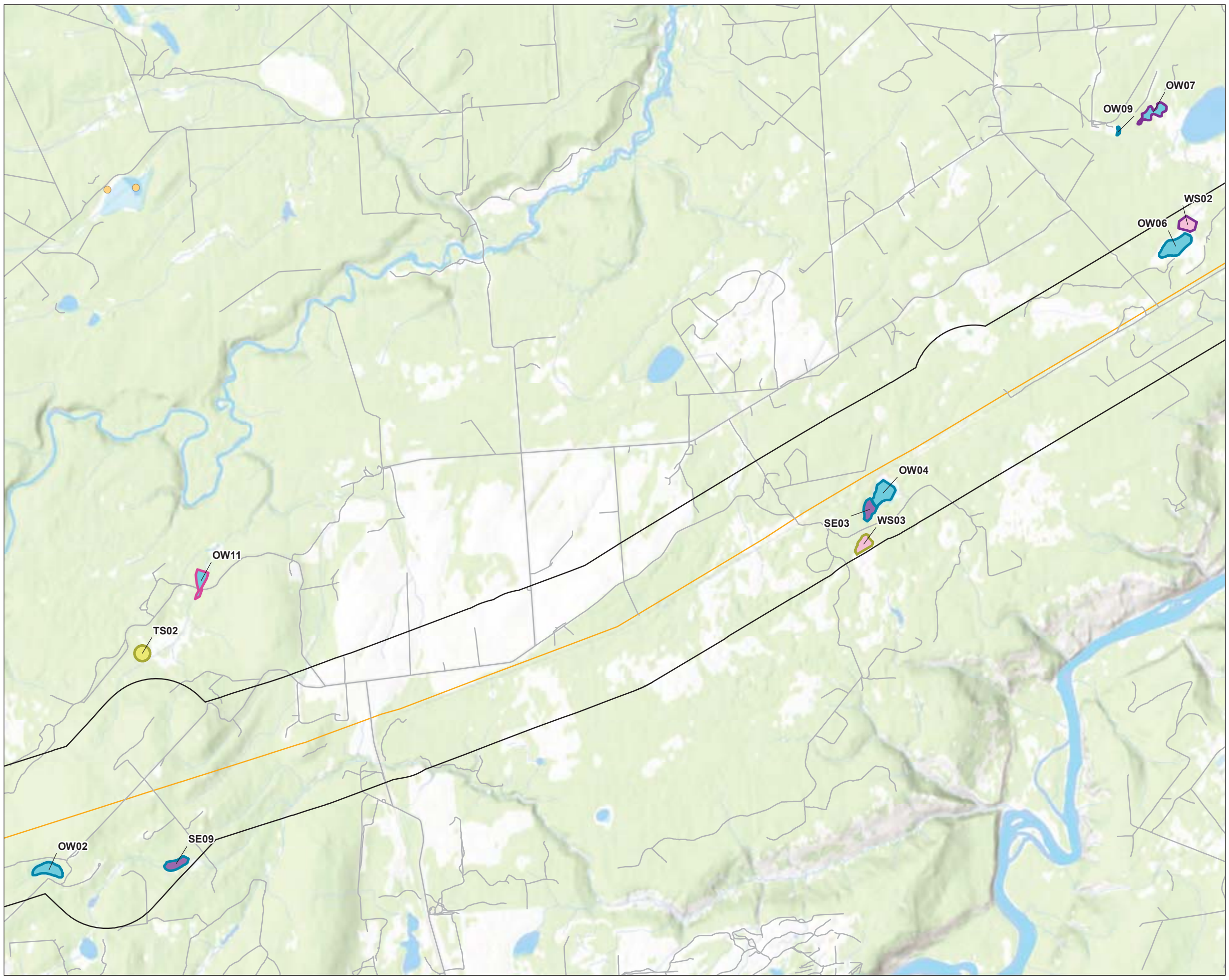
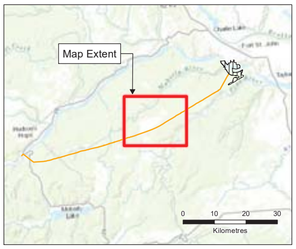
Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Wetland Survey Stations Locations on the Transmission Line Route (Central)





Legend

- Site C LAA
- Access / Service Road
- Transmission Line Right-of-Way
- Historic YERA observations from eBird and Baseline Studies

Survey Station - Dominate Wetland Types

- Sedge (SE)
- Shallow open water (OW)
- Tamarack-sedge (TS)
- Willow sedge (WS)

Survey Station - Sub-dominant Wetland Types

- Sedge (SE)
- Shallow open water (OW)
- Tamarack-sedge (TS)
- Willow sedge (WS)

Notes

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Sources

- Basemap: ESRI World Topographic Base

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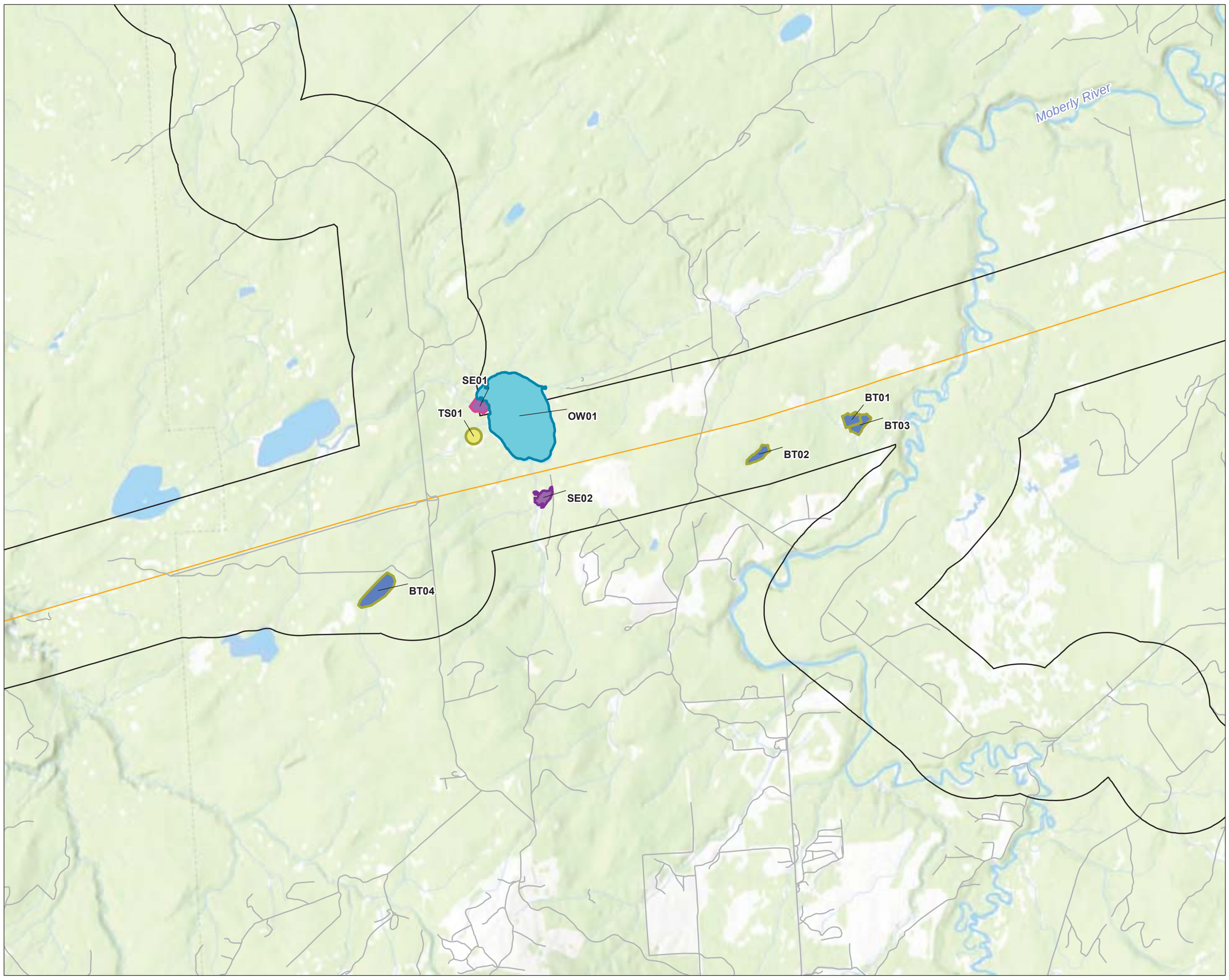
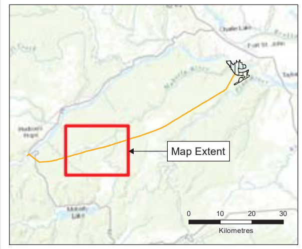
989619-07	Production Date: Dec 6, 2018	Figure 16

Hemmera An Ausenco Company
BC hydro

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Wetland Survey Stations Locations on the Transmission Line Route (West)





Legend

- Site C LAA
- Transmission Line Right-of-Way

Survey Station - Dominate Wetland Types

- Black Spruce - Labrador-tea - sedge (BT)
- Sedge (SE)
- Shallow open water (OW)
- Tamarack-sedge (TS)

Survey Station - Sub-dominant Wetland Types

- Sedge (SE)
- Shallow open water (OW)
- Tamarack-sedge (TS)
- Willow sedge (WS)

Notes

1. OW has been used as the idientfier for Shallow Open Water wetland field locations; however, please note that the wetland classification also includes LA and PD habitat codes.
2. Locations should be considered approximate.
3. 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

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Table 11 Wetland survey dates and periods during the 2017 and 2018 migratory waterbird follow-up monitoring program

Survey Period	2017 Survey Dates	2018 Survey Dates
Spring		
Early (Apr 1 – Apr 14)	Wetlands Frozen	Wetlands Frozen
Middle (Apr 15 – May 6)	April 29, 30; May 1, 2	April 27, 28, 29 May 2, 3, 4
Late (May 7 – May 30)	May 16, 17; May 18, 19, May 25, 26; May 27, 28	May 7, 8, 9 May 15, 16, 17
Fall		
Early (Aug 1 - Aug 14)	August 10, 11; 12, 13	August 6, 7, 8
Early-Middle (Aug 15 – Sept 14)	August 24, 25; 26, 27	August 22, 23, 24, September 6, 7, 10
Late-Middle (Sept 15 – Oct 14)	September 23, 24; 25, 26	September 17, 18, 19 October 1, 2, 3
Late (Oct 15 – Oct 30)	No surveys	October 17, 18, 19

Table 12 Number of wetland stations surveyed adjacent the transmission line route by survey period and dominant habitat type during the 2018 monitoring program

Dominant Habitat Type	Spring			Fall			
	Early	Middle	Late	Early	Middle-Early	Middle-Late	Late
Sedge	*Frozen*	9	13	12	13	13	13
Open water	*Frozen*	7	9	8	9	9	9
Willow-sedge	*Frozen*	3	4	4	4	4	4
Labrador tea-sedge	*Frozen*	0	3	0	3	3	3
Tamarack-sedge	*Frozen*	2	2	2	2	2	2
Total	0	21	31	26	31	31	31

Table 13 Number of wetland surveys conducted on the transmission line route by survey period and habitat type during the 2018 monitoring program

Dominant Habitat Type	Spring			Fall				Total
	Early	Middle	Late	Early	Middle-Early	Middle-Late	Late	
Sedge	*Frozen*	14	24	12	26	25	13	114
Open water	*Frozen*	12	17	8	17	18	9	81
Willow-sedge	*Frozen*	6	7	4	7	8	4	36
Labrador tea-sedge	*Frozen*	0	6	0	6	6	3	21
Tamarack-sedge	*Frozen*	3	4	2	4	4	2	19
Total	0	35	58	26	60	61	31	271

Bioacoustic monitoring for marsh birds, i.e., sora, yellow rail, and American bittern, was conducted in 2017 at six sites, recording 320 hours of acoustic data from May 19 to June 27, 2017 (**Table 14**). ARU monitoring during 2018 recorded data within a sedge dominated area adjacent to wetland survey station SE04 (**Figure 15**). The ARU program in 2018 recorded 140 hours of acoustic data from July 4 to July 23 (**Table 14**). In total 98 days (460 hours) of acoustic data were collected during marsh bird surveys in 2017 and 2018.

Bioacoustic monitoring with ARU devices detected sora at all survey sites in 2017 and 2018. No yellow rail or American bittern were detected in 2017, but yellow rail was detected at the 2018 survey site (**Table 14**). Both yellow rail and sora were only detected within sedge dominated habitat. The ARU that detected yellow rail in 2018 was deployed approximately 40 metres from a large water body with dense sedges and cattail of 1 - 1.5 m tall and scattered patches of willow-sedge habitat.

Table 14 ARU location, habitat description, survey effort, and detections of target species by day, 2017 and 2018.

ARU Survey ID	Latitude	Longitude	Habitat type	Wetland Survey Station	Deployment date	Number of days[1]	SORA	YERA	AMBI
ARU-01	56.104658	-121.044231	Sedge and willow sedge	OW-11	May 16 – May 28, 2017	12	Yes	No	No
ARU-02	56.115311	-121.090337	Sedge and upland forested	OW-09	May 16 – May 28, 2017	12	Yes	No	No
ARU-03	56.126825	-120.985543	Sedge and edge of open water	OW-42b	May 28 – June 12, 2017	14	Yes	No	No
ARU-04	56.139182	-120.898154	Sedge and upland forested	OW-42a	May 28 – June 12, 2017	14	Yes	No	No
ARU-05	56.134144	-120.941172	Sedge	Not in a wetland survey station	June 12 – June 27, 2017	15	Yes	No	No
ARU-06	56.136775	-120.923437	Sedge	Not in a wetland survey station	June 12 – June 24, 2017	12	Yes	No	No
ARU-07	56.113610	-121.094496	Sedge	OW-09	July 04 – July 23, 2018	19	Yes	Yes	No
					Total	**98**	**7/7**	**1/7**	**0/7**

[1] Days when the ARU successfully recorded acoustic data

4.2.1 Relative Abundance and Density

Summaries of relative abundance are provided below by survey method and the habitat type assessed by each method. Different methods were used to improve detection of waterbirds within each habitat type. The greatest numbers of waterbirds were detected on open water habitats within late spring and early through middle-late fall, and were primarily comprised of dabbling ducks across all wetland types and survey methods (**Table 15, Table 16** and **Table 17**). Broad differences in relative abundance were recorded across habitat types, but abundance estimates are not directly comparable considering the different survey methods employed across habitats. This is an unavoidable result of variable detection rates (i.e., survey bias) across wetland types due to differences in access constraints and lines of sight dependent on vegetation height and cover as well as water depth. Waterbird abundances are summarized as densities for standwatch and UAV surveys constrained by area, and as relative abundance for transect surveys in which birds were detected at various distances from the transect.

Standwatch surveys of open water habitat with clear lines of sight (typically permanent water features) detected a total of 1,793 individuals across 29 waterbird species in 2018 (**Appendix A**). Due to the distance at which birds are often observed with this method, more than one third of the observations (771) could not be identified to species. The greatest densities of waterbirds were observed during the late spring, as well as early and middle fall survey periods, and were comprised primarily of dabbling ducks (2.62-4.65/ha of open water during spring and through late-middle fall) (**Table 15**). The lowest densities were recorded during the late fall period which were less than half of all other survey period apart from middle spring.

Transect surveys of vegetated wetlands (sedge, willow-sedge, tamarack-sedge, Labrador tea-sedge) detected 154 individuals across 14 species during 2018 (**Appendix A**). Of these observations, the vast majority (147 individuals) were detected within sedge wetlands. One Wilson's snipe (*Gallinago delicata*) was detected incidentally within Labrador tea-sedge habitat, and no waterbirds were detected within tamarack-sedge wetlands during transect surveys. The remaining waterbirds were detected within willow-sedge wetlands. Abundances observed within vegetated habitats were also highest during the late spring survey period and lowest in the middle spring and late fall periods (**Table 16**).

UAV surveys of open water habitat surrounded or interspersed with sedge, cattail, and willow sedge habitat detected 236 individuals of eight species of waterbirds. These results reflect waterbirds observed during 66 surveys of open water habitat within wetlands obscured from visual lines of sight on the ground by vegetation. UAV surveys detected greater densities of waterbirds in early and middle-early fall compared to other survey periods (**Table 17**). Measures of density derived from UAV surveys of open water areas were lowest in the middle spring and late fall survey periods.

Table 15 Density (waterbirds per hectare) of waterbird foraging guilds during 2017 and 2018 standwatch surveys at open water (OW) wetland stations

Foraging Guild	Spring		Fall			
	Middle	Late	Early	Early-Middle	Late-Middle	Late
Benthic Feeding Divers	0.59	1.53	2.80	2.33	1.62	0.55
Dabbling Ducks	2.62	4.65	4.03	3.92	3.59	1.03
Gulls and Surface-Feeding Terns	0.00	<0.01	0.04	0.00	0.00	0.00
Large Dabblers	0.63	0.10	0.03	0.07	0.06	0.01
Piscivorous Divers	0.01	0.11	0.17	0.14	0.07	0.10
Shorebirds	<0.01	0.20	0.23	0.00	0.00	0.00
Unknown Waterbirds	0.00	0.00	0.26	0.06	0.70	0.53
Grand Total	**3.85**	**6.59**	**7.56**	**6.52**	**6.04**	**2.22**

Table 16 Relative abundance (waterbirds per 100 m transect) of foraging guilds during 2018 transect surveys at vegetated wetland (SE, WS, BT, TS) stations

Foraging Guild	Spring		Fall			
	Middle	Late	Early	Early-Middle	Late-Middle	Late
Benthic Feeding Divers	0.00	0.00	0.00	0.00	0.00	0.00
Dabbling Ducks	0.00	1.19	0.08	0.10	0.01	0.00
Large Dabblers	0.00	0.00	0.00	0.00	0.00	0.00
Marsh Birds	0.00	0.03	0.00	0.00	0.00	0.00
Piscivorous Divers	0.00	0.10	0.10	0.16	0.00	0.00
Shorebirds	0.00	0.47	0.00	0.00	0.01	0.00
Unknown Waterbirds	0.00	0.00	0.00	0.00	0.00	0.00
Grand Total	**0.00**	**1.79**	**0.18**	**0.26**	**0.02**	**0.00**

Table 17 Density (waterbirds per hectare) of foraging guilds during 2018 UAV surveys of open water wetland habitat with surrounding vegetation

Foraging Guild	Spring		Fall			
	Middle	Late	Early	Early-Middle	Late-Middle	Late
Benthic Feeding Divers	0.00	0.00	0.00	0.00	0.03	0.00
Dabbling Ducks	0.05	0.11	0.81	0.39	0.07	0.26
Large Dabblers	0.00	0.03	0.00	0.08	0.00	0.00
Unknown Waterbirds	0.28	0.39	1.30	0.43	0.25	0.05
Grand Total	**0.33**	**0.53**	**2.12**	**0.90**	**0.35**	**0.31**

Note: No Marsh birds, Piscivorous Divers, or Gulls and Surface Feeding Terns were observed during UAV surveys of open water habitat

4.2.2 Diversity

Wetland survey data was summarized to provide metrics of diversity for each survey method, survey period, and season, including species richness for species guilds (**Table 18**, **Table 19** and **Table 20**). As described above for relative abundance, differences in detection and species identification constraints across wetland habitat types do not allow for direct comparisons of diversity across habitats. Survey effort was also not even across seasons or survey periods as fewer surveys were conducted in the spring (4) as compared to fall (6) and during the early and late survey periods in fall (1) as compared to all other survey periods (2) (**Table 11**). Metrics of diversity (e.g., species richness) are biased (high) for periods with greater survey effort as more species will be detected with greater sample sizes regardless of any true differences in diversity. Thus, only survey periods sampled with the same level of effort are directly comparable: Middle and Late Spring, Early and Middle Fall.

Dabbling ducks, in addition to having the highest abundance within all wetland habitat types and seasons (**Table 15, Table 16** and **Table 17**), were the most diverse foraging guild in all wetlands (**Table 18**, **Table 19** and **Table 20**).

Apart from dabbling ducks, piscivorous divers were the next most diverse species group observed during standwatch surveys followed by benthic feeding divers and shorebirds. The highest diversities during standwatch surveys of open water were observed in the late spring; 22 species (Shannon-Weiner Index: 2.58) (**Table 18**). Metrics of diversity within open water habitat surveyed by standwatch were very similar during the two middle fall survey periods, and similar diversity was found from the early fall survey period despite the lower survey effort during this period.

Table 18 Diversity of waterbird foraging guilds in open water habitat during 2017 and 2018 standwatch surveys at open water (OW) wetland stations

Foraging Guild	Mean species richness (# of species)								
	Spring		Spring Total	Fall				Fall Total	2017-2018 Total
	Middle	Late		Early	Early-Middle	Late-Middle	**Late**		
Benthic Feeding Divers	2	4	4	2	3	2	2	3	5
Dabbling Ducks	6	9	10	4	7	10	6	11	13
Gulls and Surface-Feeding Terns	0	1	1	2	0	0	0	2	3
Large Dabblers	2	2	2	2	2	1	1	2	2
Marsh Birds	1	0	1	0	0	0	0	0	1
Piscivorous Divers	1	3	3	4	4	2	3	6	7
Shorebirds	1	3	3	2	0	0	0	2	4
Total Species Richness	**13**	**22**	**24**	**16**	**16**	**15**	**12**	**26**	**35**
Species Evenness	**0.85**	**0.84**	**0.83**	**0.80**	**0.80**	**0.80**	**0.76**	**0.72**	**0.73**
Shannon-Weiner Index	**2.18**	**2.58**	**2.63**	**2.22**	**2.21**	**2.17**	**1.89**	**2.34**	**2.58**

During vegetated wetland surveys, dabbling ducks were again the most diverse guild observed. The highest waterbird diversities during vegetated wetland transect surveys were observed in the late spring; 14 species (Shannon-Weiner Index: 1.97) and no waterbirds were observed during transects of vegetated wetlands in the middle spring or late fall (**Table 19**). Metrics of diversity within vegetated wetlands surveyed by transects were substantially lower during the middle spring and late fall.

Table 19 Diversity of waterbird foraging guilds within vegetated wetlands surveyed with 100 metre transects in 2018

Foraging Guild	Mean species richness (# of species)								
	Spring		Spring Total	Fall				Fall Total	2018 Total
	Middle	Late		Early	Early-Middle	Late-Middle	Late		
Benthic Feeding Divers	0	1	1	0	0	0	0	0	1
Dabbling Ducks	0	7	7	2	2	0	0	3	7
Gulls	0	0	0	0	0	0	0	0	0
Large Dabblers	0	1	1	0	0	0	0	0	1
Marsh Birds	0	2	2	2	2	2	0	2	2
Piscivorous Divers	0	0	0	0	0	0	0	0	0
Shorebirds	0	3	3	0	0	1	0	1	3
Total Species Richness	**0**	**14**	**14**	**4**	**4**	**2**	**0**	**6**	**14**
Species Evenness	**NA**	**0.75**	**0.75**	**0.92**	**0.80**	**0.00**	**NA**	**0.83**	**0.80**
Shannon-Weiner Index	**0.00**	**1.97**	**1.97**	**1.28**	**1.10**	**0.69**	**0.00**	**1.49**	**2.11**

Identification of waterbirds to species was often challenging due to lack of magnification capacity during filming. Consequently, the data collected was considered insufficient for determination of diversity metrics beyond species richness (**Table 20**). Apart from dabbling ducks, the only other foraging guilds with species identified from UAV surveys were large dabblers and benthic feeding divers (**Table 20**). The highest waterbird diversities during UAV surveys of open water were observed in early-middle fall (6) followed by late spring (4) survey periods.

Table 20 Diversity of waterbird foraging guilds in open water habitat surveyed by UAV in 2018

Foraging Guild	Spring		Fall				2018 Total
	Middle	Late	Early	Early-Middle	Late-Middle	Late	
Benthic Feeding Divers	0	0	0	0	1	0	1
Dabbling Ducks	1	3	3	5	2	0	5
Gulls	0	0	0	0	0	0	0
Large Dabblers	0	1	0	1	0	1	2
Marsh Birds	0	0	0	0	0	0	0
Piscivorous Divers	0	0	0	0	0	0	0
Shorebirds	0	0	0	0	0	0	0
Total Species Richness	**1**	**4**	**3**	**6**	**3**	**1**	**8**

Note: Numbers of identified species only allowed for determination of species richness diversity metrics.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Habitat Assessments

Habitat data were obtained during surveys to provide habitat characteristics associated with each waterbird observation. Flow data from the Peace River for each of the three treatment areas demonstrated that surveys were conducted during flows that are representative of the overall flow conditions for each season. Flow data may influence waterbird abundances and / or diversity, and will be considered in the future in models used to analyse trends in the relative abundance and diversity of waterbirds within habitat types.

While TEM-based mapping has been conducted for the study area, such mapping does not include landform information pertinent to waterbird presence on the Peace River. Characterization of Peace River reaches into categories in 2017 delimited four types of reaches (i.e., Off-channel, Islands, Mainstem, and Confluence), each of which is present in various proportions in the three treatment areas (see **Table 4**). Following Project commissioning, re-characterization of the reaches will provide comparisons of habitat availability relative to Project-related changes and demonstrate changes to the Impact treatment areas. The presence of waterbirds within each of the reach types across the two seasons is presented in **Section 5.2**.

Habitat data provide the information required to support future analyses examining the influence of habitat factors on waterbird abundance and diversity. The more-precise waterbird location and habitat data collected in 2017 and 2018 improve on the data available prior to 2017, in which bird observations were recorded within 5 km segments and were not associated with habitat characteristics. Additional habitat data for the Peace River were also identified as potentially useful for analyses. LIDAR data of the Peace River Valley may be considered to assess the influence of topographic features on waterbirds.

5.2 Peace River Waterbird Surveys

Boat and UAV surveys of the Peace River in 2017 and 2018 have provided estimates of relative abundance and diversity throughout the spring and fall migrations to meet the waterbird monitoring program objectives (**Section 4.1**). All target taxa, including shorebirds, were observed during boat and UAV surveys. In 2018, over 90% of waterbird observations were identified to species, and 43 distinct species were observed. In 2017, there was also 90% identification of waterbirds to species, but only 38 distinct species were observed. The increase in diversity is likely due to the observations of uncommon to rare birds, such as artic tern (*Sterna paradisaea*), and harlequin duck (*Histrionicus histrionicus*). Diversity also increased as a result of improved UAV methods in the backchannels, which were adapted as per the recommendations in 2017 to increase identification accuracy (Hemmera 2018). Adaptation of the UAV methods included standardization of flight speed (20 km/h max) and average height (20 m), both of which provided clearer images of the birds observed. There was a decrease in the proportion of unidentifiable birds observed by UAV in 2018, with 0.33 unknown birds in 2018 and 0.41 in 2017. There was a total of 3,538 waterbirds observed within backchannels by UAV in 2018, which was 3.7 times greater than in 2017, when 961 birds were observed.

The most common waterbird species observed on the Peace River in 2018 was Canada goose (8,840), mallard (2,533), and Bonaparte's gull (*Chroicocephalus philadelphia*) (2,361) (**Appendix A**). These species were also the most-commonly observed species during our 2017 surveys (Hemmera 2018, **Appendix A**). Surveys in 1996 and 1999 resulted in similarly high proportions of Canada geese, which made up over 50% of the observed waterbirds (Robertson 1999, Robertson and Hawkes 2000).

Timing of peak presence for each guild is variable, but most arrive early in the spring and the highest numbers are observed at this time. This includes large dabbling ducks, dabbling ducks, piscivorous divers, and benthic feeding divers. While modest numbers from these guilds were observed in all periods, the highest numbers are observed in the late spring. Shorebirds are low in number, the least-observed of the waterbird guilds, arriving in late spring as they migrate through the region and present in the greatest numbers in early fall. The vast majority of shorebirds observed during surveys were spotted sandpiper (*Actitis macularia*), comprising 93% of shorebird records during 2018 surveys (**Appendix A**). Gulls are abundant only in the fall, when their numbers are very high, particularly in the Confluence reaches of the Peace River.

Large dabbling ducks, made up primarily of Canada geese (96% of 2018 records [**Appendix A**]), are the most densely populated waterbird guild with more than twice the mean abundance of any other guild across survey periods (**Table 5**). Large dabblers were found in the greatest abundance in the Inundation Impact treatment area and within Island reaches and Off-channel reaches (**Table 6**). Off-channel and Island reaches within the Inundation Impact area have more low-lying vegetated habitats that offer abundant forage for this herbivorous waterbird, as well as good nesting habitat (Mowbray et al. 2002). High numbers of Canada geese were also the most abundant waterbirds observed during the 2017 waterbird surveys. The Peace River is functioning as a stopover site during spring and fall migration and as a breeding site for Canada geese.

Dabbling ducks were the second most abundant guild over 2017 and 2018 (**Table 5**) and were primarily made up of mallards (57% of 2018 records [**Appendix A**]). Mallards are known to be one of the first waterbirds to arrive during spring migration, usually just as the ice thaws (Drilling et al. 2018). The highest numbers of dabbling ducks observed in the study area were in the early and middle spring survey periods, with abundances in the late spring reduced by almost half, and numbers in the fall reduced to a quarter of early and middle spring abundances. This can be explained by the breeding cycle of mallards. Early spring is when mate selection occurs, some may breed adjacent to the Peace River, but most will find smaller wetlands to breed (Drilling et al. 2018). Shortly after breeding, while the female is incubating, drakes will depart to a more protected wetland to undergo their moult (Drilling et al. 2018).

Gulls were the third most abundant guild overall, and the most abundant waterbird guild observed during fall of 2017 and 2018 (**Table 5**). Gulls were most dense in the Flow Impact area, 5.9 times more abundant than any other guild, and at Confluence reaches they were 7.3 time more abundant than any other guild (**Table 7**), specifically at the Confluence of the Moberly River, and at the Site C dam construction zone. The most abundant gulls were the Bonaparte’s and ring-billed gulls. The abundance of Bonaparte’s gull was similar between 2017 and 2018, with 2,431 and 2,361 observed, respectively. Their consistent abundance suggests that this area is very productive with fish and insects as, unlike other gulls, Bonaparte’s gulls do not feed on human garbage (Burger and Gochfeld 2002). Ring-billed gulls have increased from 154 in 2017 to 1,239 in 2018, an eight times increase for this fish, insect and opportunistic garbage feeder (Pollet et al. 2012). As with other gulls, this species is most abundant in the fall, indicating that they are using the survey area as a fall migration stopover site.

Shorebirds were only abundant in the late spring and early fall periods; outside these times observations were rare. This timing for peak abundance, and the relatively low diversity, was consistent with that seen in previous years (Hemmera 2018). Shorebird presence was greatest in the Island reaches, with few seen outside these locations. The only abundant migratory shorebird species on the Peace River continues to be spotted sandpiper (*Actitis macularius*). The 1,027 spotted sandpipers observed in 2017 and 2018 comprised 90% of all shorebirds and of all shorebird observations. This, and the diversity data showing six species seen in 2017-2018, indicates that the Peace River is not heavily used by other shorebird species, and challenges the hypothesis that the Peace River currently supports substantial numbers of other migratory shorebirds (Blood et al. 1979).

Survey data from 2017 and 2018 show that waterbird diversity peaks in the middle of the spring season (mid-April to early May). The peak waterbird abundance is, however, in the early spring when more abundant but less diverse flocks of waterbirds are using the Peace River. During the middle spring period early and late migrant waterbirds use the river for mate selection, as a migratory stopover, and for breeding. Our findings are similar to those of other researchers who found mid-May to be the peak of the spring migration (Siddle 2010). The period from mid-August to early October (mid-fall) exhibits the highest diversity in the fall, with modest diversity of dabbling ducks and piscivorous divers and high diversity of gulls. This is likely driven by the southward migration of waterbirds to their winter stopovers south of the region. By late fall, the diversity of waterbirds is the lowest seen across the survey periods; at this time in the year waterbirds have mostly migrated through the region, and only late migrants and year-round resident species are present (Siddle 2010). Survey effort in the late fall was also lower than in any other period and may contribute to lower observed species richness and SWI.

The spatial distribution of waterbirds varied between seasons. In spring, waterbirds used Off-channel and Island reaches more than they did the Mainstem and Confluence reaches. In the fall, Island and Mainstem reaches were used very little compared to Off-channel and Confluence reaches; this finding was driven by the high abundance of large dabblers (e.g., Canada goose) in Off-channel wetlands and diverse gull species using the open Confluence reach habitats.

The following designated species at risk have been observed during the 2017-2018 Peace River surveys, as per provincial, Species at Risk Act (SARA), or Committee on the Status of Endangered Wildlife in Canada (COSEWIC):

- California gull (*Larus californicus),* BC listing (Blue)
- Surf scoter (*Melanitta perspicillata*), BC listing (Blue)
- Eared grebe (*Podiceps nigricollis*), BC listing (Blue),
- Horned grebe, (*Podiceps auratus*) COSEWIC (special concern [SC]), Schedule 1 of SARA (1-SC)
- Western grebe (*Aechmophorus occidentalis*), BC listing (Red), COSEWIC (SC), SARA (SC)

Data collected in 2017 and 2018 show that all habitats in the Peace River are used by waterbirds, with variations in timing, distribution and abundance for each of the guilds. Large dabbling ducks (Canada goose), gulls and dabbling ducks are the most commonly seen waterbirds, and shorebirds are only present in low numbers. Off-channel, Island and Confluence habitats are used the most by waterbirds, with seasonal variation in the timing of peak presence in each type. A more-diverse suite of shorebirds was observed in 2018, potentially reflecting refinement of survey methods following monitoring efforts in 2017.

Optimal survey periods that coincide with peak bird presence in the spring were identified for most foraging groups, and showed the value in altering the spread of surveys across the monitoring periods, and the value of conducting more than one survey during most periods (**Appendix E**). In the fall, the optimal survey periods were not as clear due to variation in the numbers of waterbirds recorded within periods in each part of the season. The late fall (mid to late October) survey, added as per recommendations from 2017 data analyses (Native Plant Solutions 2018), has not yet proved to be valuable. Specifically, few benthic feeding divers, for which this last survey was recommended, were detected during October. Future surveys in late fall are required to verify the utility of extending surveys into mid-late October.

The summary of data within treatment areas found that waterbird densities within the Control and Inundation Impact areas were representative of each other, and this standard assumption for BACI analysis was met. The only exceptions to this were benthic feeding divers in the fall, which occur only in low abundances, and gulls in the fall. The high numbers of gulls in the Flow Impact area appears to be an artefact of construction activities as most gulls are concentrated around disturbed habitat at the Project construction site.

As demonstrated by the results summarized within this report, survey methods provide valuable data on the pre-construction condition (Before) of the study area within both Impact and Control treatment areas. Thus, surveys will continue in subsequent years of monitoring with no change in study design recommended or planned.

5.3 Transmission Line Wetland Surveys

Wetland surveys along the transmission line successfully provided estimates of spring and fall relative abundance and diversity of waterbirds in suitable wetland habitat types. Survey results provide the data required to meet the study's monitoring objectives (**Section 4.2**). A representative suite of sampling stations has been established, and consistent monitoring of these will be conducted in future years. Consistent with observations in 2017, there was little to no use of tamarack-sedge and Labrador tea-sedge wetlands by waterbirds; therefore, monitoring of these habitats serves no utility for the program and is recommended to be discontinued in 2019.

Adaptations to the 2017 survey program that were required to improve the precision of the data collection proved to be effective. The addition of UAV methods allowed for observations of waterbirds in otherwise inaccessible / unobservable open water habitat surrounded or interspersed with sedge, and willow-sedge habitat. Standardized survey duration and distance for each of the methods has now allowed for better density metrics to be obtained. Geographic and ecological representativeness was improved in 2018 by the addition of more wetland surveys in the west and of the Labrador tea-sedge habitat type. As the construction access routes are improved to the west of the transmission line route, an even more geographically representative sampling regime can be included in the study.

Thirty-five species were detected during open water wetland surveys and 14 in vegetated wetland surveys in 2017-2018, including the 24 species that were detected during transmission line surveys in 2008 (EIS, appendix R, part 4). The increased diversity recorded under the current monitoring program likely reflects increased survey effort applied to the 2017-2018 surveys. Dabbling ducks were the most commonly recorded foraging guild in open water wetlands on the transmission line, and American wigeon (*Anas americana*), scaup species (*Aythya* spp.), and mallards were among the most-numerous species observed. In the vegetated wetlands, the northern shoveler (*Anas clypeata*), a dabbling duck, and the spotted sandpiper, were the most commonly observed species. These observations were similar to findings from 2006 and 2008, when mallards and American wigeons accounted for 69% of the observations in wetlands (EIS, appendix R, part 4), and from 2017 surveys (Hemmera 2018). Open water wetlands such as lakes and ponds had the greatest number of waterbird observations, and the highest diversity, mostly of dabbling ducks. Again, this is consistent with the 2006 through 2008 studies in the transmission line route area (EIS, appendix R, part 4) and 2017 (Hemmera 2018). The timing of peak waterbird abundance and diversity is likely linked to spring thaw and the open water habitats on the transmission line becoming available. This coincides with reduced numbers of waterbirds on the Peace River, suggesting that waterbirds switch from river to upland wetland locations in late spring. Low numbers of waterbirds were observed in the late fall surveys, instituted for the first time in 2018. This likely reflects the increasingly cold conditions in mid-October and earlier southward migration of some species. During October surveys, some wetlands were observed to be frozen and hence unavailable to waterfowl, and snow, while not settled, had begun to fall. It should also be noted that vegetated wetlands were often flooded during the middle spring survey period. Transects were not conducted through flooded wetlands and so surveys were conducted by alternate means (e.g., standwatch, UAV) which will be compared to similar methods employed during early spring at flooded SE and WS sites during future years.

Species at risk observed in low numbers during 2017 and 2018 were:

- Franklin's gull (*Leucophaeus pipixcan*) (BC status Unknown),
- Horned grebe (listed SC by COSEWIC and 1-SC under SARA),
- Eared grebe (Blue listed in BC) and
- Yellow rail (Red listed in BC, listed SC by COSEWIC and 1-SC under SARA).

Sora and yellow rail were detected in wetlands on the transmission line route. Sora was detected from both ARU and transect surveys, while yellow rail was only detected with ARU. American bittern was not detected during the 2017 - 2018 waterbird surveys. In 2006 – 2011 studies conducted for the EIS, sora were observed during formal point count and waterfowl surveys, and incidentally (EIS, appendix R, part 4). EIS studies also identified yellow rail in the Del Rio area (EIS, appendix R, part 4) which was confirmed in this study during 2018 bioacoustic monitoring. No American bittern have been observed as part of Site C wildlife studies.

Wetland surveys on the transmission line in 2018 utilized a representative sampling regime that can be applied in future years. The ARU for recording crepuscular / nocturnal observations successfully recorded yellow rail, confirming previous reports based on call-playback and point-count surveys (Hilton et al. 2013). Continuation of these methods is recommended in 2019 and beyond. The addition of the UAV survey platform used successfully on the Peace River boat surveys proved to be a successful addition to the wetland survey program, although additional efforts will be made to improve species identification during wetland surveys. This observation technique, combined with transect surveys of vegetated areas, provided for better standardization of survey effort across habitats that were previously difficult to observe due to unstable floating vegetation and water channels that are hazardous or impossible to traverse on foot.

6.0 CLOSING

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

Waterbird Species List, Foraging Guild Categories, and Cumulative Abundances from 2018

Foraging Guild	English Name	Scientific Name	River Survey Abundance [a]	Wetland Standwatch Abundance [b]	Wetland Transect Abundance [c]
Benthic Feeding Divers			**1173**	**264**	**0**
	Common Goldeneye	*Bucephala clangula*	782	22	0
	Bufflehead	*Bucephala albeola*	156	197	0
	Unknown Goldeneye	*Bucephala sp.*	98	15	0
	Barrow's Goldeneye	*Bucephala islandica*	84	3	0
	Surf Scoter	*Melanitta perspicillata*	41	26	0
	Ruddy Duck	*Oxyura jamaicensis*	4	0	0
	Harlequin Duck	*Histrionicus histrionicus*	3	0	0
	White-winged Scoter	*Melanitta fusca*	2	1	0
	Unknown Scoter	*Mellanita sp.*	2	0	0
	American Dipper	*Cinclus mexicanus*	1	0	0
Dabbling Ducks			**4479**	**761**	**96**
	Mallard	*Anas platyrhynchos*	2533	134	12
	Green-winged Teal	*Anas crecca*	741	119	12
	American Wigeon	*Anas americana*	527	155	2
	Blue-winged Teal	*Anas discors*	200	87	10
	Unknown Scaup	*n/a*	126	140	0
	Northern Pintail	*Anas acuta*	122	0	4
	American Coot	*Fulica americana*	86	5	5
	Unknown Teal	*n/a*	68	0	0
	Greater Scaup	*Aythya marila*	28	8	0
	Northern Shoveler	*Anas clypeata*	26	17	51
	Ring-necked Duck	*Aythya collaris*	8	34	0
	Gadwall	*Anas strepera*	6	10	0
	Redhead	*Aythya americana*	6	1	0
	Lesser Scaup	*Aythya affinis*	2	43	0
	Canvasback	Aythya valisineria	0	8	0
Gulls and Surface Feeding Terns			**4324**	**15**	**0**
	Bonaparte's Gull	*Chroicocephalus philadelphia*	2361	12	0
	Ring-billed Gull	*Larus delawarensis*	1239	0	0
	Franklin's Gull	*Leucophaeus pipixcan*	536	0	0
	Unknown Gull	*n/a*	135	0	0
	Mew Gull	*Larus canus*	26	0	0
	Herring Gull	*Larus argentatus*	22	0	0
	California Gull	*Larus californicus*	5	0	0
	Black Tern	*Chlidonias niger*	0	3	0
Large Dabblers			**9161**	**69**	**2**
	Canada Goose	*Branta canadensis*	8840	23	0
	Trumpeter Swan [d]	*Cygnus buccinator*	320	46	2
	Snow Goose	*Chen caerulescens*	1	0	0
Marsh Birds			**0**	**0**	**21**
	Wilson's Snipe	*Gallinago delicata*	0	0	14
	Sora	*Porzana carolina*	0	0	7
Piscivorous Divers			**683**	**59**	**0**
	Common Merganser	*Mergus merganser*	615	14	0
	Hooded Merganser	*Lophodytes cucullatus*	20	2	0
	Common Loon	*Gavia immer*	11	21	0
	Red-necked Grebe	*Podiceps grisegena*	9	10	0
	Eared Grebe	*Podiceps nigricollis*	6	12	0
	Red-breasted Merganser	*Mergus serrator*	6	0	0
	Unknown Merganser	*n/a*	6	0	0
	Unknown Loon	*n/a*	4	0	0
	Arctic Tern	*Sterna paradisaea*	2	0	0
	Unknown Grebe	*n/a*	2	0	0
	Horned Grebe	*Podiceps auritus*	1	0	0
	Unknown Tern	*Sterna spp.*	1	0	0
	Pied-billed Grebe	*Podilymbus podiceps*	0	0	0
Shorebirds			**650**	**9**	**35**
	Spotted Sandpiper	*Actitis macularius*	604	1	28
	Unknown Shorebird	*n/a*	23	0	0
	Killdeer	*Charadrius vociferus*	10	1	0
	Solitary Sandpiper	*Tringa solitaria*	9	0	4
	Unknown Peep	*Calidris sp.*	3	0	1
	Greater Yellowlegs	*Tringa melanoleuca*	1	7	2
Unknown Waterbirds			**1583**	**616**	**0**
	Unidentified Waterbird	*n/a*	1172	4	0
	Unidentified Duck	*n/a*	411	612	0
Grand Total			**22053**	**1793**	**154**

Notes:

[a] - Includes flying records as birds were often flushed to flight in front of boat.

[b] - Excludes flying records and those from stations where access was not permitted.

[c] - Includes both on-foot transects and UAV surveys.

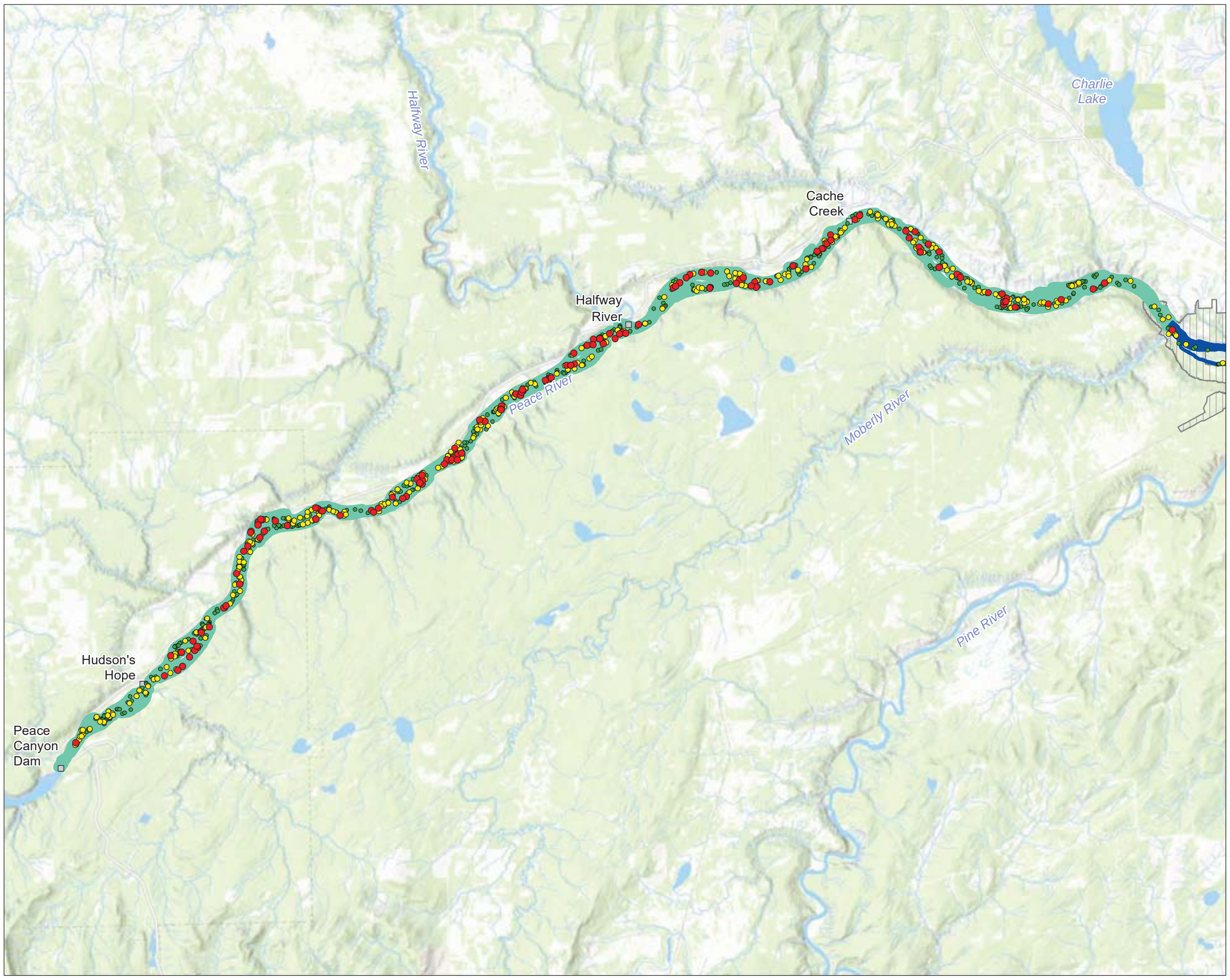
[d] - All swans were assumed trumpeter swans, but some proportion of tundra is likely based on documented presence of the species (eBird).

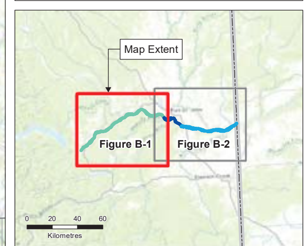
APPENDIX B

Spatial Representation of Waterbird Observations within the Peace River Study Area in Spring and Fall 2018 (Figures B-1 to B-4)

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Inundation/Reservoir Impact Area
Spring 2018





Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1-2 birds
- 3-9 birds
- 10 or more birds

Notes

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

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 5 10 15
Kilometres

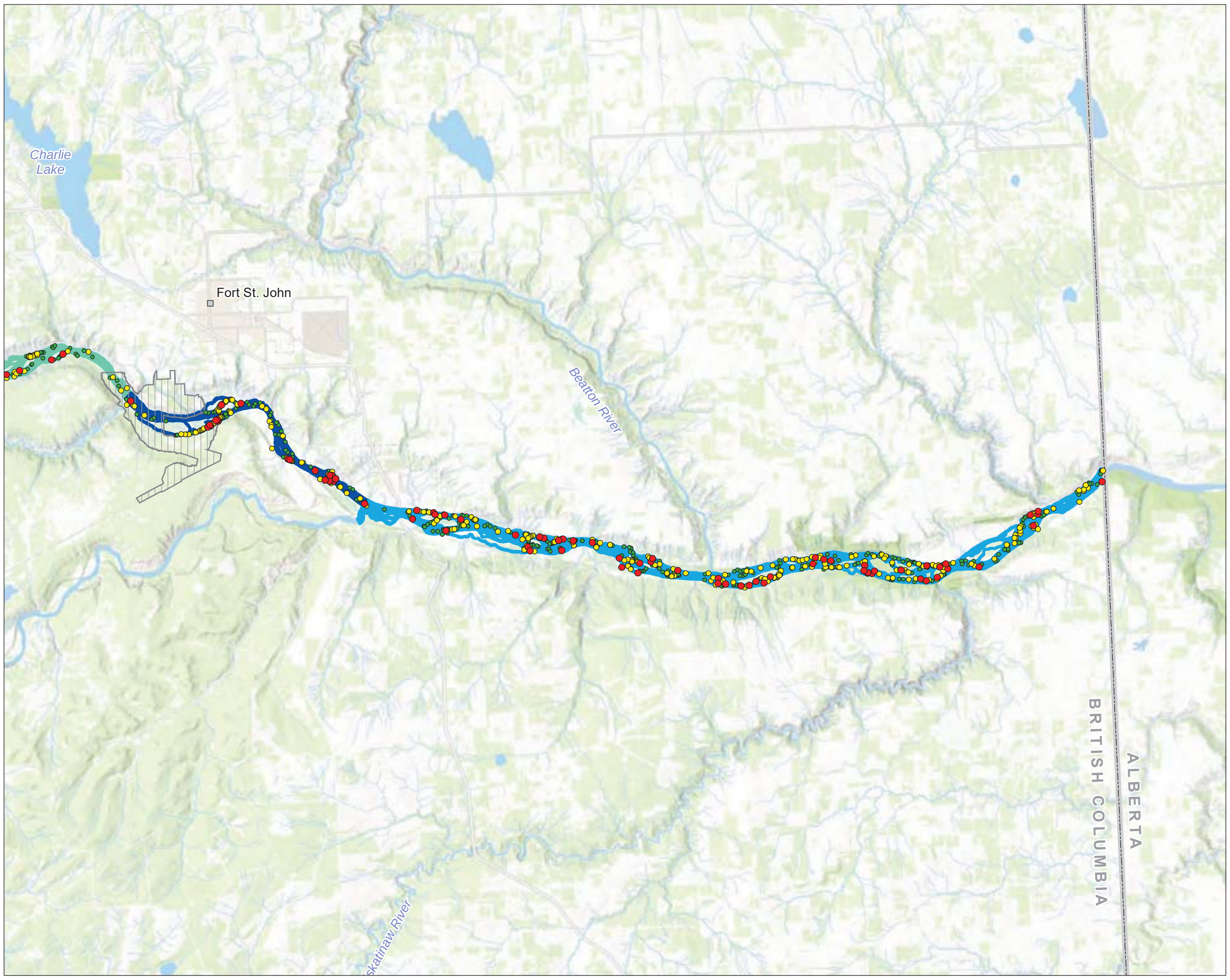
NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure B-1

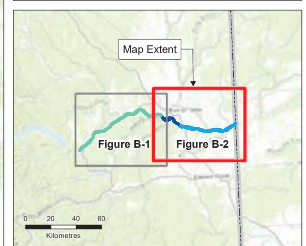
Hemmera An Ausenco Company

BC hydro



Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Flow Regime Impact Area and Control Area
Spring 2018



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1-2 birds
- 3-9 birds
- 10 or more birds

Notes

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0 5 10 15

Kilometres

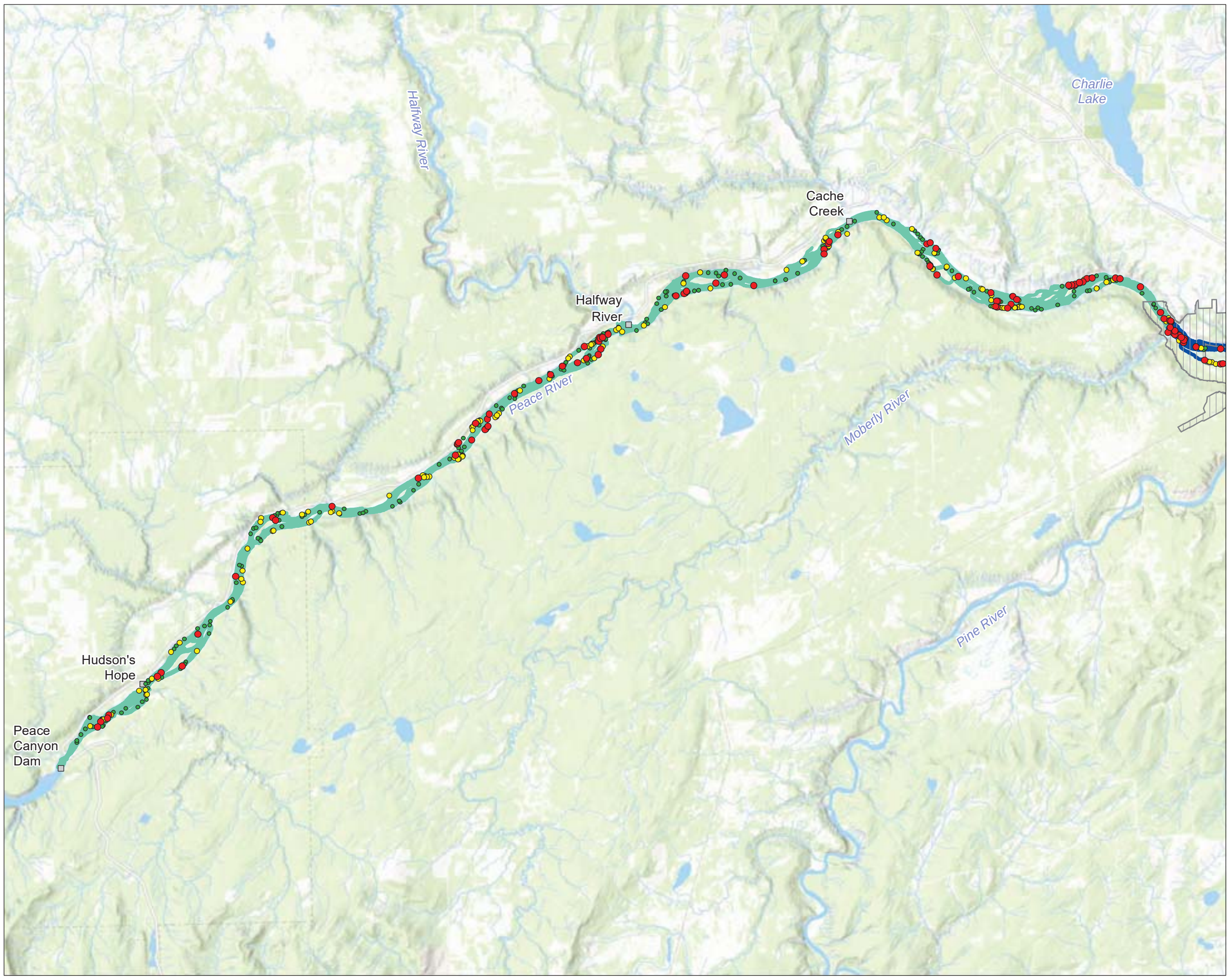
NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure B-2

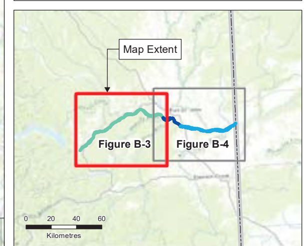
Hemmera
An Ausenco Company

BC hydro



Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Inundation/Reservoir Impact Area
Fall 2018



Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1-2 birds
- 3-9 birds
- 10 or more birds

Notes

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

Sources

- Basemap: ESRI World Topographic Base

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Kilometres

NAD 1983 UTM Zone 10N

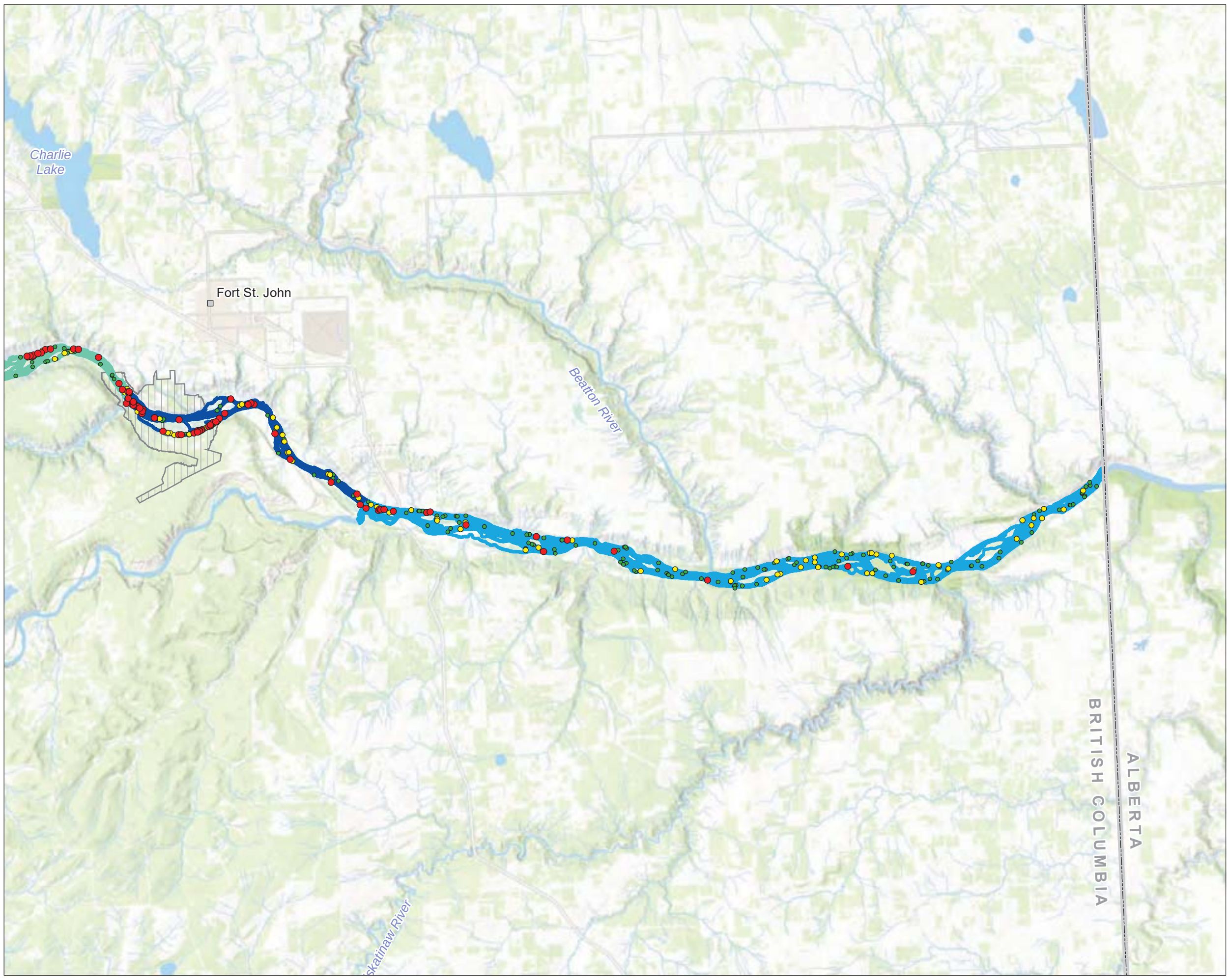
Page Size: 11" x 17"

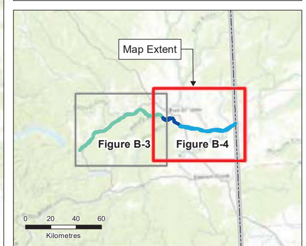
989619-07	Production Date: Dec 14, 2018	Figure B-3

Hemmera
An Ausenco Company
BC hydro

Migratory Waterbird Follow-up Monitoring Program
2018 Report
Site C, Peace River, BC

Flow Regime Impact Area and Control Area
Fall 2018





Legend

- Inundation Impact Area
- Flow Regime Impact Area
- Control Area
- Proposed Dam Site

Number of Bird Observations

- 1-2 birds
- 3-9 birds
- 10 or more birds

Notes

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

Sources

- Basemap: ESRI World Topographic Base

N

1:220,000

0 5 10 15

Kilometres

NAD 1983 UTM Zone 10N

Page Size: 11" x 17"

989619-07	Production Date: Dec 14, 2018	Figure B-4

Hemmera
An Ausenco Company

BC hydro

APPENDIX C

2018 Wetland Survey Effort by Survey Station with Dominant and Sub-Dominant Wetland Classifications

Appendix C: 2018 Wetland Survey Effort by Survey Station with Dominant and Sub-Dominant Wetland Classifications

Dominant Wetland Type	**Station ID**		**Spring**			**Fall**				
Sub Dominant Wetland Type		**Survey Method**	**Early**	**Middle**	**Late**	**Early**	**Middle-Early**	**Middle-Late**	**Late**	**Grand Total**
Labrator tea-sedge (BT)										
Tamarack-sedge (TS)	BT01	Transect	*ro en*	0	2	0	2	2	1	7
Tamarack-sedge (TS)	BT02	Transect	*ro en*	0	2	0	2	2	1	7
Tamarack-sedge (TS)	BT03	Transect	*ro en*	0	2	0	2	2	1	7
Tamarack-sedge (TS)	BT04	Transect	*ro en*	0	1	1	2	2	1	7
Open water (OW)										
Open water (OW)	OW01	Standwatch	*ro en*	2	2	1	2	2	1	10
Open water (OW)	OW02	Standwatch	*ro en*	1	2	1	2	2	1	9
Open water (OW)	OW04*	Standwatch	*ro en*	2	2	1	1	2	1	9
Open water (OW)	OW06*	Standwatch	*ro en*	2	2	1	2	2	1	10
Sedge (SE)	OW07*	SW/Trnsct + UAV	*ro en*	2	1	0	2	2	1	8
Open water (OW)	OW09*	Standwatch	*ro en*	1	2	1	2	2	1	9
Sedge (SE)	OW10*	SW/Trnsct + UAV	*ro en*	0	2	1	2	2	1	8
Willow-sedge (WS)	OW11*	Standwatch	*ro en*	0	2	1	2	2	1	8
Sedge (SE)										
Willow-sedge (WS)	SE01	Transect + UAV	*ro en*	1	2	1	2	2	1	9
Sedge (SE)	SE02	Transect + UAV	*ro en*	2	1	0	2	2	1	8
Open water (OW)	SE03	Transect + UAV	*ro en*	1	1	1	2	2	1	8
Open water (OW)	SE04	Transect + UAV	*ro en*	2	2	1	2	2	1	10
Willow-sedge (WS)	SE05	Transect	*ro en*	1	2	1	2	2	1	9
Open water (OW)	SE06	Transect + UAV	*ro en*	2	2	1	2	2	1	10
Open water (OW)	SE07	Transect + UAV	*ro en*	2	2	1	2	2	1	10
Open water (OW)	SE08	Transect + UAV	*ro en*	0	2	1	2	2	1	8
Open water (OW)	SE09	Transect + UAV	*ro en*	0	2	1	2	2	1	8
Open water (OW)	SE10	Transect + UAV	*ro en*	0	2	1	2	2	1	8
Willow-sedge (WS)	SE11	Transect	*ro en*	1	2	1	2	1	1	8
Sedge (SE)	SE12	Transect	*ro en*	0	2	1	2	2	1	8
Sedge (SE)	SE13	Transect	*ro en*	2	2	1	2	2	1	10
Open water (OW)	SE14	Transect + UAV	*ro en*	2	2	1	2	2	1	10
Tamarack-sedge (TS)										
Tamarack-sedge (TS)	TS01	Transect	*ro en*	2	2	1	2	2	1	10
Tamarack-sedge (TS)	TS02	Transect	*ro en*	1	2	1	2	2	1	9
Willow-sedge (WS)										
Sedge (SE)	WS01	Transect	*ro en*	2	2	1	1	2	1	9
Sedge (SE)	WS02	Transect	*ro en*	2	2	1	2	2	1	10
Tamarack-sedge (TS)	WS03	Transect	*ro en*	2	2	1	2	2	1	10
Total			**0**	**35**	**58**	**26**	**60**	**61**	**31**	**271**

* Stations surveyed in 2017 with standwatch methods (SW = Standwatch)

APPENDIX D
Wetland Survey Station Photos

Photo 1 Photograph of Wetland Survey Station BT01 (October 18, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 2 Photograph of Wetland Survey Station BT02 (May 9, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 3 Photograph of Wetland Survey Station BT03 (May 9, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 4 Aerial Photograph of Wetland Survey Station BT04 (August 8, 2018)

Photo 5 Aerial Photograph of Wetland Survey Station OW01 (September 9, 2018)

Photo 6 Aerial Photograph of Wetland Survey Station OW02 (September 18, 2018)

Photo 7 Photograph of Wetland Survey Station SE03 (October 2, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 8 Aerial Photograph of Wetland Survey Station OW04 (August 6, 2018)

Photo 9 Aerial Photograph of Wetland Survey Station OW06 (October 17, 2018)

Photo 10 Aerial Photograph of Wetland Survey Station OW07 (October 17, 2018)

Photo 11 Photograph of Wetland Survey Station OW09 (October 17, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 12 Aerial Photograph of Wetland Survey Station OW10 (August 6, 2018)

Photo 13 Photograph of Wetland Survey Station OW11 (October 17, 2018) Showing Habitat Representative of the Wetland Area Surveyed

Photo 14 Aerial Photograph of Wetland Survey Station SE01 (August 8, 2018)

Photo 15 Aerial Photograph of Wetland Survey Station SE02 (October 1, 2018)

Photo 16 Aerial Photograph of Wetland Survey Station SE04 (September 10, 2018)

Photo 17 Aerial Photograph of Wetland Survey Station SE05 (August 6, 2018)

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APPENDIX E

Power Analysis of 2018 Peace River Waterbird Data

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December 4, 2018

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ATTENTION: Brock Simons

RE: Waterbird Program Analysis:
Statistical Analysis of Survey Effort and Timing,
Combined 2017 and 2018 Peace River Waterbird Data

Overview

BC Hydro has requested Native Plant Solutions (NPS)/Ducks Unlimited Canada (DUC) to repeat statistical analyses performed in June 2018 on the Peace River Waterbird data, now with combined 2017 and 2018 data. The intent of this technical memo is to outline the results of the analysis to BC Hydro and Hemmera, as part of preparation of the 2018 waterbird monitoring annual report. Specifically, DUC reviewed the survey effort and timing applied in 2017 and 2018, based on the data provided by Hemmera on April 19th, 2017 and Nov 22nd, 2018. The review focused on the 2017 and 2018 River Transect Waterbird data, including statistical analyses of the difference in density observed during survey periods (Statistical Analysis #1) and the sampling effort required to detect change (Statistical Analysis #2).

Background to monitoring methodology

The statistical analysis was conducted on the combined 2017 and 2018 unmanned aerial vehicle (UAV) and river boat survey data. During each season of migration, the season was split into several periods (Spring: early, mid, late; Fall: early, early-mid, late-mid and late). Note that this definition of survey periods was revised for 2018 surveys, as compared to 2017 surveys. Survey effort in 2018 was more evenly spaced than in 2017; therefore, the idea of survey period restructuring was to align it with peaks in abundance and allow for a review of variability between periods (T. St. Clair, pers. comm.) The updated categories for survey period are listed in Table 1.

Table 1. Reallocation of survey period dates, from 2017 Peace River survey data only, to 2017+2018 combined Peace River survey data.

Survey Period	Survey Dates, June 2018 Analyses on 2017 Peace River survey data	Survey Dates, November 2018 Analyses on 2017+2018 Peace River survey data
Spring_Early	<= April 15^{th}	<= April 15^{th}
Spring_Mid	Late April dates > 15^{th}	April 16-May 8
Spring_Late	May survey dates	May 9 – 20
Fall_Early	August 1-15	August 1-15
Fall_Early-Mid	August 16 – 31 (Fall_Mid)	August 16-September 14
Fall_Late-Mid	September survey dates (Fall_Late)	September 15-October 14
Fall_Late	no October surveys in 2017 data	October 15-30; no October surveys in 2017 data

The new definitions will be retroactively applied to the survey data collected in 2017 for this combined year analysis. Therefore, differences between the “2017 only” analyses (see June 2018 technical memo prepared by NPS) and “2017 & 2018” analyses will be impacted both by addition of a years’ worth of survey effort and re-allocation of survey dates into survey periods. In addition, the fourth fall survey period (Fall Late) was added to surveys in 2018, based on the results of the June 2018 statistical analysis of the 2017 Peace River survey data.

Within each period, two replicate surveys were conducted, and each survey takes two days to complete. There was one exception in 2018 where three days were required due to ice washing down the Peace River on April 26^{th} in the middle of the survey. As well, only one replicate was conducted in early fall with the replicate survey being allotted to late fall, allowing data to be collected into October to better capture late migrants. Note that in spring 2017, one survey day was dropped from statistical analysis, due to poor weather and therefore low bird counts. Survey dates in 2017 and 2018 were as follows:

Spring_Early:	2017: April 5, 6	2018: April 13, 14
Spring_Mid:	2017: April 26, 27; May 3, 4	2018: April 25, 26 & May 1; May 5, 6
Spring_Late:	2017: May 10, 11; May 14, 15	2018: May 10, 11; May 18, 19
Fall_Early:	2017: August 8, 9; August 14, 15	2018: August 4, 5
Fall_Early-Mid:	2017: August 22, 23; August 28, 29	2018: August 20, 21; September 4, 5
Fall_Late-Mid:	2017: September 21, 22; September 27, 28	2018: September 20, 21; October 4, 5
Fall_Late:	2017: none	2018: October 15, 16

In this technical memo, the following terminology is used when referring to the waterbird monitoring program:

- **Survey period:** A survey period is the timing of when a survey happens within a season (i.e., spring or fall) to document migrants, including early, early-mid, mid, late-mid and late. The original study design of the Waterbird Migration Follow-up Monitoring Program (BC Hydro 2018) was structured to have two surveys within each period, acting as replicates to provide measures of uncertainty around estimates of relative abundance and diversity. For example, late spring is a survey period, containing two surveys.

- **Survey:** A survey is the census of waterbirds over the length of the Peace River, from the Peace Canyon Dam (Hudson's Hope) to the Alberta border (BC Hydro 2018). A survey takes two survey days to complete. For example, April 5 and 6 of early spring 2017 is a survey.
- **Survey day:** A survey takes two survey days to complete, with half of the river study area being surveyed each day and, in most cases, the whole river being surveyed in consecutive days. Each day is referred to in this technical memo as a survey day. For the purposes of statistical analysis, survey effort is analyzed at the level of survey day. Effort is considered to be equal on each survey day. In cases where survey effort was not equal, or where survey days were not conducted back-to-back to form a complete survey (e.g., due to poor weather), these survey days have been excluded from analysis. For example, 12 survey days were conducted in fall of 2017 (i.e., August 8, 9, 14, 15, 22, 23, 28 and 29, and September 21, 22, 27 and 28).

Statistical Analysis #1 - Statistical analysis of differences in density observed during survey periods (i.e., early, mid and late) in spring and fall

Statistical analysis #1 tests for differences among spring and fall survey periods, to determine if there were appreciable differences between early, mid and late periods in both spring and fall survey seasons. Based on the results of Statistical Analysis #1, the biological inference that can be made from this is to assess if the 2017 and 2018 timing and number of survey periods in spring and fall were capturing peaks in abundance during migration and which periods, in spring and fall, were important in capturing these peaks.

The spring and fall survey periods were analysed separately, fit with species- and foraging group-specific negative binomial regression models, with total bird counts as the response and survey period (Spring: early vs. mid vs. late; Fall: early vs. early-mid vs. late-mid vs. late) and year as predictors. Negative binomial regression models are appropriate for count data (i.e., values and predictions from the models must be non-negative). These models also account for over dispersion (i.e., variation is greater than normally expected from count data), which is expected to arise from the fact that birds are typically counted in groups > 1 bird.

For species that were observed more regularly throughout all survey periods, differences in density among survey periods were analyzed in spring (Table 2) and fall (Table 3). Species observed more regularly throughout all survey periods in both years included: CAGO, COME, GWTE, MALL, NSHO, TRUS. During the spring survey period, AMWI, NOPI, BAGO, COGO, and BUFF were also observed consistently. During fall surveys, BOGU and RBGU were observed consistently.

A complete list of species observed during spring and fall surveys in 2017 and 2018 is listed in Appendix A; however, note that some newly seen species and foraging groups in 2018 (e.g., bald eagles) were not included in the combined analysis, due to low densities observed. Differences in density among survey periods were also analyzed at a foraging group level. A species allocation within each foraging group is also listed in Appendix A. As noted, results at the species level are provided for review purposes; however, discussion of the 2017 and 2018 data is focused at the foraging group level because of the greater strength of inference that analysis at the foraging group level allows (see NPS 2018 technical memo).

During spring migration surveys (Table 2), at a foraging group level, the early period yielded the highest counts for Large Dabblers and Piscivorous Divers and lowest counts for Gulls. Late spring surveys yielded the highest counts for Shorebirds and lowest counts for Benthic Feeding Divers and Dabbling Ducks. Multiple survey dates within each period were particularly useful for moderating the effects of week-to-week variability. For example, the number of Benthic Feeding Divers varied from 6 to 619 during mid-Spring surveys, and the number of Piscivorous Divers varied from 23 to 288 during early spring surveys. There was also substantial variation (coefficient of variation [CV], equal to the standard error divided by the mean, was greater than 50%) among survey dates within the optimal survey periods for Gulls due to the small number of birds observed during surveys. Both the re-allocation of dates in the spring survey periods (i.e., early vs. mid vs. late, for 2017 as compared to 2017+2018; Table 1), as well as the additional year of data, has reduced the variation observed at the foraging group level, as compared to 2017 only. Benthic Feeding Divers, Gulls and Shorebirds saw a drop in CV based on the re-allocation of survey dates, as the mid and late survey periods were optimal for these foraging groups. In addition, results between 2017 and 2018 were reasonably consistent between years, at a foraging group level, serving to add additional sampling points (i.e., effort) to the waterbird data, while not contributing excessively to variation.

During fall migration surveys (Table 3), at a foraging group level, the early survey period yielded the highest counts for Shorebirds. There was greater variation among survey days within the optimal survey periods in the fall than in the spring. This variation also increased from the 2017 data, making it difficult to determine optimal survey periods for all other foraging groups in the fall.

Table 2. Spring survey periods results

Species or Forage Group	Differences in densities observed among Early, Mid, and Late Periods?	Estimated number of birds seen per survey day (standard error)[1]
AMWI	Mid > Early	E: 13.9 (5.2); M: 57.7 (14.5); L: 32.7 (8.4)
BAGO	No	6.2 (2.3)
BUFF	Mid > Early and Late	E: 0.2 (0.2); M: 11.5 (5.3); L: 1.8 (1.0)
CAGO	Early > Mid and Late	E: 938.9 (133.0); M: 295.4 (29.9); L: 248.0 (25.2)
COGO	Early and Mid > Late	E: 42.5 (21.9); M: 68.3 (24.8); L: 3.5 (1.4)
COME	Early > Mid > Late	E: 124.9 (41.8); M: 47.9 (11.4); L: 20.1 (5.0)
GWTE	Mid > Early and Late	E: 13.1 (5.8); M: 44.7 (13.7); L: 14.9 (4.7)
MALL	Early, Mid > Late	E: 277.0 (49.5); M: 189.0 (24.1); L: 100.3 (13.0)
NOPI	Early and Mid > Late	E: 19.2 (14.6); M: 57.2 (32.2); L: 1.8 (1.1)
NSHO	Late > Early and Mid	E: 0.5 (0.5); M: 0.9 (0.6); L: 7.4 (3.7)
TRUS	No	4.9 (2.5)
Benthic Feeding Divers	Early and Mid > Late	E: 59.5 (24.1); M: 110.7 (31.4); L: 12.1 (3.7)
Dabbling Ducks	Early and Mid > Late	E: 356.4 (64.2); M: 398.3 (50.8); L: 215.3 (27.6)
Gulls	Mid and Late > Early	E: 0.5 (0.5); M: 7.4 (3.6); L: 16.2 (7.6)
Large Dabblers (Geese and Swans)	Early > Mid and Late	E: 955.3 (134.8); M: 301.8 (30.4); L: 258.4 (26.1)
Piscivorous Divers	Early > Mid > Late	E: 126.6 (40.3); M: 52.7 (12.0); L: 23.0 (5.4)
Shorebirds	Late > Early and Mid	E: 1.2 (0.8); M: 1.4 (0.6); L: 48.3 (15.4)

[1] – E: early; M: mid; L: late.

Table 3. Fall survey periods results

Species or Forage Group	Differences in densities observed among Early, Early-Mid, Late-Mid, and Late Periods?	Estimated number of birds seen per survey day (standard error)[1]
BOGU	No	206.7 (92.3)
CAGO	No	264.7 (65.8)
COME	No	11.8 (2.2)
GWTE	Late-Middle > Late	E: 1.3 (1.2); E-M: 15.8 (9.0); L-M: 16.1 (10.0); L: 0.5 (0.6)
MALL	No	54.9 (16.2)
NSHO	No	0.9 (0.7)
RBGU	No	64.6 (30.5)
TRUS	No	2.5 (1.3)
Benthic Feeding Divers	No	2.5 (1.0)
Dabbling Ducks	No	78.1 (19.4)
Gulls	No	330.4 (109.3)
Large Dabblers (Geese and Swans)	No	228.8 (50.0)
Piscivorous Divers	No	15.3 (2.6)
Shorebirds	Early > Early-Mid > Late-Mid and Late	E: 76.3 (12.7); E-M: 35.7 (5.3); L-M: 0.8 (0.3); L: 0 (--)

[1] – E: early; E-M: early-mid; L-M: late-mid; L: late.

Statistical Analysis #2 - Statistical power analysis to estimate sampling efforts required to detect change

The second objective of the statistical analysis was to conduct a power analysis, based on the available 2017 and 2018 survey data, to estimate the sampling effort required to detect change of a specific magnitude. Based on the results of the statistical analysis, this provides guidance on selecting a specific quantitative goal that can be tied to an objective of the monitoring program, and a reasonable time frame in which change can be assessed.

For Statistical Analysis #2 (i.e., the power analysis), a baseline average of relative abundance data was calculated from the 2017 and 2018 survey data. Within the 2017 and 2018 survey data, some species and foraging groups exhibited differences in counts among survey periods within a season, whereas other foraging groups did not exhibit variation specific to early, mid, and late season periods. For the foraging groups for which there were statistically detectable differences in counts across survey periods, relative abundance estimates from particular survey periods are informative baselines as identifiable 'optimal' survey periods. Survey period-specific estimates will mitigate the impacts of day-to-day variation within a survey period, but will not average over important within-season differences in relative abundances for these foraging groups. Therefore, for foraging groups exhibiting statistically detectable differences in counts across survey periods, bird density was estimated using the survey date that yielded the highest density. For foraging groups without statistically detectable differences in counts across survey periods (i.e., either due to counts that did not vary much across survey periods over a season, or where day to day counts varied greatly among survey days within a survey period), relative abundance estimates from particular survey periods are not informative baselines. Rather, a pooled baseline estimate of abundance across a season is best, since it will mitigate the impacts of day-to-day variation. Therefore, for foraging groups where there were not statistically detectable differences in counts among survey periods, bird density was estimated using an average across all surveys.

Relative abundance is the number of birds that were counted on a survey day, with the assumption that survey effort is equal between survey days. Given the best estimates of foraging group relative abundances (and their standard errors) from the 2017/2018 survey data, the statistical power analyses estimated the sampling efforts required to detect changes of specified magnitude. For the purposes of this analysis, a 50% change in relative abundance was seen as a reasonable target (i.e., both statistical and biological; Hatch 2003). Table 4 and 5 give the survey effort required to detect 50% change in relative abundance given a 2017+2018 spring (Table 4) and fall (Table 5) survey baseline. Note that survey effort is given in the number of survey days (i.e., not the number of surveys) and the estimated number of years to detect change (i.e. should the current survey effort be maintained over time).

In spring (Table 4), the survey effort required to detect a 50% change in relative abundance (i.e., based on the 2017 & 2018 spring survey data) was the least for Large Dabblers (Geese and Swans), with increasing survey effort to detect change in Dabbling Ducks, Piscivorous Divers, Benthic Feeding Divers, Shorebirds and Gulls. In fall (Table 5), the survey effort required to detect a 50% change in relative abundance (i.e., based on the 2017 & 2018 fall survey data) was the least for Shorebirds, with increasing survey effort to detect change in Piscivorous Divers, Large Dabblers (Geese and Swans), Dabbling Ducks, Gulls and Benthic Feeding Divers. From spring to fall, for all foraging groups except Gulls and Shorebirds, there was a decrease in the 2017 baseline average relative abundance per forage group, and therefore an increase in the number of survey days required to detect change.

Table 4. Survey Effort required to detect 50% change in relative abundance given a 2017 and 2018 Spring Survey baseline. Following the estimated number of survey days required to detect a 50% change in relative abundance, the estimated number of years to detect that change is given in brackets, should the current (i.e., 2017 and 2018) spring survey effort of 10 survey days (i.e., 5 surveys) be maintained over time.

Forage Group	2017 & 2018 Baseline Average Relative Abundance (Standard Error)	Estimated number of survey days required to detect a 50% change in Relative Abundance with 80% statistical power
Benthic Feeding Divers	110.7 (31.4)	84 (8.4 years)
Dabbling Ducks	398.3 (50.8)	20 (2.0 years)
Gulls	16.2 (7.6)	224 (22.4 years)
Large Dabblers (Geese and Swans)	955.3 (134.8)	14 (1.4 years)
Piscivorous Divers	126.6 (40.3)	54 (5.4 years)
Shorebirds	48.3 (15.4)	106 (10.6 years)

Table 5. Survey Effort required to detect 50% change in relative abundance given a 2017 and 2018 Fall Survey baseline. Following the estimated number of survey days required to detect a 50% change in relative abundance, the estimated number of years to detect that change is given in brackets, should the current (i.e., 2017 and 2018) fall survey effort of 12 survey days (i.e., 6 surveys) be maintained over time.

Forage Group	2017 & 2018 Baseline Average Relative Abundance (Standard Error)	Estimated number of survey days required to detect a 50% change in Relative Abundance with 80% statistical power
Benthic Feeding Divers	2.5 (1.0)	526 (43.8 years)
Dabbling Ducks	78.1 (19.4)	190 (15.8 years)
Gulls	330.4 (109.3)	332 (27.7 years)
Large Dabblers (Geese and Swans)	228.8 (50.0)	146 (12.2 years)
Piscivorous Divers	15.3 (2.6)	90 (7.5 years)
Shorebirds	76.3 (12.7)	24 (2.0 years)

Discussion

For the spring 2017+2018 survey data, optimal survey periods were able to be identified for most foraging groups. The early and mid survey periods in the spring yielded the highest counts for all foraging groups except Shorebirds and Gulls, which were generally present in low densities. As presented in the statistical analyses on the 2017 waterbird data (NPS 2018), the effects of week-to-week variability for Benthic Feeding and Piscivorous Divers is moderated by multiple survey dates within a survey period, demonstrating the value of conducting more than one survey during each period.

For the fall 2017+2018 survey data, optimal survey periods were not clear, due to both within period and between period variation. For Gulls for example, counts across survey dates ranged from 0 to 2,309 Gulls observed. Within survey (i.e., survey day to survey day) variation within a single period for Gulls included 133 to 2,309 observed from September 20th to 21st. Similar within and between period variation was also observed for Dabbling Ducks and Large Dabblers in the fall, with higher within survey period variation in the fall of 2018. Excessively high variation, both within and between survey periods, makes it difficult to detect changes and is therefore reflected in the high survey effort required to detect change (Table 5).

Based on the statistical analyses on the 2017 waterbird data, a late fall survey period was recommended to be added from a biological perspective, due to the low relative abundance of Benthic Feeding Divers in fall 2017; however, the late fall period in 2018 did not yield an increase in Benthic Feeding Divers observed. In addition, Benthic Feeding Divers continue to be detected in very low numbers (i.e., 0 to 17 observed), with high variability; therefore, the amount of estimated survey effort required to detect change in this foraging group is very high. However, as only one year of data has been collected within the late fall survey period (October 15-30), we recommend another year of data collection to determine the value (particularly to Benthic Feeding Divers) of continuing with this survey period.

References

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Appendix A – Complete list of species and foraging group observed during 2017/2018 surveys, along the Peace River

Species Code	Common Name	Scientific Name	Foraging Group
AMDI	American Dipper	*Cinclus mexicanus*	Benthic Feeding Divers
BUFF	Bufflehead	*Bucephala albeola*	Benthic Feeding Divers
COGO	Common Goldeneye	*Bucephala clangula*	Benthic Feeding Divers
HADU	Harlequin Duck	*Histrionicus histrionicus*	Benthic Feeding Divers
RUDU	Ruddy Duck	*Oxyura jamaicensis*	Benthic Feeding Divers
SUSC	Surf Scoter	*Melanitta perspicillata*	Benthic Feeding Divers
UNGO	Unknown Goldeneye		Benthic Feeding Divers
UNKN SCOTER	Unknown Scoter	*Mellanita* sp.	Benthic Feeding Divers
WWSC	White-winged Scoter	*Melanitta fusca*	Benthic Feeding Divers
AMCO	American Coot	*Fulica americana*	Dabbling Ducks
AMWI	American Wigeon	*Anas americana*	Dabbling Ducks
BWTE	Blue-winged Teal	*Anas discors*	Dabbling Ducks
CANV	Canvasback	*Aythya valisineria*	Dabbling Ducks
CITE	Cinnamon Teal	*Anas cyanoptera*	Dabbling Ducks
GADW	Gadwall	*Anas strepera*	Dabbling Ducks
GRSC	Greater Scaup	*Aythya marila*	Dabbling Ducks
GWTE	Green-winged Teal	*Anas crecca*	Dabbling Ducks
LESC	Lesser Scaup	*Aythya affinis*	Dabbling Ducks
MALL	Mallard	*Anas platyrhynchos*	Dabbling Ducks
NOPI	Northern Pintail	*Anas acuta*	Dabbling Ducks
NSHO	Northern Shoveler	*Anas clypeata*	Dabbling Ducks
REDH	Redhead	*Aythya americana*	Dabbling Ducks
RNDU	Ring-necked Duck	*Aythya collaris*	Dabbling Ducks
UNSC	Unknown Scaup		Dabbling Ducks
UNTE	Unknown Teal		Dabbling Ducks
BHGU	Black-headed Gull	*Chroicocephalus ridibundus*	Gulls
BOGU	Bonaparte's Gull	*Chroicocephalus philadelphia*	Gulls
CAGU	California Gull	*Larus californicus*	Gulls
FRGU	Franklin's Gull	*Leucophaeus pipixcan*	Gulls
HEGU	Herring Gull	*Larus argentatus*	Gulls
MEGU	Mew Gull	*Larus canus*	Gulls
RBGU	Ring-billed Gull	*Larus delawarensis*	Gulls

Species Code	Common Name	Scientific Name	Foraging Group
UNGU	Unknown Gull		Gulls
CAGO	Canada Goose	*Branta canadensis*	Large Dabblers
SNGO	Snow Goose	*Chen caerulescens*	Large Dabblers
TRUS	Trumpeter Swan	*Cygnus buccinator*	Large Dabblers
TUSW	Tundra Swan	*Cygnus columbianus*	Large Dabblers
UNSW	Unknown Swan		Large Dabblers
SORA	Sora	*Porzana carolina*	Marsh Birds
WISN	Wilson's Snipe	*Gallinago delicata*	Marsh Birds
YERA	Yellow Rail	*Coturnicops noveboracensis*	Marsh Birds
ARTE	Arctic Tern	*Sterna paradisaea*	Piscivorous Divers
BAGO	Barrow's Goldeneye	*Bucephala islandica*	Benthic Feeding Divers
BEKI	Belted Kingfisher	*Megaceryle alcyon*	Piscivorous Divers
COLO	Common Loon	*Gavia immer*	Piscivorous Divers
COME	Common Merganser	*Mergus merganser*	Piscivorous Divers
EAGR	Eared Grebe	*Podiceps nigricollis*	Piscivorous Divers
HOGR	Horned Grebe	*Podiceps auritus*	Piscivorous Divers
HOME	Hooded Merganser	*Lophodytes cucullatus*	Piscivorous Divers
PBGR	Pied-billed Grebe	*Podilymbus podiceps*	Piscivorous Divers
RBME	Red-breasted Merganser	*Mergus serrator*	Piscivorous Divers
RNGR	Red-necked Grebe	*Podiceps grisegena*	Piscivorous Divers
UNGR	Unknown Grebe		Piscivorous Divers
UNKN TERN	Unknown Tern		Piscivorous Divers
UNLO	Unknown Loon		Piscivorous Divers
UNME	Unknown Merganser		Piscivorous Divers
WEGR	Western Grebe	*Aechmophorus occidentalis*	Piscivorous Divers
AMKE	American Kestrel	*Falco sparverius*	Raptors
BAEA	Bald Eagle	*Haliaeetus leucocephalus*	Raptors
OSPR	Osprey	*Pandion haliaetus*	Raptors
RTHA	Red-tailed Hawk	*Buteo jamaicensis*	Raptors
UNHA	Unknown Hawk		Raptors
UNRA	Unknown Raptor		Raptors
GRYE	Greater Yellowlegs	*Tringa melanoleuca*	Shorebirds
KILL	Killdeer	*Charadrius vociferus*	Shorebirds

Species Code	Common Name	Scientific Name	Foraging Group
LEYE	Lesser Yellowlegs	*Tringa flavipes*	Shorebirds
PEEP	Unknown small calidrid	*Calidris* sp.	Shorebirds
RNPH	Red-necked Phalarope	*Phalaropus lobatus*	Shorebirds
SOSA	Solitary Sandpiper	*Tringa solitaria*	Shorebirds
SPSA	Spotted Sandpiper	*Actitis macularius*	Shorebirds
UNSA	Unknown Sandpiper		Shorebirds
UNSH	Unknown Shorebird		Shorebirds
UNDI	Unknown Diving Bird		Unknown Waterbirds
UNDU	Unknown Duck		Unknown Waterbirds
UNKN	Unknown spp.		Unknown Waterbirds

Appendix 6. Wetland Monitoring 2018 Field Summary Report

Site C Clean Energy Project
Baseline and Construction Phase
Wetland Monitoring
2018 Field Summary Report

Date: January 25, 2019

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EXECUTIVE SUMMARY

BC Hydro developed a Baseline and Construction Phase Wetland Monitoring Program (the Program) to address, in part, requirements outlined in the Federal Decision Statement Condition 11 and Environmental Assessment Certificate Condition 12. The Program consists of two components: baseline wetland monitoring, which is focused on gathering information on the physical, ecological, biogeochemical and hydrological conditions of wetlands prior to construction activities; and construction phase wetland monitoring, which is focused on gathering information to evaluate changes from baseline conditions due to Site C Project activities.

The 2018 field program focused on gathering information on the physical, ecological, biogeochemical and hydrological conditions of wetlands within the inundation zone (i.e., the future reservoir footprint) and the transmission line and on field-testing the methods outlined in the wetland monitoring program.

The Program used the existing Site C Project map products as a basis for site selection and sampling. These mapping products includes some ecosystem classification codes that are not correlated with the current provincial classification system. As a result, a crosswalk table was created that used a "best fit" process to correlate the Site C Project map codes with the current provincial classification. The resulting updated classifications were used to select sample sites with the goal of sampling 20% of the population of each wetland class (i.e., bog, fen, swamp, marsh, or open water). Site selection focused on sampling based on wetland class increased the probability of concordance between the mapped product and the actual wetland identified in the field. This change led to efficiencies in the field and, ultimately, should lead to improved extrapolation to the entire Project Activity Zone.

The field team surveyed a total of 57 wetlands in 2018, including 36 wetlands in the reservoir footprint and 21 along the transmission line. The field team sampled from all five wetland classes and floodplains. Data on the physical, ecological, biogeochemical and hydrological conditions collected at each of the 2018 wetlands are presented in this report. In addition to this information, a Floristic Quality Assessment was tested in wetlands along the transmission line to determine if it was a suitable method for monitoring change to wetland vegetation over time.

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1. INTRODUCTION

1.1 PROJECT CONDITIONS

BC Hydro developed a Baseline and Construction Phase Wetland Monitoring Program (Native Plant Solutions 2018a) to address, in part, requirements outlined in the Federal Decision Statement Condition 11 and Environmental Assessment Certificate Condition 12.

> ***Condition 11.4.1****. Baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use.*
>
> ***Condition 11.4.3****. An approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data.*
>
> ***Condition 12****. The EAC Holder must monitor construction and operation activities that could cause changes in wetland functions.*

1.2 PROJECT OVERVIEW

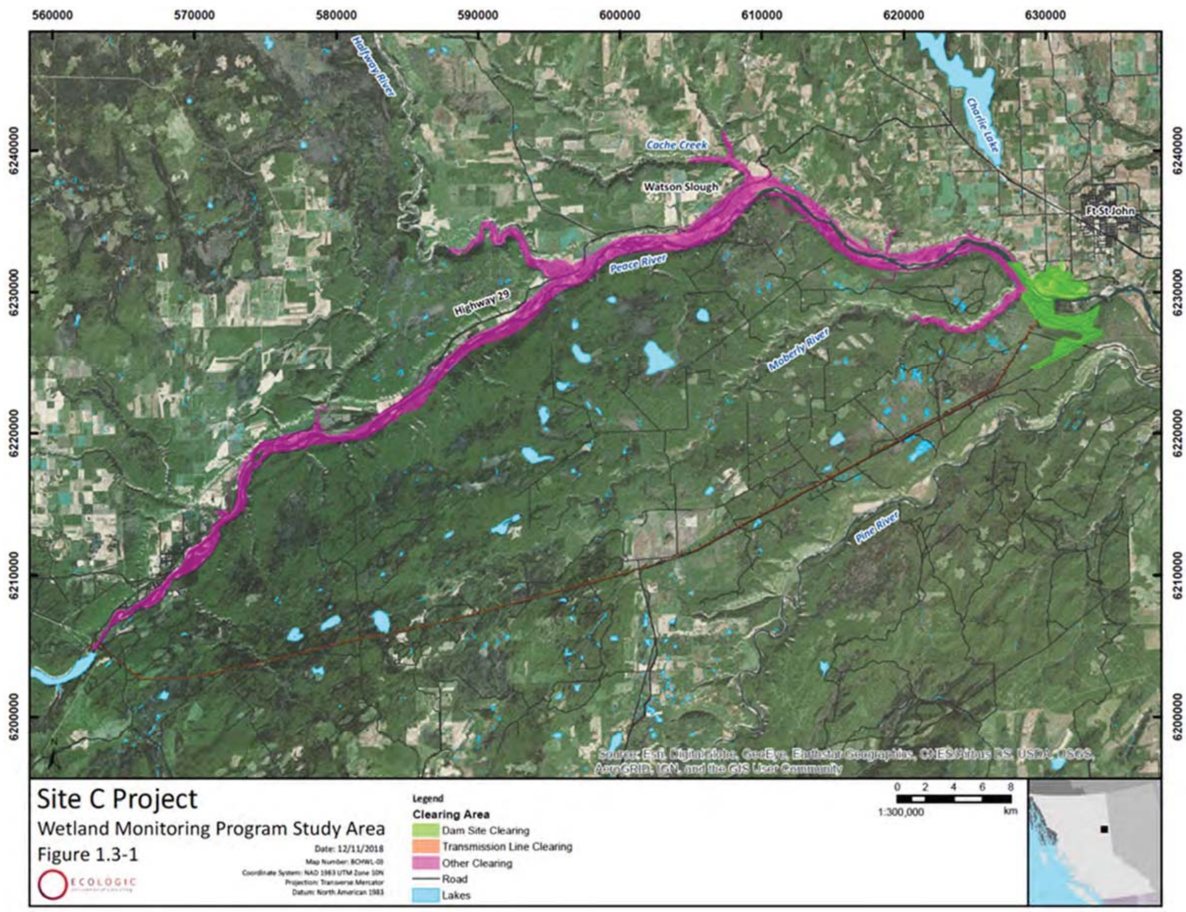
The Baseline and Construction Phase Wetland Monitoring Program (the program; Native Plant Solutions 2018a) consists of two components:

1. baseline wetland monitoring – gathers information (i.e., biogeochemical, hydrological and ecological) on wetlands prior to construction activities, including verification of ecosystem mapping and wetland condition; and
2. construction phase wetland monitoring – gathers information to evaluate changes from baseline conditions due to Site C Project activities.

1.3 STUDY AREA

The wetland monitoring study area includes three distinct areas within the Project Activity Zone (PAZ) and downstream of the dam site: the reservoir footprint (the future inundation zone); the transmission line; and the downstream area (Figure 1.3-1). The 2018 field season focused on the reservoir footprint (lower and middle) and the transmission line. Clearing of the reservoir footprint is ongoing (2015 to 2023), with inundation scheduled to start in 2023. The majority of the transmission line was cleared and grubbed in early 2018, and construction activities commenced in the fall of 2018.

Figure 1.3-1. Wetland Monitoring Program Study Area



2. METHODS

The 2018 field program focused on collecting site-level information and field-testing the methods outlined in the wetland monitoring program (Native Plant Solutions 2018b).

Monitoring programs are invariably refined once they are field-tested to maximize efficiency and data quality. As outlined in Section 2 of the wetland monitoring program (Native Plant Solutions 2018b), the monitoring program must be informative enough to allow for the following:

- *Collection of baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project;*
- *An evaluation of the change to baseline wetland conditions due to the Project;*
- *Selection of mitigation measures for loss of wetland areas and functions, including reclamation, improvement, creation and protection (BC Hydro 2015a); and*
- *Flexibility in the monitoring program to allow for further refinement in the characterization of baseline and affected wetlands, as data become available.*

The wetland monitoring program includes two approaches associated with two distinct project areas:

- the inundation zone (i.e., future reservoir footprint) where sites will be sampled and characterized once prior to inundation; and
- the transmission line where sites are sampled multiple times to assess change over time.

The 2018 field program collected information for site-level data categories (Table 2-1). Comprehensive and detailed methods are provided in the *BC Hydro Site C Wetland Monitoring Program Field Manual; Baseline and Construction Phase* (Appendix D of Native Plant Solutions 2018b).

In 2018, a number of refinements were field-tested and are proposed for discussion and potential integration into the field methodology in 2019 (See Recommendations).

Table 2-1. Baseline and Construction Phase Wetland Monitoring Program: Data Categories and Parameters

Category	Parameter	Monitoring Phase [(a)]	Federal Condition 11.4.1
Site Information	Photo stations	B/C	-
	Site diagram	B/C	-
	Wetland ecosystem classification	B/C	-
Physical Parameters	Wetland delineation	B/C*	-
	Adjacent ecosystems	B/C*	-
	Slope position	B	-
Ecological Parameters	Cover type and percent open water	B/C	biotic structure, biotic diversity,
	Vegetation cover and communities present	B/C	vegetation cover, biotic structure, biotic diversity
	Successional stage and structural stage	B/C	biotic structure, biotic diversity,
	Incidental wildlife observations	B/C	biotic structure, biotic diversity,
Biogeochemical Parameters	Water quality sampling	B/C*	groundwater quality, surface water quality
	Soil profiles	B	-
Hydrological Parameters	*Hydrology*	B/C	-
	Water depth	B/C	surface water quantity
	Inlets/Outlets	B/C	-

(a) B = Baseline field monitoring; C = Construction phase monitoring; * - reduced construction phase monitoring. Italicized parameters indicate key parameters that will be used to define wetland types.

Source: Native Plant Solutions (NPS) 2018b.

3. RESULTS

Discussion of the 2018 field program results include existing ecosystem classification and mapping (Section 3.1) and a summary of the 2018 field survey effort (Section 3.2), parameter summaries (Section 3.3), and wetland summaries within the reservoir footprint and along the transmission line (Section 3.4). Field data results and summaries are located in the following appendices:

- Appendix A. Wetland Mapping
- Appendix B. General Wetland Class and Association Descriptions
- Appendix C. Field Plot Data
- Appendix D. Vegetation Floristic Quality Index Data; and
- Appendix E. Analytical Results - Water Quality

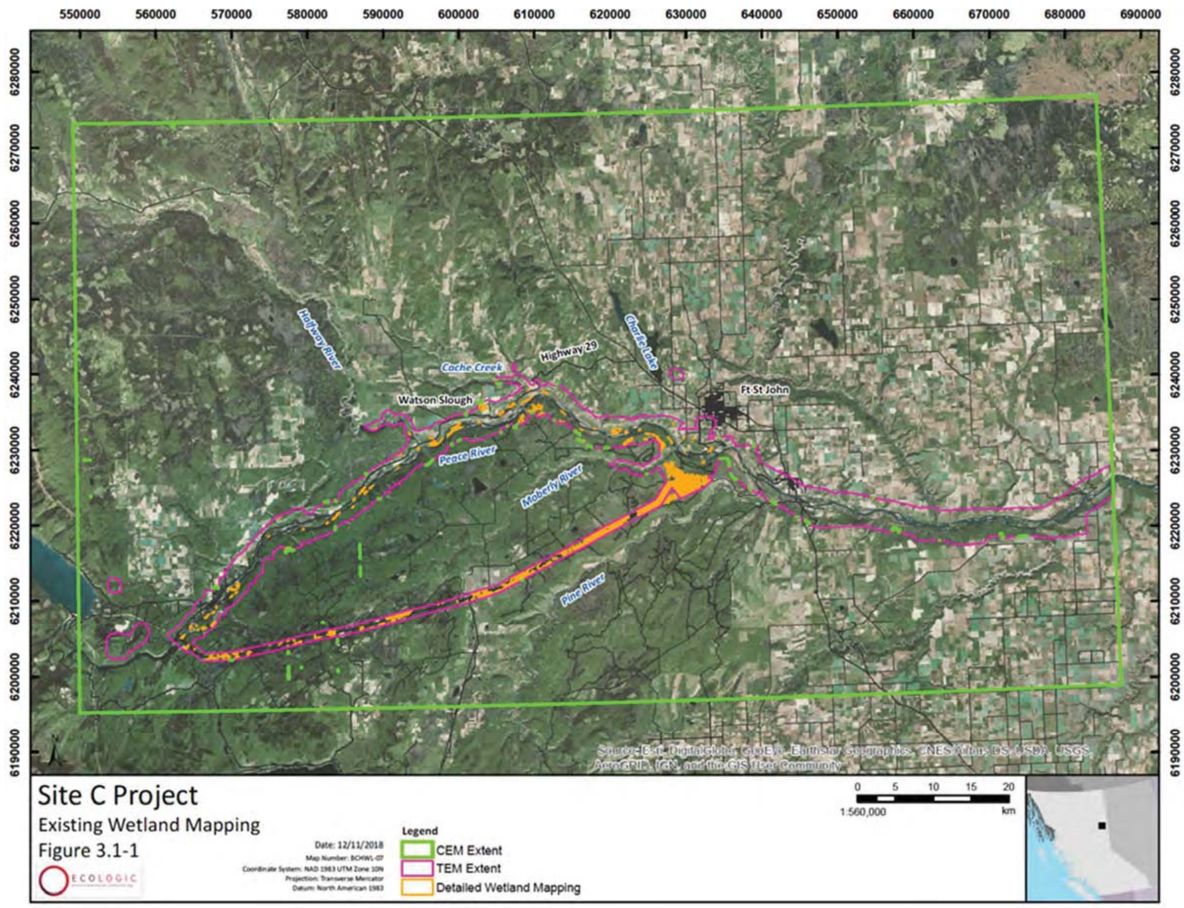
Field data collected will be reviewed by NPS and BC Hydro in the context of the wetland function assessment and the wetland monitoring program and used to inform revisions to the monitoring program and to select future monitoring sites.

3.1 Ecosystem Classification and Mapping

The existing Site C ecosystem mapping for the PAZ includes three distinct but related products: 1) Terrestrial Ecosystem Mapping (TEM); 2) broad habitat mapping; and 3) detailed wetland mapping (Figure 3.1-1). That existing ecosystem classification and mapping is based on *A Field Guide for Identification and Interpretation of Ecosystems of the Northeast Portion of the Prince George Forest Region* (DeLong et al. 1990), *Wetlands of British Columbia* (MacKenzie and Moran 2004), and new units described for the Project (2006 to 2012) by regional forest ecologists (Andrusiak and Simpson 2012).

The reservoir footprint TEM was completed at a scale of 1:20,000 in 2006 and updated in 2012 as part of the Site C Environmental Assessment (Andrusiak and Simpson 2012). However, the regional field guide (DeLong et al. 2011) was updated after the Terrestrial Ecosystem Mapping (TEM) was completed and includes new ecosystem units for the Boreal White and Black Spruce (BWBS) biogeoclimatic subzone in which the PAZ is located. The TEM classified wetlands and floodplains to the site series or site association level where possible but, due to mapping scale, it often did not separate pure wetland types or only classified ecosystems to the wetland class level (i.e., bog, fen, swamp, marsh).

Figure 3.1-1. Existing Wetland Mapping



Broad habitat mapping was created by combining a variety of available biophysical and vegetation mapping (including the provincial Vegetation Resource Inventory) projects to map the regional area to create ecosystem mapping beyond the TEM area (Andrusiak and Simpson 2012). The broad habitat mapping was largely a modelling exercise, resulting in a product with broad, generalized ecosystem classification that is intended for landscape-level analyses but is not particularly well-suited to the analysis or assessment of individual wetlands.

The detailed wetland mapping was completed using 1:5,000 and 1:15,000 scale air photos within the reservoir footprint clearing area and transmission line right-of-way. The detailed wetland mapping, which is the basis for the monitoring program (NPS 2018b), uses non-correlated ecosystem units that are not currently described in the provincial system. It also uses single ecosystem mapping codes to describe multiple wetland site associations, including combining multiple wetland classes (e.g., marsh and fen) into a single ecosystem unit (e.g., SE – Sedge Wetland).

In order to achieve the stated goals of the monitoring program and to satisfy the federal and provincial conditions, it is important that the wetland classification used is structured to accommodate the current (i.e., DeLong et al. 2011 and Mackenzie and Moran 2004) provincial classification. Therefore, Table 3.1-1 presents a crosswalk table that uses a "best fit" process to correlate existing PAZ ecosystem classification and current provincial classification system units. The crosswalk table was created by Tetra Tech and refined by EcoLogic for the 2018 wetland field program (Native Plant Solutions 2018b).

Table 3.1-1. Crosswalk of Existing PAZ Ecosystem Classification and Current Provincial Ecosystem Mapping Codes

	Existing PAZ Ecosystem Units		Current Provincial Ecosystem Units	
Wetland Class	Wetland Type (Map Code)	Vegetation Community Description	Site Association	Vegetation Community Description
Bog	BT	Sb - Labrador tea – Sphagnum	Wb03	Black spruce - Lingonberry - Peat-moss
	BT	Assumed Wb05 included in BT	Wb05	Black spruce - Water sedge - Peat-moss
	TS	Tamarack - Sedge	Wb06	Tamarack - Water sedge - Fen moss
Fen	SE	Sedge Wetland	Wf00	Fen (unclassified)
	SE	Sedge Wetland	Wf01	Water sedge - Beaked sedge
	-	-	Wf02	Scrub birch- water sedge
Marsh	SE	Sedge Wetland	Wm00	Marsh (unclassified)
	SE	Sedge Wetland	Wm01	Beaked sedge - Water sedge
	SE	Sedge Wetland	Wm02	Swamp horsetail - Beaked Sedge
	SE	Sedge Wetland	Wm03	Awned sedge
	SE	Sedge Wetland	Wm04	Common spike-rush

Wetland Class	Existing PAZ Ecosystem Units		Current Provincial Ecosystem Units	
	Wetland Type (Map Code)	Vegetation Community Description	Site Association	Vegetation Community Description
	SE	Sedge Wetland	Wm05	Cattail
	SE	Sedge Wetland	Wm06	Great bulrush
Swamp	-	-	Ws00	Swamp (unclassified)
	WS	Willow Sedge Wetland	Ws02	Mountain alder – Pink spirea – Sitka sedge
	WS	Willow Sedge Wetland	Ws03 (Ws14)	Bebb's willow - Bluejoint
	WS	Willow Sedge Wetland	Ws04	Drummond's willow - Beaked sedge
	WS	Willow Sedge Wetland	Ws05	MacCalla's willow - Beaker sedge
	WS	Willow Sedge Wetland	Ws06	Sitka willow - Sitka sedge
	-	-	Ws07	Spruce - Common horsetail - Leafy moss
	-	-	Ws15	SwSb - Labrador tea - Glow moss
Open Water	OW	Shallow open water	OW	Shallow Open Water (unclassified)
Floodplain	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl00	Low bench floodplain (unclassified)
	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl03	Pacific willow – Red-osier dogwood – Horsetail
	WH	Willow – Horsetail – Sedge – Riparian Wetland	Fl06	Sandbar willow
	-	-	Fm00	Mid bench floodplain (unclassified)
	Fm02 (09)[1]	ActSw - Red-osier dogwood	Fm02 (112)	Cottonwood - Spruce - Red-osier dogwood

3.2 Summary of the 2018 Field survey effort

The 2018 field program included four field trips: one wetland reconnaissance trip in June; two full field wetland characterization trips occurring from July 13 to 23 and August 2 to 10; and one groundwater monitoring reconnaissance trip from October 15 to 18.

The wetland reconnaissance and characterization team consisted of an ecologist, a soil scientist, and a local field assistant. A botanist was included in the field team during the initial field assessments to

[1] Map codes do not exist for the floodplain site associations. The site series associated with the Fm02 changed from 09 to 112 in the updated field guide (DeLong et al. 2011).

identify rare species and confirm willow and sedge classifications. The groundwater monitoring reconnaissance team consisted of a geoscientist and civil engineer, and a field engineer and forester.

Preliminary site selection was based on existing mapping products (see Section 3.1) with the goal of sampling 20% of the population of each wetland type (e.g., BT, TS, SE; Table 3.1-1; NPS 2018b) within the PAZ. However, due to mapping classification errors identified in the field, a decision was made to target 20% of each wetland class (i.e., bog, fen, swamp, marsh, or open water) to increase the probability of concordance between the mapped product and the actual wetland (e.g., bogs identified as bogs in the imagery are likely to be bogs in the field). This change led to efficiencies in the field and, ultimately, should lead to improved extrapolation to the entire PAZ.

The field team surveyed a total of 57 wetlands in 2018; including 36 in the reservoir footprint and 21 along the transmission line (Figure 3.2-1). The field team sampled from all five wetland classes and floodplains (Table 3.2-1):

- one bog, one fen, three swamp, six marsh, one open water, and five floodplain site associations within the reservoir footprint; and
- three bog, one fen, five swamp, and four marsh site associations along the transmission line.

3.3 Parameter Summaries for Data Collected in 2018

The following section provides a summary of the data collected at each of the 2018 wetlands as per the Site C Monitoring and Condition Field Sheets (Appendix D of Native Plant Solutions 2018b). In addition to the parameters described on the field sheets, a Floristic Quality Assessment (FQA) was tested in wetlands along the transmission line to determine if it was a suitable method for monitoring change to vegetation over time (Appendix D contains a description of the Floristic Quality Index [FQI] used for the FQA and the 2018 FQI field data). Tables 3.3-1 to 3.3-6 contains a summary of the parameters described for each wetland, organized by wetland class and location (reservoir footprint or transmission line). The data collected for the condition assessments will be provided as an addendum after QA/QC and additional GIS analyses have been completed in conjunction with NPS.

Figure 3.2-1. Location of Wetlands Assessed in 2018

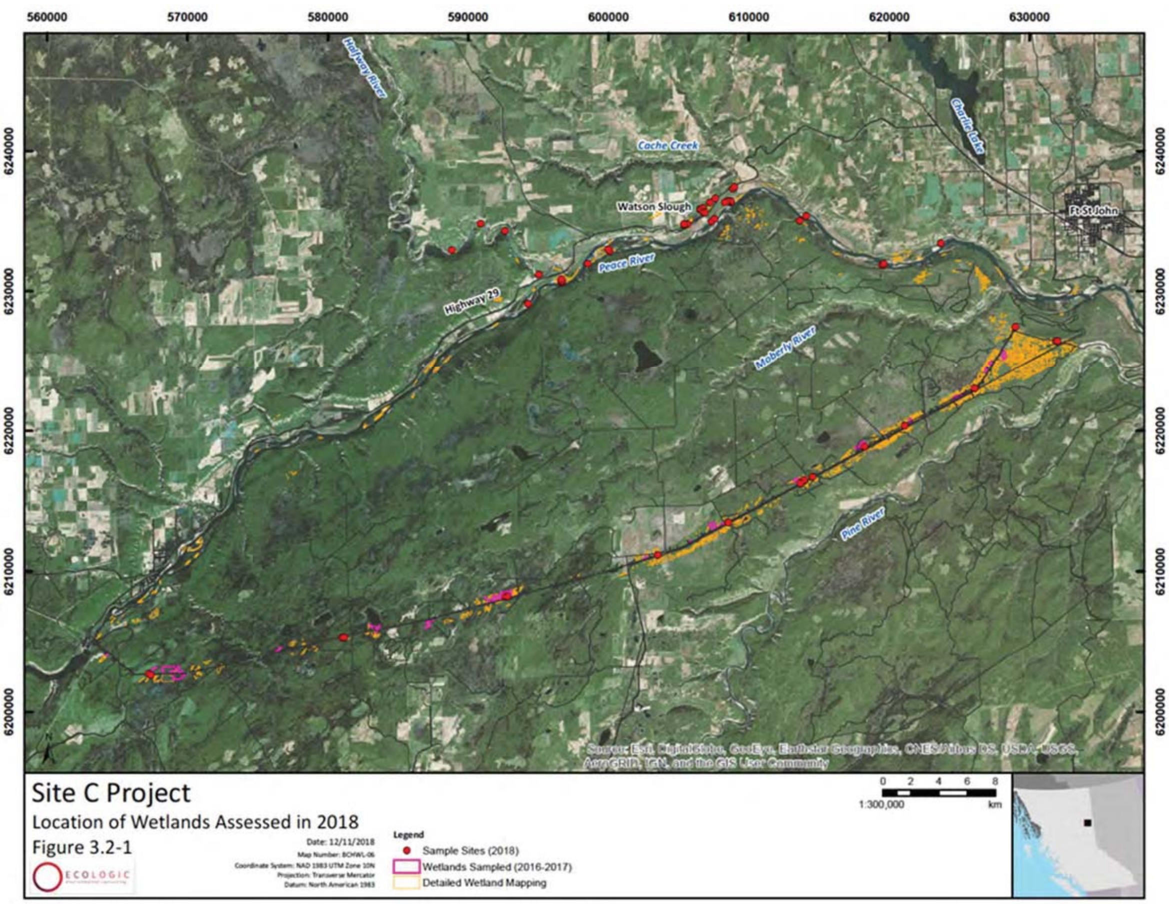


Table 3.2-1. Summary of Wetland Classes and Site Associations Surveyed in 2018

Wetland Class	Site Association	Vegetation Community	No. Sampled
Reservoir Footprint			
Bog	Wb06	Tamarack - Water sedge - Fen moss	1
Fen	Wf00	Fen (unclassified)	1
Swamp	Ws00	Swamp (unclassified)	4
	Ws05	MacCalla's willow - Beaked sedge	1
	Ws15	SwSb - Labrador tea - Glow moss	1
Marsh	Wm00	Marsh (unclassified)	1
	Wm02	Swamp horsetail - Beaked sedge	1
	Wm03	Awned sedge	2
	Wm04	Common spike-rush	1
	Wm05	Cattail	1
	Wm06	Great bulrush	1
Open Water	OW	Shallow Open Water (unclassified)	1
Floodplain	Fl00	Low bench floodplain (unclassified)	8
	Fl03	Pacific willow – Red-osier dogwood – Horsetail	1
	Fl06	Sandbar willow	4
	Fm00	Mid bench floodplain (unclassified)	2
	Fm02	Cottonwood - Spruce - Red-osier dogwood	5
Total			***36***
Transmission Line			
Bog	Wb03	Black spruce - Lingonberry - Peat-moss	1
	Wb05	Black spruce - Water sedge - Peat-moss	1
	Wb06	Tamarack - Water sedge - Fen moss	3
Fen	Wf02	Scrub birch – Water sedge	2
Swamp	Ws00	Swamp (unclassified)	1
	Ws04	Drummond's willow - Beaked sedge	1
	Ws06	Sitka willow - Sitka sedge	1
	Ws07	Spruce - Common horsetail - Leafy moss	1
	Ws14	Mountain Alder – Bebb's Willow – Bluejoint	2
Marsh	Wm01	Beaked sedge - Water sedge	4
	Wm02	Swamp horsetail - Beaked sedge	1
	Wm03	Awned sedge	1
	Wm05	Cattail	2
Total			***21***

Table 3.3-1. Bogs Parameter Summary

	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			
Wetland Field ID	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	Condition Assessment
Reservoir Footprint																			
WL008	Wb06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
Transmission Line																			
WL118	Wb03	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL114	Wb05	Yes	Yes	Yes	GIS Analysis Required	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
WL020	Wb06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL113	Wb06	Yes	Yes	Yes	GIS Analysis Required	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL115	Wb06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

Table 3.3-2. Fen Parameter Summary

Wetland Field ID	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			Condition Assessment
	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	
Reservoir Footprint																			
WL004	Wf00	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
Transmission Line																			
WL021	Wf02	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
WL102	Wf02	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	GIS Analysis Required	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

Table 3.3-3. Swamp Parameter Summary

	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			
Wetland Field ID	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	Condition Assessment
Reservoir Footprint																			
WL019	Ws00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL027	Ws00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL037	Ws00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
WL038	Ws00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
WL007	Ws05	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
WL005	Ws07	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes
Transmission Line																			
WL100	Ws00 (similar to Ws03)	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	GIS Analysis Required	Yes
WL107	Ws04	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes (see WL103)	Yes	Yes	Yes	GIS Analysis Required	Yes
WL116	Ws06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	GIS Analysis Required	Yes
WL117	Ws07	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	GIS Analysis Required	Yes
WL106	Ws14	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	GIS Analysis Required	Yes
WL108	Ws14	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

Table 3.3-4. Marsh Parameter Summary

	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			
Wetland Field ID	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	Condition Assessment
Reservoir Footprint																			
WL012	Wm00	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL022	Wm02	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL003	Wm03	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL006	Wm03	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL018	Wm04	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL036	Wm05	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL009	Wm06	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transmission Line																			
WL101	Wm01	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	GIS Analysis Required	Yes
WL103	Wm01	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	GIS Analysis Required	Yes
WL104	Wm01	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	GIS Analysis Required	Yes
WL111	Wm01	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WL105	Wm02	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	GIS Analysis Required	Yes
WL110	Wm03	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
WL109	Wm05	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (see WL110)	Yes	Yes	Yes	Yes	Yes
WL112	Wm05	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

Table 3.3-5. Open Water Parameter Summary

Wetland Field ID	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			Condition Assessment
	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	
Reservoir Footprint																			
WL025	OW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	Yes	Yes	Yes	Yes	Yes	No (too deep access)	GIS Analysis Required	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

Table 3.3-6. Floodplain Parameter Summary

	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			
Wetland Field ID	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	Condition Assessment
Reservoir Footprint																			
WL001	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL002	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL010	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL016	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL024	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL028	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL031	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL034	FI00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL014	FI03	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL011	FI06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL015	FI06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL017	FI06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes

	Site Information				Physical Parameters			Ecological Parameters						Biogeochemical Parameters		Hydrological Parameters			
Wetland Field ID	Site Association	Photo Station	Site Diagram	Ecosystem Classification	Wetland Delineation	Adjacent Ecosystems	Slope Position	Cover Type and Open Water	Vegetation Cover and Communities	Floristic Quality Index	Successional Stage	Structural Stage	Incidental Wildlife Observations	Water Quality Sampling	Soil Profiles	Hydrology	Water Depth	Inlets/Outlets	Condition Assessment
WL032	Fl06	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL023	Fm00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL030	Fm00	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL013	Fm02	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL026	Fm02	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL029	Fm02	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL033	Fm02	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes
WL035	Fm02	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	No	Yes	Yes	Yes	No Standing Water	Yes	Yes	No Standing Water	NA	Yes

Footnote.
"Yes" indicates data were collected to meet these parameters.
"No" indicates data were not collected for this parameter.
"NA" means the parameter is not applicable for the wetland class.
"GIS Analysis Required" indicates parameters that could not be fully completed in the field.
Floristic Quality Index collected for construction monitoring wetland -collected in addition to the vegetation cover and communities data.
Condition Assessment includes data from the four NPS Field Condition Assessment Forms.

3.4 Wetland Summaries

3.4.1 Overview

Along the Peace River, the strata are variably exposed depending on numerous factors such as pre-glacial topography, sediment characteristics, glacial advance and retreat during the Wisconsin Glacial Episode, potential interactions between the Laurentian and Cordilleran ice sheets, post-glacial retreat and associated erosion and deposition, as well as other factors. These materials have very different characteristics with respect to drainage, productivity, and stability, which in turn influence soil development and the resulting ecosystems. Soil parent materials along the Peace River tend to be fairly well to rapidly drained, due to the predominance of alluvium, glaciofluvial, and paleofluvial materials. As a result, wetlands are uncommon as the soil characteristics required for development are uncommon. Another factor influencing wetland occurrence is the establishment of farms throughout the Peace Valley. Many of these landscapes now under production had remnant lacustrine pockets which, if in the conducive landscape position, could have potentially supported wetlands.

The non-incised landscape that comprises the transmission line is dominated by late Wisconsin clay and silty tills over impermeable glaciolacustrine sediments. The till is often fluted and hummocky, resulting in a landscape of concave, convex, and level surfaces. As a result, wetlands are very common, as water is retained in the rooting zone throughout the growing season in many locations, forming a wide variety of marshes, swamps, fens, and bogs.

This following sections provides a summary of the wetland classes and site associations surveyed during the 2018 field season. While these wetlands are generally representative of the majority of the wetland and floodplain communities that are present in the PAZ, it is expected that additional wetland types will be identified in future surveys. Detailed maps of each wetland are provided in Appendix A (Figures A1 through A16).

3.4.2 Bog

3.4.2.1 Overview

The field team surveyed six bogs; including one site association in the reservoir footprint and three site associations along the transmission line (Table 3.4-1). Bogs along the transmission line range from isolated pure pockets to raised portions of large complexes with multiple site associations. Disturbance due to historic activity as well as project-associated clearing and grubbing for the transmission line, was identified in all sampled bog wetlands along the transmission line.

Table 3.4-1. Summary of Bog Associations Surveyed

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
Reservoir Footprint							
WL008	Wb06	Tamarack - Water sedge - Fen moss	NA	SE and TS	GPS points and air photo interpretation.	tall shrub (3b)	Blue
Transmission Line							
WL118	Wb03	Black spruce - Lingonberry - Peat-moss	BT	BT and TS.	GPS points and air photo interpretation.	tall shrub (3b)	Blue
WL114	Wb05	Black spruce - Water sedge - Peat-moss	BT	TS and BT	Not mapped as imagery (BC Hydro or other) is unavailable for this location.	pole/sapling (4)	Yellow
WL020	Wb06	Tamarack - Water sedge - Fen moss	BT	BT and TS	GPS track around disturbed portion of bog.	short shrub (3a)	Blue
WL113	Wb06	Tamarack - Water sedge - Fen moss	BT	TS and BT.	Not mapped as imagery (BC Hydro or other) is unavailable for this location.	tall shrub (3b)	Blue
WL115	Wb06	Tamarack – Water sedge – Fen moss	TS	TS and BT	GPS points and air photo interpretation.	tall shrub (3b)	Blue

3.4.2.2 Field Summary of Wetlands Surveyed

Wb06 Tamarack - Water sedge - Fen moss bog

The field team observed the Wb06 as an outer fringe around wetter herbaceous fens, as a pure wetland community, or as part of large bog complexes (Plate 3.4-1; Plate 3.4-2; Appendix A, Figure A3). It is characterized by deep Mesisols within extensive cover of tamarack, black spruce, and scrub birch (*Betula pumila* and *B. glandulosa*). The Wb06 often contains Labrador tea along with various willow species (*Salix candida, S. athabascensis, S. myrtillifolia,* and *S. serissima*) located within transitional areas. Herbaceous vegetation is varied and often includes bluejoint, scouring rush, soft-leaved sedge (*Carex* *disperma*), and water sedge. The moss layer is dominated by a continuous cover of peat mosses, golden fuzzy fen moss, and glow moss (*Aulacomnium palustre*).

Plate 3.4-1. Cleared Wb06 Tamarack - Water sedge - Fen moss bog at WL020 along the transmission line.

Plate 3.4-2. Wb06 Tamarack - Water sedge - Fen moss bog at WL008 in Watson Slough.

Wb03 Black spruce - Lingonberry - Peat-moss bog

This bog is characterized by an irregular cover of stunted black spruce (*Picea mariana*) and a deep layer of continuous peat moss (*Sphagnum* spp.) that often form hummocks of Fibrisol (poorly decomposed) organic soils (Plate 3.4-3). Shrubs, including Labrador tea (*Rhododendron groenlandicum*) and grey alder (*Alnus incana* ssp. *rugosa*) form a thick cover through the wetland. Dwarf shrubs such as Lingonberry (*Vaccinium vitis-idaea*), cloudberry (*Rubus chamaemorus*), bog cranberry (*Vaccinium oxycoccos*), and bog blueberry (*Vaccinium uliginosum*) occur sporadically, as do a variety of sedges (*Carex* spp.).

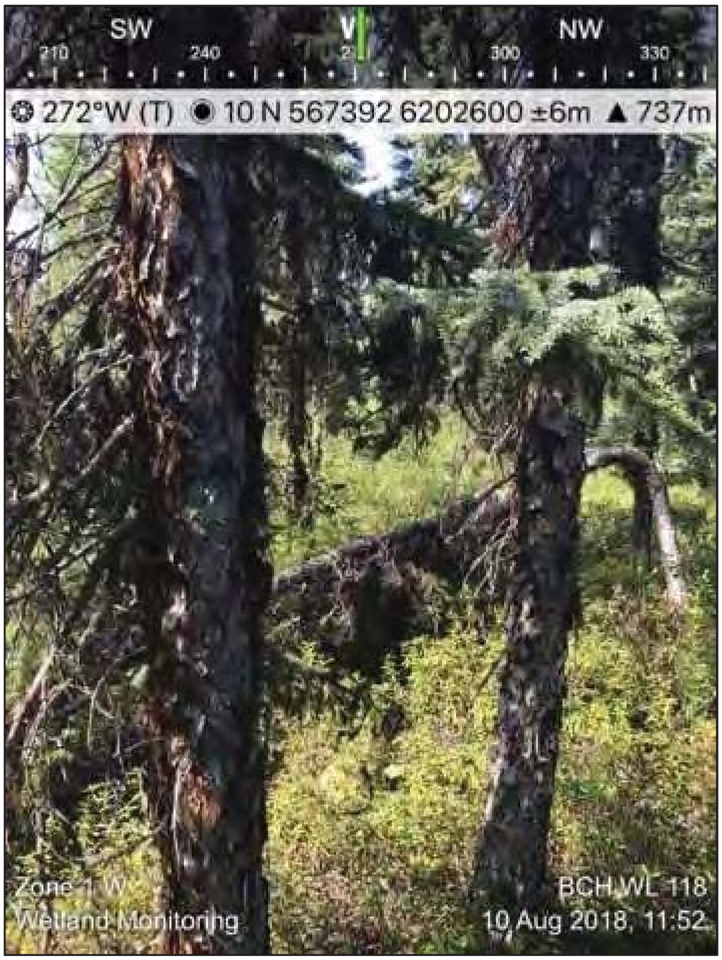


Plate 3.4-3. Wb03 Black spruce - Lingonberry - Peat-moss bog at WL118 along the transmission line.

Wb05 Black spruce - Water sedge - Peat-moss bog

This bog contains a continuous but sparse cover of black spruce, along with a variable component of tamarack (*Larix laricina* (Plate 3.4-4). The shrub layer is more diverse than many bogs, with a sparse cover of red-osier dogwood (*Cornus stolonifera*), northern blackcurrant (*Ribes hudsonianum*), black twinberry (*Lonicera involucrata* var. *involucrata*), and Labrador tea. Herbaceous vegetation, such as bluejoint (*Calamagrostis canadensis*), water sedge (*Carex aquatilis*), and scouring rush (*Equisetum* *hyemale*) can also be diverse. The moss layer is dominated by peat mosses and golden fuzzy fen moss (*Tomentypnum nitens*).

Plate 3.4-4. Wb05 Black spruce - Water sedge - Peat-moss bog at WL114 along the transmission line.

3.4.3 Fen

3.4.3.1 Overview

The field team surveyed three fens; including one site association in the reservoir footprint and one site association along the transmission line (Table 3.4-2).

Table 3.4-2. Summary of Fen Associations Surveyed

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
Reservoir Footprint							
WL004	Wf00	Fen (unclassified)	SE	SE and BT	GPS points and air photo interpretation.	2b	NA
Transmission Line							
WL021	Wf02	Scrub birch-water sedge	SE	TS and SE	GPS points, tracks, and air photo interpretation.	3a	Blue
WL102	Wf02	Scrub birch-water sedge	SE	SE	GPS points, tracks, and air photo interpretation.	3a	Blue

3.4.3.2 Field Summary of Wetlands Sampled

Wf00 Unclassified fen

The field team sampled one unclassified fen association in Watson Slough (Plate 3.4-5; Figure B3). This fen is not described in McKenzie and Moran (2004). The Wf00 is located within an extensive complex of bog, swamp, and fen wetlands. It occurs as multiple distinct herbaceous areas that are slightly wetter than the surrounding complex, on deep medium- to rich Typic Mesisols. This wetland is dominated by a continuous cover of soft-stemmed bulrush (*Schoenoplectus tabernaemontani*), a species that is more commonly associated with deep water and mineral soil marshes. Water sedge is also abundant, mainly along the shallower edges, along with sporadic cover of numerous other species such as seaside arrow-grass (*Triglochin maritima*), few-flowered spike sedge (*Eleocharis quinqueflora*), and green sedge (*Carex viridula*). The moss layer is generally absent, while free-floating aquatic species such as stonewort algae (*Chara* sp.) are common.

Wf02 Scrub birch – Water sedge fen

The field team observed the Wf02 as a component of larger wetland complexes both along the transmission line and within Watson Slough (Plate 3.4-6; Figures B9 and B11). The Wf02 occurs on deep organic soils, with Typic Mesisols commonly occurring. These sites are often hummocky, with shrubs, small trees, and drier species occurring on the mounds. Scrub birch (*Betula pumila* and *B. glandulosa*) is common and often occurs in association with willow, tamarack, and black spruce. Water sedge is always abundant, along with bluejoint, common horsetail, and a variety of other sedges (*C. bebbii, C. diandra, C. chordorriza, C. utriculata*).

Plate 3.4-5. Wf00 unclassified fen at WL004 in Watson Slough.

Plate 3.4-6. Wf02 Scrub birch – Water sedge fen at wetland WL102 on the transmission line.

3.4.4 Swamp

3.4.4.1 Overview

The field team surveyed nine swamps, including three site associations in the reservoir footprint; and six associations along the transmission line (Table 3.4-3). Many of the swamps appear to have originated as a result of human disturbance along the existing transmission line, while most of the communities in the reservoir footprint appear to be early seral communities developing on inactive floodplains and isolated side-channels.

Table 3.4-3. Summary of Swamp Associations Surveyed

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
Reservoir Footprint							
WL019	Ws00	Swamp (unclassified)	NA	Fl00 and GB (Gravel bar)	GPS points and air photo interpretation.	3b	Not Applicable (NA)
WL027	Ws00	Swamp (unclassified)	NA	Fl00	GPS points and air photo interpretation.	3a	NA
WL037	Ws00	Swamp (unclassified)	NA	Ws	GPS points and air photo interpretation.	5oC	NA
WL038	Ws00	Swamp (unclassified)	NA	SE and OW	GPS points and air photo interpretation.	3b	NA
WL007	Ws05	MacCalla's willow – Beaked sedge	NA	SE and TS	GPS points and air photo interpretation.	3b	Blue
WL005	Ws07	Spruce - Common horsetail - Leafy moss	NA	BT and upland forest	GPS points and air photo interpretation.	5sC	Blue
Transmission Line							
WL100	Ws00 (similar to Ws03)	Bebb's Willow – Bluejoint	TS	TS, SE and upland forest	GPS points and air photo interpretation.	3b	NA
WL107	Ws04	Drummond's willow - Beaked sedge	NA	Upland forest	GPS points and air photo interpretation.	3a	No status

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
WL116	Ws06	Sitka willow - Sitka sedge	BT and TS	BT and TS.	GPS points and air photo interpretation.	3b	Blue
WL117	Ws07	Spruce - Common horsetail - Leafy moss	TS	Upland forest	GPS points and air photo interpretation.	5sC	Blue
WL106	Ws14	Mountain Alder – Bebb's Willow – Bluejoint	WS	WS	GPS points and air photo interpretation.	3a	Blue
WL108	Ws14	Mountain Alder – Bebb's Willow – Bluejoint	FTR	TS and upland forest.	GPS points and air photo interpretation.	3b	Yellow

3.4.4.2 Field Summary of Wetlands Sampled

Ws00 Unclassified swamp

The field team noted several unclassified swamps within the inactive floodplains and isolated side-channels of the Peace River and other watercourses (Plate 3.4-7; Appendix A, Figure A67). While these sites meet the basic definition of swamps (based on soil and moisture), they contain vegetation assemblages that are not characteristic of known swamp communities. The unclassified swamps found along the transmission line were more often a result of past disturbance (typically roads or ditches) where swamp-like communities have regenerated, but they do not fit within the provincial classification system.

Along the Peace River, the field team sampled wetlands WL19, WL28, and WL37. These unclassified swamps represent early successional communities with finely textured (silt and silty loam) moderate to rich Orthic Gleysol soils with little organic accumulation. These sites are frequently dominated by a variety of willow species (*Salix maccalliana* and *S. interior*), grey alder, and red-osier dogwood along with a range of hydrophilic species such as water sedge (*Carex aquatilis*), silverweed (*Potentilla anserina*), and rushes (e.g., *Juncus nodosus*) (Plate 3.4-7). Additional species include a variety of grasses, upland herbs, and introduced species such as alsike clover (*Trifolium hybridum*) and yellow sweet-clover (*Melilotus officinalis*).

In Watson Slough the field team sampled a forested swamp (WL037) that could not be classified according to the provincial system (Delong 2011; Mackenzie and Moran 2004) (Plate 3.4-8; Appendix A, Figures A3 and A4). The vegetation community appears to have evolved in response to anthropogenic hydrologic alterations. It also has rich indicators such as cattails (*Typha latifolia*). The field team classified this site in the existing wetland mapping as a forested swamp; however, it does not fully meet the characteristics of a typical swamp association.

Ws04 Drummond's willow - Beaked sedge swamp

The field team surveyed the Ws04 once along the transmission line (Figure B11). In the sampled wetland, Drummond's willow (*Salix drummondiana*) was the dominant shrub, along with a near continuous cover of water sedge and beaked sedge (*Carex utriculata*; Plate 3.4-9).

Ws05 MacCalla's willow - Beaked sedge swamp

The field team surveyed the Ws05 within the reservoir footprint (Plate 3.4-10). The Watson Slough site contains Mesisols, characterized by moderately deep mesic organic tiers over gleyed silty clay loam soil horizons. The Ws05 is dominated by MacCalla's willow (*Salix maccalliana*), along with numerous other willow species (*S. discolor, S. bebbiana, S. serissima* and *S. pseudomonticola*). A thick herbaceous layer of water sedge, beaked sedge and bluejoint (*Calamagrostis canadensis*) is common, along with minor occurrences of numerous other species. The moss layer is sparse to absent and may contain leafy mosses (*Plagiomnium* sp.) and/or hook-moss (*Drepanocladus* sp.).

Plate 3.4-7. Ws00 unclassified swamp in the mid reservoir at WL027.

Plate 3.4-8. Ws00 unclassified forested swamp in Watson Slough at WL037.

Plate 3.4-9. Disturbed Ws04 Drummond's willow - Beaked sedge swamp at WL107 along the transmission line.

Plate 3.4-10. Ws05 MacCalla's willow - Beaked sedge swamp at WL007 in Watson Slough.

Ws07 Spruce - Common horsetail - Leafy moss swamp

The field team surveyed the Ws07 in the reservoir footprint (Plate 3.4-11; Appendix A, Figure A3) and along the transmission line (Figure B16). The soils are characterized by blankets of deep, rich Typic Mesisols. White spruce (*Picea glauca*) is the dominant tree species combined with lesser amounts of tamarack, black spruce, and black cottonwood common. The shrub layer is variable and contains species such as mountain alder (*Alnus incana*) along with various willows. The herbaceous layer is diverse, including common horsetail (*Equisetum arvense*), soft-leaved sedge (*Carex disperma*) and a mix of other wetland and upland herbs. The moss layer is also variable, with leafy mosses such as *Plagiomnium medium* commonly occurring along with pockets of peat mosses (*Sphagnum* spp.).

Plate 3.4-11. Ws07 Spruce - Common horsetail - Leafy moss in Watson Slough at WL005.

Ws14 Mountain alder – Bebb's willow – Glow moss swamp

The field team surveyed the Ws14 swamp twice along the transmission line (Plate 3.4-12; Appendix A, Figures A10 and A13). These sites occur in slight depressions with saturated Orthic Gleysol soil. The vegetation is characterized by a variable cover of Bebb's willow and Mackenzie's willow, with low cover of black cottonwood, grey alder, and abundant cover of bluejoint.

Plate 3.4-12. Ws14 Mountain alder – Bebb's willow – Glow moss swamp at WL106 along the transmission line.

3.4.5 Marsh

3.4.5.1 Overview

The field team surveyed fifteen marshes, including five site associations and one unclassified marsh in the reservoir footprint; and four associations along the transmission line (Table 3.4-4).

Table 3.4-4. Summary of Marsh Associations Surveyed

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
Reservoir Footprint							
WL012	Wm00	Marsh (unclassified)	FTR	Fl00 and GB	GPS points and air photo interpretation.	2b	NA
WL022	Wm02	Swamp horsetail - Beaked sedge	NA	Fm02 and GB	GPS points and air photo interpretation.	2b	Blue
WL003	Wm03	Awned sedge	SE	SE, BT and OW	GPS points and air photo interpretation.	2b	Red
WL006	Wm03	Awned sedge	SE	SE and TS	GPS points and air photo interpretation.	2b	Red
WL018	Wm04	Common spike-rush	WH	Fl00 and GB	GPS points and air photo interpretation.	2b	Blue
WL036	Wm05	Cattail	NA	SE and OW	GPS points and air photo interpretation.	2b	Blue
WL009	Wm06	Great bulrush	NA	SE and OW	GPS points and air photo interpretation.	2b	Blue
Transmission Line							
WL101	Wm01	Beaked sedge - Water sedge	SE	SE	GPS points and air photo interpretation.	2b	Yellow
WL103	Wm01	Beaked sedge - Water sedge	FTR	SE, TS and BT	GPS points and air photo interpretation.	2b	Yellow
WL104	Wm01	Beaked sedge - Water sedge	SE	SE	GPS points and air photo interpretation.	2b	Yellow
WL111	Wm01	Beaked sedge - Water sedge	NA	Upland forest.	GPS points and air photo interpretation.	2b	NA
WL105	Wm02	Swamp horsetail - Beaked Sedge	SE	SE	GPS points and air photo interpretation.	2b	Blue

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
WL110	Wm03	Awned sedge	NA	Upland forest.	GPS points, tracks and air photo interpretation.	2b	NA
WL109	Wm05	Cattail	NA	Upland forest.	GPS points, tracks and air photo interpretation.	2b	NA
WL112	Wm05	Cattail	NA	Upland forest.	GPS points, tracks and air photo interpretation.	2b	NA

3.4.5.2 *Field Summary of Wetlands Sampled*

Wm00 Unclassified Marsh

The field team characterized the Wm00 unclassified marsh as an early successional site with marsh-like characteristics that does not contain vegetation that could be classified according to provincial wetland associations (MacKenzie and Moran 2004). This Wm00 is located in an active portion of the Peace River floodplain, in an area that receives seasonal low energy, shallow flooding. It is a mineral soil based community with highly variable site conditions, including portions of deeper water, areas with significant accumulation of fine sediment from floodwaters, and portions of coarser substrates. The wetland contains a diverse assemblage of species that occur in patches in response to the varied substrate (Plate 3.4-13). Dominant species include small-flowered bulrush (*Scirpus microcarpus*), cattail (*Typha latifolia*), water sedge, beaked sedge, and sporadic MacCalla's willow.

Plate 3.4-13. Wm00 unclassified marsh at WL012 along the Peace River.

Wm01 Beaked sedge - Water sedge marsh

The field team surveyed the Wm01 along the transmission line (Appendix A, Figures A7, A12, and A13). The sites have organic veneers over gleyed mineral soils. The organic accumulation has allowed for many more species to establish than would normally be expected in the Wm01, leading the floristic community to be more representative of the similar Wf01 Water sedge - Beaked sedge fen than the

Wm01 (which has very low species richness) in some locations (Plate 3.4-14). Species such as bluejoint, large-leaved avens (*Geum macrophyllum*), swamp horsetail, and silverweed are often also present. Common introduced species include dock (*Rumex crispus*) and Canada thistle. The Wm01 sites are generally in poor condition, having multiple impacts from the historic and recent transmission line clearing.

Plate 3.4-14. Disturbed Wm02 Swamp horsetail - Beaked Sedge marsh in Wetland WL105 along transmission line.

Most sites classified as Wm01 along the transmission line were intermediate between marshes and fens. These sites are evolving into Wf01 wetlands, but organic soils have not developed enough to classify them as fens at this time.

Wm02 Swamp horsetail – Beaked Sedge marsh

The field team surveyed the Wm02 twice in the PAZ, with one site in the reservoir footprint along the Peace River (Appendix A, Figure A6) and one site along the transmission line (Appendix A, Figure A11). The wetland was dominated by a continuous cover of swamp horsetail and a variable cover of beaked sedge, water sedge, small-flowered bulrush, cattails, and free-floating duckweed. The marsh sampled along the transmission line appears to have been created by an old road or seismic line and was likely a Wf02 fen before the disturbance altered local hydrology and soils, creating a wetter site (Plate 3.4-15). The Wm02 sampled in the reservoir footprint was a natural community with no obvious disturbance (Plate 3.4-16). 4-15. Disturbed Wm02 Swamp horsetail - Beaked Sedge marsh in Wetland WL105 along transmission line.

Plate 3.4-16. Undisturbed Wm02 Swamp horsetail - Beaked Sedge marsh in complex in an isolated side channel of the Peace River at WL022.

Wm03 Awned sedge fen-marsh

The field team surveyed the Wm03 twice in Watson Slough (Plate 3.4-17; Figure B3) and once within a disturbed site along the transmission line (Figure B7). All three sites are dominated by awned sedge, with pockets of beaked sedge and water sedges in deeper water. A variety of other species occur in trace amounts including coltsfoot (*Petasites sagittatus*), rush aster (*Symphyotrichum boreale*), marsh skullcap (*Scutellaria galericulata*), and field mint (*Mentha arvensis*). These wetlands are normally too wet to develop much of a moss layer, with water-moss (*Calliergon* sp.) sporadically occurring.

Plate 3.4-17. Wm03 Awned sedge in Watson Slough at WL003.

Wm04 Common spike-rush marsh

The field team surveyed the Wm04 once along an isolated side-channel of the Peace River (Plate 3.4-18; Figure B4). The site is characterized by permanent flooding, Orthic Gleysols and a vegetation community dominated by common spike-rush (*Eleocharis palustris*), and needle spike-rush (*Eleocharis acicularis*). Additional species include scouring rush, small-flowered bulrush (*Scirpus microcarpus*) and narrow-leaved bur-reed (*Sparganium angustifolium*).

Plate 3.4-18. Wm04 Common spike-rush marsh in an isolated side-channel along Peace River at WL018.

Wm05 Cattail marsh

The field team surveyed three Wm05 marshes; one within Watson Slough in the reservoir footprint (Plate 3.4-19; Figure B3) and two along the transmission line (Figure B7). The sites are rich with a thin well-decomposed organic veneer and deep, saturated Rego Gleysols and Ortho Humic Gleysols. These sites are dominated by cattail. Various sedges may occur around the edges of these wetlands, but they are generally sparse and transitional to other marsh communities. Aquatic plants including duckweed (*Lemna minor* and *L. trisulca*) and common bladderwort (*Utricularia macrorhiza*) are common and range from sparse to high cover depending on the time of year. The wetlands sampled in the transmission line were either a result of disturbance or have been modified by the construction of the old transmission line and associated roads.

Plate 3.4-19. Constructed Wm05 Cattail marsh in Watson Slough at WL 036.

Wm06 Great bulrush marsh

The field team surveyed one Wm06 in the reservoir footprint at Watson Slough (Plate 3.4-20; Figure B3). Soils are thin mesic organics underlain by permanently saturated fine-textured sediments. Soft-stemmed bulrush (*Schoenoplectus tabernaemontani*) is the dominant species (as it is one of the few emergent plants that is adapted to living in deep water) while a minor component of cattail also frequently occurs. The shallower, outer edges of these marshes often have a population of large sedges, including water sedge and beaked sedge, as they transition to shallower sedge-dominated marshes. Free-floating aquatic plants occur regularly, including duckweed (*Lemna minor* and *L. trisulca*) and common bladderwort (*Utricularia macrorhiza*).

Plate 3.4-20. Wm06 Great bulrush in Watson Slough marsh at WL009.

3.4.6 Shallow Open Water

3.4.6.1 Overview

The field team surveyed a shallow open water community in the reservoir footprint within an isolated side-channel of the Peace River in a beaver dam controlled pond (Table 3.4-5; Plate 3.4-21; Figure B5). The pond is permanently flooded, with multiple channels flowing in and out of the system. The community contains a high cover of aquatic species, including white water-buttercup (*Ranunculus aquatilis*), narrow-leaved bur-reed, and arum-leaved arrowhead (*Sagittaria cuneata*). Emergent vegetation includes beaked sedge, swamp horsetail, small-flowered bulrush, and common spike-rush.

Table 3.4-5. Summary of Open Water Communities Sampled

Wetland Field ID	Site Association Code[2]	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
Reservoir Footprint							
WL025	OW	Shallow Open Water (unclassified)	NA	GB and RI (River)	GPS points and air photo interpretation.	2c	Not Applicable (NA)

[2] The code provided is the map code and is not specifically a site association.

Plate 3.4-21. Shallow open water wetland in an isolated channel on the Peace River at WL025.

3.4.7 Floodplain

3.4.7.1 Overview

The field team surveyed twenty floodplains within the reservoir footprint in 2018 (Table 3.4-6). Of these, 10 were identified as low-bench and 4 as mid-bench floodplains sites that could not be classified within the provincial system. As such these sites were assigned the standard Fl"00" and Fm "00" code commonly used to describe unclassified units. The remainder of the sites were classified as Fl03- Pacific willow – Red-osier dogwood – Horsetail, the Fl06- Sandbar willow, or the Fm02- Cottonwood - Spruce - Red-osier dogwood.

Table 3.4-6. Summary of Floodplain Associations Surveyed

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
WL001	FI00	Low bench floodplain - sparsely vegetated (unclassified)	NA	GB	GPS track around entire community.	2a	NA
WL002	FI00	Low bench floodplain – cottonwood (unclassified)	NA	Fl00 and GB	GPS track around entire community.	3a	NA
WL010	FI00	Low bench floodplain- sparsely vegetated (unclassified)	FTR	GB and Fl00	GPS points, tracks and air photo interpretation.	2b	NA
WL016	FI00	Low bench floodplain- herbaceous (unclassified)	NA	Fl00 and GB	GPS track around entire community.	2b	NA
WL024	FI00	Low bench floodplain - herbaceous (unclassified)	NA	GB	GPS points and air photo interpretation.	2b	NA
WL028	FI00	Low bench floodplain- herbaceous (unclassified)	NA	Fl00, Fm02, and GB	GPS points, tracks and air photo interpretation.	2a	NA
WL031	FI00	Low bench floodplain - herbaceous (unclassified)	FTR (partial)	GB and Fl00.	GPS points, tracks and air photo interpretation.	2b	NA
WL034	FI00	Low bench floodplain – cottonwood (unclassified)	NA	RI, Fm02, and GB	GPS points, tracks and air photo interpretation.	3b	NA
WL014	Fl03	Pacific willow – Red-osier dogwood – Horsetail	NA	RI, GB and Fm02	GPS points and air photo interpretation.	3b	Red
WL011	Fl06	Sandbar willow	FTR	Fl00 and GB	GPS points, tracks and air photo interpretation.	3b	Red

Wetland Field ID	Site Association Code	Site Association Name	Detailed Wetland Mapping Code	TEM Code(s)	Delineation Method	Structural Stage	BC List
WL015	Fl06	Sandbar willow	NA	RI and GB	GPS points, tracks and air photo interpretation.	3a	NA
WL017	Fl06	Sandbar willow	WH	Fl00 and GB	GPS points, tracks and air photo interpretation.	3a	Red
WL032	Fl06	Sandbar willow	NA	RI, Fm02, and GB	GPS points, tracks and air photo interpretation.	3a	Red
WL023	Fm00	Mid bench floodplain - cottonwood (unclassified)	NA	Upland forest	GPS points, tracks and air photo interpretation.	3b	NA
WL030	Fm00	Mid bench floodplain- cottonwood (unclassified)	NA	GB and Upland forest	GPS points, tracks and air photo interpretation.	3b	NA
WL013	Fm02	Cottonwood - Spruce - Red-osier dogwood	FTR	Fl00 and GB	GPS points and air photo interpretation.	5sB	Red
WL026	Fm02	Cottonwood - Spruce - Red-osier dogwood	NA	Upland forest	GPS points and air photo interpretation.	5tB	Red
WL029	Fm02	Cottonwood - Spruce - Red-osier dogwood	NA	Fm02	GPS points and air photo interpretation.	5tB	Red
WL033	Fm02	Cottonwood - Spruce - Red-osier dogwood	NA	Fl00	GPS points and air photo interpretation.	5oB	Red
WL035	Fm02	Cottonwood - Spruce - Red-osier dogwood	NA	GB, Upland forest and Fm02	GPS points and air photo interpretation.	5oB	Red

The field team observed unclassified low-bench floodplains within the reservoir footprint, while these associations could not be classified to the provincial system, there appears to be three distinct communities. The field team described these sites as unclassified sparsely vegetated; unclassified cottonwood; and unclassified herbaceous low bench floodplains. These sites are located on the edge of the Peace River and its tributaries, generally on high-energy, active fluvial plains. The communities that are located directly adjacent to the creek or river are submerged for a large portion of the year, limiting the diversity and abundance of plant species. These communities are also often scoured on a regular basis. They are composed of coarse material, sands and/ silts, depending on the depositional environment. Soils are weakly developed, often composed entirely of un-weathered material. Low-bench flood communities that occur slightly higher, or in protected locations, are also inundated for long periods, but are not subject to the constant high-energy water movement. The result is a more diverse and stable community and some soil development.

3.4.7.2 Field Summary of Wetlands Sampled

Fl00 sparsely vegetated low-bench floodplain

The field team characterized this Fl00 as a sparsely vegetated low-bench floodplain community that occurs immediately adjacent to the active river channel (Plate 3.4-22; Figure B3). These site are typically located on coarse sand and gravel with minimal pedogenesis. These communities contain a sparse cover of herbaceous pioneer vegetation that is adapted to this high-disturbance environment. Typical species include wild chives (*Allium schoenoprasum* var. *sibiricum*), tufted hairgrass (*Deschampsia cespitosa*), and Kellogg's sedge (*Carex kelloggii*). Introduced and invasive species were also common in these areas, including quackgrass (*Elymus repens*), reed canarygrass (*Phalaris arundinacea*), and alsike clover (*Trifolium hybridum*). Shrub and moss layers were generally absent, with the exception of black cottonwood and willow seedlings in protected areas (such as downstream of large woody debris).

Fl00 Unclassified cottonwood low-bench floodplain

The field team characterized this Fl00 as a sparsely vegetated low-bench floodplain community that occurs adjacent to active river channels but is isolated from flooding events (Plate 3.4-23; Figure B3). These communities are more stable than other low-bench communities as they do not flood on an annual basis. The vegetation community is dominated by black cottonwood. Other species, such as the showy locoweed (*Oxytropis splendens*), the Blue-listed Davis' locoweed (*Oxytropis campestris* var. *davisii*), yellow mountain-avens (*Dryas drummondii*) cut-leaved anemone (*Anemone multifida*), wormwood (*Artemisia campestris*), and southern milk-vetch (*Astragalus australis*) are present.

Plate 3.4-22. Fl00 unclassified sparse herbaceous low-bench floodplain along the Peace River at WL001.

Plate 3.4-23. Fl00 unclassified black cottonwood low-bench inactive floodplain along the Peace River at WL002

Fl00 Unclassified herbaceous low-bench floodplain

The field team characterized this Fl00 as a herbaceous low-bench floodplain based on its landscape position relative to the river (Plate 3.4-24; Figure B2). However, it appears to be isolated from flooding events as it has no visible signs of recent scouring or deposition. These communities are meadow-like and rarely contain any shrub seedlings. Species assemblages are diverse (with some sites having over 30 species) and include many species that are not adapted to prolonged flooding. Soils were classified as sandy Orthic Gleysols, with limited soil development. Bluejoint, tufted hairgrass (*Deschampsia cespitosa*), fowl bluegrass (*Poa palustris*), and meadow arnica (*Arnica chamissonis*) comprise a large portion of the cover, while multiple other species occur sporadically throughout.

Plate 3.4-24. Fl00 unclassified herbaceous low-bench floodplain along the Peace River at WL031.

Fl03 Pacific willow – Red-osier dogwood – Horsetail low-bench floodplain

The field team surveyed the Fl03 in one location along a recently inactive portion of the Cache Creek floodplain (Plate 3.4-25; Figure B4). The soils are moderately developed Eutric Dystric Brunisols. The site has evidence of recent flooding, but due to substantial aggradation of flood deposits and subsequent down cutting of Cache Creek into these same sediments. This site appears to be isolated from the Cache Creek floodplain. It is expected that the community will transition to a mid-bench community in the near future. The Fl03 site was dominated by a continuous, thick cover of grey alder with some Pacific willow (*Salix lucida*) and sandbar willow (*Salix interior*). Herbaceous cover was limited, with much of the site comprised of exposed un-weathered sand. Common horsetail and smooth brome (*Bromus inermis*) occurred sparsely, as did the introduced yellow sweet-clover.

Plate 3.4-25. Fl03 Pacific willow – Red-osier dogwood – Horsetail low-bench floodplain along Cache Creek at WL014.

Fl06 Sandbar willow low-bench floodplain

The field team surveyed the Fl06 in the reservoir footprint along rivers and creeks, where it occurs in small patches. The Fl06 is characterized by a sparse to thick cover of sandbar willow, often with black cottonwood and other willow species (Plate 3.4-26; Figure B4). Soils are weakly developed Brunisols. Herbaceous cover is generally sparse, although several sites had a high cover of introduced species such as yellow sweet-clover (*Melilotus officinalis*), white sweet-clover, and Canada thistle. Sites that were older and more removed from the active river contained a higher diversity, including a thick cover of bluejoint, beaked sedge, and numerous species of willow (Plate 3.4-27; Figure B3).

Plate 3.4-26. Fl06 Sandbar willow low-bench floodplain along Cache Creek at WL015.

Plate 3.4-27. Fl06 Sandbar willow low-bench floodplain along a less active side-channel of the Peace River at WL007.

Fm00 Unclassified mid-bench floodplain

The field teams described the Fm00 as having a well-spaced cover of small, stunted black cottonwood and a high diversity of herbaceous species, including locoweed and several introduced species such as sweet white-clover and yellow clover that are tolerant of poor growing conditions (Plate 3.4-28; Figures B1 and B6). The Fm00 sites have limited soil development and a high content of cobbles.

Plate 3.4-28. Fm00 Unclassified mid-bench floodplain on the Peace River at WL030.

Fm02 Cottonwood - Spruce - Red-osier dogwood mid-bench floodplain

The field team described the Fm02 as having a continuous cover of black cottonwood, with red-osier dogwood, speckled alder, and Saskatoon (*Amelanchier alnifolia;* Plates 3.4-29 and 3.4-30; Appendix A, Figures A1, A2, and A5). Herbaceous vegetation is diverse, and can include multiple introduced species. At these sites, soils are typically Orthic Regosols in the younger stands, and Eutric Dystric Brunisol and Orthic Dystric Brunisols in mature stands.

Plate 3.4-29. Young Fm02 Cottonwood - Spruce - Red-osier dogwood mid-bench floodplain in the mid-reservoir at WL026

Plate 3.4-30. Mature Fm02 Cottonwood - Spruce - Red-osier dogwood mid-bench floodplain in the mid-reservoir at WL029

4. RECOMMENDATIONS

In 2018, a number of wetland monitoring program refinements were field-tested and are proposed for discussion and potential integration into the field methodology in 2019:

1. Target future wetland sampling at complexes where multiple wetlands can be sampled in a single traverse. Complexes are the rule rather than the exception within the PAZ. Much of a wetland area, especially at the margins, is in transition to another wetland type. Sampling within a complex allows for assessment of the same disturbance on multiple wetland types, and monitoring over time may show different impacts to wetland function across the wetland types.
2. Use alternate ways to delineate wetland perimeter. Methods in the *Wetland Monitoring Program Field Manual* (Appendix D of Native Plant Solutions 2018b). prescribed traversing the perimeter of the wetland in order to determine the extent or, if this was not possible, taking four GPS points around the wetland. The first method is considered achievable for the smaller wetlands but an alternate approach is recommended for the larger wetlands. High-resolution spatial imagery could be used as a basis for delineating wetland boundaries. The use of such imagery would improve field efficiency by allowing activities to focus on necessary parameter sampling, and would assist with planning surveys, accessing sites, and assess the current level of disturbance to the wetlands.
3. Include un-disturbed wetlands that occur outside of the transmission line right-of-way in the 2019 sampling plan. It would be beneficial to sample similar types of wetlands that are adjacent to the disturbed area as most of the transmission line is already cleared and grubbed. This would allow for a better characterization of pre-clearing conditions.
4. Refine the field cards to streamline the data collection into fewer fields, particularly related to the photo logs.
5. Consider the use of the Solocator Application (App) for the permanent photo stations. The Solocator App stamps photos with the direction (azimuth), elevation, UTM, date, time, and custom descriptions. Photos can be taken in a repeatable manner (locations can be re-established with GPS, and all information is digitally imprinted on each photo instead of recorded on field sheets).
6. Document structural stage, canopy composition, and type and extent of disturbance of adjacent ecosystems as an alternative to full characterization of adjacent ecosystems due to the amount of time required to complete full characterization according to the methods outlined in the Field Manual for Describing Terrestrial Ecosystems 2nd. edition.
7. Evaluate if the Floristic Quality Index provide a suitable method for monitoring change to vegetation over time.

5. PLAN FORWARD AND NEXT STEPS

NPS will complete additional data analyses in the context of the wetland function assessment and the wetland monitoring program using data from the 2018 field season. Analysis will include the combined 2016, 2017, and 2018 monitoring data. This will be used to inform revisions to the monitoring program and to select future monitoring sites. Analysis will include the following:

1. Review wetland mapping classification error, using an error matrix, and consider error characteristics in relation to wetland monitoring program objectives. Should the error matrix show low classification accuracy for some wetland types, additional monitoring may be directed to focus on wetland types with high classification error or less common wetland types on the landscape.
2. Review delineation error (see Recommendation #2, Section 4), based on the methods for boundary delineation error calculation, as described in the wetland monitoring program (Native Plant Solutions 2018b). This includes the use of pre-existing data (i.e., Maple Leaf Forestry dataset), aerial imagery, and field delineation. Should the percent error for boundary delineation from the detailed wetlands layer be greater than is to be anticipated for wetland mapping, explore areas for improvement in boundary delineation, including the classification of high-resolution satellite imagery or use of orthophotography.
3. Assess the sampling variance for each wetland type, both at the level of TEM classification and the level of provincial wetland classification (Mackenzie and Moran 2004), for key monitoring parameters (i.e., vegetation cover and communities present, soil profiles, and hydrology). If variance is too high to characterize wetlands at baseline with low uncertainty, then two alternative approaches will be considered:
    a. a greater baseline sampling effort, per type with high uncertainty, or the use of reference sites outside of the PAZ where un-impacted wetlands of a certain type can no longer be obtained; and
    b. evaluate the difference in variance in key monitoring parameters when considered at the level of TEM classification and the level of provincial wetland classification. Should there be a large difference in the level of variance, consider the value in updating wetland ecosystem mapping of the PAZ to the provincial wetland classification;
4. Address error of wetland omission in the detailed wetland mapping. Note that this is not a unique error to mapping of wetlands within the Site C PAZ; however, addressing this error should be done via a formalized approach.
5. Conduct an assessment of the sites sampled as part of the monitoring program, including whether gaps exist in the wetland types and areas monitored. Site selection for 2019 will be based on the benefits and limitations of site selection explored in 2018, the 2018/2019 construction schedule, potential construction impacts anticipated for 2019, site access

limitations and the progress to date towards describing baseline wetland characteristics. Target areas for 2019 monitoring include:

   a. the western portion of the reservoir footprint (baseline monitoring);
   b. downstream wetland monitoring north of the Pine River confluence (baseline monitoring); and
   c. commencement of construction monitoring, for baseline transmission line wetlands visited in 2016.

6. Incorporate recommendations to the monitoring program provided as part of the 2018 annual report, for implementation in 2019.
7. Conduct a cost-benefit analysis related to acquiring high-resolution satellite imagery.

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APPENDIX A. WETLAND MAPPING

A1. 2018 Assessed Wetlands - Halfway River

A2. 2018 Assessed Wetlands – West Reservoir

A3. 2018 Assessed Wetlands – Watson Slough

A4. 2018 Assessed Wetlands – Cache Creek

A5. 2018 Assessed Wetlands – Mid Reservoir

A6. 2018 Assessed Wetlands – West of Moberly River

A7. 2018 Assessed Wetlands – Transmission Line Laydown

A8. 2018 Assessed Wetlands – Transmission Line East

A9. 2018 Assessed Wetlands – Transmission Line East 2

A10. 2018 Assessed Wetlands – Transmission Line East 3

A11. 2018 Assessed Wetlands – Transmission Line Middle

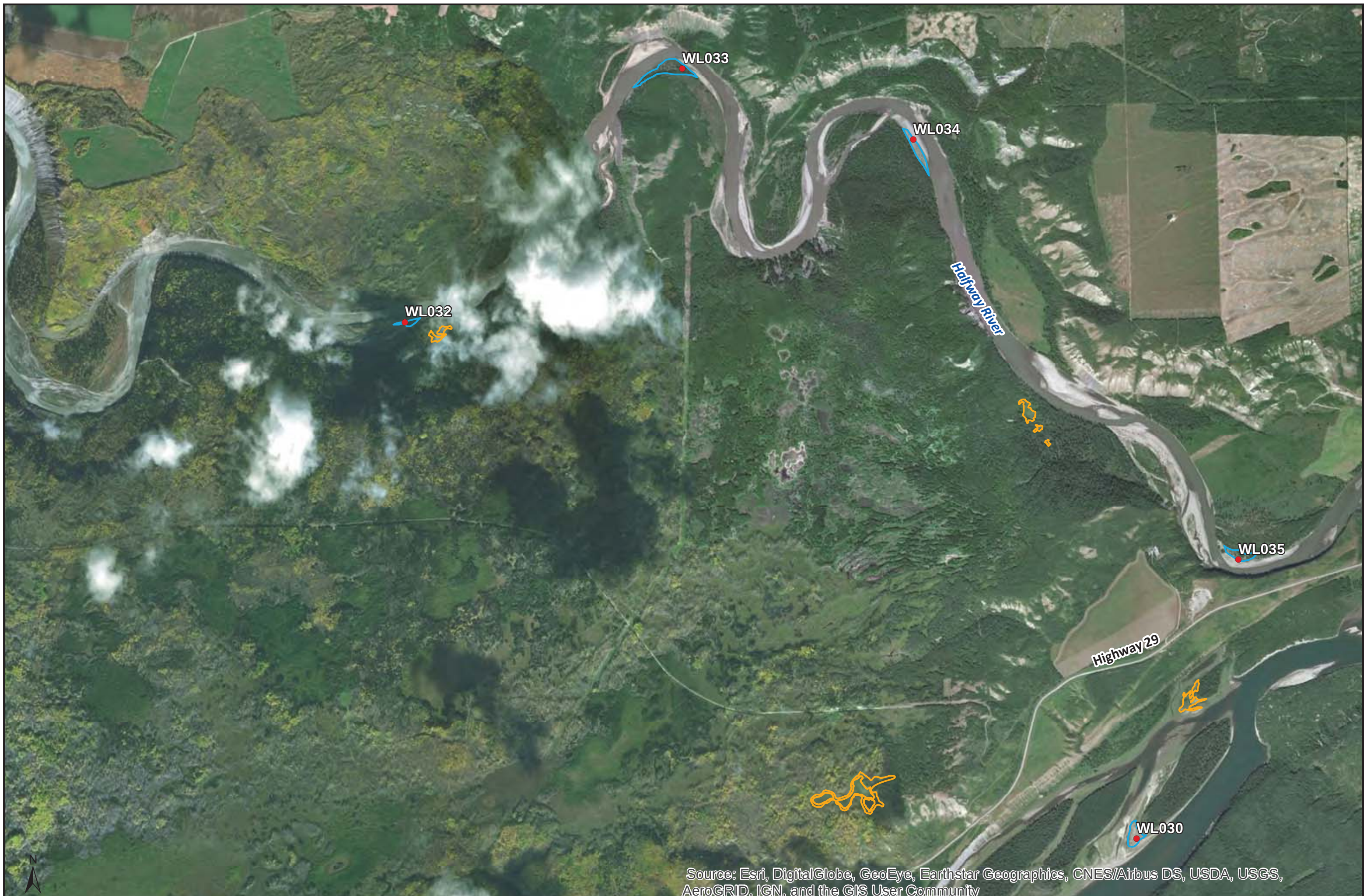
A12. 2018 Assessed Wetlands – Transmission Line Middle 2

A13. 2018 Assessed Wetlands – Transmission Line Middle 3

A14. 2018 Assessed Wetlands – Transmission Line West

A15. 2018 Assessed Wetlands – Transmission Line West 2

A16. 2018 Assessed Wetlands – Transmission Line West 3



Site C Project

2018 Assessed Wetlands - Halfway River

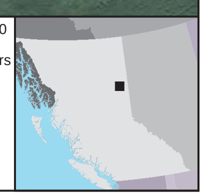
Figure A1

Date: 12/12/2018
Map Number: BCHWL-07
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

Legend

- Sample Sites (2018)
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping



Site C Project

2018 Assessed Wetlands - West Reservoir

Figure A2

Date: 2018-12-09
Map Number: BCHWL-08
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

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- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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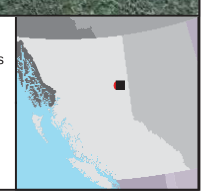

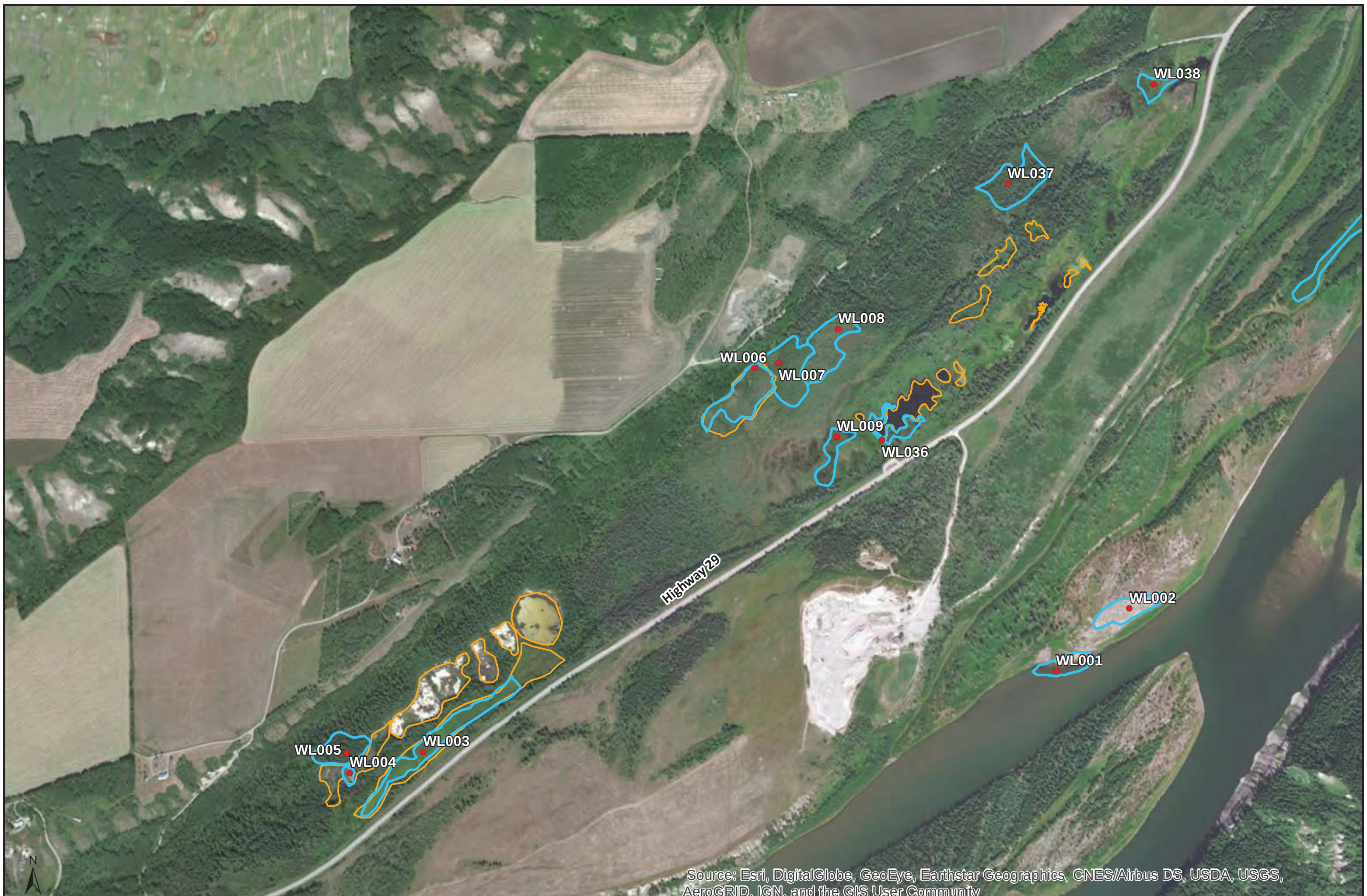

Site C Project

2018 Assessed Wetlands - Watson Slough

Figure A3

Date: 12/12/2018
Map Number: BCHWL-09
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

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- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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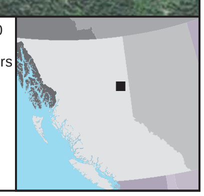

Site C Project

2018 Assessed Wetlands - Cache Creek

Figure A4

Date: 2018-12-09
Map Number: BCHWL-10
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

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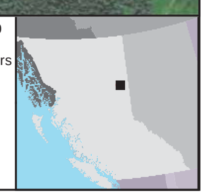
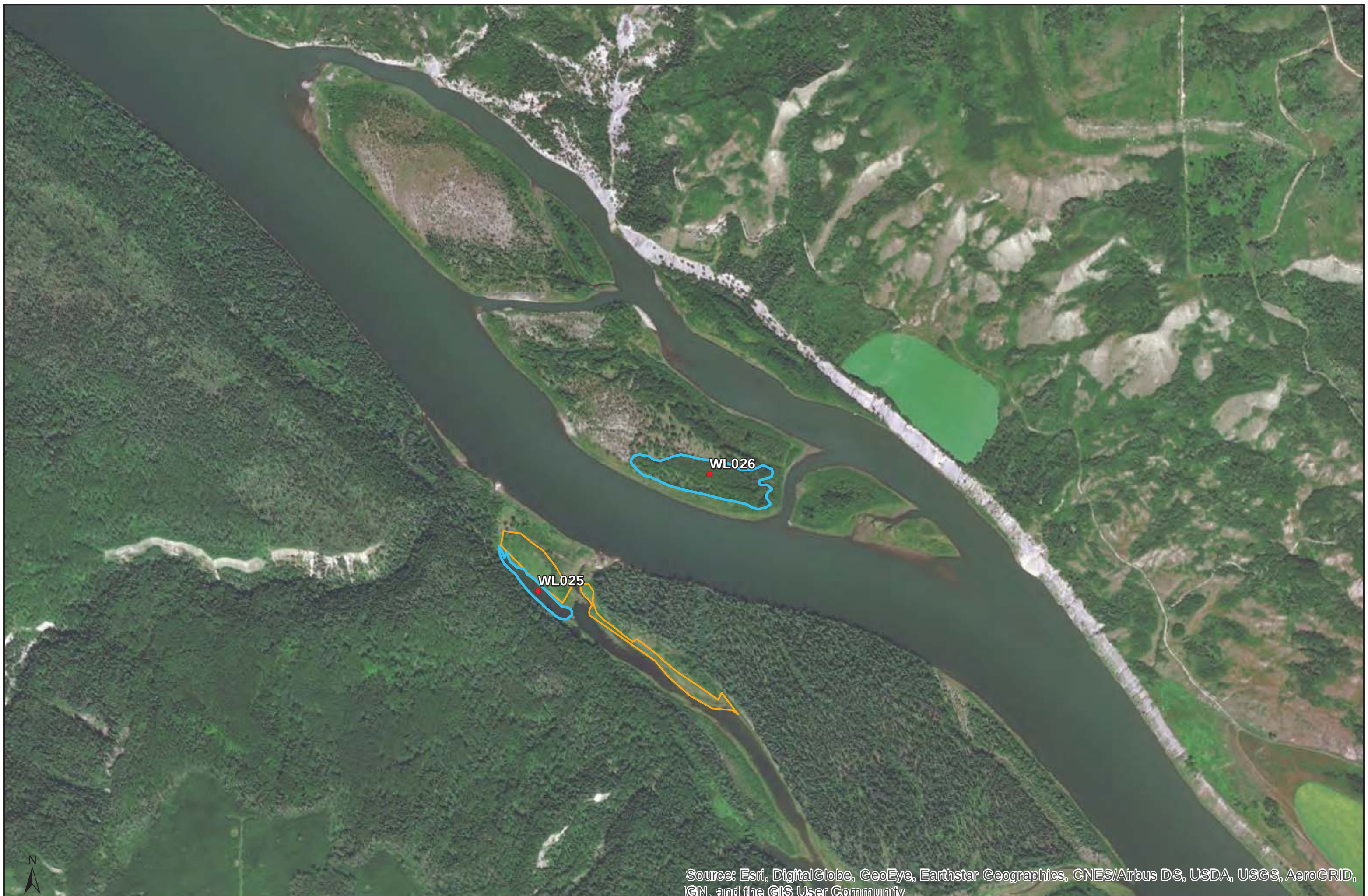
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping





Site C Project

2018 Assessed Wetlands - Mid Reservoir

Figure A5

Date: 2018-12-09
Map Number: BCHWL-11
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

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- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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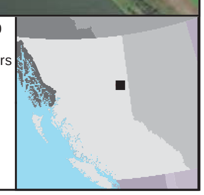

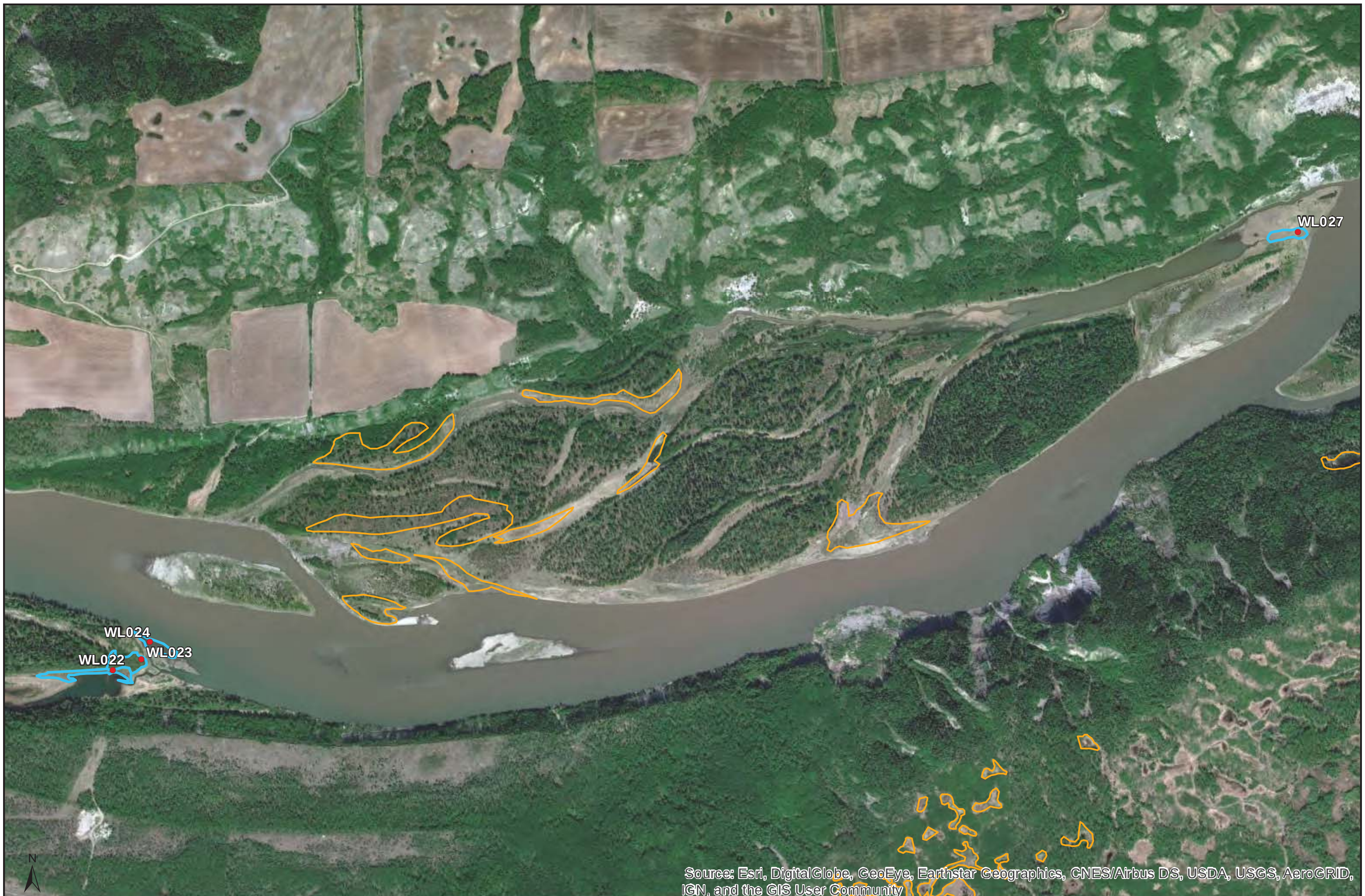

Site C Project

2018 Assessed Wetlands - West of Moberly River

Figure A6

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Map Number: BCHWL-12
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

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- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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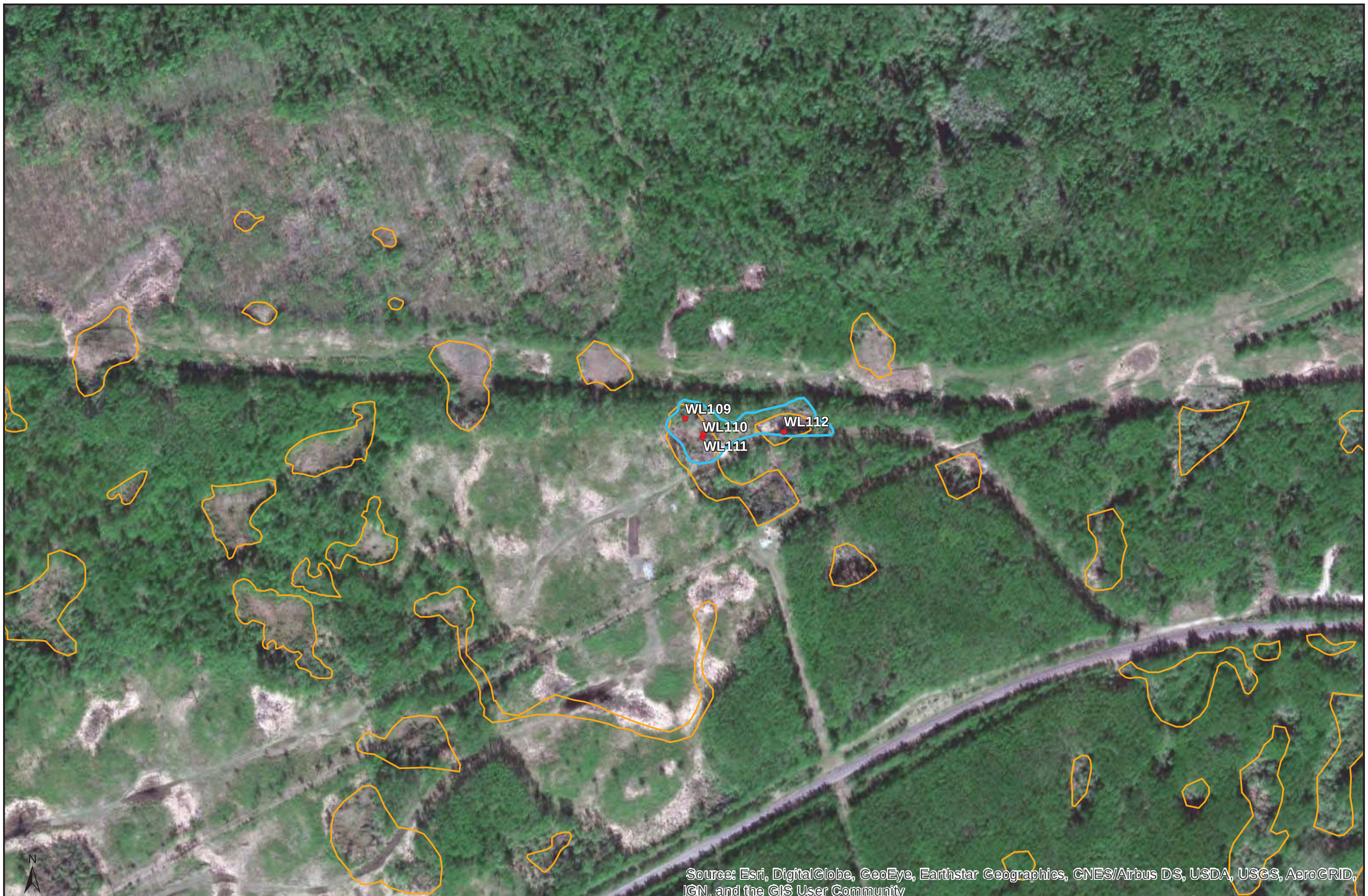

Site C Project

2018 Assessed Wetlands - Transmission Line Laydown

Figure A7

Date: 2018-12-09
Map Number: BCHWL-13
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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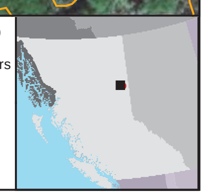
1:5,000
Meters



Site C Project

2018 Assessed Wetlands - Transmission Line East

Figure A8

Date: 2018-12-10
Map Number: BCHWL-14
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

- Sample Sites (2018)
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

Site C Project
2018 Assessed Wetlands - Transmission Line East 2
Figure A9

Date: 2018-12-10
Map Number: BCHWL-15
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend
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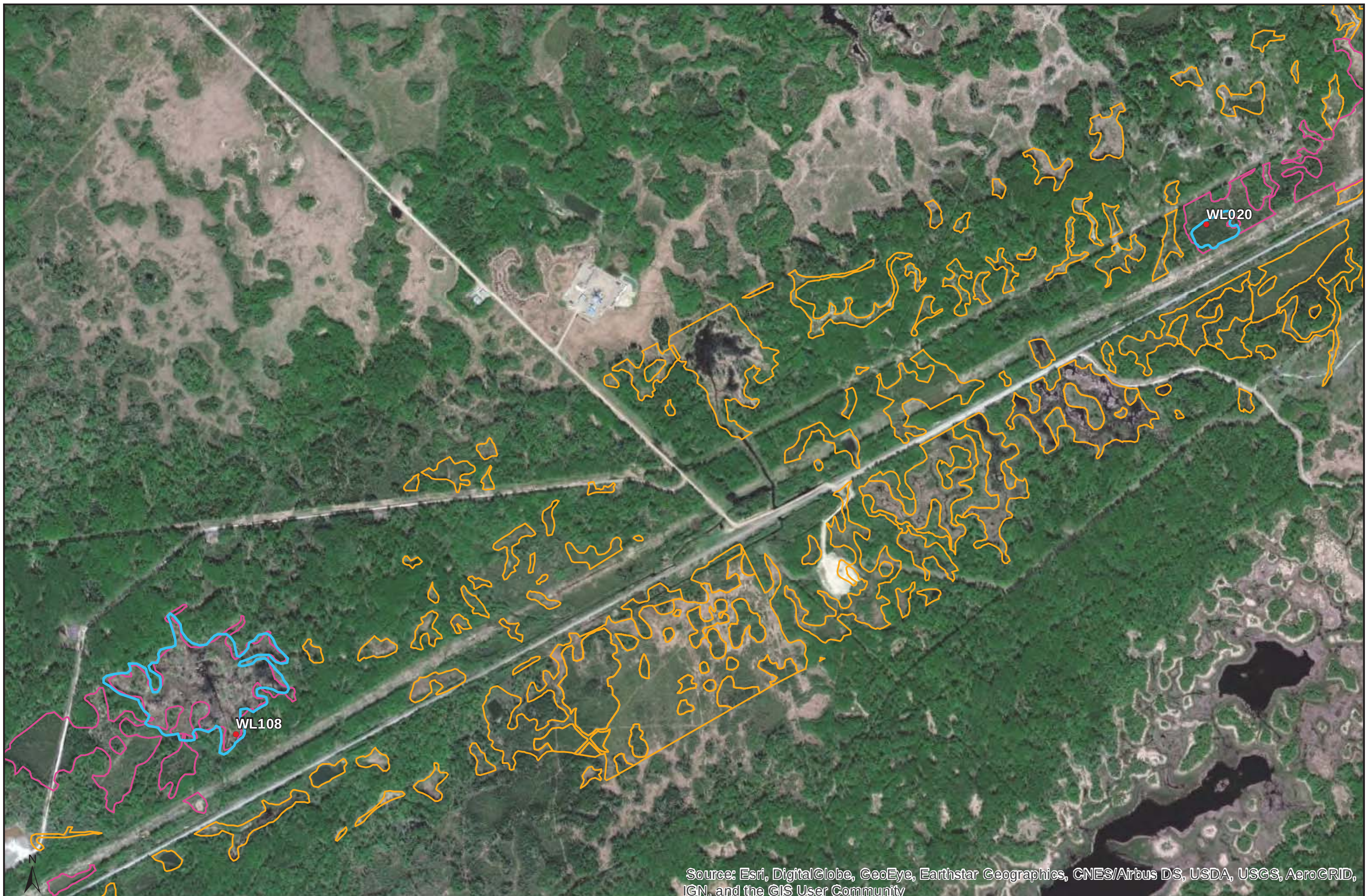
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping



Site C Project

2018 Assessed Wetlands - Transmission Line East 3

Figure A10

Date: 2018-12-10
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Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC

Legend

- Sample Sites (2018)
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

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1:15,000 Meters

Site C Project

2018 Assessed Wetlands - Transmission Line Middle

Figure A11

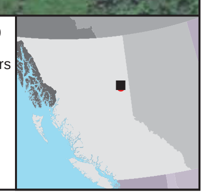
Date: 12/10/2018
Map Number: BCHWL-23
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

0 100 200
1:5,000 Meters



Site C Project

2018 Assessed Wetlands - Transmission Line Middle 2

Figure A12

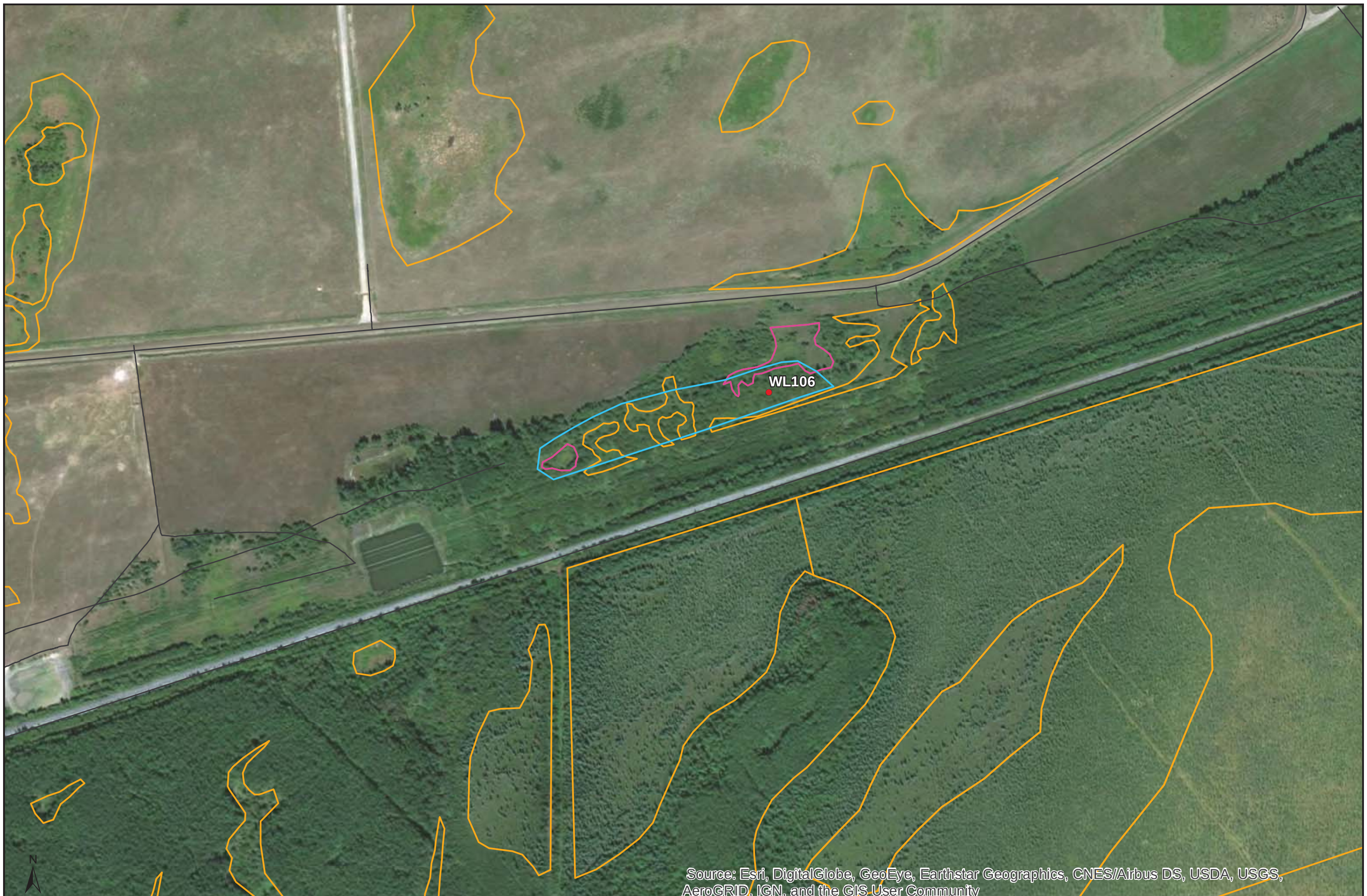
Date: 12/10/2018
Map Number: BCHWL-19
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consultants

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

0 100 200
1:5,000 Meters



Site C Project

2018 Assessed Wetlands - Transmission Line Middle 3

Figure A13

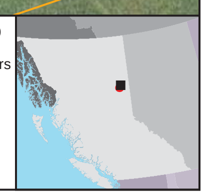
Date: 12/10/2018
Map Number: BCHWL-19
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

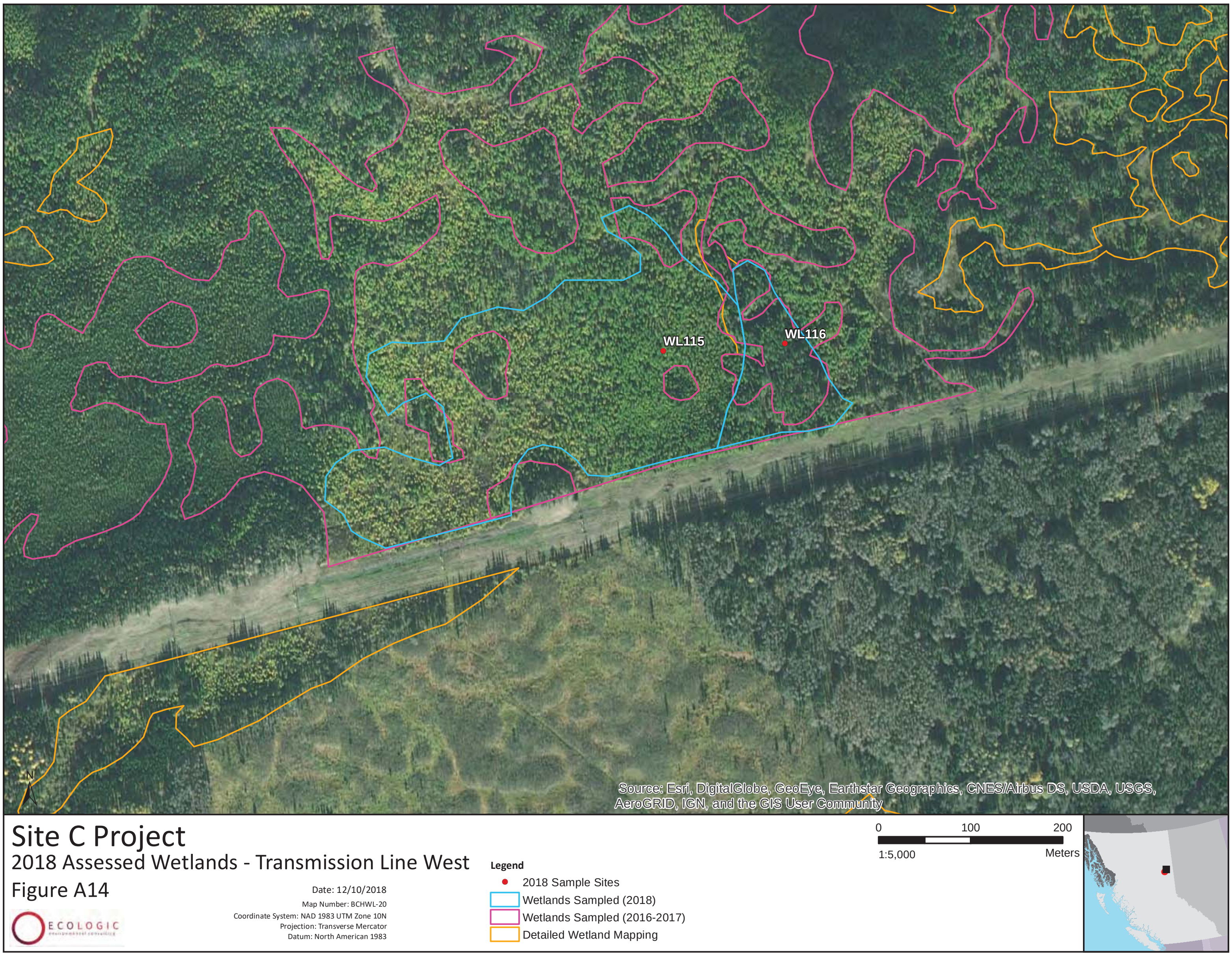
ECOLOGIC environmental consulting

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

0 100 200
1:5,000
Meters





Site C Project

2018 Assessed Wetlands - Transmission Line West

Figure A14

Date: 12/10/2018
Map Number: BCHWL-20
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

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Site C Project

2018 Assesed Wetlands - Transmission Line West 2

Figure A15

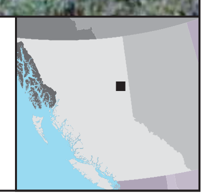
ECOLOGIC environmental consulting

Date: 12/12/2018
Map Number: BCHWL-21
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

0 150 300
1:10,000 Meters



Site C Project

2018 Assessed Wetlands - Transmission Line West 3

Figure A16

Date: 12/10/2018
Map Number: BCHWL-22
Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983

ECOLOGIC environmental consulting

Legend

- 2018 Sample Sites
- Wetlands Sampled (2018)
- Wetlands Sampled (2016-2017)
- Detailed Wetland Mapping

0 100 200
1:7,500 Meters