BC Hydro
Power smart

Vegetation and Wildlife Mitigation and Monitoring Plan 2016 Annual Report

Site C Clean Energy Project

March 31, 2017

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1.0 Background

1.1 The Site C Clean Energy Project

The Site C Clean Energy Project (the Project) will be the third dam and generating station on the Peace River in northeast B.C. The Project will provide 1,100 megawatts of capacity and about 5,100 gigawatt hours of energy each year to the province's integrated electricity system. The Project will be a source of clean, reliable and cost-effective electricity for BC Hydro's customers for more than 100 years.

The key components of the Project are:

- an earthfill dam, approximately 1,050 metres long and 60 metres high above the riverbed;
- an 83 kilometre long reservoir that will be, on average, two to three times the width of the current river;
- a generating station with six 183 MW generating units;
- two new 500 kilovolt AC transmission lines that will connect the Project facilities to the Peace Canyon Substation, along an existing right-of-way;
- realignment of six segments of Highway 29 over a total distance of approximately 30 kilometers; and
- construction of a berm at Hudson's Hope.

The Project will also include the construction of temporary access roads, a temporary bridge across the Peace River, and worker accommodation at the dam site.

The environmental assessment of the Project was carried out in accordance with the *Canadian Environmental Assessment Act, 2012* (CEAA 2012), the *BC Environmental Assessment Act* (BCEAA), and the Federal-Provincial *Agreement to Conduct a Cooperative Environmental Assessment, Including the Establishment of a Joint Review Panel of the Site C Clean Energy Project*. The assessment considered the environmental, economic, social, heritage and health effects and benefits of the Project, and included the engagement of Aboriginal groups, the public, all levels of government, and other stakeholders in the assessment process.

Detailed findings of the environmental assessment are documented in the Site C Clean Energy Project Environmental Impact Statement (EIS), which was completed in accordance with the Environmental Impact Statement Guidelines (EIS Guidelines) issued by the Minister of Environment of Canada and the Executive Director of the Environmental Assessment Office of British Columbia. The EIS was submitted to regulatory agencies in January 2013, and amended in August 2013 following a 60 day public comment period on the assessment, including open house sessions in Fort St. John, Hudson's Hope, Dawson Creek, Chetwynd, town of Peace River (Alberta) and Prince George.

In August 2013, an independent Joint Review Panel (JRP) commenced its evaluation of the EIS, and in December 2013 and January 2014 undertook five weeks of public hearings on the Project in 11 communities in the Peace region, including six Aboriginal communities. In May 2014, the JRP provided the provincial and federal governments with a report summarizing the Panel's rationale, conclusions and recommendations relating to the environmental assessment of the Project. On completion of the JRP stage of the environmental assessment, the Canadian Environmental Assessment Agency (CEA Agency) and British Columbia Environmental Assessment Office (BCEAO) consulted with Aboriginal groups on the JRP report, and finalized key documents of the environmental assessment for inclusion in a Referral Package for the Provincial Ministers of Environment and Forests, Lands and Natural Resource Operations.

Construction of the Project is also subject to regulatory permits and authorizations, and other approvals. In addition, the Crown has a duty to consult and, where appropriate, accommodate Aboriginal groups.

1.2 Environmental Assessment Findings

The environmental assessment of the Project focused on 22 valued components (VCs), or aspects of the biophysical and human setting that are considered important by Aboriginal groups, the public, the scientific community, and government agencies. In the EIS, valued components were categorized under five pillars: environmental, economic, social, heritage and health. For each VC, the assessment of the potential effects of the Project components and activities during construction and operations was based on a comparison of the biophysical and human environments between the predicted future conditions with the Project, and the predicted future conditions without the Project.

Potential adverse effects on each VC are described in the EIS along with technically and economically feasible mitigation measures, their potential effectiveness, as well as specific follow-up and related commitments for implementation. If a residual effect was found on a VC, the effect was evaluated for significance. Residual effects were categorized using criteria related to direction, magnitude, geographic extent, context, level of confidence and probability, in accordance with the EIS Guidelines.

The assessment found that the effects of the Project will largely be mitigated through careful, comprehensive mitigation programs and ongoing monitoring during construction and operations. The EIS indicates that the Project is unlikely to result in a significant adverse effect for most of the valued components. However, a determination of a significant effect of the Project was found on four VCs: Fish and Fish Habitat, Wildlife Resources, Vegetation and Ecological Communities, and Current Use of Lands and Resources for Traditional Purposes.

1.3 Environmental Assessment Conclusion

On October 14, 2014, the Provincial Ministers of Environment and of Forests, Lands and Natural Resource Operation decided that the Project is in the public interest and that the benefits provided by the Project outweigh the likely risks of significant adverse environmental, social and heritage effects (http://www.newsroom.gov.bc.ca/2014/10/site-c-project-granted-environmental-assessment-approval.html). The Ministers have issued an Environmental Assessment Certificate setting conditions under which the Project can proceed.

Further, on November 25, 2014, The Minister of Environment of Canada issued a Decision Statement confirming that, while the Project has the potential to result in some significant adverse effects, the Federal Cabinet has concluded that those effects are justified in the circumstances. The Decision Statement sets out the conditions under which the Project can proceed.

1.4 Development of Mitigation, Management and Monitoring Plans

Mitigation, management and monitoring plans for the Project have been developed taking into account the measures proposed in the EIS, information received during the Joint Review Panel hearing process, the Report of the Joint Review Panel on the Project and consultation with Environment Canada, Canadian Wildlife Services, Ministry of Environment and Ministry of Forests Lands and Natural Resources. Those plans are consistent with, and meet requirements set out in, the conditions of the Environmental Assessment Certificate and of the Decision Statement issued on October 14, 2014 and November 25, 2014 respectively.

In addition, in accordance with environmental best practices (Decision Statement Condition 3.1), these plans were informed by the best available information and knowledge, based on validated methods and models, undertaken by qualified individuals and apply the best available economically and technologically feasible mitigation strategies. These plans contain provisions for review and update as new information on the effects of the Project and on the efficacy of the mitigation measures become available.

The mitigation measures proposed by BC Hydro, and their likely success, were taken into account in the environmental assessment to determine the residual adverse effects of the Project on Vegetation and Ecological Communities and Wildlife Resources (see EIS Sections 13 and 14 on Vegetation and Ecological Communities and Wildlife Resources, respectively). As described in the EIS, the Project's adverse effect on these valued components will be significant, and mitigation cannot fully address these effects. In cases where the proposed mitigation measures are considered to be uncertain, the predicted effects of the Project on the target species will not exceed the effects predicted in the EIS.

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 2016 to meet the requirements of Decision Statement conditions 9, 10, 11, 16 and 18 and Environmental Assessment Certificate 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, are listed in Tables 1 and 2 below.

Note that the requirements of Environmental Assessment Certificate 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. They are, therefore, not addressed in this report.

Requirements of Decision Statement condition 16.3.1 and the following parts of Environmental Assessment Certificate conditions 9 and 15 were fulfilled in 2015 and results reported in the 2015 annual report and are not addressed in this report:

- Condition 9: Surveys of existing invasive species populations prior to construction. (Section 7.1.1 of the 2015 annual report)
- Condition 9: Rare and Sensitive community identification (Section 7.1.3 of the 2015 annual report)
- Condition 15: Verification of modelled results (Section 7.3.1 of the 2015 annual report)

Table 1. Federal Decision Statement Conditions and Relevant Report Section

Decision Statement Condition	Condition	Plan Reference
9.	Disturbance and destruction of migratory birds	Section 6.1 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
9.3.	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 6.1.2 Condition 9.3

Decision Statement Condition	Condition	Plan Reference
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;	Section 6.1.3 Condition 9.9
10.	Non-wetland migratory bird habitat	Section 6.2 Decision Statement Condition 10
10.3	The plan shall include:	
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 6.2.1 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 purposes by Aboriginal peoples; and	Section 6.2.2 Condition 10.3.5
11.	Wetlands used by migratory birds and for current use of lands and resources for traditional purposes	Section 6.3 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
11.4	The plan shall include:	
11.4.2.	mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost;	Section 6.3.3 Condition 11.4.2
11.4.3.	an approach to monitor and evaluate any changes to baseline conditions, as defined in condition	Section 6.3.4 Condition 11.4.3

Decision Statement Condition	Condition	Plan Reference
	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	Section 6.3.5 Condition 11.4.4
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 6.3.6 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 6.3.7 Condition 11.9
16	Species at risk, at-risk and sensitive ecological communities and rare plants	Section 6.4 Decision Statement Condition 16
16.3.	The plan shall include:	
16.3.2	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.	
16.3.3.	measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;	Section 6.4.2 Condition 16.3.3
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;	Section 6.4.3 Condition 16.3.5
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-	Section 6.4.4 Condition 16.3.6

Decision Statement Condition	Condition	Plan Reference
	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.	Section 6.4.5 Condition 16.3.7

Table 2. Environmental Assessment Certificate Conditions and Relevant Plan Sections.

EAC Condition	Condition	Plan Reference
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:	
	Rare Plants and Sensitive Ecosystems	
	• 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 7.1.1 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	Section 7.1.2 Spatial Database of Known Rare Plant Occurrences

EAC Condition	Condition	Plan Reference
	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.	Section 7.1.3 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 7.1.4 Protect tufa seeps, wetlands and rare plants located adjacent to construction areas
10	The EAC Holder must fund or undertake directly with the use of a Rare Plant Botanist the following, during construction:	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 by the MOEs Conservation Framework requiring additional inventories	Section 7.2.1 Targeted rare plant surveys in the RAA
12	The EAC Holder must develop a Wetland Mitigation and Compensation Plan.	Section 7.3 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 7.3.1 Wetland Mitigation and Compensation
	The Wetland Mitigation and Compensation Plan must include at least the following:	
	• If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;	Section 7.3.1.1 Installation of culverts to maintain hydrological balance at wetlands affected by roads
	• Stormwater management will be designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur.	Section 7.3.1.2 Stormwater management

EAC Condition	Condition	Plan Reference
	• 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.	Section 7.3.1.2 Site-specific mitigation measures for 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).	Section 7.4.1.3 Implementation of Approved work practices and Develop with Care
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 7.4
	Definition of the study design for the rare plant translocation program (see condition 9).	7.4.1 Definition of the study design for the 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.	7.4.2 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.	7.4.3 Measurement criteria for translocated plants
	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:	

EAC Condition	Condition	Plan Reference
	• Measures to avoid, if feasible, constructing in sensitive wildlife habitats. If avoiding sensitive wildlife habitats is not feasible, condition 16 applies.	Section 7.5.1 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 7.5.2 Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.
	• Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.	Section 7.5.3 Mitigation of adverse effects to wildlife
	• 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 7.5.4 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.	Section 7.5.5 Environmental training of workers
	The EAC Holder must ensure that all workers are familiar with the Wildlife Management Plan.	Section 7.5.6 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 7.6 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.	Section 7.6.1 Management of EAC Holder-owned lands

EAC Condition	Condition	Plan Reference
	• 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 7.6.2 A design for bat roosting habitat in HWY 29 bridges
	• 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 7.6.3 Cold weather rest 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 7.7
	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.	
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 7.8 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 7.8.1 Monitoring of Bald Eagle nesting populations
	• Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.	Section 7.8.2 Monitoring waterfowl and shorebird populations
	• Survey songbird and ground-nesting raptor populations during construction and operations	Section 7.8.3 Survey songbird and ground-nesting raptor populations

EAC Condition	Condition	Plan Reference
	• Require annual reporting during the construction phase and during the first 10 years of operations to EAO, beginning 180 days following commencement of construction.	Section 7.8.4 Annual reporting beginning 180 days following 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 7.9 EAC Condition 23

3.0 Consultation

Consultation regarding the development and implementation of individual programs conducted in 2016 is provided below.

3.1 Canadian Wildlife Services

In 2016 BC Hydro continued to consult with Canadian Wildlife Services during plan development and implementation. The majority of the consultation occurred as part of the Vegetation and Wildlife Technical Committee established by the Comptroller of Water Rights under Conditional Water Licences 132990 and 132991. Details are provided in section 3.4 below.

Consultation with Canadian Wildlife Services with regard to the November 18, 2015 Transmission Line Collision Risk Assessment and the January 8, 2015 Wetland Function Assessment continued in 2016.

Bird-Transmission Line Collison Risk Assessment: BC Hydro received comments from Environment Canada on the November 18, 2015 Bird-Transmission Line Collision Risk Assessment on April 13, 2016. BC Hydro finalized the document taking into consideration comments received from Environment Canada (see Section 6.1.3 below). The document is provided in

Appendix 1.

Wetland Function Assessment: On January 8, 2016 BC Hydro met with representatives of Environment Canada (EC) and the Canadian Wildlife Services (CWS), the Ministry of Forests Lands and Resource Management (FLNRO) and the Ministry of Environment (MOE) to discuss the revised draft Wetland Function Assessment (Appendix 7). Comments on this revised document were received on July 8, 2016, October 28, 29 and 31, 2016.

The function assessment was revised taking into consideration comments received from agencies in July and October of 2016. The revised document was provided to FLNRO, MOE and CWS for review on December 28, 2016. On January 20, 2017 BC Hydro met with representatives of FLNRO, MOE and CWS to review the revised document.

3.2 Consultation with the Province

To meet the request of the BC Comptroller of Water Rights for a process to provide ongoing provincial engagement with respect to the implementation of vegetation and wildlife mitigation and monitoring programs, BC Hydro, MOE and FLNRO established a Vegetation and Wildlife Mitigation and Monitoring Technical Committee (VWTC). The province requested that this Technical Committee be formed, to facilitate overall governance between BC and BC Hydro over the Technical Committee, 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.

In 2016 the VWTC met in person or via conference call fourteen (14) times between April and December 2016 to address Program Areas as 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, 2016.

Table 3. Status of Schedule A Program Areas as of December 31, 2016.

Program Area	Status as of December 1, 2016
Completed	
1. Ungulates	Complete
7. Eagles	Complete
9. Ground Nesting Raptors	Complete
10. Cavity Nesting Species	Complete
13. Lighting Effects	Complete
14. Carnivore Den Sites	Complete
15. Other Raptors	Complete
In Progress	
2. Wetlands and Riparian Habitat	In progress
4. Bats	In progress
6. Amphibians	In progress

8. Breeding and Migratory Birds	In progress
11. Rare Plants	In progress
12. Sharp-tailed Grouse	In progress
16. Other Species at Risk	In progress
Not Started	
3. Fisher	Not started
5. Snake	Not started

4.0 Qualified professionals

The following Qualified Professionals were involved in development and implantation of programs in 2016:

Qualified Individual	Area of Work
K. Anré McIntosh, R.P.Bio. P.Ag, PMP BC Hydro	Vegetation and Wildlife
Randy Krickbaum, M.Sc., P.Biol., R.P.Bio, Eagle Cap Consulting	Pre-construction rare plant surveys
Lisette Ross, M.Sc., Native Plant Solutions	Wetland Function assessment, Waterfowl and shorebird spring migration surreys
Llwellyn Armstrong Native Plant Solutions	Statistician
Darryl Kroeker, M.Sc., Ducks Unlimited Canada	Wetlands, wetland birds
Claudio Bianchini, R.P. Bio., Bianchini Biological Services	Breeding bird and raptor monitoring
Jeff Matheson, M.Sc., R.P.Bio., Tetra Tech Canada Inc.	Breeding bird and raptor monitoring
Nick Bartok, M.Sc., R.P.Bio., Tetra Tech Canada Inc.	Breeding bird and raptor monitoring
Kayla Hatzel, M.Sc., B.I.T., Tetra Tech Canada Inc.	Breeding bird and raptor monitoring
Natasha Bush, P.Ag., Ecologic	Rare plant translocation and rare plant survey program
Dan McAllister, M.Sc., P.Ag., Ecologic	Rare plant translocation and rare plant survey program
Jamie Fenneman, Ph.D. candidate, R.P.Bio., Ecologic	Rare plant translocation and rare plant survey program
Terry McIntosh, Ph.D., Ecologic	Rare plant translocation and rare plant survey program
Ryan Durrand, R.P.Bio., Ecologic	Rare plant translocation and rare plant survey program
Charlie Palmer M.Sc., P,Biol., R.P.Bio., Hemmera Envirochem	Cavity Nesting Birds work-plan, Waterfowl work-plan and waterfowl monitoring surveys, Shorebird work-plan
Andrew Venning, B.Sc., R.P.Bio. , Hemmera Envirochem	Cavity Nesting Birds work-plan
Brian Paterson, B.Eng, R.P.Bio. , Hemmera Envirochem	Waterfowl work-plan and waterfowl monitoring surveys
James Rourke, M.Sc., R.P.Bio. , Hemmera Envirochem	Shorebird work-plan
Kyle Routledge, B.Sc., BiT., Hemmera Envirochem	Western Toad (downstream) work-plan
Toby St.Clair, M.Sc. , Hemmera Envirochem	Shorebird work-plan

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 Decision Statement conditions; Section 7.0 describes those measures that were implemented to meet the requirements of the Environmental Assessment Certificate conditions (EAC). Cross-references are provided in Section 7.0 where information provided to meet the Environmental Certificate conditions is the same as that provided for the Decision Statement conditions (DS).

Several of the programs outlined in the Vegetation and Wildlife Mitigation Plan were not implemented in 2016. Table 3 below outlines which programs were not implemented, when they will be implemented and reported in subsequent annual reports.

Table 4. Summary of programs not implemented in 2016

Condition Number	Program to be Implemented	Implementation Year	Inclusion in Annual Report
DS 10.3.3	Littoral zone enhancements	2019	2019
	Riparian plantings	TBD	TBD
EAC 11	Assistance to habitat enhancement projects in the RAA	2017	2017
EAC 16	Construction of artificial snake hibernacula	2017	2017
	Creation of bat hibernacula at Portage Mountain	TBD	TBD
EAC 21	Monitor amphibian use of migration crossing structures	TBD	TBD
	Downstream surveys for western toad and garter snake	2019	2019

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

Conditions 9, 10, 11, and 16 of the Decision Statement, 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.

The following programs implemented or continued in 2016 are described in the subsequent sections of this report:

- Section 6.1 Decision Statement Condition 9
    - *Section 6.1.1* Avoidance of disturbance to migratory birds and their nests (Decision Statement 9.1)
    - *Section 6.1.2* Waterfowl and Shorebird monitoring (Decision Statement 9.3)
    - *Section 6.1.3* Transmission Collision Risk assessment (Decision Statement 9.9: 9.9.1
- Section 6.2 Decision Statement Condition 10
    - *Section 6.2.1* Compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with Canada Warbler,

the Cape May Warbler and the Bay-breasted Warbler (Decision Statement 10.3.4)
    - *Section 6.2.2* 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 (Decision Statement 10.3.5)
- Section 6.3 Decision Statement Condition 11
    - *Section 6.3.1* 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 (Decision Statement 11.1)
    - *Section 6.3.2* 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 (Decision Statement 11.2)
    - *Section 6.3.3* mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost (Decision Statement 11.4.2)
    - *Section 6.3.4* 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. (Decision Statement 11.4.3)
    - *Section 6.3.5* 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.(Decision Statement 11.4.4)
    - *Section 6.3.6* 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 (Decision Statement 11.8)
    - *Section 6.3.7* 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 (Decision Statement 11.9)
- Section 6.4 Decision Statement Condition 16
    - *Section 6.4.1* surveys to determine whether the rare plant species potentially facing extirpation in the Project Activity Zone are found elsewhere in the region (Decision Statement 16.3.2)
    - *Section 6.4.2* measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants (Decision Statement 16.3.3)
    - *Section 6.4.3* 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 (Decision Statement 16.3.5)
    - *Section 6.4.4* 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 (Decision Statement 16.3.6)
    - *Section 6.4.5* 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 (Decision Statement 16.3.7)

6.1 Decision Statement Condition 9: Migratory Bird Mitigation and Monitoring

This section of the annual report summarizes the programs conducted in 2016 in accordance with the requirements of Decision Statement 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 and EAC Condition 17 BC Hydro has, where feasible given Project requirements, scheduled vegetation clearing during the Peace Region terrestrial wildlife least-risk windows for birds, as identified by BC and Environment Canada (Region 6). 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 the Vegetation Clearing and Debris Management Plan (Section 3.5.1).

A breeding season pre-clearing nest survey methodology was developed which outlines specific field procedures to be followed to passively identify the presence of active bird nests within areas scheduled to be cleared outside of avian least-risk windows, as well as specific buffers to be applied in the event active bird nests are identified. This protocol was updated in 2016 to incorporate site specific learnings. The revised methodology is provided in Appendix 2.

In 2016 pre-clearing nest surveys were completed between February and August on the left and right banks at the dam site, at Portage Mountain and along the transmission line right-of-way. If active or suspected nest areas were identified, then protective buffers were established around the nest area. In some cases, mitigation strategies were developed and implemented to allow work activities to continue while ensuring that modified buffered nest areas were not unduly impacted and breeding activities were not compromised.

After each area was surveyed a free-to-work survey report was produced. The report mapped the area surveyed and indicated 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. A sample free-to-work status report is provided in Appendix 3. Within the areas surveyed 94 active nests within and adjacent to work zones were found and buffered.

Six mitigation strategies (see Appendix 3) were developed between May and August 2016 and were implemented to allow for work activities to continue at a time when mitigation procedures would not cause undue disturbance to known active bird nests. Mitigation protocols and guidelines were produced to provide direction on how best to proceed with developing and implementing mitigation strategies. Mitigation strategies included: modifying buffer sizes and shapes with subsequent monitoring, installing visual screening with subsequent monitoring, and frequent work site monitoring to identify unused potential nesting habitat that could be modified or removed to discourage re-nesting. Twice during the nesting season modifications were required for existing nest buffers. In both cases, a formal assessment to determine any potential impacts to bird nesting activities was conducted prior to any buffer alterations

The species and number of nests for which buffers were installed were:

- four (4) Bald Eagle
- six (6) Common Raven

- twenty-one (21) Song Sparrow
- fourteen (14) American Robin
- twelve (12) Lincoln's Sparrow
- eleven (11) White-throated Sparrow
- seven (7) Eastern Phoebe
- seven (7) Killdeer
- six (6) Dark-eyed Junco
- five (5) Spotted Sandpiper
- one (1) Cedar Waxwing

6.1.2 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.*

6.1.2.1 Spring waterfowl surveys

Spring waterfowl and shorebird surveys along the Peace River and adjacent large lakes were conducted on March 30, April 20 and May 17, 2016. Five transects were surveyed by fixed-wing aircraft (Figure 1). The survey flights were conducted using a single engine Cessna 206 flying at 152.4 m and a speed of 150 km/h. The Peace River main stem was the only open body of water observed during the March 30 survey.

A total of 2166 individuals of eight waterfowl species were observed. The number of observed was similar between the three survey periods, with the second survey having species than the first and third (
Table 5). The number of individual birds detected was highest on the first survey and lowest on the second survey (Table 6).

Figure 1. Spring and Fall Migration Survey Transects.

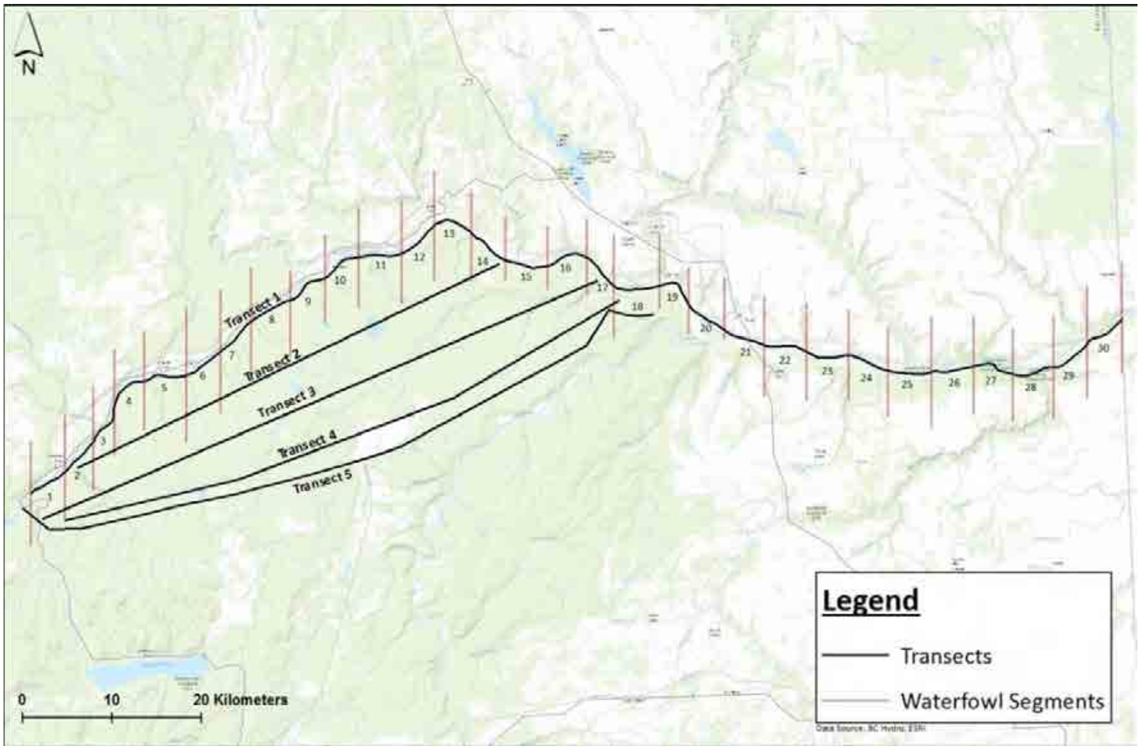

Table 5. Species Observed During Spring 2016 Waterfowl and Shorebird Surveys

Species		Species Abundance by Survey				
Common Name	**Scientific Name**	**March 30**	**April 20**	**May 17**	**Total**	**% of total observations**
Bufflehead	*Bucephala albeoloa*	202	131	128	461	21
Blue-winged teal	*Anas discors*	72	56	62	190	9
Canada goose	*Branta canadensis*	855	75	267	1197	55
Canvasback	*Aythya valisineria*	14	0	14	28	1
Common goldeneye	*Bucephala clangula*	0	1	0	1	<1
Gadwall	*Anas strepera*	2	0	0	2	<1
Mallard	*Anas platyrhynchos*	3	39	13	55	2.5
Trumpeter swan	*Cygnus buccinator*	10	66	36	112	5
Unidentified gull		7	0	36	43	2
Unidentified scaup		0	2	4	6	<1
Unidentified duck		18	7	37	62	3
Unidentified shorebird		0	0	9	9	<1
Total		**1183**	**377**	**606**	**2166**	

The most commonly detected species was the Canada goose, making up 55% (n=1197) of all observations. The next most common species was the bufflehead (21%, n=461), followed by the blue-winged teal (8.7%, n=190) and trumpeter swan (5%, n=112). The remaining four species made up 3% or less of the observations (Table 6).

Waterfowl observations were linked to 16 different habitat types (Table 6). The widest use of habitats was seen during survey 2. Survey 1 had the fewest habitats used. All habitats were used minimally in relation to the Peace River (Table 5). Based on Shannon-Wiener diversity index calculations, which take into account both species richness and abundance, Labrador tea-sphagnum habitat (BT) had the most individuals of the most species, followed by the lingonberry-coltsfoot (BL), then red-osier dogwood (FM02). Current-bluebells (SC) habitat had diversity indices of zero, which means it was used by a few species (n=1, trumpeter swan) with low abundances.

The survey of transect one, the Peace River, was divided into 30 segments with segments both upstream and downstream of the proposed dam site. 75% (n=1314) of the waterfowl observations occurred upstream of the dam site. The highest abundance of waterfowl was detected during the first survey, upstream of the dam (n=919), followed by survey 1, downstream of the dam (n=269) then survey 3, upstream of the dam (n=238). Average count/segment followed the same order. The Shannon-Wiener diversity index showed that diversity between upstream and downstream sections were not significantly different. Only survey 1 had a large decrease in diversity in the upstream portion. The diversity was also not significantly different between the three surveys.

Transects 2-5 sampled wetland use by migrating waterfowl. Multiple wetland types were present and several were used by various species. Observations of wetland use by waterfowl during spring migration include:

- All wetlands, including large lake habitats, were frozen and therefore unavailable for early migrating waterfowl to use during the first spring survey.
- Labrador tea-sphagnum bogs, followed by lingonberry-coltsfoot habitat had the highest diversity of all habitats.
- Common goldeneyes were only seen on sedge wetlands.
- Gadwalls exclusively used red osier dogwood habitats.

The 2016 spring waterfowl and shorebird survey report provided in Appendix 5.

Table 6. Number of Waterfowl Observations by Habitat: Spring 2016.

Species	Habitat															
Common Name	**AM**	**BL**	**BT**	**CF**	**Fm02**	**GB**	**LA**	**PD**	**RI**	**SC**	**SE**	**SH**	**SW**	**TS**	**WH**	**WS**	**Grand Total**
Bufflehead	11	4	43		19	20	104	2	201		14	4	35	3	1		461
Blue-winged teal	6		6	5	23	3	5		57		39			40	6		190
Canada goose	5	1			72	145	2	1	760		3	10	18		180		1197
Canvasback	1		8		1	1	1		16								28
Common Goldeneye											1						1
Gadwall					2												2
Trumpeter swan	7	4	4	7	3	8	9		37	2	8	2		13	4	4	112
Mallard	4		6		5		5	5	14	6	2	8					55
Unidentified gull	2		20		4	8			9								43
Unidentified scaup					4									2			6
Unidentified duck	8	5	2			4			32		2			2		7	62
Unidentified shorebird									9								9
Grand Total	**12**	**20**	**95**	**12**	**133**	**189**	**137**	**8**	**1136**	**2**	**69**	**24**	**53**	**74**	**191**	**11**	**2166**

6.1.2.2 Summary of fall waterfowl surveys

Fall waterfowl and shorebird surveys were conducted on September 12 and October 12 2016. Five transects were surveyed by fixed-wing aircraft (Figure 1). The survey flights were conducted using a single engine Cessna 180 flying at 150 km/hr and heights of 500m. A third survey was unable to be conducted due to persistent unsuitable conditions (low cloud, fog and rain) for surveys during the fall 2016 migration period.

A total of 6,219 individual birds of 13 species were detected across all surveys, with the most individuals observed during the October survey (Table 7). Based on comments received during discussions with the Vegetation and Wildlife Technical Committee, beginning in the fall of 2016, bird observed along the Peace River transect (Transect 1) were categorized based on their observed position on the river. The most commonly observed position was ‘side channel’ (45%, n=1,624), followed by ‘flying’ (26%, n=931) and ‘gravel bar’ (10%, n=377).

Waterfowl observations recorded during 2016 waterfowl surveys were grouped by habitat type using TEM mapping. The most commonly used habitat type (Table 8), within 200m of each observation, was river (47%), followed by white spruce-current-bluebells (15%) and white spruce-trembling aspen-step moss (11%). 59% (n=3,646) of all bird observations were located along the Peace River. The most commonly observed species on the Peace River was Canada goose (66% of birds on Transect 1, n=2,419), followed by unidentified duck (16%, n=588) and American wigeon (6%, n=220).

Table 7. Species Observed During Fall 2016 Waterfowl and Shorebird Surveys.

Species		**Species Abundance by Survey**			
Common Name	**Scientific Name**	**September 12**	**October 12**	**Total**	**% of total observations**
American wigeon	*Anas americana*	0	250	250	4
Belted kingfisher	*Megaceryle alcyon*	1	0	1	<1
Bufflehead	*Bucephala albeoloa*	6	296	302	4.9
Canada goose	*Branta canadensis*	1495	1690	3185	51.4
California Gull	*Larus californicus*	5	0	5	<1
Common goldeneye	*Bucephala clangula*	6	223	229	3.7
Common loon	*Gavia immer*	1	0	1	<1
Common merganser	*Mergus merganser*	12	1	13	<1
Franklin’s Gull	*Leucophaeus pipixcan*	181	0	181	2.9
Mallard	*Anas platyrhynchos*	9	574	583	9.4
Northern Shoveler	*Anas clypeata*	0	32	32	<1
Spotted Sandpiper	*Actitis macularius*	1	0	1	<1
Trumpeter swan	*Cygnus buccinator*	102	41	143	2.3
Unidentified duck		452	763	1215	19.6
Unidentified gull		41	16	57	<1
Unidentified bird		20	0	20	<1
Unidentified shorebird		1	0	1	<1
Total		**2311**	**3637**	**6298**	

Use of wetlands by fall migrants included:

- use of Tamarack sedge (TS), Willow-sedge (WS) and Black spruce-Labrador tea-sphagnum (BT) wetlands by Trumpeter Swan
- use of BT wetlands by American Wigeon, Bufflehead, Common Goldeneye and Trumpeter Swan
- use of Willow-horsetail-sedge wetlands (WH) by Canada Geese, Common Goldeneye and unidentified ducks
- use of sedge wetlands (SE), by unidentified ducks

The 2016 fall waterfowl and shorebird survey report provided in Appendix 6.

Table 8. Waterfowl Usage by Habitat Type, Fall 2016.

Habitat Type	Habitat Code	Relative Waterfowl Usage (%)	Number of Birds Observed*
White spruce-trembling aspen-step moss	AM	10.96%	681
Black spruce-lingonberry-coltsfoot	BL	1.21%	75
Black spruce-Labrador tea-sphagnum	BT	1.54%	96
Cutbank	CB	0.10%	6
Cultivated field	CF	0.02%	1
Cottonwood-white spruce-red-osier dogwood	Fm02	4.50%	280
Gravel bar	GB	1.66%	103
Lake	LA	10.42%	648
Lodgepole pine-lingonberry-velvet-leaved blueberry	LL	1.16%	72
Pond	PD	0.03%	2
River	RI	46.51%	2891
White spruce-currant-bluebells	SC	14.56%	905
Sedge wetland	SE	0.87%	54
White spruce-currant-horsetail	SH	0.97%	60
White spruce-currant-oak fern	SO	0.05%	3
White spruce-wildrye-peavine	SW	0.85%	53
Tamarack-sedge	TS	0.03%	2
Willow-horsetail-sedge	WH	4.54%	282
Willow-sedge	WS	0.03%	2

*shorebirds and kingfishers removed from habitat analysis in order to show waterfowl only

6.1.3 Condition 9.9

This section summarizes actions taken in accordance with the following requirement of Condition 9.9: *The Proponent shall address potential risks of bird collisions with the transmission line, in consultation with Environment Canada, by:*

9.1.1. conducting a risk assessment for bird collisions under the current transmission line design;

The final Collision Risk Assessment is provided in

Appendix 1. In response to comments received from Environment Canada on April 13, 2016 the following changes were made to the collision risk assessment:

- Adjacent land use was added as a landscape feature associated with collisions
- Foraging and perching behaviours were added to characteristics of bird biology associated with collisions
- Clarification on how landscape features associated with increased collision risk along the right-of-way were identified
- The following species at risk were added to the assessment: Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler and Nelson's Sparrow
- The structural features section was updated to address the tower types selected for the new lines
- An analyses incorporating wetland density, as opposed to wetland presence was conducted. The results were not qualitatively different than the results based on wetland presence.

Bird density and abundance were not incorporated into the analysis as these data are not available at sufficient resolution for entry into the habitat models.

It was not possible to expand the analysis to include non-habitat (e.g., weather) or non-topographic features (e.g., crop type in adjacent lands, foraging behavior) into the spatially explicit analysis as the necessary data were either not available or were not available at a useable spatial scale.

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

This section of the annual report summarizes the applicable components of the Vegetation and wildlife mitigation and monitoring plan implemented to fulfill Decision Statement Condition 10 in 2016 in accordance with the requirements of Decision Statement condition 10.8. For context, the complete requirements of 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 10.3.4

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

BC Hydro continues to manage the three properties (Marl Fen, Rutledge and Wilder Creek) retained to provide habitat for non-wetland migratory birds. No new properties were added to the program in 2016.

In 2016 the two wells were drilled on the Marl Fen property stop the withdrawal of water from the wetland to support the grazing cattle.

6.2.2 Condition 10.3.5

This section summarizes actions taken in accordance with the following requirement of Condition 10.3.4: *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 case of BC Hydro, lease lands by the leaseholder.

6.3 Decision Statement Condition 11

This section of the annual report summarizes the components of the Vegetation and wildlife mitigation and monitoring plan implemented to fulfill Decision Statement Condition 11 in 2016 in accordance with the requirements of Decision Statement condition 11.9. For context, the complete requirements of 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 location and boundaries of wetland habitats along the transmission line right-of-way were field truthed, their boundaries flagged and coordinates recorded using GPS. Riparian Vegetation Management Areas (RVMA) /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 the RVMA. Vegetation with a normal mature height less than 3 m and conifers less than 2m will not be removed from the RVMA.

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 6.3.2.1 below.

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.*

6.3.2.1 Wetland Mitigation

Please refer to Section 3.0 for information on consultation undertaken in 2016 for development of the wetland function assessment component of the wetland mitigation plan.

In 2016 BC Hydro revised the wetland function assessment. The final assessment was reviewed by CWS, MOE and FLNRO on January 20, 2017. The wetland function assessment is provided in Appendix 7.

In 2016 BC Hydro entered into exploratory discussions with several private land owners regarding the potential to carry out wetland mitigation works on their fee simple lands. BC Hydro will continue these discussions in 2017 and hopes to identify 2-3 opportunities to include in the Wetland Mitigation Program.

6.3.2.2 Current Use

Doig River First Nations (DRFN) and McLeod Lake Indian Band (MLIB) conducted ground-truthing activities in 2016. Ground-truthing information received from DRFN specifically noted that DRFN members harvested medicinal plants and berries, such as Saskatoon's, in the Watson Slough/Bear Flats area. Similarly, when MLIB ground-truthed the wetland habitat at Watson Slough it was advised that the area was widely used by ungulates, squirrels and birds, as well as insects. MLIB also identified a number of mosses, lichens, sedges, grasses, and berries (including bog cranberry, currant, gooseberry and raspberry) that were generally used by MLIB, however no information was provided as to specific MLIB use of the area.

6.3.3 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 (see Section 7.3.1.1 below) and installation of special management/ no disturbance buffers around wetlands.

6.3.4 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.

Please refer to Section 6.1.2.1 and 6.1.2.2 above for details on spring and fall waterfowl and shorebird surveys conducted in 2016. Data collected during these surveys builds on the pre-disturbance baseline data against which changes will be monitored against.

6.3.5 Condition 11.4.4

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

Please see Section 6.3.2.1 above for details on the wetland mitigation program and function assessment.

6.3.6 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 6.2.1 for details on implementation of the compensation measures in 2015, the first year of construction.

6.3.7 Condition 11.9

This section summarizes actions taken in accordance with the following requirement of Condition 11.8: 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.

The following amendments were made to the 2015 plan based on survey results and consultation with CWS, FLNRO and MOE:

- Based on results of 2016 surveys and in consultation with FLNRO, MOE and CWS BC Hydro will develop and implement a ground based survey program to document the presence and use of habitat by shorebirds (See Sections 6.1.2.1 and 6.1.2.2). The need to develop this program was identified upon review of the data collected and the paucity of shorebird observations collected under the current survey program.

- The two plant species potentially extirpated by the Project have been added to the Regional Rare plant survey program (See Section 6.4.1) to expand the area searched for their presence.

6.4 Decision Statement Condition 16

This section of the annual report summarizes the programs implemented in 2015 in accordance with the requirements of Decision Statement condition 16.6.

For context, the complete requirements of 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 16.3.2

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

Surveys for the two species potentially facing extirpation in the Project Activity Zone were carried out within the Project Footprint and within the Peace Region:

- The three known occurrences of persistent sepal yellowcress were visited. No plants documented.
- The one known occurrence of peace daisy was visited, 5.7km of transects were surveyed in and around the occurrence and one plant was documented.
- No additional occurrences of either species were documented within the Peace Region during regional surveys (see Section 7.2.1).

6.4.2 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 2016 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 on roads and portions of the transmission line corridor not surveyed during baseline surveys (described below)
- Development and inclusion in the CEMP R4 of mitigation measures to be implemented when construction occurs within 2km of Sharp-tailed Grouse leks (described below)
- Completion of amphibian salvages (described below)
- Implementation of a buffer zone around a rare plant occurrence within the Portage Mountain Quarry
- Inclusion in the CEMP R4 of fisher dens as sensitive environmental features that require buffering when occupied
- Implementation of protection measures in CEMP (See Section 6.3.1 above)
- The Environmental Features Map was updated with the 2016 rare plant data on September 1, 2016 and posted in the data room for contractors to access in their planning.
- Implementation of the rare plant compensation program is being developed in consultation with MOE, FLNRO and CWS.
- Avoidance of hibernacula at Portage Mountain. The memo outlining how hibernacula at Portage Mountain will be avoided is provided in Appendix 9.

6.4.2.1 Pre-construction rare plant surveys

Field surveys for rare plants along roads and portions of the transmission line not surveyed during baseline were conducted between July 25 and August 3, 2016. A total of 84.1 km were surveyed.

Forty (40) occurrences of 14 different rare plant species-10 vascular plants and 4 lichens were documented. Of the 16 rare species, 5 are on the BC Ministry of Environment's 'Red' list, with the remaining 8 being on the 'Blue' list. None of the taxa are listed on Schedule 1 of the Species at Risk Act, or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2015b).

No new rare plant species were documented during the 2016 surveys although identification of lichens is still underway. The complete 2016 program report is attached in Appendix 10.

6.4.2.2 Sharp-tailed Grouse Lek mitigation

Text regarding Sharp-tailed Grouse Lek Mitigation was added to the Project's CEMP (Refer to Appendix 8 Sharp-tailed Grouse Lek Mitigation).

6.4.2.3 Amphibian Salvage

In 2016 BC Hydro conducted two amphibian salvages. The first was an emergency salvage conducted in May and June 2016 under the direction of FLNRO along the side channel on the south bank of the Site Peace River. During this salvage 364 amphibians were removed from and relocated outside of the work zone.

The second salvage was conducted under *Wildlife Act Permit* FJ16-226024 in July and August 2016 along the side channel on the south bank of the Site Peace River. Approximately 5,053 amphibians were removed from and relocated outside of the work zone including 4,981 western toad, 70 wood frog, 2 boreal chorus frog. Eleven (11) common garter snakes were also removed from the work zone.

6.4.3 Condition 16.3.5

This section summarizes actions taken in accordance with the following requirement of Condition 16.3.5: *the plan shall include*: *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.*

Herbicides and pesticides were not used by the Site C Project in 2016.

6.4.4 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.*

Please see Section 6.4.2.1 above for a summary of the pre-construction rare plant surveys conducted in 2016.

6.4.5 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 identification and ranking of species at risk revised rankings were released in the Spring of 2016. The following documents were reviewed to identify changes to rankings of species documented in the LAA during baseline surveys:

- Animal 2016 List Changes
- Plant 2016 List Changes

A list of recovery planning documents (http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning/recovery-planning-documents/recovery-planning-documents) was reviewed to determine which species whose rankings were changed have species recovery plans.

Species listed on Schedules 1, 2 and 3 of the federal Species at Risk Act were reviewed to determine if any species occurring in the Project area had been added or had their rankings changed. No changes were found.

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

6.4.5.1 Rare Plants

In 2016 no rare plants were added to the lists or up listed that overlap with the Site C Project footprint. Two species, Tawny Paintbrush and Purple-stemmed Aster, that occur within the Site C Project footprint, were down listed to yellow in 2016. As such they are no longer considered rare plants.

The rankings of field pussytoes and pretty cinquefoil were changed in 2015 anticipation of construction of the Site C Clean Energy Project. The rational provided by the CDC for the rank changes is:

- field pussytoes- much of the range is threatened by a hydroelectric development and other threats (CDC 2015a)
- pretty cinquefoil-occurs in BC Only in the Peace Lowlands (CDC 2015a)

Recovery planning documents are not yet available for field pussytoes or pretty cinquefoil

BC Hydro will work with FLNR and MOE, through the wildlife technical sub-committee, to quantify effects of the Project on these species and to determine if any changes to the Projects associated management plans or monitoring programs are required to mitigate effects of the Project on these listed species.

6.4.5.2 Wildlife

Recovery strategies for Canada Warbler and Common Nighthawk were released by the Government of Canada in 2016. BC Hydro is addressing mitigation for these species in consultation with Environment Canada through the Vegetation and Wildlife Technical Committee (See Section 3.0 above).

None of the wildlife species added to the *Species at Risk A*ct in 2016 occur within the Site C Project area.

None of the wildlife species added to the provincial red and blue lists occur within the Site C Project area.

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.

The following programs were implemented in 2015 are described in the subsequent sections of this report:

- Section 7.1: Vegetation and Invasive Plant Management (Condition 9)
- Section 7.2: Rare Plant Surveys (Condition 10)
- Section 7.3: Wetland Mitigation and Compensation (Condition 12)
- Section 7.4: Rare Plant Translocation (Condition 14)
- Section 7.5 Wildlife Management (Condition 15)
- Section 7.6 Compensation for Loss of Wetland Habitat (Condition 16)
- Section 7.7: Monitoring Wildlife Mitigation Measures (Condition 19)
- Section 7.8: Manage harmful effects on Wildlife Resources (Condition 21)
- Section 7.9: Tracking Changes in the Status of Listed Species (Condition 23)

7.1 EAC Condition 9

This section of the annual report summarizes the programs implemented in 2015 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 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 6.4.2.1 above for the results of the rare plant surveys conducted in areas not already surveyed.

7.1.2 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 Environmental Features Map was updated with the 2016 rare plant data on September 1, 2016 and posted in the data room for contractors to access in their planning.

The 2016 rare plant data were submitted to Jennifer Penny, Program Botanist at the BC Conservation Data Center, MOE on January 19 and 27, 201.

Voucher specimens were submitted to the Herbarium at the University of British Columbia in late January and early February 2017.

7.1.3 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.*

The way in which BC Hydro fulfilled this part of Condition 9 during the transmission line design phase was reported in the 2015 annual report. Construction of the transmission line is scheduled to start in 2017. As such, measures employed during construction to fulfill this condition will be summarized in the 2017 annual report.

7.1.4 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 Wetland 1 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 the RVMA. Vegetation with a normal mature height less than 3 m and conifers less than 2m will not be removed from the RVMA.

7.2 EAC Condition 10

This section of the annual report summarizes the programs implemented in 2016 in accordance with the requirements of Condition 10.

For context, the complete requirements of Condition 10 are shown below.

EAC Condition 10

The EAC Holder must fund or undertake directly with the use of a Rare Plant Botanist the following, during construction:

- 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 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).

The EAC Holder must provide FLNR and MOE (BC Conservation Data Centre) with the findings and analysis of results from the surveys and taxonomic study.

7.2.1 Targeted rare plant surveys in the RAA

Targeted surveys in the RAA for 18 directly affected rare plant species were initiated in 2016. Of the 18 species identified in the EIS the status of six species has changed from blue (5) or red (1) to yellow (Table 9). Yellow listed species are not considered rare plants and as such these species will not be targeted

Field surveys were conducted from August 11 to 18, 2016 at six sites in the RAA. Table 10 summarizes the results of the 2016 surveys. The complete survey report is provided in Appendix 11.

Table 9. At Risk Plant Species Down Listed to Yellow Between 2013 and 2016.

Scientific Name	Common Name	Historic Conservation Status Information as defined in the amended EIS[1]			Current Conservation Status Information	
		BC CDC and NatureServe Conservation Status Rank (2013[1])	BC CDC and NatureServe Conservation Framework Priority [b](2013)	Conservation Framework Action Groups [c](2013)	BC CDC and NatureServe Conservation Status Rank (2016)	Rank Status Designation Year
Anemone virginiana var. *cylindroidea*	riverbank anemone	Blue (S3)	2	Inventory	Yellow (S4)	2015
Galium labradoricum	northern bog bedstraw	Blue (S3)	2	Inventory	Yellow (S3S4)	2015
Salix serissima	autumn willow	Blue (S2S3)	2	Inventory	Yellow (S3S4)	2015
Juncus confusus	Colorado rush	Red (S1)	2	Inventory	Yellow (S4)	2016
Muhlenbergia glomerata	marsh muhly	Blue (S3)	4	Inventory	Yellow (S4)	2015
Symphyotrichum puniceum var. *puniceum*	purple-stemmed aster var. gardneri	Blue (S3)	2	Inventory	Yellow (S3S4)	2016

Table 10. Number of Populations/Subpopulations of Rare and Target Species per Survey

Scientific Name	Common Name	BC Status	Target	Survey Site					
				1	2	3	4	5	6
Anemone virginiana* var. *cylindroidea	riverbank anemone	Yellow (S4) [delisted 2015]	Y	0	1	0	0	0	0
Antennaria neglecta	field pussytoes	Blue (S2S3)	N	0	2	3	0	0	0
Artemisia herriotii	white sagebrush	Red (S2)	Y	0	0	0	3	0	1
Avenula hookeri	spike oat	Blue (S3)	Y	0	2	3	0	0	0
Calamagrostis montanensis	plains reedgrass	Blue (S3)	Y	1	6	0	0	0	0
Carex sychnocephala	many-headed sedge	Yellow (S3S4) [delisted 2015]	Y	0	0	0	0	0	1
Carex torreyi	Torrey's sedge	Blue (S2S3)	Y	0	1	0	0	0	0
Carex xerantica	dry-land sedge	Blue (S2S3)	Y	0	1	0	1	0	0
Elymus albicans	Montana wildrye	Red (S1S2)	N	0	1	0	0	0	0
Elymus lanceolatus ssp. *psammophilus*	sand- dune wheatgrass	Blue (S2S3)	N	0	0	1	0	0	0
Geum triflorum var. *triflorum*	old man's whiskers	Red (S1S3)	N	3	7	1	0	0	0
Penstemon gracilis	slender penstemon	Red (S2)	Y	2	7	0	0	0	0
Potentilla pulcherrima	pretty cinquefoil	Red (S2)	N	0	0	1	0	0	0
Silene drummondii* var. *drummondii	Drummond's campion	Blue (S3)	Y	1	0	2	0	0	0
Symphyotrichum lanceolatum var. *lanceolatum*	western willow aster	to be ranked in 2017	N	0	0	0	2	0	0
Symphyotrichum puniceum* var. *puniceum	purple stemmed aster	Yellow (S3S4) [delisted 2016]	Y	0	0	0	0	2	1

Site 1 = Beatton River; Site 2 = Leahy Pit Road; Site 3 = Upper Halfway River; Site 4 = Pouce Coupé River; Site 5 = Pine River area; Site 6 = Cecil Lake area.

7.3 EAC Condition 12

This section of the annual report summarizes the programs implemented in 2015 in accordance with the requirements of Condition 12.

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.

7.3.1 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 6.3.2.1 above for a summary of wetland mitigation plan development.

7.3.1.1 Installation of culverts to maintain hydrological balance at wetlands affected by roads

This section summarizes actions taken in accordance with the following requirement of Condition 12: *If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;*

Project access roads

A total of 21 new culverts were installed in 2016 during the construction of Septimus Road (Figure 2).

Transmission Line Right-of-Way

BC Hydro has engaged a forestry consultant to design access roads and clearing prescriptions along the transmission line. A hydrologist on staff with the forestry consultant has reviewed the design to ensure that the hydrology of wetlands along the transmission line is maintained. Clearing work on the eastern portion of the transmission line where most of the wetlands are located has been schedule for winter, when frozen ground conditions should mitigate impacts to the wetland hydrology. Transmission line construction and clearing works are anticipated to commence in 2017.

7.3.1.2 Stormwater management

This section summarizes actions taken in accordance with the following requirement of *Condition 12: Stormwater management will be designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur.*

Stormwater across the site is managed by contractors under the Sediment Control Program. Management includes installation of sedimentation ponds (Photo 1) and interception ditches (Photo 2). Interception ditches capture and divert stormwater away from construction areas into the sedimentation ponds. Water from the sedimentation ponds is discharged into the surrounding environment.

Figure 2. Locations of Culverts Installed During Construction of Septimus Road

Photo 1. Stormwater Management Settling Pond

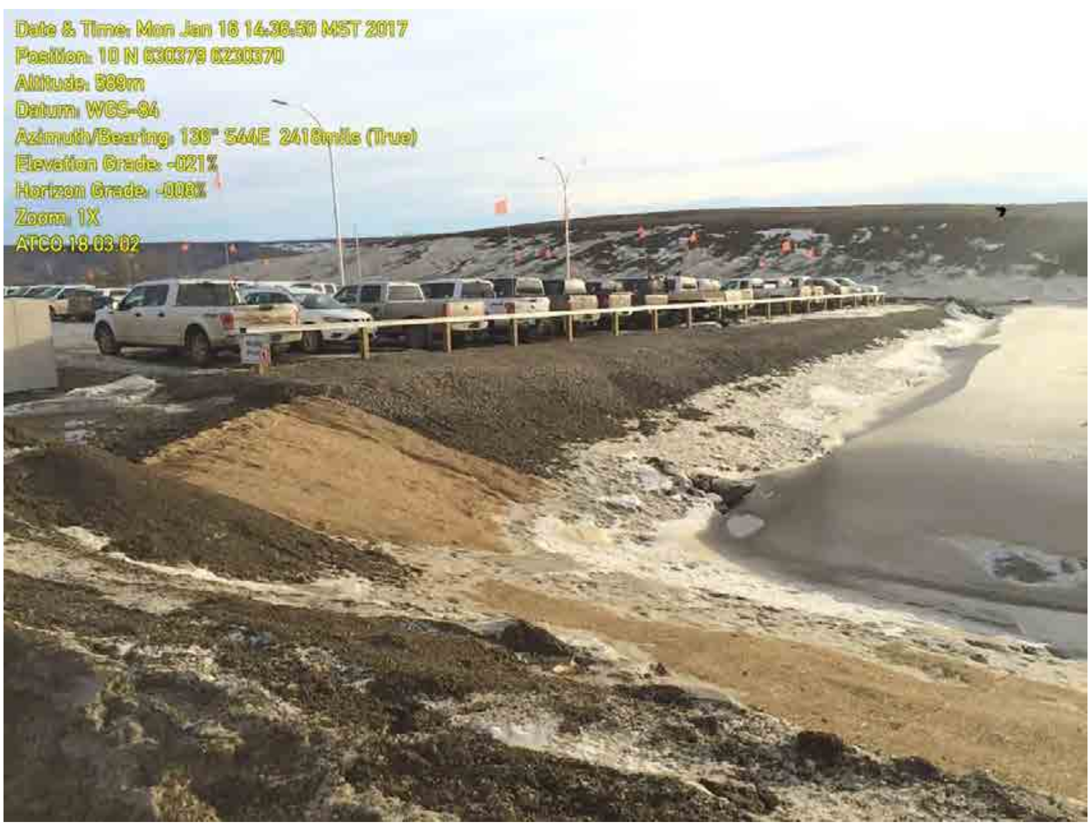

Photo 2. Stormwater Drainage Ditch

7.3.1.3 Implementation of Approved work practices and Develop with Care

This section summarizes actions taken in accordance with the following requirement of Condition 12: *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).*

The following changes were made to Section 4.13 of the CEMP between R2 and R4, issued February 2, 2016 and July 26, 2016:

- the requirements for content of spill kits and that "spills if any volume are an Environmental Incident
- revised to provide greater clarity related to spill contingency supply, training, emergency response and external reporting requirements, added "spills of any volume are an Environmental Incident"
- when working within, above, or within 15 metres of a watercourse or wetland with equipment that may result in a spill of a hazardous substance that suitable absorbent and containment booms be onsite and available for deployment in the event of a spill
- appropriate training of workers in the use of spill response equipment, including the location, type, and correct deployment of spill response equipment relating to the nature and location of work and potential onsite spills.
- notify/Report (EMBC 1-800-663-3456 when necessary – see Table 3)

Site and activity specific EPPs must include procedures to address spill response related to identified environmental hazards. Generally these procedures would include:

1) MAKE THE AREA SAFE

- Evaluate risk to personal/public, electrical and environmental safety;
- Wear appropriate Personal Protective Equipment (PPE);
- Never rush in, always determine the product spilled before taking action;
- Warn people in the immediate vicinity; and
- Verify that no ignition sources are present if the spill is a flammable material.

2) STOP THE FLOW (when possible and safe to do so)

- Act quickly to reduce the risk of environmental impacts;
- Close valves, shut off pumps or plug holes/leaks; and
- Stop the flow or the spill at its source.

3) SECURE THE AREA

- Limit access to the spill area; and
- Prevent unauthorized entry onto the site.

4) CONTAIN THE SPILL

- Block off and protect drains and culverts
- Prevent spilled material from entering drainage structures (ditches, culverts, drains)
- Use spill containment and sorbent material to contain the spill appropriate to site location and spilled materials

5) Notification/ Reporting – as per Table 2 below and Table 1 in Section 4.3

- Determine appropriate Contractor, BC Hydro and regulatory notification obligations and notify appropriate personnel
- When necessary, the first external call shall be made to **Emergency Management BC (EMBC)**, formerly known as the Provincial Emergency Program (PEP), **at 1-800-663-3456 (24 Hour)**. Spills would then be reported to the appropriate ministries/agencies according to Table 2 below to allow for immediate response (as required) by appropriate staff. For spills to aquatic habitat, collection of water samples shall be undertaken to characterize the nature and extent of the release.
- Provide the required information for input into BC Hydro's EIR system

Table 2: Spill Reporting Matrix from Spill Reporting Regulation Schedule of Reportable Levels for Certain Substances

Item	Substance	Quantity	External Reporting Requirements	Internal Reporting Requirements
-	Any Spill	Any amount in aquatic habitat	EMBC, DFO and MFLNRO	Environmental Incident Report (EIR)
-	Oil and Waste Oil	Any amount ≥1L	N/A	EIR
1	Class 1, Explosives as defined in section 2.9 of the Federal Regulations	Any quantity that could pose a danger to public safety or 50 kg	EMBC	EIR
2	Class 2.1, Flammable Gases, other than natural gas, as defined in section 2.14 (a) of the Federal Regulations	≥10 kg	EMBC	EIR
3	Class 2.2 Non-Flammable and Non-Toxic Gases as defined in section 2.14 (b) of the Federal Regulations	≥10 kg	EMBC	EIR
4	Class 2.3, Toxic Gases as defined in section 2.14 (c) of the Federal Regulations	≥5 kg	EMBC	EIR
5	Class 3, Flammable Liquids as defined in section 2.18 of the Federal Regulations	≥100 L	EMBC	EIR
6	Class 4, Flammable Solids as defined in section 2.20 of the Federal Regulations	≥25 kg	EMBC	EIR

Item	Substance	Quantity	External Reporting Requirements	Internal Reporting Requirements
7	Class 5.1, Oxidizing Substances as defined in section 2.24 (a) of the Federal Regulations	≥50 kg or 50 L	EMBC	EIR
8	Class 5.2, Organic Peroxides as defined in section 2.24 (b) of the Federal Regulations	≥1 kg or 1 L	EMBC	EIR
9	Class 6.1, Toxic Substances as defined in section 2.27 (a) of the Federal Regulations	≥5 kg or 5 L	EMBC	EIR
10	Class 6.2, Infectious Substances as defined in section 2.27 (b) of the Federal Regulations	≥1 kg or 1 L, or less if the waste poses a danger to public safety or the environment	EMBC	EIR
11	Class 7, Radioactive Materials as defined in section 2.37 of the Federal Regulations	Any quantity that could pose a danger to public safety and an emission level greater than the emission level established in section 20 of the "Packaging and Transport of Nuclear Substances Regulations"	EMBC	EIR
12	Class 8, Corrosives as defined in section 2.40 of the Federal Regulations	≥5 kg or 5 L	EMBC	EIR
13	Class 9, Miscellaneous Products, Substances or Organisms as defined in section 2.43 of the Federal Regulations	≥25 kg or 25 L	EMBC	EIR
14	Waste containing dioxin as defined in section 1 of the Hazardous Waste Regulation	≥1 kg or 1 L, or less if the waste poses a danger to public safety or the environment	EMBC	EIR
15	Leachable toxic waste as defined in section 1 of the Hazardous Waste Regulation	≥25 kg or 25 L	EMBC	EIR
16	Waste containing polycyclic aromatic hydrocarbons as defined in section 1 of the hazardous Waste Regulation	≥5 kg or 5 L	EMBC	EIR
17	Waste asbestos as defined in section 1 of the Hazardous Waste Regulation	≥50 kg	EMBC	EIR
18	Waste oil as defined in section 1 of	≥100 L	EMBC	EIR

Item	Substance	Quantity	External Reporting Requirements	Internal Reporting Requirements
	the Hazardous Waste Regulation			
19	Waste containing a pest control product as defined in section 1 of the Hazardous Waste Regulation	≥5 kg or 5 L	EMBC	EIR
20	PCB Wastes as defined in section 1 of the Hazardous Waste Regulation	≥25 kg or 25 L	EMBC	EIR
21	Waste containing tetrachloroethylene as defined in section 1 of the Hazardous Waste Regulation	≥50 kg or 50 L	EMBC	EIR
22	Biomedical waste as defined in section 1 of the Hazardous Waste Regulation	≥1 kg or 1 L, or less if the waste poses a danger to public safety or the environment	EMBC	EIR
23	A hazardous waste as defined in section 1 of the Hazardous Waste Regulation and not covered under items 1 – 22	≥25 kg or 25 L	EMBC	EIR
24	A substance, not covered by items 1 to 23, that can cause pollution	≥200 kg or 200 L	EMBC	EIR
25	Natural gas	≥10 kg, if there is a breakage in a pipeline or fitting operated above 100 psi that results in a sudden and uncontrolled release of natural gas	EMBC	EIR

Note: Federal Regulations means the Transportation of Dangerous Goods Regulations made under the *Transportation of Dangerous Goods Act*; Hazardous Waste Regulation" means B.C. Reg. 63/88.

6) CLEAN-UP

- Determine cleanup options and requirements with appropriately qualified professionals
- Mobilize recovery equipment and cleanup crew and conduct cleanup activities
- Dispose of all equipment and/or material used in clean up (e.g., used sorbent, oil containment materials, etc.) in accordance with MFLNRO requirements. Disposal of special wastes (e.g., material with > 3% oil by mass) and contaminated soil must comply with the Environmental Management Act and Regulations
- Replenish spill response kits and equipment.

7.4 EAC Condition 14

This section of the annual report summarizes the programs implemented in 2016 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.

7.4.1 Definition of the study design for the rare plant translocation program

As outlined in the VWMPP (BC Hydro 2015) the study design for the translocation program will follow that the five step approach, as outlined in Maslovat (2009). The program consists of seven years of study: 2016 (Year 1) to 2022 (Year 7). The program is divided into seven phases:

1. research, development, and monitoring program development (2016-2017);
2. field work and data collection (2017);
3. ex situ propagation (2017 and 2018);
4. data analysis (2017 and 2018)
5. translocation implementation (2018 and 2019);
6. post-translocation care and maintenance (2018-2022); and
7. monitoring (2018-2022).

7.4.2 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.

The monitoring program will document a suite of measurable parameters designed to evaluate the efficacy of translocation methods and management in relation to the stated objectives of the program (IUCN 1995; Vallee et al. 2004). Monitoring is scheduled to begin in 2018 and continue through 2022. Specifically, the monitoring program will measure, document, and evaluate the following:

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

2. 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

3. the follow-up procedures applied to address any declines in survival or fitness of the translocated plants/populations.

7.4.3 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.

Please see Section 7.4.2 above for how the effectiveness of the rare plant translocation program will be measured.

7.5 EAC Condition 15

This section of the annual report summarizes the programs implemented in 2016 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.

7.5.1 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.*

Please see Section 6.4.2 above for measures taken to avoid constructing in sensitive wildlife habitats.

Avoidance of wetland habitat at the dam site

In accordance with the CEMP Wetland 1 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.

7.5.2 Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.

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*

In accordance with the CEMP Wetland 1 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.

7.5.3 Mitigation of adverse effects to wildlife

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.*

Please see section 6.4.2 above for a summary the amphibian salvages conducted in 2016.

7.5.4 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.*

Lighting was focused on the work site at all construction sites.

7.5.5 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 and 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.

7.6 EAC Condition 16

This section of the annual report summarizes the programs implemented in 2016 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.

7.6.1 Management of EAC Holder-owned lands

This section summarizes actions taken in accordance with the following requirement of Condition 16: *Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.*

BC Hydro continues to manage three BCH owned properties identified for retention and management to date. All three properties provide suitable habitat for non-wetland birds, including the northern harrier and Short-eared Owl. Surveys in 2016 documented Short-eared Owl on one property and Northern Harrier on all three properties.

7.6.2 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.*

BC Hydro continues to work with MOTI on including roosting structures for bats in bridges. In 2016 MOTI identified preliminary locations for bat boxes on the Cache Creek Bridge. Designs were sent to the VWTC for review.

7.6.3 Cold weather rest 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 piles for fisher were created within the dam site area in 2016 (

Figure 3).

Figure 3. Location of Coarse Woody Debris Piles for Fisher within the Dam Site Area.

7.7 EAC Condition 19

This section of the annual report summarizes the programs implemented in 2016 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.

BC Hydro did not conduct pre-work amphibian surveys along the access road at Portage Mountain. The EAO issued an order to BC Hydro. In response to the order, BC Hydro has developed a protocol for conducting amphibian assessments within and adjacent to work sites to avoid such an omission in the future.

The 2016 transmission line center line surveys identified and buffered wetlands within and adjacent to the right-of-way, and tower locations. Amphibian surveys following the protocol developed in response to the EAO order will be employed during construction of the transmission line.

7.8 EAC Condition 21

This section of the annual report summarizes the programs implemented in 2015 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.

7.8.1 Monitoring of Bald Eagle nesting populations

Sixty seven (67) stick nests were surveyed in September 2016; 60 of these were confirmed as Bald Eagle nests during the 2014 survey. For the confirmed Bald Eagle nests, the September survey determined 4 of these nests to be inactive, 15 could not be relocated and 41 were confirmed present but could not have an activity status assigned as the young had fledged.

7.8.2 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.*

Please see Section 6.1.2.1 and 6.1.2.2 for summaries of spring and fall waterfowl and shorebird surveys.

7.8.3 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.*

Songbirds

Songbirds were surveyed using 100 m fixed-radius point counts conducted May 11 to July 9, 2016. Survey stations were located within three zones: Upstream Peace River Valley, Downstream Peace River Valley and Plateau (the area between the Upstream Peace River Valley and the transmission line). Stations were stratified by Broad Habitat Mapping unit. Surveys were conducted at 143 stations and 275 surveys were conducted, including revisits to the same stations.

A total of 2049 birds of 68 songbird species were recorded during the point count surveys. The Upstream Valley had the largest number of species and the highest average station species richness; the Plateau had the lowest. Nine 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. Point count stations were located within two of three BC Hydro Compensation properties. Surveys in the Marl Fen property and the Wilder Creek property found 27 and 34 songbird species respectively.

The 2016 breeding bird follow-up monitoring report provided in Appendix 12.

Ground nesting raptors

The ground nesting surveys were completed in three BC Hydro compensation properties (Marl Fen, Rutledge Property and Wilder Creek). Surveys were also intended to be completed in cleared portions of the Site C dam headpond area however no clearing had occurred prior to the 2016 surveys.

Ground nesting raptor surveys were completed three times between May and June 2016. The surveys were conducted using a combination of encounter transects walked on foot and stationary standwatches. Ground nesting raptors were observed at each of the three properties. One Short-eared Owl was observed at Marl Fen. The remaining observations were Northern Harrier: six at Marl Fen and one observation each at Rutledge and Wilder Creek. No nests or evidence of nesting were observed.

The 2016 ground nesting raptor survey report is provided in

Appendix 13.

7.8.4 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.

7.9 EAC Condition 23

This section of the annual report summarizes the programs implemented in 2016 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.

7.9.1 Rare Plants
Please see Section 6.4.5.1 above for a summary of ranking changes to rare plants

7.9.2 Wildlife
Please see Section 6.4.5.2 above for a summary of ranking changes to wildlife.

Appendix 1

Bird-Transmission Line Collision Risk Assessment

Bird-Transmission Line Collision Risk Assessment

PRESENTED TO

British Columbia Hydro and Power Authority

JANUARY 6, 2017
ISSUED FOR USE
FILE: 704-ENV.VENV03094-01

Tetra Tech Canada Inc.
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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) conducted an assessment of the potential risk for bird-transmission line collisions with the two proposed 500-kV transmission lines connecting the new Site C substation to the existing Peace Canyon substation along and adjacent to an existing 77-km right-of-way (ROW). In addition to a literature review summarizing known contributors to avian collisions with transmission lines, the assessment provided two additional components:

- A spatially explicit model of collision risk along the proposed ROW that differentiates ROW segments of varying potential for bird collisions with the proposed transmission line; and
- A qualitative bird collision risk assessment of the proposed ROW and the proposed tower types and conductor arrangements that focused on those features identified during the literature review that are relevant to the landscape surrounding the proposed ROW.

The study area for the model was defined as 500 m on either side of the ROW. The topography along the ROW and the available contour resolution (i.e., 20m) made it difficult to develop a GIS algorithm for identifying ridges and depressions. As a result, Tetra Tech visually identified valleys and ridges based on available imagery and made a qualitative assessment of whether or not a given feature would cause birds to alter their flight behaviour. The definition of ridge, valley, or depression features was not dependent on relative spatial proximity. Open-water wetlands and waterbodies capable of utilization by waterfowl (e.g., ducks and geese) and waterbirds (e.g., grebes, rails) were identified from TEM mapping.

To qualitatively assess potential for bird collision risk, Tetra Tech developed a simple risk score method for each segment based on three features:

- Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
- Segment is within 100 m of a wetland (score = 1.0); and
- Segment is within 100 m to 500 m of a wetland (score = 0.5).

Each segment was given an overall score of 0.0 to 2.5 based on the sum of the three criteria. A higher score indicates higher potential risk.

Additional features known to influence collision risk were not included in the models due to a lack of data availability at the appropriate scale and resolution (e.g., fine-scale weather data) or a general lack of a particular feature along the ROW (e.g., agricultural fields).

In addition to the generalized avian risk assessment, Tetra Tech developed nine species-specific assessments to evaluate potential risk to protected species (e.g., *Species at Risk Act* [SARA], *Migratory Birds Convention Act*) and to assess potential risk to birds that do not exclusively use wetland habitats. An additional selection criterion was the frequency with which species were detected during baseline studies. Estimating species-specific probabilities of collision was not possible due to lack of bird relative abundance data at the appropriate scale and resolution along the ROW.

- Trumpeter Swan (*Cygnus buccinators*; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of secluded open-water wetlands with 75% of their margin surrounded by forest.

- Horned Grebe (*Podiceps auritus*; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of open-water wetlands smaller than 10 ha.
- Common Nighthawk (*Chordeiles minor*; Threatened – SARA Schedule 1; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of key wetland and non-wetland habitat types (e.g., gravel bars);
- Olive-sided Flycatcher (*Contopus cooperi*; Threatened – SARA Schedule 1; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types;
- Connecticut Warbler (*Oporornis agilis*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types;
- Cape May Warbler (*Setophaga tigrina*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types;
- Black-throated Green Warbler (*Setophaga virens*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types;
- Nelson's Sparrow (*Ammodramus nelsoni*; BC List – Red) – the model included the same study area as the generalized model and focused on the presence of specific wetland cover types;
- Rusty Blackbird (*Euphagus carolinus*; Special Concern – SARA Schedule 1; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of key habitat types.

Seven of the 150 ROW segments (9% of total ROW length) were identified as potential high-risk collision areas for one or more of the modeled scenarios:

- Two segments in the central ROW encompassing towers 34/3, 35/1 and 35/2: Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler;
- Two additional segments in the central ROW encompassing towers 44/2, 44/3, 45/1, and 45/2: generalized avian risk, Horned Grebe, Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler, Nelson's Sparrow, Rusty Blackbird; and
- Three segments in the western ROW encompassing towers 64/1, 64/2, 65/1, 65/2, 66/1, and 66/2: Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler, Nelson's Sparrow, Rusty Blackbird.

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of British Columbia Hydro and Power Authority and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than British Columbia Hydro and Power Authority, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech's Services Agreement. Tetra Tech's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

On behalf of the Saulteau EBA Environmental Services Joint Venture (SEES JV), Tetra Tech Canada Inc. (Tetra Tech) is pleased to provide this assessment of the potential risk for bird-transmission line collisions with the two proposed 500-kV transmission lines connecting the new Site C substation to the existing Peace Canyon substation along and adjacent to an existing 77-km right-of-way (ROW). The assessment has three components:

- A literature review summarizing known contributors to avian collisions with transmission lines. The primary goal of the review was to identify: (a) structural features of high voltage transmission lines that are associated with bird collisions, (b) landscape features that may increase collision probabilities, and (c) landscape and habitat use patterns of bird species prone to collisions.
- A spatially explicit model of collision risk along the proposed ROW that differentiates ROW segments of varying potential for bird collisions with the proposed transmission line.
- A qualitative risk assessment of the proposed ROW and the proposed tower types and conductor arrangements. This assessment will focus on those features identified during the literature review that are relevant to the landscape surrounding the proposed ROW.

2.0 LITERATURE REVIEW

2.1 Structural Features

Several structural features of high voltage (i.e., 500-kV) transmission lines are associated with bird collision risk (Table 2-1). In general, these features all relate to the visibility of the structures to flying birds.

Table 2-1 Structural Features of High Voltage Transmission Lines associated with Bird Collision Risk

Characteristic	Risk Feature	Interaction	Literature Cited
Shield/grounding wire	Diameter and location	Tend to be smaller than and placed above conductors, thereby limiting visibility. Most avian collisions are thought to occur with shield wires. Elimination of shield wires is considered the best design measure to reduce avian mortalities.	Savereno et al. 1996; Jenkins et al. 2010; Rioux et al. 2013
Conductor configuration	Horizontal plane versus vertical offset.	Few collisions when conductors arranged in horizontal plane.	APLIC 2012
Conductor spacers	Overall visibility	Using conductor spacers can increase overall visibility, thereby decreasing collision risk	APLIC 2012
Tower lighting	Light spectrum and deployment.	In low light or low visibility conditions, birds can be attracted to constant source (i.e., non-strobe) lights of specific spectra. Attraction to the transmission line increases risk of collision.	Evans Ogden 1996; Manville 2005; Longcore et al. 2008
Guy wires	Diameter and location	Tend to be smaller than conductors, thereby limiting visibility.	Longcore et al. 2008; APLIC 2012

Characteristic	Risk Feature	Interaction	Literature Cited
Co-location of lines	Density of anthropogenic features	▪ Clustering lines within single ROWs may increase the visual 'footprint', thereby increasing the probability of generating avoidance behaviours. ▪ Increased obstacle density can increase collision risk in low light or low visibility conditions.	Bevanger 1998; Drewitt and Langston 2008; APLIC 2012

2.2 Landscape Features

Landscape features that influence either transmission line visibility or bird movement paths have been linked to bird collision risk are summarized in Table 2-2.

Table 2-2: Landscape Features associated with Bird Collisions with High Voltage Transmission Lines

Characteristic	Risk Feature	Interaction	Literature Cited
Ridge lines	Ridge lines tend to concentrate flight activity and bird densities in a narrow altitudinal band	Collision risk higher for transmission lines running on top of and parallel to ridge lines.	Savereno et al. 1996; Janss and Ferrer 2000; Martin and Shaw 2010
Topographical depressions (e.g., river valley)	Tendency for depressions to be used as travel corridors	Collision risk higher for transmission lines spanning topographical depressions (i.e., perpendicular to flight paths).	McNeil et al. 1985; Janss and Ferrer 2000; Martin and Shaw 2010; APLIC 2012
Standing vegetation	Height of transmission line relative to nearby vegetation	Collision risk decreases when transmission lines (i.e., conductors) are below the height of surrounding vegetation.	APLIC 2012
Wetlands	Waterfowl/waterbird congregations; hunting areas for raptors	Close proximity of wetlands and transmission lines (i.e., within 500 m) increases the frequency with which collision-susceptible birds could interact with transmission lines. Collision risk can be increased if transmission lines run between wetlands and other utilized habitats.	APLIC 2012
Adjacent Land Use, especially crop agriculture	Waterfowl/waterbird congregations; hunting areas for raptors	Collision-susceptible birds often congregate and forage in agricultural fields, thereby increasing the frequency with which they could interact with transmission lines.	APLIC 2012

2.3 Biological Features

Collision data provide a consistent assessment of which bird groups are most at risk from transmission line collisions (APLIC 2012, Rioux et al. 2013, and references therein): waterfowl (Anseriformes), grebes (Podicipedidae), gulls and shorebirds (Charadriiformes) and cranes (Gruiformes). Additional bird groups that demonstrate susceptibility to transmission line collisions include herons (Pelecaniformes), grouse (Galliformes) and raptors (Accipitriformes and Falconiformes). Bird species within each of these groups exhibit multiple behavioural or physical characteristics that contribute to increased collision risk (Table 2-3).

Table 2-3: Behavioural and Physical Features of Birds associated with Increased Collision Risk

Characteristic	Risk Feature	Interaction	Example Possible or Known Species in Project Area with Risk Feature	Literature Cited
Morphology	Low wing aspect ratio (i.e., short and broad wings). High wing loading (i.e., high body weight relative to wing size).	Low aspect ratio and high wing loading lead to lower maneuverability in flight.	Trumpeter Swan (*Cygnus buccinator*) Canada Goose (*Branta canadensis*) Common Merganser (*Mergus merganser*) Common Goldeneye (*Bucephala clangula*)	Bevanger 1998; Janss 2000; Rubolini et al. 2005
Flocking	Tendency to travel in dense flocks.	Travelling in dense flocks can limit visibility and maneuverability.	Canada Goose Sandhill Crane (*Grus canadensis*)	Bevanger 1998; Drewitt and Langston 2006; Murphy et al. 2009
Flight height	Tendency to fly at heights of transmission lines (i.e., under 60 m).	Birds can only collide with transmission lines when flying at the height of transmission lines.	Trumpeter Swan Canada Goose Common Merganser Common Goldeneye Sandhill Crane	Bevanger 1998; Jenkins et al. 2010
Flight behaviour	Non-transit behaviours during flight (e.g., aerial courtship displays).	Complex flight behaviours or flight activities can draw attention away from surroundings.	Northern Harrier (*Circus cyaneus*) Short-eared Owl (*Asio flammeus*)	Martin 2011; APLIC 2012
Foraging behaviour	Non-transit behaviours during flight (e.g., hunting).	Foraging behavior (e.g., downward facing visual focus) can draw attention away from surroundings.	Northern Harrier Short-eared Owl Swallows	Martin 2011; APLIC 2012
Perching behaviour	Attraction to infrastructure.	Birds that hunt from perches (e.g., *Buteo* raptors) may be attracted to transmission towers.	Red-tailed Hawk (*Buteo jamaicensis*)	APLIC 2012; Rioux et al. 2013
Sight	Poor depth perception or visual acuity.	Species with eye adapted for underwater vision (e.g., waterfowl) tend to be nearsighted in air.	Common Merganser Common Goldeneye	Jones et al. 2007; Martin and Shaw 2010; Martin 2011

Table 2-3: Behavioural and Physical Features of Birds associated with Increased Collision Risk

Characteristic	Risk Feature	Interaction	Example Possible or Known Species in Project Area with Risk Feature	Literature Cited
Age	Younger birds are inexperienced flyers.	Inexperience lowers maneuverability and limits awareness of risk factors (i.e., young birds naïve to risk posed by obstacles).	All	Drewiit and Langston 2008; Jenkins et al. 2010
Nocturnal or crepuscular activity	Tendency to fly in low light conditions.	Low light conditions can limit response times to obstacles in flight paths.	Short-eared Owl	Brown and Drewien 1995

3.0 RISK ASSESSMENT

Tetra Tech developed a spatially explicit model of collision risk along the proposed ROW with the goal of differentiating ROW segments of varying potential for bird collisions with the proposed transmission line. This model was augmented with a qualitative risk assessment of the proposed tower types and conductor arrangements, in the context of those features identified (Table 2-2) during the literature review that are associated with increased or decrease bird collision risk.

3.1 Spatially Explicit GIS Model of Landscape-based Risk Features

3.1.1 Model Development

3.1.1.1 Generalized Avian Risk

Tetra Tech delineated the ROW as the outer two lines of a KML file provided by British Columbia Hydro and Power Authority (BC Hydro) on September 29 2015, and extracted proposed tower locations from the same file. The study area for the model was defined as 500 m on either side of the ROW as this distance is consistent with the extent of available TEM data provided by BC Hydro (the buffer is less than 500 m in some locations). The corridor was collapsed to a single centerline feature and divided into 500 m segments starting at the eastern end of the alignment, with a remaining segment of 354 m at the western end of the alignment.

The topography along the ROW and the available contour resolution (i.e., 20m) made it difficult to develop a GIS algorithm for identifying ridges and depressions. As a result, Tetra Tech visually identified valleys and ridges based on available imagery and made a qualitative assessment of whether or not a given feature would cause birds to alter their flight behaviour. The definition of ridge, valley, or depression features was not dependent on relative spatial proximity.

Open-water wetlands and waterbodies capable of utilization by waterfowl (e.g., ducks and geese) and waterbirds (e.g., grebes, rails) were identified from TEM mapping by selecting polygons with the following site codes in any of the three deciles: Lake (LA), Shallow Open Water (OW), Pond (PD), Reservoir (RE), River (RI), and Willow-Horsetail-Sedge-Riparian Wetland (WH).

To qualitatively assess potential for bird collision risk, Tetra Tech developed a simple risk score method for each segment based on three features:

- Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
- Segment is within 100 m of a wetland (score = 1.0); and
- Segment is within 100 m to 500 m of a wetland (score = 0.5).

Each segment was given an overall score of 0.0 to 2.5 based on the sum of the three criteria. A higher score indicates higher potential risk.

Wetlands within 100 m of the corridor were identified by buffering the centerline by 140 m and intersecting the buffer with the wetland layer. The additional 40 m was added to account for half the average width of the corridor. Wetlands within 100 m to 500 m of the corridor were identified by buffering the centerline by 540 m, removing the area within 140 m of the centerline, and intersecting the buffer with the wetland layer. Tetra Tech conducted analyses using wetland area within a segment (rather than wetland presence) and the results were qualitatively similar to using the simpler metric.

Additional features known to influence collision risk were not included in the models due to a lack of data availability at the appropriate scale and resolution (e.g., fine-scale weather data) or a general lack of a particular feature along the ROW (e.g., agricultural fields).

3.1.1.2 Species-Specific Risk Assessments

In addition to the generalized avian risk assessment, Tetra Tech developed nine species-specific assessments to evaluate potential risk to protected species (e.g., *Species at Risk Act* [SARA], *Migratory Birds Convention Act*) and to assess potential risk to birds that do not exclusively use wetland habitats. An additional selection criterion was the frequency with which species were detected during baseline studies.

- Trumpeter Swan (*Cygnus buccinators*; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of secluded open-water wetlands (as defined above) with 75% of their margin surrounded by forest. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of a suitable wetland (score = 1.0); and
  - Segment is within 100 m to 500 m of a suitable wetland (score = 0.5).
- Horned Grebe (*Podiceps auritus*; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of open-water wetlands (as defined above) smaller than 10 ha. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of a suitable wetland (score = 1.0); and
  - Segment is within 100 m to 500 m of a suitable wetland (score = 0.5).
- Common Nighthawk (*Chordeiles minor*; Threatened – SARA Schedule 1; BC List – Yellow) – the model included the same study area as the generalized model and focused on the presence of key habitat types: Cultivated Fields (CF), Exposed Soil (ES), Fuzzy-spiked Wildrye-Wolf Willow (WW), Gravel Bar (GB), Gravel Pit (GP),

Mine Tailings (RY), Rural (RW), Sedge Wetland (SE), Tamarack-Sedge Ren (TS), Urban (UR), WH, and Willow-Sedge Wetland (WS). Scoring was based on:

- Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
- Segment is within 100 m of suitable habitat (score = 1.0); and
- Segment is within 100 m to 500 m of suitable habitat (score = 0.5).

- Olive-sided Flycatcher (*Contopus cooperi*; Threatened – SARA Schedule 1; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types: White Spruce series (AM, AS, SC, SH, SO, SW), Black Spruce series (BL, BT), Black Cottonwood (Fm02), Lodgepole Pine (LL), and TS. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and
  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).
- Connecticut Warbler (*Oporornis agilis*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types: White Spruce series (AM, SC, SH, SW), Black Spruce series (BL), and LL. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and
  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).
- Cape May Warbler (*Setophaga tigrina*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types: White Spruce series (AM, SH, SO, SW), BL, and Fm02. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and
  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).
- Black-throated Green Warbler (*Setophaga virens*; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of specific forest cover types: White Spruce series (AM, SC, SH, SM, SO, SW), and Fm02). Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and
  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).
- Nelson's Sparrow (*Ammodramus nelsoni*; BC List – Red) – the model included the same study area as the generalized model and focused on the presence of specific wetland cover types: TS, WH, and WS. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and

  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).

- Rusty Blackbird (*Euphagus carolinus*; Special Concern – SARA Schedule 1; BC List – Blue) – the model included the same study area as the generalized model and focused on the presence of key habitat types: BT, SE, TS, WH, and WS. Scoring was based on:
  - Segment crosses a topographical depression or runs parallel to a ridge (score = 1.0);
  - Segment is within 100 m of suitable habitat (score = 1.0); and
  - Segment is within 100 m to 500 m of suitable habitat (score = 0.5).

Estimating species-specific probabilities of collision was not possible due to lack of bird relative abundance data at the appropriate scale and resolution along the ROW.

3.1.2 Model Results

3.1.2.1 Generalized Avian Risk

Two of the 150 segments received a high risk score of 2.5; this represents approximately 1.3% of the total ROW length (Figure 1). These segments are located in the central portion of the ROW and encompass tower locations 44/2, 44/3, 45/1, and 45/2. The combination of wetland presence and the crossing of a topographical depression (i.e., Moberly River) contributed to the high ranking. Fifty-three of the 150 segments received a moderate risk score of 1.5; this represents approximately 35% of the total ROW length (Figures 1a-d). Although segments receiving a score of 1.5 can be found along the entire length of the ROW, there is a notable concentration in the easternmost 20 km, due to the extensive wetland network in this area. One limitation of the binary scoring method (i.e., is there a wetland or not?) is that a given segment will receive a 1.0 or 0.5 score for any wetland, regardless of size or waterfowl supporting capacity, within 100 m or 500 m, respectively. The remaining 95 segments (approximately 63% of the total ROW length) received low risk scores of 1.0, 0.5, or 0.

3.1.2.2 Species-specific Assessments

Trumpeter Swan – None of the 150 segments received a high risk score of 2.5 for Trumpeter Swan (Figure 2). Forty of the 150 segments received a moderate risk score of 1.5; this represents approximately 27% of the total ROW length. The remaining 110 segments (approximately 73% of the total ROW length) received low risk scores of 1.0, 0.5 or 0.

Horned Grebe – Two of the 150 segments received a high risk score of 2.5 for Horned Grebe; this represents approximately 1.3% of the total ROW length (Figure 3). These segments are located in the central portion of the ROW and encompass tower locations 44/2, 44/3, 45/1, and 45/2. The combination of wetland presence and the crossing of a topographical depression (i.e., Moberly River) contributed to the high ranking. Forty-four of the 150 segments received a moderate risk score of 1.5; this represents approximately 29% of the total ROW length. The remaining 104 segments (approximately 69% of the total ROW length) received low risk scores of 1.0, 0.5 or 0.

Common Nighthawk – Seven of the 150 segments received a high risk score of 2.5 for Common Nighthawk; this represents approximately 4.7% of the total ROW length (Figure 4). These segments were concentrated within the central (tower locations: 35/1, 35/2, 44/2, 44/3, 45/1, and 45/2) and western (64/1, 64/2, 65/1, 65/2, 66/1, and 66/2) portions of the ROW where a higher diversity of preferred nighthawk habitats are located. One hundred and eighteen segments received a moderate risk score of 1.5 or 2.0; this represents approximately 77% of the total ROW length; the relatively large proportion of moderate risk segments is indicative of the generalist habitat tendencies of this species, particularly for foraging habitats. The remaining 25 segments (approximately 17% of the total ROW length) received low risk scores of 1.0, 0.5 or 0.

Olive-sided Flycatcher – None of the 150 segments received a high risk score of 2.5 for Olive-sided Flycatcher (Figure 5). Twenty-nine of the 150 segments received a moderate risk score of 1.5; this represents approximately 19% of the total ROW length. The remaining 121 segments (approximately 81% of the total ROW length) received low risk scores of 1.0, 0.5 or 0.

Connecticut Warbler – Ten of the 150 segments received a high risk score of 2.5 for Connecticut Warbler; this represents approximately 6.7% of the total ROW length (Figure 6). These segments are located primarily in the western portions of the ROW (tower locations: 60/2, 60/3, 61/1, 61/2, 64/1, 64/2, 64/3, 64/4, 65/1, 65/2, 66/1, 66/2) with other locations in the central portion (34/3. 35/1, 35/2, 44/2, 44/3, 45/1, 45/2). 138 of the 150 segments received a moderate risk scope of 1.5; this represents approximately 92.0% of the total ROW. The relatively large proportion of moderate risk segments is indicative of the widespread habitat availability for this species along the ROW. The remaining two segments (approximately 1.3% of the total ROW length) received a low risk score of 0.5.

Cape May Warbler – Seven of the 150 segments received a high risk score of 2.5 for Cape May Warbler; this represents approximately 4.7% of the total ROW length (Figure 7). These segments are located primarily in the western portions of the ROW (tower locations: 60/2, 60/3, 61/1, 61/2, 64/1, 64/2, 66/1, 66/2) with other locations in the central portion (35/1, 35/2, 44/2, 44/3, 45/1, 45/2). 87 of the 150 segments received a moderate risk scope of 1.5; this represents approximately 58% of the total ROW. The remaining 56 segments (approximately 37.3% of the total ROW length) received a low risk scores of 1.0, 0.5 or 0.

Black-throated Green Warbler – Ten of the 150 segments received a high risk score of 2.5 for Black-throated Green Warbler; this represents approximately 6.7% of the total ROW length (Figure 8). These segments are located primarily in the western portions of the ROW (tower locations: 60/2, 60/3, 61/1, 61/2, 64/1, 64/2, 64/3, 64/4, 65/1, 65/2. 66/1, 66/2) with other locations in the central portion (34/3, 35/1, 35/2, 44/2, 44/3, 45/1, 45/2). 139 of the 150 segments received a moderate risk scope of 1.5; this represents approximately 92.7% of the total ROW. The relatively large proportion of moderate risk segments is indicative of the widespread habitat availability for this species along the ROW. The remaining segment (approximately 0.6% of the total ROW length) received a low risk score of 0.5.

Nelson's Sparrow – Three of the 150 segments received a high risk score of 2.5 for Nelson's Sparrow; this represents approximately 2.0% of the total ROW length (Figure 9). These segments were concentrated in the central (tower locations: 44/2, 44/3, 45/1, 45/2) and western (64/1, 64/2) portions of the ROW. 95 of the 150 segments received a moderate risk scope of 1.5; this represents approximately 63.3% of the total ROW. The remaining 52 segments (approximately 34.7% of the total ROW length) received low risk scores of 1.0, 0.5 and 0.

Rusty Blackbird – Five of the 150 segments received a high risk score of 2.5 for Rusty Blackbird; this represents approximately 3.3% of the total ROW length (Figure 10). These segments are located in the central (tower locations: 44/2, 44/3, 45/1, and 45/2) and western (64/1, 64/2, 65/1, 65/2, 66/1, and 66/2) portions of the ROW. The combination of wetland presence and the crossing of a topographical depression (e.g., Moberly River) contributed to the high ranking. Ninety-one of the 150 segments received a moderate risk score of 1.5; this represents approximately 61% of the total ROW length. The remaining 54 segments (approximately 36% of the total ROW length) received low risk scores of 1.0, 0.5 or 0.

3.1.2.3 Summary of Potential High-risk Areas

The following locations were identified as potential high-risk areas for one or more of the modeled scenarios:

- Two ROW segments encompassing towers 34/3, 35/1 and 35/2: Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler;

- Two ROW segments encompassing towers 44/2, 44/3, 45/1, and 45/2: generalized avian risk, Horned Grebe, Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler, Nelson's Sparrow, Rusty Blackbird; and
- Three ROW segments encompassing towers 64/1, 64/2, 65/1, 65/2, 66/1, and 66/2: Common Nighthawk, Connecticut Warbler, Cape May Warbler, Black-throated Green Warbler, Nelson's Sparrow, Rusty Blackbird.

In total, only seven of 150 ROW segments (approximately 9% of total ROW length) are predicted to pose potentially high risk of bird collisions.

3.2 Additional Risk Factors

3.2.1 Biological Features

Data collected by BC Hydro as part of their ongoing monitoring indicates that species known to be susceptible to collisions with transmission lines (e.g., waterfowl) are present in the region and have been observed in wetlands along the ROW. Species detected include Trumpeter Swan, Canada Goose, Common Merganser, and Common Goldeneye.

3.2.2 Structural Features

The current design under consideration for the two 500-kV transmission lines includes features known to minimize the potential for bird collisions (e.g. elimination of shield wires, co-location of lines in a single ROW) and some that may increase the potential for bird collisions (e.g., guy wires, vertical conductor arrangement) (Table 3-1). Elimination of shield wires is considered the best design measure to reduce avian mortalities.

Table 3-1: Presence of Structural Risk Factors for Bird Collisions in Current Proposed Transmission Line Design*

Feature	Conductor Design	Tower Type 54A/C/J	Tower Type 54GA	Tower Type 2AGM/8KG
Shield/ground wires**	**No**	**Yes**	**No**	**No**
Conductor spacers	**Yes**	NA	NA	NA
Horizontal conductor arrangement	NA	**No**	**No**	**Yes**
Tower lighting	NA	**No**	**No**	**No**
Guy wires	NA	**No**	**Yes**	**No**

* Green shading indicates presence of features known to minimize the potential for bird collisions. Red shading indicates presence of features that may increase the potential for bird collisions.

**Limited shield wiring (approx. 1.6km) will be required at each end of the ROW as part of substation protection procedures.

The selection of guyed versus unguyed towers represents a trade-off between potential effects. Unguyed towers have fewer, small-diameter wires that present collision risk but they provide more opportunities for bird perching (thereby attracting birds to the infrastructure) and they require a large foundation footprint (i.e., more ground disturbance and potential habitat loss). In contrast, guyed towers have, by definition, more wires but are generally smaller structures with less lattice and a smaller ground-based footprint.

The current design of the project includes the co-location of the two lines into a single ROW for the majority of the length of the ROW. The co-location of lines within single ROWs may increase the visual 'footprint', thereby increasing the probability of generating avoidance behaviours in birds crossing the ROW.

4.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

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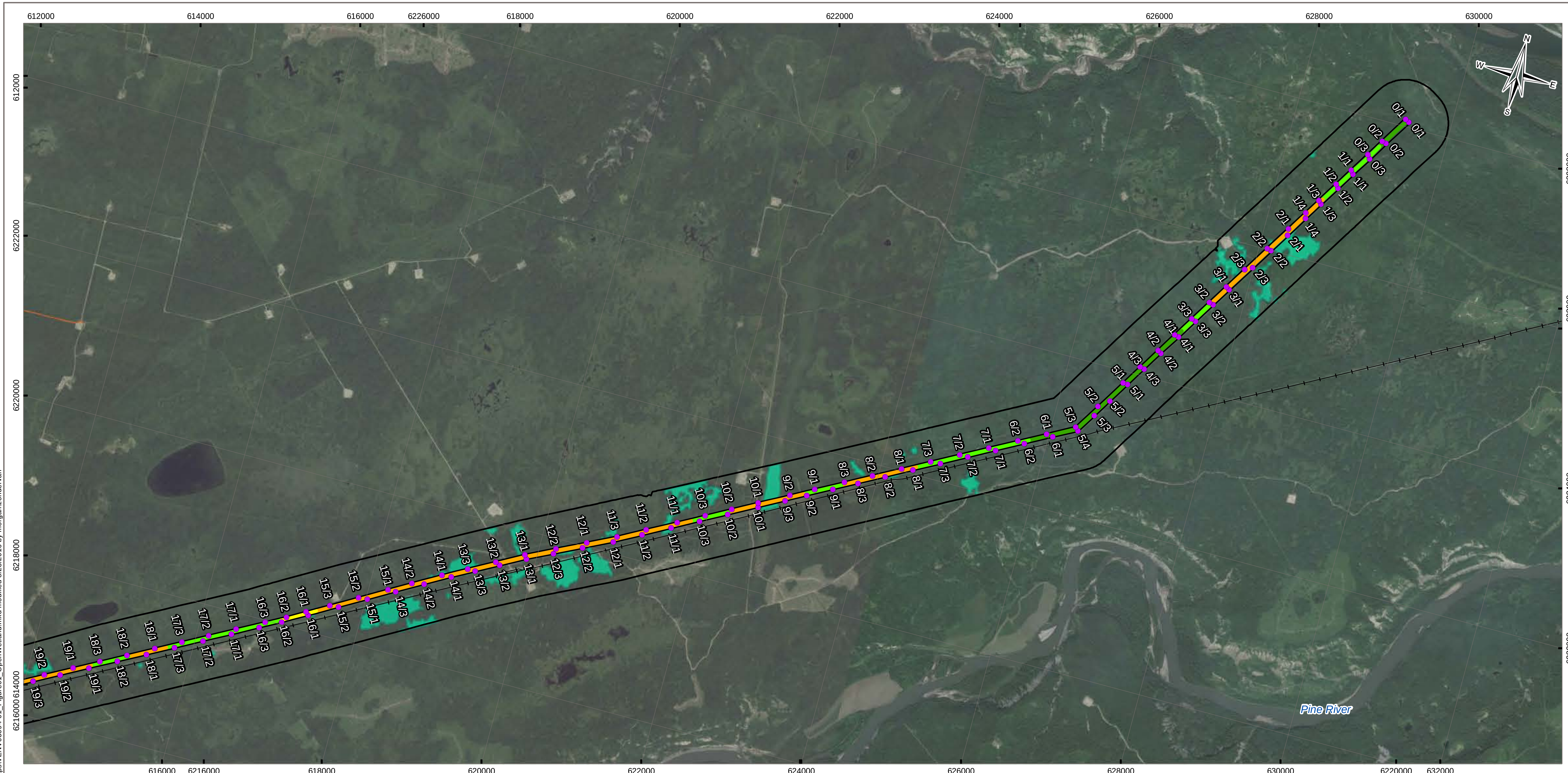
FIGURES

Figure 1a to 1d	Potential Bird Strike Risk Ranking
Figure 2a to 2d	Potential Trumpeter Swan Strike Risk Ranking
Figure 3a to 3d	Potential Horned Grebe Strike Risk Ranking
Figure 4a to 4d	Potential Common Nighthawk Strike Risk Ranking
Figure 5a to 5d	Potential Olive-sided Flycatcher Strike Risk Ranking
Figure 6a to 6d	Potential Connecticut Warbler Strike Risk Ranking
Figure 7a to 7d	Potential Cape May Warbler Strike Risk Ranking
Figure 8a to 8d	Potential Black-throated Green Warbler Strike Risk Ranking
Figure 9a to 9d	Potential Nelson's Sparrow Strike Risk Ranking
Figure 10a to 10d	Potential Rusty Blackbird Strike Risk Ranking

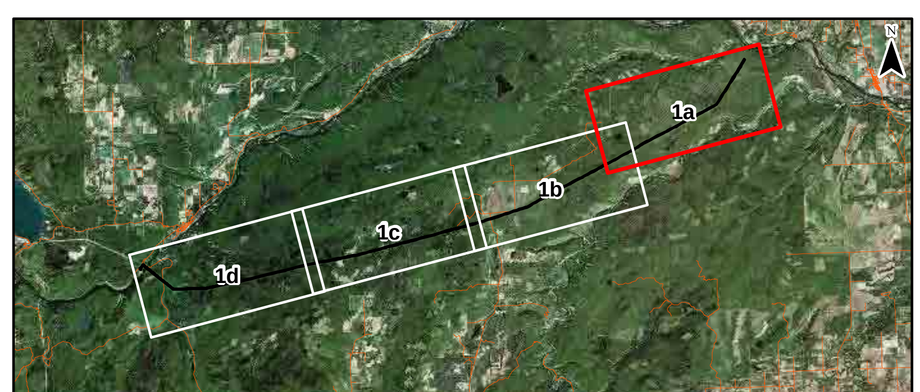


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Open Water Wetland within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Bird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure01_OpenWetland.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 1a

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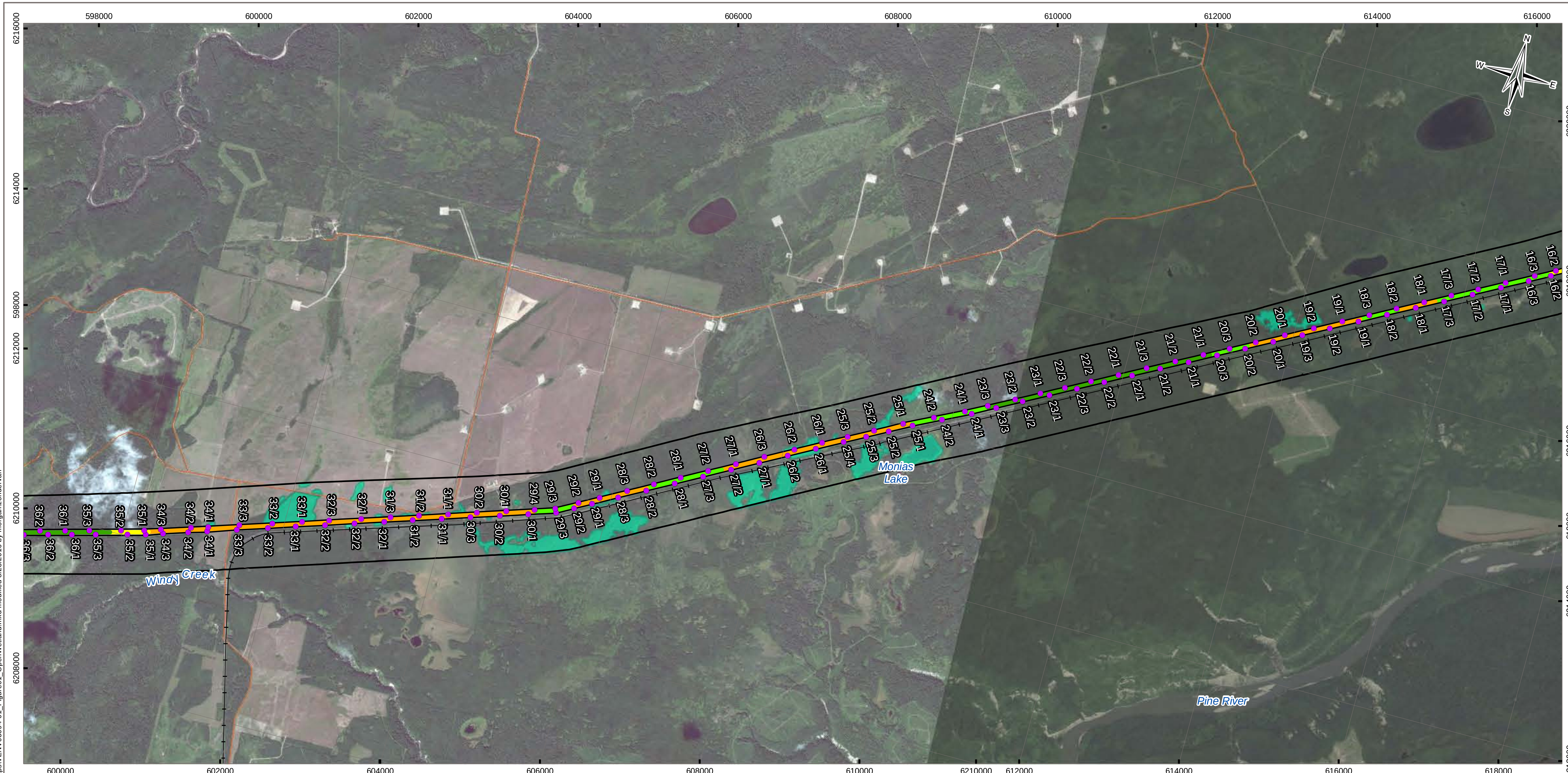
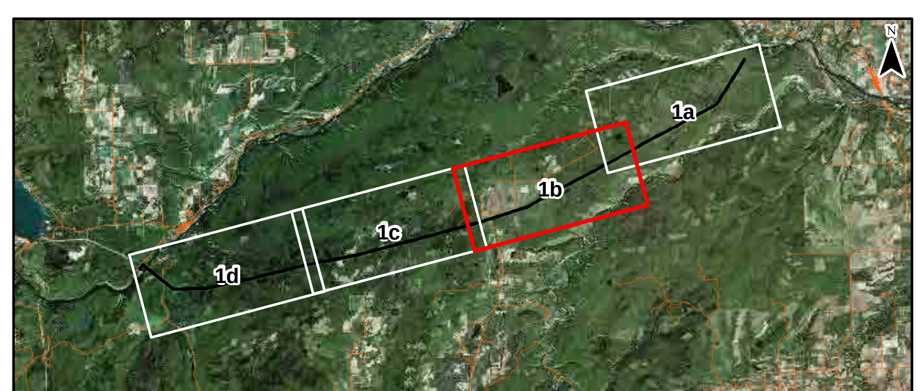


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Open Water Wetland within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Bird Strike Risk Ranking

PROJECTION: UTM Zone 10	DATUM: NAD83			
Scale: 1:50,000 (1 0.5 0 1 Kilometres)				
FILE NO.: VENV03094-01_Figure01_OpenWetland.mxd				
PROJECT NO.: ENV.VENV03094-01	DWN: MEZ	CKD: SL	APVD: JJ	REV: 0
OFFICE: Tt EBA-VANC	DATE: August 23, 2016			

CLIENT: BC hydro

TETRA TECH EBA

Figure 1b

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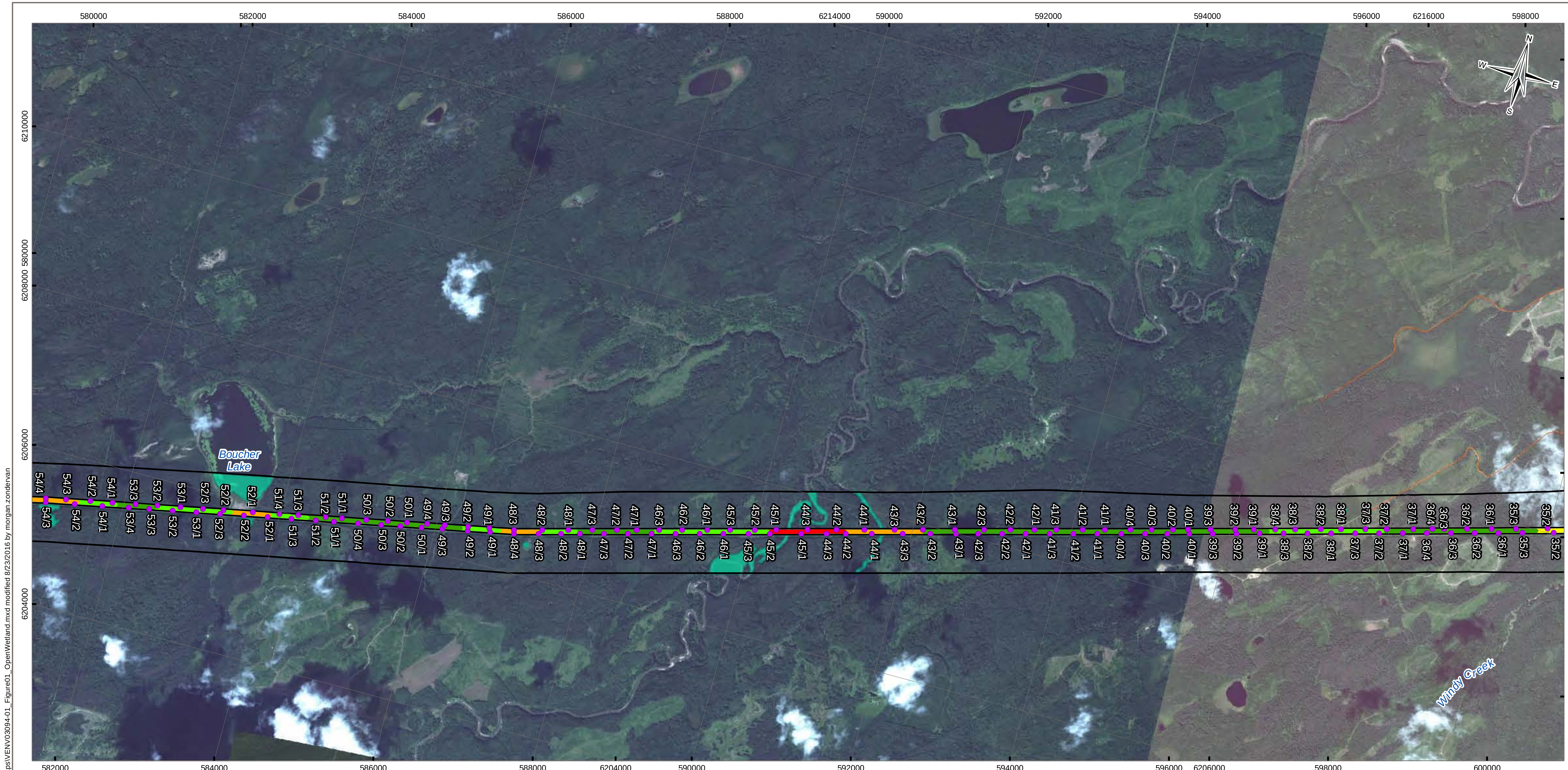
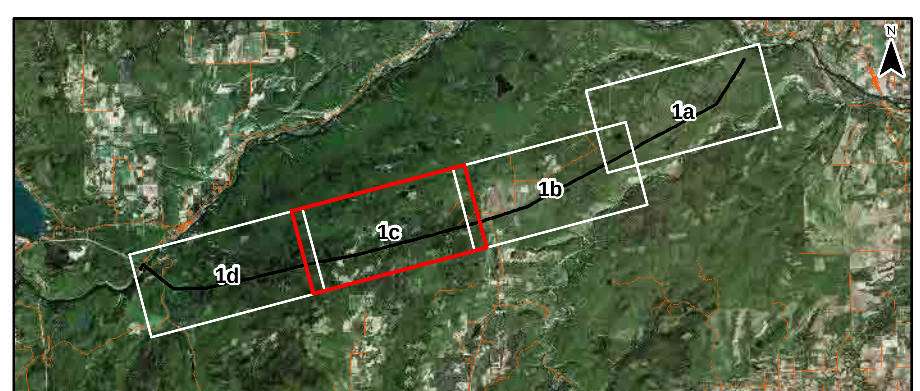


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Open Water Wetland within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Bird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure01_OpenWetland.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE: Tt EBA-VANC
DATE: August 23, 2016

Figure 1c

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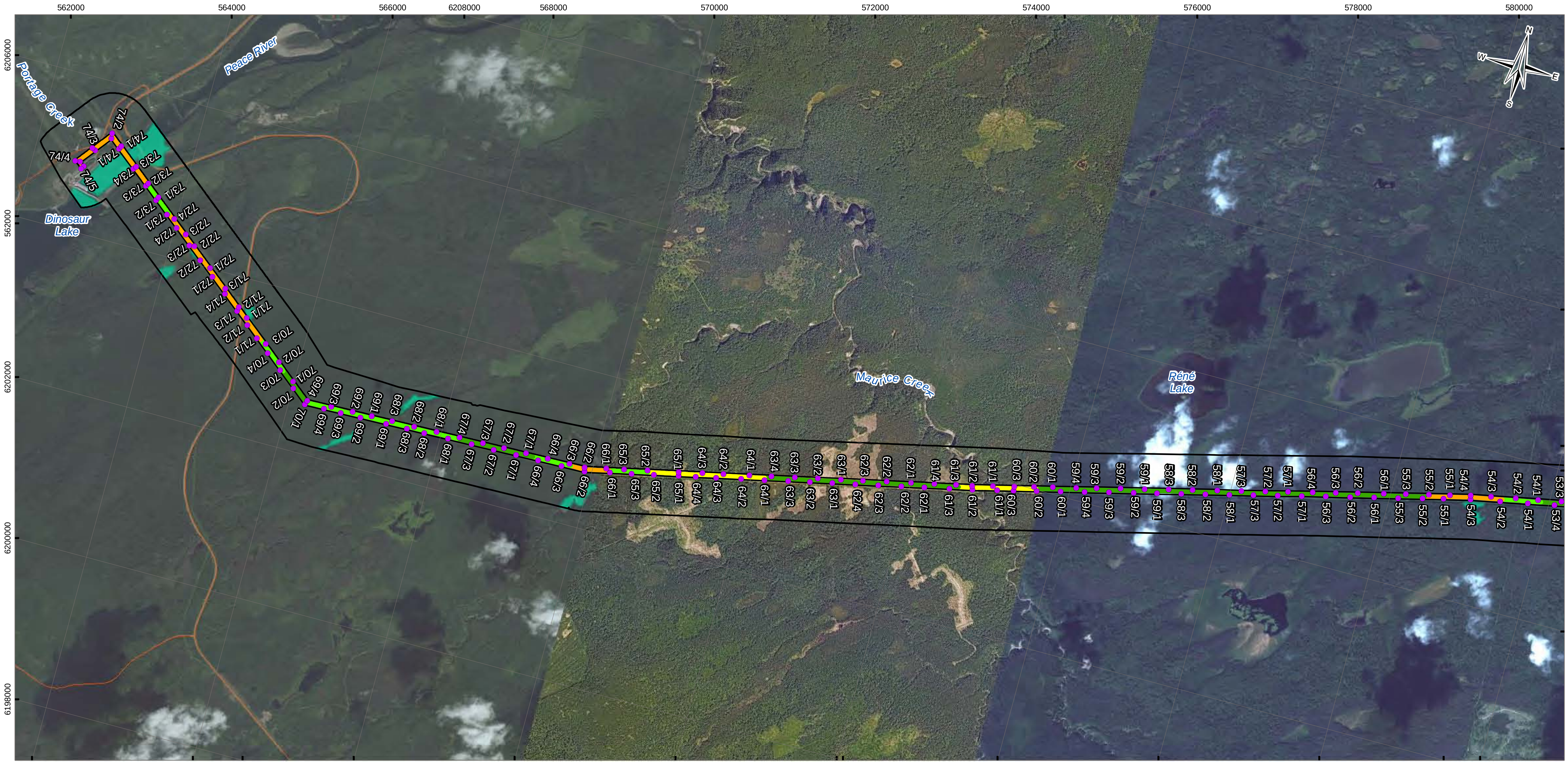
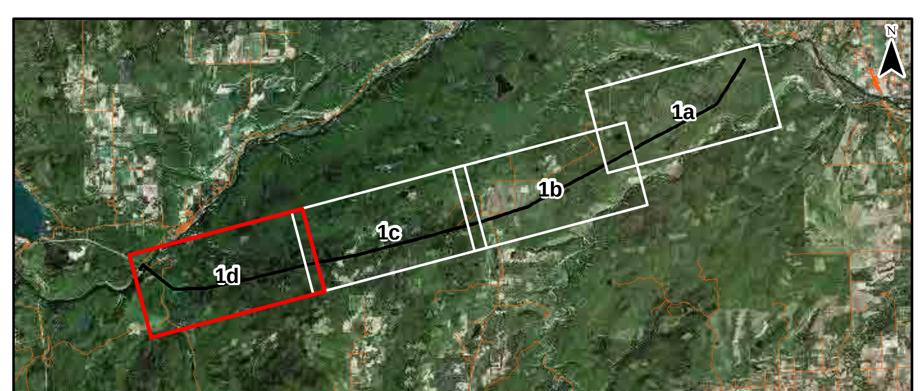


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Open Water Wetland within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



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STATUS
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SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Bird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure01_OpenWetland.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 1d

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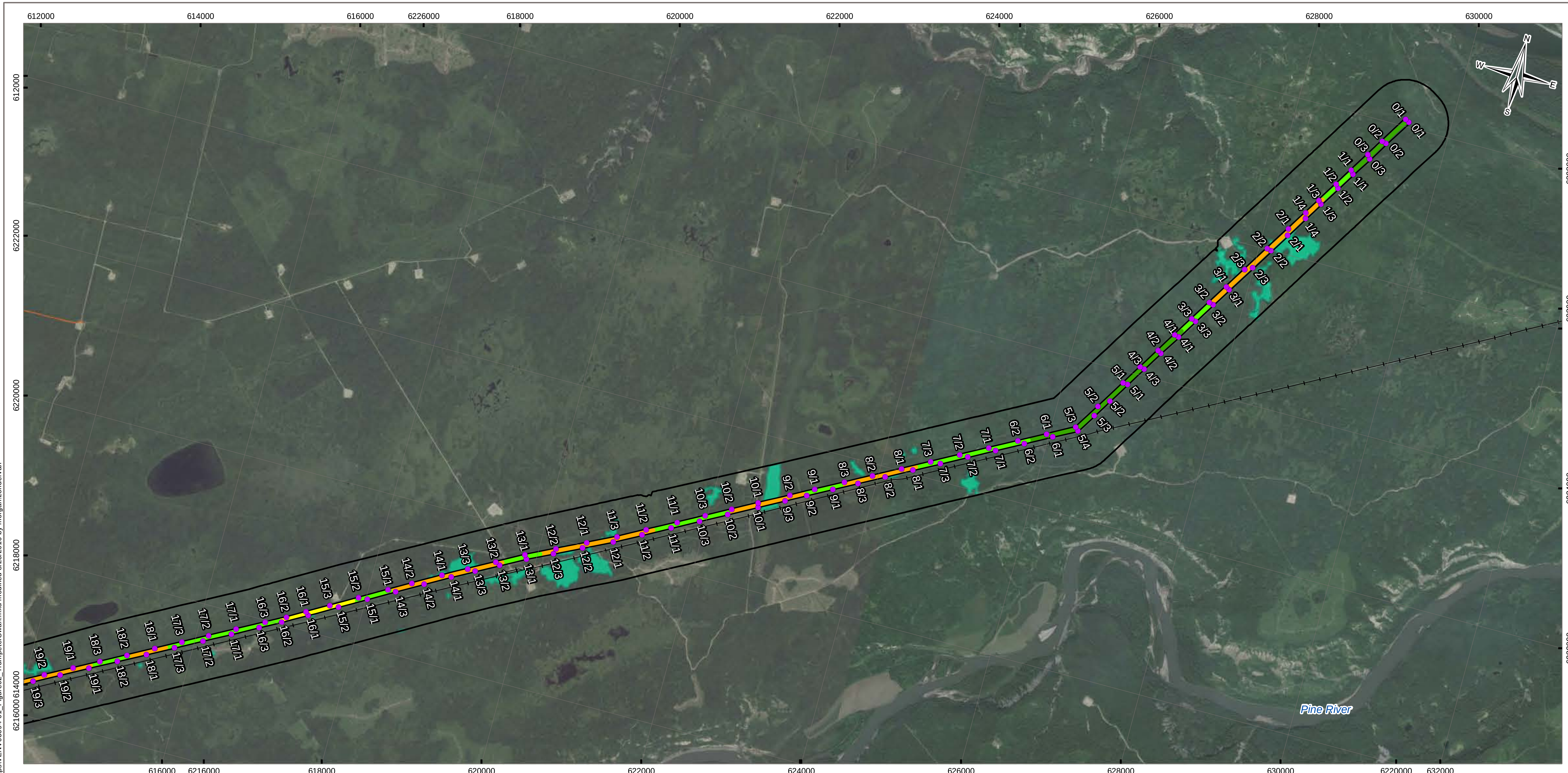
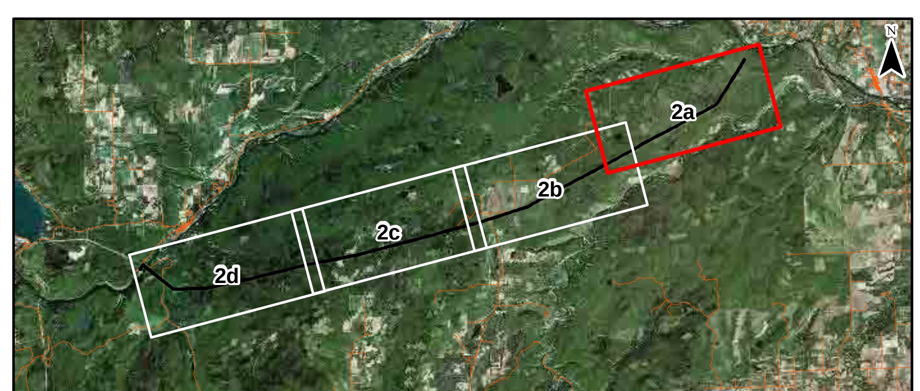


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Trumpeter Swan Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Trumpeter Swan Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure02_TrumpeterSwan.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 2a

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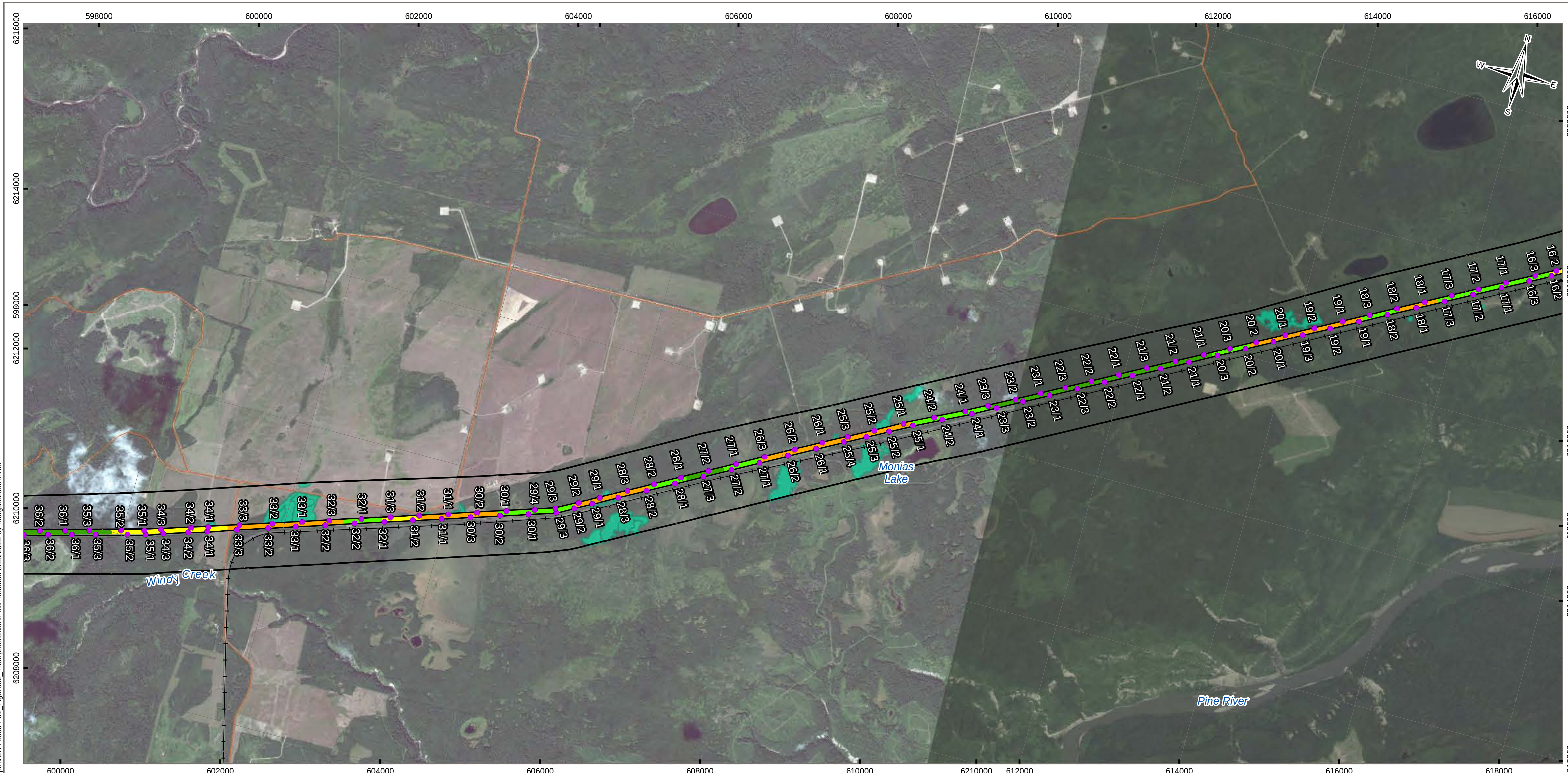
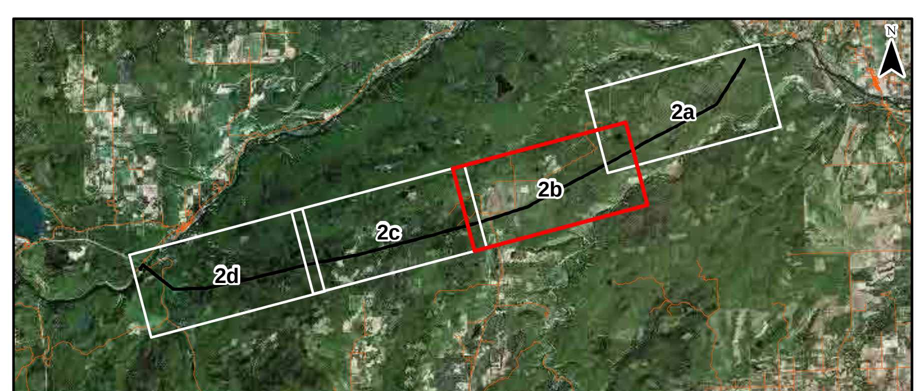


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Trumpeter Swan Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Trumpeter Swan Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure02_TrumpeterSwan.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 2b

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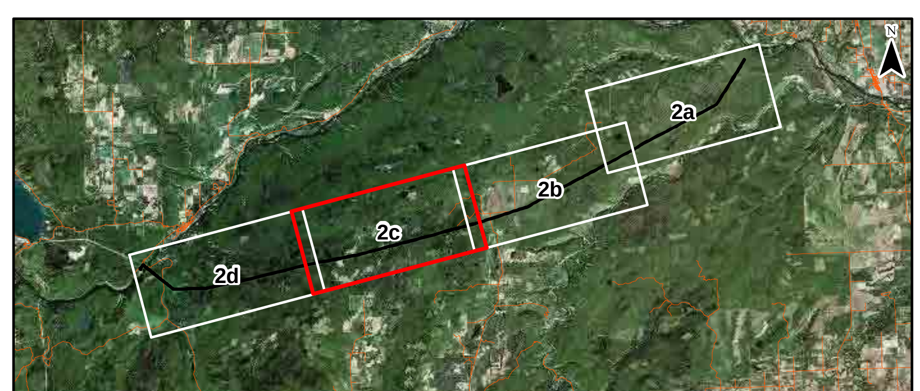
LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Trumpeter Swan Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Trumpeter Swan Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure02_TrumpeterSwan.mxd

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ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 2c

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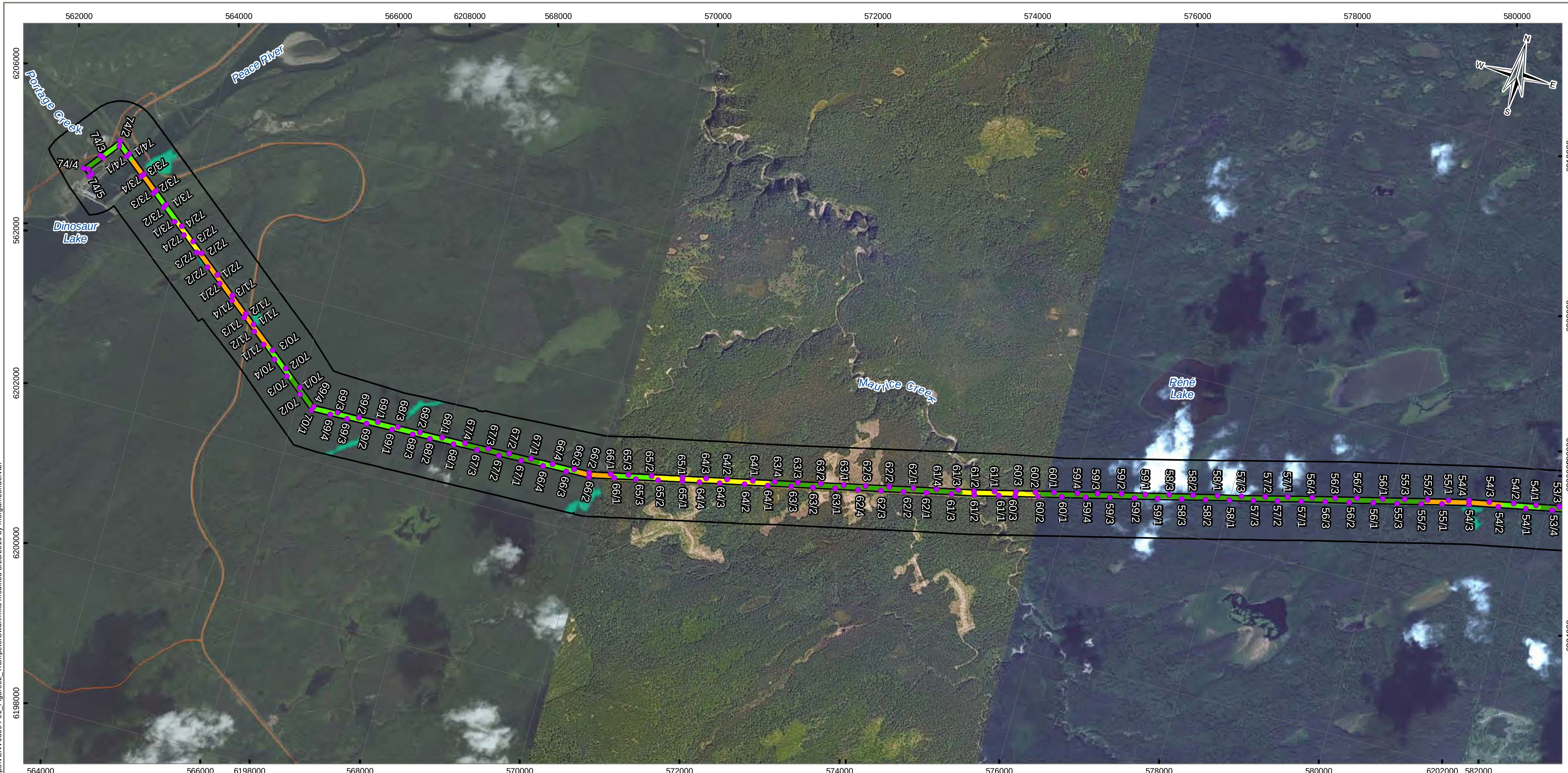

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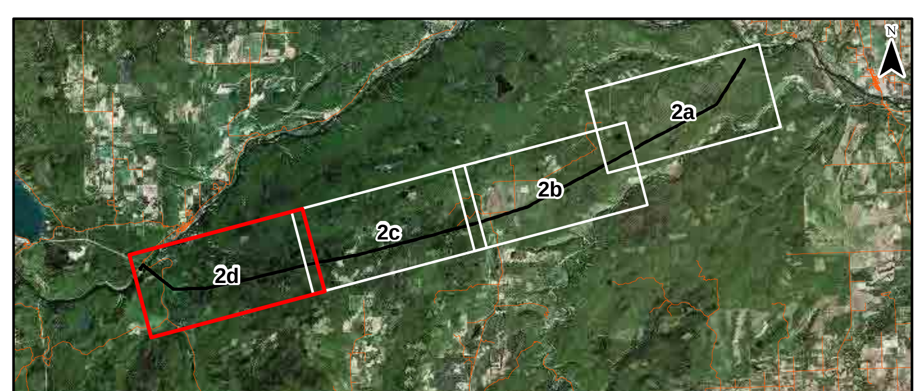
LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Trumpeter Swan Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Trumpeter Swan Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

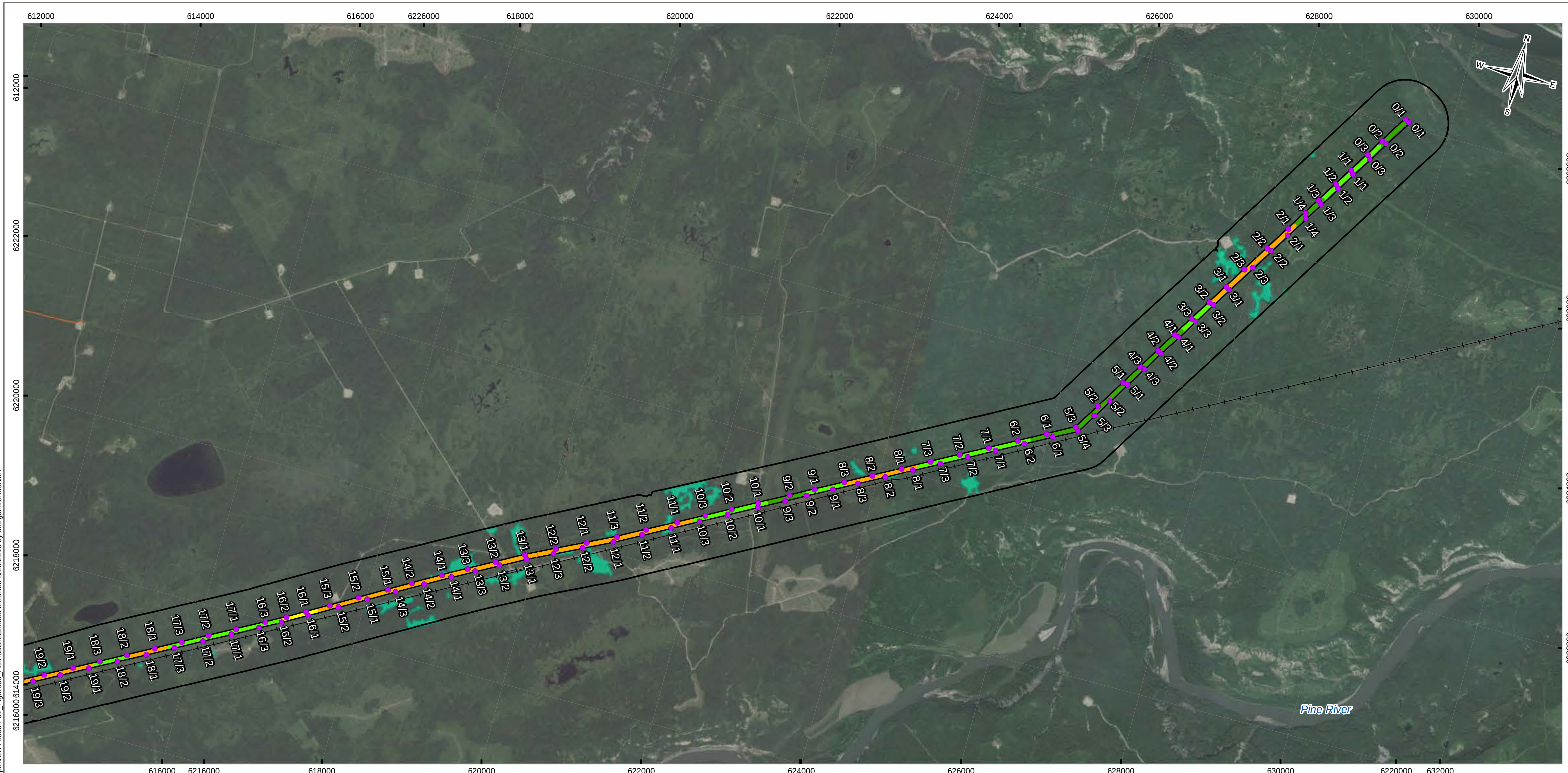
FILE NO.
VENV03094-01_Figure02_TrumpeterSwan.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 2d

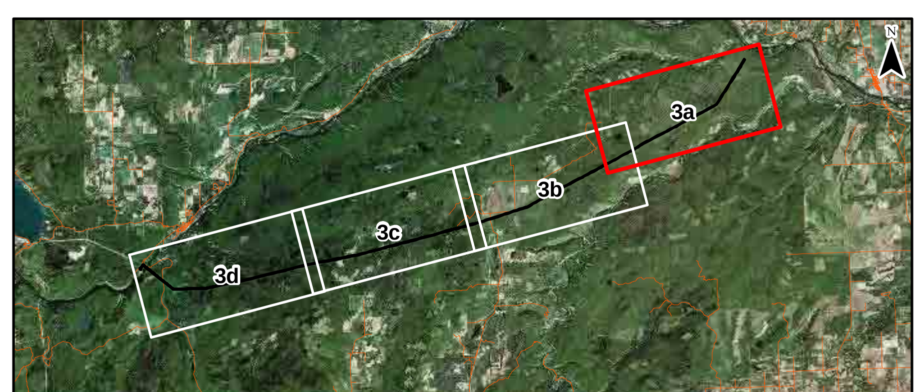


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Horned Grebe Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Horned Grebe Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure03_HornedGrebe.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 3a

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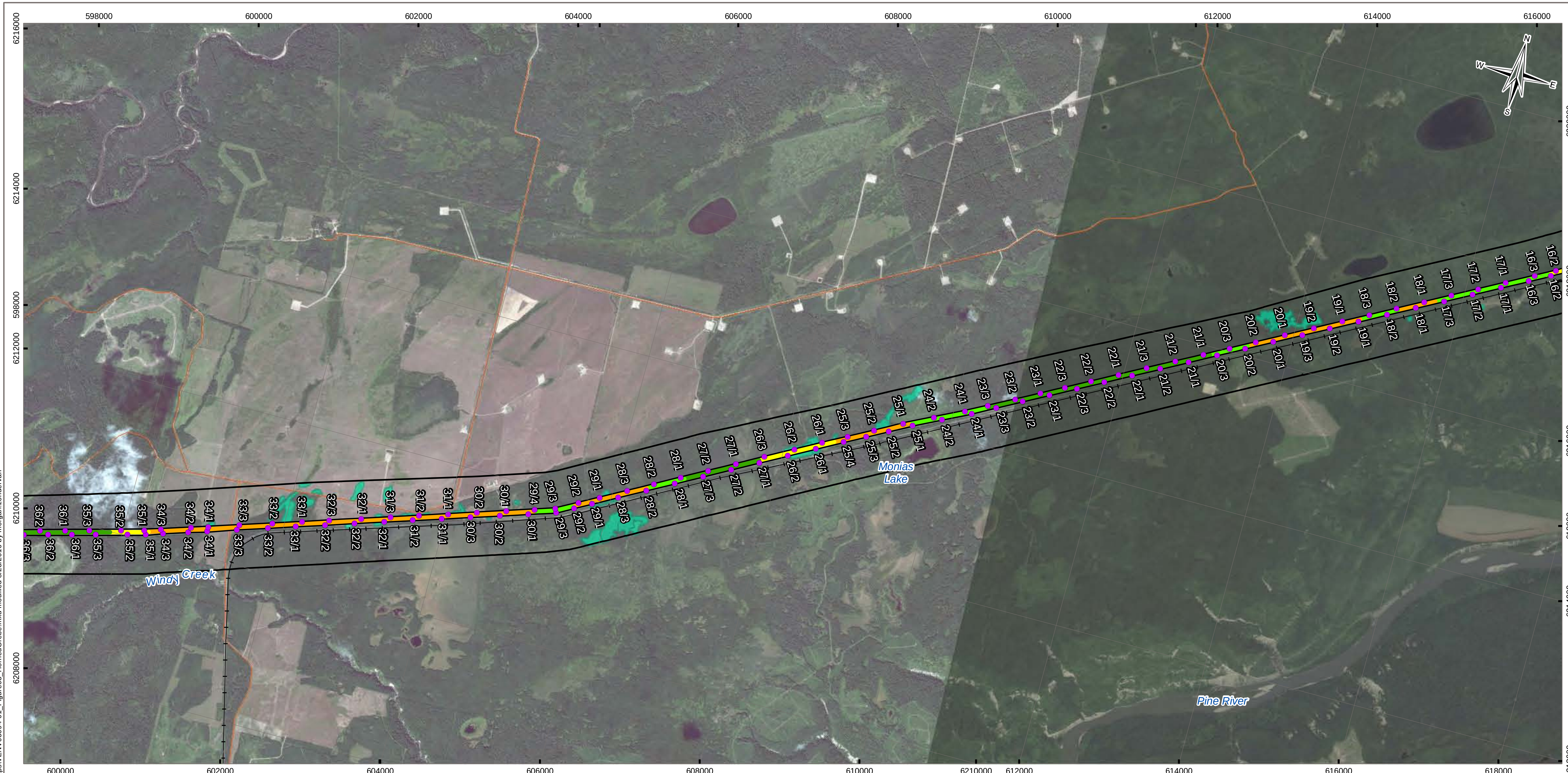
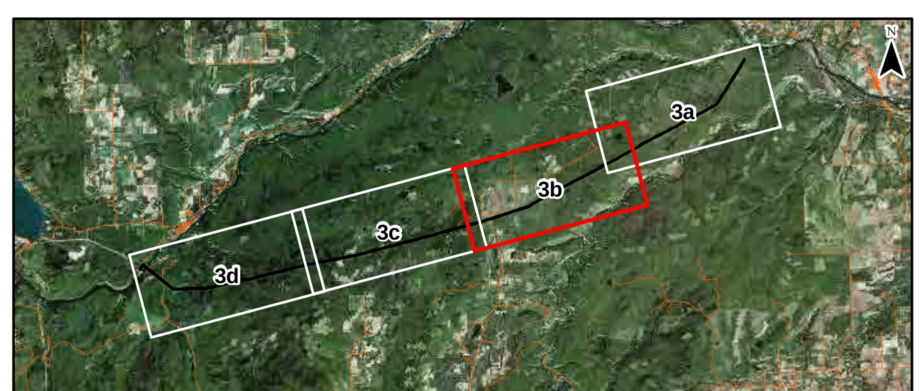


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Horned Grebe Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Horned Grebe Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure03_HornedGrebe.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 3b

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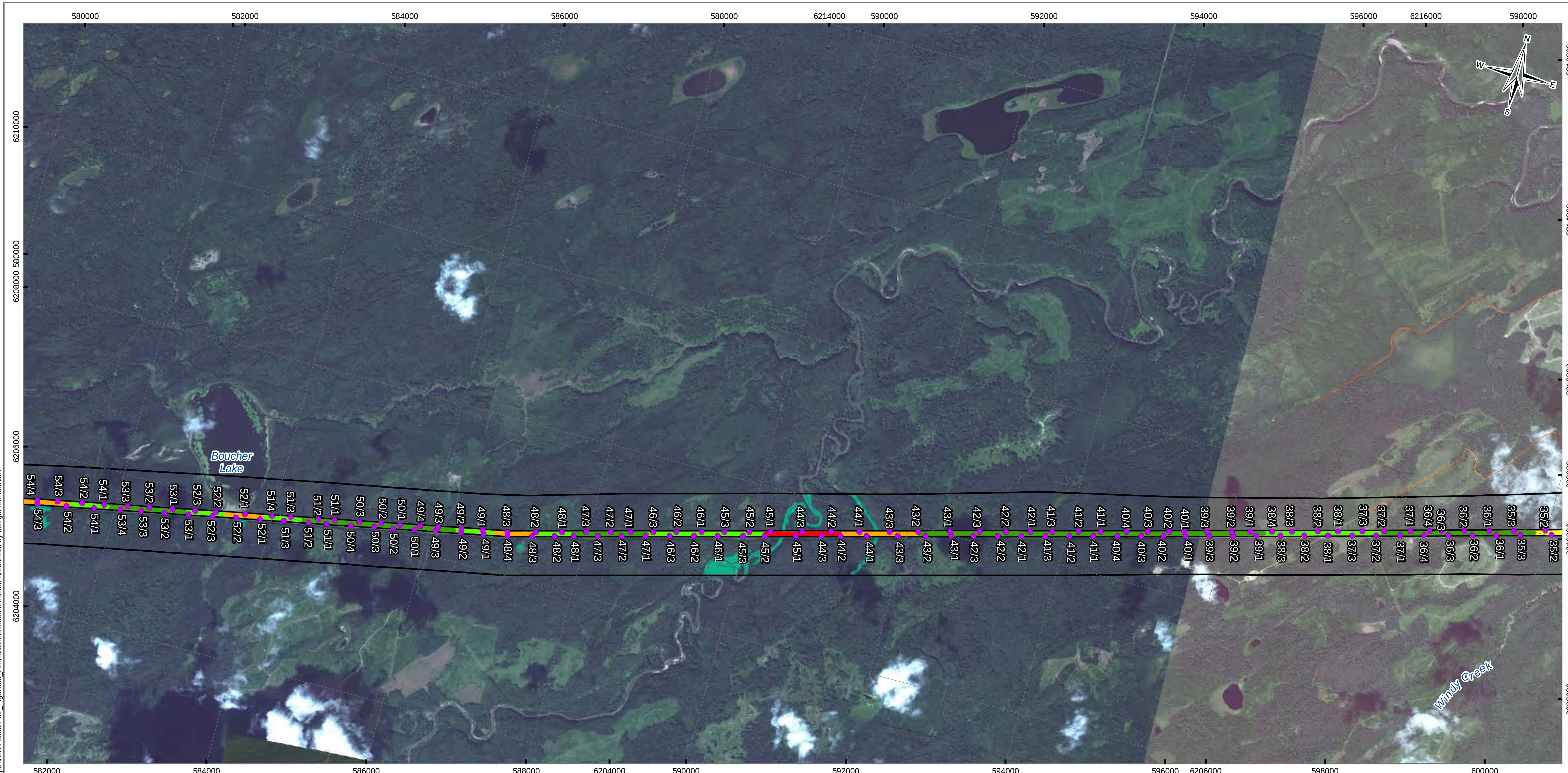
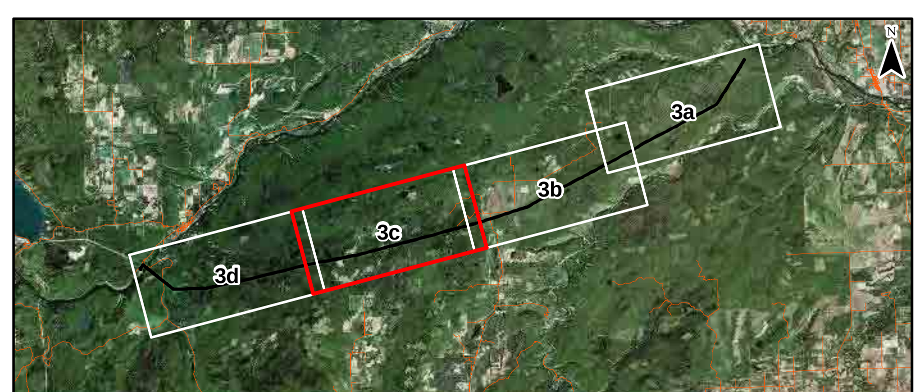


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Horned Grebe Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
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Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Horned Grebe Strike Risk Ranking

PROJECTION	UTM Zone 10
DATUM	NAD83
CLIENT	BC hydro
Scale	1:50,000 (1, 0.5, 0, 1 Kilometres)
FILE NO.	VENV03094-01_Figure03_HornedGrebe.mxd
PROJECT NO.	ENV.VENV03094-01
DWN	MEZ
CKD	SL
APVD	JJ
REV	0
OFFICE	Tt EBA-VANC
DATE	August 23, 2016

TETRA TECH EBA

Figure 3c

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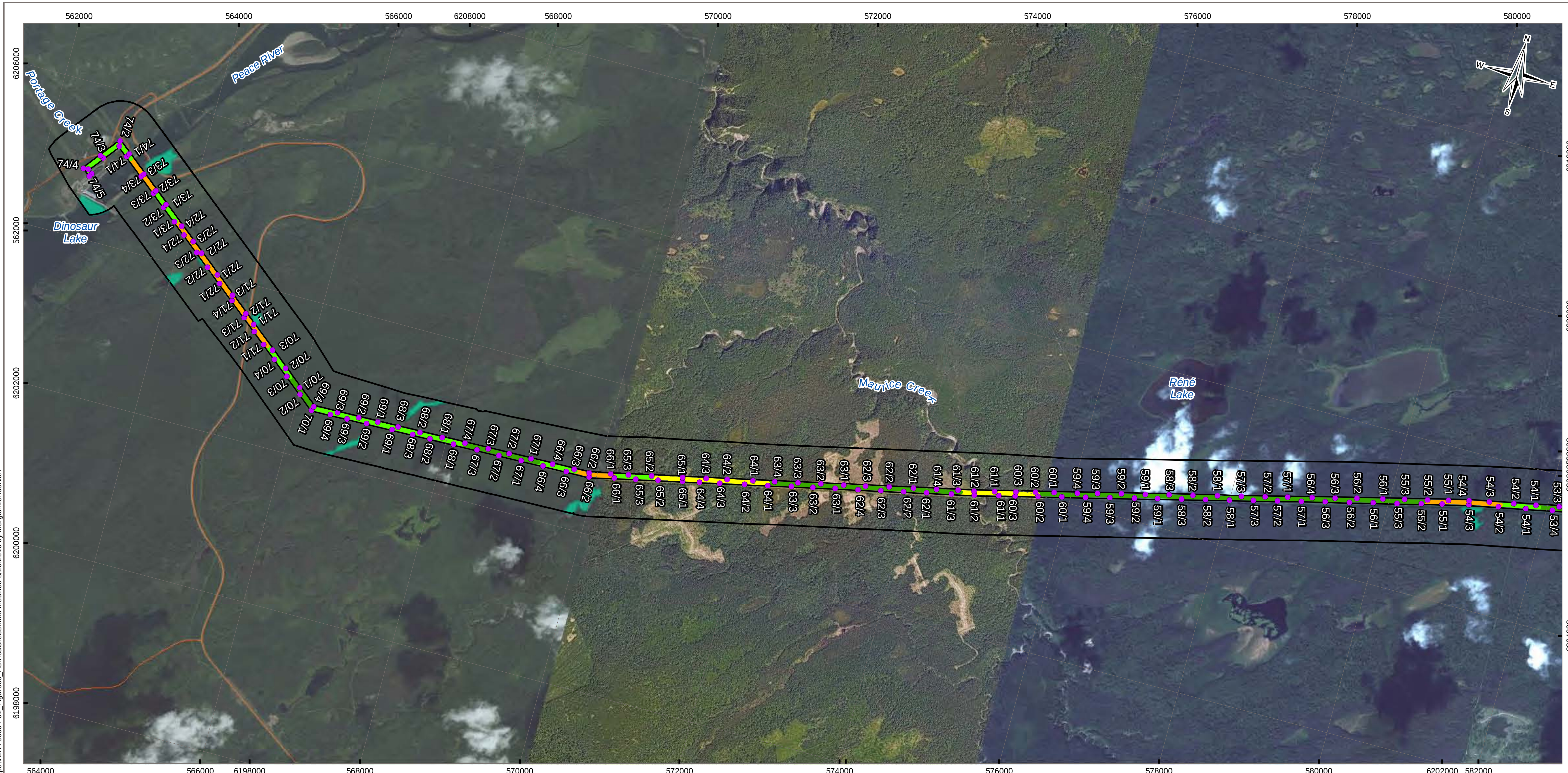
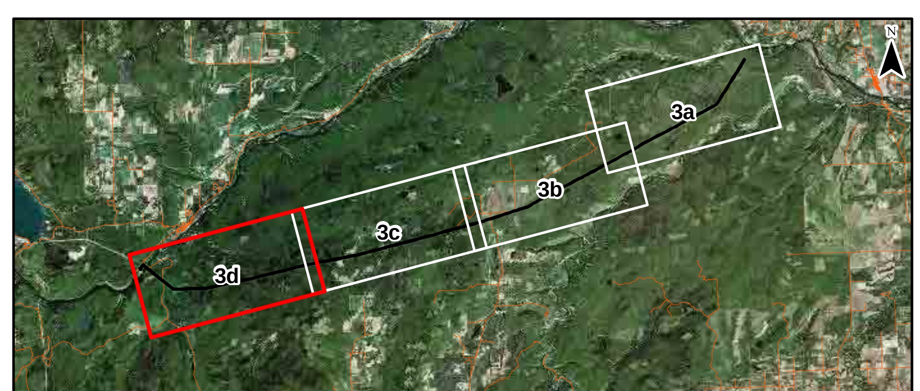


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Horned Grebe Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



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Base data source:
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Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Horned Grebe Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

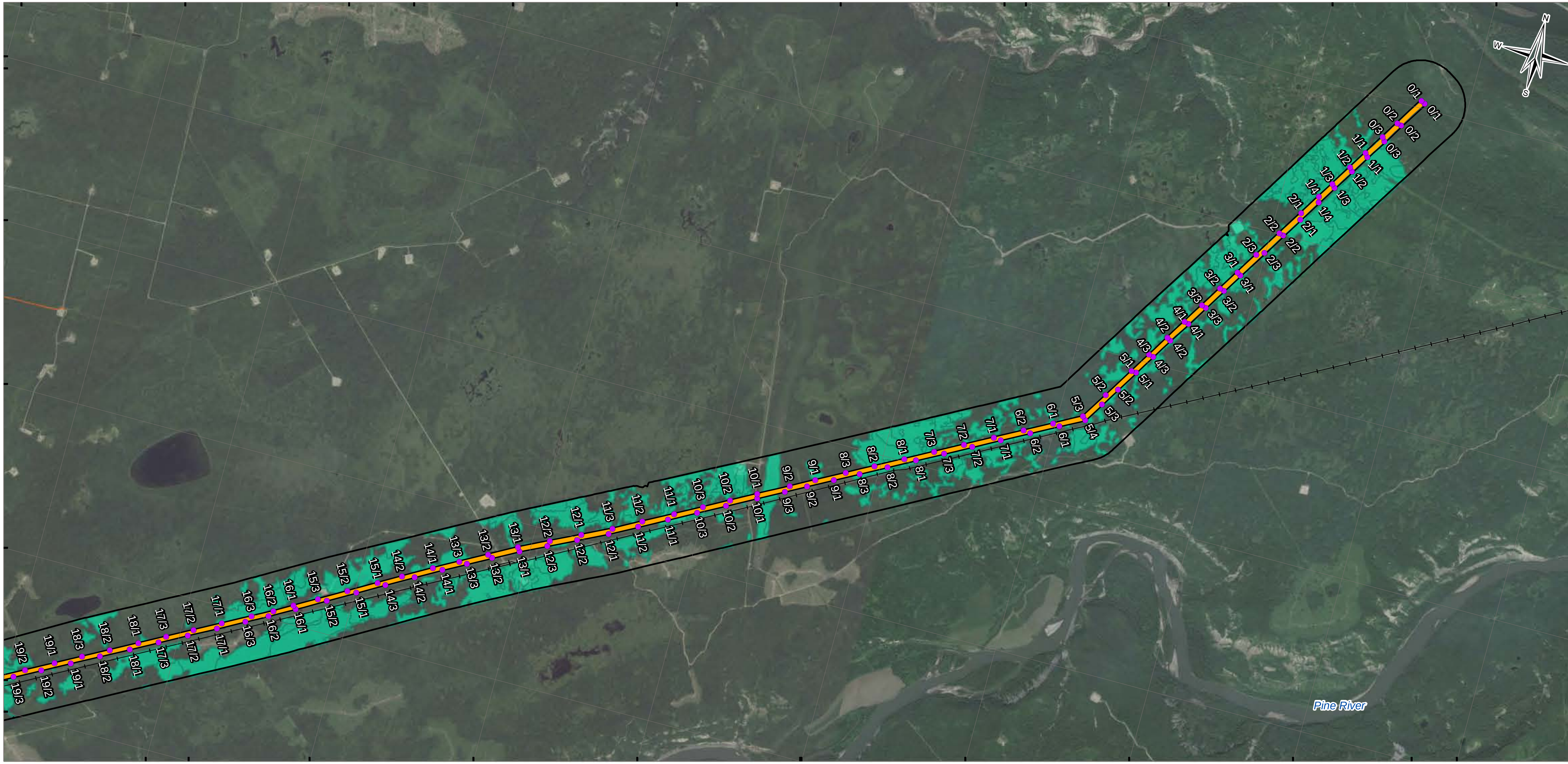
FILE NO.
VENV03094-01_Figure03_HornedGrebe.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 3d

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure03_HornedGrebe.mxd modified 8/23/2016 by morgan.zondervan

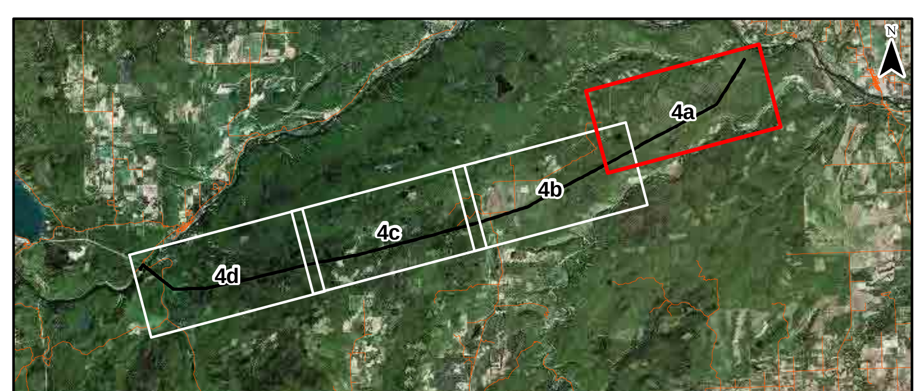


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Common Nighthawk Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Common Nighthawk Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

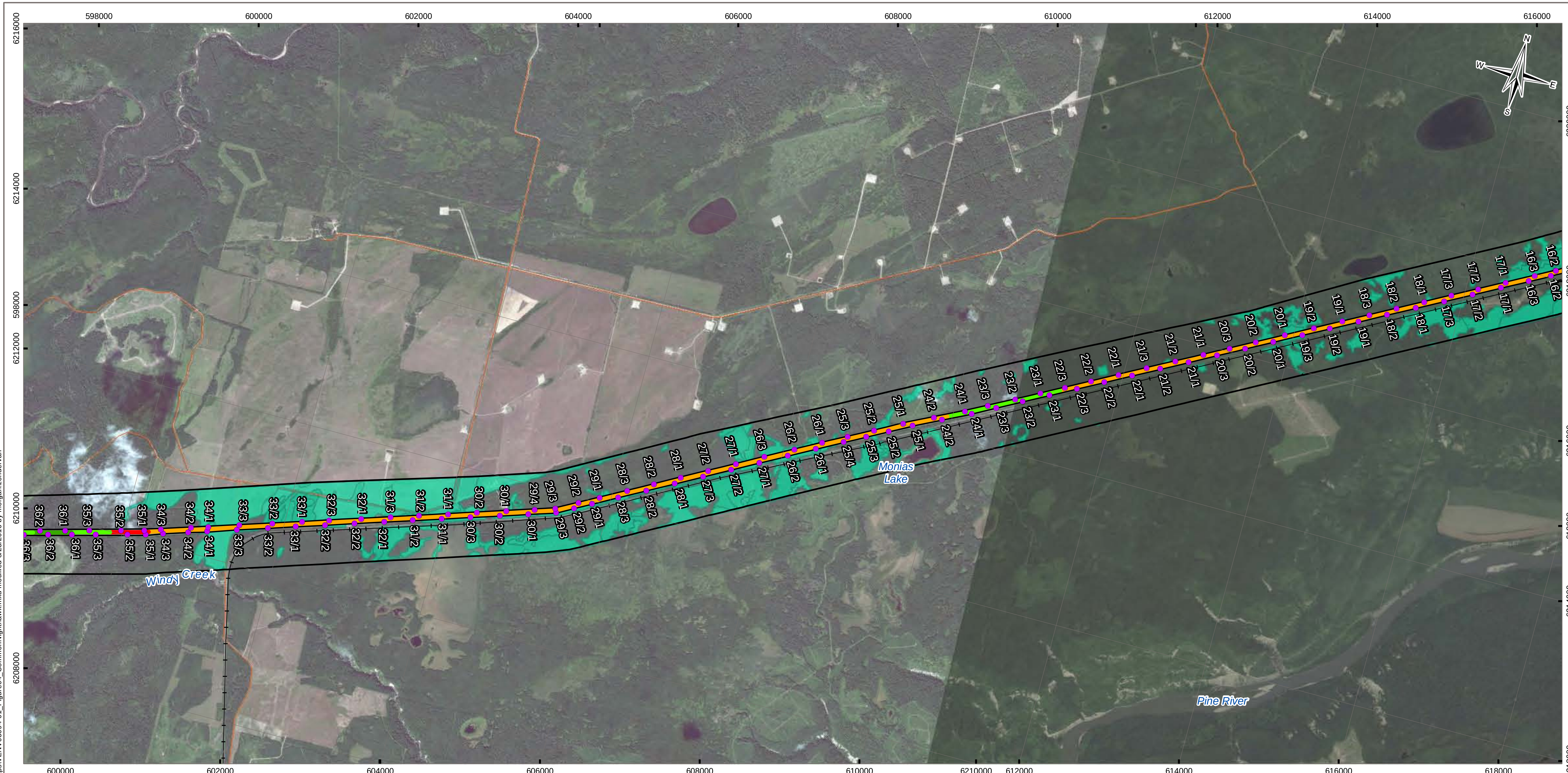
FILE NO.
VENV03094-01_Figure04_CommonNighthawk.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 4a

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydroMaps\VENV03094-01_Figure04_CommonNighthawk.mxd modified 8/23/2016 by morgan.zondervan

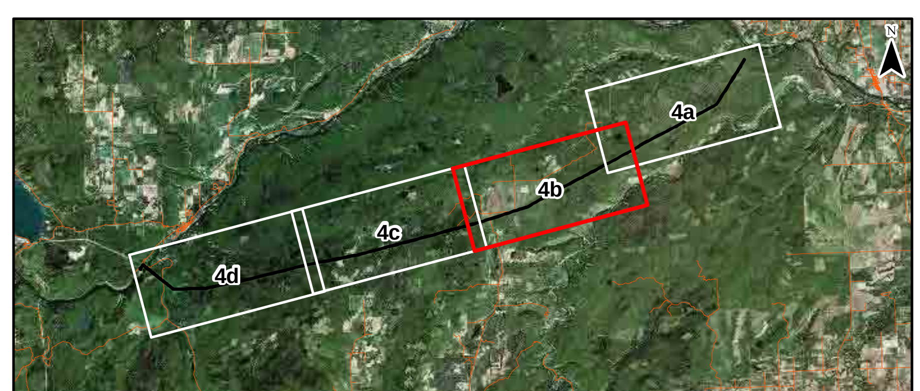


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Common Nighthawk Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Common Nighthawk Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure04_CommonNighthawk.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 4b

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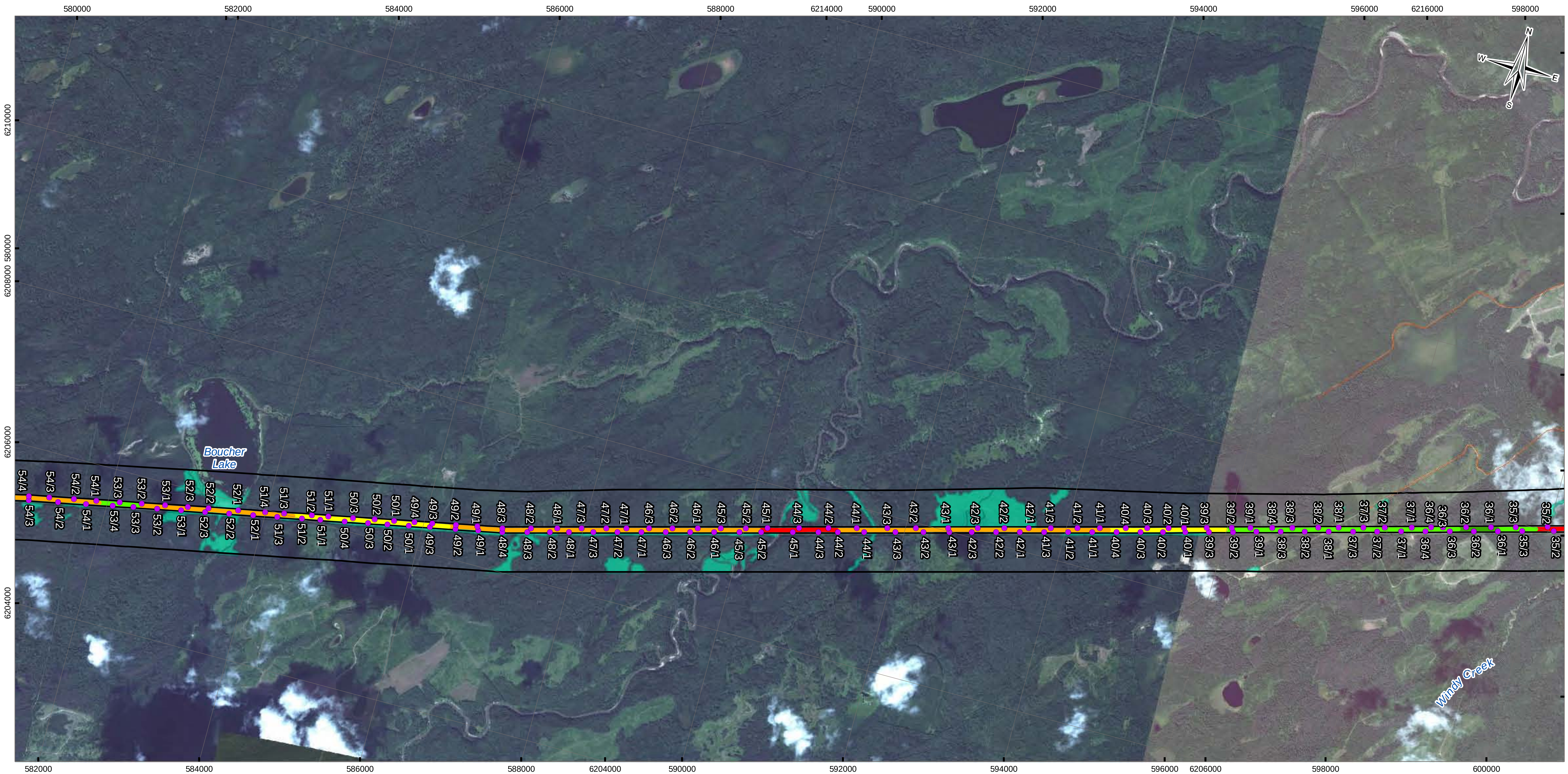
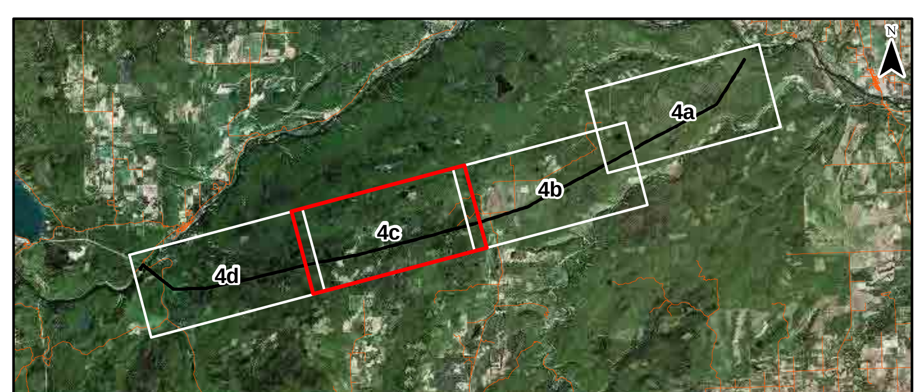


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Common Nighthawk Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Common Nighthawk Strike Risk Ranking

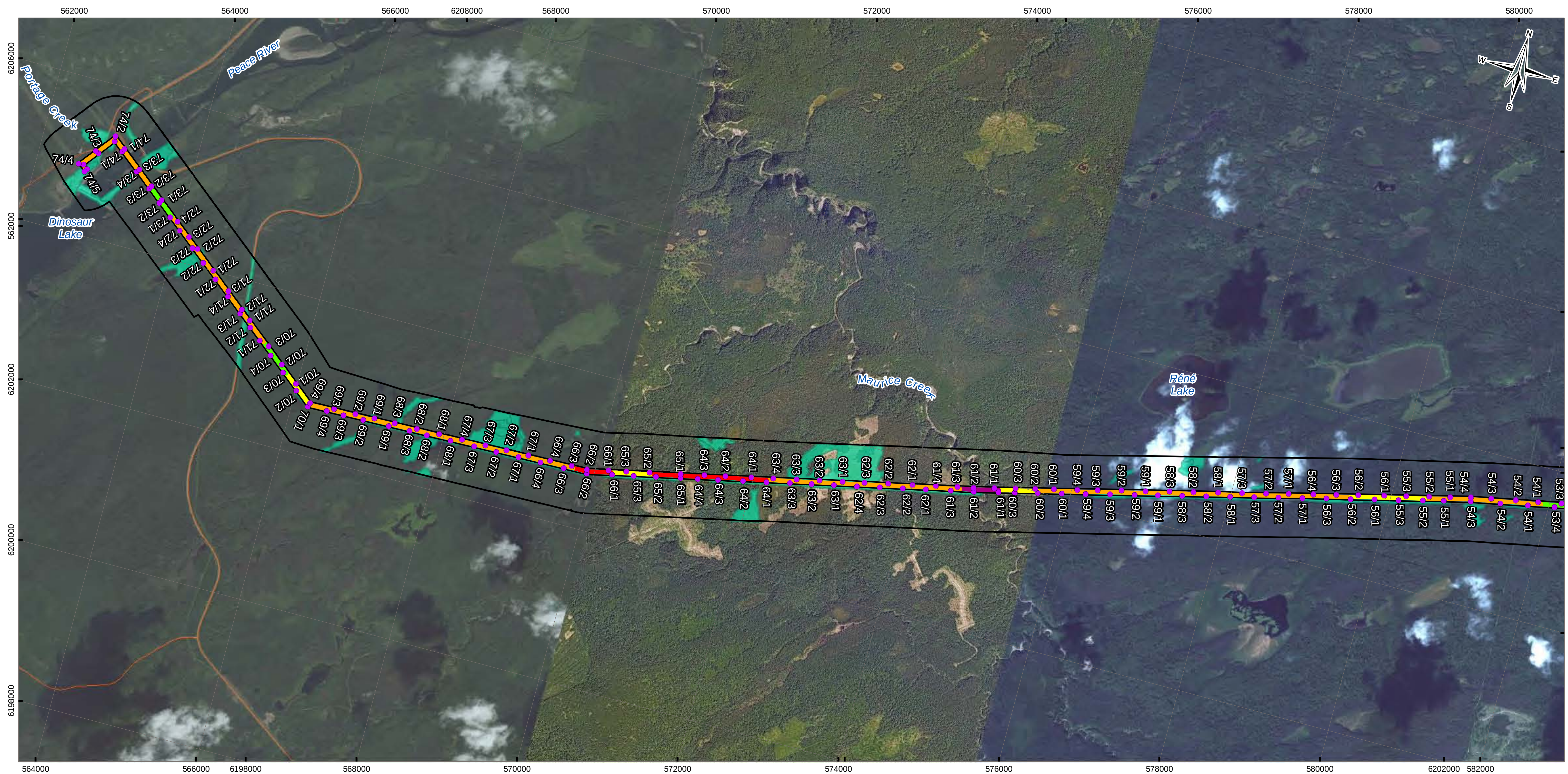
PROJECTION: UTM Zone 10	DATUM: NAD83			
Scale: 1:50,000 (1 0.5 0 1 Kilometres)				
FILE NO.: VENV03094-01_Figure04_CommonNighthawk.mxd				
PROJECT NO.: ENV.VENV03094-01	DWN: MEZ	CKD: SL	APVD: JJ	REV: 0
OFFICE: Tt EBA-VANC	DATE: August 23, 2016			

CLIENT: BC hydro

TETRA TECH EBA

STATUS
ISSUED FOR USE

Figure 4c



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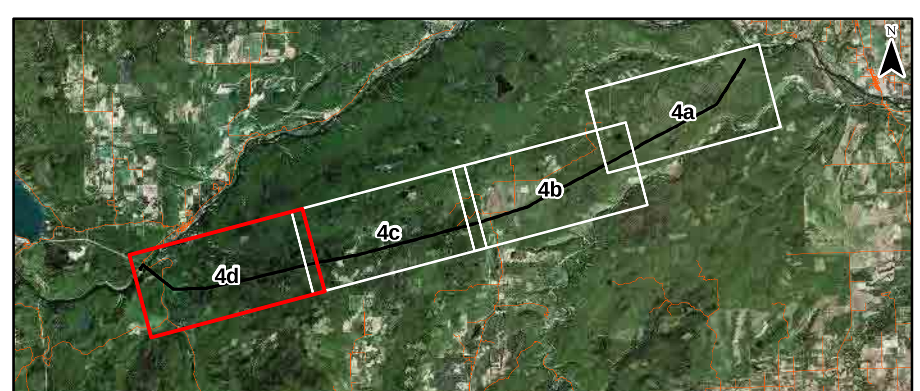
LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Common Nighthawk Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Common Nighthawk Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure04_CommonNighthawk.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

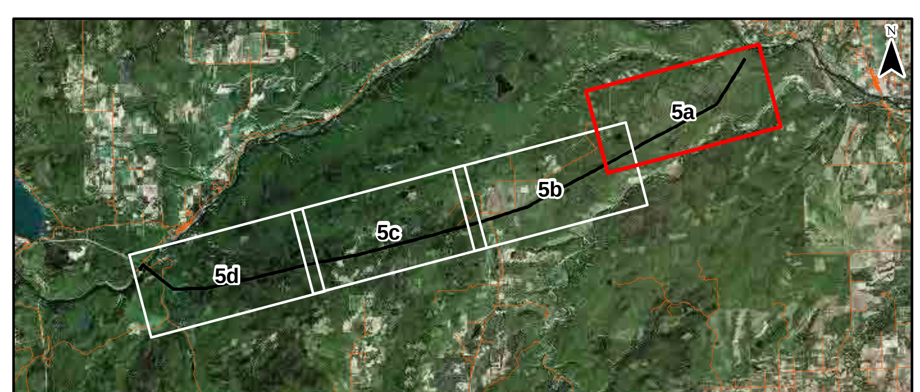
Figure 4d

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Olive-sided Flycatcher Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Olive-sided Flycatcher Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

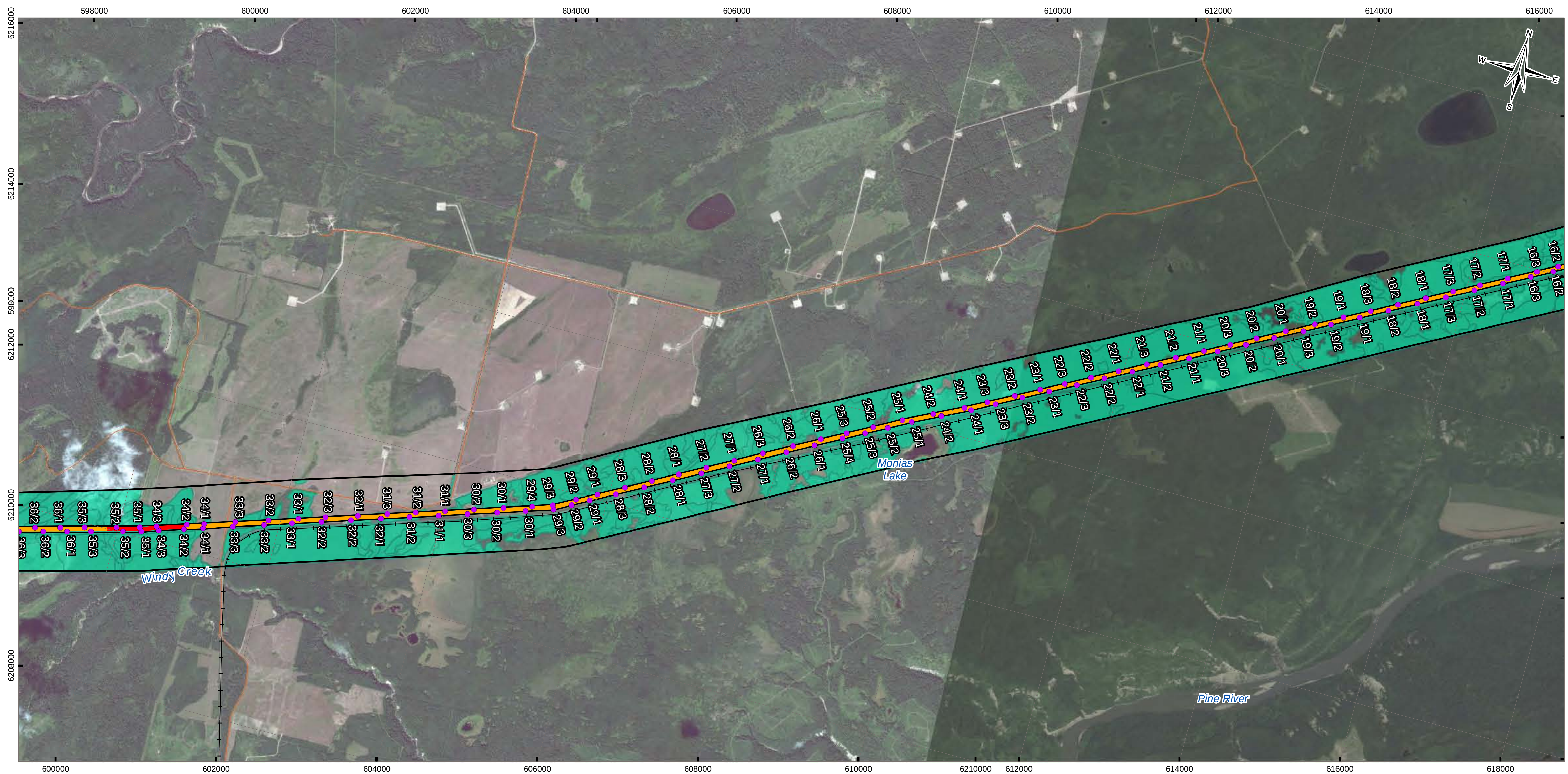
FILE NO.
VENV03094-01_Figure05_OlivesidedFlycatcher.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 5a

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure05_OlivesidedFlycatcher.mxd modified 8/23/2016 by morgan.zondervan

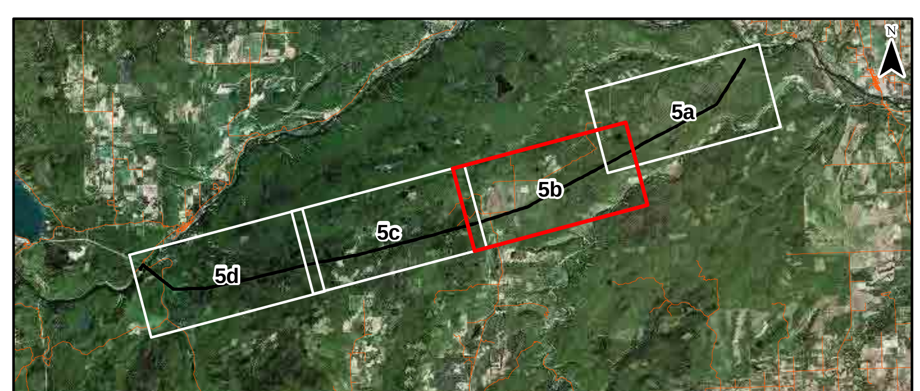


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Olive-sided Flycatcher Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Olive-sided Flycatcher Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000

1 0.5 0 1

Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure05_OlivesidedFlycatcher.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 5b

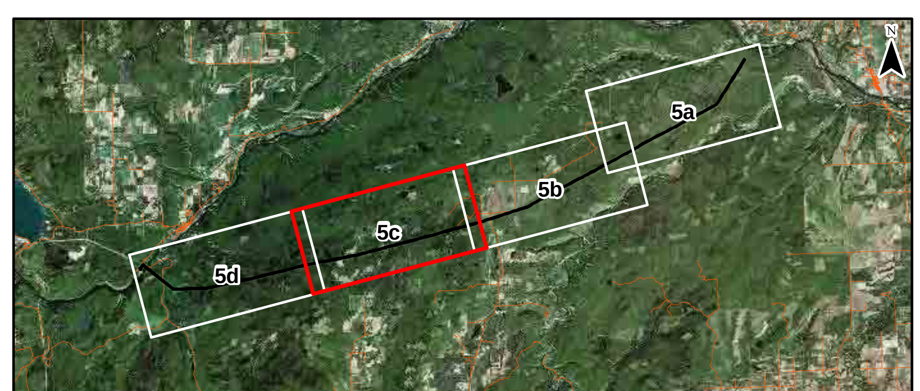
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure05_OlivesidedFlycatcher.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Olive-sided Flycatcher Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastructure, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Olive-sided Flycatcher Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000

1 0.5 0 1

Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure05_OlivesidedFlycatcher.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 5c

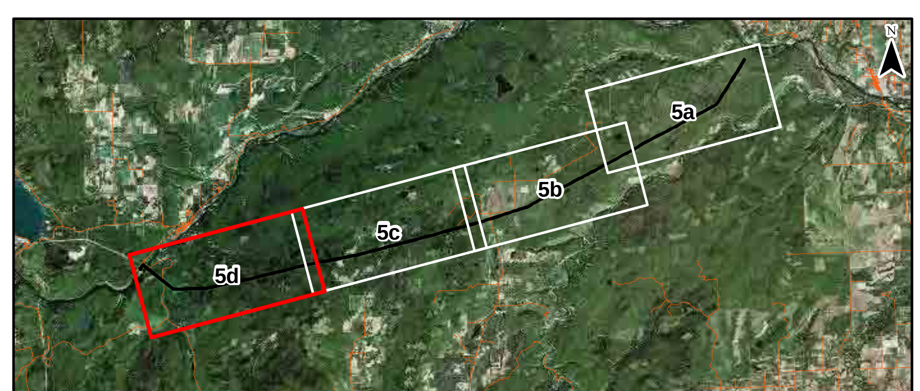
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure05_OlivesidedFlycatcher.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Olive-sided Flycatcher Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Olive-sided Flycatcher Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

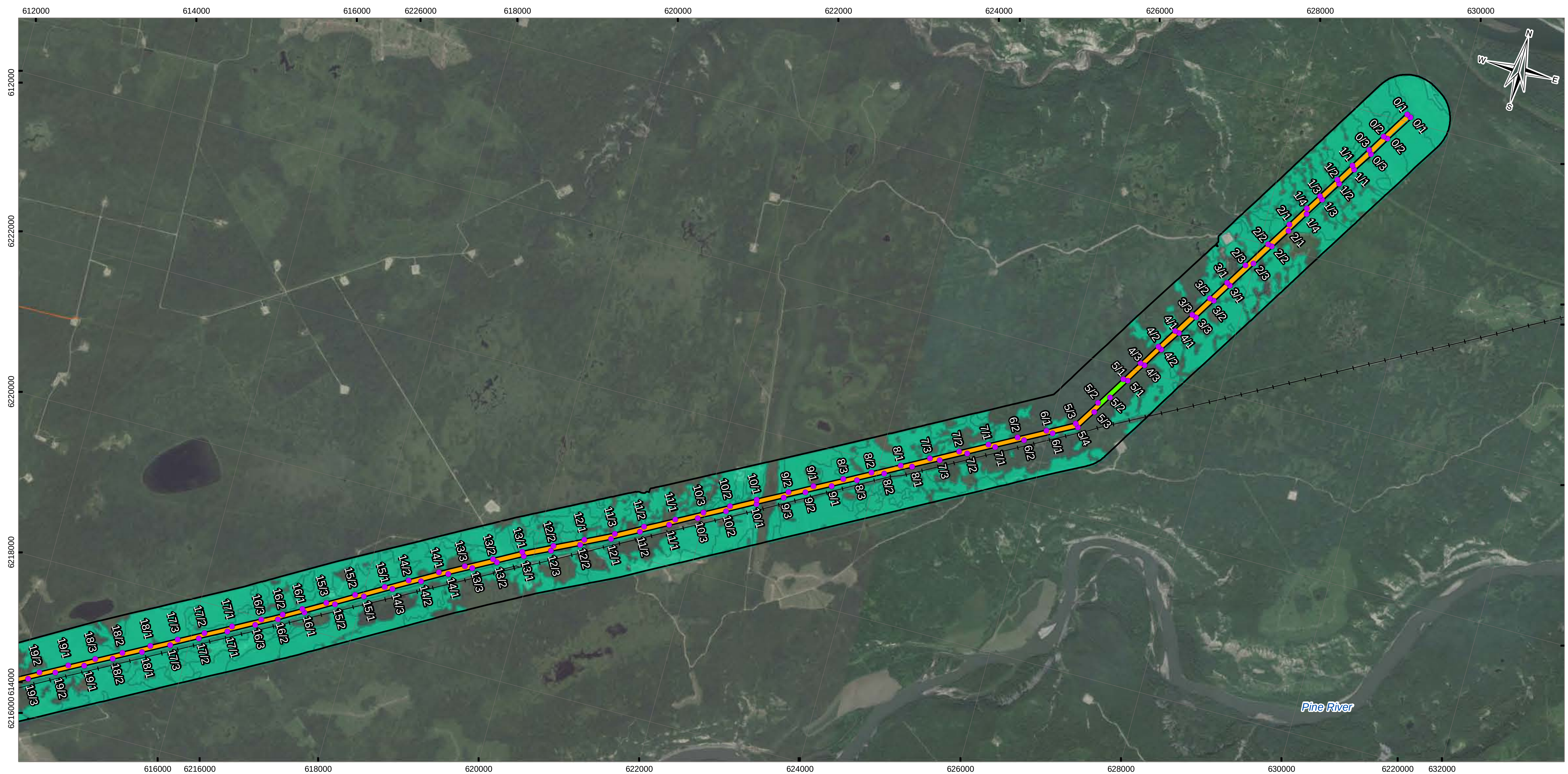
Scale: 1:50,000
Kilometres

FILE NO.				
VENV03094-01_Figure05_OlivesidedFlycatcher.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0
OFFICE	DATE			
Tt EBA-VANC	August 23, 2016			

TETRA TECH EBA

Figure 5d

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure05_OlivesidedFlycatcher.mxd modified 8/23/2016 by morgan.zondervan

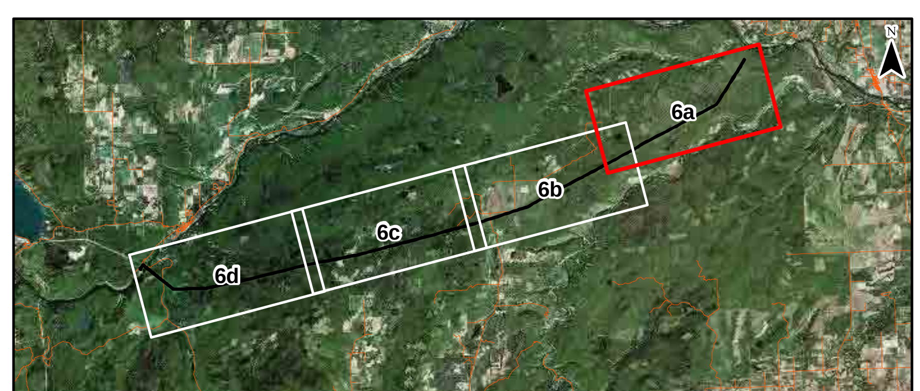


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Connecticut Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Connecticut Warbler Strike Risk Ranking

PROJECTION: UTM Zone 10	DATUM: NAD83

Scale: 1:50,000

1 0.5 0 1
Kilometres

CLIENT: BC hydro

TETRA TECH EBA

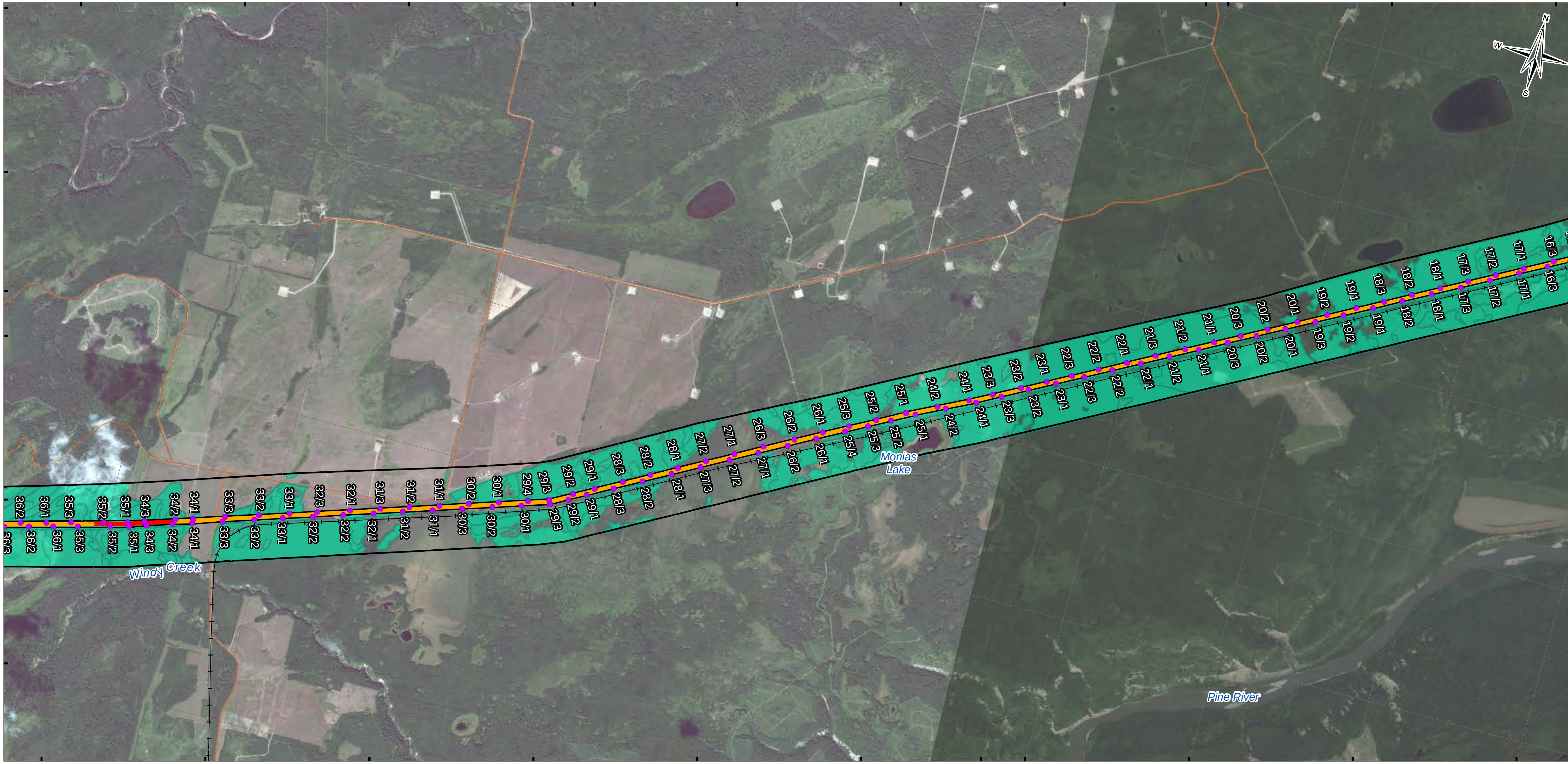
FILE NO.
VENV03094-01_Figure06_ConnecticutWarbler.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 6a

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure06_ConnecticutWarbler.mxd modified 8/23/2016 by morgan.zondervan

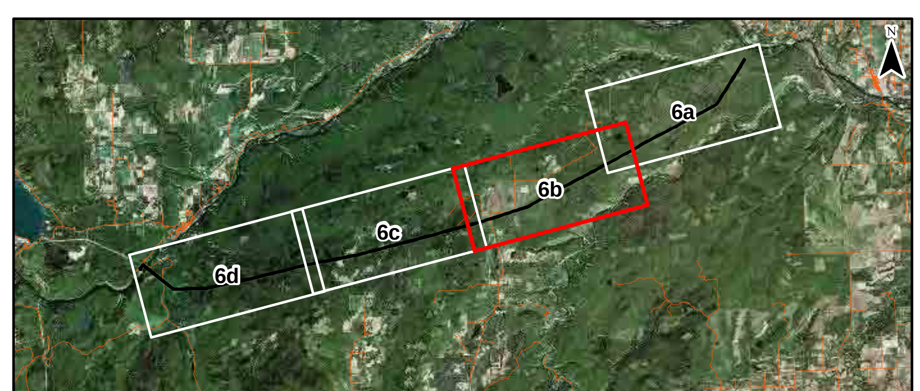


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Connecticut Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Connecticut Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

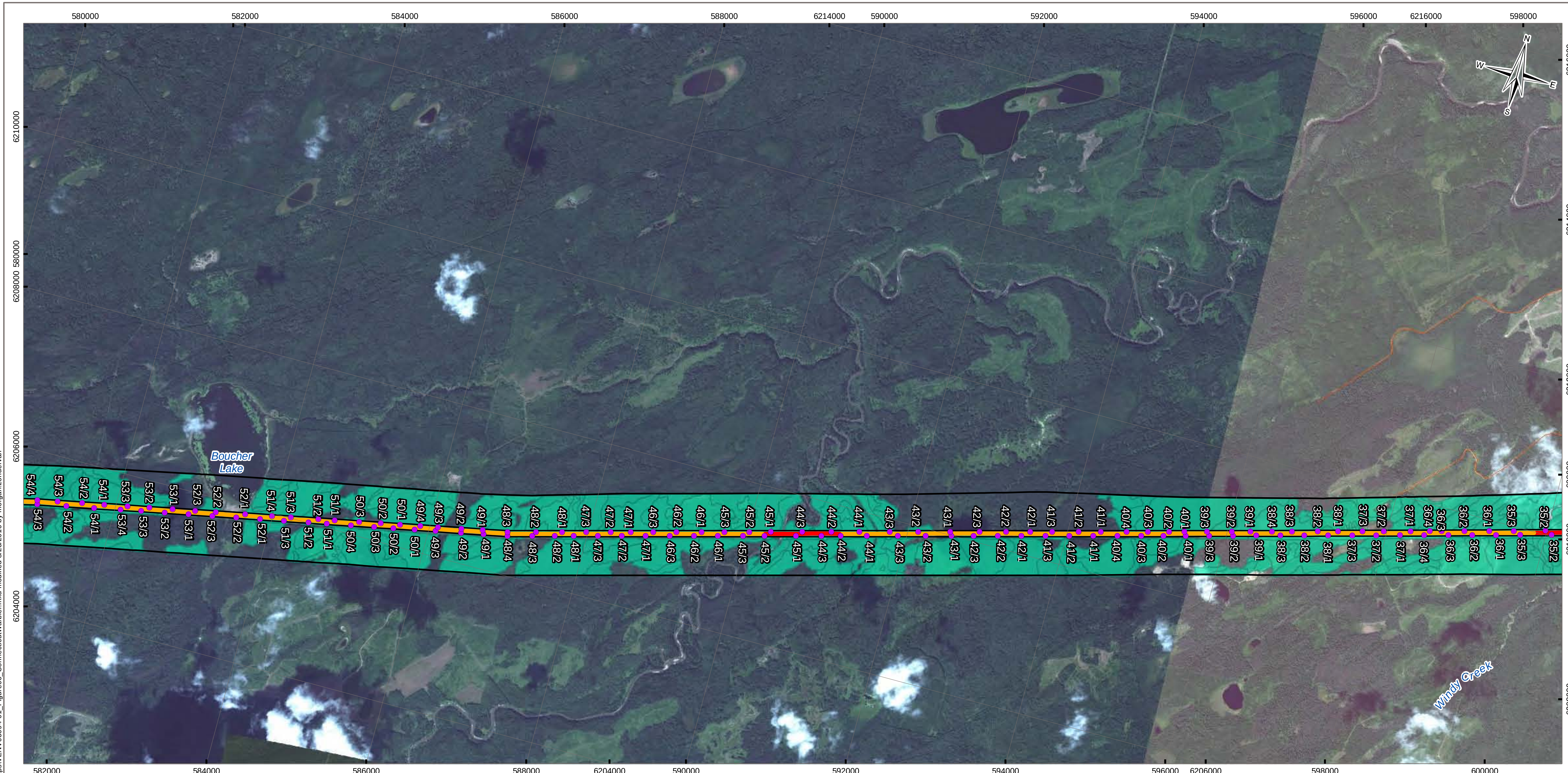
FILE NO.
VENV03094-01_Figure06_ConnecticutWarbler.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 6b

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure06_ConnecticutWarbler.mxd modified 8/23/2016 by morgan.zondervan

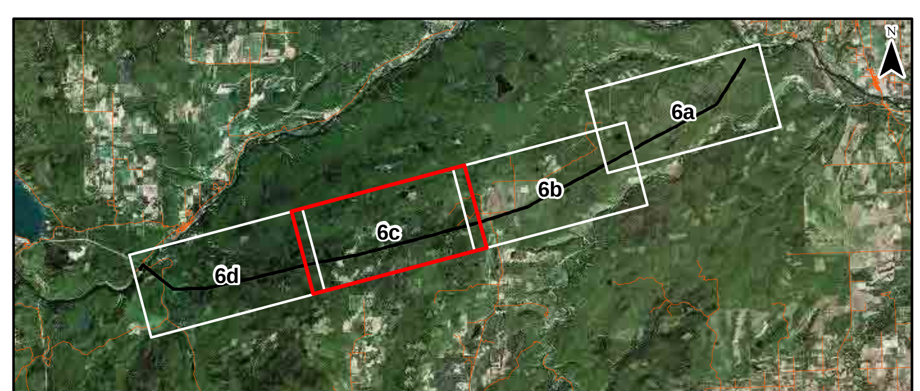


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Connecticut Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
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STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Connecticut Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure06_ConnecticutWarbler.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 6c

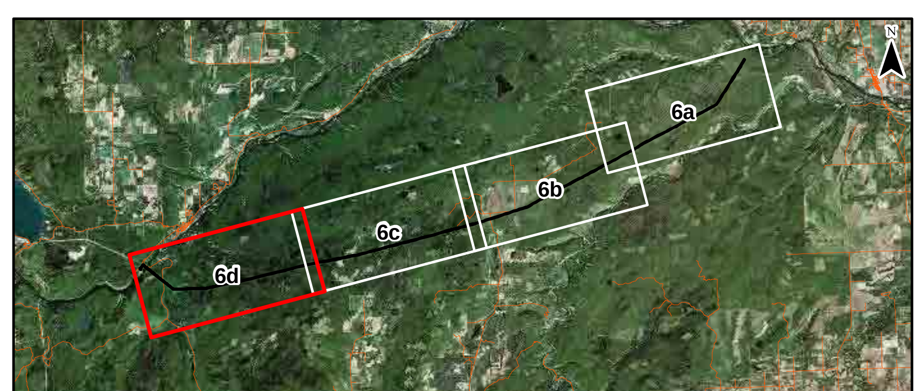
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure06_ConnecticutWarbler.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Connecticut Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Connecticut Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure06_ConnecticutWarbler.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 6d

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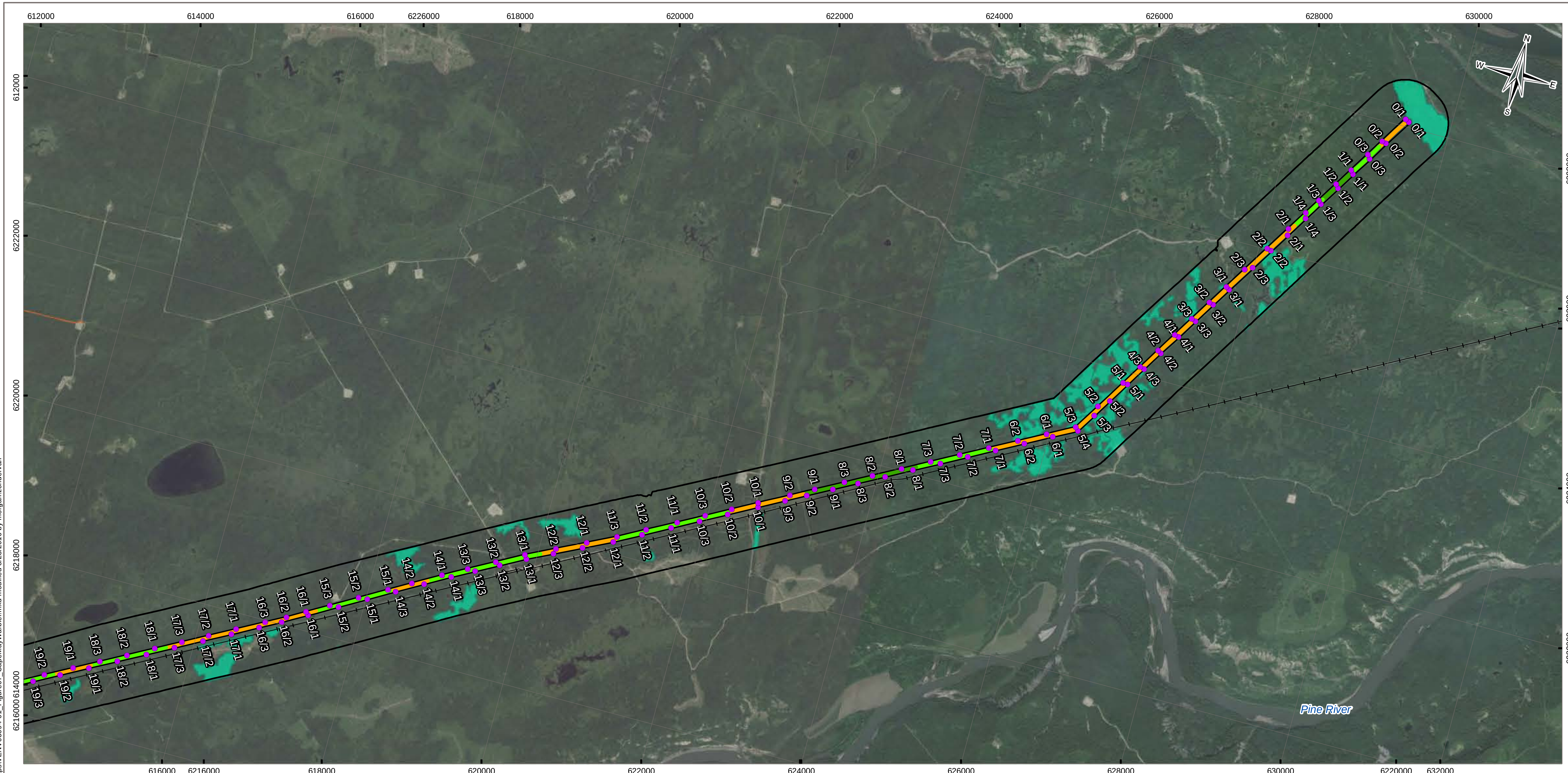
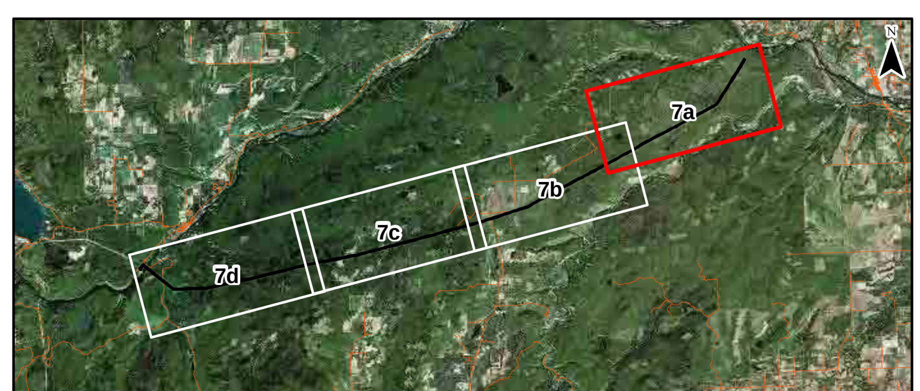


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Cape May Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Cape May Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure07_CapeMayWarbler.mxd

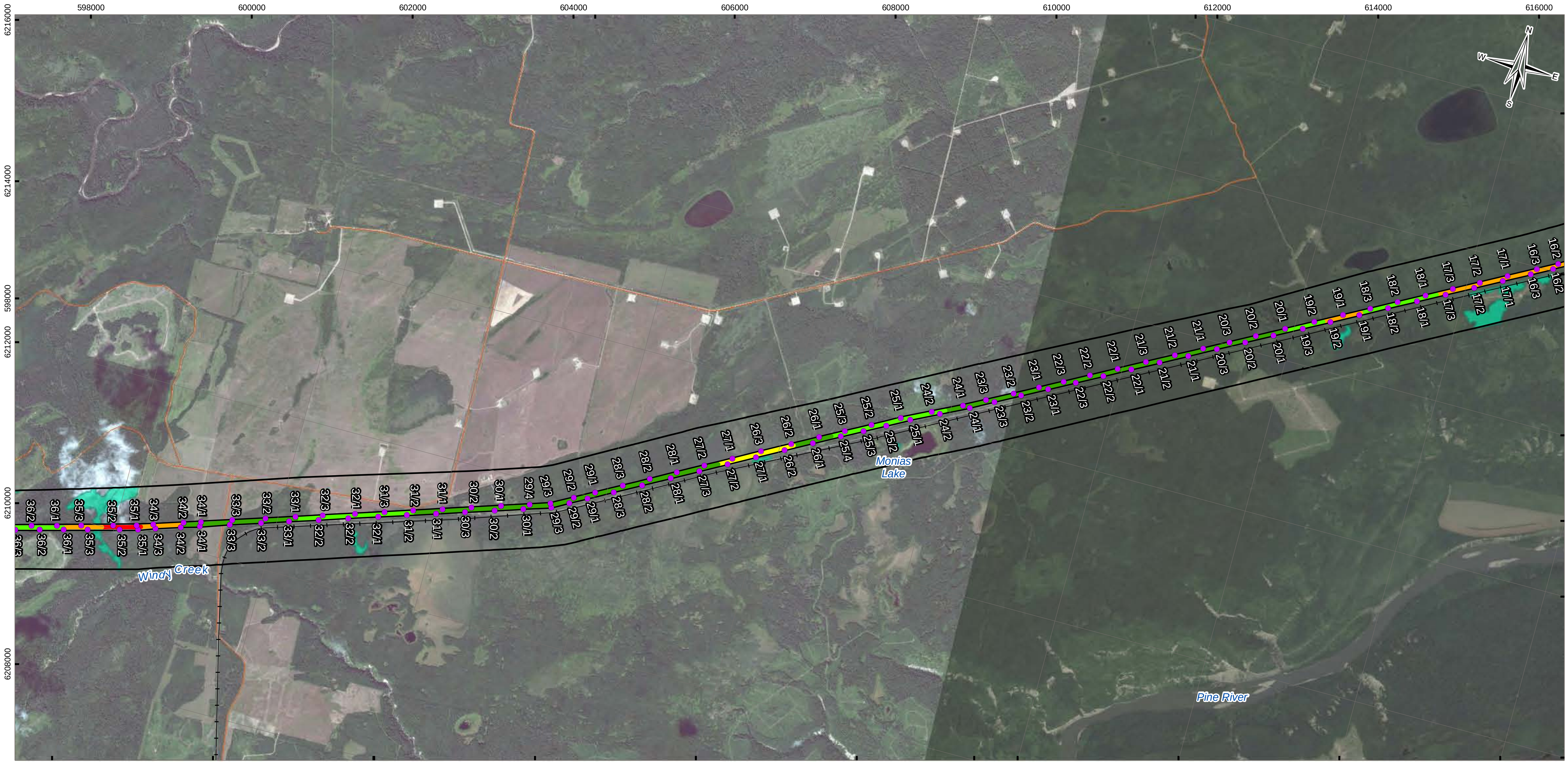
TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 7a

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure07_CapeMayWarbler.mxd modified 8/23/2016 by morgan.zondervan

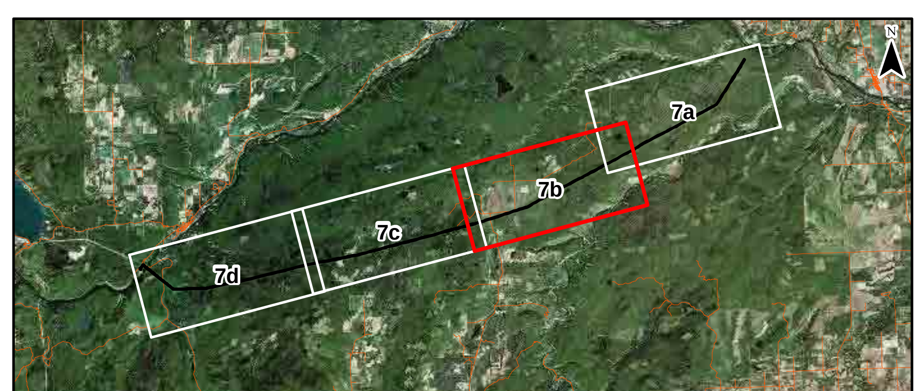


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Cape May Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Cape May Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

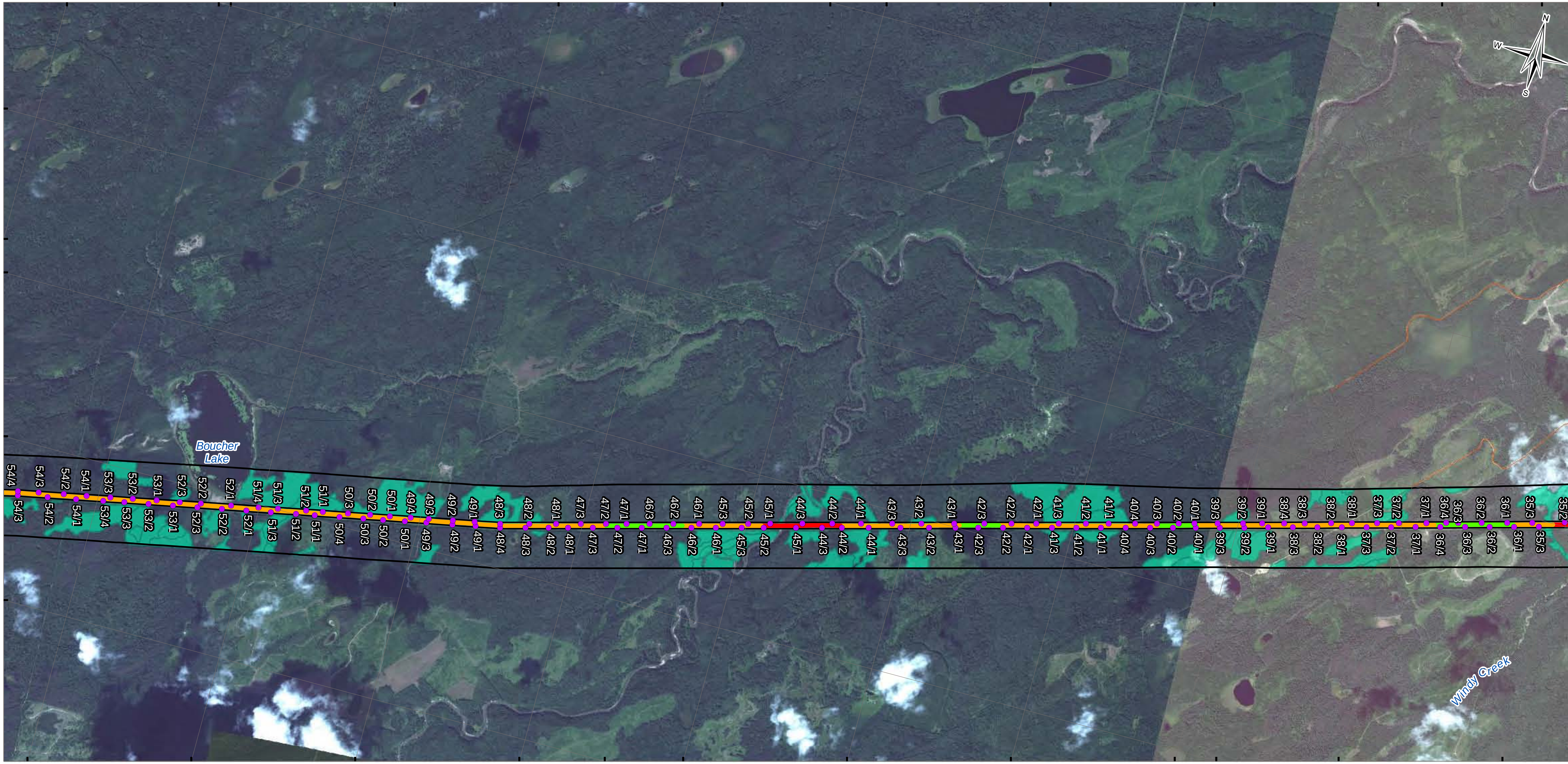
FILE NO.
VENV03094-01_Figure07_CapeMayWarbler.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 7b

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure07_CapeMayWarbler.mxd modified 8/23/2016 by morgan.zondervan

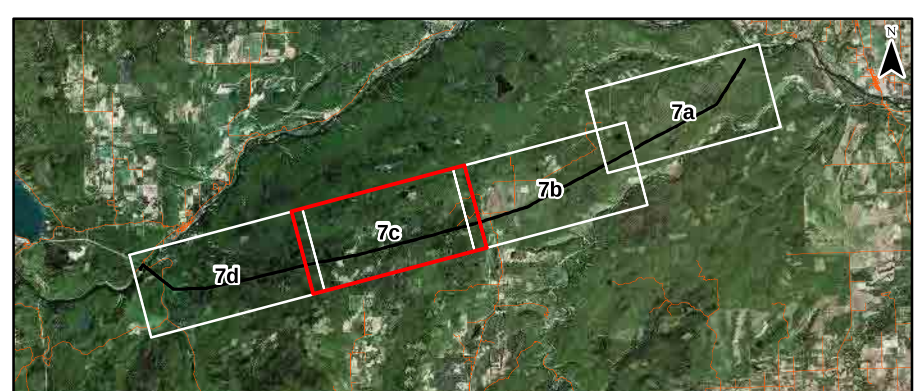


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Cape May Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Cape May Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure07_CapeMayWarbler.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 7c

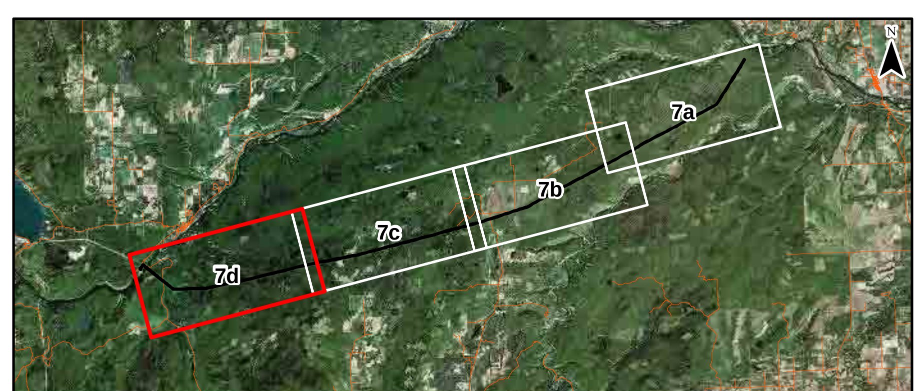
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydroMaps\VENV03094-01_Figure07_CapeMayWarbler.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Cape May Warbler Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Cape May Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure07_CapeMayWarbler.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 7d

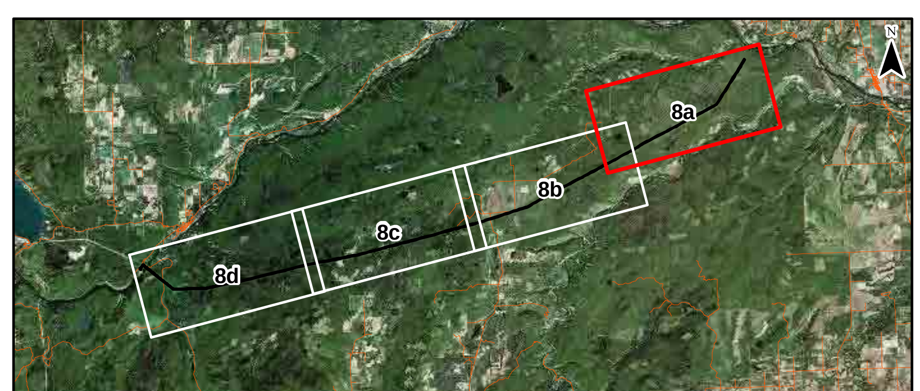
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure07_CapeMayWarbler.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Black-throated Green Warbler Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Black-throated Green Warbler Strike Risk Ranking

PROJECTION
UTM Zone 10

DATUM
NAD83

Scale: 1:50,000
1 0.5 0 1
Kilometres

CLIENT
BC hydro

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure08_BlackthroatedGW.mxd

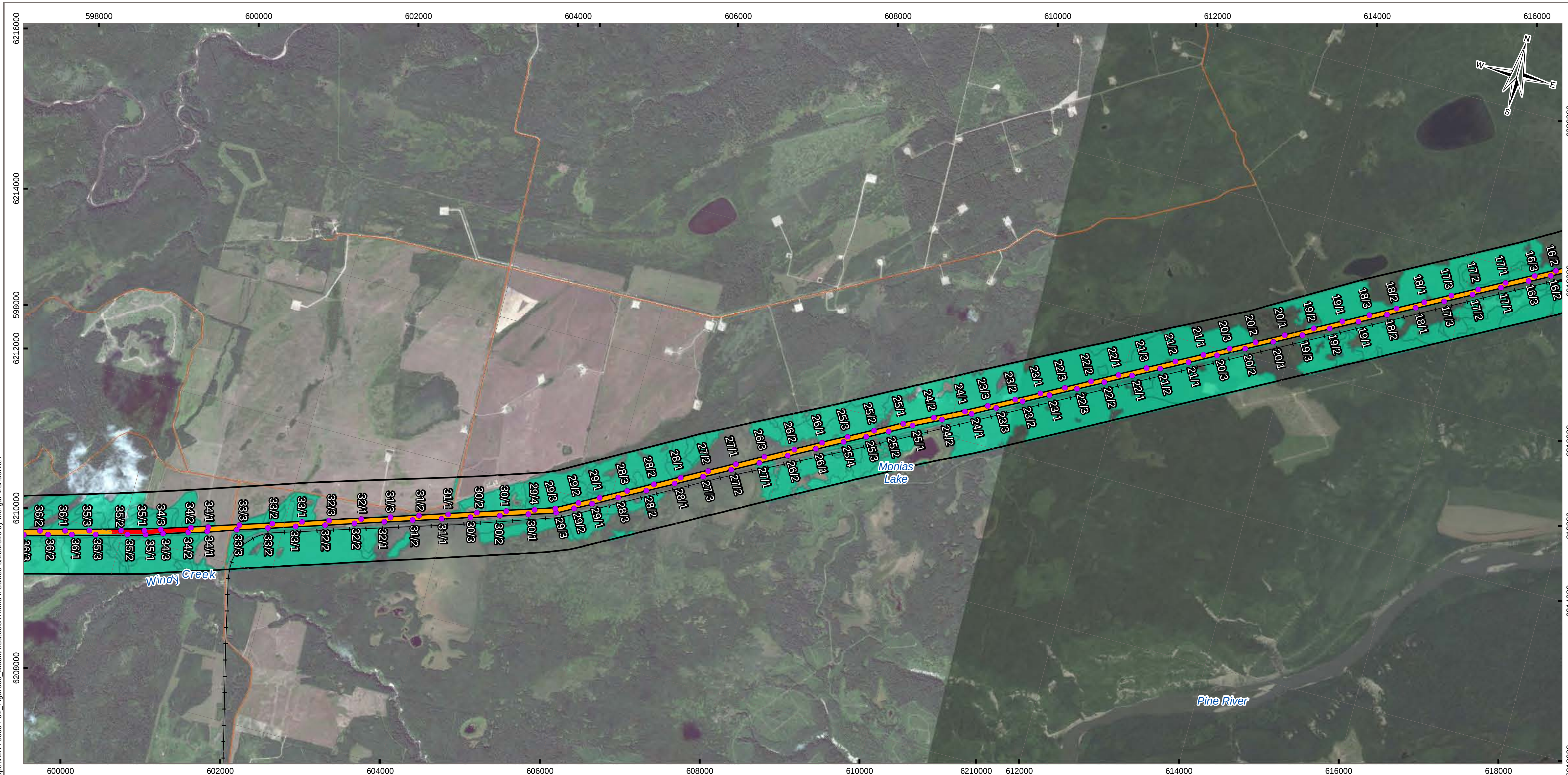
PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE
Tt EBA-VANC

DATE
August 23, 2016

Figure 8a

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure08_BlackthroatedGW.mxd modified 8/23/2016 by morgan.zondervan

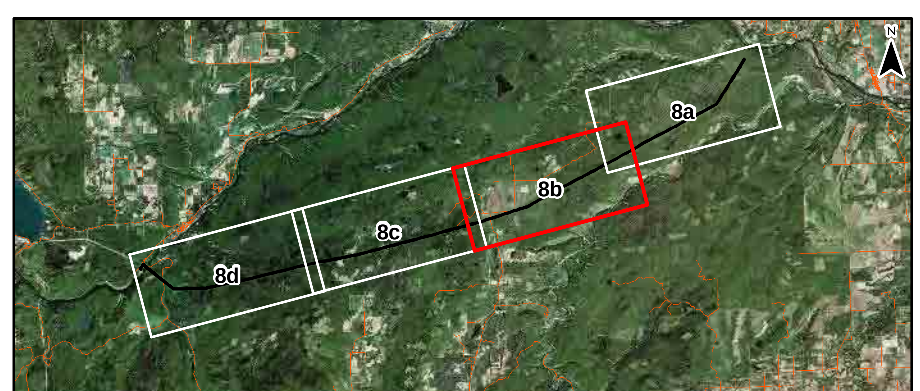


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Black-throated Green Warbler Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Black-throated Green Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure08_BlackthroatedGW.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 8b

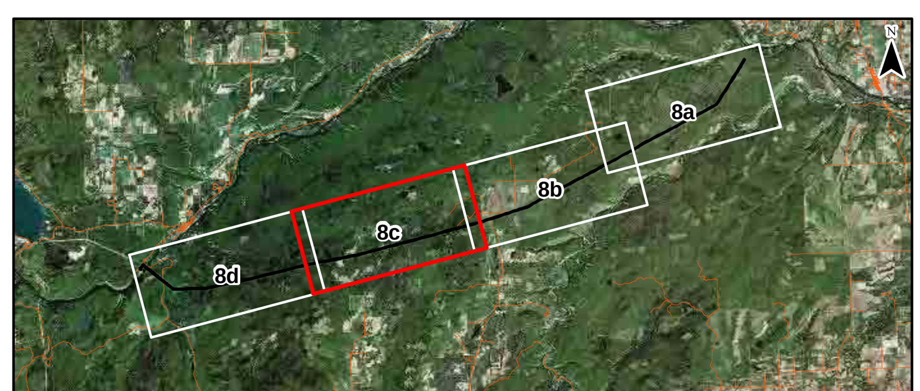
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure08_BlackthroatedGW.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Black-throated Green Warbler Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES

Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Black-throated Green Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000

1 0.5 0 1

Kilometres

FILE NO.
VENV03094-01_Figure08_BlackthroatedGW.mxd

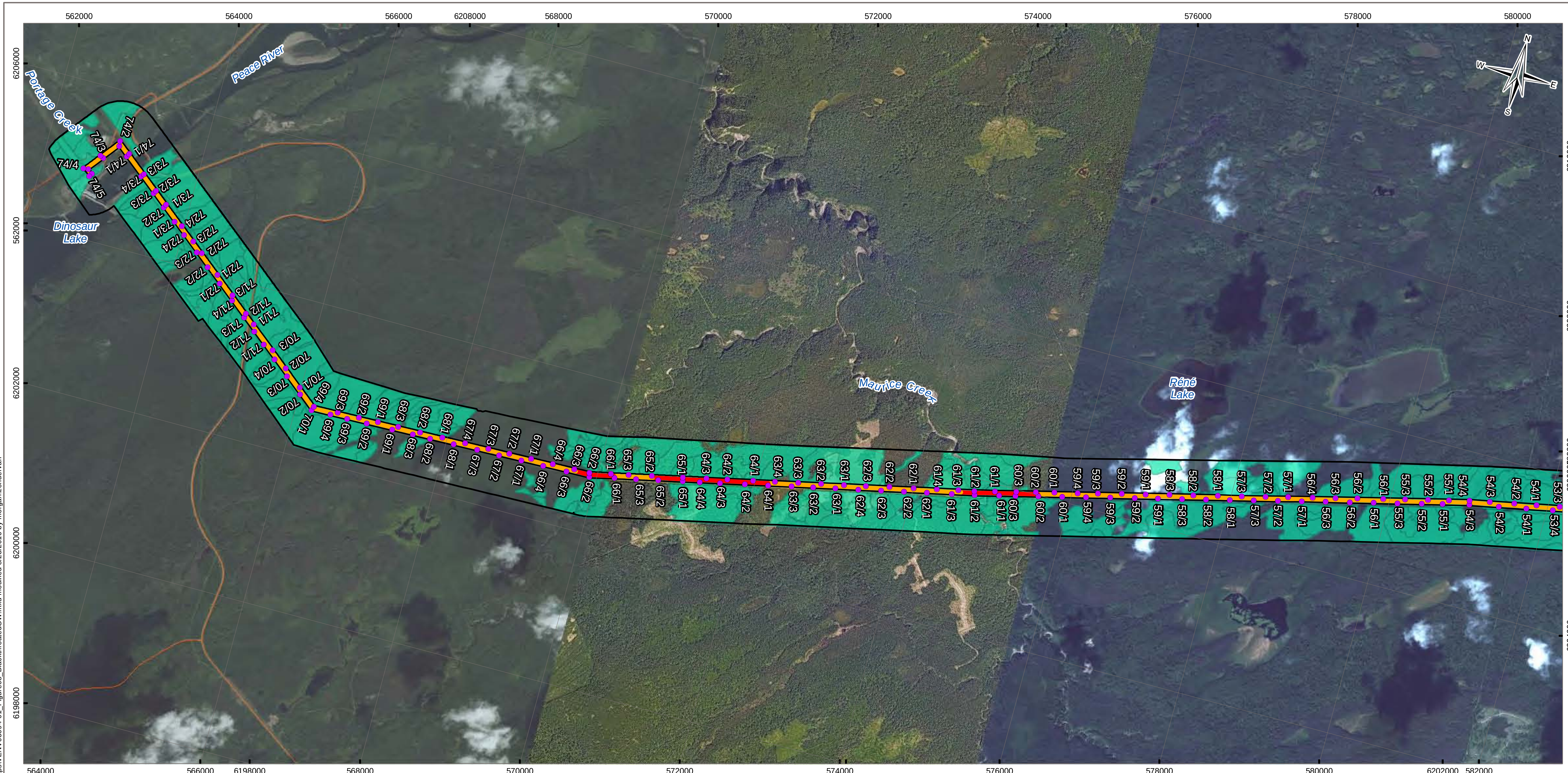
TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 8c

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure08_BlackthroatedGW.mxd modified 8/23/2016 by morgan.zondervan

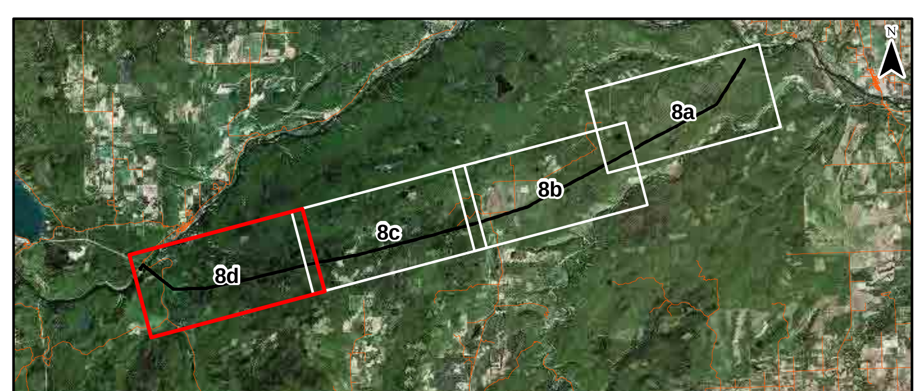


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Black-throated Green Warbler Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0.5
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Black-throated Green Warbler Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

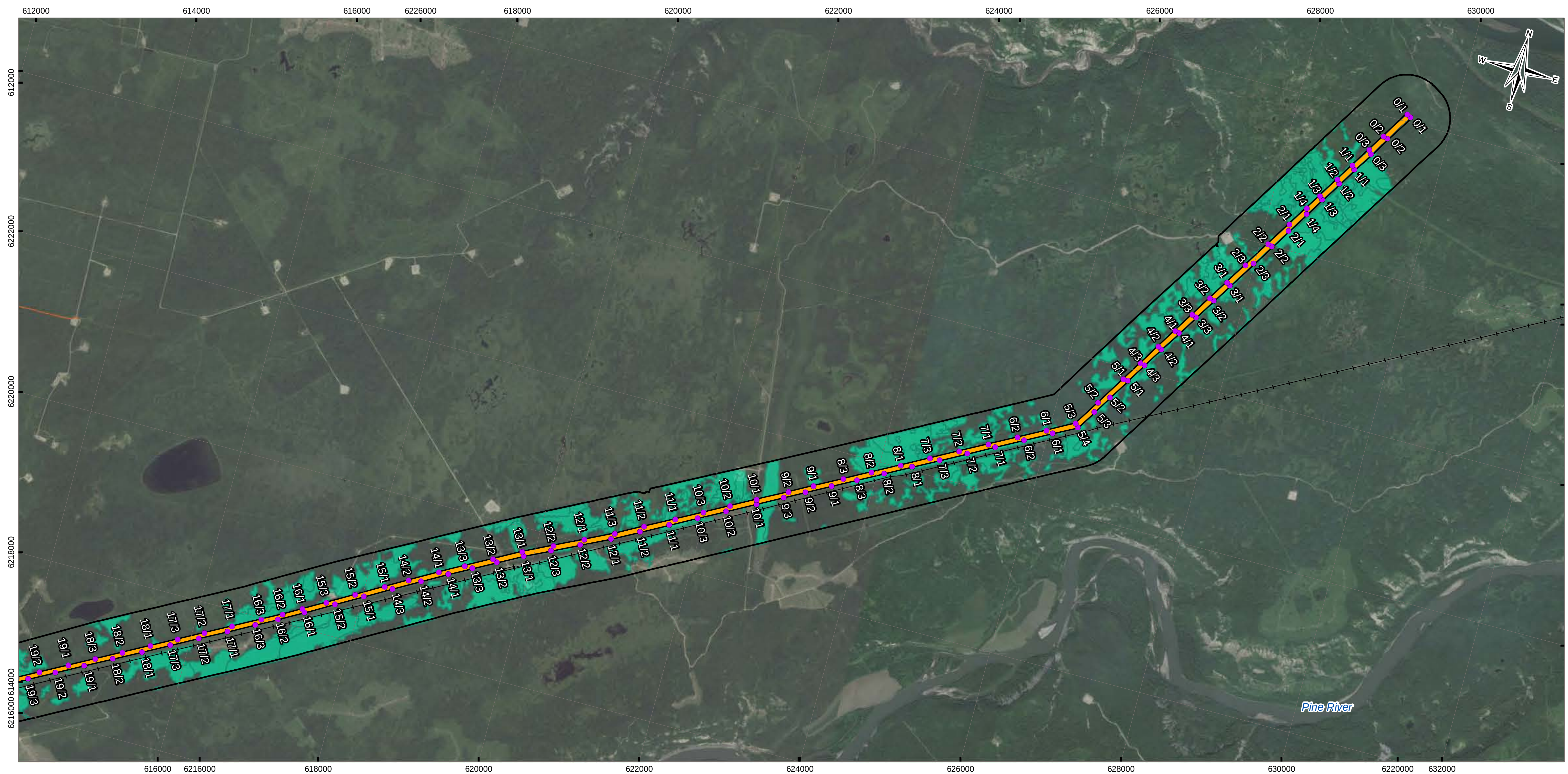
FILE NO.
VENV03094-01_Figure08_BlackthroatedGW.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 8d

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure08_BlackthroatedGW.mxd modified 8/23/2016 by morgan.zondervan

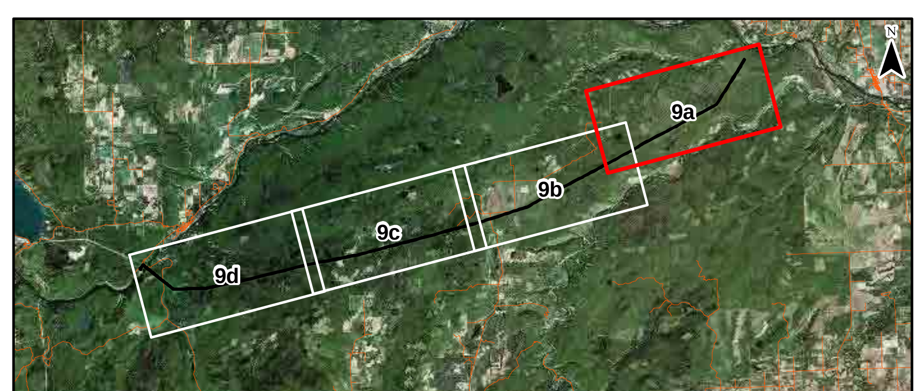


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Nelson's Sparrow Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015 and July 2016)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

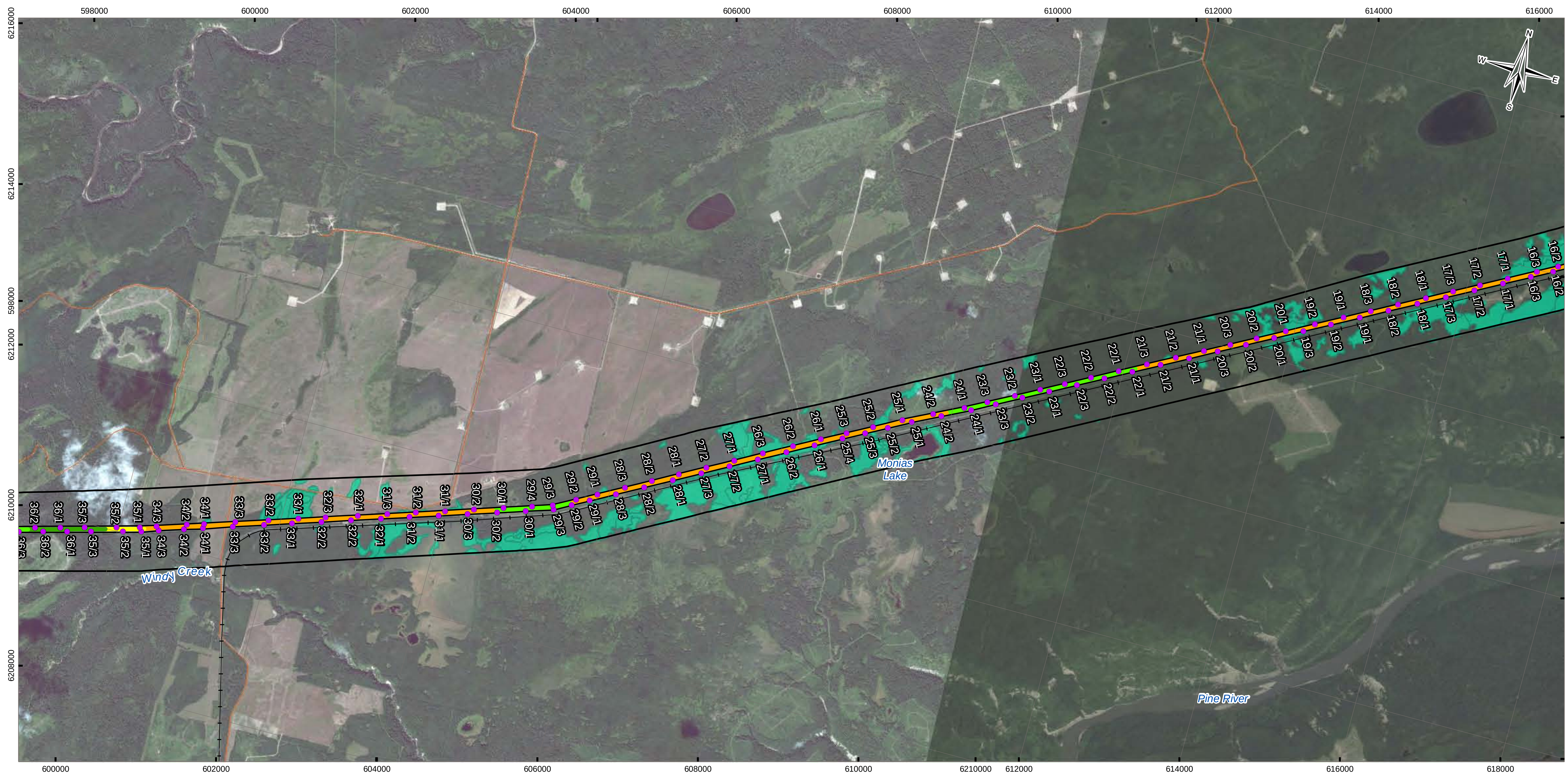
STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Nelson's Sparrow Strike Risk Ranking

PROJECTION UTM Zone 10			DATUM NAD83		CLIENT BC hydro
Scale: 1:50,000 1 0.5 0 1 Kilometres					TETRA TECH EBA
FILE NO. VENV03094-01_Figure09_NelsonsSparrow.mxd					
PROJECT NO. ENV.VENV03094-01	DWN MEZ	CKD SL	APVD JJ	REV 0	Figure 9a
OFFICE Tt EBA-VANC	DATE August 23, 2016				

Q:\Vancouver\GIS\ENVIRONMENTAL\VEN\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure09_NelsonsSparrow.mxd modified 8/23/2016 by morgan.zondervan

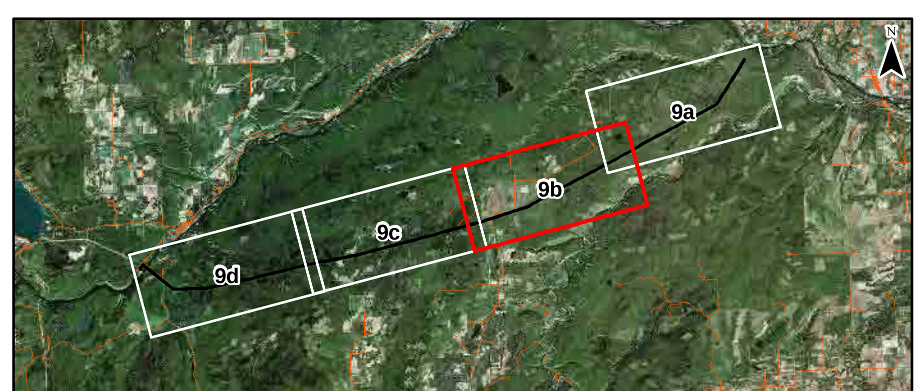


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Nelson's Sparrow Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015 and July 2016)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Nelson's Sparrow Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure09_NelsonsSparrow.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 9b

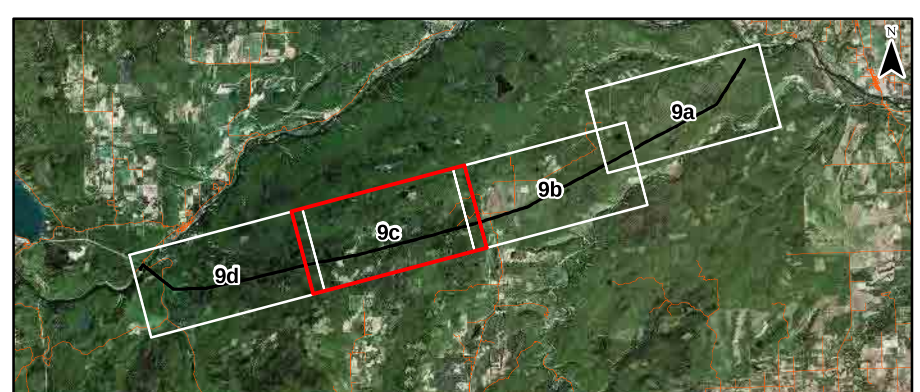
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure09_NelsonsSparrow.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Nelson's Sparrow Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015 and July 2016)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Nelson's Sparrow Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

FILE NO.
VENV03094-01_Figure09_NelsonsSparrow.mxd

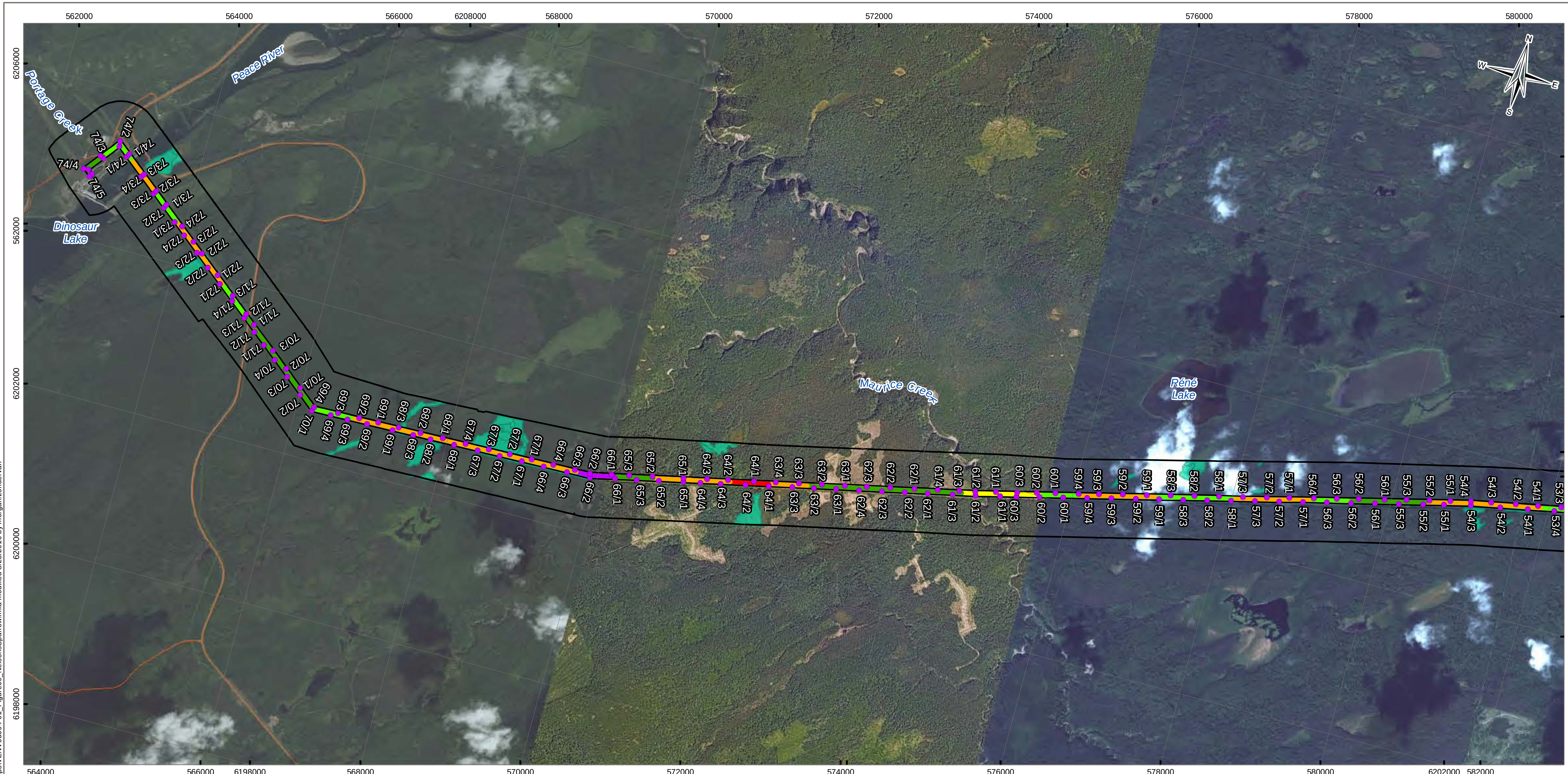
PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

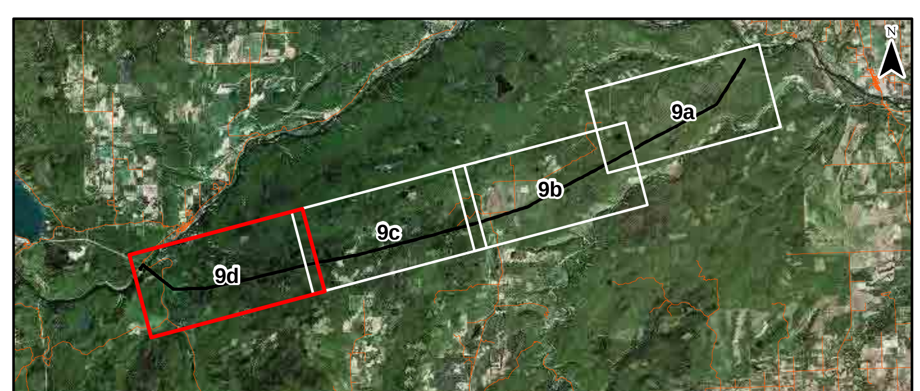
OFFICE	DATE
Tt EBA-VANC	August 23, 2016

TETRA TECH EBA

Figure 9c

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure09_NelsonsSparrow.mxd modified 8/23/2016 by morgan.zondervan





LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Nelson's Sparrow Habitat within the Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5

NOTES

Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015 and July 2016)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Nelson's Sparrow Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000 — 1 0.5 0 1 Kilometres

TETRA TECH EBA

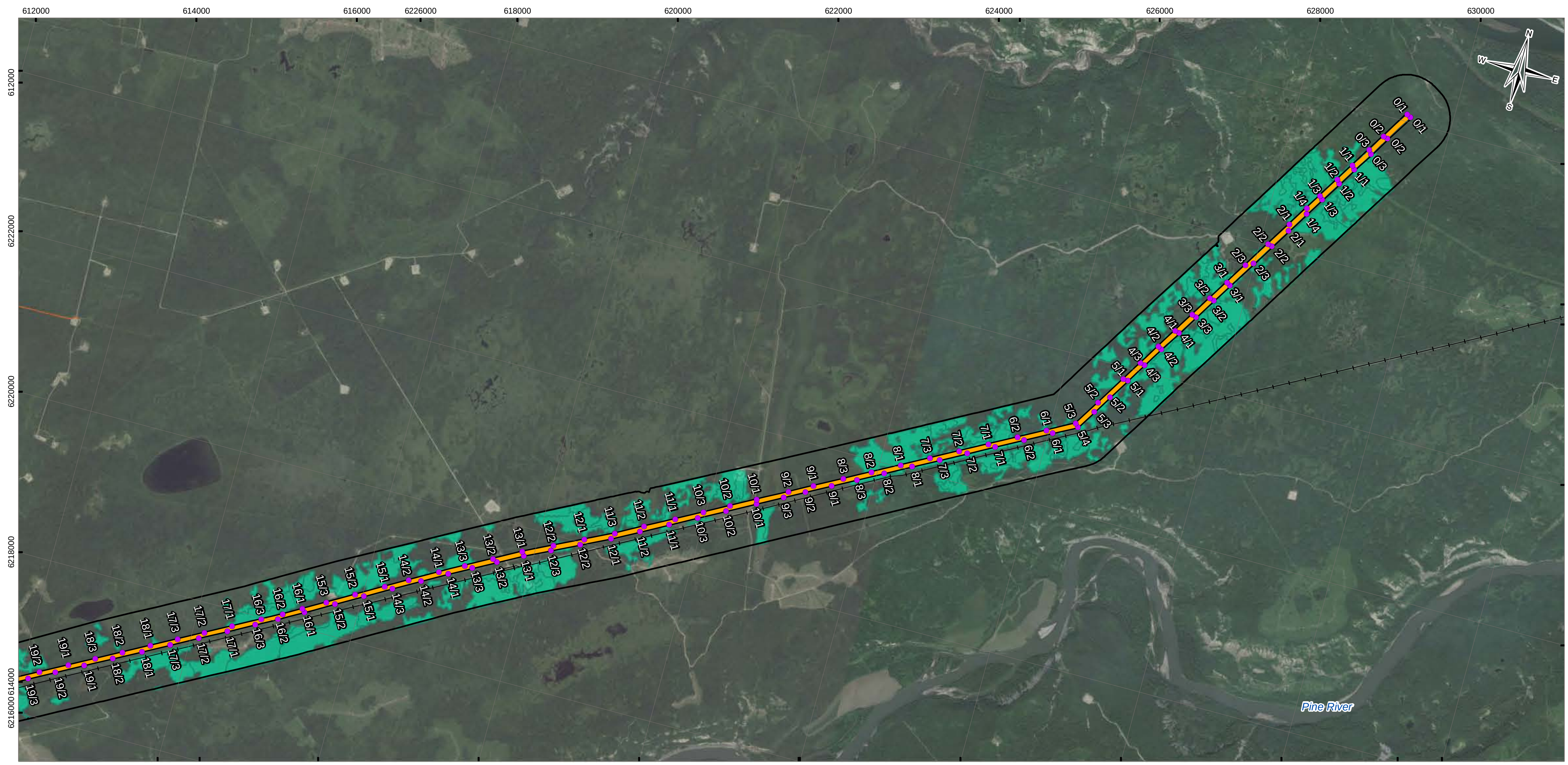
FILE NO.
VENV03094-01_Figure09_NelsonsSparrow.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 9d

Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure09_NelsonsSparrow.mxd modified 8/23/2016 by morgan.zondervan

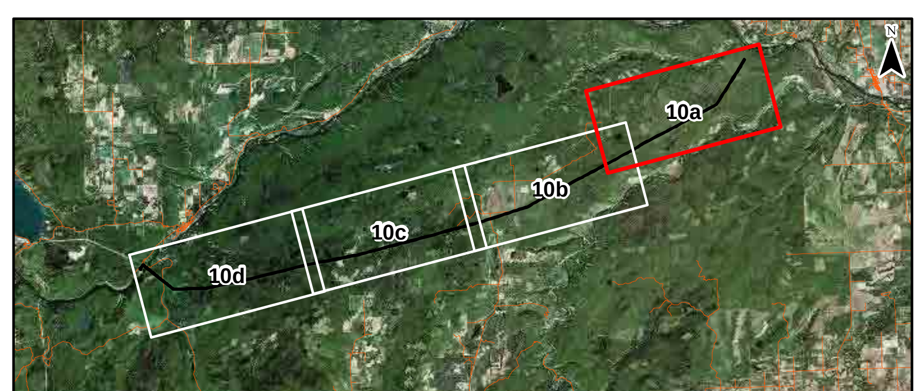


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Rusty Blackbird Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Rusty Blackbird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

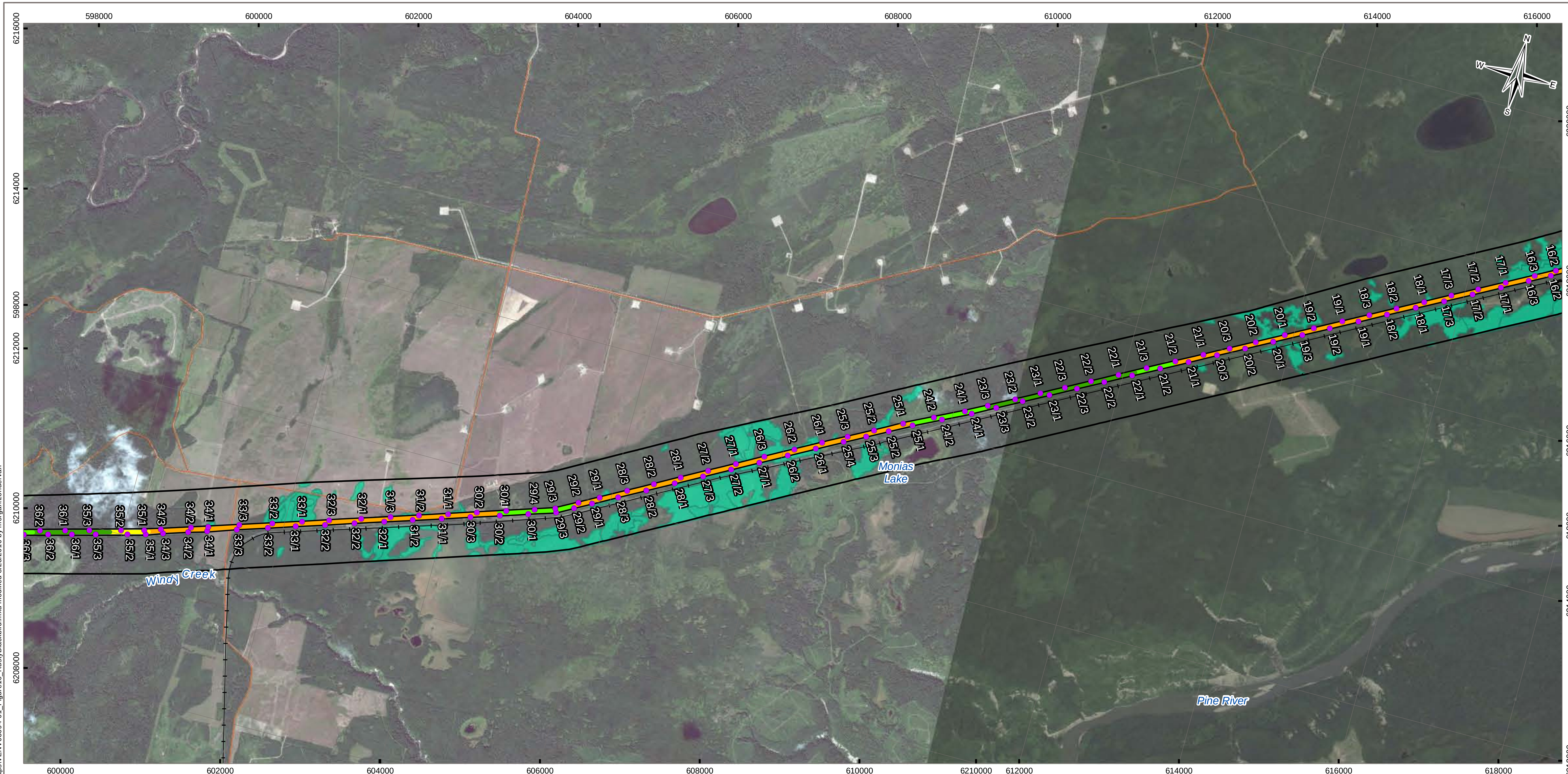
TETRA TECH EBA

FILE NO.
VENV03094-01_Figure10_RustyBlackbird.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 10a

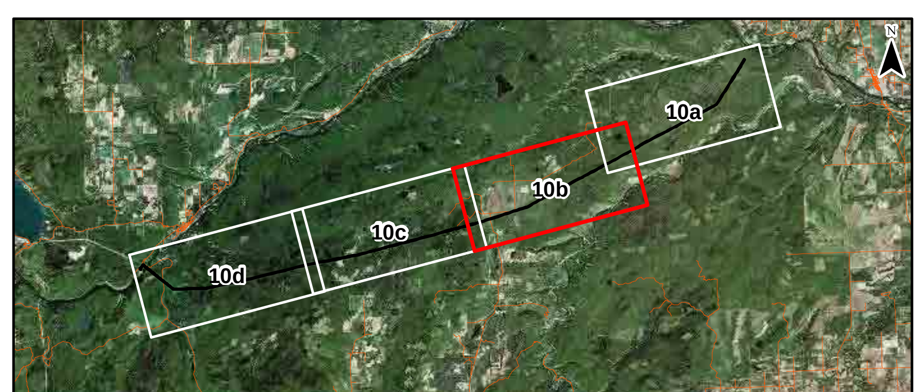


LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Rusty Blackbird Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Rusty Blackbird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure10_RustyBlackbird.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 10b

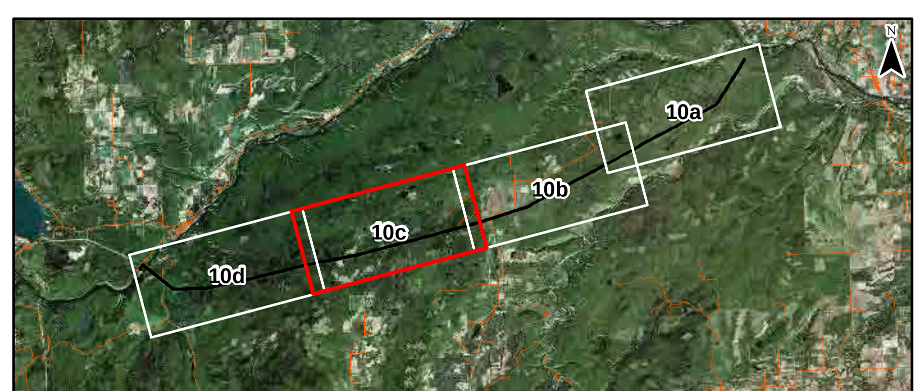
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure10_RustyBlackbird.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Rusty Blackbird Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrasrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT
WILDLIFE MITIGATION AND MONITORING

Potential Rusty Blackbird Strike Risk Ranking

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:50,000
1 0.5 0 1
Kilometres

TETRA TECH EBA

FILE NO.
VENV03094-01_Figure10_RustyBlackbird.mxd

PROJECT NO.	DWN	CKD	APVD	REV
ENV.VENV03094-01	MEZ	SL	JJ	0

OFFICE	DATE
Tt EBA-VANC	August 23, 2016

Figure 10c

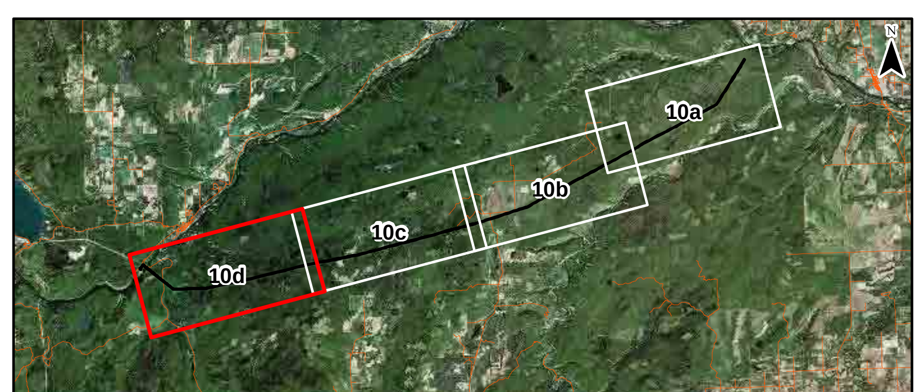
Q:\Vancouver\GIS\ENVIRONMENTAL\VENV\VENV03094-01_BCHydro\Maps\VENV03094-01_Figure10_RustyBlackbird.mxd modified 8/23/2016 by morgan.zondervan

LEGEND

- Tower Location
- Proposed Alignment Corridor
- Study Area (500 m Buffer)
- Rusty Blackbird Habitat within Study Area
- Existing Road
- Railway

Segment Risk Score

- 0
- 0.5
- 1
- 1.5
- 2.5



NOTES
Base data source:
Proposed Infrastrucutre, TEM Mapping and TRIM base data provided by BC Hydro (October 2015)
Imagery from BING Imagery Service for ArcGIS
CanVec 1:50,000

STATUS
ISSUED FOR USE

SITE C CLEAN ENERGY PROJECT WILDLIFE MITIGATION AND MONITORING

Potential Rusty Blackbird Strike Risk Ranking

PROJECTION: UTM Zone 10		DATUM: NAD83			CLIENT: BC hydro
Scale: 1:50,000 (1 0.5 0 1 Kilometres)					TETRA TECH EBA
FILE NO.: VENV03094-01_Figure10_RustyBlackbird.mxd					
PROJECT NO.: ENV.VENV03094-01	DWN: MEZ	CKD: SL	APVD: JJ	REV: 0	
OFFICE: Tt EBA-VANC	DATE: August 23, 2016				Figure 10d

APPENDIX A
TETRA TECH'S GENERAL CONDITIONS

GENERAL CONDITIONS

NATURAL SCIENCES

This report incorporates and is subject to these "General Conditions".

1.1 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development or activity, and/or a specific scope of work. The report may include plans, drawings, profiles and other supporting documents that collectively constitute the report (the "Report").

The Report is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contract entered into with the Client (either of which is termed the "Services Agreement" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Report when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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1.2 ALTERNATIVE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of the Report or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH 's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive the original signed and/or sealed version for a maximum period of 10 years.

Both electronic file and hard copy versions of TETRA TECH 's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH 's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH 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 TETRA TECH for the Report have been conducted in accordance with the Services Agreement, 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 Report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Report.

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

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 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.

1.5 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Services Agreement, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.6 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Report, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.7 GENERAL LIMITATIONS OF REPORT

This Report is based solely on the conditions present and the data available to TETRA TECH at the time the data were collected in the field or gathered from publically available databases.

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

The Report 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 at or the development proposed as of the date of the Report requires a supplementary investigation and assessment.

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.

The Client acknowledges that TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of property, the decisions on which are the sole responsibility of the Client.

1.8 JOB SITE SAFETY

TETRA TECH is only responsible for the activities of its employees on the job site and was not and will not be responsible for the supervision of any other persons whatsoever. The presence of TETRA TECH personnel on site shall not be construed in any way to relieve the Client or any other persons on site from their responsibility for job site safety.

Appendix 2

Breeding season pre-clearing nest survey methodology

Methodology to determine the presence of active bird nests for the Site C Clean Energy Project area

25 October 2016

Report prepared by:
Strategic Resource Solutions (SRS)
Victoria, BC

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OVERVIEW

This document is based on the previous bird nest survey methodology version dated 14 January 2016 (Manning et al. 2016). This document is a substantial revision, intended to clarify and refine the methodology based on an adaptive management approach and experience gained during the 2016 field season. Important aspects include:

- Expanding the document's scope to address nesting bird issues beyond direct vegetation clearing;
- Modification of survey condition and effort guidelines to reflect variability in terrain, vegetation, weather and nesting season phenology;
- Modification of the nesting bird risk window table to include all species groups likely to occur within the Site C Clean Energy Project area, and incorporation of recently acquired knowledge on nesting chronology.

The British Columbia *Wildlife Act* (Section 34) (Province of BC 1996) and the federal *Migratory Birds Convention Act* (*MBCA*) (Section 5[9]) (Government of Canada 1994) provide legislation that prohibits the disturbance or destruction of a bird, its nest, or eggs. The federal *Species at Risk Act* (*SARA*) (Government of Canada 2002) provides similar protection for listed bird species as well as their 'residence' or nesting habitat.

As there currently are no provincial or federal standards for conducting bird nest surveys, it is the responsibility of the proponent of a proposed development project to produce and adhere to its own bird nest survey methodology to demonstrate due diligence in not contravening any related legislation. This document describes BC Hydro's bird nest survey methodology to be implemented at the Site C Clean Energy Project site and adjacent areas impacted by the project. The methodology was developed using avoidance guidance from CWS (Environment Canada 2016a), provincial Best Management Practices (BC MFLNRO 2013 and 2014), and bird nest survey methodology produced for similar development projects in British Columbia (BC EAO 2016). BC Hydro's bird nest survey methodology is intended to reduce the likelihood of any non-compliance with the *Wildlife Act*, *MBCA* and *SARA* in relation to work activities at the Site C Clean Energy Project.

METHODS

The high variability in seasonality of bird nesting (see Appendix 1), as well as the complexities of breeding bird biology results in many challenges for creating effective nest survey and monitoring strategies. The same principles apply throughout the breeding season for all target species.

- Utilize experienced observers, supervised by a Bird Biologist Qualified Environmental Professional (hereinafter referred to as QEP),
- Ensure adequate survey effort to minimize the risk of missing active nest sites, and
- Embrace an adaptive approach to efficiently conducting surveys, while maintaining due diligence in protecting birds and their nests.

Most nest surveys and associated reporting will involve the following:

- Walking through the survey area in such a way that the entire target area is adequately covered.
- Noting Significant Evidence Indicators (SEIs) of bird nesting activity. SEIs include active nests, and behaviours such as distraction displays, persistent alarm calls, and birds carrying food or nesting material.
- Creating appropriate-sized buffers around active nests and probable active nest locations.
- Monitoring nesting activity at previously-detected active nest sites.
- Communicating to work crews the locations and status of nest buffers and any related work restrictions.
- Preparing and disseminating "Free to Work" reports to BC Hydro and contractors, prior to commencement or continuation of work activities.

Survey Conditions and Survey Effort

It is important to conduct surveys under observation conditions that are adequate to minimize the risk of non-compliance with bird protection legislation. Appropriate conditions vary with the bird species being surveyed, vegetation cover, topography and the seasonal timing of surveys. Likewise, the amount of survey effort required varies with observation conditions and timing related to the breeding season.

It will be at the discretion of the QEP to determine the adequacy of survey conditions and survey effort.

Optimal Survey Conditions

When feasible, surveys should be conducted under optimal conditions. Surveys in poor conditions will usually be inadequate to ensure nest site detection. General survey condition guidelines are as follows:

- Conduct surveys in light winds (<20 km/h) and no precipitation. Bird activity decreases as wind speed and precipitation increases, and detectably of singing birds (particularly arboreal species) declines substantially.
- During the main songbird incubation season, in particular from late May through June, conduct surveys within the first five hours after sunrise. Bird activity tends to decrease from mid-morning onwards through the day.

Survey Effort and Timing

Ideally, an initial walk-through survey will be conducted approximately two weeks prior to work commencing. During this survey the QEP will assess potential nesting conflicts with the proposed work, and recommend a general survey/mitigation strategy.

Within three days prior to clearing or construction activities, nest surveys will be completed, with ongoing monitoring conducted until bird breeding activity ceases or work in the area has been completed. Typically, at least two complete surveys will be necessary. With few exceptions, a single survey is insufficient for identifying active nests, as nesting activity can easily be missed due to variables such as:

a) Timing of surveys related to the seasonal breeding cycle (e.g., incubating birds often sit tightly on the nest and will not readily be detectable, whereas birds feeding young will be much more noticeable);
b) At times, newly arriving breeding birds show up daily during the nesting season and as such, new nests could easily be missed with only a single survey; and
c) Weather conditions during surveys may limit the ability of observers to detect nesting activity.

At times, additional surveys will be required due to variables such as:

a) Onset of the breeding season, when new territories and nests may be established on a daily basis;
b) A major weather event (e.g., prolonged rain with unseasonably low air temperatures) disrupting the breeding cycle, with subsequent re-nesting expected and potential realignment of breeding territories;
c) Difficulty of nest detection (e.g., arboreal locations, waste wood accumulations), and
d) Prolonged poor survey conditions.

Determining and Maintaining Free to Work Windows

The following steps are required to establish and maintain Free to Work windows:

- Conduct an appropriate number (as determined by QEP) of nest surveys prior to commencement of work;
- Prepare a "Free to Work" report upon completion of the surveys. The report will describe and include a map of the areas that are Free to Work, detail nest locations/buffers, and recommend mitigation measures as required;
- Indicate a "Free to Work" period (typically three days during the critical nesting period) with an expiry date; and
- On an ongoing basis, monitor work areas for bird nesting activity, renewing or modifying the "Free to Work" status and associated dates.

NEST BUFFERS

A no work/no disturbance nest buffer is usually required when work is anticipated in the vicinity of active and suspected nest areas. Buffers will help ensure that any work activities conducted outside of the buffer will not render a nest ineffective or cause it to become inactive.

Buffer configuration

The size and shape of the buffer depends on various factors, including: site topography, proximity of the nest to naturally open areas, type and amount of surrounding vegetation cover, nesting period and breeding chronology, a particular bird species' sensitivity to disturbance, rareness of the species in the local/regional area, and the type, extent and duration of work activities that will be occurring adjacent to the buffer. <u>In general, for work activities using heavy equipment, a minimum of a 30 m radius buffer will be established around active nests or probable nest locations</u>. The precautionary principle should usually be implemented when establishing nest buffers: when in doubt, larger is better. In some situations, where work activities do not create a high degree of disturbance, the adaptive buffer size methodology (below) may be implemented. No work activities deemed to be potentially disruptive to nesting birds will be allowed within an established buffer area. See Table 1 for recommended minimum nest buffer sizes for various bird species.

Table 1. Recommended minimum buffer sizes around active bird nests and probable nest locations for work activities utilizing heavy equipment.

Bird Species[3]	Recommended Buffer Size[1,2]
Most bird species	30 m radius
Pileated Woodpecker and Common Nighthawk	50 m radius
Bald Eagle	300 m radius[4]
Other raptors and owls (ground nesters/stick nesters/non-cavity nesters), including Golden Eagle, Osprey, Peregrine Falcon, Northern Goshawk, Great Horned Owl	100 m radius
Trumpeter Swan, Sandhill Crane	200 m radius
Great Blue Heron	300 m radius
Sharp-tailed Grouse leks	2000 m radius

Monitoring nesting activity within buffers

Buffers are temporary mitigation measures to protect active and probable nest locations. Nesting activity within buffers will be checked from time to time, primarily for the following reasons;

a) To verify nesting status of the breeding season (i.e., incubation, nestlings),
b) To establish whether or not a nest location is still active without harming or disturbing the nesting birds,
c) To document new nest sites (same or different species) that are established within the initial nest buffer. In this case, the buffer configuration may need to be modified to accommodate the new nest location.

It is important to minimize the duration and extent of nest area visits, thereby reducing the likelihood of nest failure.

Adaptive Buffer Size Methodology

Under certain site specific circumstances and with written rationale approved by the QEP, buffer sizes and shapes may be altered from those described in Table 1. The QEP will determine the appropriate site specific buffer size, configuration and mitigation strategy on a case by case basis.

Circumstances where Adaptive Buffer Size Methodology may be applied include, but are not limited to:

1. During courtship, nest-building, egg-laying and hatching periods, most bird species are very sensitive to disturbance. Larger buffers may be appropriate initially, then reduced in size during incubation and nestling periods as birds become more committed to the nest site.

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[1] Recommended buffer sizes were developed from a combination of sources including: recommended buffer sizes in *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia 2013* (BC MFLNRO 2013); Buffer Zone and Setback Distances Recommendations (Environment Canada 2016b); and *Develop With Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MFLNRO 2014).

[2] Buffer sizes can be altered by the onsite QEP as described in the "Adaptive Buffer Size Methodology" above.

[3] Golden Eagle, Osprey, Peregrine Falcon, Sandhill Crane and Great Blue Heron have not currently been documented as nesting within the Site C Project footprint area.

[4] This buffer size changed from 200 m radius as recommended in the previous version of this Methodology (Manning et al. 2016) and is consistent with the 300 m radius buffer size as recommended in the revised and current CEMP for Bald Eagle (BC Hydro July 26, 2016. Refer to this document for further information).

2. Birds habituated to human activities. Examples include swallows nesting under bridges or on buildings, birds constructing nests along active roads or in active work areas.
3. Some work activities (e.g., land surveying, amphibian salvage, and archaeological excavation with hand tools) may not be highly disruptive to nesting birds. Thus, smaller buffers may be appropriate in these situations.
4. Naturally occurring topographic features or vegetation structure provide sufficient buffering/shielding around the nest.
5. A mitigation plan or strategy is developed and implemented to minimize disturbance effects or impacts on a nesting bird. In most cases this will be a written strategy developed prior to commencement of work activities. Depending on variables such as unforeseen work tasks, a verbal strategy could be developed and communicated to crews onsite by the QEP; this information would subsequently be documented in written format. Situations where a mitigation plan/strategy can be implemented include, but are not limited to:
    - Hand clearing is substituted for machine clearing.
    - Temporary physical barriers (i.e., landscape fabric curtains) erected between a bird nest and the work site, thereby providing a visual and auditory shield.
    - Bird nesting behaviour is monitored under the direction of a QEP. Work activities must be halted if a nesting bird is disturbed from the nest. If such disturbance occurs, the QEP will determine an appropriate alternate mitigation strategy to be implemented prior to the resumption of proximal work. This may include the re-establishment of the original buffer.

Species-Specific Breeding Activity Survey Methodologies

For some bird species, specialized survey methodologies may be required to adequately determine breeding activity status. For the Site C project area, such methodologies have been developed for Bald Eagle (Appendix 2), White-winged Crossbill (Appendix 3) and Sharp-tailed Grouse (Appendix 4).

Chance Finds of Active or Probable Nest Locations

Workers on site may incidentally encounter active nests or Significant Evidence Indicators of bird nest sites. If work is transient in the vicinity of a songbird nest (either active or probable), workers will move far enough away so that no agitated bird behaviour is noted (typically at least 5 m from the nest site). Otherwise, work will cease until the nesting status is assessed by the QEP and an appropriate mitigation strategy implemented.

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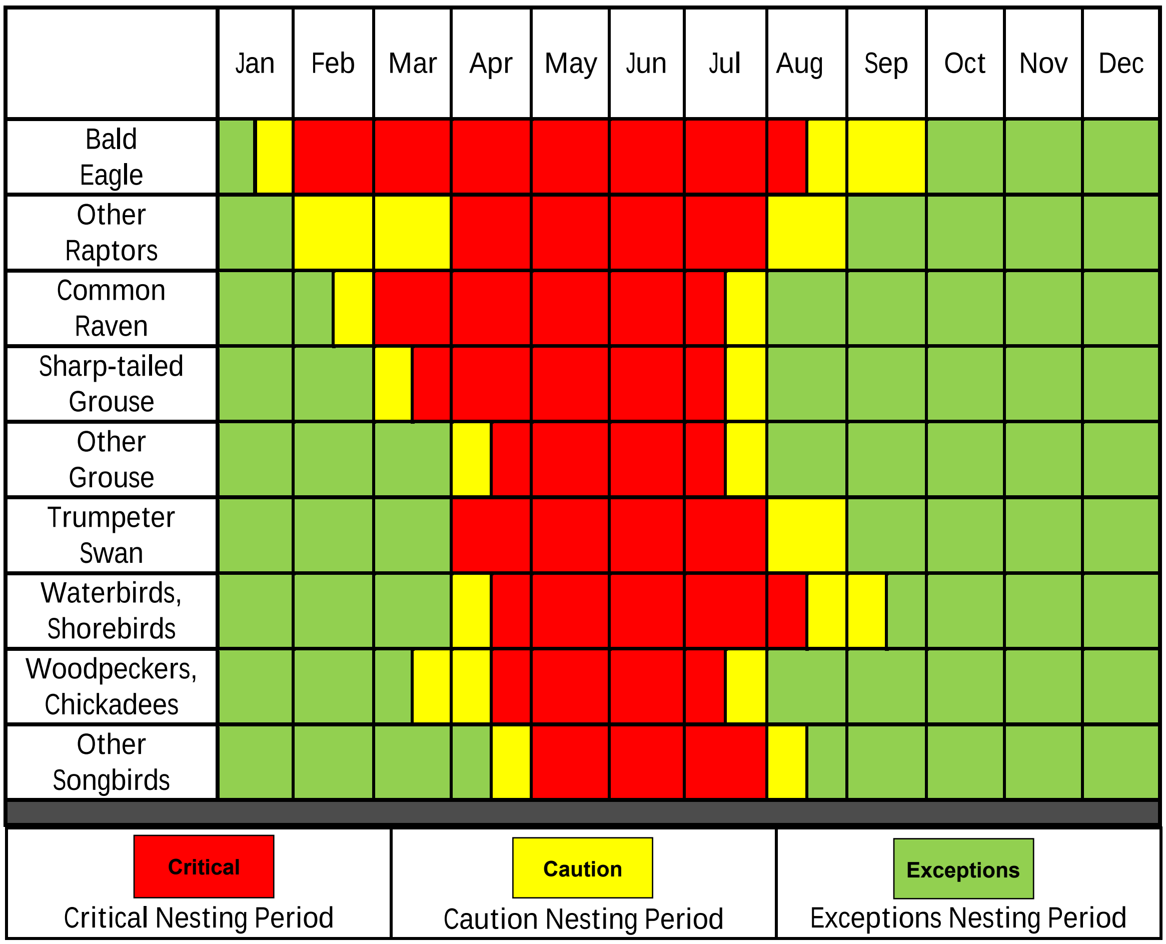
Appendix 1. Nesting Bird Risk Windows

Table 2 illustrates bird nesting risk windows at Site C and vicinity. The Critical Nesting Period (shaded red) is the time period in which the majority of nesting activity occurs, the Caution Nesting Period (shaded yellow) encompasses times when some of the bird population may be nesting, and the Exceptions Nesting Period is when very few birds are expected to be nesting.

Table 2. Peace Region terrestrial nesting bird risk windows (adapted from BC MFLNRO 2011 and Environment Canada 2016a, and supplemented by recent observations at Site C (SRS unpubl. data)).



The timeframes in Table 2 should be used as a general guideline. Local weather conditions and timing of seasonal bird movements will vary across regions and among years due to seasonal weather, annual abundance of forage resources, and other variables such as overwintering conditions (i.e., for migratory species), which in turn influence seasonal arrival and nest construction times, and potentially local annual species abundance.

Appendix 2. Bald Eagle Nest Assessment Methodology

Bald Eagle nests are protected year round (whether occupied or not) under section 34b of the *BC Wildlife Act*. BC Hydro currently holds permits to remove Bald Eagle nests within the Site C footprint (FJ14-154018) that have been deemed by a QEP to be unoccupied. The permit prohibits removal of Bald Eagle nests between April 1 and July 31. The permit also requires that a QEP confirm nests are inactive prior to their removal between March 1-31 and August 1-September 30.

The following methodology enhances due diligence in ensuring that nests are unoccupied before removal and/or remain undisturbed if they are adjacent to construction activities.

1) Consult the BC Hydro Site C Environmental Features map and latest Bald Eagle nest database to determine location of known nests within or adjacent to the work area.
2) A nest survey will be conducted approximately two months prior to commencement of clearing activities to confirm presence of known nests and document any new nests. Note: BC Hydro will be conducting annual Bald Eagle nest inventories, but timing of these surveys may not coincide with surveys needed prior to clearing activities. Depending on the area to be cleared, this survey may be conducted on foot, by boat, by unmanned aerial vehicle (UAV), or by helicopter. This survey will help confirm the location and activity status of any eagle nests in these areas, and to allow a reasonable amount of time to develop appropriate mitigation strategies.
3) Commencing no less than 10 days prior to any nearby vegetation clearing activities, a QEP will search for Bald Eagles up to 2 km upstream and downstream of the areas slated for clearing/construction. If an active[5] Bald Eagle nest is located, a 300 m radius initial buffer will be installed[6]. Clearing will not be allowed within the buffered zone until a QEP declares the nest unoccupied.
4) Consistent with step #3, if eagle nests in the survey area are determined by a QEP to be inactive but there is evidence of breeding activity nearby (e.g., adult eagles perched at or near known nest trees, eagles observed carrying nest material, adult eagle pairs closely associating, courtship displays, any of which could occur as early as late January), then the QEP will conduct daily surveys up to and including nest removal in order to assess nesting activity. These surveys will continue until a nest is either determined to be active, the nest is removed, or the scheduled clearing is postponed or cancelled. Surveys should be conducted in suitable observation conditions. If adverse weather conditions preclude such survey effort, then a minimum of 3 surveys in suitable conditions will be conducted during a 10 day period. If a nest is determined to be active then it will be buffered appropriately as determined by the QEP (typically with a 300 m radius initial buffer as per Table 1). This survey will be conducted according to the following steps:
    a) Number of surveys per day: one survey per day.
    b) Time of day: commencing no earlier than one hour after sunrise, and ending no later than one hour prior to sunset.
    c) Length of survey: 30 minute stand watch in vicinity of nests, plus 30 minutes minimum searching the shoreline (both banks) by boat to 2 km upstream and 2 km downstream from the nest sites; this is in order to locate eagles that are perching elsewhere but may be associated with the nest in question.

[5] An active nest is defined as one that is determined to be in use for the purpose of breeding. Indicators of activity include nest construction/refurbishing, adults sitting or standing on the nest (note that an eagle perched in a nest tree does not necessarily indicate nesting activity), and the presence of eggs or young in nest.
[6] As per the Adaptive Buffer Size Methodology, the size and configuration of the nest buffer may be changed if determined appropriate by an onsite QEP.

    d) Survey conditions: surveys should be conducted when winds are light to moderate, and not during moderate-heavy precipitation. This means eagles will likely be more visible (i.e., in high winds or high precipitation eagles may be soaring or temporarily roosting elsewhere and may not be seen near the nest tree in question).
    e) Data to be recorded: use *BC Hydro Bald Eagle Nest Activity Data Sheet*, with observations including number and age cohort (adult, immature) of any eagles seen, and any observations that indicate breeding activity (e.g., adult birds perching together, adults carrying sticks or other nest material, nest construction/refurbishing). Also record a GPS track to document the survey route.
5) Where an eagle nest/nest tree is scheduled for removal, if the activity status of the nest cannot be confirmed via ground surveys then an aerial reconnaissance over the nest (using a helicopter or UAV) will be made within 3 days prior to tree removal/nest re-location in order to confirm that the nest is inactive (not occupied by eggs or eagles). Photo documentation of the nest(s) from above or suitable viewing angle will be taken at this time. On nest removal day, the QEP will commence nest site monitoring a minimum of one hour prior to arrival of the falling crew, and will monitor potential eagle nest occupancy until the nest tree has been felled. If the nest is determined to be active, clearing activities will be halted.
6) When eagle nests are to be salvaged and relocated, if feasible, consider a partial-salvage procedure involving removal of the primary supporting limbs and nest structure (as opposed to falling the entire tree first). In this way the majority of the sticks and some of the supporting limbs can be salvaged with less damage, and be used to aid reconstruction of a substitute nest elsewhere. If partial salvage is not possible, then collect as much of the original nest structure material as possible once the tree has been felled. This material will be used to aid reconstruction of a substitute nest.
7) All feathers in the eagle nest are to be collected and provided to BC Ministry of Forests, Lands and Natural Resource Operations via Front Counter BC. A receipt is to be obtained from Front Counter BC indicating they have received the collected feathers.

Appendix 3. White-winged Crossbill Breeding Activity Assessment Methodology

In years of heavy spruce cone crops, White-winged Crossbills may breed at any time of year. The species nests almost exclusively in mixed-wood or spruce dominant stands. When it is determined by the QEP that crossbills are widespread and settling in spruce areas, then a general walk-through survey of areas scheduled to be cleared over the subsequent two months will be conducted. Surveyors will note the locations of mixed-wood and spruce stands where crossbills are occurring and document numbers of birds and breeding evidence (e.g., persistent singing, nest building, courtship). Locations that are being actively used for feeding should then be visited again within a week to re-assess the breeding status.

If a spruce stand is occupied and breeding activity is continuing, then a polygonal buffer will be established that encompasses the majority of spruce trees with a minimum 50 m radius of the suspected nest area. White-winged Crossbills are at times semi-colonial nesters with several pairs potentially utilizing even a small spruce stand, and are somewhat reliant on the cone crop immediately surrounding the nest tree for feeding their young. Such sites will then be monitored on a schedule determined by the QEP, considering breeding phenology and the timing of proposed clearing operations. Once sufficient evidence is found to declare active nesting, then monitoring should continue until evidence of breeding activity has ceased.

Appendix 4. Sharp-tailed Grouse Breeding Activity Assessment Methodology

Sharp-tailed Grouse are widespread, but uncommon in the vicinity of the Site C footprint. They occur primarily in grassland/shrubland and adjacent agricultural areas where suitable habitat exists above the Peace River canyon rim. Leks have been documented on the right bank downstream of the dam site, and near Highway 29 in the vicinity of Cache Creek (A. McIntosh, BC Hydro, *pers. comm*.). Currently, potentially suitable habitat is found mainly along the left bank of the Peace River.

Sharp-tailed Grouse are most susceptible to disturbance during the courtship period (March through early May) when males hold territory at traditional lek sites. When clearing or other work activities are planned within 2000 m of grassland/agricultural areas, sample lek surveys (RISC 1997) will be conducted.

The Site C Construction Environmental Management Plan (BC Hydro July 26, 2016, v4: Section 4.17) details lek survey methodology. The CEMP is available at: https://www.sitecproject.com .

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Methodology to determine the presence of active bird nests

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January 14, 2016

Methodology to determine the presence of active bird nests

1.0 Introduction

The British Columbia *Wildlife Act* (Section 34) (Province of BC 1996) and the federal *Migratory Birds Convention Act* (*MBCA*) (Section 5[9]) (Government of Canada 1994) provide legislation that prohibits the disturbance or destruction of a bird, its nest, or eggs. The federal *Species at Risk Act* (*SARA*) (Government of Canada 2002) provides similar protection for bird species at risk listed under *SARA*, regardless of whether they are also protected under the BC *Wildlife Act* or the *MBCA*.

Proposed development projects, such as BC Hydro Site C, require vegetated areas to be cleared for project infrastructure, and access and transmission corridors. Although most clearing on the proposed Site C Dam site will occur during the bird non-nesting season, some areas will require clearing during the bird breeding/nesting season. Additionally, dam construction, aggregate removal and other landscape modification may occur during the breeding season (see Appendix 1 for further discussion). The Canadian Wildlife Service (CWS) Pacific Yukon region provides advice on compliance with the *MBCA* to minimize effects of vegetation clearing during the migratory bird breeding season (Environment Canada 2014a). Generally, bird nest surveys are required prior to any vegetation clearing during the nesting season to identify any active and nests and avoid any contraventions of the BC *Wildlife Act* and *MBCA*.

There currently are no provincial or federal standards for conducting bird nest surveys. As such, it is the responsibility of the proponent of a proposed development project to produce and adhere to their own bird nest survey methodology to demonstrate due diligence in not contravening any related legislation. The following document describes BC Hydro's bird nest survey methodology and methodology that will be implemented on the proposed Site C Dam construction project. The methodology was developed using avoidance guidance from CWS (Environment Canada 2014a), provincial Best Management Practices (BC MFLNRO 2013 and 2014), and bird nest survey methodology produced for similar development projects in British Columbia (BC EAO 2014). BC Hydro's bird nest survey methodology and procedures described below are intended to reduce the likelihood of any non-compliance with the *Wildlife Act*, *MBCA* and *SARA* in relation to vegetation clearing for the proposed Site C construction project.

2.0 Seasonal Timing of Surveys

Bird nest surveys should be conducted according to the following methodology (Table 1) if vegetation clearing is to occur, particularly between 1 March and 30 September, in areas associated with project activity, including ancillary areas outside the project footprint used for project related activities such as maintenance, storage, borrow pits, or any camp activities.

Table 1. Peace Region terrestrial wildlife least-risk windows (adapted from BC MFLNRO 2011).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Songbirds				1*	1	-	31	15*				
Raptors and Owls			1	1	-	-	31	-	30			
Trumpeter Swans				1	-	-	31	31				

Exceptions	**Exceptions Nesting Period:** Any required clearing activities during this period should follow survey methods for the Exceptions Nesting Period (see Section 3.2.7.3), to accommodate bird species that may breed outside of the typical nesting period.
Caution	**Caution Nesting Period:** Any required clearing activities during this period should follow survey methods for the Caution Nesting Period (see Section 3.2.7.1).
Critical	**Critical Nesting Period:** Clearing activities should be avoided during this period. If clearing is required during this period, then survey methods for the Critical Nesting Period (see Section 3.2.7.2) should be followed.

* Caution Nesting Period for songbirds was added by BC Hydro as none were suggested by BC MFLNRO (2011).

The Critical Nesting Period for songbirds for the project area is generally between 1 May and 31 July (BC MFLNRO 2011). The Critical Nesting Period for raptors, owls and Trumpeter Swans starts earlier (1 April to 31 July). The Caution Nesting Period for raptors and owls is 1-31 March and 1 August to 30 September, while for Trumpeter Swan it is 1-31 August. Although no Caution Nesting Period was suggested for songbirds by BC MFLNRO (2011), as a matter of due diligence BC Hydro has adopted 1-30 April and 1-15 August as the Caution Nesting Period for songbirds. The Exceptions Nesting Period occurs during all other times outside of the Critical and Caution Nesting Periods. Environment Canada suggests the regional nesting period for the project area (nesting zone B6) is from the end of April to early August (Environment Canada 2014a).

The timeframes in Table 1 should be used as a general guideline. Local weather conditions and timing of seasonal bird movements will vary across regions and among years due to seasonal weather, annual abundance of forage resources, and other variables such as overwintering conditions (i.e., for migratory species), which in turn influence seasonal arrival and nest construction times, and potentially local annual species abundance. **It will be at the discretion of the onsite Qualified Environmental Professional (QEP)[1] to determine or confirm which nesting period is currently underway during the survey period**.

[1] For the purposes of this document a Qualified Environmental Professional (QEP) is defined as a person by way of education, training, skills, experience or a combination thereof, who is able to accurately identify native bird species using field observations (e.g., physical characteristics, audible songs and calls, behavior, life history strategy, relevant habitat attributes, etc.).

3.0 METHODS

Surveys should be conducted by or under the direction of a QEP who has demonstrated bird survey experience. Field crew and coordinators conducting the nest surveys should have a background in birding, bird identification, or bird biology, and should be trained in the appropriate survey methodology or have past experience with conducting such surveys. **At least one onsite QEP should be present during surveys**.

Project personnel involved in clearing should also be familiar with the bird nest survey methodology. **Strong and clear communication will be necessary between the bird survey and clearing crews to ensure that clearing crews are kept apprised of what areas are free-to-clear and for what period of time**.

Two main types of survey methodologies will be used to identifying any active nests within the project footprint prior to any clearing: i) aerial surveys to identify large stick nests, and Trumpeter Swan and Sandhill Crane nests; and ii) ground surveys to identify nest sites of other species (e.g. songbirds, shorebirds, cavity-nesting owls and woodpeckers). Additional specialized methods have been developed for Bald Eagle (sec. 3.3) and Sharp-tailed Grouse (sec. 3.4).

3.1 Aerial Large Stick Nest Survey Methods

Aerial surveys may be necessary for Bald Eagle nest assessment if the QEP determines that ground surveys will be insufficient to locate large stick nests. Large stick nests are often more readily detected from the air rather than from the ground due to their size and position in the tree canopy. Ideally, surveys should be conducted in early spring prior to leaf-out to maximize the detection of large stick nests from the air. Wetlands that provide suitable habitat for nesting Trumpeter Swan and Sandhill Crane should also be inspected during aerial surveys. In most cases, a single aerial survey that covers the footprint area or specific locations that may not have existing survey data, may be sufficient. Follow-up ground or aerial surveys may be required later in the season to determine if identified inactive nest structures are being utilized by late nesters prior to any clearing.

Pre-flight planning should include: i) relevant literature review; ii) locations on maps or GPS waypoints of any previously recorded nest locations; and iii) a familiarization of relevant topographic maps and proposed project clearing areas. Aerial surveys can also be done opportunistically if other qualified crews require helicopter access to more remote locations.

Aerial grid patterns should be flown across large areas to be cleared, while linear flight lines should be flown along proposed transmission line and access corridors to be cleared. Survey flights will maintain a minimum height of 50 m above the tree tops with speeds ranging between 30-130 km/h (RISC 2001). Low flights over nesting sites should be avoided as they can cause disturbance and may result in birds abandoning a nest.

The flight survey path should be recorded by using the 'track' feature on a GPS. **The locations of all nests observed from the air will be recorded with a GPS waypoint**.

To determine whether a nest is active or inactive, the biologist will rely on clues that include nesting or territorial behavior by adults, the presence of new nest branches or greenery, and/or eggs, young or whitewash. Every attempt will be made to identify the bird species associated with each active nest without causing undue disturbance to the nesting birds. Many raptor species reuse the same nest sites year after year. Because of this behavior, some raptor nests (e.g., eagle, Peregrine Falcon and Osprey[2] are legally protected year-round, even once the young have fledged and regardless of the presence or absence of breeding activity in a given year (Province of BC 1996).

3.2 Ground-based Nest Survey Methods

3.2.1 *Survey Conditions*

The intent of ground-based nest surveys is to identify the location of nests and nesting birds. Although there is generally an increase in bird activity (e.g., territorial singing and foraging) during early morning hours, nest surveys can be conducted throughout the day provided that bird activity, and weather and light conditions are suitable for location of nests. Data gathered during the morning is useful for determining species composition and diversity, however, **the primary goal of the survey is to passively locate nests**.

Surveys should not be conducted during inclement weather such as rain, snow, fog, or high wind, as bird detectability may be limited during these conditions. Conducting surveys under these conditions may also add stress to the adults or cause the female to flush from the nest and endanger the survivability of eggs or nestlings. During the Critical and Caution Nesting Periods, it is important that at least one complete survey be conducted under optimal conditions – in general these are daylight within 5 hours of sunrise, light winds (<20 km/h) and no precipitation. **It will be at the discretion of the bird biologist to determine the suitability of weather and bird activity in relation to adequate survey coverage.**

3.2.2 *Survey Effort*

Finding nests can be difficult as most birds purposefully construct their nests in hidden locations to avoid detectability and depredation. Consequently, surveys should be conducted methodically and thoroughly to maximize efficacy of locating nests. As a general rule, **survey effort should not exceed 1 ha/hr during the Critical Nesting Period in high quality nesting habitat**. However, the actual duration of the survey may be significantly faster depending on factors such as terrain, time of year, forest type, understory vegetation (i.e., the amount of shrub and herbaceous ground cover), and experience of the nest searchers. **Surveys should be conducted both within the clearing limits and up to 30 m beyond the limits**.

Generally, survey personnel should walk transects through the area to be cleared, passively searching for nests and nesting activity. For crews of two or more, individuals should be spaced within visual distance and walk parallel to one another along the transect.

[2] While Peregrine Falcon and Osprey are not documented nesters in the Site C footprint area, they are possible breeders for this area and occurrence of their nests should be included in aerial surveys.

In addition to visually searching for nest structures, surveyors should also employ additional survey techniques to increase the likelihood of finding nests, such as observing bird song or behaviour as cues to locate nests. These may include behaviors such as adults carrying fecal sacs away from the nest, adults bringing food to the nest, young begging for food, adults giving alarm calls or exhibiting agitated behavior. The survey transect should be recorded using the 'track' feature on a GPS device.

All nests that are encountered should be documented in the following manor:

- The nest location (UTMs) using a handheld GPS.
- The species attributable to the nest (if possible).
- The nest and general habitat characteristics (e.g., tree species, nest height, dbh and position; and dominant vegetation cover), nest contents if possible (e.g., presence of eggs, young, or empty, or under construction), and adult behaviour (e.g., nest building, incubating or brooding).
- The nest status (e.g., active or inactive).

If an adult bird flushes from an area that is suspected of being potential nesting habitat, the surveyor should briefly search the immediate area for a nest. Care and attention should be used during the nest search as to not cause any significant stress or duress to nesting birds, which may lead to nest abandonment. Surveyors should minimize time spent in the nest area, particularly during periods of inclement weather when eggs or nestlings may be exposed to the elements. If a nest is not located, the surveyor should back away from the encounter area and observe the detection site for any further bird activity through binoculars from a concealed location that does not cause unnecessary disturbance to the possible nesting pair. If adult birds exhibit excessive agitated behavior, surveyors should leave the area immediately. If the adult does not return or if a nest is not located, **the flushing location should be recorded as a GPS waypoint so that it may be revisited during the next survey round** to try and confirm the potential nest location. Similarly, any apparently active nest that is not attended by adult birds will be marked and revisited to confirm activity on the next survey round.

Under no circumstances should the surveyor physically touch a nest or attempt to climb a tree to look into a nest. Additionally, the surveyor should not intentionally cause birds to flush from the nest thereby risking exposure or depredation of the eggs or nestlings. Bird survey crews should communicate daily information regarding the number of active nests identified, their locations, and predicted nest completion date to the construction manager and clearing crew.

3.2.3 *Determining Nest Status*

Each nest observed will be given a designation of active or inactive. Nests that are determined not to be in current use due to derelict condition or other biological indicators (e.g., lack of adult birds nearby, spider webs across nest cavity entrances, moss growing on the nest cup, etc.) , will be given the designation of inactive. If the contents of the nest are easily observed from a distance, the presence of eggs or new nesting material can be used as indicators of current activity. Other means to determine nesting activity include observations of adult birds exhibiting nesting or territorial behavior in the vicinity of the nest.

Nests that appear in good condition and are suspected of being active, but bird presence or breeding activity was not confirmed, should be given a tentative active designation. It is only **after two observation periods of approximately 1 hour each, on two separate day visits that a potentially active nest can be designated as inactive**. Surveyors should avoid approaching a nest if nesting activity is observed or if a nest has the potential to be active. Instead, surveyors should observe the nest from a concealed distant location, viewing the nest through binoculars or a spotting scope.

3.2.4 *Nest Buffers*

A no-clearing nest buffer should be established around all confirmed active nests and suspected nest areas with significant evidence of breeding. Buffers will ensure as best as possible, that any clearing outside of the buffer will not render a nest ineffective or cause it to become inactive. An experienced QEP familiar with the habits and life histories of encountered bird species will be able to make a professional judgment on the likelihood of a nest being present when one is not directly found. Arboreal nests and nests in root wads or dense vegetative tangles are generally extremely difficult to locate. However, by using 'significant evidence indicators', suspected nest areas can be marked and appropriately buffered, thus better meeting the intent of the non-disturbance legislation and minimizing intrusion on an actual nest. Significant evidence indicators of breeding activity include:

a) Birds carrying food – for most songbirds (in particular), this activity indicates a nest or young in close proximity.
b) Birds carrying nesting material – indicates a nest is likely nearby.
c) Distraction displays – generally only performed within a few metres of an active nest site. Examples of distraction displays include, but are not limited to: a Killdeer, plover or sandpiper performing a broken-wing display, usually with an outstretched wing and flared tail; songbirds (wood-warblers and ground-nesters in particular) performing an injured display where both wings are tucked near to the body and fluttered rapidly; waterfowl performing an injured display with both wings loping or dragging alongside the body, and raptors, gulls or terns diving-bombing an intruder. Most distraction displayed are accompanied by emphatic vocalizations.
d) Persistent alarm calls and agitated behaviour. This is species-specific, but typically indicates a nest or young is close by. Examples include: birds giving scold notes, cries, or loud, abrupt, screeches, screams and other vocalizations; birds snapping their bills; birds flitting in and out of immediate view; or birds boisterously rushing towards an intruder.

If an experienced QEP observes at least one of the significant evidence indicators above, then the suspected nest area should be buffered. In most cases, an experienced observer will likely be able to narrow down the nest location to within a few meters.

The size and shape of the buffer will depend on various factors, including: site topography, proximity of the nest to naturally open areas, type and amount of surrounding vegetation cover, nesting period, a particular species' sensitivity to disturbance, rareness of the species in the local/regional area, and the type and extent of clearing activities that will be occurring next to the buffer. The onsite QEP will recommend the size of nest buffer to be established based on the above factors. For most bird nests, a minimum of a 30 m radius buffer should be established around active nests. In general, the precautionary principle should be implemented when establishing nest buffers: when in doubt, larger is better. See Table 2 for recommended minimum nest buffer sizes for various bird species and guilds.

Table 2: Recommended minimum buffer sizes around active bird nests.

Bird Species or Guild	Recommended Buffer Size[3]
Songbirds[4]	30 m radius
Ground Nesters (e.g., grouse, Common Nighthawk)	30 m radius
Waterfowl and Shorebirds	30 m radius
Cavity Nesters (including cavity-nesting owls and raptors, and most woodpeckers/sapsuckers)	30 m radius
Pileated Woodpecker	50 m radius
Raptors and Owls (stick nesters/non-cavity nesters)	100 m radius
Bald Eagle, Golden Eagle, Osprey, Peregrine Falcon, Northern Goshawk, Trumpeter Swan, Sandhill Crane	200 m radius
Great Blue Heron	300 m radius

No clearing activities within the established buffer areas should occur until after the QEP has determined that nesting and fledging are complete, or if the status of the nest has been changed from active to inactive.

3.2.5 *Adaptive Buffer Size Methodology*

Under certain site specific circumstances and with written rationale and documentation approved by the QEP, proposed buffer sizes may be reduced in size or changed in shape from those described in Table 2. Such circumstances may include, but are not limited to:

1) Proposed activities adjacent to nest buffers are not considered highly disruptive or to cause significant disturbance to a nesting bird (e.g., no clearing or disruptive activities are required near the buffer area; work only involves moving crews, machinery or equipment past buffers with no stationary/proximal work intended; or no heavy machinery use is required adjacent to buffers).

2) A proposed mitigation plan or strategy is developed and implemented to minimize disturbance effects or impacts on a nesting bird (e.g., hand clearing is substituted for machine clearing; temporary physical barriers (i.e., landscape fabric curtains) are erected between proposed activities and the buffer zone thereby providing a visual and auditory shield; bird nesting behaviour is directly monitored by an onsite QEP during proposed activities and activities are immediately halted if a nesting bird is disturbed from the nest; or naturally occurring topographic features or vegetation structure provide sufficient buffering/shielding around the nest).

[3] Recommended buffer sizes were developed from a combination of sources including: buffer sizes recommended for similar proposed development projects (BC EAO 2014); recommended buffer sizes in *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia 2013* (BC MFLNRO 2013); Buffer Zone and Setback Distances Recommendations (Environment Canada 2014b); and *Develop With Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MFLNRO 2014).

[4] For White-winged Crossbill nest area buffers, refer to sec. 3.2.7.3.

3) Timing and duration of the bird breeding season can vary across regions and among years (see discussion in sec. 2.0). Consequently, if the onsite QEP is able to confirm that a particular nesting period is off-set from the timing windows shown in Table 1, then the onsite biologist has the discretion to adjust the required nest survey methods (i.e., survey cycles and effort, see sec. 3.2.7) and resultant least-risk timing and work windows. For example, if in a given year, peak songbird nesting is confirmed as ended by the middle of July (as opposed to 31 July in Table 1), then at that time the "critical" least-risk window can be shifted to "caution".

3.2.6 *Flagging Nest Buffers*

Active bird nest locations will be flagged using assigned coloured flagging tape. Fallers, foremen and inspectors will be made aware of what colour of flagging is used to delineate nest buffers. Flagging tape should be hung approximately 5 m from the nest to show generally where the nest is located. A waterproof, permanent marker should be used to indicate the direction, distance and height to the nest from the flagging, for any follow-up monitoring. The bird species standardized 4-letter code and a unique nest number (e.g., AMRO-21) should also be written directly on the flagging tape.

The appropriately sized nest buffer should also be clearly flagged with the assigned coloured flagging tape. In dense vegetation a solid barricade strip of flagging may be necessary to ensure its visibility. It is important that the buffer be visible from a distance so approaching clearing crews can plan their route.

After the birds are thought to have fledged the nest and buffer area will be re-searched using the same methods as described above prior to giving a 'free-to-clear' designation.

Inactive nests should also be inconspicuously flagged at dbh on the nest tree and labeled with date, nest number and status of nest. The flagging should not be visible for clearing crews, but only visible to bird surveyors for follow-up nest surveys.

3.2.7 Survey Cycle

During the Critical Nesting Period (see Table 1) **three complete nest surveys** (a full survey cycle) should be completed prior to clearing, during the Caution Nesting Period (see Table 1) **two complete nest surveys** (a full survey cycle), while for the Exceptions Nesting Period (see Table 1) one complete nest survey is sufficient for a full survey cycle. Refer to Table 3 below for a summary of these methods.

Table 3: Summary of the bird nest survey methodology for the different nesting periods.

Nesting Period	Total # of Bird Surveys Required for a Full Cycle	Number of Days to Complete a Full Cycle	Number of Days that are 'Free to Clear' after a Full Cycle	Number of Days after the Last Survey Date where a Single Nest Survey will Commence a New 'Free to Clear' Period
Critical	3 Surveys	5 Days	3 Days	5 Days
Caution	2 Surveys	5 Days	3 Days	5 Days
Exceptions	1 Survey	1 Day	5 Days	6 Days

During the Critical and Caution Nesting Periods, a single survey is insufficient for identifying active nests, as nesting activity can easily be missed due to variables such as:

a) Timing of surveys related to the seasonal breeding cycle (e.g., incubating birds often sit tightly on the nest and will not readily be detectable, whereas birds feeding young will be much more noticeable); and
b) New breeding birds (i.e., individuals of the same or new species) are constantly showing up daily during the nesting season and as such, new nests could easily be missed with only a single survey.

However, during the Exceptions Nesting Period, a single survey may be sufficient as there are very few bird species or individuals that typically nest during this period.

3.2.7.1 During the Critical Nesting Period

The full survey cycle (three nest surveys) should be performed within a maximum of 5 days. This will allow clearing to occur following the final survey for a 3-day period. If clearing does not occur within these 3 days, a single follow-up nest survey can be completed within 5 days from the last survey date, which would commence a new 3 day period where clearing is allowed. If no clearing has occurred within the 5 days of the last survey date of a full survey cycle, then a new full survey cycle (three nest surveys) should be initiated. Figure 1 provides a 14-day example overview of the survey and ‘free to clear’ cycles for this duration of time within the Critical Nesting Period.

Days	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Bird Survey	Yes	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No	No
	Bird Survey 1		Bird Survey 2		Bird Survey 3	Clearing Allowed	Clearing Allowed	Clearing Allowed	No Clearing Allowed	No Clearing Allowed and Last Day*	Clearing Allowed	Clearing Allowed	Clearing Allowed	No Clearing Allowed
	3 Surveys Completed within a 5 Day Full Cycle					Free to Clear for 3 Days					Free to Clear for 3 Days			

* Last day to complete a single bird survey to commence a new 3 day 'Free to Clear' period. If no survey occurs on this day, then a new '3 Surveys Completed within a 5 day Full Cycle' would be required prior to any clearing.

Figure 1: An example of how the bird nest survey methodology would work during the Critical Nesting Period.

3.2.7.2 During the Caution Nesting Period

The full survey cycle (two nest surveys) should be performed within a maximum of a 5 day period and will allow clearing to occur following the final survey for a 3 day period. If clearing does not occur within these 3 days, a follow-up nest survey can be completed within 5 days from the last survey date, which would commence a new 3 day period where clearing is allowed. If no clearing has occurred within the 5 days of the last survey date of a full survey cycle, then a new full survey cycle (two nest surveys) should be initiated. If the onsite QEP determines that breeding activity is advancing early, then they should implement the Critical Nesting Period survey methodology during the Caution Nesting Period.

3.2.7.3 During the Exceptions Nesting Period

The Exceptions Nesting Period survey methodology is typically employed at times of year when very few bird species are expected to be breeding. Due to the highly variable nature of bird nesting behavior at this time, overall and species specific methodologies have been designed to minimize risk of non-compliance with the *BC Wildlife Act*, *MBCA* and *SARA.*

Application of the Exceptions Nesting Period Methodology: No breeding activity expected

For time periods (generally September 1 to February 15) when the QEP determines that bird breeding activity is unlikely, then no formal surveys will be conducted and "free to clear" status can be implemented until breeding evidence is detected. These determinations should also be habitat specific (example: aspen forest is "free to clear", but proposed clearing in spruce stands and bogs require a survey). Breeding assessments should be conducted semi-regularly in areas scheduled for clearing; the frequency of surveys during the Exceptions Period will be dependent on observations of local bird breeding activity and the type of habitat (e.g., spruce vs. aspen) slated for clearing. Breeding assessments will consist of a walk-through of different habitat types, looking specifically for breeding activity of target species. If no breeding evidence is detected then a "free to clear" status can continue. If breeding evidence is found, then species-specific survey methods will be implemented as described below.

Application of the Exceptions Nesting Period Methodology: Late breeding activity expected or detected

During August and occasionally extending into September, several species of songbirds frequently exhibit breeding behavior, including nest building, egg laying and the successful fledgling of young. Nest sites are typically distributed widely over the landscape, but can usually be detected relatively easily. Therefore, once the Caution Nest Period is over as determined by the QEP, the following methodology can be implemented for the Exceptions Period, generally expected until August 31.

Assessments will consist of a single nest survey that will allow clearing to occur following the survey for a 5 day period. If clearing does not occur within these 5 days, then a new nest survey should be completed which would commence a new 5 day period where clearing is allowed. This methodology should generally be followed until August 31 unless local breeding chronology and species observations suggest otherwise.

Application of the Exceptions Nesting Period Methodology: Early breeding activity expected

For several species such as Gray Jays, ravens and some owls (e.g., Great Horned Owl, Gray Gray Owl), nesting activity may commence in mid-late February. White-winged Crossbills begin nesting in response to the availability of ripening cone crops, and can potentially nest at any time of year. Species-specific survey methodologies will be implemented as determined by the onsite QEP. If the QEP determines that breeding activity is advancing early, then in this circumstance the Caution Nesting Period survey methodology could be implemented sooner.

Species-specific Survey Methodologies during the Exceptions Nesting Period

White-winged Crossbill

In years of heavy spruce cone crops (as in 2015), White-winged Crossbills are expected to be breeding as early as late August or September, continuing until spruce seed (their main food source) availability becomes limited. The species nests almost exclusively in mixed-wood or spruce dominant stands. When it is determined by the onsite QEP that crossbills are widespread and settling in spruce areas, <u>then a general walk-through survey of areas scheduled to be cleared over the subsequent two months should be conducted</u>. Surveyors will note the locations of mixed-wood and spruce stands where crossbills are occurring, documenting numbers of birds and breeding evidence (e.g., persistent singing, nest building, courtship). Locations that are being actively used for feeding should then be visited again within a week to re-assess the breeding status. If a spruce stand is occupied and breeding activity is continuing, then a polygonal buffer should be established that <u>encompasses the majority of spruce trees within a 50 m radius of the suspected nest area</u>. White-winged Crossbills are at times semi-colonial nesters with several pairs potentially utilizing even a small spruce stand, and are somewhat reliant on the cone crop immediately surrounding the nest tree for feeding their young. Such sites should then be monitored on a schedule determined by the QEP, considering breeding phenology and the timing of proposed clearing operations. Once sufficient evidence is found to declare active nesting, then monitoring should continue until evidence of breeding activity has ceased.

3.2.8 Active Nest Reassessments

Once a nest is designated active, **additional survey time should be spent near the nest to document the change in status from active to inactive**. Based on the species biology and the stage of the nesting cycle, the onsite QEP should determine the timing and amount of effort required. Generally, to ensure that sufficient time has passed to allow for completion of nesting activities, a minimum of 5 days should elapse prior to initiating a reassessment of the nest (day one begins on the day following the last survey). Typically, most songbirds require 25-35 days from when eggs are laid in the nest until the nestlings have subsequently fledged from the nest.

Upon approaching the nest site, if the nest is obviously active, the surveyor should document such activity and leave the site. Otherwise, two one-hour watches should be conducted on two separate days (e.g., one 1-hr watch per day for 2 days) for a nest to be properly reassessed. The timing of nest reassessments should be chosen based on the likelihood of observing birds at the nest. If a nest is well-concealed and/or high enough in a tree that an incubating/brooding adult might not be observed, a third one hour nest watch will be conducted; this can be completed later on during the same day as the second survey.

Care should be taken to ensure that the presence of the observer does not deter birds from returning to the nest. Surveys should be conducted from an unobtrusive position, as far away from the nest as possible. Observers should use topographic features and vegetation to conceal their position. If a bird is observed spending time nearby but does not approach the nest, is carrying food and does not approach the nest, or is showing signs of distress (e.g., alarm calls, distraction/decoy behaviors), the survey should be halted and started again the following day from a different location.

An active nest status may be changed to inactive if, upon completing the appropriate number of nest watches described above, no adult, nestling or fledgling activity is observed associated with the nest or buffer habitat. As a final verification of inactivity, the nest can be approached, inspected and documented for nest damage, signs of abandonment, or successful fledging. **Clearing of nest buffers may occur upon confirmation from the onsite QEP that the status of**

the nest has changed to inactive. This confirmation will be provided in writing prior to commencement of clearing.

During reassessment surveys, if any bird behaviour is observed that indicates the nest is still active, then the nest will retain its active designation and further nest reassessments should be halted to minimize disturbance. The no-clearing nest buffer shall remain in place until the nest is determined to be inactive by the onsite QEP. A subsequent nest reassessment may be conducted 5 days after the last reassessment survey date.

All active nests for which the status has changed to inactive should be reassessed at least 3 days prior to clearing as a matter of due diligence. Many bird species have multiple broods during the nesting season and may reuse the same nest again during the same breeding season. As a result, an active nest that has been reassessed as inactive may be reused later on in the nesting season by the same adult pair for another nesting attempt.

Active nests that are expected to remain active beyond the Critical and Caution Nesting Periods are still subject to the prohibitions of the *Wildlife Act* and the *MBCA*. Therefore, if a nest is discovered that remains active beyond either nesting period, an onsite QEP will need to reassess the nest to verify its inactive status prior to any clearing work.

3.3 Bald Eagle Nest Assessment Methodology

Bald Eagle nests are protected year round (whether occupied or not) under section 34b of the BC Wildlife Act. BC Hydro currently holds permits to remove Bald Eagle nests which have been deemed by a QEP to be unoccupied. The following methodology enhances due diligence in ensuring that nests are unoccupied before removal.

Ideally nests should NOT be scheduled for removal/relocation in either the Critical Nesting Period or the Caution Nesting Period.

The following steps are intended to be followed in the order written below. Also refer to Appendix 2 (attached separately) for a schematic illustration of steps #2-8.

1) An aerial nest survey should be conducted early in the breeding season (ideally early May, before cottonwood leaf-out) of areas slated for clearing during the subsequent 12 months. This will help confirm the location and activity status of any eagle nests in these areas.
2) BC Hydro will have an environmental monitor (EM) or other suitable designate, opportunistically report any observations of adult Bald Eagles seen along the Peace River within and as far as 2 km upstream and downstream of the areas slated for clearing. As a minimum, this information should be collected at least 10 days prior to any scheduled clearing activities. Such information will aid in any further monitoring which may be necessary as per step #3.
3) If eagles are detected in the area as per step #2 AND if there is evidence of breeding activity (see below), then a QEP should be on site to monitor and assess breeding season progress as per step #4. Important indicators of potential breeding activity are:

- Adult Bald Eagles perched at or near known eagle nest trees
- Adult Bald Eagles carrying sticks or other vegetation
- Nest building/refurbishing
- Adult Bald Eagle pairs closely associating (e.g., perching together in close proximity)
- Courtship displays
- Presence of eggs or young in nest.

4) If evidence of breeding activity is observed as per step #3, then <u>commencing 10 days prior</u> to the planned nest removal/relocation date, the QEP will check for eagle activity in the immediate area of the nests and as far as 2 km upstream and downstream. <u>Surveys should be conducted on a daily basis during suitable observation conditions</u> (see #5d below). If adverse weather conditions preclude such survey effort, then a minimum of 3 surveys in optimal conditions should be conducted during this 10 day period.
5) If adult Bald Eagles are detected in the area as per steps #3 and #4, but it is unknown whether or not a nest is active, a QEP should perform a <u>detailed daily survey commencing 3 days prior</u> to the scheduled nest removal/relocation date, and extending right up to the time of nest tree removal. This survey should be conducted according to steps 5a-5e, below.

   <u>If a nest is determined to be active then it should be buffered by 200 m</u>, and subsequently monitored as per normal methodology (Section 3.2.8 of this document).

   a) **Number of surveys per day**: one survey per day
   b) T**ime of day**: commencing no earlier than one hour after sunrise, and ending no later than one hour prior to sunset
   c) **Length of survey**: 30 minute stand watch in vicinity of nests, plus one hour minimum searching the shoreline (both banks) by boat to 2 km upstream and 2 km downstream from the nest sites; this is in order to locate eagles that are perching elsewhere but may be associated with the nest in question
   d) **Survey conditions**: surveys should be conducted when winds are light to moderate, and not during moderate-heavy precipitation. This means eagles will likely be more visible (i.e., in high winds or high precipitation eagles may be soaring or temporarily roosting elsewhere and may not be seen near the nest tree in question)
   e) **Data to be recorded**: use *BC Hydro Bald Eagle Nest Activity Data Sheet*, with observations including number and age cohort (adult, immature) of any eagles seen, and any observations that indicate breeding activity (e.g., adult birds perching together, adults carrying sticks or other vegetation, nest construction/refurbishing). Also record a GPS track to document the survey route
6) If no eagle activity is detected by the EM or QEP in steps #2-5, then the <u>QEP should be on site one day prior to nest removal</u> in order to monitor potential eagle activity in the immediate vicinity during clearing/falling activities.
7) If the QEP is not confident that a nest is NOT occupied based on the observations from steps #2-5, then an aerial reconnaissance over the nest (using a helicopter or drone) should be made within 5 days prior to tree removal/nest re-location in order to verify lack of occupancy. Photo documentation of the nest(s) from above should be taken at this time.
8) When nests are to be salvaged and relocated, if feasible consider a partial-salvage procedure involving removal of the primary supporting limbs and nest structure (as opposed to falling the entire tree first). In this way, the majority of the sticks and some of the supporting limbs can be easily salvaged with less damage, and be used to aid reconstruction of a substitute

nest elsewhere. If partial salvage is not possible, then collect as much of the original nest structure material as possible once the tree has been felled. This material will be used to aid reconstruction of a substitute nest.

3.4 Sharp-tailed Grouse Lek Assessment Methodology

Sharp-tailed Grouse (*Tympanuchus phasianellus*) are widespread, but uncommon in the vicinity of the Site C footprint. They likely occur primarily in grassland/shrubland and adjacent agricultural areas where suitable habitat exists above the Peace River canyon rim. Leks have been documented on the south bank downstream of the dam site, and near Highway 29 in the vicinity of Cache Creek (A. McIntosh, BC Hydro, *pers. comm*.). Currently, potentially suitable habitat is found mainly along the north bank of the Peace River.

Sharp-tailed Grouse are most susceptible to disturbance during the courtship period (mid-March through early May) when males hold territory at traditional lek sites. When clearing or other ancillary activities are planned within 200 m of grassland/agricultural areas, then surveys for this species should be conducted.

RISC (1997) recommends sample lek surveys be conducted for determining presence/not detected status of breeding Sharp-tailed Grouse. The BC Hydro methodology will entail the following for lek surveys:

- Sample lek surveys will be <u>conducted between April 15-30, 2016 in appropriate habitat</u> for 500 m horizontal distance beyond the north rim of the Peace River Canyon, access permitting. These surveys will guide the necessity of future lek surveys.
- In subsequent years if clearing or other industrial activities are planned between March 1 and May 15 AND within 200 m of suitable habitat, then lek surveys will be conducted in those areas during that time period
- As access may not always be possible due to private land issues, surveys will be mainly conducted from roadways, with some site access possible on foot or by boat
- As per RISC (1997) the following methodologies will be followed:
    - Survey period: mid-March to early May
    - Survey time of day: 0.5 hours before sunrise to 2.0 hours after sunrise
    - Survey conditions: calm or winds < 20 km/h, minimal precipitation
    - Observers will watch for dancing displays and listen for auditory clues of grouse presence
    - If a lek is discovered, then the location will be documented and the number of grouse detected recorded.

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Appendix 1. Discussion of work activities that can potentially disturb bird nesting activity.

Most industrial activities conducted during the bird breeding season pose some risk to nesting birds. This appendix elaborates on issues related to such activities. The majority of the main methodology document focuses on nest surveys prior to forest harvesting. However, below is a discussion of potential nest habitat issues related to other work activities, and for which bird nesting activity should be monitored and active nest sites buffered appropriately.

- ARCHAEOLOGICAL DIGS AND LABOURER ACTIVITIES:
  Activities such as these can substantially disturb nesting birds. Most often archaeological crews making small test pit excavations and can avoid disturbances by being aware of agitated birds and not working close to a nest site. Sites of larger excavations, however, should be pre-assessed and monitored for nesting bird activity. Labourers removing old fences can inadvertently destroy nest sites of wrens and other cavity nesters often use old fenceposts or trees that fencing is attached to.

- LOG PROCESSING, SKIDDING, GRUBBING, MULCHING, ROADSIDE BRUSHING, SLOPE CONTOURING:
  Many types of work activities occur well after trees have been harvested. Some species of edge and shrubland-associated birds (i.e. juncos, sparrows, wrens) can quickly colonize newly available habitat, including log decks and debris piles.

- NON-VEGETATED OR LIGHTLY VEGETATED SITES SUCH AS BORROW PITS, AGGREGATE REMOVAL SITES:
  Waterbirds such as ducks and grebes will colonize borrow pits. Killdeer, Spotted Sandpipers and Common Nighthawks will nest on bare ground

Appendix 2. Flow chart of Bald Eagle nest assessment methodology.

- Separate document

Appendix 3

Right Bank Grinding and Log Processing Area

Bird Surveys Free-To-Work Schedule for BC Hydro Site C

15 May 2016

Appendix 3. Sample free-to work report.

Right Bank Grinding and Log Processing Area

Bird Surveys Free-To-Work Schedule for BC Hydro Site C

15 May 2016

IMPORTANT NOTE: Within each polygon, the “Free to Work” status is valid ONLY for the activities indicated on the map. For SECTIONS A, B, C & E, only the portions of the polygons applicable to current grinding, log processing, and log loading/hauling were surveyed. Adjacent forest, shrubland, grassland and bare ground areas were not surveyed recently. Note that PRHP is conducting bird surveys in their areas of interest within SECTIONS A, C & E - SRS is not duplicating surveys there. SECTION D is available for all activities including Duz Cho stripping, etc.

Section A	**Season:** Critical - All Species
Most Recent Survey Date:	15 May 2016
Free-to-Work Until and Including:	18 May 2016

Notes:

- No probable or active bird nests found
- No buffers established
- Map of “Free to Work” polygon is below

Section B	**Season:** Critical - All Species
Most Recent Survey Date:	15 May 2016
Free-to-Work Until and Including:	18 May 2016

Notes:

- IMPORTANT: there are many active bird nests along the Back Channel – do NOT process wood on south side of the Red Bridge.
- No probable or active bird nests found
- No buffers established
- Map of “Free to Work” polygon is below

Section C	**Season:** Critical - All Species
Most Recent Survey Date:	12 May 2016
Free-to-Work Until and Including:	15 May 2016

Notes:

- Active Eastern Phoebe nest (label N16-013) is located on the main hunting camp building, UTM 10V 630718E 6228348N. Buffer **WILL NOT** impact planned log processing or grinding.
- Probable American Robin nest (label N16-014) in roadside waste wood pile at UTM 10V 630775E 6228233N. If nest remains active, buffer **WILL** impact grinding at that location. Agitated male robin was perched atop the pile, its mate carried nesting material into the pile.
- Probable White-throated Sparrow nest (label N16-015) in tops of unprocessed logs at UTM 10V 631329E 6228140N. If nest remains active, buffer **WILL** impact log processing and grinding at that location. Pair of sparrows closely associating, with the female gathering nesting material.
- **NEW:** Probable American Robin nest (label N16-021) in processed log deck at UTM 10V 632387E 6227934N. Female robin making multiple trips with nesting material (including mud) into the log deck. Male perched nearby. If nest remains active, buffer **WILL** impact work activities scheduled for May. Approximate nest location is indicated on the map by a yellow circle outlined in red.
- Approximate nest locations and preliminary buffers were flagged yellow in the field.
- Map of “Free to Work” polygon is below. Approximate nest locations are indicated

on the map by yellow circles outlined in red.		
Section D	**Season:**	Critical - All Species
Most Recent Survey Date:	14 May 2016	
Free-to-Work Until and Including:	17 May 2016	

Notes:

- Active raven nest (label N16-012) located 22 m outside polygon at UTM 10V 633205E 6228409N and approximately 60 m from nearest grinding pile or log deck. A 30 m buffer (flagged yellow) has been installed within the cleared area. Buffer currently does **NOT** conflict with work activities scheduled for May.
- Probable American Robin nest (label N16-016) in processed log deck or associated tops at roadside waste wood pile at UTM 10V 633062E 6228376N. Male and female robins were carrying nesting material into the log deck. If nest remains active, buffer **WILL** impact work activities scheduled for May. Approximate nest location is indicated on the map by a yellow circle outlined in red.
- Map of "Free to Work" polygon is below.

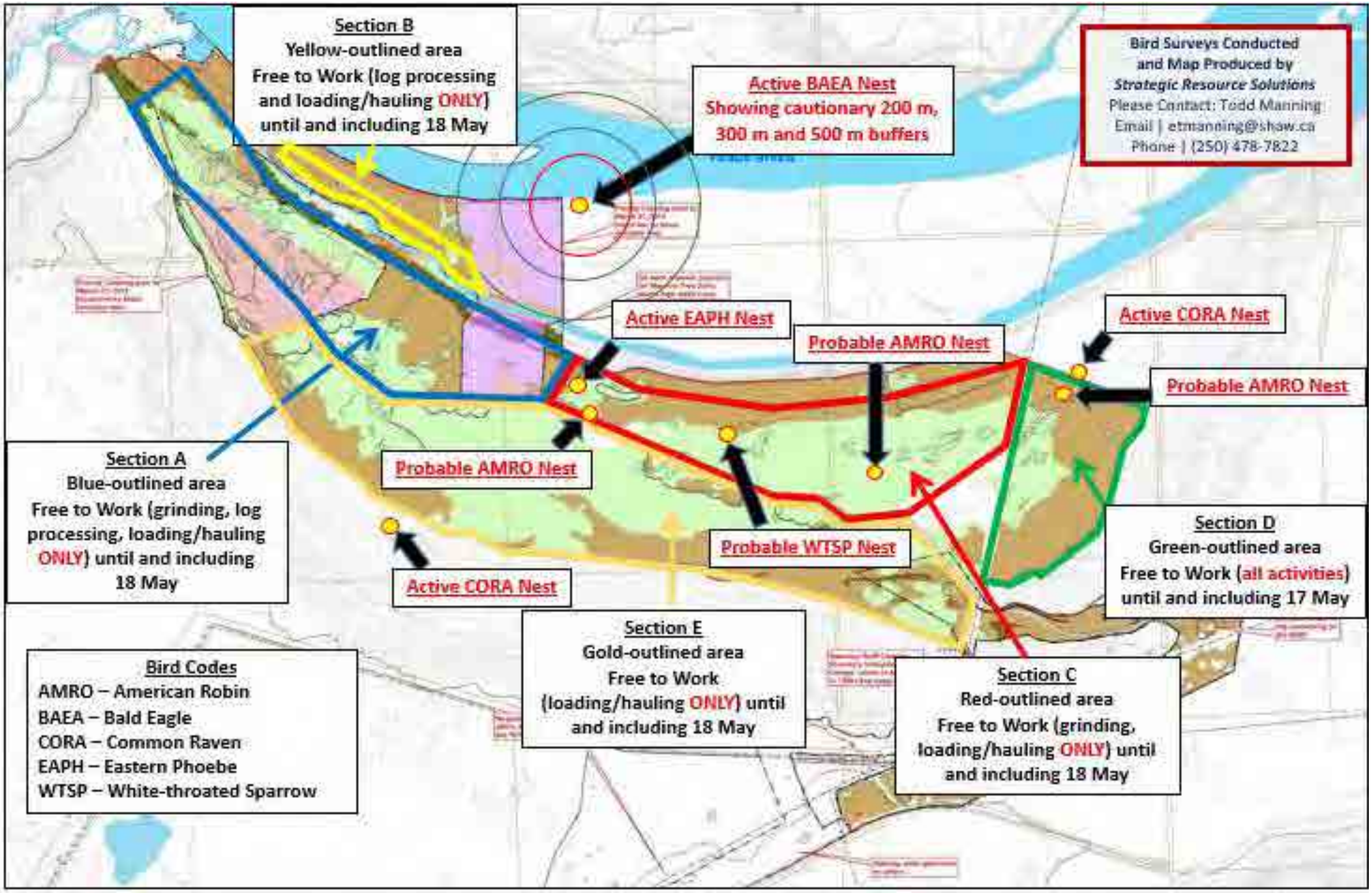
Section E	**Season:**	Critical - All Species
Most Recent Survey Date:	15 May 2016	
Free-to-Work Until and Including:	18 May 2016	

Notes:

- No probable or active bird nests found
- No buffers established
- Map of "Free to Work" polygon is below

Nest survey conducted by Michael Shepard. Report prepared by Michael Shepard (RPBio., QEP), Strategic Resource Solutions (SRS).

Michael G. Shepard, RPBio
Senior Wildlife Biologist
Strategic Resource Solutions (SRS)
(250) 478-7822, (250) 857-0777 (mobile)



Section B
Yellow-outlined area
Free to Work (log processing and loading/hauling ONLY) until and including 18 May
Active BAEA Nest
Showing cautionary 200 m, 300 m and 500 m buffers
Bird Surveys Conducted and Map Produced by
Strategic Resource Solutions
Please Contact: Todd Manning
Email | etmanning@shaw.ca
Phone | (250) 478-7822
Active EAPH Nest
Probable AMRO Nest
Active CORA Nest
Probable AMRO Nest
Section A
Blue-outlined area
Free to Work (grinding, log processing, loading/hauling ONLY) until and including 18 May
Probable AMRO Nest
Probable WTSP Nest
Active CORA Nest
Section D
Green-outlined area
Free to Work (all activities) until and including 17 May
Bird Codes
AMRO – American Robin
BAEA – Bald Eagle
CORA – Common Raven
EAPH – Eastern Phoebe
WTSP – White-throated Sparrow
Section E
Gold-outlined area
Free to Work (loading/hauling ONLY) until and including 18 May
Section C
Red-outlined area
Free to Work (grinding, loading/hauling ONLY) until and including 18 May

Appendix 4

Pre-clearing Nest Survey Reports

BC Hydro Site C

Bird Surveys Summary Report

Nesting Season 2016

25 October 2016

Report Prepared by:

Strategic Resource Solutions (SRS)

Victoria, BC

Executive Summary

SRS bird biologists have conducted bird nest pre-clearing surveys and monitoring at Site C since June 2015. This report summarizes bird survey results and mitigation strategy implementation for the 2016 bird nesting season. During this period, SRS bird biologists were responsible for ensuring that BC Hydro Site C work related activities were in compliance with provincial and federal legislation in relation to the protection of active bird nests. Bird surveys and monitoring were completed on both the right and left banks immediately adjacent to the dam site/lower reservoir area, Portage Mountain quarry, and at an archaeological site approximately 15 km upstream of the dam site. Surveys were completed for the following BC Hydro work projects and activities: archaeological sites, borrow areas and quarries, channel dewatering, vegetation clearing activities, waste wood grinding, distribution line clearing and construction, dyke construction, fisher habitat piles, ground stripping, log decks and log processing, pipeline crossings, river bank riprap installation, and road construction.

Early-nesting bird surveys were conducted between February and April 2016, targeting eagles, ravens, crossbills, woodpeckers and owls. Four active Bald Eagle nests were located in the vicinity of the dam site. These were monitored from February through July 2016, and likely fledged at least 5 young in late July. Eagle Nest #400 was in close proximity to clearing operations and Nest #401 was near waste wood grinding activities; both were buffered and monitored to minimize potential disturbance to the nesting eagles. No evidence of disturbance to eagle nesting was detected during these work activities, and at least one young fledged from each nest. In March and April, six active Common Raven nests were located and buffers were established around those nests that were located near active work areas. Monitoring of these nests showed no evidence of disturbance from adjacent work activities.

Free-to-work songbird surveys and reports were completed throughout the critical nesting season (May to July). Results were regularly communicated to work crews to ensure their activities were in compliance with legislation. Only one near miss of incidental bird take was reported; a mitigation strategy was subsequently developed and implemented to minimize any future similar occurrences.

Observation, monitoring and assessment data suggested that no birds or their nests monitored by SRS bird biologists were directly harmed due to BC Hydro work related activities in 2016.

Introduction

SRS bird biologists conducted bird nest pre-clearing surveys and monitoring at Site C between January and August 2016. Most surveys were focused on the left and right banks immediately adjacent to the dam footprint (Figure 1). Surveys were conducted unevenly across the study area and within the survey period since associated work activities occurred in only specific areas at specific times and other biological contractors were responsible for conducting bird surveys in other construction areas.

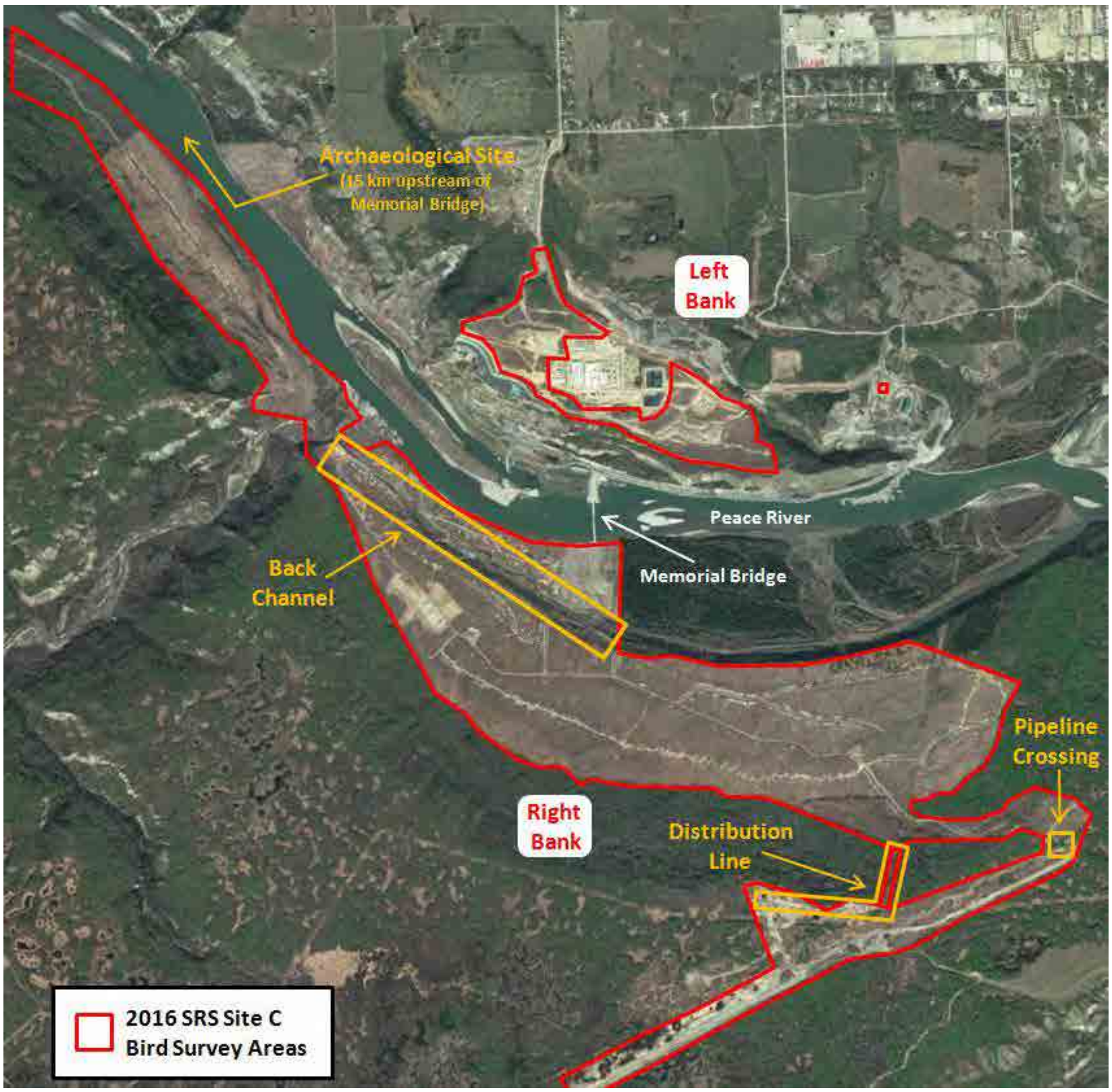


Figure 1: Study area outlined in red indicating areas where SRS bird surveys were conducted in 2016.

Surveys were conducted in areas prior to any work, clearing or construction activities to ensure that no active bird nests would be impacted by such activities. If active or suspected nest areas were identified, then protective buffers were established around the nest area. In some cases, mitigation strategies were developed and implemented to allow work activities to continue while ensuring that modified buffered nest areas were not unduly impacted and breeding activities were not compromised. Surveys for particular species and species guilds were conducted at different times of the year depending on the species' breeding chronology, and are summarized below.

Early-Nesting Birds Surveys

Bird nest free-to-work surveys were conducted from late February through April 2016, prior to and during Lower Reservoir clearing (RSEM-R5a and vicinity), and over a wider area of both Left and Right Banks where waste wood grinding and log processing were planned. Active nests of Bald Eagle and Common Raven were found (see sections below). No nesting evidence of any other bird species was detected during this survey period.

Bald Eagle Nest Monitoring

Five Bald Eagle nests along the Peace River in the vicinity of the dam site were monitored during the breeding season (Table 1; Figure 2). Monitoring of the nests began in late February and continued until late July 2016. Nesting activity was first observed on 24 February 2016, but nest building activities likely began 2-3 weeks prior to this.

Figure 2: Locations of five Bald Eagle nests monitored by SRS in 2016.

Four (62C, 306, 400 and 401) of the five monitored eagle nests located in the lower reservoir area were active in 2016, while Nest 116 was inactive. The four active nests likely fledged a total of at least five young. Fledgling dates ranged from approximately 20-27 July.

Table 1: Likely number of fledglings for monitored Bald Eagle nests near Site C Dam in 2016.

Nest #	UTM	Location Description	Status	Likely # of Fledglings
62C	10V 633601E/ 6229861N	3.2 km downstream of Memorial Bridge	Active	2
116	10V 624831E/ 6233390N	Tea Island - 7.2 km upstream of Memorial Bridge	Inactive	0
306	10V 624738E/ 6233453N	Tea Island - 7.4 km upstream of Memorial Bridge	Active	1
400	10V 626880E/ 6232600N	5.0 km upstream of Memorial Bridge	Active	1
401	10V 630712E/ 6229248N	0.24 km downstream of Memorial Bridge	Active	1

Both eagle nests #400 and #401 were newly built in early 2016 and were documented during ongoing construction and clearing activities in the lower reservoir area. Nest monitoring procedures were developed and implemented for these two nests during work activity periods (Shepard and Manning 2016). Buffers (200 m radius) were established around both nests and subsequently monitored for any disturbance (Shepard 2016d). Regular monitoring of these nests showed no evidence of disturbance from adjacent work activities and each nest fledged at least one young. All other Bald Eagle nests were >500 m from any work activities and consequently were only periodically monitored during the nesting season.

Common Raven Nest Monitoring

Six active Common Raven nests were located starting in mid-March near the dam site on both the left and right banks (Figure 1). Buffers of 30-100 m were established around nests that were in close proximity to any work activities and subsequently monitored for any potential disturbance. At least one of the monitored nests failed due to unknown causes (Shepard 2016c), while the others were thought to have successfully fledged young.

Free-to-Work Songbird Surveys

Free-to-work songbird surveys were initiated during the second week of March and continued throughout the breeding season until 7 August 2016, at which time observation data indicated that the songbird nesting season had ended for the survey area. During this period, free-to-work bird surveys were conducted for several work related projects and activities, including: archaeological sites, borrow areas and quarries, channel dewatering, vegetation clearing activities, waste wood grinding, distribution line clearing and construction, dyke construction, fisher habitat piles, ground stripping, log decks and log processing, pipeline crossings, riprap installation, and road construction. Surveys were conducted primarily on the Right Bank, but also on the Left Bank (Figure 1) and at Portage Mountain quarry (near Hudson's Hope).

At times, free-to-work surveys deviated from survey protocols previously described in (Manning et al. 2016), as it was determined that surveys required adopting a more fluid, adaptive management approach to properly ensure that work activities were not impacting any bird nesting activities. In general, survey protocols included pre-clearing bird nest surveys as described in Manning et al. 2016, as well as additional intensive nest sweeps done immediately prior to any work activities where previous monitoring had resulted in bird nest buffers being established (Shepard 2016e). Approximately 100 free-to-work survey reports were produced throughout the survey period, prior to any proposed work, clearing or construction. Each report clearly indicated and mapped what specific areas were free to work in, any conditions placed on work activities, and the expiry date of the free-to-work status period (see Appendix A for an example report).

Nearly 100 active nest areas were identified and buffered across the study area. Buffers (number in parentheses) were established primarily for the following species: Song Sparrow (21), American Robin (14), Lincoln's Sparrow (12), White-throated Sparrow (11), Eastern Phoebe (7), Killdeer (7), Dark-eyed Junco (6) and Spotted Sandpiper (5). Many more nest areas were identified, but these did not require buffers as the nest areas were either already captured in an existing nest buffer or there were no nearby or immediate work activities planned for the area.

Observation, monitoring and assessment data suggested that no birds were directly harmed and no bird nesting activities as monitored by SRS bird biologists were known to have been compromised due to BC Hydro work related activities. One near miss of incidental bird take was reported of a young, flightless Spotted Sandpiper that fell into an amphibian pitfall trap, and was subsequently released unharmed (Chytyk 2016e). A mitigation strategy was consequently developed and implemented for this location to minimize the possibility of any further similar incidents.

Mitigation Strategies

Six mitigation strategies were developed between May and August 2016 and were implemented to allow for work activities to continue at a time when mitigation procedures would not cause undue disturbance to known active bird nests. Mitigation protocols and guidelines were produced (Shepard et al. 2016) to provide direction on how best to proceed with developing and implementing mitigation strategies. Mitigation strategies included: modifying buffer sizes and shapes with subsequent monitoring, installing visual screening with subsequent monitoring, and frequent work site monitoring to identify unused potential nesting habitat that could be modified or removed to discourage re-nesting. Twice during the nesting season modifications were required for existing nest buffers. In both cases, a formal assessment to determine any potential impacts to bird nesting activities was conducted prior to any buffer alterations (Chytyk 2016c,d).

All mitigation strategies were developed, supervised, implemented and subsequently monitored by an onsite, experienced bird biologist QEP (see list of authors of this report below). Mitigation strategy implementation either shortened the overall time period of nesting activities (i.e., deterring re-nesting) so that work activities could begin earlier, or allowed work activities to occur concurrently with nesting activities (i.e., visual screening and modified buffers with subsequent monitoring).

It is estimated that mitigation strategies implemented by SRS biologists/QEP's avoided 45-70 days of construction delays and associated delay costs (Table 2). These mitigation strategies were implemented without any evidence of bird nesting activity or productivity being compromised at the nest areas being mitigated.

Table 2: Estimated number of days of work activity delays that were averted due to bird mitigation strategy implementation.

Site C Project Activity Area	Estimated Number of Days of Work Activity Delays Averted Due to Bird Mitigation Strategy Implementation
Archaeological Site	5-10 days
Back Channel	15-25 days
Distribution Line	10-15 days
Pipeline Crossing	15-20 days
Total # of Work Delay Days Averted	45-70 days

Archaeological Site

A mitigation strategy was developed for an active Cedar Waxwing nest located at an archaeological excavation site on the left bank approximately 15 km upstream of Memorial Bridge (Figure 1) (Chytyk 2016b; Chytyk and Shepard 2016b). This mitigation strategy allowed for hand clearing and archaeological excavations to occur within 3.5 m of the active nest by installing a 2 m high opaque visual barrier (landscape cloth) between the active nest and work activities. The waxwing nest was subsequently monitored to ensure work activities did not unduly impact bird nesting. Four young were thought to have successfully fledged from the nest. This mitigation strategy averted an estimated 5-10 days in work activity delays.

Back Channel

A mitigation strategy was developed for the Back Channel area (Figure 1) (Shepard 2016b), to allow for the installation of water pumps and hoses for dewatering the Back Channel and minor clearing around active songbird nest areas of primarily Lincoln's Sparrows (2 pairs), Song Sparrows (2-3 pairs), Common Yellowthroat (1 pair) and Spotted Sandpiper (1 pair). Nesting activity and habitat use was monitored to ensure work activities did not negatively impact nesting. A second mitigation strategy was developed for the construction of a dyke in an area occupied by individual pairs of American Robin, Eastern Phoebe and Song Sparrow. Daily monitoring of these nest areas identified times when nesting activities had ceased, which allowed for habitat modification (removal of shrub cover and woody debris accumulations) to discourage potential re-nesting (Chytyk and Shepard 2016b). A third mitigation strategy was developed for avoiding potential incidental bird take from the use of amphibian pitfall traps which had been deployed in the area (e.g., Spotted Sandpiper chicks falling into pitfall traps) (Chytyk 2016e). These mitigation strategies averted an estimated 15-25 days in work activity delays.

Distribution Line

A mitigation strategy was developed for the distribution line to the east of the substation near 13 km along Right Bank Road (Figure 1) (Chytyk 2016a; Shepard 2016a). This area had numerous active songbird nest areas, including that of the federally Threatened Canada Warbler. The mitigation strategy used regular monitoring and modified buffers to identify habitat areas not used by nesting birds to allow for the clearing of pole footprints and construction access trails. This mitigation strategy averted an estimated 10-15 days in work activity delays.

Pipeline Crossing

A mitigation strategy was developed for the Septimus Road crossing of the Spectra Pipeline near 10 km on Right Bank Road (Figure 1) (Chytyk 2016f). The pipeline right-of-way had various songbird species nesting along it that were regularly monitored to identify when nesting activities had ceased in order to allow for habitat modification and vegetation removal, thereby discouraging re-nesting of species such as American Robin and White-throated Sparrow. This mitigation strategy averted an estimated 15-20 days in work activity delays.

The above mitigation strategies were possible because experienced onsite bird biologists regularly monitored bird nesting activity and local breeding chronology to allow for the identification of habitat areas that were not being used by nesting birds, and periods when nesting activity had ceased.

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October 25, 2016

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Appendix A: Sample Free-to-Work Report

Right Bank Grinding and Log Processing Area

Bird Surveys Free-To-Work Schedule for BC Hydro Site C

15 May 2016

IMPORTANT NOTE: Within each polygon, the "Free to Work" status is valid ONLY for the activities indicated on the map. For SECTIONS A, B, C & E, only the portions of the polygons applicable to current grinding, log processing, and log loading/hauling were surveyed. Adjacent forest, shrubland, grassland and bare ground areas were not surveyed recently. Note that PRHP is conducting bird surveys in their areas of interest within SECTIONS A, C & E - SRS is not duplicating surveys there. SECTION D is available for all activities including Duz Cho stripping, etc.

Section A	Season:	Critical - All Species
Most Recent Survey Date:	15 May 2016	
Free-to-Work Until and Including:	18 May 2016	
Notes: • No probable or active bird nests found • No buffers established • Map of "Free to Work" polygon is below		
Section B	Season:	Critical - All Species
Most Recent Survey Date:	15 May 2016	
Free-to-Work Until and Including:	18 May 2016	
Notes: • IMPORTANT: there are many active bird nests along the Back Channel – do NOT process wood on south side of the Red Bridge. • No probable or active bird nests found • No buffers established • Map of "Free to Work" polygon is below		
Section C	Season:	Critical - All Species
Most Recent Survey Date:	12 May 2016	
Free-to-Work Until and Including:	15 May 2016	
Notes: • Active Eastern Phoebe nest (label N16-013) is located on the main hunting camp building, UTM 10V 630718E 6228348N. Buffer WILL NOT impact planned log processing or grinding. • Probable American Robin nest (label N16-014) in roadside waste wood pile at UTM 10V 630775E 6228233N. If nest remains active, buffer WILL impact grinding at that location. Agitated male robin was perched atop the pile, its mate carried nesting material into the pile. • Probable White-throated Sparrow nest (label N16-015) in tops of unprocessed		

logs at UTM 10V 631329E 6228140N. If nest remains active, buffer WILL impact log processing and grinding at that location. Pair of sparrows closely associating, with the female gathering nesting material.

- NEW: Probable American Robin nest (label N16-021) in processed log deck at UTM 10V 632387E 6227934N. Female robin making multiple trips with nesting material (including mud) into the log deck. Male perched nearby. If nest remains active, buffer WILL impact work activities scheduled for May. Approximate nest location is indicated on the map by a yellow circle outlined in red.
- Approximate nest locations and preliminary buffers were flagged yellow in the field.
- Map of "Free to Work" polygon is below. Approximate nest locations are indicated on the map by yellow circles outlined in red.

Section D	Season:	Critical - All Species
Most Recent Survey Date:	14 May 2016	
Free-to-Work Until and Including:	17 May 2016	

Notes:

- Active raven nest (label N16-012) located 22 m outside polygon at UTM 10V 633205E 6228409N and approximately 60 m from nearest grinding pile or log deck. A 30 m buffer (flagged yellow) has been installed within the cleared area. Buffer currently does NOT conflict with work activities scheduled for May.
- Probable American Robin nest (label N16-016) in processed log deck or associated tops at roadside waste wood pile at UTM 10V 633062E 6228376N. Male and female robins were carrying nesting material into the log deck. If nest remains active, buffer WILL impact work activities scheduled for May. Approximate nest location is indicated on the map by a yellow circle outlined in red.
- Map of "Free to Work" polygon is below.

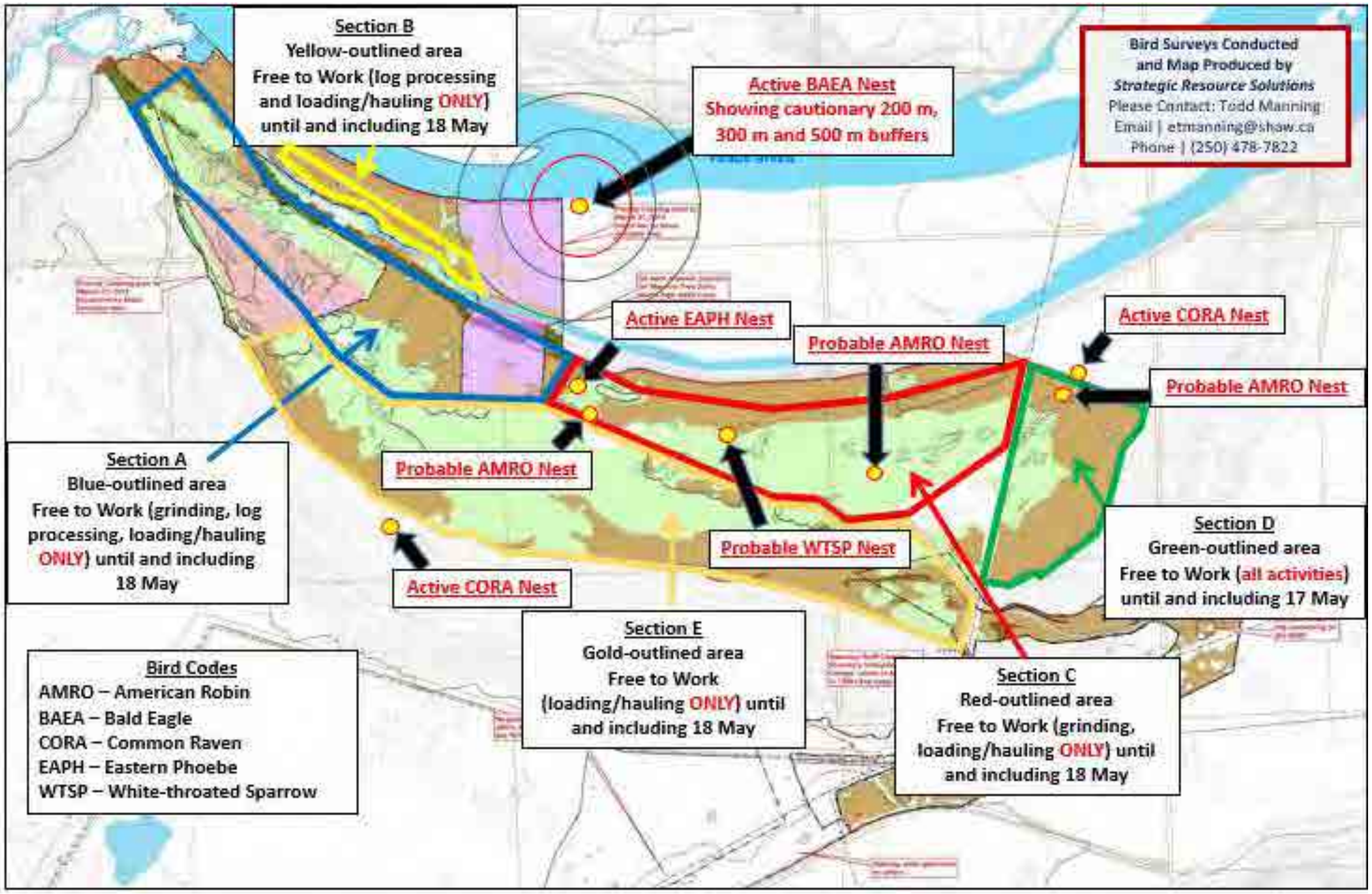
Section E	Season:	Critical - All Species
Most Recent Survey Date:	15 May 2016	
Free-to-Work Until and Including:	18 May 2016	

Notes:

- No probable or active bird nests found
- No buffers established
- Map of "Free to Work" polygon is below

Nest survey conducted by Michael Shepard. Report prepared by Michael Shepard (RPBio., QEP), Strategic Resource Solutions (SRS).

Michael G. Shepard, RPBio
Senior Wildlife Biologist
Strategic Resource Solutions (SRS)
(250) 478-7822, (250) 857-0777 (mobile)



Section B
Yellow-outlined area
Free to Work (log processing and loading/hauling ONLY) until and including 18 May
Active BAEA Nest
Showing cautionary 200 m, 300 m and 500 m buffers
Bird Surveys Conducted and Map Produced by
Strategic Resource Solutions
Please Contact: Todd Manning
Email | etmanning@shaw.ca
Phone | (250) 478-7822
Active EAPH Nest
Probable AMRO Nest
Active CORA Nest
Probable AMRO Nest
Section A
Blue-outlined area
Free to Work (grinding, log processing, loading/hauling ONLY) until and including 18 May
Probable AMRO Nest
Probable WTSP Nest
Active CORA Nest
Section D
Green-outlined area
Free to Work (all activities) until and including 17 May
Section E
Gold-outlined area
Free to Work (loading/hauling ONLY) until and including 18 May
Section C
Red-outlined area
Free to Work (grinding, loading/hauling ONLY) until and including 18 May
Bird Codes
AMRO – American Robin
BAEA – Bald Eagle
CORA – Common Raven
EAPH – Eastern Phoebe
WTSP – White-throated Sparrow

Appendix 5

Spring Waterfowl and Shorebird Survey Report

2016 Spring Migration Waterfowl Surveys: Site C Clean Energy Project

–Prepared for BC Hydro –

November 2016

v2






Prepared by:

M. Mushanski, J. Vitt, L. Ross

Native Plant Solutions / Ducks Unlimited Canada

Disclaimer

This report was prepared exclusively for BC Hydro by Native Plant Solutions.

The quality of information, conclusions, and estimates contained herein is consistent with the level of effort expended and is based on:

i) Information available at the time of preparation;

ii) Data collected by Native Plant Solutions and/ or supplied by outside sources; and,

iii) The assumptions, conditions, and qualifications set forth in this report.

This report is intended to be used by BC Hydro only, subject to the terms and conditions of its contract with Native Plant Solutions. Any other use or reliance on this report by any third party is at that party's sole risk.

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Introduction

The Site C Clean Energy Project (the “Project”), currently under construction, will be a third dam and hydroelectric generating station on the Peace River in northeast BC. The Federal Decision Statement (CEAA 2014) requires BC Hydro to:

- 10.3.3: Include 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; and
- 11.1: 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.

Condition 12 of the Schedule B Table of Conditions (September 2014) issued by the Province of B.C. requires BC Hydro to:

- 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).

One of the objectives of the spring and fall waterfowl and shorebird surveys was to continue to build the pre-project database on the presence and use of habitats in the Project area by waterfowl and shorebirds during spring migration. In 2015 the program was expanded to collect additional data to assist in informing the wetland function assessment and wetland mitigation plan and was continued in 2016.

With the aim of fulfilling EAC condition 12 and FDR condition 11.1 Native Plant Solutions (NPS), in conjunction with BC Hydro, developed a wetland function assessment methodology to identify the relative importance of wetlands to specific migratory birds, other wildlife species and rare plants. In order to better inform the wetland function assessment tool aerial waterbird surveys conducted during spring migration in 2016 will document the relative use of wetland habitats by migratory waterfowl and shorebirds along the plateau between the transmission line right-of-way and the Peace River. The river and wetlands in the study area are suspected to be important habitat for waterbirds during spring migration. Wetland habitats are also used by migrating individuals for staging before engaging in long, energetically demanding flights to breeding grounds. To survive these journeys birds must increase their fat stores prior to leaving (O’Neal et al. 2012). This means that habitats providing sufficient food resources for a wide range of bird species must be available along the migration route.

The data collected during these surveys will assist in:

- Documenting changes in species composition and numbers as a result of Project construction and operations.
- Comparing waterfowl and shorebird use data to pre-project baseline data.
- Documenting how waterfowl and shorebirds respond to changes in aquatic and riparian-related food resources (fish and insects) associated with the change from a fluvial to a reservoir system.

Methodology

Survey Area

The survey area includes the main channel of the Peace River from Hudson's Hope to the Alberta border, the southern transmission line that runs between Hudson's Hope and Moberly River, and the area in between these two features (the Plateau) (Figure 1).

The survey area falls within the Peace River Basin ecoregion. This ecoregion is a wide plain surrounded by rolling uplands and dissected by the Peace River and its tributaries. The survey area is also within the Peace Lowlands ecosection. This area is dominated by trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white spruce (*Picea glauca*), black spruce (*Picea mariana*), logepole pine (*Pinus contorta*) and tamarack (*Larix laricina*).

Sampling Design and Effort

Spring migration surveys were conducted three times during the spring migration season between late March and May, to detect early, mid- and late migrants within the survey area. In addition to transects along the Peace River, four (4) survey transects were established along the Plateau (Figure 1, Table 1).

Table 1. Longitude and latitude coordinates of the start and end points for each transect surveyed with the approximate length.

Transect	Start coordinates	End coordinates	Approximate Length (km)

1	56.001	-121.971	56.146	-120.001	150.0
2	56.025	-121.887	56.222	-121.119	52.6
3	55.975	-121.950	56.202	-120.942	67.6
4	55.973	-121.910	56.182	-120.905	67.3
5	55.987	-121.986	56.166	-120.843	77.9

Transect 1 was flown along the Peace River beginning at the Alberta border and ending at Hudson’s Hope. This transect was divided into 30 - 5 km segments, with 17 between Hudson’s Hope and the proposed dam site and 13 between the dam site and the Alberta border. This was consistent with past surveys conducted along the Peace River to allow for comparison with previous data. Transects 2-4 included wetlands between the Peace River and the transmission line (Figure 1). Transect 5 followed the transmission line from Hudson’s Hope to Moberly River (Figure 1). Each transect was 400 m wide, extending 200 m out from both sides of the plane.

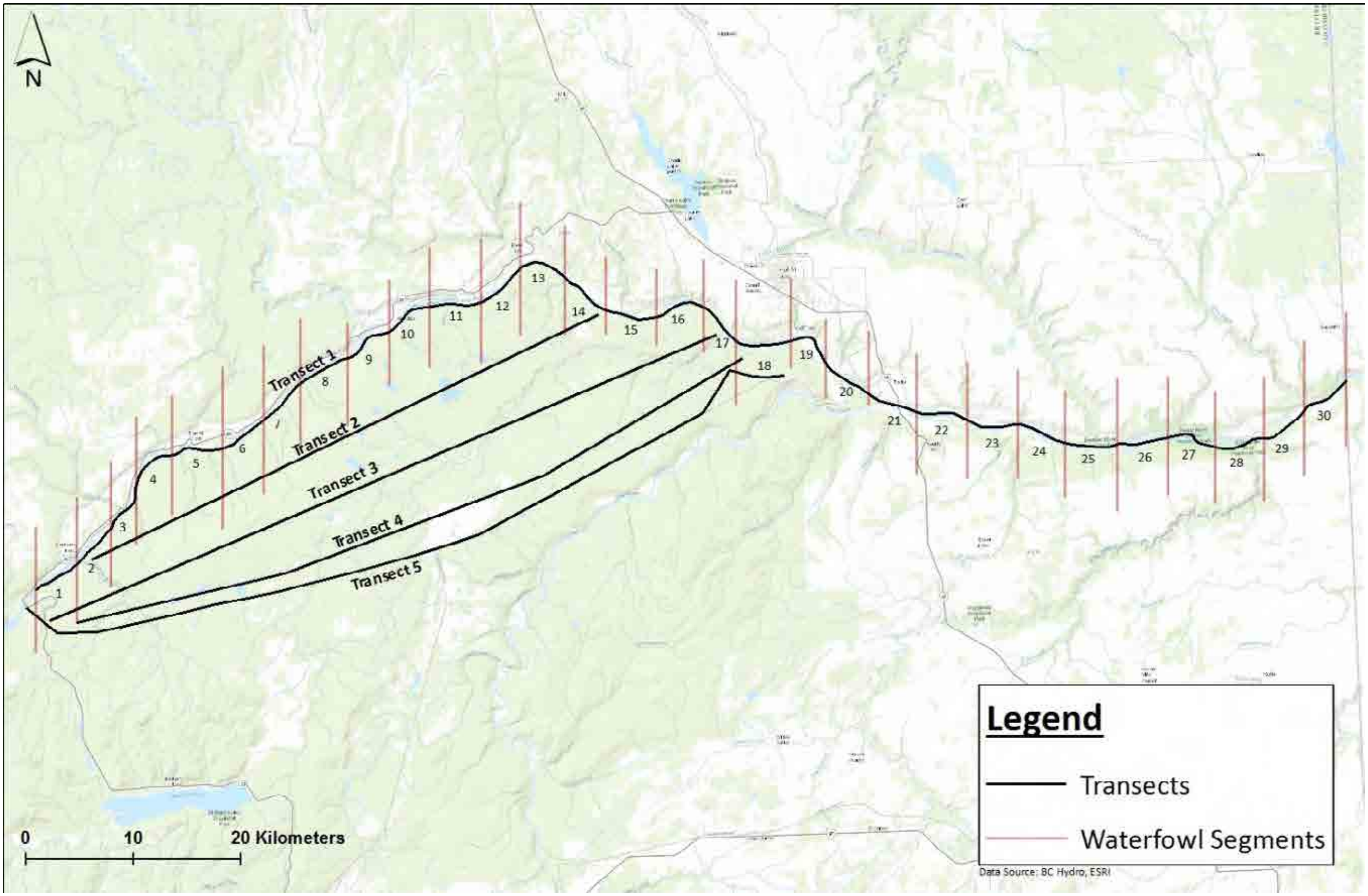


Figure 1. Map of study area showing the 5 transects that were flown for each survey.

Transect boundaries were estimated by determining the angle from the window at eye height on the plane strut that each observer had to look at to observe 200 m on the ground. The extent of the five transects ensures that sufficient wetland area was surveyed to obtain a statistically significant understanding of habitat use by migrating waterfowl (at least 2% of the study area). Each transect was flown with a Cessna 180 following the approximate centreline of the Peace River and of each transect. The flight elevation of the survey was approximately 500 ft. The flight path was recorded using a handheld Garmin GPSmap78s GPS as well as BU-353S4 USB GPS receivers which were linked to ArcMap on laptop computers. The Garmin GPS units were set up to record a track log which recorded a GPS point every second for the duration of the flights. The GPS receivers used in conjunction with ArcMap were used to aid in navigating each transect and ensured that both observers knew which transect was being surveyed at all times. A 200m buffer was also created on either side of each transect, and viewed in ArcMap to allow observers to estimate the extent/width of each transect.

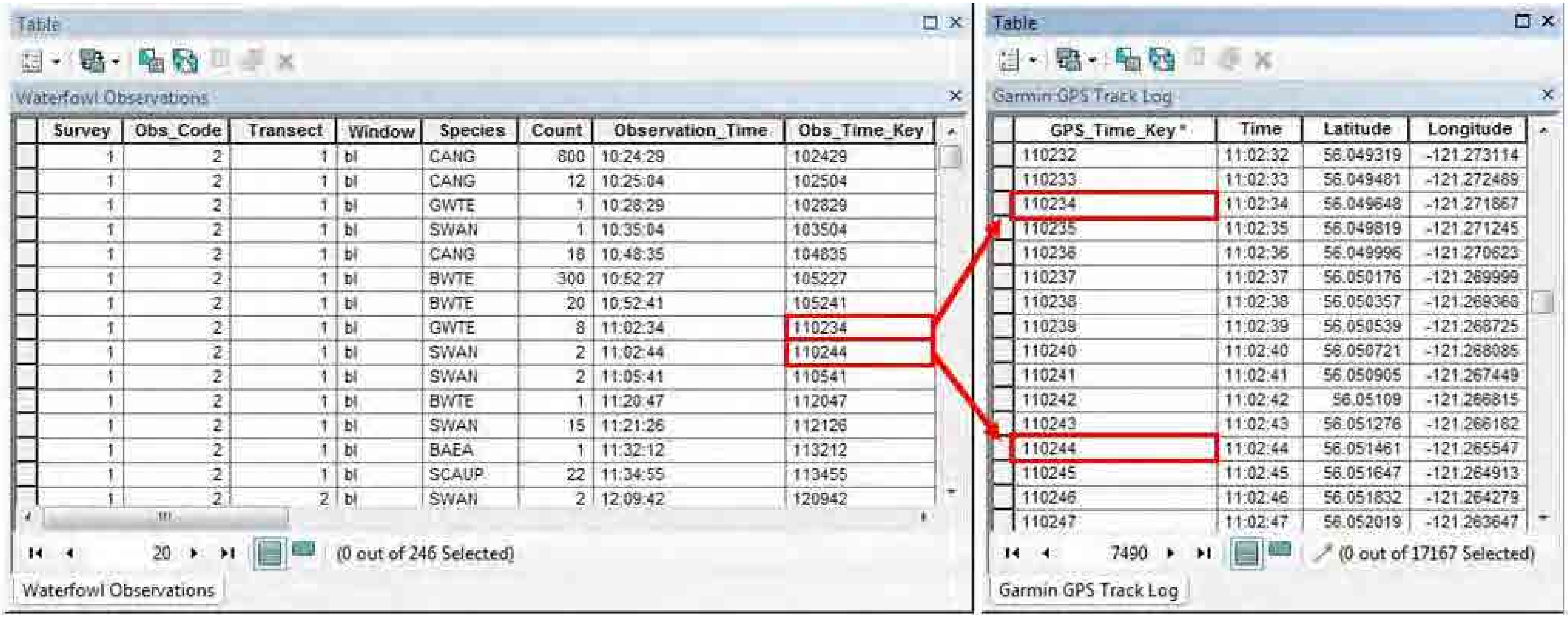
The goal of the surveys was to document 100% of the waterfowl and shorebirds present along each transect. Two observers were present for each survey. One was situated in the front right, next to the pilot, while the other sat in the back left. Each observer recorded all species seen on their side of the plane. All birds observed were recorded, including incidental observations of non-waterfowl species (corvids and raptors) using a Sony IC voice recorder. For each observation the time of detection was recorded, in addition to species and count, to allow for the observation to be linked to the time stamped GPS locations recorded by the handheld GPS unit.

Data Entry and Analysis

To begin, field data on the voice recorders was transcribed to data sheets by the observer who recorded the observations. Appendix A is an example of a data sheet used to transcribe observations from the recorded data on the voice recorders. The observation data from these data sheets (time of observation, species, and count) was then entered into an excel spreadsheet along with weather observations that were made at the beginning of each survey.

The data analysis portion consisted of linking the voice recorded observation data with a GPS location in order to determine the habitat that the waterfowl were occupying at the time of detection. Using ArcMap, the excel table containing the observations was converted into a table within an ArcGIS geodatabase in preparation to be linked to the GPS data. The track logs recorded by the Garmin GPS were exported from the device and converted into points within a geodatabase. Every point in this track log contained the associated GPS coordinates at that position along with a time stamp. The track log was joined to the observations table using the time stamp field as the common key so that each record in the observations table had a GPS coordinate associated with it (i.e., every waterfowl observation had a GPS coordinate associated with it) (Figure 2). Once joined each observation was plotted as a point to be used to determine the habitat type that each of the observations occurred in.

The observation data was then linked to the Terrestrial Ecosystem Mapping (TEM) habitat data in order to quantify the habitat use by waterfowl and shorebirds during the surveys. This was done using the Identity tool within ArcMap, which assigns the attributes from a polygon (TEM habitat data in this case) to any point that falls within it (waterfowl observations) (Figure 3). Once the observation data was appended to the habitat data, it was summarized by habitat type, species and count.



Table

Waterfowl Observations

Survey	Obs_Code	Transect	Window	Species	Count	Observation_Time	Obs_Time_Key
1	2	1	bl	CANG	800	10:24:29	102429
1	2	1	bl	CANG	12	10:25:04	102504
1	2	1	bl	GWTE	1	10:28:29	102829
1	2	1	bl	SWAN	1	10:35:04	103504
1	2	1	bl	CANG	18	10:48:35	104835
1	2	1	bl	BWTE	300	10:52:27	105227
1	2	1	bl	BWTE	20	10:52:41	105241
1	2	1	bl	GWTE	8	11:02:34	110234
1	2	1	bl	SWAN	2	11:02:44	110244
1	2	1	bl	SWAN	2	11:05:41	110541
1	2	1	bl	BWTE	1	11:20:47	112047
1	2	1	bl	SWAN	15	11:21:26	112126
1	2	1	bl	BAEA	1	11:32:12	113212
1	2	1	bl	SCAUP	22	11:34:55	113455
1	2	2	bl	SWAN	2	12:09:42	120942

20 (0 out of 246 Selected)

Waterfowl Observations

Table

Garmin GPS Track Log

GPS_Time_Key *	Time	Latitude	Longitude
110232	11:02:32	56.049319	-121.273114
110233	11:02:33	56.049481	-121.272489
110234	11:02:34	56.049648	-121.271867
110235	11:02:35	56.049819	-121.271245
110236	11:02:36	56.049996	-121.270623
110237	11:02:37	56.050176	-121.269999
110238	11:02:38	56.050357	-121.269368
110239	11:02:39	56.050539	-121.268725
110240	11:02:40	56.050721	-121.268085
110241	11:02:41	56.050905	-121.267449
110242	11:02:42	56.05109	-121.266815
110243	11:02:43	56.051276	-121.266182
110244	11:02:44	56.051461	-121.265547
110245	11:02:45	56.051647	-121.264913
110246	11:02:46	56.051832	-121.264279
110247	11:02:47	56.052019	-121.263647

7490 (0 out of 17167 Selected)

Garmin GPS Track Log

Figure 2. Joining the track log to the observations table in order to assign GPS coordinates to each waterfowl observation.

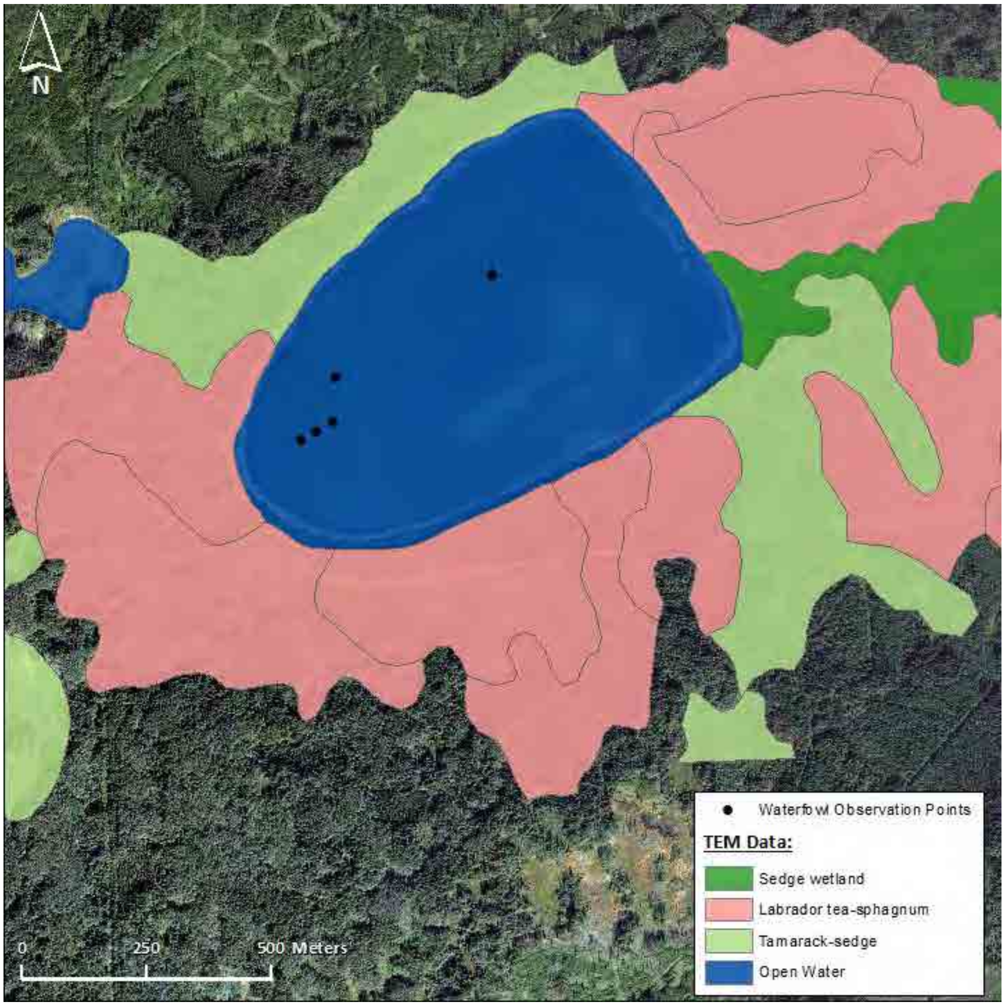


Figure 3. Assigning a habitat code from the TEM data to each waterfowl observation using the Identify tool in ArcMap.

Waterfowl abundance along the Peace River was divided into upstream (transects 1-17) and downstream (transects 18-30) of the Site C Dam. Abundance was summarized by the number of waterfowl counted on each 5 km segment. Waterfowl diversity was calculated using the Shannon-Wiener diversity index for each survey as well as to compare the upstream and downstream sections of the Peace River. This index takes into account how common a species is within the area, with higher values indicating higher diversity (Keylock 2005).

Results

Surveys were completed on March 30, April 20 and May 17 using a Cessna 180 fixed-wing aircraft. They were conducted at flight speeds of approximately 150 km/hr and heights of 500 ft (152.4 m). Surveys were completed in favorable weather conditions only. Wind speeds ranged from 0-15 km/h with temperatures ranging from 2-13° C. No precipitation was recorded during surveys. Survey time ranged from 3 hours and 07 minutes to 3 hours and 51 minutes (Table 2). The average time to complete each transect varied from 34 to 42 minutes (Table 2).

Table 2. Summary of waterfowl survey effort with counts of individuals and species detected, and habitats used.

Survey Dates	Total Survey Time (hh:mm:ss)	Average Time/Transect (hh:mm:ss)	Total bird count	Species Richness	Total Habitats Types Used
30-Mar-16	3:36:44	0:38:52	1189	8	7
20-Apr-16	3:07:39	0:34:40	387	7	16
17-May-16	3:51:28	0:42:46	627	8	13

Waterfowl Abundance

A total of eight waterfowl species comprising 2166 individuals were observed. Four groups of waterfowl, including ducks (n=62), gulls (n=43), shorebirds (n=9) and scaups (n=6), that could not be identified to the species level were also observed (Table 3). The number of species observed was similar between the three survey periods, with the second survey having one less species than the first and third (Table 2). The number of individual birds detected was highest on the first survey and lowest on the second survey (Table 3).

Table 3. Species abundance detected for each survey (See Appendix B for non-waterfowl species).

Species		Species Abundance by Survey				
Common Name	**Scientific Name**	**1**	**2**	**3**	**Total**	**% of total observations**
Bufflehead	*Bucephala albeoloa*	202	131	128	461	21
Blue-winged teal	*Anas discors*	72	56	62	190	9
Canada goose	*Branta canadensis*	855	75	267	1197	55
Canvasback	*Aythya valisineria*	14	0	14	28	1
Common goldeneye	*Bucephala clangula*	0	1	0	1	<1
Gadwall	*Anas strepera*	2	0	0	2	<1
Mallard	*Anas platyrhynchos*	3	39	13	55	2.5
Trumpeter swan	*Cygnus buccinator*	10	66	36	112	5
Unidentified gull		7	0	36	43	2
Unidentified scaup		0	2	4	6	<1
Unidentified duck		18	7	37	62	3
Unidentified shorebird		0	0	9	9	<1
Total		**1183**	**377**	**606**	**2166**	

Waterfowl observations were linked to 16 different habitat types (Table 4). The widest use of habitats was seen during survey 2, which had the lowest species richness observed (Table 2). Survey 1 had the fewest habitats used (Table 2). Non-waterfowl observations are summarized in Appendix C.

Table 4. Number of observations of each species detected within each habitat type (see Appendix C for a list of wetland habitat types and abundances).

Species	Habitat																
Common Name	**AM**	**BL**	**BT**	**CF**	**Fm02**	**GB**	**LA**	**PD**	**RI**	**SC**	**SE**	**SH**	**SW**	**TS**	**WH**	**WS**	**Grand Total**
Bufflehead	11	4	43		19	20	104	2	201		14	4	35	3	1		461
Blue-winged teal	6		6	5	23	3	5		57		39			40	6		190
Canada goose	5	1			72	145	2	1	760		3	10	18		180		1197
Canvasback	1		8		1	1	1		16								28
Common Goldeneye											1						1
Gadwall					2												2
Trumpeter swan	7	4	4	7	3	8	9		37	2	8	2		13	4	4	112
Mallard	4		6		5		5	5	14	6	2	8					55
Unidentified gull	2		20		4	8			9								43
Unidentified scaup					4									2			6
Unidentified duck	8	5	2			4			32		2			2		7	62
Unidentified shorebird									9								9
Grand Total	**12**	**20**	**95**	**12**	**133**	**189**	**137**	**8**	**1136**	**2**	**69**	**24**	**53**	**74**	**191**	**11**	**2166**

Species Composition

The most commonly detected species was the Canada goose, making up 55% (n=1197) of all observations. The next most common species was the bufflehead (21%, n=461), followed by the blue-winged teal (8.7%, n=190) and trumpeter swan (5%, n=112). The remaining four species made up 3% or less of the observations (Table 5).

Habitat Use

The habitat used most often by spring migrating waterfowl was the Peace River (RI) which had 52.5% of all detections. Followed by willow-horsetail-sedge wetlands (WH, 9%) and gravel bars (GB, 8.6%).

Table 5. Habitat type with habitat mapping code, relative waterfowl usage and Shannon-Wiener diversity index of each habitat (%).

Habitat Type	Habitat Code	Relative Waterfowl Usage (%)	Diversity Index
River	RI	52.5	1.13
Willow-horsetail-sedge	WH	9.0	0.27
Gravel bar	GB	8.6	0.88
Red-osier dogwood	Fm02	6.1	1.43
Lake	LA	5.8	0.75
Labrador tea-sphagnum	BT	4.0	1.54
Sedge wetland	SE	3.1	1.30
Tamarack-sedge	TS	2.7	1.19
Wildrye-peavine	SW	2.5	0.64
Step Moss	AM	2.1	1.36
White spruce- horsetails	SH	1.1	1.24
Lingonberry-coltsfoot	BL	0.6	1.50
Cultivated field	CF	0.5	0.68
Willow-sedge	WS	0.5	0.66
Pond	PD	0.4	0.90
Current-bluebells	SC	0.4	0.00

All habitats were used minimally in relation to the RI habitat (Table 5). Appendix C shows the distribution map of waterfowl observations within the study area. Based on Shannon-Wiener diversity index calculations, which take into account both species richness and abundance, Labrador tea-sphagnum habitat (BT) had the most individuals of the most species, followed by the lingonberry-coltsfoot (BL), then red-osier dogwood (FM02). Current-bluebells (SC) habitat had diversity indices of zero, which means it was used by a few species (n=1, trumpeter swan) with low abundances (Figure 4). Given that this habitat is not associated with wetlands it is understandable that few wetland species would be using it.

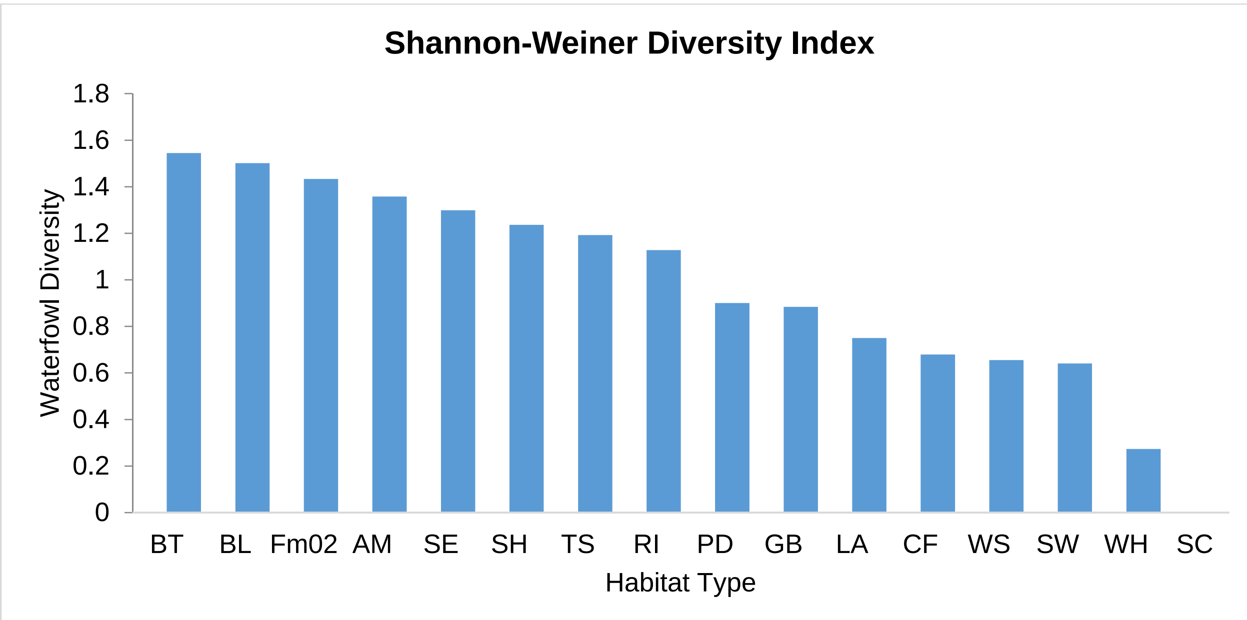


Figure 4. Shannon-Wiener Diversity Index for each habitat type.

All species, with the exception of unidentified gulls, Common Goldeneyes, Gadwalls and scaups were found most often on river (RI) habitats (Table 4). Gulls had higher abundance in BT habitat while goldeneye, Gadwall and scaup were not observed using RI habitat. Common Goldeneyes used sedge wetland habitat (SE) exclusively, and Gadwalls used FM02 exclusively. Common Goldeneyes were the only species not found in FM02 habitat. All remaining species used multiple habitat types (Table 4).

River Transect

The survey of transect one, the Peace River, was divided into 30 segments with segments both upstream and downstream of the proposed dam site (Table 6).

Table 6. Waterfowl observations along the Peace River broken into 30-5 km segments.

River Segment	Survey				
	1	2	3	Total	General Location
1	63	2	17	82	Proposed Reservoir/Upstream of proposed dam
2	18	3	14	35	
3	8	15	34	57	
4	19	9	49	77	
5	13	3	4	20	
6	19	0	6	25	
7	42	2	7	51	
8	69	0	12	81	
9	129	77	11	217	
10	352	5	15	372	
11	58	2	6	66	
12	14	11	1	26	
13	28	0	11	39	
14	18	3	6	27	
15	46	2	22	70	
16	5	21	3	29	
17	18	2	20	40	Upstream n=1314
18	9	1	20	30	Downstream of proposed dam
19	4	3	13	20	
20	42	0	16	58	
21	16	2	10	28	
22	28	0	5	33	
23	20	1	12	33	
24	38	5	19	62	
25	6	0	11	17	
26	49	0	23	72	
27	1	0	13	14	
28	23	0	7	30	
29	10	0	5	15	
30	23	0	5	28	
Total:	**1188**	**169**	**397**	**1754**	Downstream n=440

75% (n=1314) of the waterfowl observations occurred upstream of the dam site (Table 6). The highest abundance of waterfowl was detected during the first survey, upstream of the dam (n=919), followed by survey 1, downstream of the dam (n=269) then survey 3, upstream of the dam (n=238). Average count/segment followed the same order (Table 7). The Shannon-Wiener diversity index showed that diversity between upstream and downstream sections were not significantly different. Only survey 1 had a large decrease in diversity in the upstream portion. The diversity was also not significantly different between the three surveys (Table 7).

Table 7. Sum of observations, average count/segment, and Shannon-Wiener diversity index for each survey divided by upstream and downstream.

	Upstream			Downstream		
Survey	**1**	**2**	**3**	**1**	**2**	**3**
Sum of Observations	919	157	238	269	12	159
Average Count/Segment	54.1	11.2	14.0	20.7	2.4	12.2
Diversity Index	0.5	1.2	1.1	1.3	1.0	1.1

Discussion

The species that were seen in highest abundances during survey 1 were early spring migrants (Bufflehead and Canada Goose).

Survey 1 had the highest bird counts suggesting that migration was peaking at this time. During this survey the Peace River had no ice cover while all other wetland habitat and large lakes were completely frozen and therefore unavailable for waterfowl use. Over all three surveys 61.1% of all waterfowl were observed using the river. This is a reflection of the fact that limited other open water habitat, off the river, was available to for water birds to use during early spring migration. This makes the Peace River, both upstream and downstream of the dam site, important habitat for early spring migrants. This changes in Survey 2 where 72.7% of birds were detected in non-riverine habitat as wetlands thaw and become available. Survey 3 then changes again with 57.5% of birds found on the Peace River. The majority of birds detected along the Peace River were found using the upstream portion of the river (segments 1-17 east of the Site C dam). Waterfowl abundance was also consistently higher in the upstream portion of the river during spring migration. When looking at the diversity of species using the river, the highest diversity during the first survey was found downstream. Survey 2 and 3 both showed no significant different between diversities upstream and downstream of the proposed damn site. Diversity takes into account the number of species present as well as the abundance of each species. When abundances of each species are similar the diversity index will be greater. If the bird abundance is dominated by one group of birds, such as Canada Geese, as was the case in the upstream portion of survey one on the Peace River, the diversity index will be lower. If we were to remove Canada Geese from the diversity calculation upstream diversity increases while downstream diversity decreases. However, the results remain statistically insignificant for all surveys. This trend in diversity deviates from trends seen with past migratory surveys conducted on the Peace River in the springs of 2012-2015. All but two surveys in 2013 found diversity highest upstream of the Site C dam site. Based on H3D ice modeling (Rogers 2012), after construction is complete it is estimated that the upstream reservoir will be approximately 66% covered by ice. This would limit the habitat that is available for early spring migrants. The downstream portion of the Peace River to the Alberta border is expected to have reduced probability of ice cover (10%) and therefore the river will be available (e.g. remain ice free) for use by early migrants (Jasek 2012).

Several waterfowl species detected during previous migratory surveys were not detected during spring 2016 surveys (Churchland et al. 2015) notably:

- Common Merganser: detected in high abundances in 2013-2015 (n=357-1147).
- Green-winged Teals: detected in 2013, 2014 and 2015 (n=28-251)
- Northern Pintails: observed in 2013 and 2014 (n=65, n=172))
- American Wigeon: observed in 2014 (n=903)

Several other species, including Hooded Merganser, Ring Necked Duck, Ruddy Duck, Wood Duck, Cackling Goose, Surf Scoter, Pied Billed Grebe and Redhead were observed in 2013-2014 surveys and were not 2015 or 2016. There are many reasons why a species may not have been observed in the same area, including survey timing, variations of resources available, and environmental conditions (e.g. early spring/late spring).

Surveys conducted in 2013 and 2014 were conducted in a helicopter, rather than a fixed-wing aircraft, which has greater maneuverability to pause over, or return to, flocks for identification purposes. The change in survey methods from a helicopter to a plane in 2015 may have decreased the number of individuals and species documented by affecting the ability to differentiate species due to the higher altitude and faster flight speed. Spring and fall migration surveys conducted in 2015 and 2016 used a fixed-wing aircraft and saw a decline in species richness compared to surveys conducted in 2013 and 2014 using a helicopter (Bianchini 2015).

Use of Wetlands

Transects 2-5 sampled wetland use by migrating waterfowl. Multiple wetland types were present and several were used by various species. Observations of wetland use by waterfowl during spring migration include:

- All wetlands, including large lake habitats, were frozen and therefore unavailable for early migrating waterfowl to use during the first spring survey.
- Labrador tea-sphagnum bogs, followed by lingonberry-coltsfoot habitat had the highest diversity of all habitats.
- Common goldeneyes were only seen on sedge wetlands.
- Gadwalls exclusively used red osier dogwood habitats.

Recommendations

- Conduct the spring 2017 surveys every two weeks, beginning at the end of March.

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Keylock, C. J. 2005. Simpson diversity and the Shannon–Wiener index as special cases of a generalized entropy. Oikos, 109(1), 203-207.

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Appendix A – Data Collection Methods

NPS's SITE C Aerial Surveys 2015

STUDY AREA: __________ **SURVEY:** _____ **DATE (MM/DD/YY):** ___/___/2015 **SURVEY TYPE:**

Obs. Initials: _____ **Crew:** ______ **Front Right:** _____ **Rear Left:** _____ **Pilot:** ________ **Transcription Time(s):**__________________

Flight time: Start: ___:___:___ **Finish:** ___:___:___ **Weather: Temperature:** _____°C **Cloud Cover:** _____ **Precipitation:** ____ **Wind Dir. and Speed:** _______

		Grid Weather					Time Stamp (24 hr: hh:mm:ss)									
Transect #		Temperature (°C)	Cloud Cover	Precipitation	Wind Dir. and Speed		In Time	Out Time	Survey Dir.	Waterbody Type	Pass 1st or 2nd	Window (F, L or R)	Species		Count	Observation Time (24 hr hh:mm:ss)	Comments
							: :	: :								: :	
							: :	: :								: :	
							: :	: :								: :	
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Figure A.1. Data sheet used to transcribe waterfowl observations from recorders used during surveys.

Appendix B – Habitat Type and Abundance

Table B.1. List of acronyms of each habitat used by water birds during spring migratory surveys and the number of each habitat present along each transect.

Habitat Type	Habitat Code	Count					
		Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Total
Lingon-berry-coltsfoot	BL		54	35	44	133	265
Labrador Tea-sphagnum	BT		31	19	54	91	195
Red-osier dogwood	Fm02	143		1		2	146
Gravel bar	GB	94		1			95
Lake	LA		3	8	15	2	28
Shallow open water	OW				1	3	4
Pond	PD	1				12	13
River	RI	4	1	2	2	1	10
Sedge wetland	SE		6	17	32	109	163
Wildrye-peavine	SW	43	5	31	15	35	126
Tamarack-sedge	TS	1	4	6	48	50	109
Willow-horsetail-sedge	WH	69		4		3	76
Willow sedge	WS	1	3	5	6	12	27

Appendix C – Non Waterfowl Observations

Table C.1. Non waterfowl species and the habitat they were found in during the spring migratory surveys.

Species		Habitat					
Common Name	**Scientific Name**	**AM**	**Fm02**	**RI**	**SW**	**WH**	**Total**
American crow	*Corvus brachyrhynchos*	2	3	12	1	8	26
Bald eagle	*Heliaeetus leucocephalus*	0	1	7	0	0	8
Black-billed magpie	*Pica hudsonia*	0	0	1	0	0	1
Unidentified swallow		0	0	2	0	0	2
Total:		2	4	22	1	8	37

Appendix D – Map of Waterfowl Observations

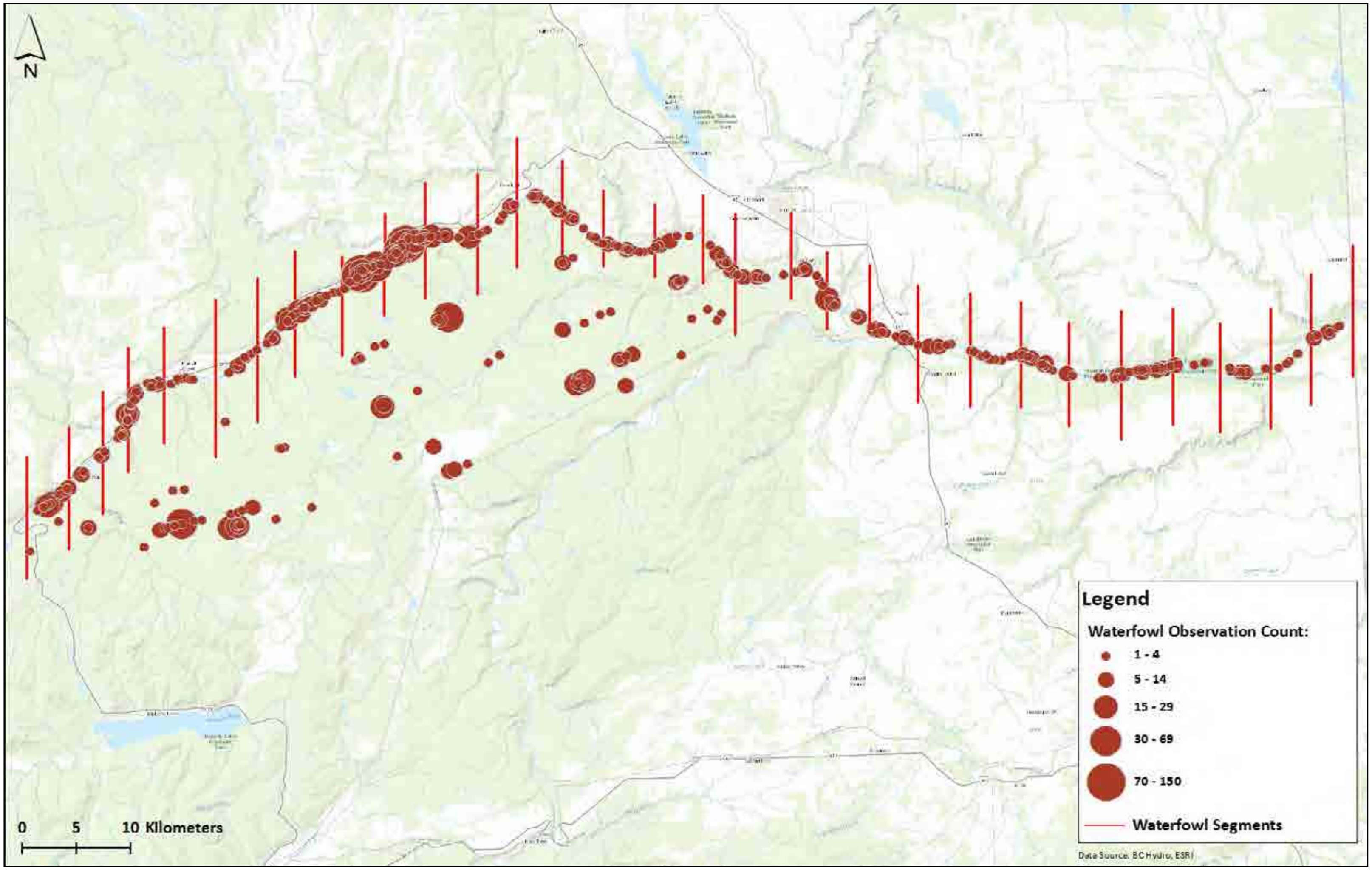

Figure D.1. Map of all species observations within the study area.

Appendix 6

Fall Waterfowl and Shorebird Survey Report

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January 6, 2017
File: 398-173.07

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

Attn: André McIntosh, Wildlife Lead

Dear André,

Re: Site C Clean Energy Project – 2016 Waterfowl Surveys

1.0 INTRODUCTION

As part of BC Hydro's wildlife monitoring program for the Site C Clean Energy Project, Hemmera conducted fall waterfowl surveys in 2016[1], along the Peace River and at natural wetlands adjacent to the Site C transmission line right-of-way. The objectives of monitoring are to document changes in waterfowl abundance, species composition, and distribution during spring and fall migration. In the future, these surveys will also be used to document the effects of ice on waterfowl use of the reservoir and downstream habitats.

2.0 METHODS

Five transects were surveyed by fixed-wing aircraft during fall migration in 2016 (**Figure 1**) over two survey sessions (September and October). Survey protocols followed pre-Project specifics used by the Canadian Wildlife Service (CWS), as described in the *Standard Operating Procedures for Aerial Waterfowl Breeding Ground Population and Habitat Surveys in North America* (US Fish and Wildlife Service and Canadian Wildlife Service 1987 as cited in Hilton et al. 2013): 400 m wide transects wide were surveyed by two observers in a fixed-wing aircraft at a flight height of 500 m above-ground-level (AGL) at a speed of 150 km/h. All birds observed were recorded along with time, species, number, and location.

[1] Spring 2016 surveys were conducted by another consultant and the results are provided in a separate report.

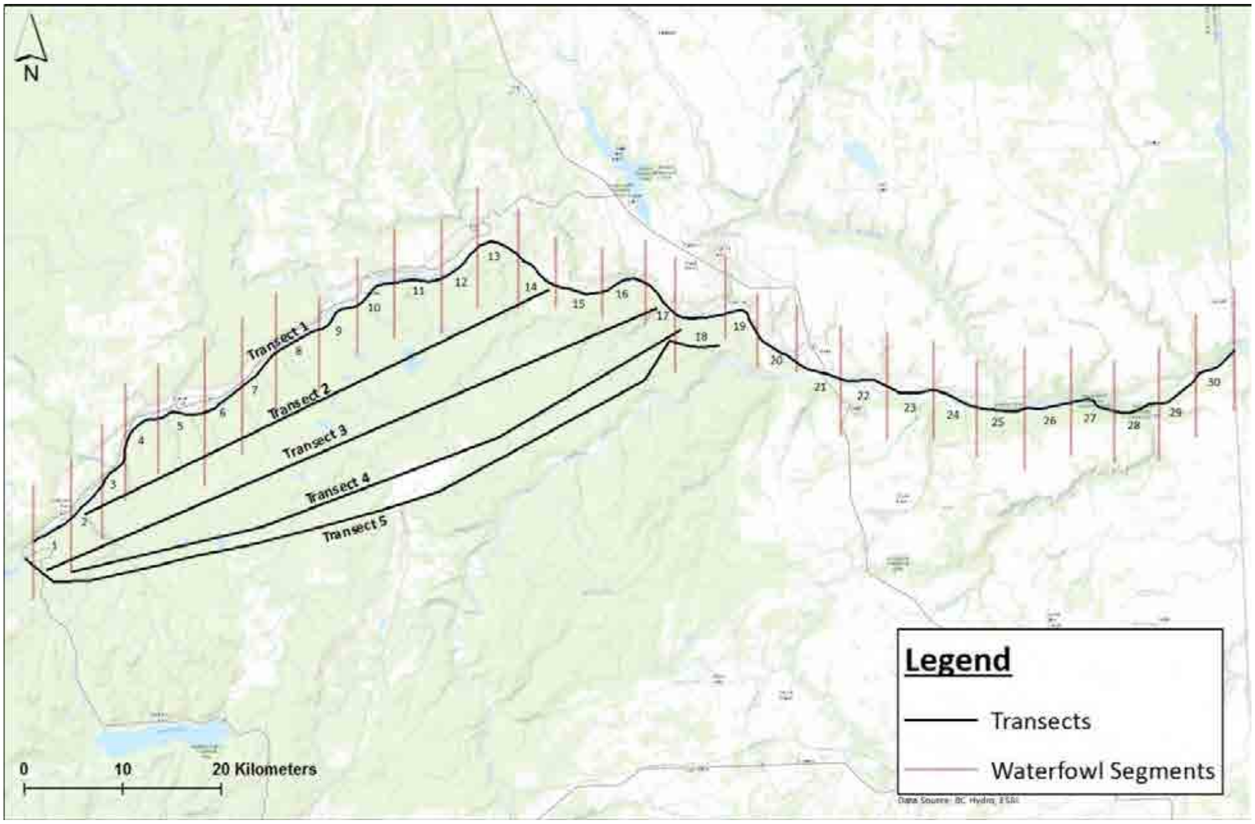

Figure 1 Waterfowl survey transects

3.0 RESULTS

Waterfowl surveys were conducted on September 12, 2016 and October 12, 2016. A third survey was unable to be conducted due to persistent unsuitable conditions for surveys during the fall 2016 migration period (low cloud, fog and rain). A total of 6,219 birds were observed during the surveys, represented by thirteen identifiable species (**Table 1**). The most commonly observed species was Canada goose (*Branta canadensis*) (51%, n=3,185), followed by unidentified duck (20%, n=1,215) and mallard (*Anas platyrhynchos*) (9%, n=583). Unidentified ducks were commonly recorded due to the difficulty in confidently identifying specific avian species from a distance, particularly in large groups. Approximately half of the unknown records came from only nine observations of large groups that were tagged with comments indicating a probable identification, e.g., “mostly geese,” “wigeons, mallards and other mixed ducks,” “likely common goldeneye.”

Table 1 Species and numbers of birds observed during waterfowl surveys, fall 2016

English Name	Scientific Name	Number Observed
September 2016		
Belted kingfisher	*Megaceryle alcyon*	1
Bufflehead	*Bucephala albeola*	6
Canada goose	*Branta canadensis*	1,495
California gull	*Larus californicus*	5
Common goldeneye	*Bucephala clangula*	6
Common loon	*Gavia immer*	1
Common merganser	*Mergus merganser*	12
Franklin's gull	*Leucophaeus pipixcan*	181
Mallard	*Anas platyrhynchos*	9
Spotted sandpiper	*Actitis macularius*	1
Trumpeter swan	*Cygnus buccinator*	102
Unidentified duck	-	452
Unidentified gull	-	41
Unidentified bird	-	20
Unidentified shorebird	-	1
October 2016		
American wigeon	*Anas americana*	250
Bufflehead	*Bucephala albeola*	296
Canada goose	*Branta canadensis*	1,690
Common goldeneye	*Bucephala clangula*	223
Common merganser	*Mergus merganser*	1
Mallard	*Anas platyrhynchos*	574
Northern shoveler	*Anas clypeata*	32
Trumpeter swan	*Cygnus buccinator*	41
Unidentified duck	-	763
Unidentified gull	-	16
	Total	**6,219**

Waterfowl detected along the Peace River transect (Transect 1) are displayed in **Table 2**. 59% (n=3,646) of all bird observations were located along Transect 1; the most commonly observed species was Canada goose (66% of birds on Transect 1, n=2,419), followed by unidentified duck (16%, n=588) and American wigeon (6%, n=220).

Table 2 Species and numbers of birds observed along Transect 1, fall 2016

English Name	Scientific Name	Number Observed
American wigeon	*Anas americana*	220
Bufflehead	*Bucephala albeola*	6
Canada goose	*Branta canadensis*	2,419
California gull	*Larus californicus*	5
Common goldeneye	*Bucephala clangula*	34
Common loon	*Gavia immer*	1
Common merganser	*Mergus merganser*	13
Franklin's gull	*Leucophaeus pipixcan*	181
Mallard	*Anas platyrhynchos*	83
Trumpeter swan	*Cygnus buccinator*	39
Unidentified duck	-	588
Unidentified gull	-	57
	Total	**3,646**

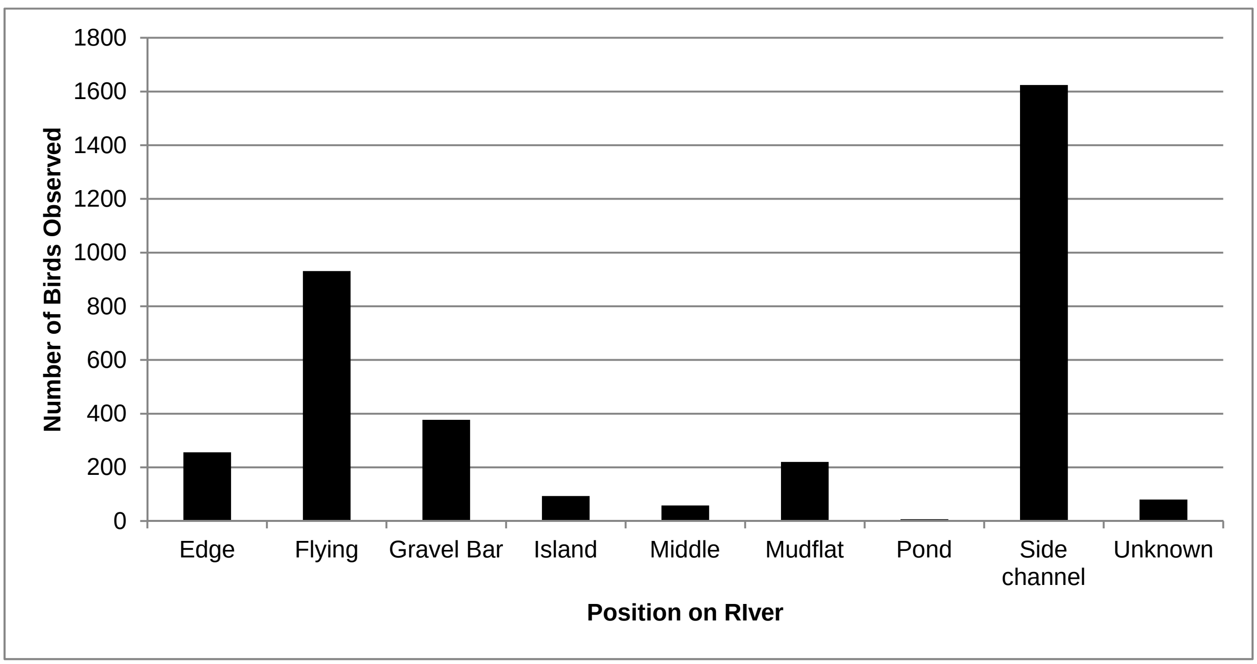

Figure 2 Position of birds observed along the Peace River (Transect 1), fall 2016

Birds observed along the Peace River transect (Transect 1) were categorized based on their observed position on the river (**Figure 2**). The most commonly observed position was 'side channel' (45%, n=1,624), followed by 'flying' (26%, n=931) and 'gravel bar' (10%, n=377).

Bird observations recorded during 2016 waterfowl surveys were grouped by habitat type using TEM mapping in **Table 3**. The most commonly used habitat type, within 200m of each observation, was river (47%), followed by white spruce-currant-bluebells (15%) and white spruce-trembling aspen-step moss (11%).

Table 3 Waterfowl usage by habitat type, fall 2016

Habitat Type	Habitat Code	Relative Waterfowl Usage (%)	Number of Birds Observed*
White spruce-trembling aspen-step moss	AM	10.96%	681
Black spruce-lingonberry-coltsfoot	BL	1.21%	75
Black spruce-Labrador tea-sphagnum	BT	1.54%	96
Cutbank	CB	0.10%	6
Cultivated field	CF	0.02%	1
Cottonwood-white spruce-red-osier dogwood	Fm02	4.50%	280
Gravel bar	GB	1.66%	103
Lake	LA	10.42%	648
Lodgepole pine-lingonberry-velvet-leaved blueberry	LL	1.16%	72
Pond	PD	0.03%	2
River	RI	46.51%	2,891
White spruce-currant-bluebells	SC	14.56%	905
Sedge wetland	SE	0.87%	54
White spruce-currant-horsetail	SH	0.97%	60
White spruce-currant-oak fern	SO	0.05%	3
White spruce-wildrye-peavine	SW	0.85%	53
Tamarack-sedge	TS	0.03%	2
Willow-horsetail-sedge	WH	4.54%	282
Willow-sedge	WS	0.03%	2

*shorebirds and kingfishers removed from habitat analysis in order to show waterfowl only

Species specific bird observations grouped by habitat type are presented in **Table 4**, as well as number and percent of birds within each habitat type observed along Transect 1. All birds observed in cutbank, cottonwood-white spruce-red-osier-dogwood, gravel bar, river, white spruce-currant-oak fern, and willow-horsetail-sedge were located along Transect 1.

Table 4 Species specific usage by habitat type, fall 2016

Species	Habitat Type																			
Common Name	**AM**	**BL**	**BT**	**CB**	**CF**	**Fm02**	**GB**	**LA**	**LL**	**PD**	**RI**	**SC**	**SE**	**SH**	**SO**	**SW**	**TS**	**WH**	**WS**	**Grand Total**
American wigeon			30								220									250
Bufflehead		25	2					204			6	40				25				302
California gull											5									5
Canada goose	84			6		175	76	30	4		2,154	650						6		3,185
Common goldeneye	40		55				4	50			29	50						1		229
Common loon											1									1
Common merganser											12					1				13
Franklin's gull						75	5				101									181
Mallard	30	20				2	6	350	35		35	65		40						583
Northern shoveler	32																			32
Trumpeter swan	57	18	9		1			2	4	2	27			15		4	2		2	143
Unidentified bird	20																			20
Unidentified duck	418	12				3		12	29		290	100	54			22		275		1,215
Unidentified gull						25	12				11			5	3	1				57
Grand Total	**681**	**75**	**96**	**6**	**1**	**280**	**103**	**648**	**72**	**2**	**2,891**	**905**	**54**	**60**	**3**	**53**	**2**	**282**	**2**	**6,216**
Transect 1	0	0	0	6	0	280	103	0	2	0	2,891	0	0	57	3	22	0	282	0	3,646
% within Transect 1	0	0	0	100	0	100	100	0	3	0	100	0	0	95	100	42	0	100	0	59

4.0 CONCLUSION

Waterfowl surveys were conducted in the fall of 2016 to continue to document fall migration. The data collected will build on baseline data of pre-reservoir waterfowl use and will illustrate what effect the change in system (from fluvial to reservoir) has on waterfowl. This information will be used to guide future mitigation for migrating waterfowl along the Peace River, if such mitigation is required.

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Appendix 7

Wetland Function Assessment

Assessment of Wetland Function for the Site C Clean Energy Project

– Prepared for BC Hydro –

December 2016

Version 1






Prepared by:

L. Ross, P. Rose, J. Raizenne, L. Dupuis, and L. Armstrong

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Introduction

Condition 11 of the Federal Decision Statement requires BC Hydro to develop a plan that addresses, amongst other things, the potential effects of the Project on wetlands.

Condition 11.4 states that 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;*
>
> *11.4.4 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;*

Condition 12 of Schedule B Table of Conditions issued by the province 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.*

This report outlines the wetland function assessment process (Figure 1) that was used to characterize the ecological functioning of wetlands for migratory birds, species at risk, and wetland plant and wildlife species used for traditional purposes by Aboriginal people (in accordance with Federal condition 11 and Provincial condition 12 above), then describes baseline ecological functioning of wetlands in the areas that may be affected by the Project.

This scientifically based system identifies function at the landscape level and uses peer-reviewed literature, in conjunction with existing GIS and baseline survey data from the Project, to identify the relative importance of wetlands for migratory birds, amphibians, bats, species important to Aboriginal land use and species at risk (see Table 11 and 'Record Keeping' section). It uses a statistical evaluation process, based on wetland function assessment processes reviewed in the literature such as a Habitat Equivalency Analysis (HEA; see 'Assessment of Wetland Functions' section) to model the loss of wetland area and function supporting migratory birds, rare plants, amphibians, bats, species important to Aboriginal land use and species at risk. Finally, it evaluates assumptions and uncertainty of the wetland function assessment process by running a sensitivity analysis, to ensure compensation measures address wetland area and function loss. To provide context for the model structure, below is a review of wetland function assessment literature and discussion on the considerations made in developing a model to address the loss of wetland function supporting migratory birds, species and risk and current use of lands and resources by Aboriginal people for the Site C Clean Energy Project.

Assessment of Wetland Functions

Wetland function assessments measure an array of wetland functions and typically assign them a quantitative value (e.g., numerical) or qualitative ranking (e.g., high, medium, low; United States Department of Agriculture 2008, Novitzki et al. 1997). These values and rankings can be used to determine the importance of individual functions in terms of maintaining a particular wetland or the degree to which a wetland function benefits the overall ecosystem. Wetland function is defined in Smith et al. (1995) as the normal or characteristic activities that take place in wetland ecosystems as a result of their physical, chemical, and biological attributes (e.g., short-term storage of surface water, cycling of nutrients, maintenance/support of plant and animal communities, etc.). In many cases it is impossible or impractical to measure wetland functions directly, so "indicators" are used as a representation (e.g., the number of waterfowl/acre is used as an indicator to measure how well a wetland is performing its waterfowl habitat function; Novitzki et al. 1997). Each situation is unique as not all wetlands are able to perform every function (e.g., a wetland's geographic location may determine the species it supports) and many factors determine how well these functions are performed (e.g., climatic conditions, quantity and quality of water entering the wetland, and disturbances or alterations within the wetland or the surrounding ecosystem; Novitzki et al. 1997).

By assessing the functional value of several individual wetlands of the same type and making comparisons between them, wetlands can be ranked based on their ecological significance with those areas that receive a high ranking avoided, if possible, during development. For projects where wetland loss is unavoidable, this information can be applied to the mitigation process and alternative wetlands can be enhanced, restored or constructed to offset the wetland functions lost. Wetland function assessments can also be used to determine the success (or failure) of programs and policies intended to protect or manage wetland resources (e.g., continuous assessment of the same wetlands in an agricultural area shows that the functional capacity of wetlands to provide habitat for aquatic animals improves as fertilizer restrictions are put in place) and to assist in identifying long-term trends in the condition of wetland resources (Novitzki et al. 1997).

The primary purpose of a wetland function assessment is to assist with wetland monitoring and assess project-level impacts to wetlands. Many wetland assessments are designed to estimate the loss or gain of wetland function as a result of a proposed project. Wetland processes can be assigned a score, which are then multiplied by the acreage of wetlands affected to develop the mitigation ratios (Kusler 2006). One challenge of using wetland assessments to calculate mitigation ratios is that they can require detailed knowledge and data of the resource being managed, which is not always practical to obtain due to budget constraints, the amount of field data required, the accuracy of the information collected, or the intent of the original field data collection process. This is not a constraint if sufficient published information is available to develop regional benchmarks (Clark & Bradford 2014).

The wetland function assessment for the Site C project exclusively considers the functional score of wetlands to specific wildlife and plant groups during important periods of their lifecycles. Standardized wetland assessments, such as Rapid Wetland Assessment Methods and a Hydrogeomorphic Approach (HGM), typically address wetland functions related to the chemical, physical, and biological processes of wetlands (Kusler 2006) and rarely use a scope as focused as this project (i.e., wetland functions associated with migratory birds, species at risk and the current use of lands and resources by Aboriginal people). Because most wetland function assessments are completed at a much broader scale, so too is their high-level evaluation of wetland habitat functions (e.g., Does the existing wetland exhibit strong evidence of wildlife utilization, moderate evidence of wildlife utilization, minimal evidence of wildlife utilization, or no evidence of wildlife utilization?). Specific methodologies have been developed to evaluate animal species and biological communities in wetlands (e.g., Habitat Evaluation Procedures; U.S. Fish and Wildlife Service 1980, WETHINGS; Hicks 1996, Indices of Biological Integrity; EPA 2002), but these are used primarily to monitor changes in habitat quality over time (Kusler 2006).

Most wetland function assessments only make comparisons between wetlands of the same types or classes. The BC Hydro Site C project wetland function assessment calculated the total loss of each wetland habitat function by quantifying the degree of loss for each respective wetland type (i.e., SE, TS, etc.). This is weighted based on the habitat type's ability to perform a specific function and the wetland area scheduled to be lost as a result of construction. Function loss for each individual wetland type can then be combined to achieve an understanding of total function loss for each wetland function (i.e., functional loss of migratory bird breeding habitat in Sedge wetland, Tamarack Sedge wetland, Willow Sedge wetland, etc. all combined to calculate total functional loss of migratory bird breeding habitat). Some area-wide function assessments have been created, but these primarily focus on soils, topography and locations of wetlands and do not consider habitat functions or species of interest (Kusler 2006).

Wetland function assessments typically use a series of reference wetlands which are selected to represent "natural conditions", then functional values of these wetlands are determined (e.g., HGM). The functional values for reference wetlands are then used as the benchmark for comparison amongst all other wetlands evaluated during the assessment process (Smith et al. 1995). During the wetland function assessment used for the BC Hydro Site C project, the existing state of wetland functions during the pre-construction period, which are scheduled to be impacted as a result of construction activities, are used as the baseline reference and then equated to total function gained from mitigation efforts in an attempt to offset the two. This method is known as a habitat equivalency analysis (HEA), where "interim losses are quantified as lost habitat resources and services, and the scale of the restoration projects is that which provides equivalency between the lost and restored resources and services" (Penn & Tomasi 2002, Clarke & Bradford 2014). Service losses are represented as generic values (usually a percentage of the undamaged habitat) that attempt to integrate the overall loss of service. This avoids the need for detailed ecosystem studies (Clark & Bradford 2014). The science of equivalence is still in its early stages and although the HEA concept was introduced in 1990, many of the primary papers discussing its utility were written in the mid 2000's and the process is still subject to refinement (Clark & Bradford 2014).

Assessment of Wetland Functions for the Site C Clean Energy Project

Based on the literature reviewed above, in order to quantify project-related wetland function loss as per Federal Condition 11.4 and Condition 12 issued by the Province of British Columbia, the wetland function assessment process for the Site C Clean Energy Project considers three components:

Step 1. Classification of Wetland Types and Area;
Step 2. Selection of Wetland Indicator Species, including migratory birds, rare plants, amphibians, bats, species important to aboriginal land use and species at risk; and
Step 3. Identification of Important Wetland Habitat Functions.

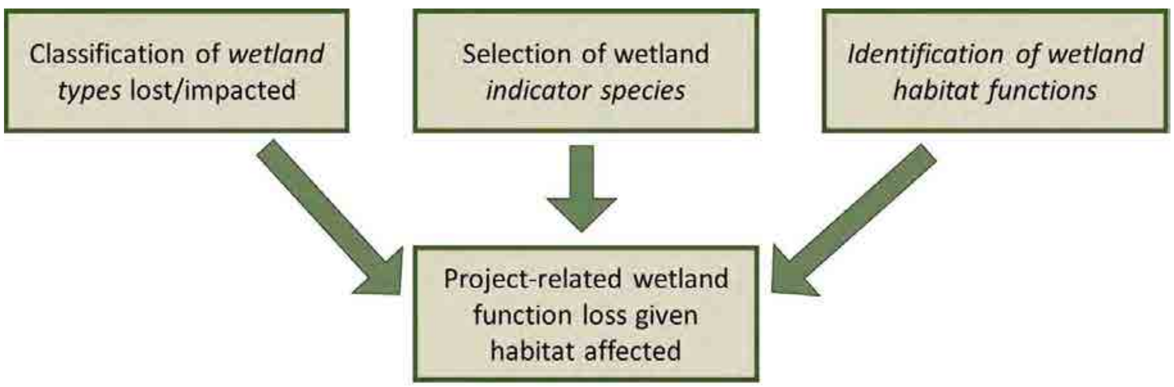


Figure 1. Wetland function assessment process for the Project.

For the purposes of this wetland function assessment, this process defines:

- *Wetland function* as the "…natural processes that are associated with wetlands, independent of considerations of the benefits of those processes to humans." (Hanson et al. 2008), with a specific focus on the wetland functions important to migratory birds, amphibians, bats, rare plants, species important to Aboriginal land use and species at risk.
- *Indicator species* as a species whose presence in a given area is used to indicate suitable conditions for a broader group of additional species.

Together, these three steps are used to Determine Total Loss Given Habitat Affected, Step 4 of the wetland function assessment process for the project. First, a Manly-Chesson Selectivity Index (Manly et al. 1972, Chesson 1978) is established for each wetland habitat function. This index is used to quantify the probability that an indicator species/assemblage will use a specific wetland type based on its habitat preferences and the proportion of that habitat type within the landscape. A simplified Habitat Equivalency Analysis, calculating area of habitat to restore based on estimates of the total loss of function provided by the wetland habitats, is then used to determine *Total Function Loss Given Habitat Affected*. This is calculated using the selectivity index created for indicator species/assemblages and the area of wetland habitat that will be affected as a result of construction activities associated with the Site C project. An understanding of *Total Function Loss Given Habitat Affected* helps assess wetland habitat function that will be lost across all species groups identified (e.g., migratory birds, amphibians, bats, rare plants, species important to aboriginal land use and species at risk) due to the Project and will inform planning and estimation of the mitigation measures required to offset functional loss. This equivalency analysis is classified as an "out of kind" offset as the impacts and offsets are of a different form than a like-for-like comparison and wetland function is used as the common metric (i.e., wetland habitat types are not replaced on a like-for-like basis although wetland habitat functions lost are equal to wetland habitat functions gained through mitigation efforts; Clark & Bradford 2014).

The literature review and data assessment are summarized in order to provide the structure for the habitat value ranking process. The ranking process is then outlined step by step for fauna then flora species, as well as practical examples and assumptions made as part of the process. All calculations in the ranking process are provided in Excel spreadsheets, as well as described below. Two excel spreadsheets for flora and fauna (NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx and NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx), as well as one for species important to Aboriginal land use (NPS_bchydro_siteC_Aboriginalspp_wetlandfunction_Dec2016.xlsx) also provide the baseline data used in the ranking and allocates that information to wetlands within the LAA. The LAA was defined in the EIS (Hilton et al. 2013) as:

> "The area within which the potential adverse effects of the Project are assessed. The LAA encompasses the Project activity zone, buffered by an additional 1,000 m. For the proposed reservoir, the erosion impact line has a 1,000 m buffer. The LAA also extends downstream from the dam to the Alberta border, and includes a 1,000 m buffer on both the south and north banks of the Peace River."

This document provides a summary of the process described above, and outlines the ranking process, commencing with Step 1, the classification of wetland types to be affected by the Project.

Step 1. Classification of Wetland Types and Area.

Classification of wetland types in the LAA followed the structure of mapping and terrestrial ecosystem classification presented in the EIS (Hilton et al. 2013a). TEM developed for the Site C project was used to confirm the area and distribution of wetland types across the LAA (Figure 2). While the total wetland area within the transmission line right-of-way is included in the function assessment not all will be affected by the Project. The area of wetland to be affected by the Project, including habitat alteration and fragmentation (i.e., see Section 13.1.2.3 in Hilton et al., 2013a for further description of potential project interactions with vegetation and ecological communities, including wetlands) will be calculated based on the final transmission line design and the construction footprint. Areas presented in Table 1 will be adjusted based on monitoring during construction, to provide an accurate value for wetlands lost and impacted. Some additional ecosystem types mapped have been classified as wetlands for this function assessment. Examples are:

- The Labrador Tea – Sphagnum ecosystem type (BT) has been added as a wetland type due to its description as a bog.
- Tufa seep and marl fen habitats were included due to their uniqueness as habitats for rare plants. Tufa seep and marl fen habitat were recorded in the baseline as point occurrences; therefore, the ranking of their wetland function has not been included at this time. Their habitat will be included at a later date once their areas have been verified in the field.

The Provincial classification system was used to identify wetlands. Therefore, wetlands could not be assigned to one of the five major classes of the Canadian Wetland Classification System (National Wetlands Working Group 1997; i.e., swamp, bog, marsh, fen and shallow open water). Several of the wetland ecosystem types described in Hilton et al. (2013a) share characteristics of more than one of the five major classes (e.g., BT has characteristics of both a bog and a swamp). Descriptions of these wetland ecosystem types, including the dominant and associated plant species for each structural stage as well as location characteristics for the project site, can be found in Hilton et al. (2013d).

Where possible, habitat associations and categories of use for the indicator species were described by mapped wetland types (Table 1). Baseline information on the biogeochemical, hydrological and ecological functioning of the wetland habitat types, where it informed indicator species use, was inferred based on general descriptions of the habitat types in the EIS (Hilton et al. 2013a), MacKenzie and Moran (2004), and Delong et al. (2011). Further information on the wetland habitat features, as per Federal Condition 11.4.1, will be verified in the field as part of the wetland monitoring program (see 'Step 5. Collecting Baseline Data on the Biogeochemical, Hydrological and Ecological Functioning of the Project Area Wetlands'). For rare plants, in the review of secondary habitat associations, species were assessed following classification used in MacKenzie and Moran (2004), and then compiled to the level of classification used in the EIS.

During operations the monitoring of wetlands along and adjacent to the transmission line will be used to gather data on potential changes to area and function. Data collected will also be used to inform the wetland mitigation plan through the assessment of existing wetland features, attributes, landscape positioning and connectivity to other habitat systems.

Table 1. Wetland ecosystem types in the Site C LAA[1].

Wetland Ecosystem	Total area in LAA (ha)	Total area to be affected by construction (ha)	Total area to be affected by operations (ha)
Labrador Tea – Sphagnum (BT)	2051	93	58
Shallow Open Water (OW)	75	17	1
Sedge wetland (SE)	1169	142	55
Tamarack Sedge (TS)	1406	68	47
Willow-Horsetail-Sedge riparian wetland (WH)	1009	392	1
Willow Sedge wetland (WS)	363	50	16
Scrub Birch-Water Sedge (Wf02)	10	0	0
Narrow-leaved Cotton-Grass Shore Sedge (Wf13)	9	<1	<1
Marl Fen			
Tufa Seep			

[1] Ecosystem coding is shown in brackets, where present, total area in the LAA, and area to be affected by construction and operations (modified from Hilton et al. 2013a). Labrador Tea – Sphagnum (BT) habitat was included as part of this wetland function assessment. This was not considered wetland in the EIS. At this time, the exact area for marl fen and tufa seep are not available.

Step 2. Selection of Wetland Indicator Species.

In order to determine project-related wetland function loss, indicator species (see definition on how this term was utilized in the section 'Assessment of Wetland Functions') were selected from the list of species documented in the Project baseline studies. The selection of wetland indicator species for migratory birds, amphibians, bats, rare plants, species important to aboriginal land use and species at risk are described below. Information from peer-reviewed literature, provincial databases, and experts have been used to form an understanding of wetland habitat use by indicator species for the wetland function ranking. Baseline wildlife and vegetation survey data from the LAA was used to verify and confirm the literature review. See 'Step 3: Identification of Important Wetland Functions' as to how this information was used. Appendices A and B in this document lists the literature reviewed for each of the indicator species considered as part of this process.

Selection of Migratory Bird Indicator Species

A detailed review of the baseline conditions and the available literature was used to identify the important functions wetland habitats provide migratory bird species and how the Project will impact these functions. Due to the high number of migratory bird species observed in the LAA, bird species were combined into assemblages that share similar morphology and habitat use patterns. One to three indicator species were then selected to represent each assemblage. Thirteen assemblages of migratory bird species were identified and are described below. Information on species assemblages was taken from the National Geographic Field Guide to the Birds of North America (Dunn & Alderfer 2006) and the Cornell Lab of Ornithology: All About Birds website (Cornell University 2011).

Dabbling Ducks – Ducks of the genus *Anas* that feed on the water surface or by tipping, tail up, to reach aquatic plants. In most cases this assemblage nests in dry locations above the waterline at suitable wetland and upland sites.

Diving Ducks – Duck species that feed by diving below the water's surface and typically nest over water or close to the water's edge. This assemblage includes pochards (*Aythya*) and stiff-tailed ducks (*Oxyura*), as well as most sea ducks (*Melanitta, Clangula*, and *Histrionicus*) and mergansers (*Mergus*), with the exception of those that nest in tree cavities.

Cavity-nesting Ducks – Duck species that utilize tree cavities for nesting. All are diving ducks from the genera *Bucephala, Mergus*, and *Lophodytes,* with the exception of Wood Ducks (*Aix sponsa*), which are surface feeders.

Swans and Geese – Large, long-necked and primarily aquatic birds from the family Anatidae. This assemblage of waterfowl contains the genera *Cygnus, Anser, Chen,* and *Branta*.

Waterbirds – Aquatic diving birds from the families Gaviidae (loons) and Podicepedidae (grebes).

Gulls and Terns **–** Species from the family Laridae, which frequent coastal waters or inland lakes and wetlands and can be highly pelagic.

Forest-nesting Shorebirds – Species from the family Scolopacidae that spend most of their time along the water's edge and tend to nest in forested or shrubby areas.

Marsh-nesting Shorebirds – Species from the families Charadriidae and Scolopacidae that spend most of their time along the water's edge and tend to nest in open or marshy areas.

Rails – Marsh birds with short tails and short, rounded wings from the family Rallidae

Open Habitat Songbirds – Songbirds include the orders Passeriformes, Apodiformes, Columbiformes, and Coraciiformes. This assemblage consists of songbirds that occupy primarily open habitat types.

Deciduous Songbirds – Songbirds include the orders Passeriformes, Apodiformes, Columbiformes, and Coraciiformes. This assemblage consists of songbirds that occupy primarily deciduous tree- or shrub-dominated habitat types

Coniferous Songbirds – Songbirds include the orders Passeriformes, Apodiformes, Columbiformes, and Coraciiformes. This assemblage consists of songbirds that occupy primarily coniferous-dominated habitat types

Aerial Insectivores – Swallows and nighthawks from the families Hirundinidae and Caprimulgidae that feed on swarming insects during flight.

Indicator species representing the 13 assemblages were chosen from the species recorded during baseline inventories conducted within the LAA. The chosen species had a strong association with wetland habitats, used the Peace River region as a core part of their range, were important from a conservation standpoint, and do not have broad or generalized habitat preferences. Species with generalized habitat preferences were not selected because they would diminish the importance of wetland habitats in terms of assessing their functional value as many generalist species use a wide array of habitat types. To narrow this list of representative species further, species identified by Environment Canada as conservation priorities for the Boreal Taiga Plains Region (BCR-6), which includes the Peace River area, were also selected (Environment Canada 2013a). Species listed as "priority species" in wetland habitats were preferred as indicator species.

Wetland habitat classes included bogs, fens, marshes, swamps, and shallow open water (largely non-vegetated surface, but <2m deep; Environment Canada 2013a). The final selection of species excluded species that were found in low numbers during baseline studies in the LAA (i.e., less than 100 observations for waterfowl during transect surveys, and less than 10 detections for other bird species, during breeding bird surveys), occurred in the region at the periphery of their range, had habitat preferences that mirrored other species on the list, were not considered migratory, or had more general habitat preferences in relation to other species that fell into the same category. Experts from within Ducks Unlimited Canada were also consulted during the selection process and included Stuart Slattery PhD (Research Scientist – boreal waterfowl ecology), Darryl Kroeker (Head of Conservation Programs, BC Peace), and Julienne Morissette PhD (Conservation Scientist – National Boreal Program). In total, 23 species were selected to represent the 13 different assemblages. See Table 2 for the complete rationale behind the inclusion or exclusion of BCR-6 priority species for wetland habitats from the list and Figure 3 for a flow chart that outlines the selection process for migratory bird indicator species. This initial list was further refined following discussion with colleagues from Environment Canada's Canadian Wildlife Service and British Columbia's MOE.

Few songbird species met the above criteria and often those that did were extremely rare on the landscape, therefore it was suggested that additional species be added to the Deciduous Songbirds and Coniferous Songbirds species assemblages to improve their representation (Julienne Morrisette, pers. comm., Ducks Unlimited Canada). Based on their distinct preferences for specific wetland habitat types and occurrence within the LAA, the two species added were Lincoln's Sparrow and Northern Waterthrush. Lincoln's Sparrows are representative of shrubby and coniferous wetland and riparian habitat types in the boreal region and Northern Waterthrush are representative of deciduous wetland and riparian habitat types. It was also recommended after initial review that a swallow species be added to represent the aerial insectivore assemblage. There were no swallow species classified by Environment Canada as priority species in wetland habitats, but one swallow species observed in the Site C LAA, the Bank Swallow, is considered a priority species in "Waterbodies" habitat (i.e., lakes and ponds >2 m deep, rivers, streams and reservoirs). Therefore, Bank Swallows were selected to represent the aerial insectivore assemblage. With the addition of these three species the total number of indicator species representing migratory birds in the wetland function assessment is 26. A list and description of the wetland habitat types used by the migratory bird indicator species selected can be found in the Excel file 'NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx', under the 'Species Habitat Use' tab.

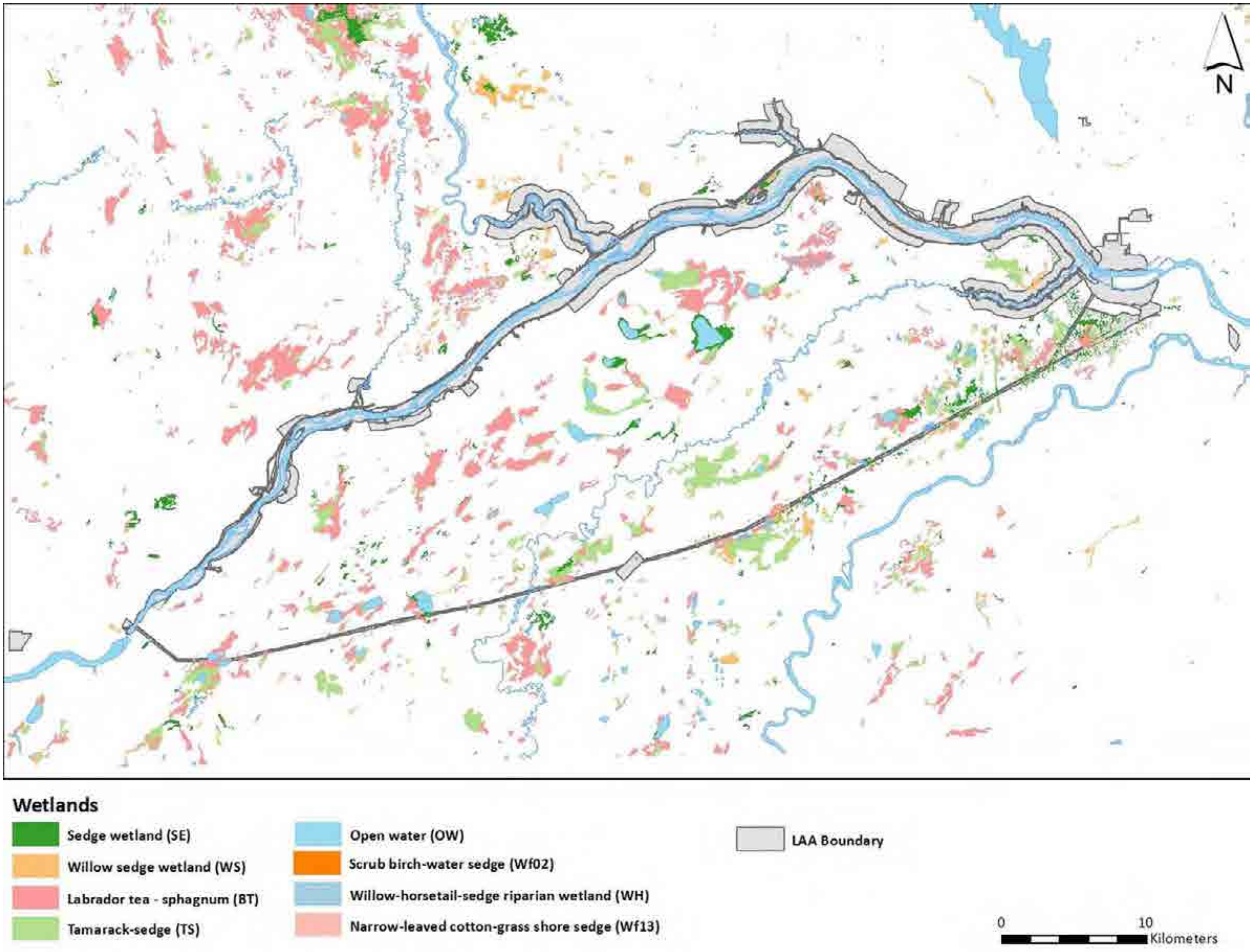


Figure 2. Detailed and TEM wetland mapping for the Site C project.

Table 2. Rationale for migratory bird species inclusion[1]. Yellow highlight indicates species selected as an indicator.

Species Category	Included	Rationale[2]
Songbirds		
Alder Flycatcher	Y	Wetland species found in bog habitats; represents deciduous and early successional habitat types
Common Yellowthroat	Y	Found in deciduous-dominated wetland and riparian areas; important habitat features include a dense shrub understory
Connecticut Warbler	N	Red-listed wetland species. In this part of its range, habitat preferences shift from bog habitats towards upland deciduous types
Le Conte's Sparrow	Y	Found in marsh and bog habitats; represents open habitat types
Nelson's Sparrow	Y	Red-listed wetland species found in marsh and fen habitats; represents open habitat types
Olive-sided Flycatcher	Y	Blue-listed wetland species associated with coniferous habitats with tall trees/snags and forest openings; represents coniferous habitat types
Rusty Blackbird	Y	Blue-listed wetland species; represents coniferous and early successional habitat types
Lincoln's Sparrow	Y	Not a priority species in wetland habitats within BCR-6, but indicative of shrubby and coniferous (Julienne Morissette, pers. comm., Ducks Unlimited Canada) wetlands and frequent throughout the landscape
Northern Waterthrush	Y	Not a priority species in wetland habitats within BCR-6, but indicative of deciduous wetland and riparian habitats (Julienne Morissette, pers. comm., Ducks Unlimited Canada) and frequent throughout the landscape
Aerial Insectivores		
Bank Swallow	Y	Priority species in waterbody habitats in BCR-6; strong association with rivers and perennial streams due to their nesting requirements
Common Nighthawk	Y	Federally listed as Threatened under the *Species at Risk Act*; nests in bogs and other open wetlands containing bare ground and forages over waterbodies and open habitats
Shorebirds		
Greater Yellowlegs	N	Similar habitat preferences as Lesser Yellowlegs and Solitary Sandpiper and found in low numbers within the study area
Killdeer	N	Considered a habitat generalist found in open or disturbed habitat types

Table 2. (continued)

Shorebirds *continued*	Included	Rationale[2]
Least Sandpiper	N	Found in low numbers within the study area and considered a transient species found only during migration
Lesser Yellowlegs	Y	Shorebird species found in marshes and all types of forested habitat near water; nesting occurs in forested habitat types
Solitary Sandpiper	Y	Shorebird species occupying bogs and found in coniferous and early successional habitat types near water; nesting occurs in forested habitat types
Upland Sandpiper	N	Red listed; found in low numbers within the study area and has similar habitat preferences to Wilson's Snipe
Wilson's Snipe	Y	Shorebird species found in marshes and early successional habitats near water; nesting occurs in open habitat types
Rails		
Sora	Y	Found in marsh habitat associated with non-perennial ponds/small lakes
Yellow Rail	Y	Red-listed; found in bog, fen, and marsh habitat
Gulls and Terns		
Arctic Tern	N	Found in low numbers in the study area and considered a transient species
Black Tern	Y	Found in marshes and shallow water; emergent vegetation is an important habitat feature
Bonaparte's Gull	Y	Found in marshes and bogs; islands are an important habitat feature; preferred nesting sites are in coniferous trees near water
California Gull	N	Blue-listed; found in low numbers in the study area and considered a transient species
Caspian Tern	N	Blue-listed; found in low numbers in the study area and considered a transient species
Common Tern	N	Found in low numbers in the study area and considered a transient species
Waterbirds		
Common Loon	Y	Found in marsh habitat and lakes and wetlands with shallow water (<0.5 m); prefers large perennial lakes
Horned Grebe	Y	Designated as Special Concern by COSEWIC; found in shallow water and associated with emergent vegetation; prefers smaller waterbodies or secluded areas of lakes

Table 2. (continued)

Waterbirds *continued*	Included	Rationale[2]
Pacific Loon	N	Found in low numbers in the study area and considered a transient
Pied-billed Grebe	N	Very similar to Horned Grebe in terms of habitat use; found in marsh habitat; prefers smaller waterbodies or secluded areas of lakes
Red-necked Grebe	N	Similar to Horned Grebe and Common Loon in terms of habitat use; prefers large perennial lakes
Dabbling Ducks		
American Wigeon	Y	Common within the area, but is a species of conservation interest due to population declines in the boreal region (Stuart Slattery, pers. comm., Ducks Unlimited Canada)
Blue-winged Teal	N	Numbers lower than other dabbling duck species with similar habitat preferences within the area
Gadwall	N	Very low numbers found within the study area; similar habitat preferences to other dabbling ducks
Green-winged Teal	Y	Common species within the region and represents the typical habitat use of dabbling ducks, using a mixture of wetlands and adjacent uplands for breeding
Mallard	N	Very common species within the study area but has the most generalized nesting preferences of all dabbling ducks
Northern Pintail	N	A relatively common dabbling duck species in the area with breeding observations and migration requirements similar to other dabbling duck species
Northern Shoveler	N	Numbers within the study area were low in relation to other dabbling duck species and habitat preferences similar to American Wigeon and Green-winged Teal
Diving Ducks		
Canvasback	N	Very low numbers within the study area, has similar habitat preferences to other diving duck species, and does not sufficiently represent the waterfowl community in the Peace River region (Darryl Kroeker, pers. comm., Ducks Unlimited Canada)
Lesser Scaup	Y	Common diving duck species within the area and nests on land and over water
Long-tailed Duck	N	Blue-listed; very low numbers within the study area and considered a transient species
Ring-necked Duck	Y	Most common diving duck species within the area and nests over water, which is typical of diving duck species

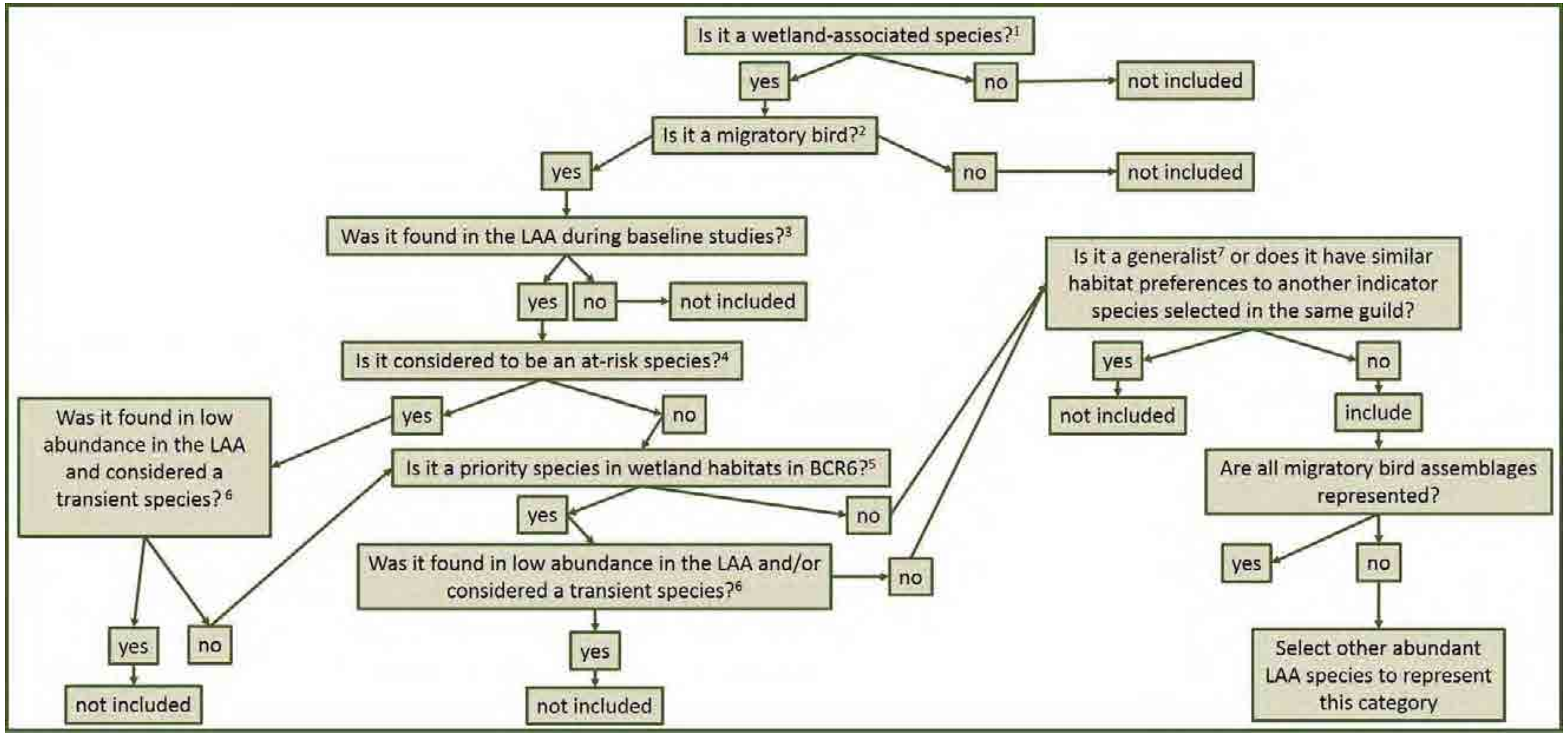
Table 2. (continued)

Diving Ducks *continued*	Included	Rationale[2]
Surf Scoter	N	Blue-listed; very low numbers within the study area and does not sufficiently represent the waterfowl community in the Peace River region (Darryl Kroeker, pers. comm., Ducks Unlimited Canada)
White-winged Scoter	N	Very low numbers within the study area and does not sufficiently represent the waterfowl community in the Peace River region (Darryl Kroeker, pers. comm., Ducks Unlimited Canada)
Cavity-nesting Ducks		
Barrow's Goldeneye	N	Found in the study area in much lower numbers than other cavity nesting waterfowl, has similar habitat preferences, and does not sufficiently represent the waterfowl community in the Peace River region (Darryl Kroeker, Ducks Unlimited Canada pers. comm.)
Bufflehead	Y	Common cavity nesting species that uses wooded areas adjacent to wetlands for nesting
Common Goldeneye	Y	Common cavity nesting species that uses wooded areas adjacent to wetlands for nesting
Geese and Swans		
Cackling Goose	N	Low numbers within the study area and considered a transient species
Trumpeter Swan	Y	Breeds within the study area and has narrower nesting habitat preferences than Canada Goose

[1] All species listed in the table are listed as 'Priority species' for wetland habitat in the BCR-6 by Environment Canada (except for Lincoln's Sparrow and Northern Waterthrush) and were found in the BC Hydro Site C LAA.

[2] 'low numbers' within the LAA was defined as less than 100 observations for waterfowl during transect surveys, and less than 10 detections for other bird species, during breeding bird surveys.

Figure 3. Flow chart outlining indicator species selection process for migratory birds.



[1] A wetland-associated species was defined as a species that shows a strong association with wetland habitats in the LAA for an important life function (e.g., nesting) in the region.

[2] A migratory bird species was defined as one that is listed under the Migratory Birds Convention Act, 1994 (Environment Canada, 2016a).

[3] Baseline studies include breeding bird point counts (2006, 2008, 2011, 2012), migratory encounter surveys (2012), waterfowl surveys (2006, 2008, 2013, 2014), Common Nighthawk call playback surveys (2010-2012), marsh bird call playback surveys (2008, 2011, 2012), swallow nest counts (2010) and swallow point counts (2011-2012).

[4] An at risk species is one that is federally-listed (Environment Canada, 2016b) or has been defined as at risk (i.e., red- or blue-listed) by the British Columbia Conservation Data Centre (B.C. Conservation Data Centre, 2016.).

[5] See Environment Canada (2013a).

[6] Low abundance was defined as species that were found during baseline studies in low numbers within the LAA (i.e., less than 100 observations for waterfowl during transect surveys, and less than 10 detections for other bird species, during breeding bird surveys). Transient was defined as species that occurred in the region at the periphery of their range.

[7] A generalist was defined as a species that uses a wide array of wetland habitat types for a particular function.

Selection of Amphibian Indicator Species

Amphibians are particularly vulnerable to wetland disturbance as they rely on available water to complete their breeding cycle. Five amphibian species were detected within the LAA during baseline surveys: Boreal Chorus Frogs, Columbia Spotted Frogs, Long-toed Salamanders, Western Toads, and Wood Frogs. Due to the low detection rate of Columbia Spotted Frogs and Long-toed Salamanders they were considered to be rare in the LAA (as defined by Hilton et al. 2013c). Three amphibian species were selected to represent the amphibian assemblage. Each differs based on the type of wetlands they use for breeding and their use of upland habitats. Columbia Spotted Frogs are highly dependent on permanent water sources. Western Toads require pools of water to breed, but otherwise inhabit drier upland sites. The habitat requirements of Boreal Chorus Frogs exists between these two extremes using both wetland and upland habitat during the non-breeding period. The Western Toad is the only amphibian recorded in the LAA that is a provincially or federally listed species. It is provincially blue-listed (B.C. Ministry of Environment 2014) and on Schedule 1 of *SARA,* where it has a designation of species of concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014). A list and description of the wetland habitat types used by the amphibian indicator species can be found in the Excel file 'NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx', under the 'Species Habitat Use' tab.

Selection of Bat Indicator Species

Eight bat species were captured or detected acoustically during baseline surveys in the LAA: the Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*), Long-eared Myotis (*Myotis evotis*), Long-legged Myotis (*Myotis volans*), Big Brown Bat (*Eptesicus fuscus*), Silver-haired Bat (*Lasionycteris noctivagans*), Hoary Bat (*Lasiurus cinereus*), and Eastern Red Bat (*Lasiurus borealis*). The Northern Myotis is a Blue-listed species (B.C. Ministry of Environment 2014). The Little Brown Myotis and Northern Myotis have received emergency listings as Endangered by COSEWIC as a result of an outbreak of a fungal disease in eastern Canada known as white-nose syndrome (COSEWIC 2014). Both species have been added to Schedule 1 of *SARA*.

Because all eight bat species differ in terms of their foraging and roosting habitat preferences, all were selected to represent bats and the potential loss of important functions this group would experience as a result of wetland loss. A list and description of the wetland habitat types used by the bat indicator species can be found in the Excel file 'NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx', under the 'Species Habitat Use' tab.

Selection of Flora Indicator Species

This wetland function assessment focused only on rare plant species documented in the LAA that have strong associations to wetland habitat types. An initial list of wetland-associated rare plants was compiled from baseline data (Hilton et al., 2013a), confirmed with the BC Hydro rare plant botanist, reassessed based on their conservation status rank (Table 3) and used to conduct the preliminary ranking. Rare plant species were confirmed as wetland plants by their wetland indicator status for the Western Mountains, Valleys, and Coast (USDA, 2014; Lichvar, 2013; Table 4). Wetland zonation for plants includes Obligate Wetland (OBL) species and Facultative Wetland (FACW) species (Table 4). OBL species are plants that always occur in wetlands. FACW plants typically occur in wetlands but can also be found in non-wetland habitats (USDA, 2014). Rare plant species were selected, based on their conservation status rank and their assignment to the Conservation Data Centre's (CDC) red or blue list (i.e., Red: S1 and/or S2 and Blue: S2 and/or S3; BC CDC, 2016a-k; see Table 3), which includes any indigenous species or subspecies considered to be threatened or vulnerable in BC. A list and description of the wetland habitat types used by the flora indicator species can be found in the Excel file 'NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx'.

Table 3. Rare plant species considered threatened or vulnerable by the BC CDC (2016a-k).

Common Name	Scientific Name	Provincial Rank (i.e., Red or Blue; 2016)
Hudson Bay Sedge	*Carax heleonastes*	Blue
Iowa Golden-saxifrage	*Chrysosplenium iowense*	Red
Hall's Willowherb	*Epilobium halleanum*	Blue
Slender Mannagrass	*Glyceria pulchella*	Blue
White Adder's-mouth Orchid	*Malaxis brachypoda*	Blue
Small-flowered Lousewort	*Pedicularis parviflora* ssp. *parviflora*	Red
Meadow Willow	*Salix petiolaris*	Blue
Slender Wedgegrass	*Sphenopholis intermedia*	Blue
Ochroleucous Bladderwort	*Utricularia ochroleuca*	Blue
No common name given	*Herzogiella turfacea*	Red
Rocky Mountain Willowherb	*Epilobium saximontanum*	Red

Table 4. Rare plant species wetland indicator status for the Western Mountains, Valleys, and Coast zone, unless otherwise noted (USDA, 2014; Anderson, 2006).

Common Name	Scientific Name	Wetland Status[1]
Hudson Bay Sedge	*Carax heleonastes*	OBL (Alaska)
Iowa Golden-saxifrage	*Chrysosplenium iowense*	OBL (Midwest)
Hall's Willowherb	*Epilobium halleanum*	FACW
Slender Mannagrass	*Glyceria pulchella*	OBL (Alaska)
White Adder's-mouth Orchid	*Malaxis brachypoda*	FACW(Alaska)[A]
Small-flowered Lousewort	*Pedicularis parviflora ssp. parviflora*	FACW (Alaska)
Meadow Willow	*Salix petiolaris*	OBL
Slender Wedgegrass	*Sphenopholis intermedia*	FAC
Ochroleucous Bladderwort	*Utricularia ochroleuca*	OBL
No common name	*Herzogiella turfacea*	N/A
Rocky Mountain Willowherb	*Epilobium saximontanum*	FACW

[1] Wetland indicator status taken from Anderson, 2006. OBL - Obligate Wetland, FACW - Facultative Wetland, FAC – Facultative wetland and non-wetland habitats.

Selection of Species Important to Aboriginal Land Use

To assist in assessing potential impacts to Aboriginal Groups, Traditional Land Use Studies (TLUS) were prepared for the Project during completion of the Environmental Impact Statement (BC Hydro, 2013a). Eight plant and one wildlife wetland associated species were identified in the EIS as being species of traditional use in the LAA. These species could be impacted by Project construction activities and were included in the function assessment.

Only plant species that had a strong association with wetland habitats were included (i.e., plant species that with either OBL or FACW wetland status in the Western Mountains, Valleys, and Coast Zone (USDA 2014, Anderson 2006) and these are provided in Table 5. Two plant species with a strong association to wetlands were included in this category (i.e., Labrador Tea and Highbush Cranberry). Moose were also included because of their use of wetland habitat for important functions, such as feeding and birthing sites. A list and description of the wetland habitat types used by the species important to Aboriginal land use can be found in the Excel file 'NPS_bchydro_siteC_Aboriginalspp_wetlandfunction_Dec2016.xlsx', under the 'Species Habitat Associations' tab. Additional species may be added following further consultation with Aboriginal groups.

Table 5. List of species important to Aboriginal land use and their wetland indicator status for the Western Mountains, Valleys, and Coast zone (USDA 2014, Anderson 2006). Yellow shading indicate a species with a strong association to wetlands, which were included in the Site C wetland habitat function assessment.

Common Name	Scientific Name	Wetland Status[A]
Labrador Tea	*Ledum groenlandicum*	OBL
Lingonberry	*Vaccinium vitis-idaea*	N/A
Dwarf Red Raspberry	*Rubus arcticus*	FAC
Cloudberry	*Rubus chamaemorus*	N/A
Highbush Cranberry	*Viburnum opulus* var. *americanum*	FACW
Prickly Rose	*Rosa acicularis*	FACU
Stinging Nettle	*Urtica dioica*	FAC
Red Raspberry	*Rubus idaeus*	FACU

[A] Wetland indicator status taken from Anderson, 2006. OBL - Obligate Wetland, FACW - Facultative Wetland, FAC – Facultative wetland and non-wetland habitats, FACU – Facultative Upland.

Selection of Species at Risk

In accordance with Federal Condition 11.4.4, fauna species at risk, considered separately from flora species at risk, are included in the wetland function assessment. An at risk species is one that is federally-listed under the Species at Risk Act (SARA; Environment Canada, 2016b) or has been defined as at risk (i.e., red- or blue-listed) by the British Columbia Conservation Data Centre (B.C. Conservation Data

Centre, 2016.), as of December 2016. Of the list of federally- and provincially-listed species at risk found in the LAA, only those that were wetland-associated were considered (i.e., a species that shows a strong association with wetland habitats for an important life function (e.g., nesting) in the region). In addition, if a species was found in low abundance during baseline surveys (i.e., less than 100 observations for waterfowl during transect surveys, and less than 10 detections for other bird species, during breeding bird surveys) and was transient to the region (i.e., species that occurred in the region at the periphery of their range), it was not included. In total, 19 species at risk were incorporated into the model, including seven butterflies, one dragonfly, one amphibian, two bats and eight birds (Table 6). Of the eight birds, five are also included as indicator species for migratory bird wetland functions. The one amphibian and two bats are also included as an indicator species for wetland function. A list and description of the wetland habitat types used by the species at risk indicator species can be found in the Excel file 'NPS_bchydro_siteC_faunaspp_wetland function_Dec2016.xlsx'.

Table 6. List of species at risk, including their federal and provincial status.

Common name	Provincial status	Species at Risk Act status
Aphrodite Fritillary, *manitoba* subspecies	Blue	No status
Assiniboine Skipper	Red	No status
Bronze Copper	Blue	No status
Common Ringlet, *benjamini* subspecies	Blue	No status
Common Woodnymph	Blue	No status
Great Spangled Fritillary, *pseudocarpenteri* subspecies	Red	No status
Tawny Crescent	Blue	No status
Prairie Bluet	Blue	No status
Western Toad	Blue	Schedule 1-SC
Northern Myotis	Blue	Schedule 1-E
Little Brown Myotis	Yellow	Schedule 1-E
Surf Scoter	Blue	No status
Common Nighthawk	Yellow	Schedule 1-T
Barn Swallow	Blue	No status
Rusty Blackbird	Blue	Schedule 1-SC
Olive-sided Flycatcher	Blue	Schedule 1-T
Nelson's Sparrow	Red	No status
Yellow Rail	Red	Schedule 1-SC
Short-eared Owl	Blue	Schedule 1-SC

Step 3. Identification of Important Wetland Habitat Functions.

A total of 12 wetland habitat functions were selected that are applicable to migratory birds, amphibians, bats, rare plants, species important to Aboriginal land use and species at risk (Table 7). Wetland functions were selected based on the critical habitat requirements for each species assemblage and the indicator species chosen to represent them.

Functions provided by wetlands for migratory bird species were divided into four categories: Nesting, Feeding, Brood-rearing, and Migration. Wetland functions provided to amphibians included: Feeding, Breeding, and Wintering. The following functions for bat species are also provided by wetlands: Feeding and Roosting. The wetland function associated with rare plants, Species Important to Aboriginal land use and species at risk consisted of a wetland type's ability to support these species.

A detailed review of available literature and the baseline conditions in the LAA was conducted to identify which existing wetland habitats within the project area may facilitate each of these wildlife habitat functions. These sources are summarized in Appendices A and B. Species inventories were conducted during baseline surveys for the EIS; however, these inventories were never intended to evaluate wetland habitat use. Therefore, habitat type, including wetland habitat type, was rarely recorded with species observations. For many of the datasets, a thorough review as part of this report found that the sampling effort within wetland habitat types and the inability to confidently associate habitat type with observations makes them inadequate for this purpose (Appendix C). Therefore, scientific literature was used as the primary source for assigning habitat use to indicator species and assemblages due to the shortage of raw data linked to specific wetland habitat types available from the region. Where possible, literature that was reflective of the species-habitat relationship in the region was selected. Existing baseline data was used, where possible, only to confirm indicator species habitat use. For example, in datasets (e.g., breeding bird point counts) where UTM coordinates were provided for a point count station, habitats were determined by overlaying UTM coordinates with mapped habitat data (Appendix C). However, UTM coordinates given for a point count station may not represent the habitat a species was recorded in (e.g., a bird survey station occurs in SE habitat; however, a bird is detected 100 m to the west of the station); therefore, baseline data use was treated with caution.

Table 7. Wildlife and rare plant habitat functions provided by wetlands.

Function 1 – Migratory Bird Nesting Habitat
Function 2 – Migratory Bird Feeding Habitat
Function 3 – Migratory Bird Brood-Rearing Habitat
Function 4 – Migratory Bird Migration Habitat
Function 5 – Amphibian Breeding Habitat
Function 6 – Amphibian Feeding Habitat
Function 7 – Amphibian Wintering Habitat
Function 8 – Bat Feeding Habitat
Function 9 – Bat Roosting Habitat
Function 10 – Rare Plant Use
Function 11 – Species Important to Aboriginal Land Use
Function 12 – Species at Risk Use

Function 1: Migratory Bird Nesting Habitat

Definition: The ability of wetlands to provide critical nesting habitat for migratory bird species is defined as their capacity to support nesting populations of bird species that require resources provided by wetland habitats, such as proximity to the water's edge, moisture requirements at the nest site, and preferred vegetation species and vegetation structure. This wetland function considers nesting habitat selection at a species-specific level, as well as generalized preference at an assemblage level for the diversity of bird assemblages that rely on wetland habitat types for nesting (e.g., waterfowl, songbirds, etc.)

Rationale: For migratory bird species, nesting habitat is considered to be one of the most important habitat functions in terms of long term persistence of a species. Without adequate nesting habitat to successfully raise offspring to adulthood, populations would quickly decline. Bellrose (1977) found that waterfowl densities and production generally increased as the number of wetlands increased. Marsh wetland types generally provide a higher habitat value for waterfowl species than other wetland types because of the nesting habitat they provide (Mackenzie & Moran 2004, Environment Canada 2013b). Wetlands also provide an important buffer or barrier to some land-based predators and reduce the risk of predation to nesting or young birds and many species have adapted to take advantage of this by nesting over water or on islands (Stewart 2014). Wetland obligate and wetland dependent species are particularly constrained to wetland habitat for nesting success. An estimated 38% of all waterfowl of Canada and the United States breed in the boreal forest of North America. In conjunction with adjacent and connected forest and riparian ecosystems, boreal wetlands provide nesting habitat for an estimated 26 million waterfowl comprising 35 species. Boreal wetlands also provide important shorebird habitat and up to 7 million shorebirds are estimated to breed within these wetlands (Cheskey et al. 2011). Because wetland birds are a diverse group of species, they also exhibit a high degree of variability in their nesting preferences, ranging from highly aquatic to terrestrial: (i) completely floating nests of buoyant vegetation (small grebes); (ii) in water but essentially resting on some substrate (some rails and ducks); (iii) above water and remote from shore (Least bitterns, herons); (iv) near shore but at wet-to-damp sites (some rails, American Bitterns, and ducks); (v) dry ground with varying degrees of short, herbaceous cover, at varying distances from, but associated with water (Common Yellowthroats, Sedge Wrens, some ducks); (vi) at bases of tall emergent vegetation, over land or water (sparrows, some New World blackbirds); (vii) mid-level in robust herbaceous vegetation or small trees that can support the weight of nest, eggs, and the incubating parent (New World blackbirds); (viii) at the top of sturdy vegetation such as trees or snags (ospreys, certain eagles, herons); (ix) tree holes created by woodpeckers (Bufflehead), larger tree cavities or crevices (Hooded Mergansers, Wood Ducks); and (x) cliff faces or solid soil banks (kingfishers; Weller 1999).

Relevant Site C EIS Datasets:

- 2006, 2008, 2011, & 2012 Breeding Bird Counts
- 2010 & 2012 Common Nighthawk Call Playback Surveys
- 2008, 2011, & 2012 Marsh Bird Call Playback Surveys
- 2010 Swallow Nest Counts
- 2011 & 2012 Swallow Point Counts

Function 2: Migratory Bird Feeding Habitat

Definition: The ability for wetlands to support important feeding habitat for migratory birds is defined as the degree to which wetland habitat types provide suitable food sources and foraging habitat for wetland-dependent species. At a temporal scale, feeding habitat may overlap with other wetland functions associated with migratory birds (e.g., nesting habitat, migration habitat).

Rationale: Availability and timing of food resources utilized by wetland birds is critical so that energy can be directed towards functions, such as flight, migration, breeding, defense, etc. (Weller 1999). Wetlands are dynamic ecosystems and contain a unique assemblage of microhabitats and food resources that are products of the diversity of vegetation and animals they contain, which are themselves related to hydroperiods (i.e., duration of water in days, weeks, or months per year), timing of biological and environmental events (e.g., seasonal chronology), and water depths in different wetland types. Over time wetland birds have adapted to exploit every zone existing within wetland habitats (e.g., shoreline, above water, surface, water column, mudflat, basin substrate) and all of major foods they contain (e.g., seeds, plant material, invertebrates, fish, reptiles, amphibians, small mammals; Weller 1999, Stewart 2014). The standing water found in some wetland types (e.g., marshes) provides important breeding areas for invertebrates such as some caddisflies and midges, which are important food sources for many bird species (Environment Canada 2013b). Shorebirds diets are composed largely of invertebrates, such as insect larvae, worms, crustaceans, and mollusks, existing within the mud and soils of wetlands (Cheskey et al. 2011). Food resources within wetlands can be diverse and vary temporally and spatially. Most birds are unique among vertebrates in their ability to use wetlands dispersed over hundreds or thousands of miles in their annual range (Weller 1999).

Relevant Site C EIS Datasets:

- None

Function 3: Migratory Bird Brood-Rearing Habitat

Definition: Migratory bird brood-rearing habitat is defined as the ability of a wetland to support family groups during the brood-rearing period, which occurs once eggs have hatched and the family group has left the nest site. Brood-rearing is a wetland function that is only applicable to bird species with precocious young that develop the ability to travel with the female and abandon the nest site soon after the eggs hatch (e.g., waterfowl). The functional capacity of a wetland to provide brood-rearing habitat considers both the proportional use of a wetland type by a species in relation to other habitat types, as well as diversity of bird assemblages that rely on wetland habitat types (e.g., waterfowl, shorebirds, etc.).

Rationale: Brood-rearing habitats must contain a mixture of suitable food resources for the growth and development of young birds, and adequate vegetation cover, while young birds remain flightless and are vulnerable to predation. The food required by young and adult birds often differs; therefore, different habitats or microhabitats are required during this early stage, which separates it from *Function 2: Migratory Birds Feeding Habitat*. Young omnivores gradually shift from animal protein in early growth to more seeds and then foliage as they mature. Carnivores or piscivores show shifts more in size and species of prey (Weller 1999). Brood-rearing locations may be situated near nesting sites and occur in similar habitat, but females of some species, such as mallards, may move greater than two kilometers to reach suitable habitat in entirely different wetland complexes (Baldassarre 2014).

Relevant Site C EIS Datasets:

- None

Function 4: Migratory Bird Migration Habitat

Definition: The functional capacity of wetlands to provide suitable migration habitat for bird species is defined as its ability to supply the appropriate food and cover resources during both the spring and fall migration periods. Assessment of this function takes into consideration both the functional importance of migration at a species-specific level, as well as wetland habitat utilization for migration at an assemblage level (e.g., waterfowl, songbirds, etc.).

Rationale: Wetland habitats offer important stopover areas for waterfowl and other wetland birds for resting and to replenish energy reserves (Environment Canada 2013b, Stewart 2014). Birds linked to wetlands and riparian areas tend to migrate along large perennial streams and use marshes, wetlands, lakes, reservoirs, and other water bodies for stopover sites. Large lakes and wetlands in close proximity can support large groups of migrating waterfowl and shorebirds and provide safety from predators (Pocewicz et al. 2013). During the fall a total of 3.5 to 5 billion birds migrate south through the boreal region. Of the 7 million shorebirds estimated to breed in boreal forest wetlands, millions more also depend on them as stopover locations during migration (Cheskey et al. 2011). Wetland use by migratory birds also varies for spring and fall migrations. At northern latitudes, birds that are adapted to water environments are restricted to pools of run-off and ice-free wetlands and waterbodies during spring migration (Stewart 2014).

Relevant Site C EIS Datasets:

- 2012 Migratory Bird Encounter Surveys
- 2006, 2008, 2013, & 2014 Waterfowl Encounter Surveys

Function 5: Amphibian Breeding Habitat

Definition: The ability of wetlands to provide amphibian breeding habitat is defined as whether or not a wetland type contains the appropriate habitat features to support egg laying, tadpole development, and metamorphosis for amphibian species inhabiting the Peace River Region.

Rationale: Most amphibians require some sort of aquatic component to their habitat for breeding sites, egg laying, and habitat for larval development (Environment Canada 2013b, Meyer et al. 2003), although the specific hydrological requirements for each species varies (EPA 2002). Wetland classes are highly variable in terms of their hydrological conditions and therefore different amphibian species will inhabit different wetland classes. The aquatic larval stage of amphibians may last several days to many months (EPA 2003), and therefore the habitats required by breeding amphibians range from vernal wetlands or temporary pools to permanent ponds (EPA 2002). Wetland habitats used by amphibians for breeding may include marshes, swamps, bogs, and fens (EPA 2003).

Relevant Site C EIS Datasets:

- 2006 & 2008 Amphibian Auditory Surveys
- 2006, 2008, & 2012 Amphibian Pond Surveys

Function 6: Amphibian Feeding Habitat

Definition: The ability of wetland habitats to provide suitable foraging sites and prey species for amphibians throughout their active period. Feeding habitat exists in both the breeding and non-breeding periods but tends to be less specialized once breeding is complete.

Rationale: Wetlands provide a primary food source for many amphibian species, which includes prey such as insects, spiders, snails, worms, and small fish (EPA 2003). The importance of wetland habitats to amphibians for feeding varies considerably amongst species. Highly aquatic species, such as Columbia Spotted Frogs, feed primarily in or at the edge of the water in wetlands or waterbodies, but will occasionally forage in nearby meadows or damp woods during rainy periods; whereas Western Toads are less reliant on wetland habitats, using fields, forests, meadows, and shrubby thickets when foraging (B.C. Ministry of Forests 2014). However, because of moisture requirements even the most terrestrial amphibian species must seek out wetland habitats during prolonged dry periods (EPA 2003).

Relevant Site C EIS Datasets:

- None

Function 7: Amphibian Wintering Habitat

Definition: The ability for wetland habitats to contain appropriate over-wintering sites for amphibian species, including water depth, burrow requirements and structure.

Rationale: Typical wintering habitat includes waterbodies that do not freeze entirely to the bottom or burrows in the ground that maintain moisture and do not fall below a specific temperature range, although some frogs can tolerate freezing conditions. The importance of wetland habitat types is difficult to quantify as wintering habitat varies considerably amongst amphibian species. In the northern extent of their range, Columbia spotted frogs overwinter in the muddy bottoms of wetlands and waterbodies requiring highly-oxygenated water that does not freeze to the bottom (B.C. Ministry of Forests 2014). Other amphibian species (e.g., Western Toad, Wood Frog, Boreal Chorus Frog) hibernate on land in small mammal burrows, root masses, or beneath logs and leaf litter (B.C. Ministry of Forests 2014, Alaska Fish and Game 2008). Conditions suitable for these other amphibian species may be present in wetland or terrestrial habitat types.

Relevant Site C EIS Datasets:

- None

Function 8: Bat Feeding Habitat

Definition: The capacity for wetland habitats to provide suitable foraging habitat for bat species. Suitable foraging habitat must contain concentrations of swarming insects and the appropriate vertical vegetation structure required by each individual species.

Rationale: Many bat species have frequently been observed feeding in wetlands and over water. Bat species at the northern extent of their range feed exclusively on insects and wetlands provide important breeding habitat for prey species, such as caddisflies and midges (Environment Canada 2013b, Maslonek 2009). Some bat species could also be considered wetland-dependent if the insect biomass produced by these wetlands in the late summer and early fall provides an essential portion of the pre-hibernation diet (Tiner 2005).

Relevant Site C EIS Datasets:

- 2005, 2006, 2008, 2009, & 2011 Bat Capture Surveys
- 2005, 2006, & 2008 Bat Detector Surveys

Function 9: Bat Roosting Habitat

Definition: The ability for wetlands to provide roosting habitat for bat species is defined as whether a habitat supports the necessary structural complexity required for bat roosting sites.

Rationale: Trees are important roost sites for many bat species (e.g., Big Brown Bat, Silver-haired Bat, Long-eared Myotis, Long-legged Myotis), which will occupy woodpecker holes, natural tree cavities and cracks, and areas beneath loose bark (Vohnof & Barclay 1996, OMNR 2000). Very little research has been conducted on the roosting potential of forested wetlands, but because they contain trees and are situated near important feeding areas, these wetland types are expected to provide suitable roosting habitat.

Relevant Site C EIS Datasets:

- 2006, 2008, & 2009 Bat Telemetry Studies

Function 10: Rare Plant Use

Definition: The likelihood that a wetland habitat demonstrates the appropriate conditions to support the presence of a rare plant species. This function takes into consideration both the primary and secondary habitat associations of rare plant species recorded within the LAA.

Rationale: Unlike migratory birds, which have multiple categories of use (e.g., breeding, feeding, etc.) within wetland habitats, rare plants are either present or absent. Rare plants are particularly vulnerable as many are habitat specialists, adapting to their unique wetland environments over long periods of time (Haeussler, 1998). These rare species are of importance because further loss of known occurrences may have impacts on their overall persistence. Wetland habitats also exhibit many unique conditions related to their hydrology and soils, which translates to numerous plant species that are specialists to these areas. Some wetland habitats such as fens support a wide variety of rare or unique plant species. Of 320 vascular plant species found within fens in Iowa, 44% were considered rare (Meyer et al. 2003).

In the Manitoba boreal region, Locky and Bayley (2006) also found that a high diversity and rarity of plants occurred in some peatland types (e.g., wooded moderate-rich fens, Black Spruce swamps, and open moderate-rich fens), which would suggest they are important from a rare plant and conservation perspective.

For each of the 11 plant species associated with wetland habitats, scientific literature was compiled to collect information on their growth characteristics, distribution and habitat in other similar regions to the LAA (see Appendix A). This information was used to confirm two methods that were selected to explore LAA rare plants associated with wetland habitats, and assess the rare plant use function across wetland habitat types: primary habitat associations and secondary habitat associations.

- Primary habitat associations: Primary habitat associations for rare plant species consist of direct observations from the baseline survey data of rare plants in wetland habitat types (Table 8). This included both raw data from baseline inventories conducted within the LAA, as well as descriptions in the EIS (Hilton et al., 2013a; Bjork et al. 2009). In total, 8 of the 11 species have been directly linked to a wetland habitat type located in the LAA. The remaining 3 of the 11 species were either not linked to wetland habitat types found in the LAA (i.e., Meadow Willow), or were found as part of earlier studies in the Peace River Region (i.e., Slender Mannagrass, Rocky Mountain Willowherb).
- Secondary habitat associations: The primary habitat associations from the baseline data may not completely describe the extent of the rare species wetland habitat associations; therefore, secondary habitat associations were considered (e.g., a rare plant was located in the LAA only in a fen but may also use a marsh habitat) to fully evaluate the importance of wetland function for these species. This method considered the associated species found with rare plants during the baseline vegetation surveys in the LAA (Table 9), and evaluated the wetland habitat used by these associated species. For each associated species, their importance as an indicator of a particular wetland habitat type was considered (e.g., uncommon to dominant, in terms of presence in a wetland type), according to the Wetlands of British Columbia: A Guide to Identification (MacKenzie and Moran, 2004; see 'Species Importance Tables' in MacKenzie and Moran, 2004 and Excel file '<u>NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx'</u>). The importance of each associated species as an indicator ranged from infrequent (i.e., occurred sporadically within sites surveyed, usually <30% of plots surveyed) to dominant (i.e., occurred on all sites surveyed, at >25% cover and being the most abundant species surveyed). Data used to create these species-wetland habitat associations comes from approximately 2600 survey plots conducted throughout British Columbia, collected as part of classification programs, mapping projects and theses (MacKenzie and Moran, 2004). Caution was taken when interpreting the associated species that occurred with rare plants as an indication of a habitat type. Associated species were not considered if they were generalists, invasive, not indicated in baseline observations (i.e., genus only given), or not described in MacKenzie and Moran (2004). This information was then used in the ranking process. The likelihood of an associated species to occur in a particular wetland habitat (from 0-100%; MacKenzie and Moran, 2004) was weighted by the number of times the associated plant occurred with a rare plant in the field. This produced a secondary habitat association value, or an estimate of the likelihood that a rare

plant will occur in a wetland type, based on its associated species (see Step a in the 'Flora ranking protocol' section for a step-by-step example of how secondary habitat values are calculated). For the Iowa Golden-Saxifrage, its associated species were either generalists or invasive; therefore, no secondary habitat association was calculated. For Slender Mannagrass and Rocky Mountain Willowherb, because they were found as part of earlier studies in the Peace River Region, survey methods differed and no associated species were recorded.

Note that although insufficient information is available at this time for primary or secondary habitat ranks to be calculated for Slender Mannagrass and Rocky Mountain Willowherb, they have been left as placeholders in the model should habitat information be recorded during future surveys.

Relevant Site C EIS Datasets:

- 2005, 2006, 2008, 2011, & 2012 Rare Plant Surveys

Table 8. Primary habitat associations for rare plant occurrences in the EIS.

Rare Plant Species Detected	Primary Habitat Associations[A]
Ochroleucous Bladderwort	SE
Hudson Bay Sedge, Hall's Willowherb, *Herzogiella turfacea,* White Adder's-mouth Orchid	TS
Slender wedgegrass	WH
White Adder's-mouth Orchid, Small-flowered Lousewort	BT
Iowa Golden-saxifrage	Tufa Seep

[A] Rare plant occurrences in habitat types taken from Hilton et al, 2013a; Bjork et al., 2009; Data from Rare Plant Surveys 2008, Data from Rare vascular plant 2005, 2006, 2008, 2011, 2012 (SE=Sedge wetland, TS=Tamarack-Sedge - Fen, WH=Willow – Horsetail – Sedge – Riparian wetland, WS = Willow – Sedge – wetland, BT = Black Spruce – Labrador Tea – Sphagnum).

Table 9. Associated species used to determine secondary habitat associations for rare plants.

Rare Plant Species	Associated Species[A]
Hudson Bay Sedge	Tamarack, Labrador Tea, Black Spruce, Golden Fuzzy Fen Moss
Iowa Golden-saxifrage	N/A
Hall's Sillowherb	Tamarack, Labrador Tea, Black Spruce, Prickly Rose, Drummond's Willow, Golden Fuzzy Fen Moss
Slender Mannagrass	No data
White Adder's-mouth Orchid	Glow Moss, Black Spruce, Balsam Poplar, Bilberry Willow, Golden Fuzzy Fen Moss
Small-flowered Lousewort	Crowberry, Tamarack, Labrador Tea, Black Spruce, Lingonberry
Meadow Willow	Drummond's Willow, Pacific Willow
Slender Wedgegrass	Bluejoint Reedgrass, Water Sedge, Awned Sedge, Nightshade, Tufted Hairgrass, Common Horsetail, Broadleaf Cattail, Stinging Nettle
Rocky Mountain Willowherb	No data
Ochroleucous Bladderwort	Awned Sedge, Beaked Sedge, Swamp Horsetail, Hemlock Water Parsnip, Bluejoint Reedgrass
Herzogiella turfacea	Bilberry Willow, Labrador Tea, Soft Leaved Sedge, Yellow Star-moss

[A] Associated species for rare plants, as indicators of a wetland habitat type in the LAA taken from Hilton et al, 2013a; rare vascular plant surveyes 2005, 2006, 2008, 2011, 2012 ; MacKenzie & Moran, 2004. Associated species with rare plants were not considered if they were generalists (i.e., as for Iowa Golden-Saxifrage), invasive, if the level of genus was indicated only for associated species during baseline surveys, or if the species was not described in MacKenzie and Moran (2004) as an indicator of wetland habitat type. Note that Slender Mannagrass and Rocky Mountain Willowherb were recorded during surveys outside of the baseline studies, where associated species were not noted.

Function 11: Species Important to Aboriginal land use

Definition: The ability of wetland habitat types to support plant and wildlife species that have a high traditional value to Aboriginal people, including sustenance and medicinal value.

Rationale: Wetland associated species identified as being used for traditional purposes by Aboriginal Groups in TLUS studies completed for the Project (See EIS Volume 2, Sections 13 and 14; BC Hydro, 2013a). Loss of wetland habitat could affect the distribution of the species on the landscape and alter continued use by Aboriginal Groups.

Relevant Site C EIS Datasets:

- 2010, 2011, & 2012 Ungulate Radio-collar Data
- EIS, Volume 2, Sections 13 and 14

Function 12: Species at Risk use

Definition: The likelihood that a wetland habitat demonstrates the appropriate conditions to support a species at risk.

Rationale: Of the species at risk in the LAA whose populations have been identified as endangered, threatened or of special concern, habitat loss and modification is often listed as a threat to population decline. For example, the loss of wetlands has been noted to be a key threat to the Rusty Blackbird's breeding range (Environment Canada, 2016c). Therefore, estimating a value for functional loss given the wetland habitat that is to be affected by construction in the LAA is important to ensuring the functional needs of species at risk are met through mitigation.

Unlike functions for migratory birds, amphibians and bats, which were given multiple categories of use (e.g., breeding, feeding, etc.) within wetland habitats, species at risk were considered as to their habitat use only (i.e., a single function). This is due to the fact that, for some species at risk, limited information is available to make habitat associations at a functional level. For example, for the 'at risk' butterflies considered, insufficient information on feeding (i.e., larval) habitat and its associated plants was available to create a selectivity index for butterfly wetland function - feeding (Table 6; Hilton et al. 2013e). However, for species at risk that were also considered as indicator species for other groups (e.g., Western Toad for amphibians; Common Nighthawk, Rusty Blackbird, Olive-sided Flycatcher, Nelson's Sparrow and Yellow Rail for migratory birds; Northern Myotis and Little Brown Myotis for bats), an average functional use was considered across all functions evaluated (e.g., for Western Toad, an average was taken across the indicator values for amphibian breeding, feeding and hibernation habitat). For those species that were considered as indicators only as part of the species at risk group, species models completed in the EIS were used to make species-habitat associations where available (i.e., seven butterflies, one dragonfly and one owl). A literature review, the results of which were compared to baseline studies in the LAA, was conducted for remaining species (i.e., Surf Scoter, Barn Swallow).

Relevant Site C EIS Datasets:

- 2006, 2008, 2011, & 2012 Breeding Bird Counts
- 2010 & 2012 Common Nighthawk Call Playback Surveys
- 2008, 2011, & 2012 Marsh Bird Call Playback Surveys
- 2010 Swallow Nest Counts
- 2011 & 2012 Swallow Point Counts
- 2012 Migratory Bird Encounter Surveys
- 2006, 2008, 2013, & 2014 Waterfowl Encounter Surveys
- 2006 & 2008 Amphibian Auditory Surveys
- 2006, 2008, & 2012 Amphibian Pond Surveys
- 2005, 2006, 2008, 2009, & 2011 Bat Capture Surveys
- 2005, 2006, & 2008 Bat Detector Surveys
- 2006, 2008, & 2009 Bat Telemetry Studies

Step 4. Determining Total Loss Given Habitat Affected.

An evaluation process has been developed by Native Plant Solutions that considers the three factors described above (i.e., indicator species, wetland habitat functions, and wetland type) to quantify functional loss expected to occur within wetland habitat given the impacts linked with construction activities associated with the Site C project. This evaluation process can also be used in the future to quantify additional function losses associated with indirect effects to wetlands along the transmission line documented during operations. Although the evaluation process is similar for each species group considered (i.e., migratory birds, amphibians, bats, plants, species important to Aboriginal land use and species at risk), there are slight differences between methods for fauna and flora. A step by step process for calculating Total Function Loss Given Habitat Affected is considered below, along with examples, for fauna and flora separately. For each example, a series of screenshots from the Excel files are presented (see Appendix D and Appendix E), in order to aid the reader in following along with the examples. It is recommended that the reader print the screenshots, for reference while reading the examples, to allow for ease of comprehension. Note that the 'habitat values' calculated, as a measure of wetland function, have no units, and are relative values for comparison purposes only.

Fauna ranking protocol for wetland habitat value: Migratory birds, Amphibians, Bats, Species at Risk and Species Important to Aboriginal Land Use

Refer to Excel file 'NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx' as a companion document to the step-by-step ranking protocol below. Screenshots from this spreadsheet are given in Appendix D, to aid the reader in following the examples provided. The Excel file also contains comments to demonstrate each step.

a) *Summarize the number of wetland habitat functions each wetland type provides to indicator species:* This step compiles the indicator species selected, their use of the wetland habitats (see 'Species Habitat Use' tab in Excel file) and the existing wetland habitat functions they provide (e.g., nesting, brood-rearing, feeding, etc.) for each assemblage (e.g., dabbling ducks). See 'Functional Loss per Habitat' tab in Excel file, which provides a summary of the wetland functions important to each species assemblage in each wetland type. By first organizing the applicable information, it can then be incorporated into the evaluation process.

   For example: (see screenshot 1 & 2 in Appendix D) Dabbling ducks (represented by American Wigeon and Green-winged Teal as indicator species) may use wetland types WS, WH, SE, Wf02 and Wf13 for nesting.

b) *Standardize the indicator values for each species assemblage:* Some species use multiple wetland habitat types for one category of use, where as other species are restricted to one habitat type. To consider the difference between species which are specialists, versus generalists, the use of each habitat by an indicator species (or assemblage) is referred to as its indicator value and is standardized to 1. This is considered for each wetland habitat function (refer to Table 7 for full list of wetland habitat functions).

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 3 in Appendix D): Dabbling ducks may use five different wetland habitat types for nesting; therefore, each wetland habitat gets an indicator value of 0.2 (1/5). On the other hand, swans and geese may only use one wetland habitat in the area for nesting; therefore, this wetland habitat gets an indicator value of 1 (1/1).

c) *Indicator values summarized for each wetland type, to calculate Total Relative Preference:* For each wetland habitat function, the indicator values for each species assemblage within a particular wetland type (e.g., SE, TS) are summed to calculate Total Relative Preference. This value summarizes habitat usage expected to occur within each wetland type assuming that all habitats are equally available within the landscape.

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 4 in Appendix D): The Total Relative Preference for Migratory Bird Nesting Habitat in wetland type WS is 1.3, this is a sum of the indicator values for dabbling ducks, forest-nesting shorebirds, deciduous songbirds, coniferous songbirds and aerial insectivores.

d) *Standardize total relative preference across all wetland habitat types:* This standardization is the final step for developing a Manly-Chesson Standardized Selectivity Index and is used to quantify habitat use over multiple habitat types. The Proportional Wetland Type Preference represents the relative expected use of each wetland type if all types are equally available on the landscape. Total Relative Preference is standardized so that selectivity indices remain comparable amongst all wetland habitat functions examined.

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 5 in Appendix D): The Proportional Wetland Type- Preference for Migratory Bird Nesting Habitat in wetland type WS is 0.11. This is the Total Relative Preference for WS (1.3) divided by the sum of the Total Relative Preference values for each wetland type (12).

e) *Calculate baseline wetland area percentages for wetland types occurring within the LAA:* Baseline wetland areas are standardized to 1 by dividing the area of each wetland type by total wetland area. The same standardized baseline wetland areas are used during the evaluation of each wetland habitat function.

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 6 in Appendix D): 363ha of WS occur within the Site C LAA and this is divided by 6092ha of total wetland area to get a Percentage Baseline Area of 0.0595. This means that 6.0% of the baseline wetland habitat within the LAA is classified as WS.

f) *Multiply the Proportional Wetland Type Preference by percentage baseline wetland area to determine Preference Given Habitat Availability:* Expected habitat usage is modified to reflect how much habitat is actually available upon the landscape. Some wetland types may provide valuable wetland functions for indicator species/assemblages but if its availability is limited this diminishes its potential usage. Conversely, some wetland types with low functional value to indicator species may be very common in the LAA and therefore usage would increase. This step takes into account that wetland habitats in the LAA are not equally available and is the product of Percentage Baseline Wetland Area and the Manly-Chesson Standardized Selectivity Index (i.e., Proportional Wetland Type Preference) and scales habitat usage within each wetland type to actual habitat availability existing within the LAA.

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 7 in Appendix D): WS has a proportional wetland type preference for migratory bird nesting habitat of 0.11, and a percentage baseline wetland area within the LAA of 0.0595. The two values are multiplied, which leads to a Preference Given Habitat Availability for WS of approximately 0.0065. Because WS is not a dominant wetland type on the landscape, its potential use as migratory bird nesting habitat decreases in comparison to other wetland types that would experience similar usage if all wetland types were equally available (e.g., WH).

g) *Standardize preference given habitat availability:* This represents the expected relative preference of habitats given the baseline habitat availability and habitat selection indices. Preference given baseline habitat availability is standardized in order to keep values comparable amongst all wetland habitat functions examined.

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 8 in Appendix D): The Preference Given Habitat Availability for WS (0.0065) is divided by the sum of Preference Given Habitat Availability values for all wetland types (0.1390), which results in a Standardized Preference Given Habitat Availability of 0.0464. This means that given the baseline proportion of wetlands existing within the LAA, 4.6% of migratory bird nesting habitat is predicted to occur in WS wetlands.

h) *Calculate Total Loss Given Habitat Affected:* Although some wetland types in the LAA may be common on the landscape, they may represent only a small proportion of what is estimated to be affected on the landscape. Conversely, other wetland types in the LAA may have limited coverage, but represent a larger proportion of what is estimated to be affected by the project. The importance of a wetland type for a specific habitat function is adjusted based on the wetland area that is expected to be affected by construction activities. This is the product of value of services (i.e., standardized preference given habitat availability) and area affected (i.e., Construction), which are the two primary components of a Habitat Equivalency Analysis. Total Loss Given Habitat Affected is calculated separately based on wetland area affected by construction. Total Loss values are summed across each wetland type and this directly relates to Total Gain Given Habitat Restored (see step i). The overall goal is to achieve a balance between the two (i.e., Total Loss values = Total Gain values)

For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 9 in Appendix D): WS has a Standardized Preference Given Habitat Availability of 0.0464 for migratory bird nesting habitat, and a total of 50ha of WS will be affected by construction activities. This leads to a Total Loss Given Habitat Affected of 2.32 for migratory bird nesting habitat in WS.

i) *Calculate Total Gain Given Habitat Restored:* Wetland function is applied to Total Gain Given Habitat Restored using the same principles for calculating Total Loss. Total Gain is calculated by multiplying amount and type of wetland habitat being restored by value of services. Total Gain values are summed across each wetland type and this directly relates to Total Loss Given Habitat Affected (see step h). The overall goal is to achieve a balance between the two (i.e., Total Loss values = Total Gain values).

Hypothetical example (see screenshot 10): If 100ha of WS wetlands were restored, this is multiplied by the Standardized Preference Given Habitat Availability to calculate a Total Gain Given Habitat Restored value of 4.64 for WS. If 100ha of WS, 100ha of SE and 100ha of BT were restored to compensate for habitat lost during construction you are nearly half way to meeting your mitigation goals for migratory bird nesting habitat (i.e., Total Gain Given Habitat Restored = 73.90, which is approximately half of Total Loss Given Habitat Affected = 152.79).

Flora ranking protocol for wetland habitat value: Rare Plant Species

Refer to Excel file 'NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx' as a companion document to the step-by-step function assessment protocol below. Screenshots from this spreadsheet are given in Appendix E, to aid the reader in following the examples provided. The Excel file also contains comments to demonstrate each step.

a) *Summarize the wetland type associations with rare plants by both primary and secondary habitat associations:* Rare plants are associated to wetland habitat types based on their presence or absence in a wetland type. Their associations to wetland types were considered based on recorded observations in the LAA (i.e., primary habitat associations), or based on associated species they were observed with in the field (i.e., secondary habitat associations). Habitat values are first ranked based on primary or secondary wetland habitat associations with particular wetland types. In the case of secondary habitat associations, wetland classification according to MacKenzie and Moran (2004) is then averaged where there may be more than one descriptor for a wetland type in the LAA (e.g., Fl01, Fl03 and Fl05 secondary habitat associations are averaged, to provide a value for WH).

   For example (for primary habitat associations; see 'Species associated habitats' tab and 'Primary habitat use' tab in Excel file and screenshot 11 in Appendix E): Hudson Bay Sedge was observed in TS, during baseline rare plant surveys in the LAA.

   For example (for secondary habitat associations; see 'Species associated habitats' tab and 'Secondary habitat use' tab in Excel file and screenshots 12-14 in Appendix E): Slender Wedgegrass was observed three times in the LAA. Eight plant species were observed with Slender Wedgegrass and were selected as associated species to help better indicate what their wetland habitat preference is in the LAA. The percent occurrence of the associated species with the rare plant in the field was multiplied by the likelihood of the associated species to occur in a certain wetland type (according to MacKenzie and Moran, 2004).

   - For example (screenshot 12, Appendix E), Bluejoint Reedgrass occurred with Slender Wedgegrass in 1 out of 3 observations in the field (1/3 = 33%) and has an 80% chance of being associated with Fl05, a WH wetland habitat (MacKenzie and Moran, 2004). Therefore the likelihood that Slender Wedgegrass would occur adjacent to Bluejoint Reedgrass in a WH wetland habitat is 0.33*0.80 = 0.26. These values are averaged across all associated species with Slender Wedgegrass to provide a secondary habitat use value for Fl05 (e.g., for Slender Wedgegrass, three of the eight associated species were indicators of Fl05, and these values were averaged to provide a secondary habitat value for Fl05 of 0.04 [0.26 + 0.05 + 0.05/8=0.05]; see 'Species Associated Habitats' tab in Excel file).
   - Screenshot 13 & 14, Appendix E: Wetland classification according to MacKenzie and Moran (2004) is then averaged where there may be more than one descriptor for a wetland type in the LAA. For example, Fl01, Fl03 and Fl05 secondary habitat associations are averaged ([0.02+0.01+0.05]/3, to provide an indicator value for WH for Slender Wedgegrass = 0.03). Note that this calculation is hidden in the Excel file (see 'Species Associated Habitats' tab and 'Secondary habitat use' tab in Excel file).

b) *Standardize the indicator values for each rare species:* Some species use multiple wetland habitat types, whereas other species are restricted to one habitat type. To consider the difference between species that are specialists, versus generalists, the importance of each habitat to a rare plant species is referred to as an indicator value and is standardized to 1. The same process applies to the calculation of wetland function loss using both primary habitat and secondary habitat associations.

For example (for primary habitat associations; see 'Primary habitat use' tab and 'Primary habitat rank' tab in Excel file and screenshots 15 & 16 in Appendix E): based on primary habitat data collected in the LAA, Small-flowered Lousewort was found in TS and BT (screenshot 15); therefore each habitat gets an indicator value of 0.5 (1/2; screenshot 16).

For example (for secondary habitat associations; see 'Secondary habitat use' tab and 'Secondary habitat rank' tab in Excel file and screenshots 17 & 18 in Appendix E): Based on secondary habitat data, Small-flowered Lousewort was associated with TS and BT, with a total secondary indicator value of 0.6183 (screenshot 17). Therefore, to standardize to 1, TS as an example, gets a standardized indicator value of 0.1833/0.6183 = 0.2965 (see screenshots 17 & 18).

c) *Indicator values summarized for each wetland type, to calculate Total Relative Preference:* The indicator values for each rare species occurring within a particular wetland type (e.g., SE, TS) are summed to calculate Total Relative Preference. This value summarizes habitat preference for rare plants, assuming that all habitats are equally available within the landscape. The same process applies to the calculation of wetland function loss using both primary habitat and secondary habitat associations.

For example (see 'Primary habitat rank' tab in Excel file and screenshot 19 in Appendix E): the total relative preference for TS is 3.5, which is the sum of indicator values for Hudson Bay Sedge, Hall's Willowherb, Small-flowered Lousewort and *Herzogiella turfacea*.

d) *Standardize Total Relative Preference across all wetland types:* This standardization is the final step for developing a Manly-Chesson Standardized Selectivity Index (i.e., Proportional wetland type preference) and is used to quantify rare species occurrence over multiple habitat types. Proportional Wetland Type Preference represents the relative expected occurrence of rare plant species within each wetland type if all types are equally available in the landscape. Total Relative Preference is standardized so that selectivity indices remain comparable amongst all wetland habitat functions examined. The same process applies to the calculation of wetland function loss using both primary habitat and secondary habitat associations.

For example (see 'Primary habitat rank' tab in Excel file and screenshot 20 in Appendix E): The Proportional Wetland Type Preference for rare plant primary habitat associations in wetland type TS is 0.438. This is the Total Relative Preference for TS (3.5) divided by the sum of the Total Relative Preference values for each wetland type (8). This means that if habitats were equally available on the landscape, 43.8% of rare plant primary habitat associations are predicted to occur in TS wetlands (does not include upland habitats).

e) *Calculate baseline wetland area percentages for wetland types occurring within the LAA:* Baseline wetland areas are standardized to 1 by dividing the area of each wetland type by total wetland area. The same standardized baseline wetland areas are used during the evaluation of each wetland habitat function. The same process applies to calculating wetland function loss using both primary habitat and secondary habitat associations.

   For example (see 'Primary habitat rank' tab in Excel file and screenshot 21 in Appendix E): 1406ha of TS occur within the Site C LAA and is divided by 6092ha of total wetland area to get a Percentage Baseline Wetland Area of 0.2308. This means that 23.1% of the baseline wetland habitat within the LAA is classified as TS.

f) *Multiply the Proportional Wetland Type Preference by percentage baseline wetland area to determine Preference Given Baseline Habitat Availability:* Expected habitat preference is modified to reflect how much habitat is actually available upon the landscape. Some wetland types may provide valuable habitat for rare plants but if its availability is limited this diminishes its potential occurrence. Conversely, some wetland types with low functional value to rare plants may be very common in the LAA and therefore likelihood of occurrence would increase. This step takes into account that wetland habitats in the LAA are not equally available and is the product of Percentage Baseline Wetland Area and the Manly-Chesson Standardized Selectivity Index (i.e., Proportional Wetland Type Preference) and scales rare species occurrence within each wetland type to actual habitat availability existing within the LAA. The same process applies to the calculation of wetland function loss using both primary habitat and secondary habitat associations.

   For example (see 'Primary habitat rank' tab in Excel file and screenshot 22 in Appendix E): TS has a Proportional Wetland Type Preference for primary habitat of 0.438, and a Percentage Baseline Wetland Area of 0.2308. This leads to a Preference Given Baseline Availability of approximately 0.1010.

g) *Standardize preference given baseline habitat availability:* This represents the expected occurrence of rare plants given the baseline habitat availability and habitat selection indices. Preference given baseline habitat availability is standardized in order to keep values comparable amongst all wetland habitat functions examined. The same process applies to the calculation of wetland function loss using both primary habitat and secondary habitat associations.

   For example (see 'Primary habitat rank' tab in Excel file and screenshot 23 in Appendix E): The Preference Given Habitat Availability for TS (0.1010) is divided by the sum of Preference Given Habitat Availability values for all wetland types (0.2088), which results in a Standardized Preference Given Habitat Availability of 0.4836. This means that given the baseline proportion of wetlands existing within the LAA, 48.4% of rare plant primary habitat associations are predicted to occur in TS wetlands.

h) *Average Primary and Secondary Standardized Preferences Given Baseline Habitat Availability:* Although wetland habitat value for rare plants can be explored based on primary habitat associations (i.e., based on field observations) or secondary habitat associations (i.e., based on associated species), Average Standardized Preference Given Baseline Habitat Availability is calculated to summarize rare plant occurrence within the LAA, as both provide a representation of the same function – presence.

For example (see 'Summary habitat rank' tab in Excel file and screenshots 24 in Appendix E): For rare plants, the Primary Standardized Preference Given Habitat Availability for TS is 0.4836 and the Secondary Standardized Preference Given Habitat Availability is 0.2577. These two values are averaged to obtain the Average Standardized Preference Given Habitat Availability, which is 0.3707 for TS ([0.4836 +.0.2577]/2 = 0.3707).

i) *Calculate Total Loss Given Habitat Affected:* Although some wetland types in the LAA may be common on the landscape, they may represent only a small proportion of what is estimated to be affected on the landscape. Conversely, other wetland types in the LAA may have limited coverage, but represent a larger proportion of what is estimated to be affected by the project. The importance of a wetland type for a specific habitat function is adjusted based on the wetland area that is expected to be affected by construction activities. This is the product of value of services (i.e., standardized preference given habitat availability) and area affected (i.e., Construction), which are the two primary components of a Habitat Equivalency Analysis. Total Loss Given Habitat Affected is calculated separately based on wetland area affected by construction. Total Loss values are summed across each wetland type and this directly relates to Total Gain Given Habitat Restored (see step j). The overall goal is to achieve a balance between the two (i.e., Total Loss values = Total Gain values)

For example (see 'Summary habitat rank' tab in Excel file and screenshot 25 in Appendix E): TS has an Average Standardized Density Given Habitat Availability of 0.3707, and a total area of 68ha of area to be affected by construction. This leads to a Total Loss Given Habitat Affected – Construction value for TS of approximately 25.20 for rare plants.

j) *Calculate Total Gain Given Habitat Restored:* Wetland function is applied to Total Gain Given Habitat Restored using the same principles for calculating Total Loss. Total Gain is calculated by multiplying amount and type of wetland habitat being restored by value of services. Total Gain values are summed across each wetland type and this directly relates to Total Loss Given Habitat Affected (see step i). The overall goal is to achieve a balance between the two (i.e., Total Loss values = Total Gain values)

Hypothetical example (see screenshot 26): If 100ha of TS wetlands are restored, this is multiplied by the Average Standardized Preference Given Habitat Availability to calculate a Total Gain Given Habitat Restored value of 37.06 for TS. If 100ha of SE, 100ha of TS and 50ha of BT are restored to compensate for habitat lost during construction you are approximately half way to meeting your mitigation goals for rare plant habitat (i.e., Total Gain Given Habitat Restored = 66.08, which is approximately half of Total Loss Given Habitat Affected = 120.147).

Model assumptions and sensitivity analysis

In the case of the above ranking process for fauna species, a number of assumptions are made to obtain an overall wetland habitat value:

1. The ranking process assumes that habitats where indicator species are found are equally preferred. For example, for nesting dabbling ducks, the process assumes that they would equally use WS, WH, SE, Wf02 or Wf13.
2. The ranking process assumes that species assemblages are equally valuable, in terms of mitigation for loss. For example, dabbling ducks are equally as valuable as cavity nesters.
3. Relative usages of wetland habitats are consistent with the amount of habitat in the LAA, area affected, or area restored. For example, given equal habitat availability, migratory nesting birds would use SE at a rate three times the use of Wf02 (0.39 vs. 0.13) whether the area under consideration is 100ha or 1000ha.
4. Habitat quality and fragmentation of individual patches does not significantly impact usage rates.

For the above ranking process for flora species, similar assumptions are made to obtain an overall habitat value:

1. For primary habitat ranking, the ranking process assumes that habitats with a rare plant species have an equal probability of having that plant present. For example, for Small-flowered Lousewort, the process assumes it equally prefers TS and BT.
2. The ranking process assumes that rare plant species are equally valuable in terms of what is to be mitigated for wetland loss. For example, Hudson Bay Sedge is equally as valuable as Hall's Willowherb.
3. For primary habitat ranking, the ranking process assumes that equal sampling effort was conducted across all wetland habitat types during baseline rare plant species surveys.

While acknowledging the limitations associated with model assumptions, its ability to provide information on wetland function at a species-specific level across a variety of wetland types makes it a useful tool for estimating wetland area and functional loss supporting migratory birds, species at risk and species important to Aboriginal land use. In order to test the uncertainty in the model based on the assumptions made, a sensitivity analysis was completed.

Statistical simulations were used to examine the sensitivity of calculated losses to changes in the preferences for habitats where indicator species are found. In the absence of good quality estimates of species usages or densities across habitats of interest, initial estimates considered habitats to be equally preferred by indicator species (i.e., model assumption #1 for both fauna and flora). For example, for nesting dabbling ducks, it was initially assumed that they would equally use WS, WH, SE, Wf02, and Wf13 where they are equally available.

The following process was used to "perturb" the preference for one habitat at a time and then re-allocate preference equally among the remaining habitats. Perturbations of +/-20% and +/-50% were used on habitat preferences. If no habitats or only one was used, no perturbation was conducted.

<u>Step 1:</u> At a function and species or species-group level, randomly select one of the k used habitats.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): for nesting dabbling ducks, randomly select one of WS, WH, SE, Wf02, and Wf13.

<u>Step 2:</u> Perturb preference for the selected habitat by adding or subtracting a fixed percentage.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): Say we selected WH in step 1. If its preference is perturbed by increasing it by 20%, then preference for WH becomes = 1.2*(1/5) = 0.24. Preference for each of the remaining habitats (WS, WH, SE, Wf02, and Wf13) becomes = (1 – 0.24) / 4 = 0.19.

<u>Step 3:</u> For each species or assemblage, repeat steps 1 and 2.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): Perturb preference of one habitat for each of Diving Ducks, Cavity-Nesting Ducks, Swans & Geese, Waterbirds, Terns & Gulls, Forest-nesting Shorebirds, Marsh-nesting Shorebirds, Rails, Open Habitat Songbirds, Deciduous Songbirds, Coniferous Songbirds, Aerial Insectivores.

<u>Step 4:</u> Proceed to calculate total loss by habitat and across habitats for each species-group and function.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): For nesting dabbling ducks, compute loss attributed to each of the habitats (OW, WS, WH, SE, TS, Wf02, Wf13, BT). Sum across habitats to calculate total loss for nesting dabbling ducks.

<u>Step 5:</u> Repeat steps 1-4 a large number of times, say 1000.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): There will then be 1000 estimates of habitat-specific and total losses for nesting dabbling ducks as preference for a habitat is perturbed by 20%.

<u>Step 6:</u> Compute 2.5th and 97.5th percentiles of the 1000 estimates to obtain a probable range of total loss values, given up to x% change in habitat preference.

For example (see 'Migratory Birds Nesting' tab in Excel file <u>NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx</u>): For migratory bird nesting habitat, we estimated a loss value of 50.6 in WH habitat. If a preference is varied by up to 20%, we would expect loss to fall somewhere in the range of (44.2, 56.7). Totalled across all habitats, we would estimate a total loss of 152.8. If a preference is varied by up to 20%, we would expect total loss to fall somewhere in the range of (147.7, 157.6).

For flora, preferences for primary habitat rankings were perturbed as described above. For secondary habitat rankings, preference for a single habitat was perturbed and then all habitat preferences were rescaled to add to one. However, secondary habitat rankings were based on secondary habitat data and therefore did not assume equal use of a habitat across all wetland types for a particular species. Therefore, the calculations to rescale to add to one differ from fauna, as in Step #2 above. Preference for any particular habitat was restricted to a maximum of 1.

> For example (see 'Secondary habitat rank' tab in Excel file NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx): Say we selected TS to perturb for preference of Hudson Bay Sedge. If its preference is perturbed by increasing it by 20%, then raw preference for TS becomes = 1.2*(0.4068768) = 0.48825216. Rescaling so that all relative habitat preferences sum to 1, we obtain TS preference = 0.48825216 / (0.48825216 + 0.051576 + 0.5415473) = 0.4515; Wf13 preference = 0.051576 / (0.48825216 + 0.051576 + 0.5415473) = 0.0477; BT preference = 0.5415473 / (0.48825216 + 0.051576 + 0.5415473) = 0.5008.

The 95% confidence intervals for 20% and 50% perturbations for each functional group are presented in Tables E1- E12 in Appendix F. To provide a range of 'Total Loss Given Habitat Affected – Construction', and therefore a range in restored wetland area to compensate for functional loss to migratory birds, species at risk and species important to Aboriginal land use, the 95% confidence intervals for a 50% perturbation have been included in all model spreadsheets. This addition helps to compensate for the uncertainty in the model associated with assumption #1 for flora and fauna, as well as provide compensation for the estimate of indirect effects on wetland area (e.g., sensory disturbance, downstream effects) to wetland function and time delays related to the mitigation process.

Step 5. Collecting Baseline Data on the Biogeochemical, Hydrological and Ecological Functioning of the Project Area Wetlands.

In order to provide field verification of the wetland types in the LAA, a wetland monitoring program for wetlands and their associated riparian habitat in the area affected by the Designated Project was conducted in August 2016. This monitoring program will record information on the biogeochemical, hydrological and ecological characteristics of the eight wetland types that support the functions for migratory birds, species at risk and the species important to Aboriginal land use. Baseline data on wetlands in the area affected by the Designated Project, collected through field sampling, ground truthing and GIS assessment of wetland attributes, will then be used to inform the Wetland Mitigation and Compensation Plan, so that characteristics of wetland types lost can be represented by wetland types restored. In addition, field data collected is to be used to develop wetland buffer requirements, as per the recommendations in the Forest and Range Practices Act (Forest Planning and Practices Regulation, SBC 2002).

Field sampling and ground truthing was conducted on 20% of the number of wetlands of each wetland type that falls within the area to be affected. For wetlands that were noted to require further ground truthing following mapping, all wetlands were verified as to their type, in addition to the 20% requiring detailed field sampling. Wetlands were classified using the methods in MacKenzie and Moran (2004) and guided by Resources Inventory Standards Committee methods for terrestrial ecosystem mapping (RISC 1998).

Baseline data collected during the field sampling include: wetland type; substrate type; size of the wetland (i.e., verification of imagery); water depth; organic substrate depth; current wetland status (i.e., has the wetland been impacted?); area of wetland to be lost; wetland hydrological function (i.e., inlet location, outlet location and requirements to maintain hydrological functioning of wetland); wetland complex description (i.e., is the wetland isolated or connected to other wetlands, and if so what types); cover type description (i.e., percent cover of vegetation, soil and water); mesoslope position; description of surrounding landscape (e.g., adjacent habitat types, general list of plant species) and identification of the wetland vegetation present.

In addition to field verification, additional wetland features will be assessed via high-resolution imagery (i.e., 50cm resolution). Wetland attributes for each type to be collected via high-resolution imagery include: wetland size; shoreline complexity and length; distance to nearest wetland/waterway neighbour; connectivity to other wetland types; extent/description of surrounding upland habitat (i.e., extent/width of buffer, type with description to within 500m of edge including any existing disturbances); and depth of wetland vegetation bands. Wetland attribute assessment via high-resolution imagery is to be conducted on all wetlands in the affected area of the Designated Project.

Summary

Overall, this process assessed 62 indicator species, and their categories of use (e.g., nesting, brood-rearing, feeding and migration) in wetland habitats in order to evaluate the functional importance of wetland habitat in the LAA for migratory birds, species at risk, amphibians, bats, and species important to Aboriginal land use (Figure 4). An estimated 763ha of wetland area will be lost or affected by construction. As the assessment process outlines above, functional importance for wetland habitat to be affected for these 62 species can be identified using a scientifically based process for estimating and evaluating wetland function.

Table 10 summarizes the results of the wetland function assessment process. Note that the total loss values for wetland function should only be compared within species indicator groups (i.e., migratory birds, amphibians, bats and rare plants), rather than across groups, as the habitat values for wetland function are relative. The greatest functional loss of migratory bird habitat functions was calculated to occur in sedge wetlands (SE) affected during construction. Willow-Horsetail-Sedge riparian wetlands (WH) affected during construction also contributed to functional loss for all migratory bird functions, except brood-rearing. Functional loss to migratory bird brood-rearing habitat will occur primarily in SE wetland types.

The greatest functional loss of amphibian breeding habitat as a result of construction activities was found to occur within SE wetlands. Construction activities also impacted WH, Labrador Tea-Sphagnum (BT), and Tamarack-Sedge (TS) wetlands for amphibian breeding. Amphibian feeding function loss in wetlands affected by construction activities was the most prevalent in WH, followed by BT, SE, and TS. Feeding function loss associated with construction activities will have the most impact on WH wetlands, followed by BT, and SE wetlands. Function loss associated with amphibian wintering habitat that will be impacted by construction activities will be the greatest in WH wetland types, as well as Willow Sedge wetlands (WS).

The functional loss of bat feeding habitat as a result of constructions activities will be the greatest in WH wetlands, followed by BT, TS, and SE wetlands. Bat roosting habitat will be affected the greatest by construction activities in WH wetlands, followed by BT, TS, and WS wetland types.

Wetland function loss caused by construction activities regarding their ability to support rare plant species was calculated to be the greatest in WH, followed by BT, TS, and SE.

Functional loss associated with species important to Aboriginal land use and as a result of construction activities will be the greatest in WH and BT wetland types.

Finally, functional loss for species at risk, as a results of construction activities, was calculated to be the greatest for WH habitat, followed by SE, BT and TS.

The results from this process will be used to inform implementation of the wetland mitigation compensation program and can be used to guide field-level wetland and species monitoring programs.

Table 10. Summary of Total Loss Given Habitat Affected values for construction and representing wetland functions for migratory birds, species at risk, amphibians, bats, and species important to Aboriginal land use.

	Wetland habitat type								
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
	Migratory Bird Nesting Habitat								
Construction	0	2.32	50.6	77.32	8.78	0	0.00124	13.77	152.79
	Migratory Bird Brood-rearing Habitat								
Construction	2.72	0	0	118.01	0	0	0.00427	0	120.73
	Migratory Bird Feeding Habitat								
Construction	1.05	2.4	52.29	84.01	4.47	0	0.00143	8.91	153.13
	Migratory Bird Migration Habitat								
Construction	1.76	3.43	74.76	51.53	7.46	0	0.00186	14.88	153.83
	Amphibian Breeding Habitat								
Construction	0.45	2.12	46.1	58.04	11.14	0	0.00105	22.23	140.08
	Amphibian Feeding Habitat								
Construction	0	3.02	65.74	27.59	15.89	0	0	31.7	143.93
	Amphibian Wintering Habitat								
Construction	0.88	12.54	273.34	0	0	0	0	0	286.77
	Bat Feeding Habitat								
Construction	0.13	2.42	52.7	16.59	19.11	0	0.0009	38.12	129.07
	Bat Roosting Habitat								
Construction	0	7.19	156.69	0	12.62	0	0	25.19	201.69
	Rare Plant Habitat								
Construction	0.00	0.61	43.67	10.68	25.20	0.00	0.00	39.97	120.15
	Habitat for Species Important to Aboriginal Land Use								
Construction	0	2.86	62.38	9.82	14.14	0	0.00053	47.01	136.21
	Species at Risk Habitat								
Construction	0.10	1.10	83.63	38.35	15.12	0.00	0.00	24.64	162.94

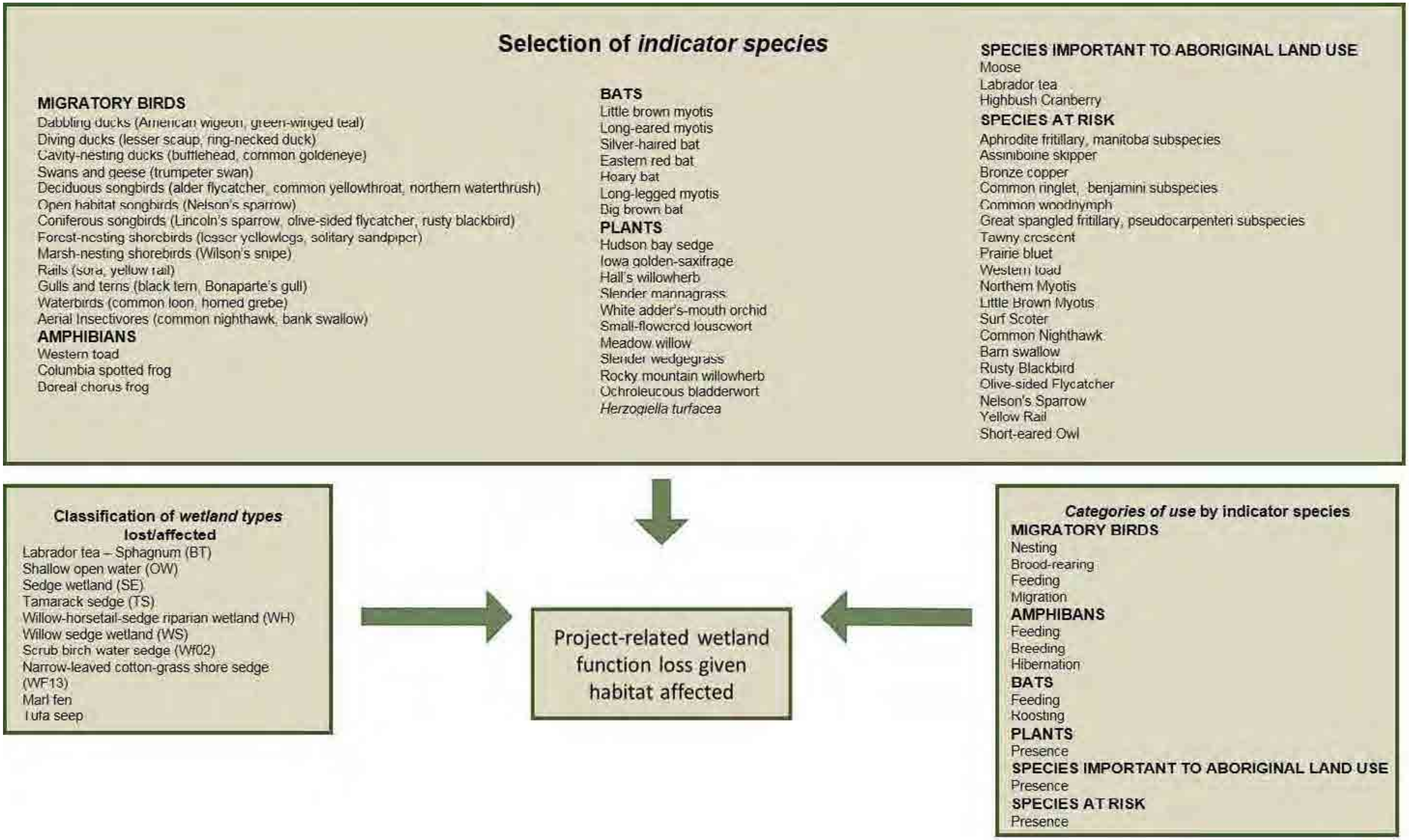


Figure 4. Components of the wetland function assessment process for the BC Hydro Site C Clean Energy Project.

Record keeping

Table 11. Record keeping detail, as per federal condition 18. For data sources utilized, see Appendix A and Hilton et al. 2013a, b, c.

Sampling Location	N/A
Date of Sampling	N/A
Time of sampling	N/A
Name of sampler(s)	N/A
Analyses Performed	Wetland function assessment: literature review and analysis
Date of analyses	October 2014 to December 2016
Person(s) who collected sample(s)	N/A
Person(s) who conducted analysis	Native Plant Solutions/Ducks Unlimited Canada (Lisette Ross, Phil Rose, Jade Raizenne, Lynn Dupuis)

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Appendix A: BC Hydro Site C Baseline Data Investigated

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1.1 Ecosystem Mapping

1.1.2 Results

1.1.2.1 Habitats within the LAA

1.2 At-risk and Sensitive Ecological Communities

1.2.2 Results

1.2.2.3 Wetland Function

Appendix A Terrestrial Ecosystem Mapping Expanded Legend

Appendix G Rare Plant Species Accounts

G.6 *Carex heleonastes* (Hudson Bay sedge)

G.12 *Chrysosplenium iowense* (Iowa golden-saxifrage)

G.16 *Epilobium halleanum* (Hall's willowherb)

G.17 *Epilobium saximontanum* (Rocky Mountain willowherb)

G.19 *Glyceria pulchella* (slender mannagrass)

G.24 *Malaxis brachypoda* (white adder's-mouth orchid)

G.27 *Pedicularis parviflora* ssp. *parviflora* (small-flowered lousewort)

G.32 *Salix petiolaris* (meadow willow)

G. 37 *Sphenopholis intermedia* (slender wedgegrass)

G.38 *Symphotrichum puniceum* var. *puniceum* (purple-stemmed aster)

G.40 *Utricularia ochroleuca* (ochroleucous bladderwort)

Hilton, S., Andrusiak, L, Simpson, L., and Sarell, M. 2013. Part 3 Amphibians and Reptiles. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC

1.1 Amphibians

1.1.3 Field Survey Results

1.1.3.1 Pond Breeding Surveys

1.1.3.2 Auditory Surveys

A.1 Species – Habitat Model for Western Toad

Hilton, S., Simpson, L., Andrusiak, L., and Albrecht, C. 2013. Part 4 Migratory Birds. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

1.1 Songbirds

1.1.3 Field Survey Results

1.1.3.1 Breeding Bird Surveys

1.1.3.2 Seasonal Habitat Analysis: Breeding

1.1.3.3 Seasonal Habitat Analysis: Migration

1.2 Swallows

1.2.3 Field Survey Results

1.2.3.1 Point-count Surveys

1.3 Waterfowl

1.3.3 Field Survey Results

1.3.3.3 2013 Aerial Surveys

1.4 Marsh Birds

1.4.3 Field Survey Results

1.4.3.1 Habitat Suitability

1.6 Common Nighthawk

1.6.3 Field Survey Results

A.6 Species Model: Rusty Blackbird

A.7 Songbird species counts during point-counts

A.8 Songbird species counts during migration surveys: 2012

B.1 Waterfowl Detections

C.2 Species Model: Nelson's Sparrow

C.3 Species Model: Yellow Rail

E.1 Species Model: Common Nighthawk

Simpson, K., Simpson, T.K., Simpson, L., Andrusiak, L., Hilton, S., Kellner, M., Klafki, K., Mattson, I., and Creagh, A. 2013. Part 7 Mammals. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver BC.

1.1 Bats

1.1.3 Results

1.1.3.1 Bat Capture

1.1.3.2 Radio-telemetry

1.1.3.3 Acoustic Sampling

1.4 Ungulates

1.4.3 Results

1.4.3.1 Radio-collaring

1.4.3.3 Birthing Site Investigations

1.4.3.8 Moose

A.1 Species – Habitat Model for Bats

C.1 Summary of Ungulates, Pregnancy Status, and Relocations

C.3 Resource Selection Function Models

Hilton, S., L. Simpson, and C. Guppy. 2013. Part 2 Butterflies and Dragonflies. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

1.1 Dragonflies

1.1.1 Species

1.1.2 Field Survey Methods

1.1.3 Field Survey Results

1.2 Butterflies

1.2.1 Species

1.2.2 Field Survey Methods

1.2.3 Field Survey Results

A.2 Species Model: Aphrodite Fritillary (*manitoba* subspecies)

A.5 Species Model: Assiniboine Skipper

A.6 Species Model: Bronze Copper

A.7 Species Model: Common Ringlet (*benjamini* subspecies)

A.8 Species Model: Common Woodnymph (*nephele* subspecies)

A.10 Species Model: Great Spangled Fritillary (*pseudocarpenteri* subspecies)

A.13 Species Model: Tawny Crescent

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

1.2 Broad-winged Hawk

1.2.1 Species

1.2.2 Field Survey Methods

1.2.3 Field Survey Results

1.5 Owls

1.5.1 Species

1.5.2 Field Survey Methods

1.5.3 Field Survey Results

A.1 Species Habitat Model: Broad-winged Hawk

D.5 Species Habitat Model: Short-eared Owl

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Appendix B: Sources used to identify individual species' habitat preferences

Migratory Birds

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Appendix C: Evaluation of existing datasets and their ability to inform the Wetland Function Assessment

Dataset	Years Available	Description	Applicable to Wetland Function Assessment	Rationale	Limitations[1]
Amphibian_AuditorySurveys_2006_2008	2006 2008	Record of breeding adults calling from point count locations	Yes	Provides data on the diversity, relative abundance, and frequency of breeding amphibian species and the habitats they were detected in (i.e. habitat can be determined by overlaying UTM coordinates with mapping data)	a
Amphibian_PondSurveys_2006_2008_2012	2006 2008 2012	Record of amphibian life stages (eggs, tadpoles, juveniles, adults) observed at wetlands surveyed	Partial	Provides data on the diversity, relative abundance, life stage, and frequency of amphibian species and the habitats they were detected in (i.e. habitats could be determined by overlaying transects with mapping data)	b
Amphibian_RoadSurveys_2006_2008	2006 2008	Record of migrating amphibians encountered along roadway transects	No	Provides data on amphibian (specifically western toad) movements throughout the study area following metamorphosis, but does not provide any applicable habitat use data	
Bat_Capture_2005_2006_2008_2009_2011	2005 2006 2008 2009 2011	Record of bats captured during mist net sampling	Yes	Provides data on the diversity, relative abundance, gender, age class, reproductive stage, and site series code at bat capture sites (site series should be verified with map data)	e
Bat_Telemetry_2006_2008_2009	2006 2008 2009	Record of roost sites used by bats fitted with radio transmitters	Yes	Provides data on the specific roosts used by individual bats and the site series codes they were occurred in (site series should be verified with map data)	e

Dataset	Years Available	Description	Applicable to Wetland Function Assessment	Rationale	Limitations[1]
Bat_DetectorSurvey_2005_2006_2008	2005 2006 2008	Record of bat activity and the species groups using an area (i.e., Myotis, Big Bat, Hoary Bat)	No	Provides a measure of bat activity within a habitat type and provides site series code (site series should be verified with map data), but no measure of abundance (1 bat travelling through an area 4 times is recorded the same as 4 bats travelling through once)	c
Breeding_Bird_Point_Count_2006_2008 & Breeding_Bird_Point_Count_2011_2012	2006 2008 2011 2012	Record of breeding bird species detected at point count locations	Yes	Provides data on the diversity, relative abundance, and frequency of breeding bird species and the habitats they were detected in (i.e. habitat can be determined by overlaying UTM coordinates with mapping data)	a
Migratory_Encounter_2012	2012	Record of birds present during the fall migration period	Partial	Provides data on the diversity, relative abundance, and frequency of bird species during migration and the habitats they were detected in (i.e. habitats could be determined by overlaying transects with mapping data)	b
Waterfowl_Encounter_2006_2008 & 'Keystone waterfowl 2013 2014 data combined"	2006 2008 2013 2014	Record of waterfowl species detected during spring and fall migration and the breeding season	No	Provides data on the diversity and relative abundance of waterfowl species during migration and transect segments they were detected in (i.e. habitats could be determined by overlaying transects with mapping data). 2006 & 2008 data stratified into: River, Backchannel, Wetland, and Lake	b, d

Dataset	Years Available	Description	Applicable to Wetland Function Assessment	Rationale	Limitations[1]
CONI_Call_Playback_2010_2012	2010 2012	Record of common nighthawks detected at call playback locations	Yes	Provides data on the relative abundance, and frequency of common nighthawks and the habitats they were detected in (i.e. habitat can be determined by overlaying UTM coordinates with mapping data)	a
MarshBirds_Call_Playback_2008_2011_2012	2008 2011 2012	Record of marsh bird species detected at call playback locations	Yes	Provides data on the relative abundance, and frequency of marsh bird species and the habitats they were detected in (i.e. habitat can be determined by overlaying UTM coordinates with mapping data)	a
Swallow_NestCounts_2010	2010	Record of swallow nests detected along the Peace River	No	Provides data on the location of swallow nesting sites, but nests of targeted species restricted to habitat features associated with manmade structures or cliffs and banks along riparian areas and are not found in wetland habitats	d
Swallow_PointCount_2011_2012	2011 2012	Record of swallow detections at point count locations along the Peace River	Partial	Provides data on the relative abundance, and frequency of swallow species and the habitats they were detected in (i.e. habitat can be determined by overlaying UTM coordinates with mapping data)	a, d

[1] Limitations

a - habitats correspond to the ecosystem at the center of the point count station and may not represent the habitat in which the species was present (e.g., a bird survey station occurs in SE habitat and a bird is detected 100 m to the west of the station, but 100 m to the west could be a different habitat type)

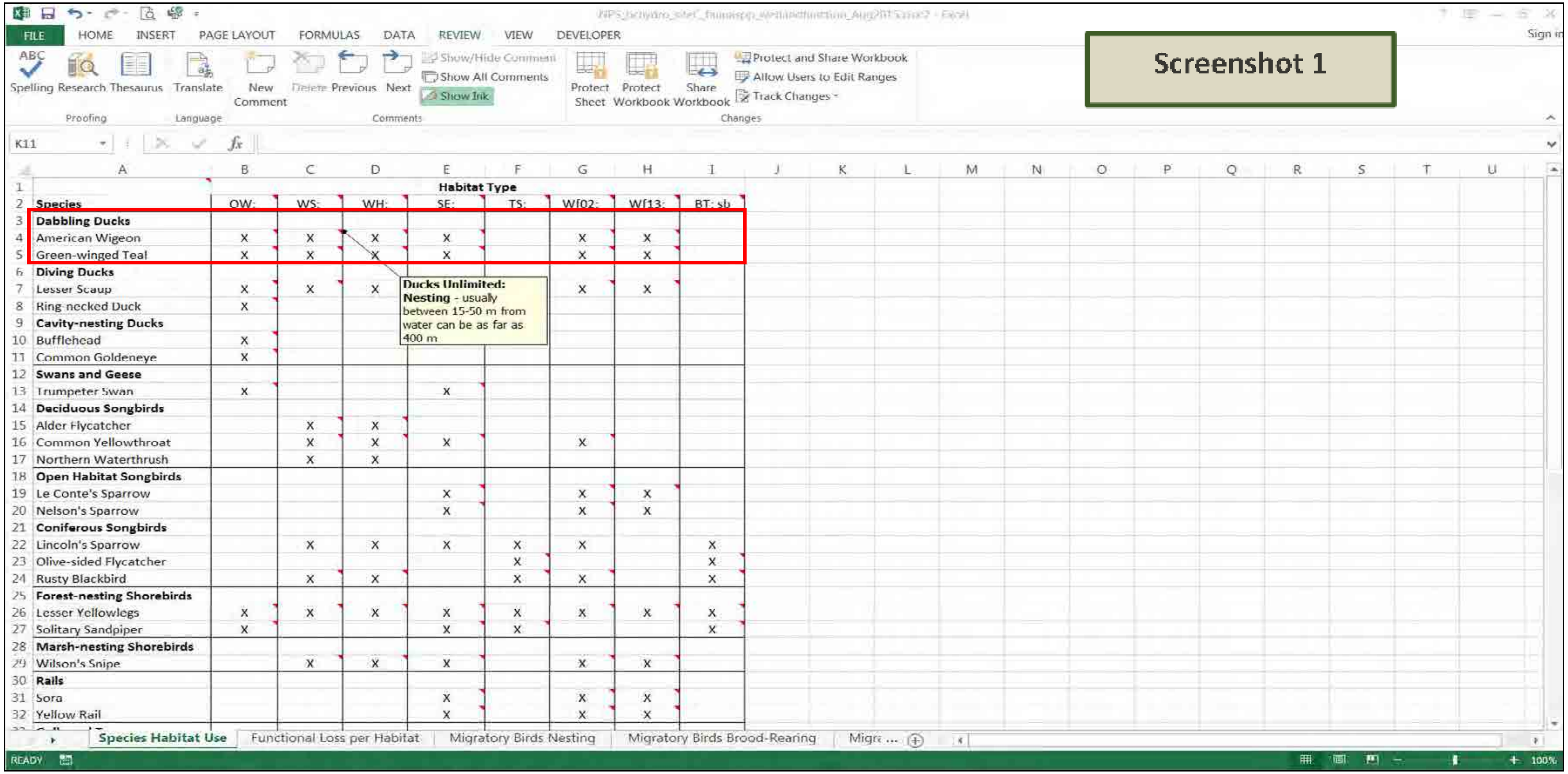
b – because most detections were made along transect surveys it makes it difficult to distinguish the actual habitat type the detection occurred in if transect routes passed through multiple habitat types

c - data can only be separated into species groups (i.e., Myotis, Big Bat, Hoary Bat) and not individual species

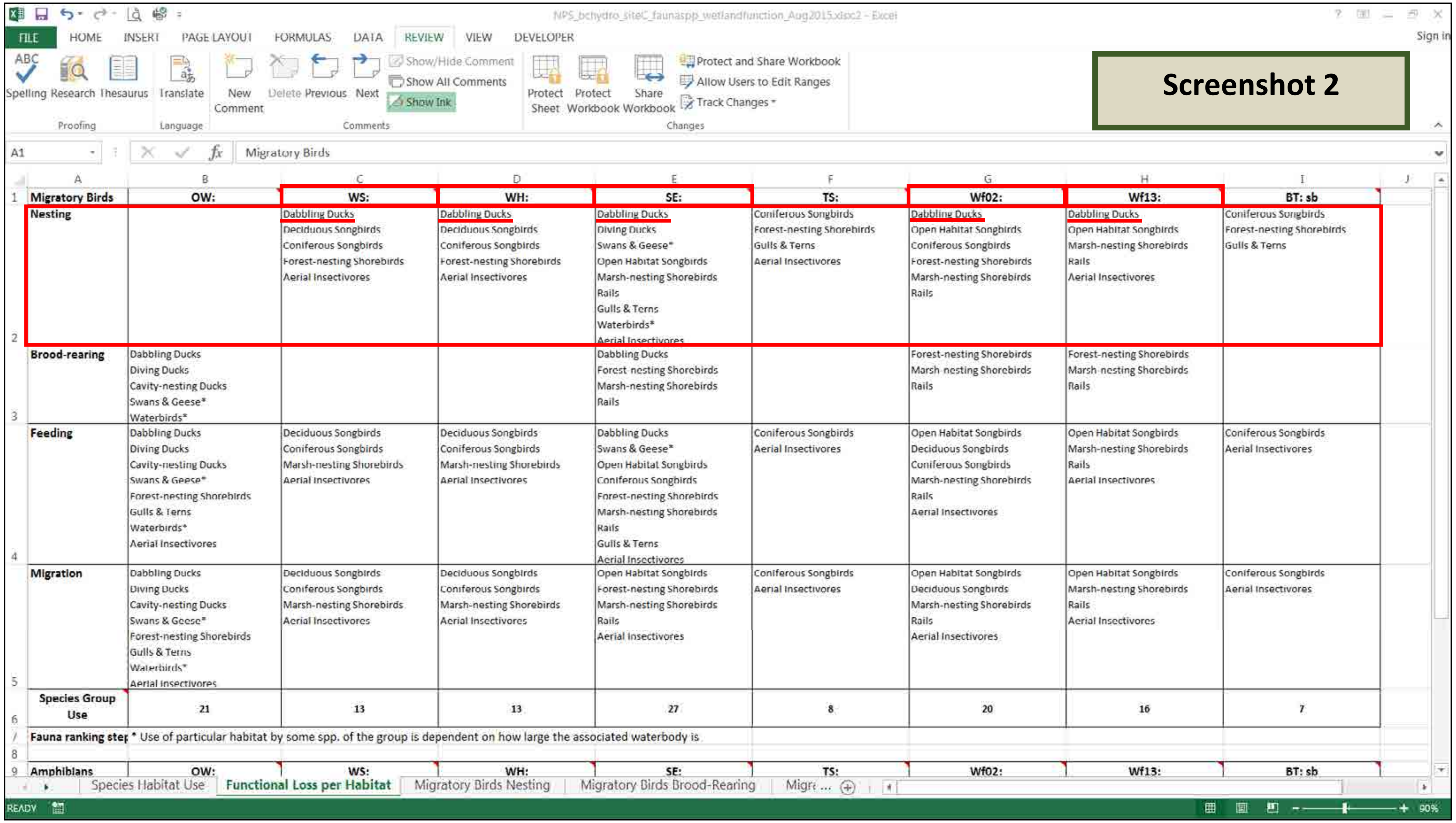
d - surveys were restricted to habitats adjacent to the river and do not sample off-system wetlands (this is not entirely true for waterfowl as some wetlands were also surveyed but a majority of the effort was focused on the Peace River)

e – potentially small sample size

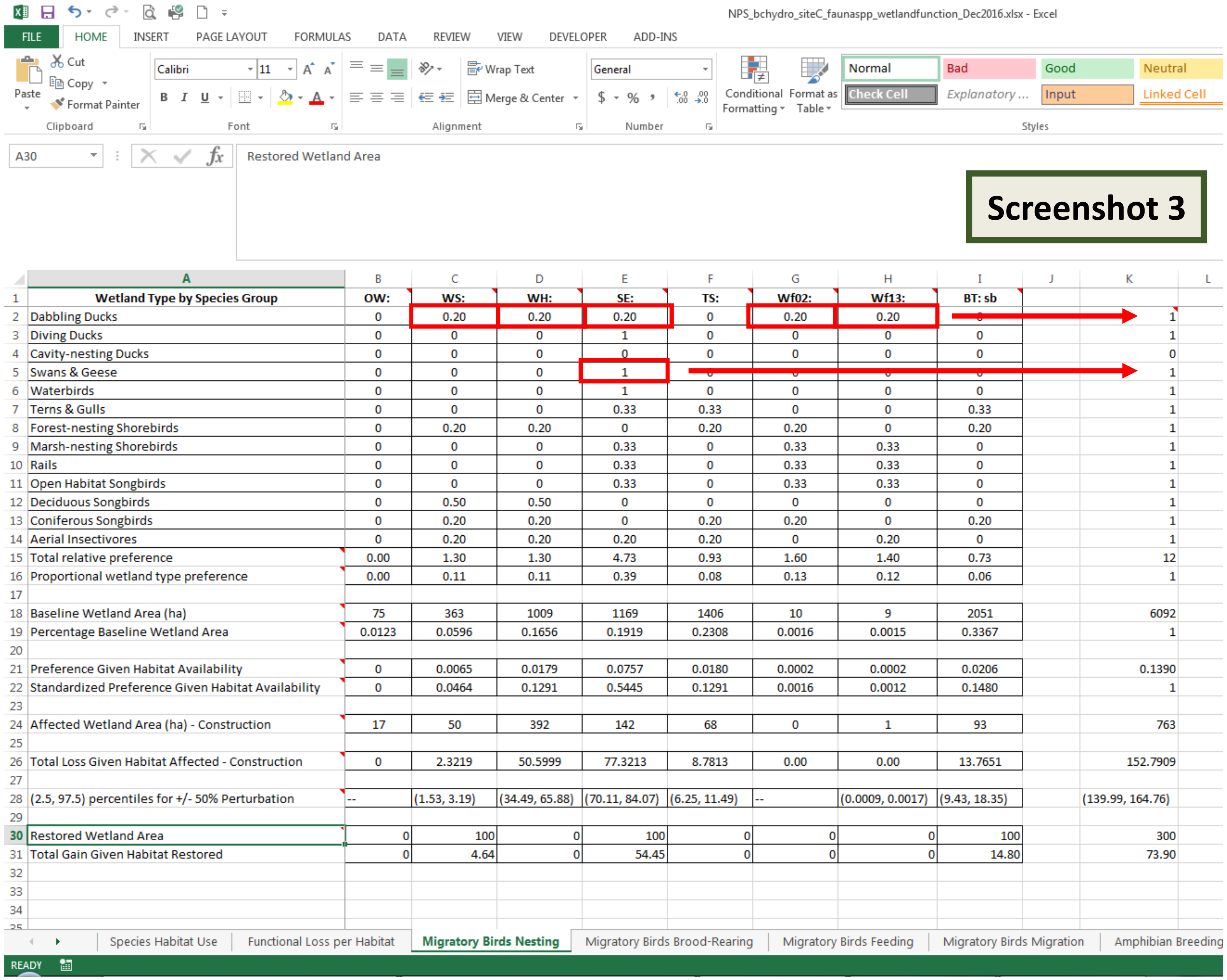
Appendix D: Screenshots for fauna ranking examples



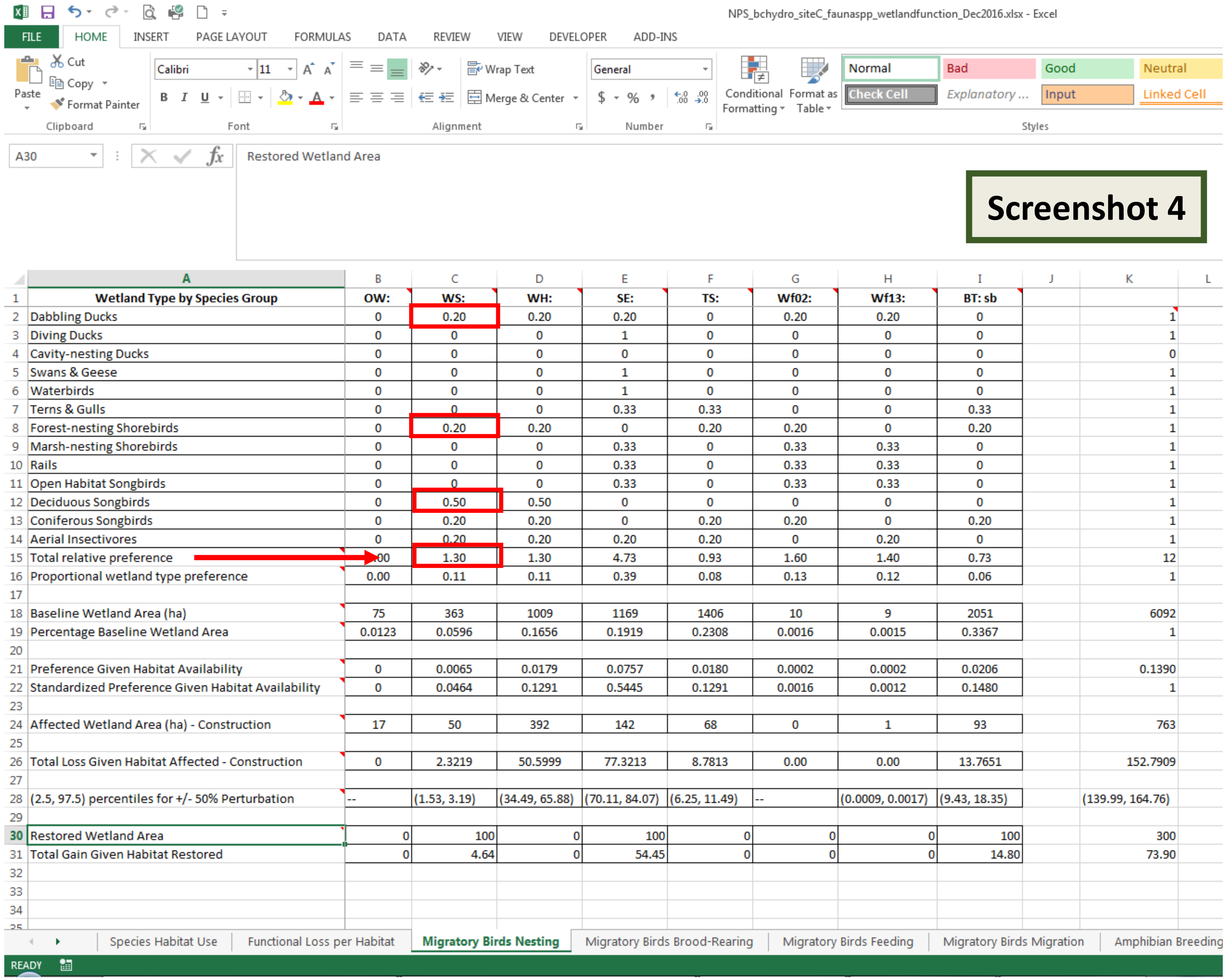
	Habitat Type							
Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Dabbling Ducks								
American Wigeon	X	X	X	X		X	X	
Green-winged Teal	X	X	X	X		X	X	
Diving Ducks								
Lesser Scaup	X	X	X			X	X	
Ring-necked Duck	X							
Cavity-nesting Ducks								
Bufflehead	X							
Common Goldeneye	X							
Swans and Geese								
Trumpeter Swan	X			X				
Deciduous Songbirds								
Alder Flycatcher		X	X					
Common Yellowthroat		X	X	X		X		
Northern Waterthrush		X	X					
Open Habitat Songbirds								
Le Conte's Sparrow				X		X	X	
Nelson's Sparrow				X		X	X	
Coniferous Songbirds								
Lincoln's Sparrow		X	X	X	X	X		X
Olive-sided Flycatcher					X			X
Rusty Blackbird		X	X		X	X		X
Forest-nesting Shorebirds								
Lesser Yellowlegs	X	X	X	X	X	X	X	X
Solitary Sandpiper	X			X	X			X
Marsh-nesting Shorebirds								
Wilson's Snipe		X	X	X		X	X	
Rails								
Sora				X		X	X	
Yellow Rail				X		X	X	



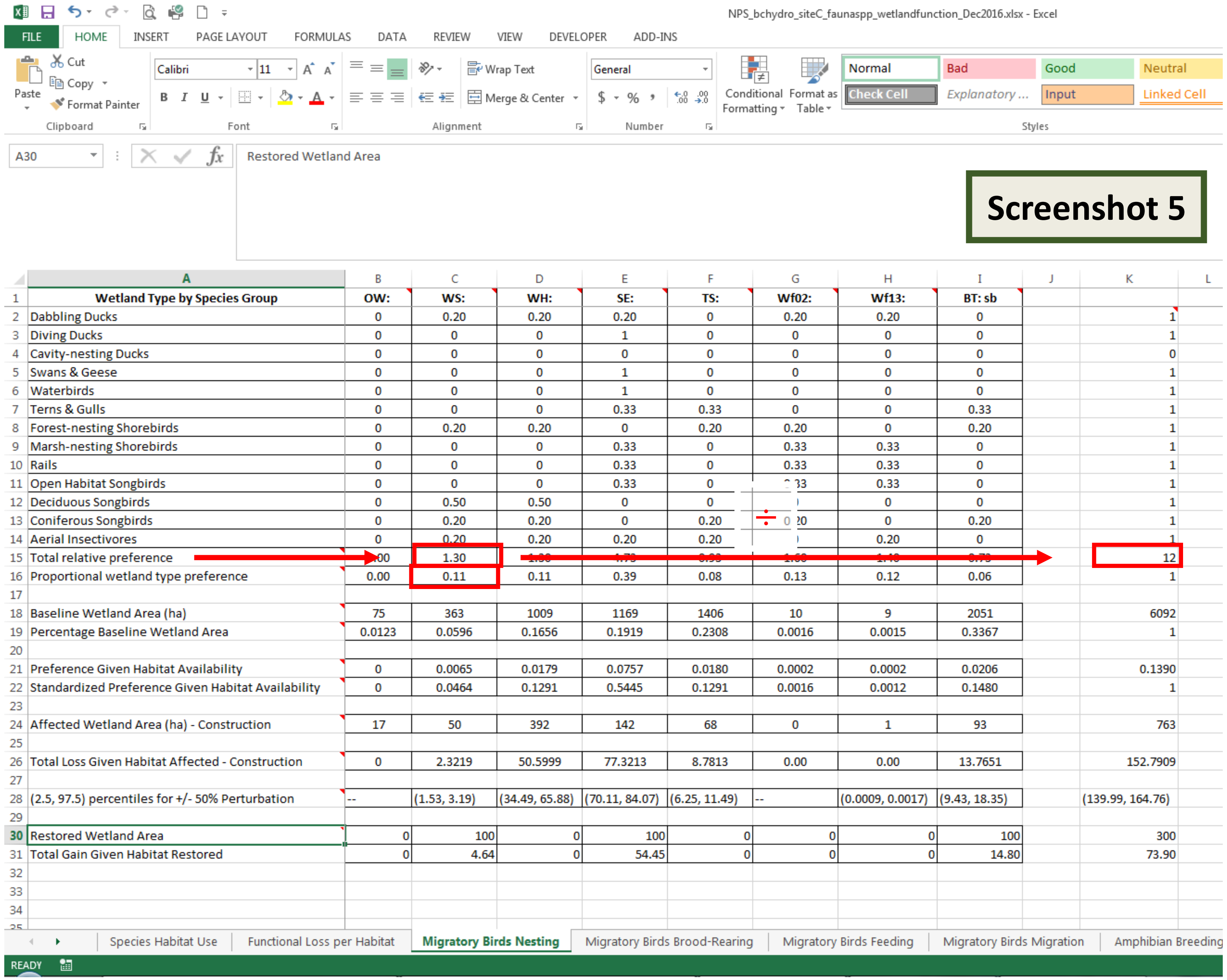
	A	B	C	D	E	F	G	H	I
1	**Migratory Birds**	**OW:**	**WS:**	**WH:**	**SE:**	**TS:**	**Wf02:**	**Wf13:**	**BT: sb**
2	**Nesting**		Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Diving Ducks Swans & Geese* Open Habitat Songbirds Marsh-nesting Shorebirds Rails Gulls & Terns Waterbirds* Aerial Insectivores	Coniferous Songbirds Forest-nesting Shorebirds Gulls & Terns Aerial Insectivores	Dabbling Ducks Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Dabbling Ducks Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Forest-nesting Shorebirds Gulls & Terns
3	**Brood-rearing**	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Waterbirds*			Dabbling Ducks Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails		Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	
4	**Feeding**	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Forest-nesting Shorebirds Gulls & Terns Waterbirds* Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Swans & Geese* Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails Gulls & Terns Aerial Insectivores	Coniferous Songbirds Aerial Insectivores	Open Habitat Songbirds Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores
5	**Migration**	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Forest-nesting Shorebirds Gulls & Terns Waterbirds* Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Open Habitat Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores	Open Habitat Songbirds Deciduous Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores
6	**Species Group Use**	21	13	13	27	8	20	16	7
7	**Fauna ranking step**	* Use of particular habitat by some spp. of the group is dependent on how large the associated waterbody is							
8									
9	**Amphibians**	**OW:**	**WS:**	**WH:**	**SE:**	**TS:**	**Wf02:**	**Wf13:**	**BT: sb**



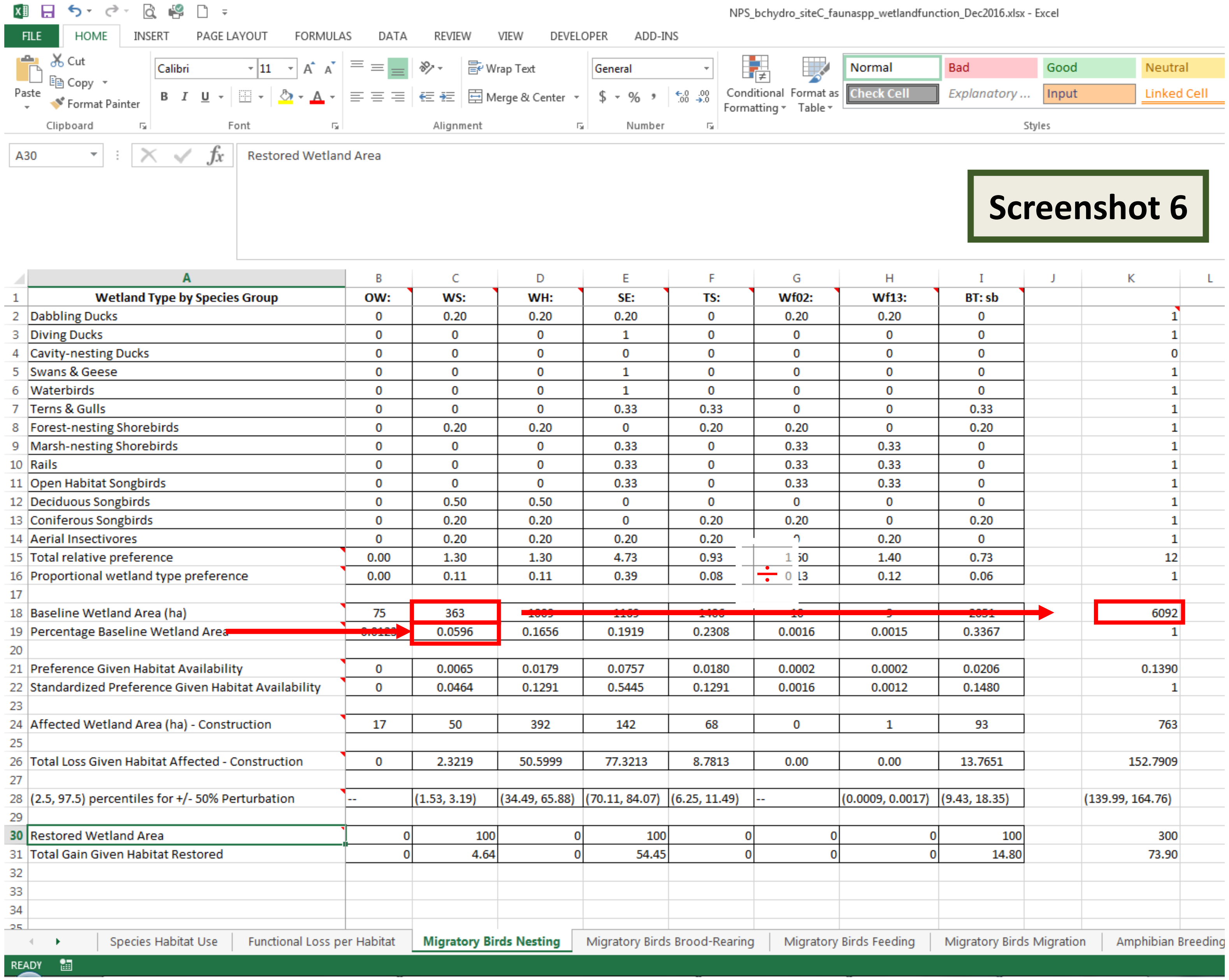
	A	B	C	D	E	F	G	H	I	J	K
1	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2	Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
9	Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
10	Rails	0	0	0	0.33	0	0.33	0.33	0		1
11	Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
12	Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
14	Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
15	Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
16	Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
17											
18	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
19	Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
20											
21	Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
22	Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
23											
24	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
25											
26	Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
27											
28	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
29											
30	Restored Wetland Area	0	100	0	100	0	0	0	100		300
31	Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



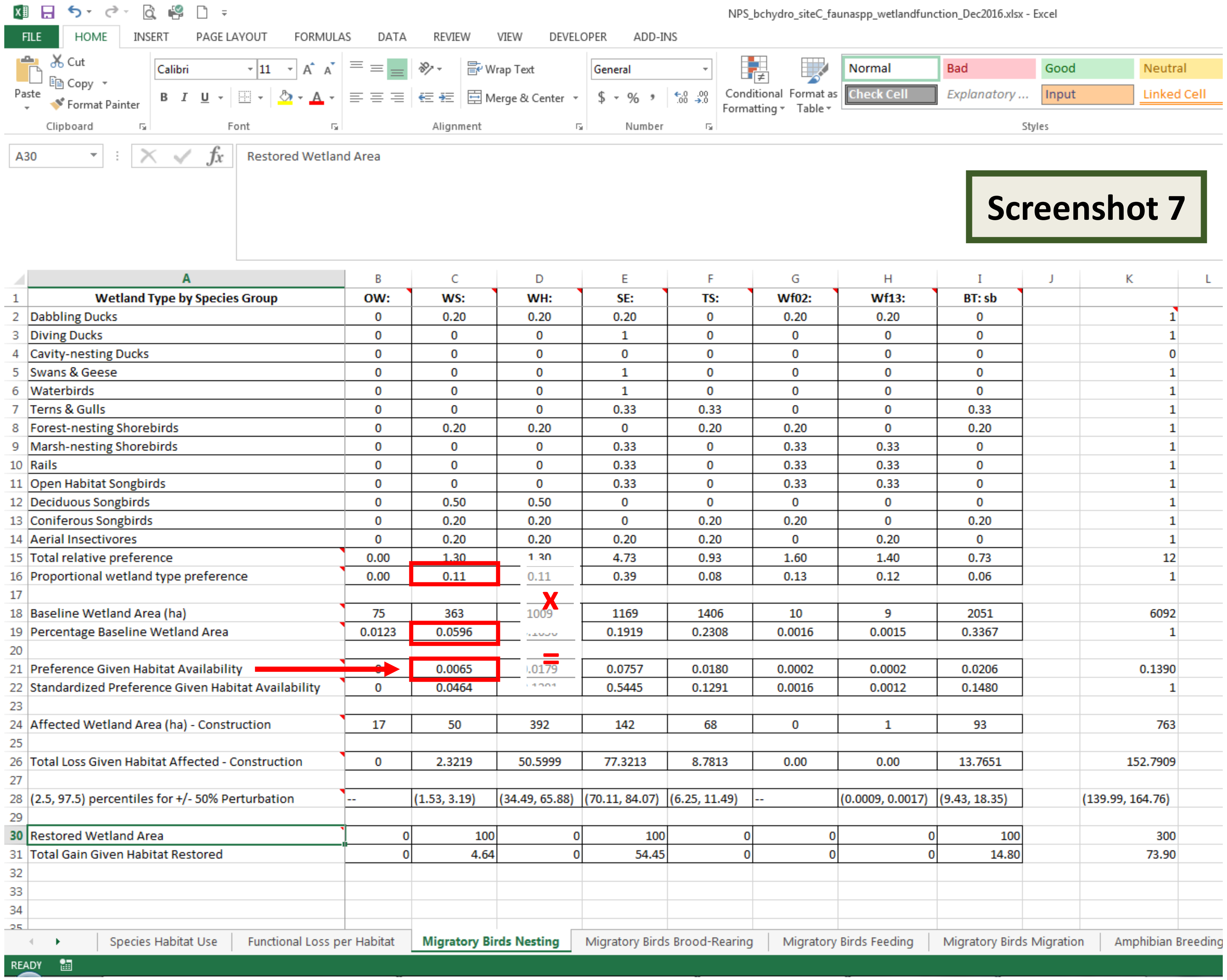
Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
Diving Ducks	0	0	0	1	0	0	0	0		1
Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
Swans & Geese	0	0	0	1	0	0	0	0		1
Waterbirds	0	0	0	1	0	0	0	0		1
Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
Rails	0	0	0	0.33	0	0.33	0.33	0		1
Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
Restored Wetland Area	0	100	0	100	0	0	0	100		300
Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



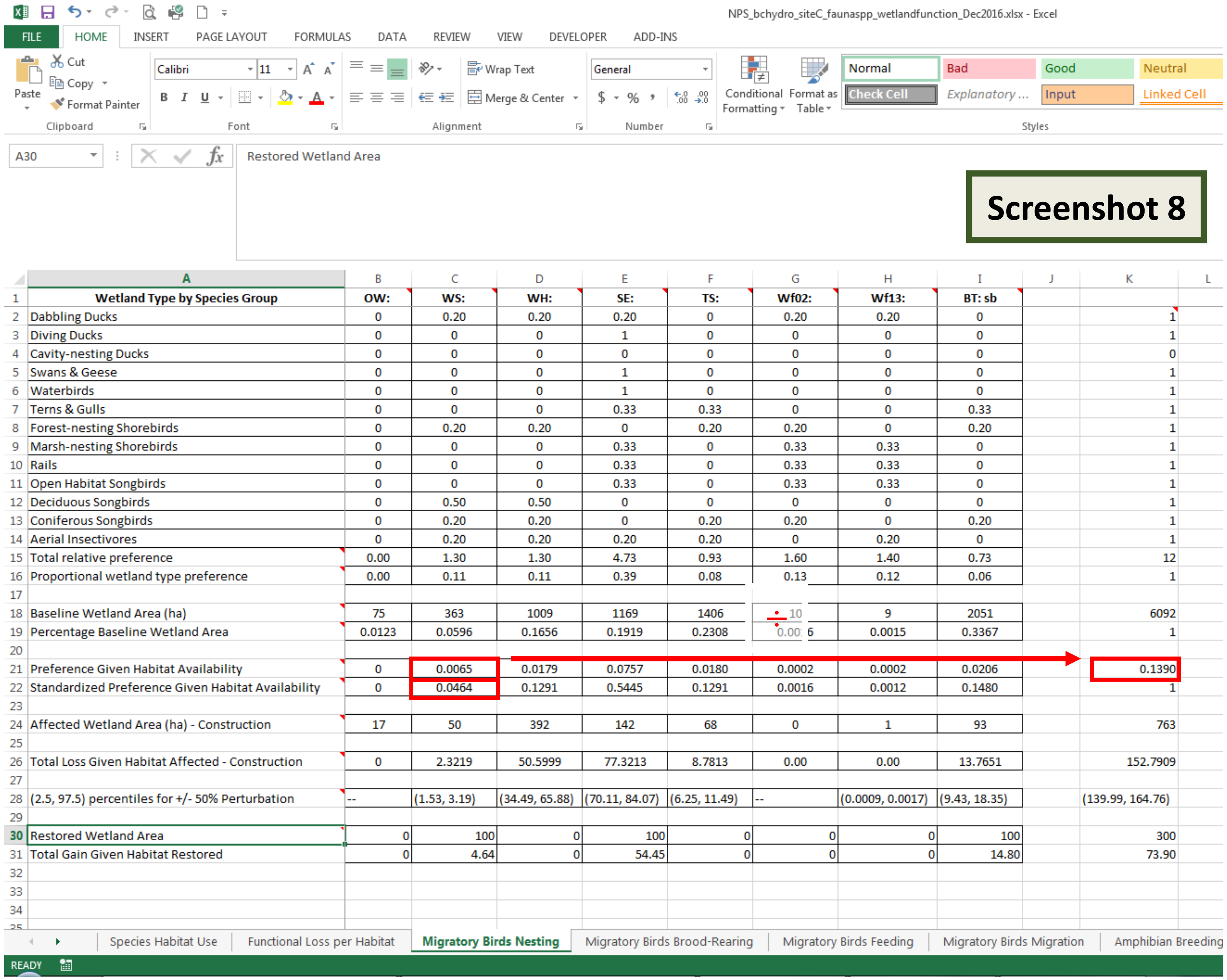
Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
Diving Ducks	0	0	0	1	0	0	0	0		1
Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
Swans & Geese	0	0	0	1	0	0	0	0		1
Waterbirds	0	0	0	1	0	0	0	0		1
Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
Rails	0	0	0	0.33	0	0.33	0.33	0		1
Open Habitat Songbirds	0	0	0	0.33	0	[illegible]	0.33	0		1
Deciduous Songbirds	0	0.50	0.50	0	0	[illegible]	0	0		1
Coniferous Songbirds	0	0.20	0.20	0	0.20	[illegible]	0	0.20		1
Aerial Insectivores	0	0.20	0.20	0.20	0.20	[illegible]	0.20	0		1
Total relative preference	[illegible]	1.30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		12
Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
Restored Wetland Area	0	100	0	100	0	0	0	100		300
Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



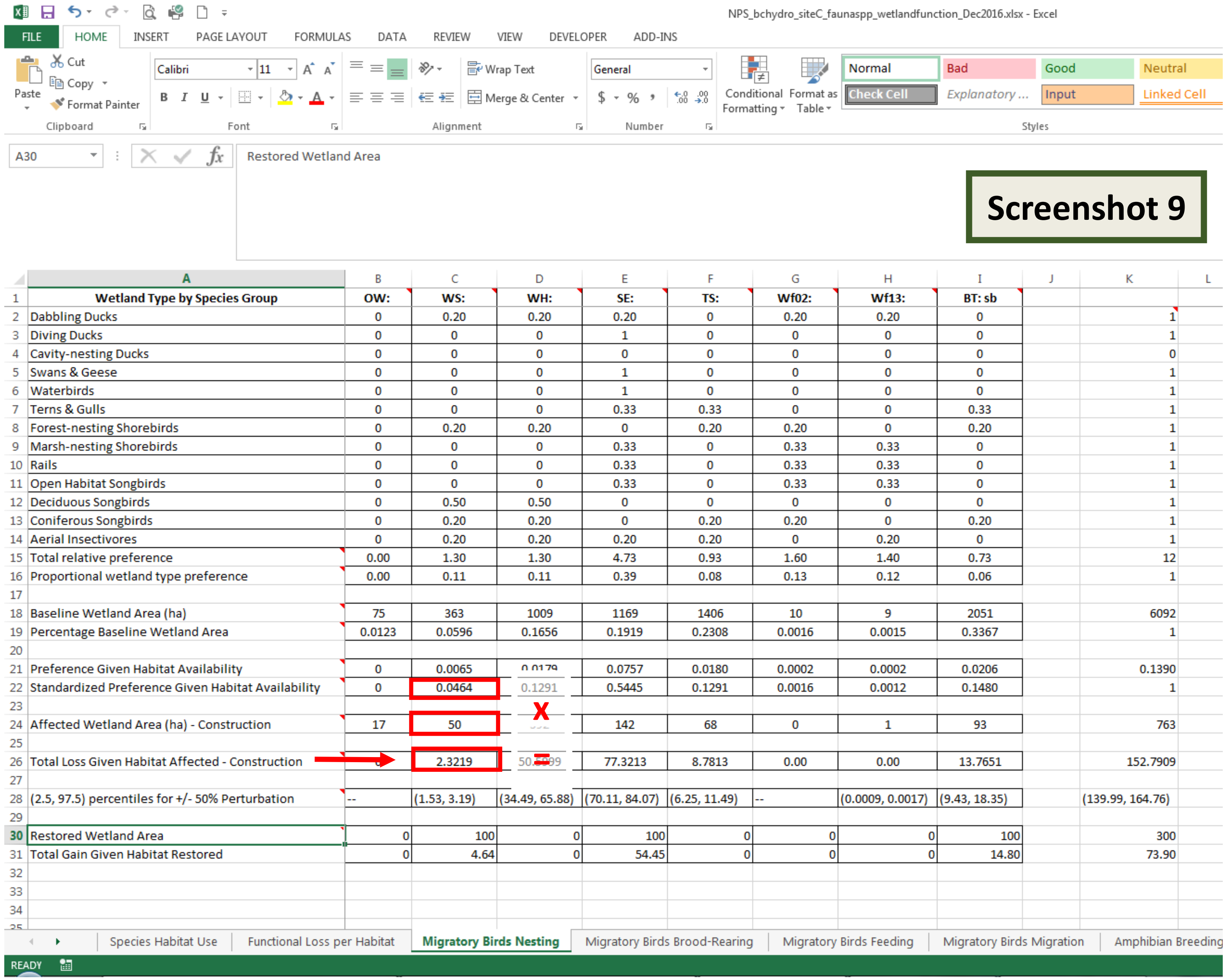
	A	B	C	D	E	F	G	H	I	J	K
1	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2	Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
9	Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
10	Rails	0	0	0	0.33	0	0.33	0.33	0		1
11	Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
12	Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
14	Aerial Insectivores	0	0.20	0.20	0.20	0.20	[illegible]	0.20	0		1
15	Total relative preference	0.00	1.30	1.30	4.73	0.93	[illegible]	1.40	0.73		12
16	Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	[illegible]	0.12	0.06		1
17											
18	Baseline Wetland Area (ha)	75	363	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		6092
19	Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
20											
21	Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
22	Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
23											
24	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
25											
26	Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
27											
28	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
29											
30	Restored Wetland Area	0	100	0	100	0	0	0	100		300
31	Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



	A	B	C	D	E	F	G	H	I	J	K
1	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2	Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
9	Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
10	Rails	0	0	0	0.33	0	0.33	0.33	0		1
11	Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
12	Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
14	Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
15	Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
16	Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
17											
18	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
19	Percentage Baseline Wetland Area	0.0123	0.0596	[illegible]	0.1919	0.2308	0.0016	0.0015	0.3367		1
20											
21	Preference Given Habitat Availability	0	0.0065	.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
22	Standardized Preference Given Habitat Availability	0	0.0464	[illegible]	0.5445	0.1291	0.0016	0.0012	0.1480		1
23											
24	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
25											
26	Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
27											
28	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
29											
30	Restored Wetland Area	0	100	0	100	0	0	0	100		300
31	Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



	A	B	C	D	E	F	G	H	I	J	K
1	**Wetland Type by Species Group**	**OW:**	**WS:**	**WH:**	**SE:**	**TS:**	**Wf02:**	**Wf13:**	**BT: sb**		
2	Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
9	Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
10	Rails	0	0	0	0.33	0	0.33	0.33	0		1
11	Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
12	Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
14	Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
15	Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
16	Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
17											
18	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
19	Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.00[illegible]6	0.0015	0.3367		1
20											
21	Preference Given Habitat Availability	0	$\boxed{0.0065}$	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		$\boxed{0.1390}$
22	Standardized Preference Given Habitat Availability	0	$\boxed{0.0464}$	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
23											
24	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
25											
26	Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
27											
28	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
29											
30	Restored Wetland Area	0	100	0	100	0	0	0	100		300
31	Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90



NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx - Excel

A30 Restored Wetland Area

Screenshot 9

	A	B	C	D	E	F	G	H	I	J	K
1	**Wetland Type by Species Group**	**OW:**	**WS:**	**WH:**	**SE:**	**TS:**	**Wf02:**	**Wf13:**	**BT: sb**		
2	Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
9	Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
10	Rails	0	0	0	0.33	0	0.33	0.33	0		1
11	Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
12	Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
14	Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
15	Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
16	Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
17											
18	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
19	Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
20											
21	Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
22	Standardized Preference Given Habitat Availability	0	$\boxed{0.0464}$	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
23				X							
24	Affected Wetland Area (ha) - Construction	17	$\boxed{50}$	[illegible]	142	68	0	1	93		763
25				=							
26	Total Loss Given Habitat Affected - Construction	[illegible]	$\boxed{2.3219}$	50.[illegible]99	77.3213	8.7813	0.00	0.00	13.7651		152.7909
27											
28	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
29											
30	Restored Wetland Area	0	100	0	100	0	0	0	100		300
31	Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90

Species Habitat Use | Functional Loss per Habitat | **Migratory Birds Nesting** | Migratory Birds Brood-Rearing | Migratory Birds Feeding | Migratory Birds Migration | Amphibian Breeding

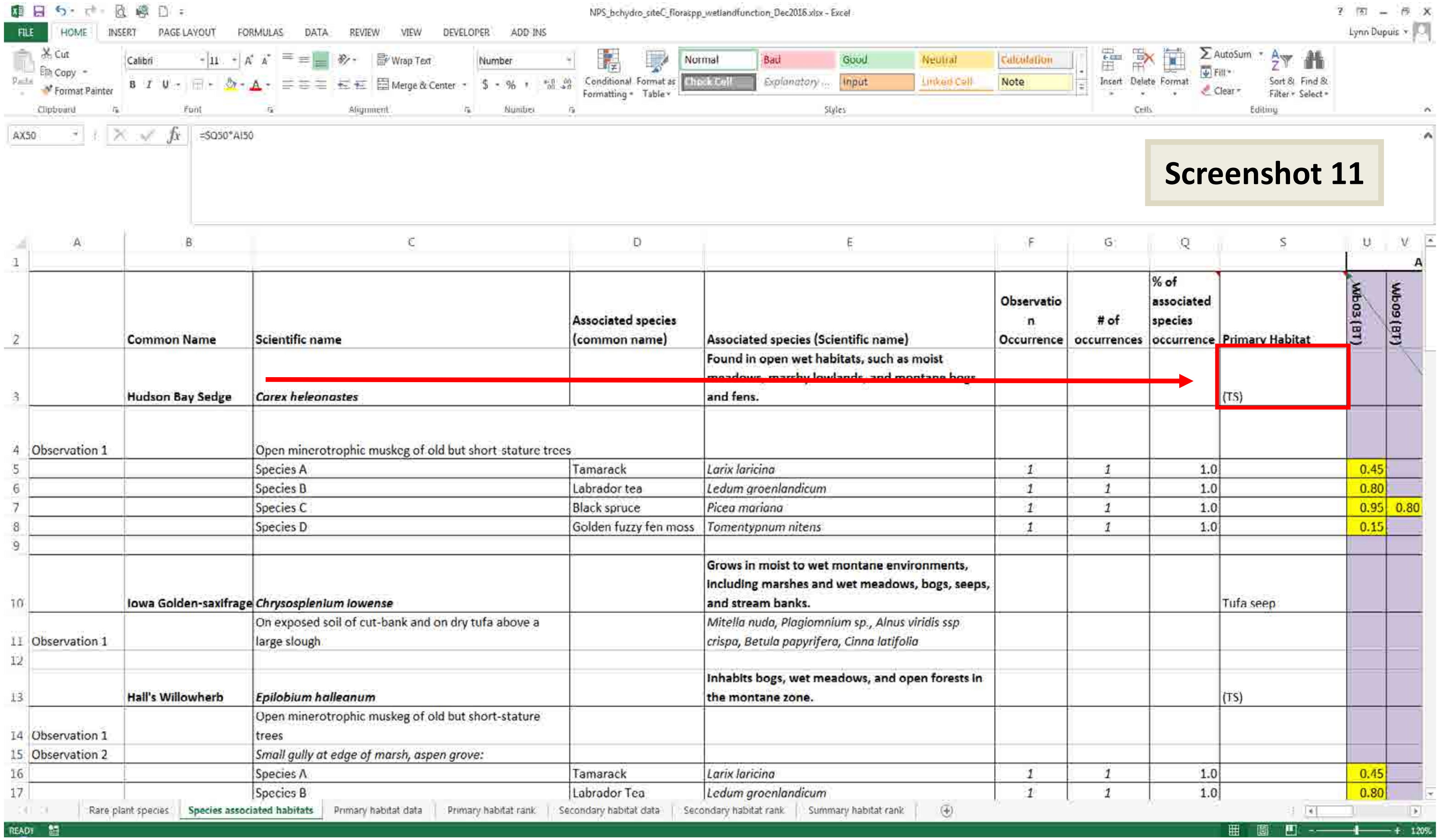
NPS_bchydro_siteC_faunaspp_wetlandfunction_Dec2016.xlsx - Excel

Screenshot 10

Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0		1
Diving Ducks	0	0	0	1	0	0	0	0		1
Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
Swans & Geese	0	0	0	1	0	0	0	0		1
Waterbirds	0	0	0	1	0	0	0	0		1
Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0		1
Rails	0	0	0	0.33	0	0.33	0.33	0		1
Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0		1
Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0		1
Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20		1
Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0		1
Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73		12
Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06		1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367		1
Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206		0.1390
Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480		1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
			X							
Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651		152.7909
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)		(139.99, 164.76)
Restored Wetland Area	0	100	0	100	0	0	0	100		300
Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80		73.90

Species Habitat Use | Functional Loss per Habitat | Migratory Birds Nesting | Migratory Birds Brood-Rearing | Migratory Birds Feeding | Migratory Birds Migration | Amphibian Breeding

Appendix E: Screenshots for flora ranking examples



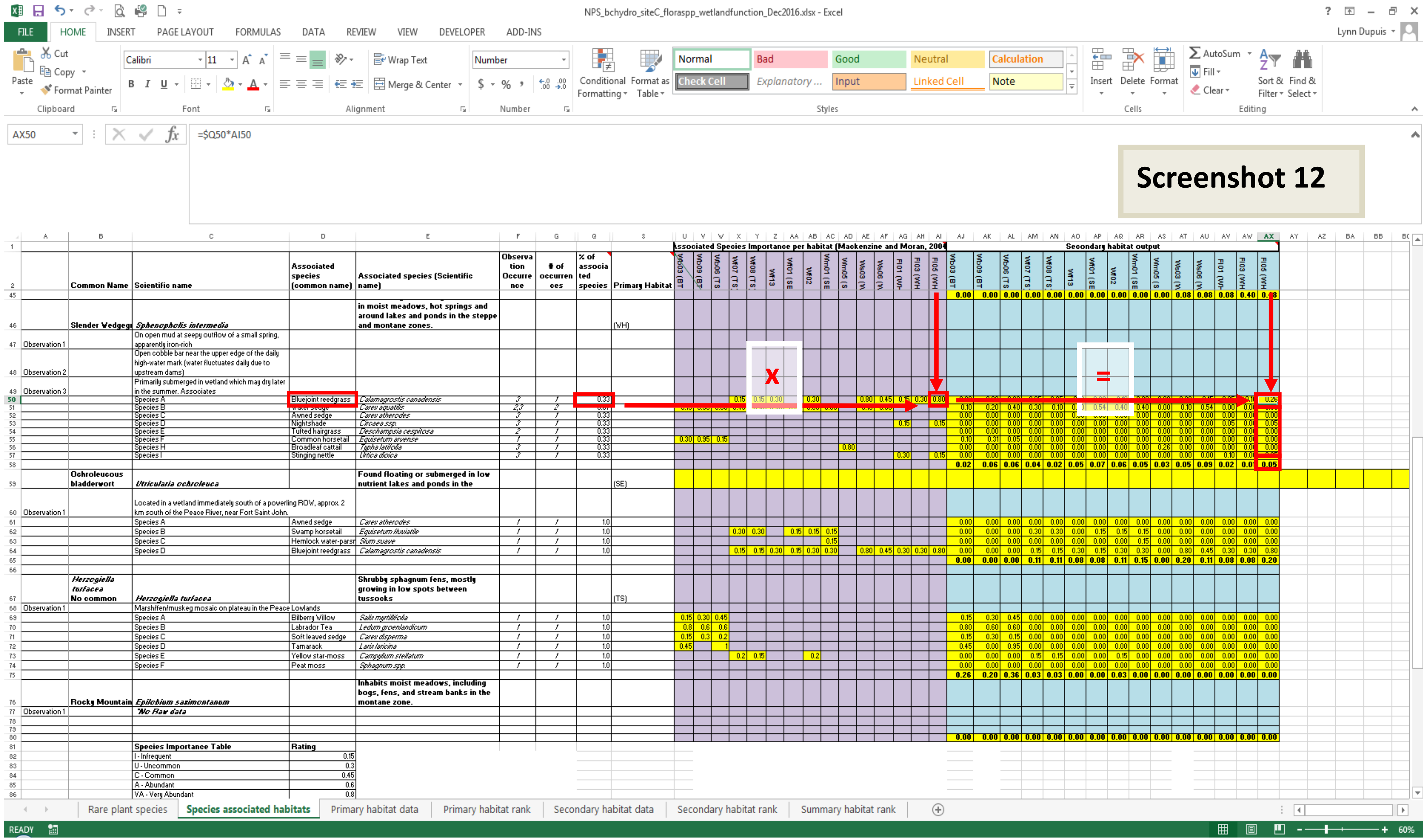
Screenshot 11

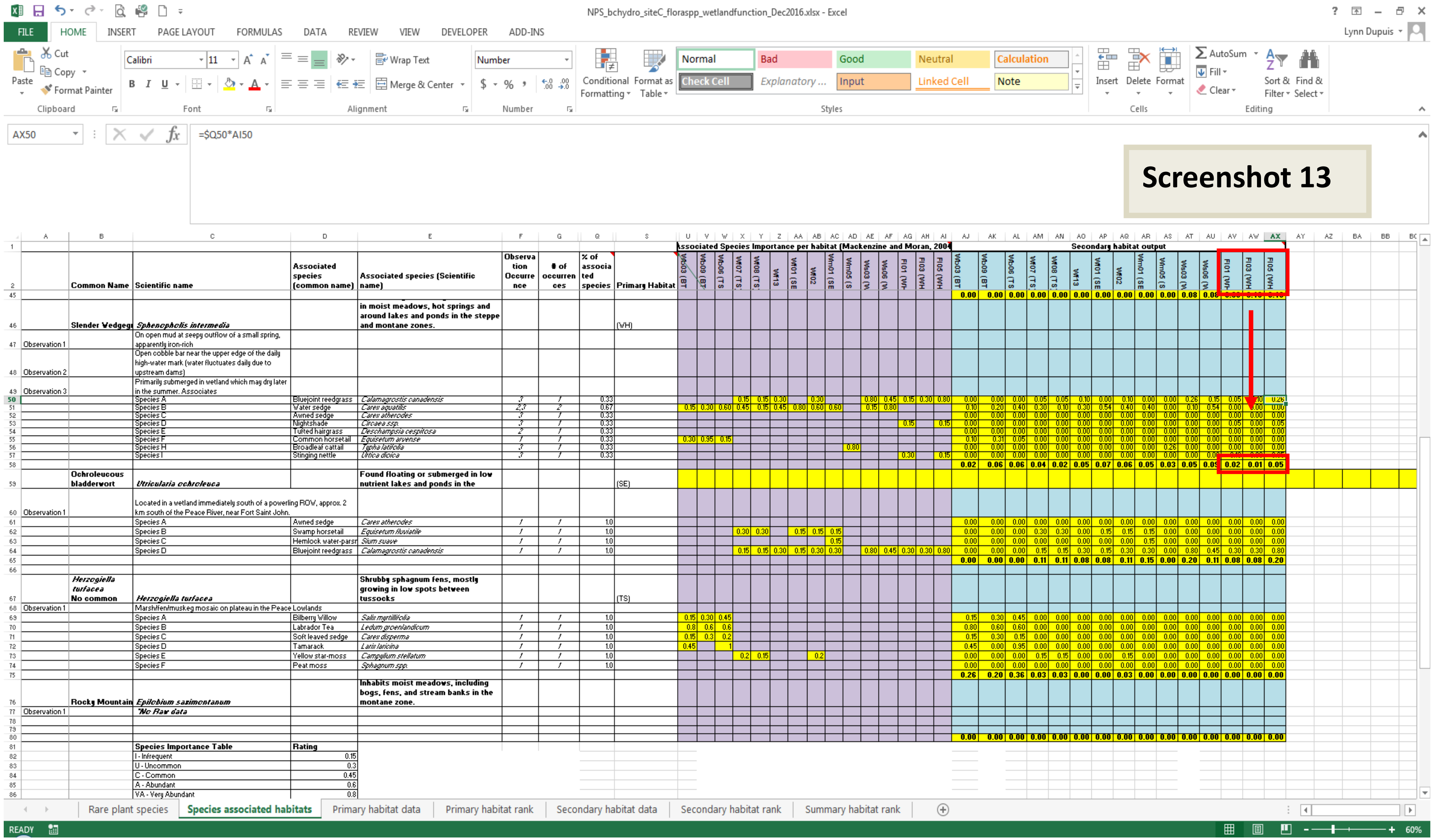
NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx - Excel

AX50 | =$Q50*AI50

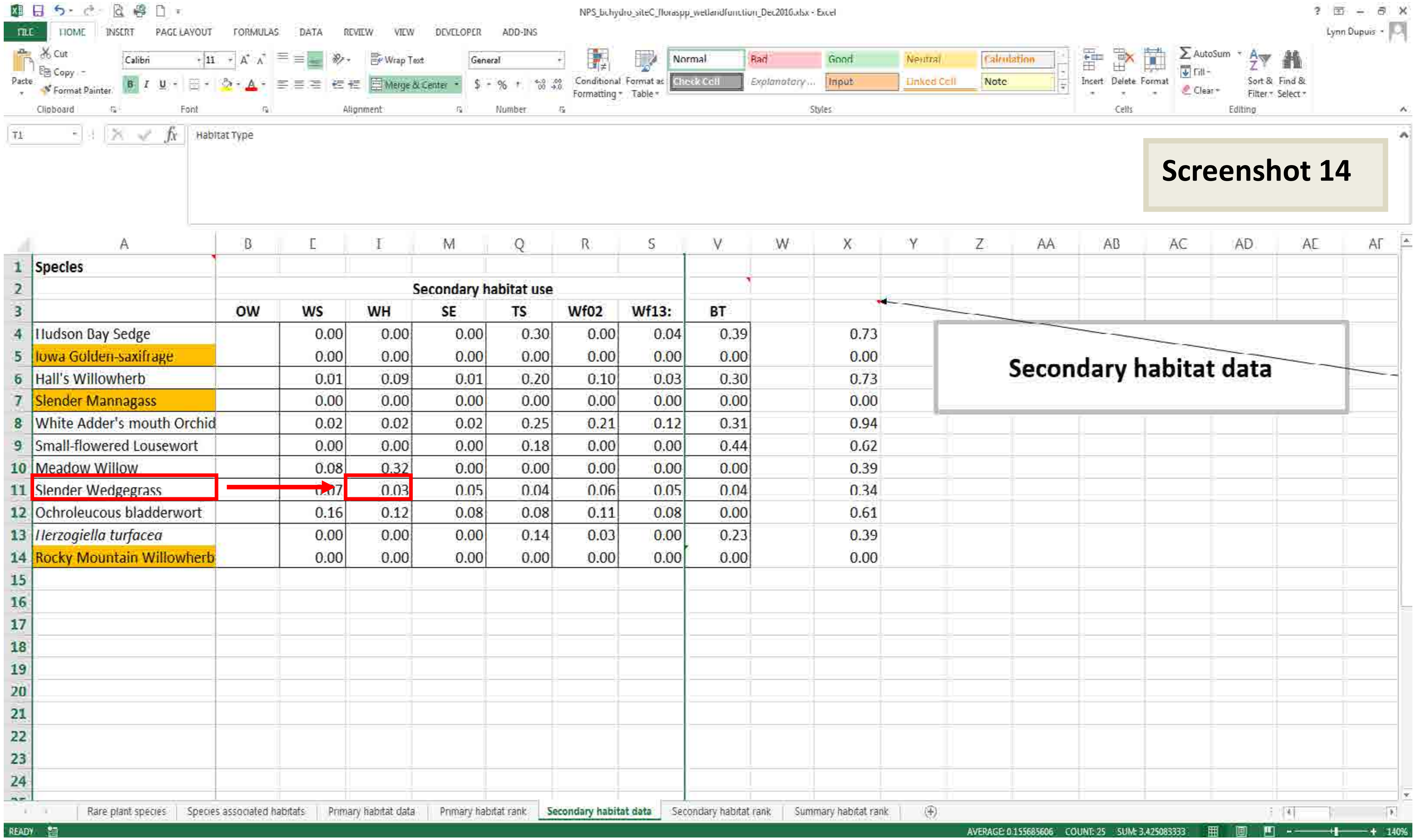
	A	B	C	D	E	F	G	Q	S	U	V
1											A
2		Common Name	Scientific name	Associated species (common name)	Associated species (Scientific name)	Observation Occurrence	# of occurrences	% of associated species occurrence	Primary Habitat	Wb03 (BT)	Wb09 (BT)
3		**Hudson Bay Sedge**	***Carex heleonastes***		**Found in open wet habitats, such as moist meadows, marshy lowlands, and montane bogs and fens.**				(TS)		
4	Observation 1		Open minerotrophic muskeg of old but short stature trees								
5			Species A	Tamarack	*Larix laricina*	1	1	1.0		0.45	
6			Species B	Labrador tea	*Ledum groenlandicum*	1	1	1.0		0.80	
7			Species C	Black spruce	*Picea mariana*	1	1	1.0		0.95	0.80
8			Species D	Golden fuzzy fen moss	*Tomentypnum nitens*	1	1	1.0		0.15	
9											
10		**Iowa Golden-saxifrage**	***Chrysosplenium iowense***		**Grows in moist to wet montane environments, including marshes and wet meadows, bogs, seeps, and stream banks.**				Tufa seep		
11	Observation 1		On exposed soil of cut-bank and on dry tufa above a large slough		*Mitella nuda, Plagiomnium sp., Alnus viridis ssp crispa, Betula papyrifera, Cinna latifolia*						
12											
13		**Hall's Willowherb**	***Epilobium halleanum***		**Inhabits bogs, wet meadows, and open forests in the montane zone.**				(TS)		
14	Observation 1		Open minerotrophic muskeg of old but short-stature trees								
15	Observation 2		*Small gully at edge of marsh, aspen grove:*								
16			Species A	Tamarack	*Larix laricina*	1	1	1.0		0.45	
17			Species B	Labrador Tea	*Ledum groenlandicum*	1	1	1.0		0.80	

Rare plant species | Species associated habitats | Primary habitat data | Primary habitat rank | Secondary habitat data | Secondary habitat rank | Summary habitat rank

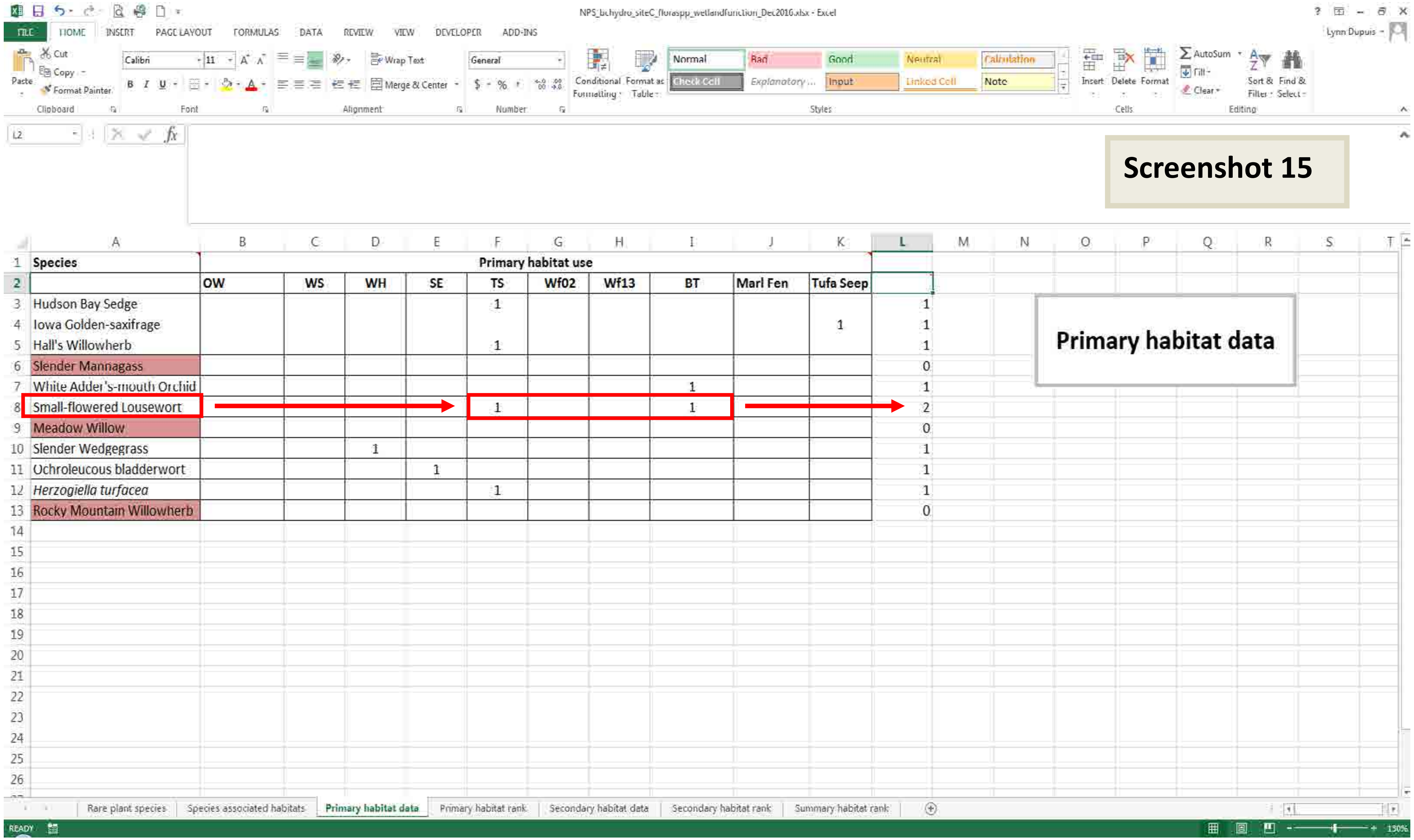

NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx - Excel
AX50
=$Q50*AI50
Screenshot 12
Associated Species Importance per habitat (Mackenzine and Moran, 2004)
Secondary habitat output
Common Name
Scientific name
Associated species (common name)
Associated species (Scientific name)
Primary Habitat
Slender Wedgegr
Sphenopholis intermedia
Ochroleucous bladderwort
Utricularia ochroleuca
Rocky Mountain
Epilobium saximontanum
Species Importance Table
Rating
Rare plant species
Species associated habitats
Primary habitat data
Primary habitat rank
Secondary habitat data
Secondary habitat rank
Summary habitat rank



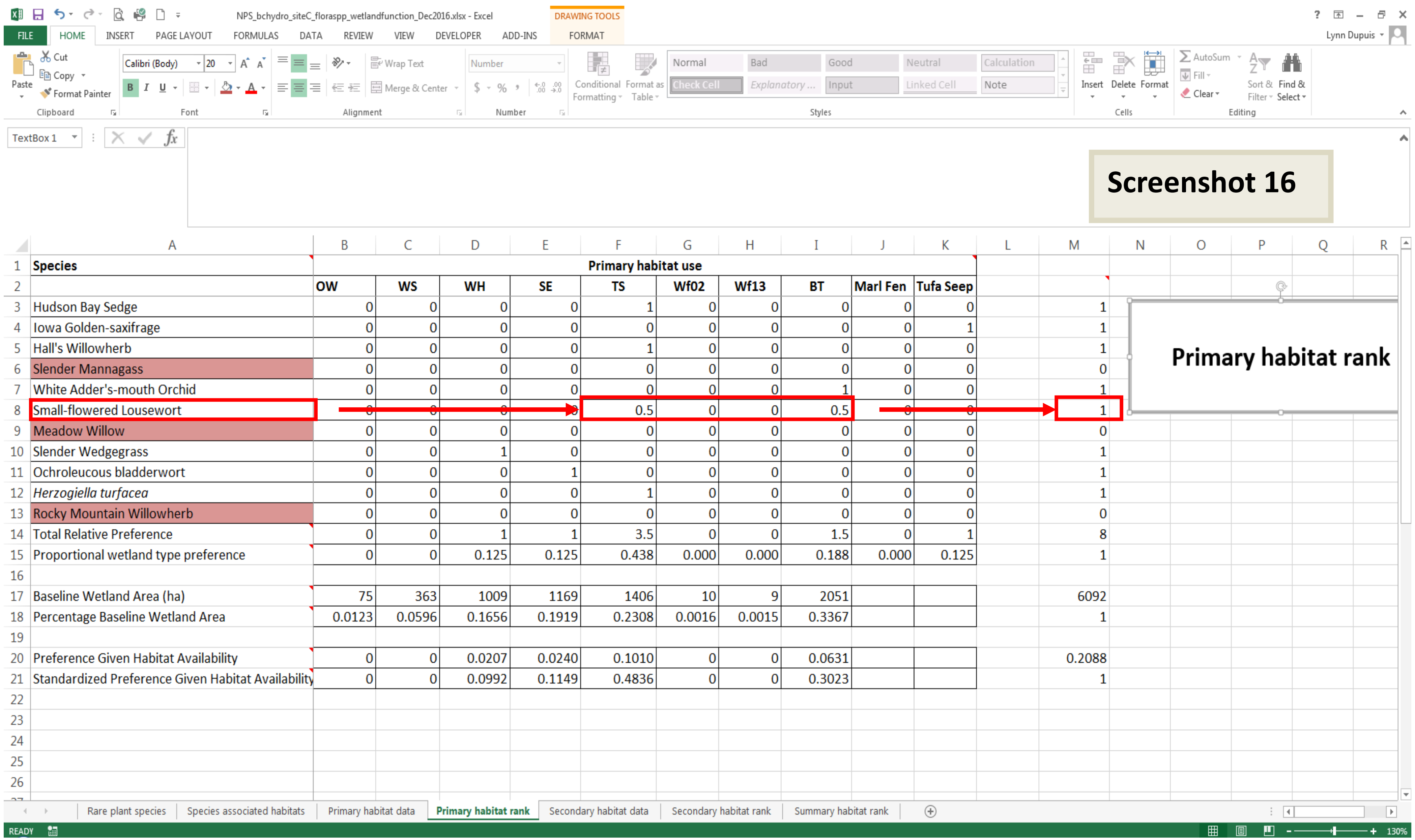
NPS_bchydro_siteC_floraspp_wetlandfunction_Dec2016.xlsx - Excel
AX50
=$Q50*AI50
Screenshot 13
Associated Species Importance per habitat (Mackenzine and Moran, 2004
Secondary habitat output
Rare plant species
Species associated habitats
Primary habitat data
Primary habitat rank
Secondary habitat data
Secondary habitat rank
Summary habitat rank



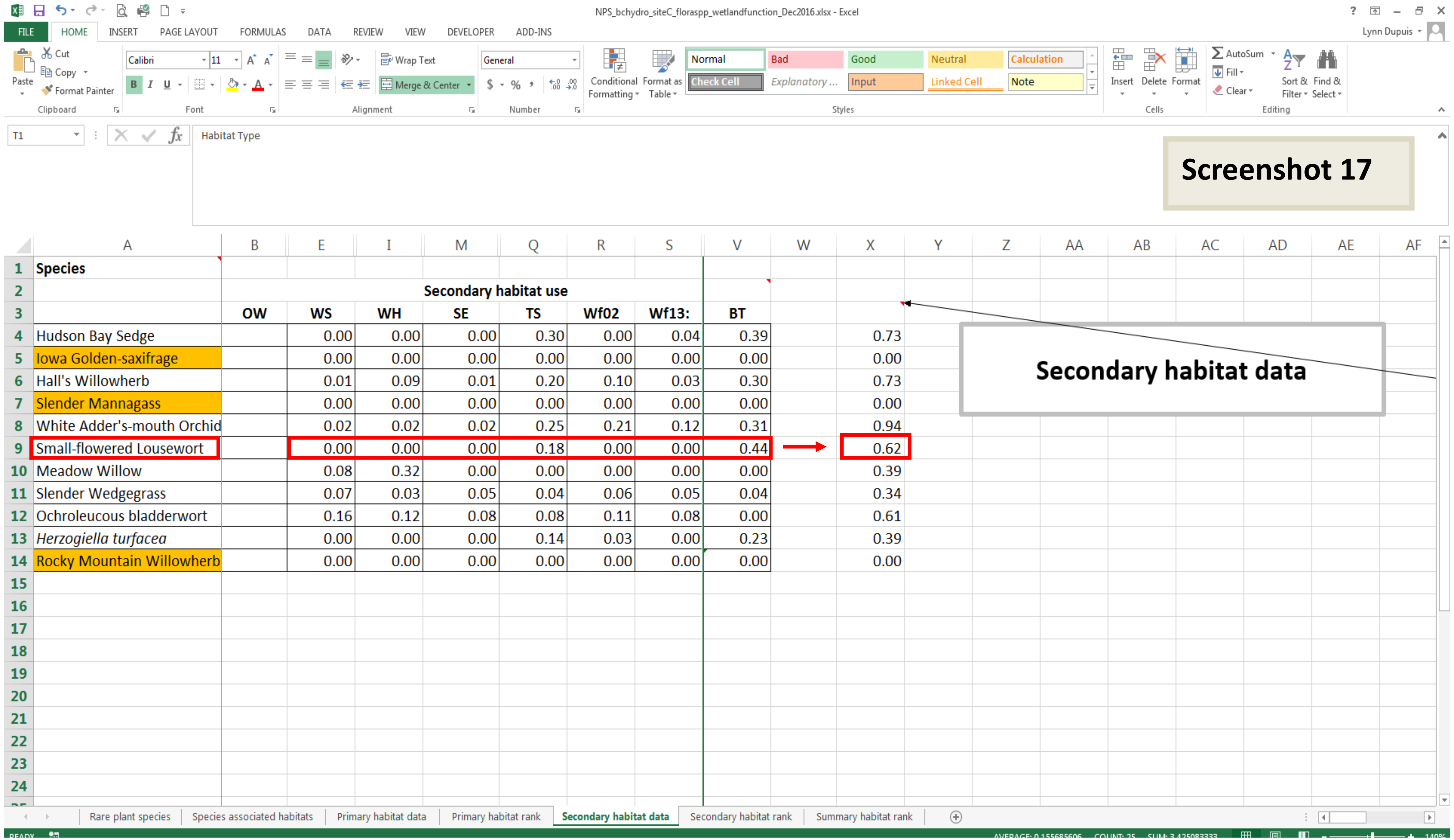
Species									
	Secondary habitat use								
	OW	WS	WH	SE	TS	Wf02	Wf13:	BT	
Hudson Bay Sedge		0.00	0.00	0.00	0.30	0.00	0.04	0.39	0.73
Iowa Golden-saxifrage		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hall's Willowherb		0.01	0.09	0.01	0.20	0.10	0.03	0.30	0.73
Slender Mannagass		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Adder's mouth Orchid		0.02	0.02	0.02	0.25	0.21	0.12	0.31	0.94
Small-flowered Lousewort		0.00	0.00	0.00	0.18	0.00	0.00	0.44	0.62
Meadow Willow		0.08	0.32	0.00	0.00	0.00	0.00	0.00	0.39
Slender Wedgegrass		0.07	0.03	0.05	0.04	0.06	0.05	0.04	0.34
Ochroleucous bladderwort		0.16	0.12	0.08	0.08	0.11	0.08	0.00	0.61
Herzogiella turfacea		0.00	0.00	0.00	0.14	0.03	0.00	0.23	0.39
Rocky Mountain Willowherb		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge					1						1
Iowa Golden-saxifrage										1	1
Hall's Willowherb					1						1
Slender Mannagass											0
White Adder's-mouth Orchid								1			1
Small-flowered Lousewort					1			1			2
Meadow Willow											0
Slender Wedgegrass			1								1
Ochroleucous bladderwort				1							1
Herzogiella turfacea					1						1
Rocky Mountain Willowherb											0

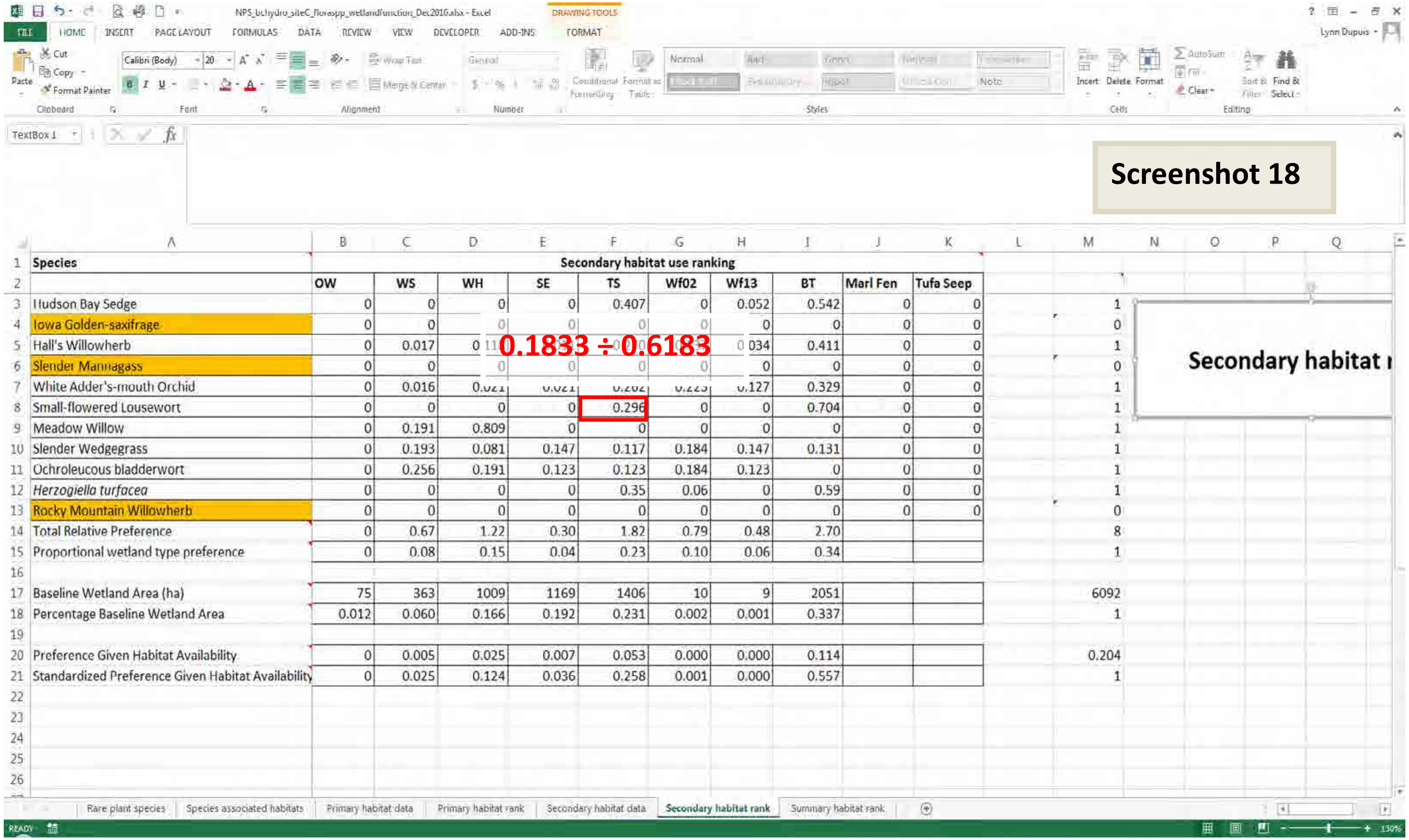


Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
Herzogiella turfacea	0	0	0	0	1	0	0	0	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1	8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367			1
Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631			0.2088
Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023			1

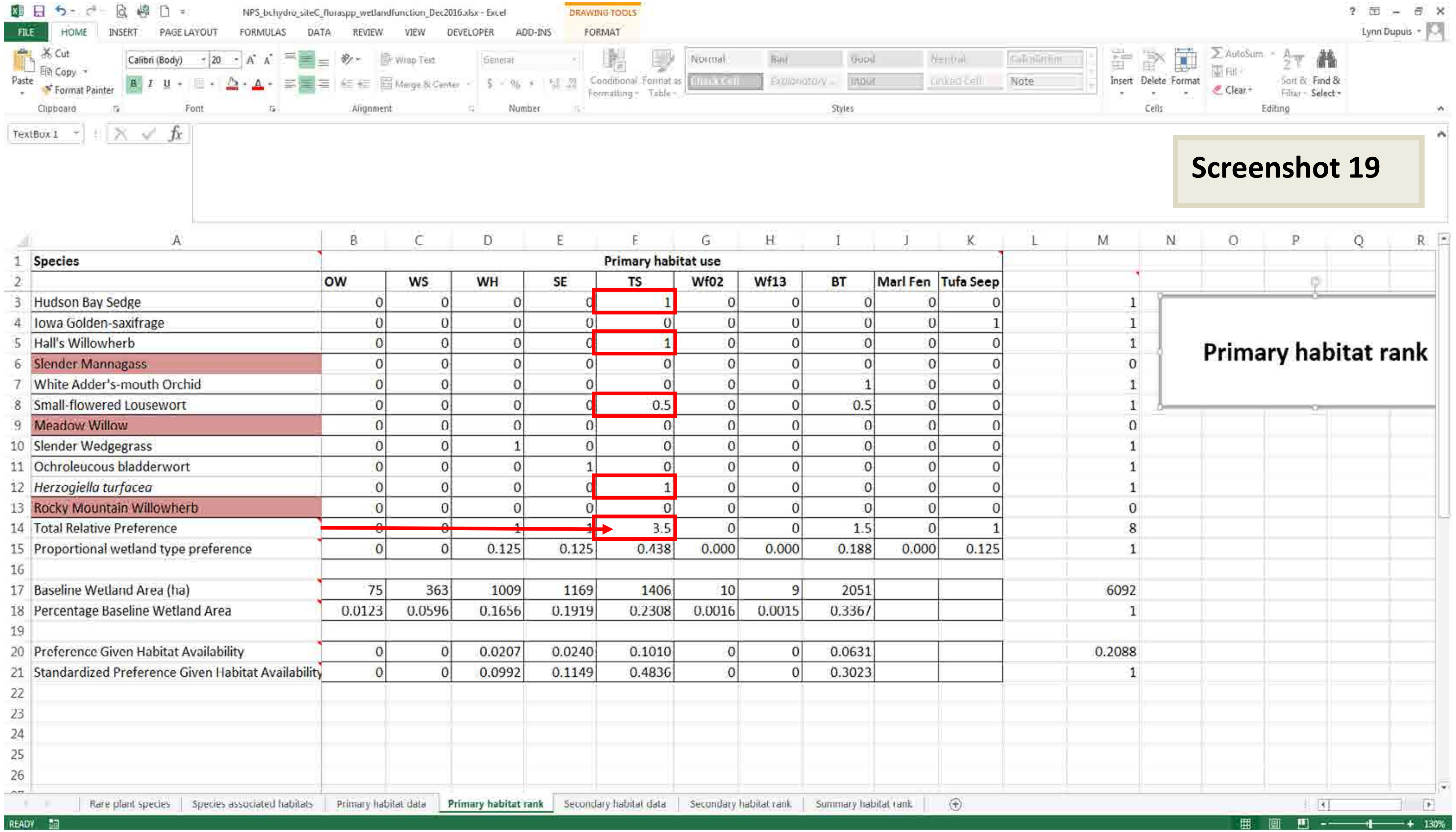


Species									
	Secondary habitat use								
	OW	WS	WH	SE	TS	Wf02	Wf13:	BT	
Hudson Bay Sedge		0.00	0.00	0.00	0.30	0.00	0.04	0.39	0.73
Iowa Golden-saxifrage		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hall's Willowherb		0.01	0.09	0.01	0.20	0.10	0.03	0.30	0.73
Slender Mannagass		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Adder's-mouth Orchid		0.02	0.02	0.02	0.25	0.21	0.12	0.31	0.94
Small-flowered Lousewort		0.00	0.00	0.00	0.18	0.00	0.00	0.44	0.62
Meadow Willow		0.08	0.32	0.00	0.00	0.00	0.00	0.00	0.39
Slender Wedgegrass		0.07	0.03	0.05	0.04	0.06	0.05	0.04	0.34
Ochroleucous bladderwort		0.16	0.12	0.08	0.08	0.11	0.08	0.00	0.61
Herzogiella turfacea		0.00	0.00	0.00	0.14	0.03	0.00	0.23	0.39
Rocky Mountain Willowherb		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Screenshot 18



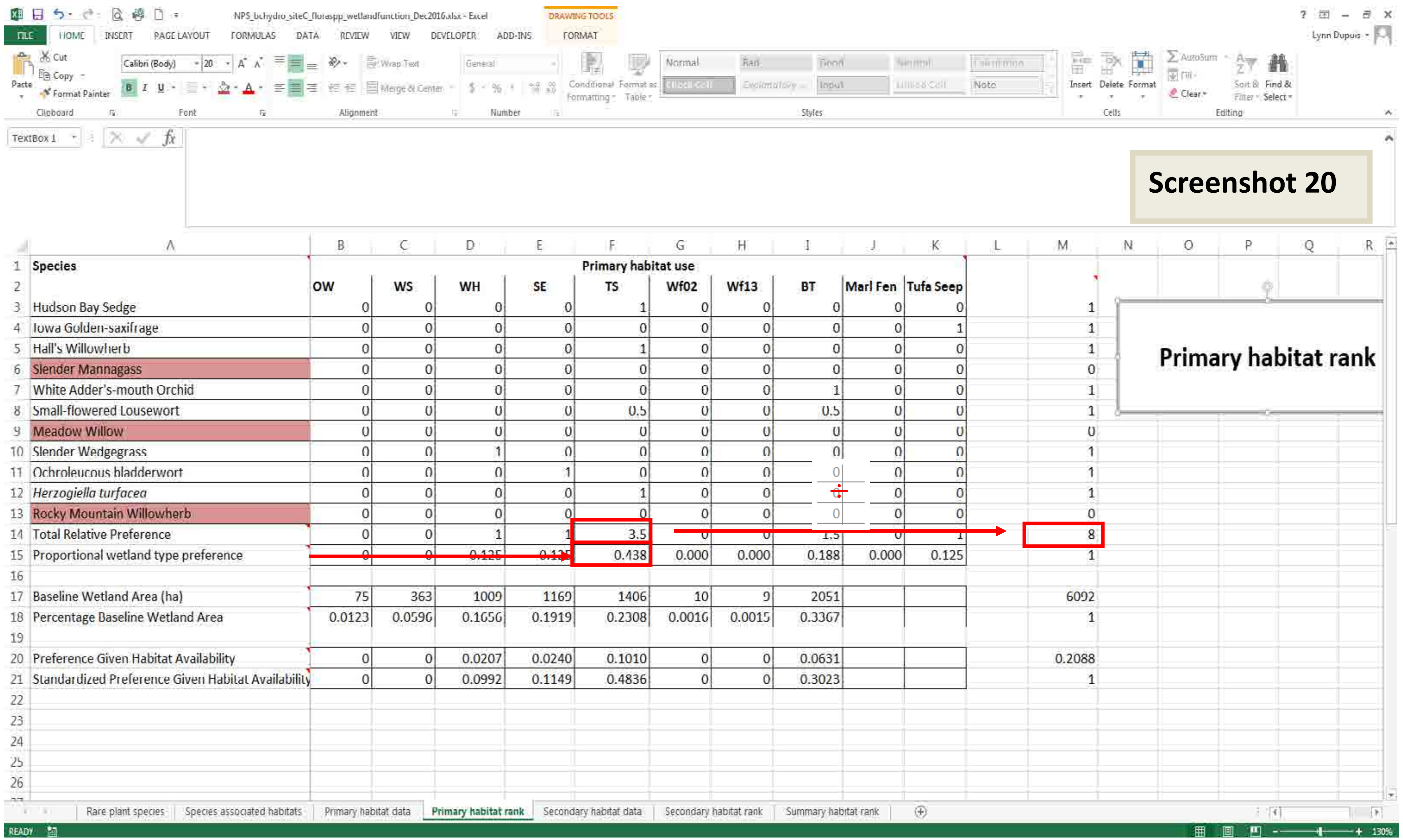
Species	Secondary habitat use ranking										M
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	0.407	0	0.052	0.542	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	0	0
Hall's Willowherb	0	0.017	[illegible]	[illegible]	[illegible]	[illegible]	0.034	0.411	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0.016	0.021	0.021	[illegible]	[illegible]	0.127	0.329	0	0	1
Small-flowered Lousewort	0	0	0	0	0.296	0	0	0.704	0	0	1
Meadow Willow	0	0.191	0.809	0	0	0	0	0	0	0	1
Slender Wedgegrass	0	0.193	0.081	0.147	0.117	0.184	0.147	0.131	0	0	1
Ochroleucous bladderwort	0	0.256	0.191	0.123	0.123	0.184	0.123	0	0	0	1
Herzogiella turfacea	0	0	0	0	0.35	0.06	0	0.59	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0.67	1.22	0.30	1.82	0.79	0.48	2.70			8
Proportional wetland type preference	0	0.08	0.15	0.04	0.23	0.10	0.06	0.34			1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.012	0.060	0.166	0.192	0.231	0.002	0.001	0.337			1
Preference Given Habitat Availability	0	0.005	0.025	0.007	0.053	0.000	0.000	0.114			0.204
Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	0.001	0.000	0.557			1



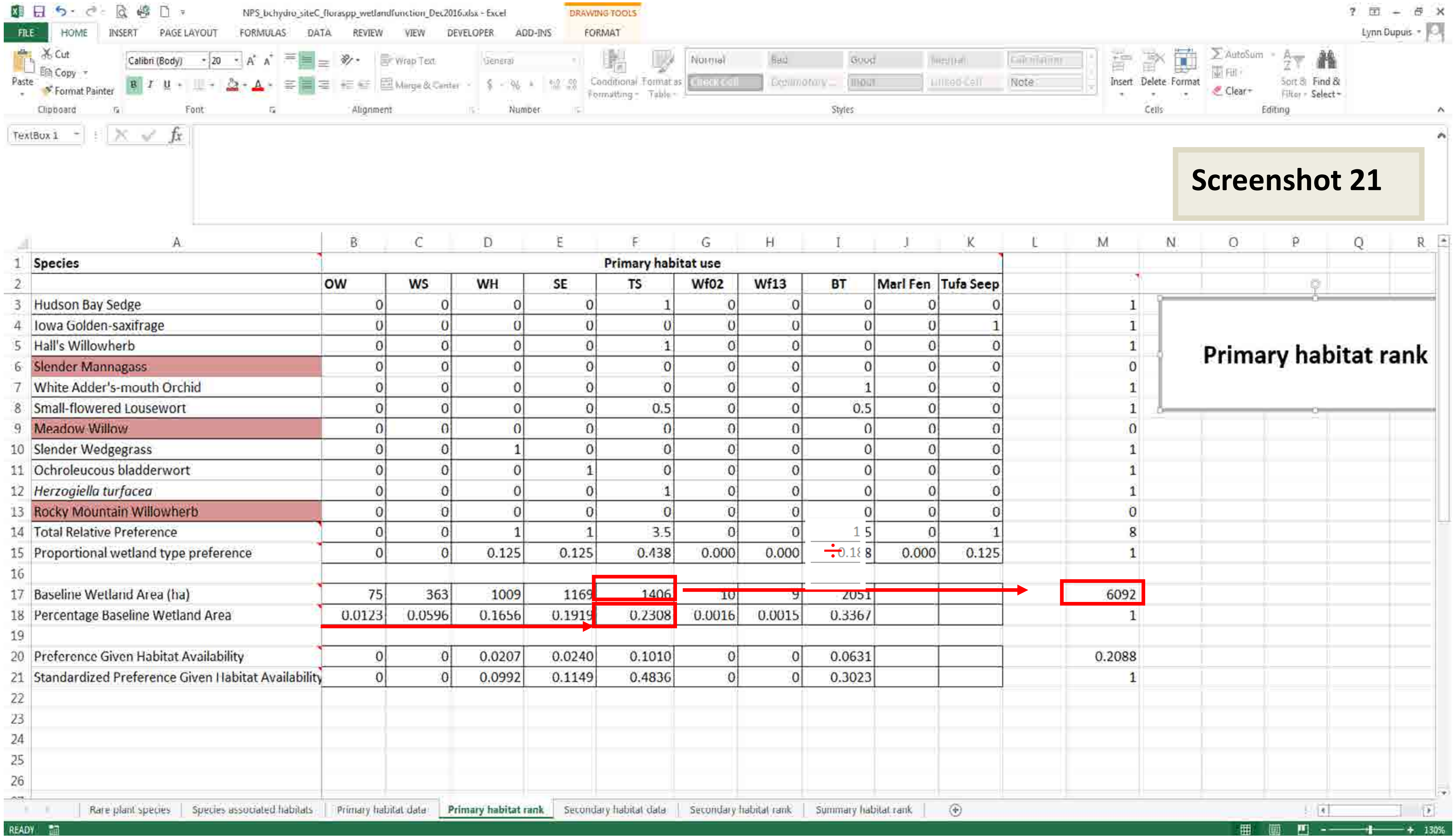
Screenshot 19

Primary habitat rank

Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
Herzogiella turfacea	0	0	0	0	1	0	0	0	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1	8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367			1
Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631			0.2088
Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023			1



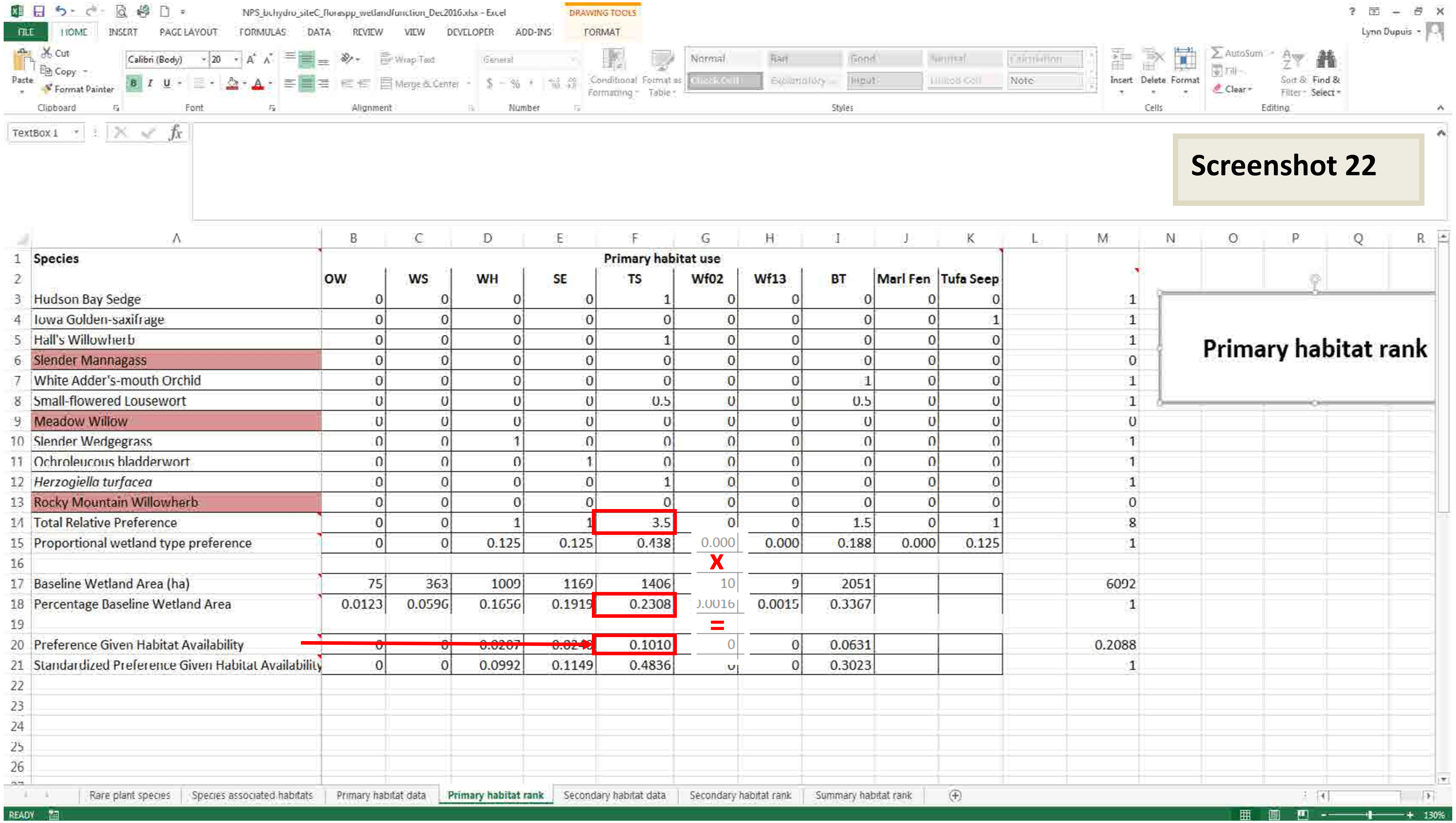
Species	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep		
	Primary habitat use											
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0		1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1		1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0		1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0		0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0		1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0		1
Meadow Willow	0	0	0	0	0	0	0	0	0	0		0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0		1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0		1
Herzogiella turfacea	0	0	0	0	1	0	0	[illegible]	0	0		1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0		0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1		8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125		1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051				6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367				1
Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631				0.2088
Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023				1



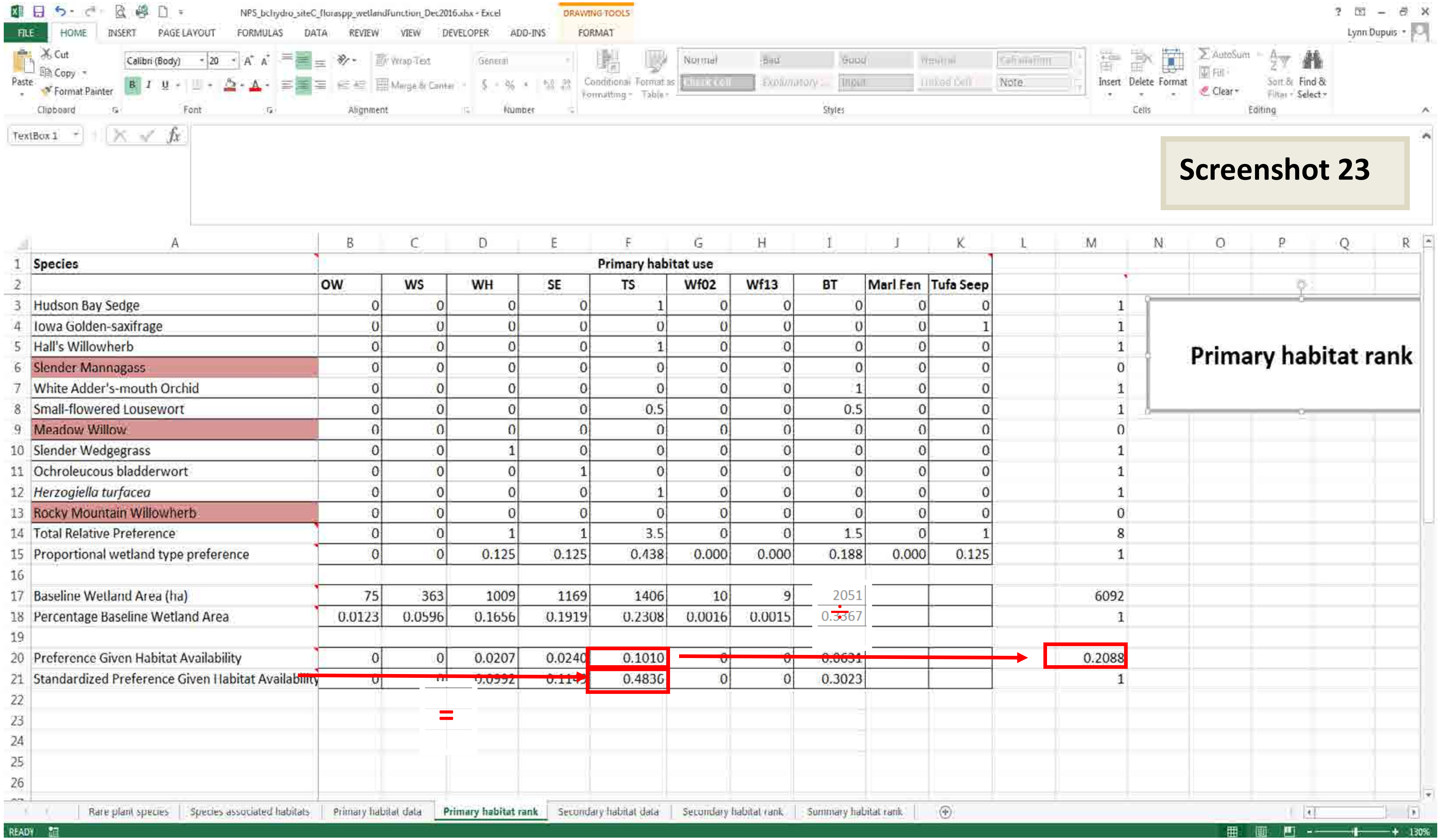
Screenshot 21

Primary habitat rank

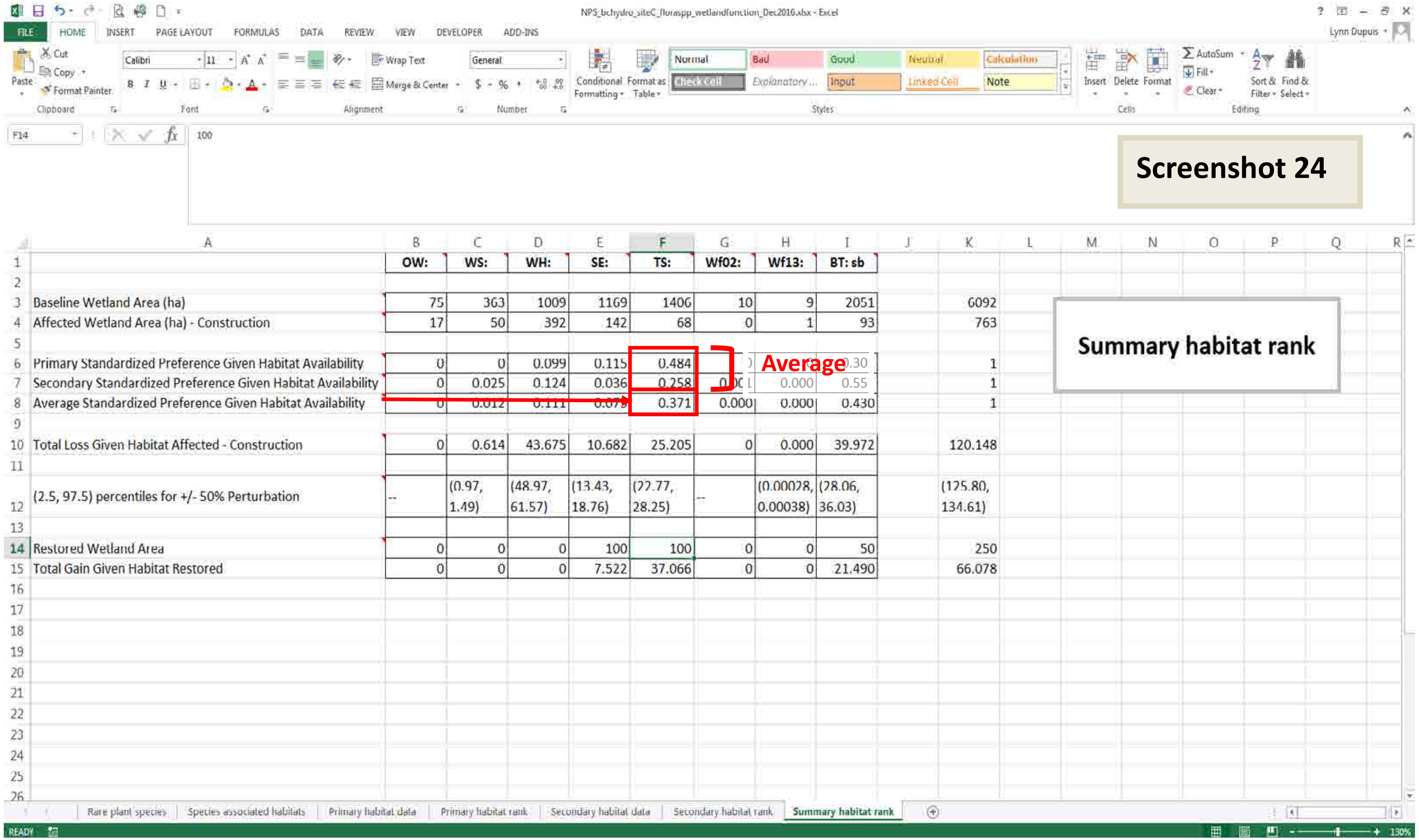
	Species	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	M
1	**Species**					**Primary habitat use**						
2		OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
3	Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
4	Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
5	Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
6	Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
7	White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
8	Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
9	Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
10	Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
11	Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
12	*Herzogiella turfacea*	0	0	0	0	1	0	0	0	0	0	1
13	Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
14	Total Relative Preference	0	0	1	1	3.5	0	0	1 5	0	1	8
15	Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.1[illegible]8	0.000	0.125	1
16												
17	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
18	Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367			1
19												
20	Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631			0.2088
21	Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023			1



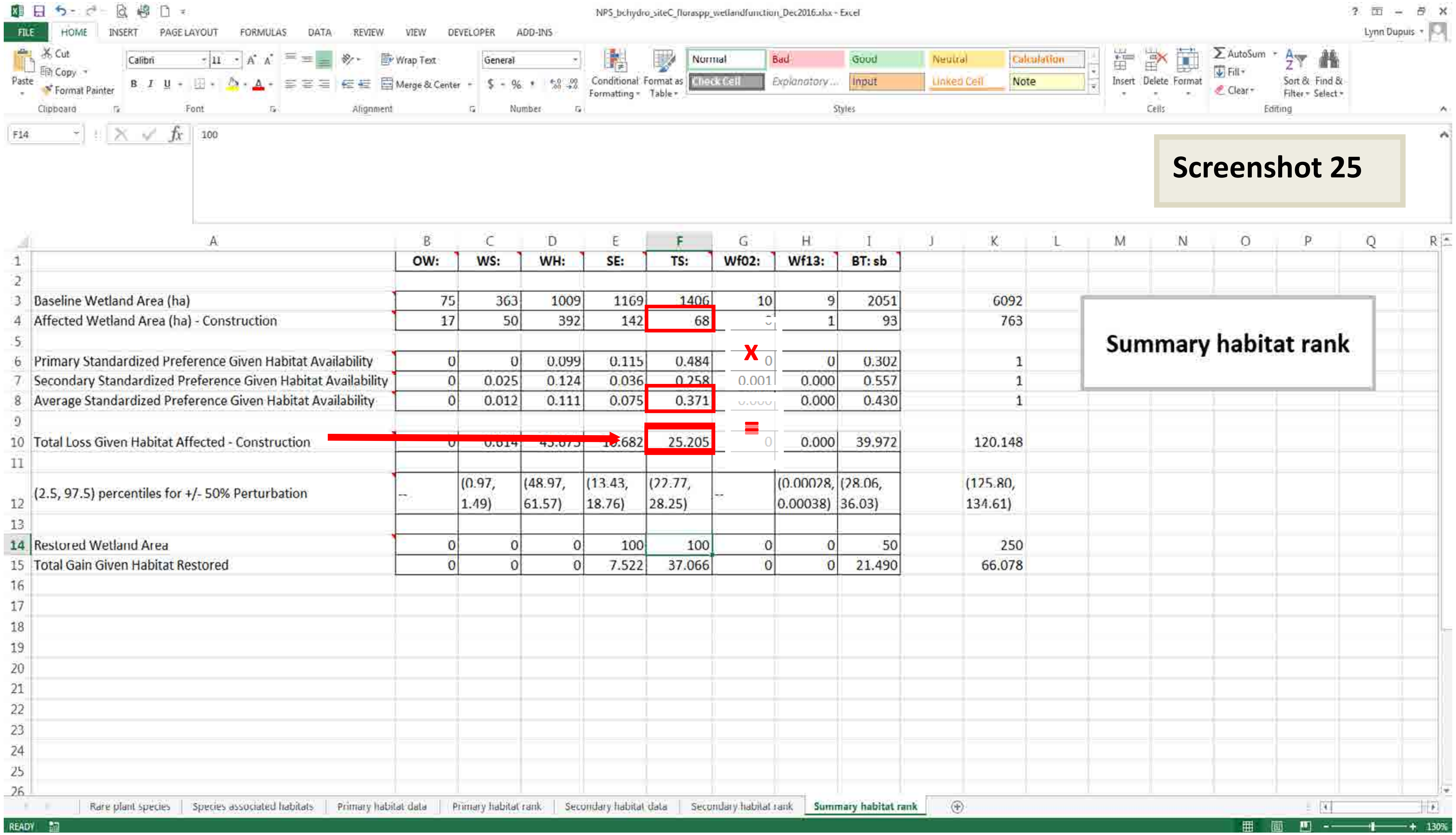
Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
Herzogiella turfacea	0	0	0	0	1	0	0	0	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1	8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	.0016	0.0015	0.3367			1
Preference Given Habitat Availability	0	0	0.0207	[illegible]	0.1010	0	0	0.0631			0.2088
Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023			1



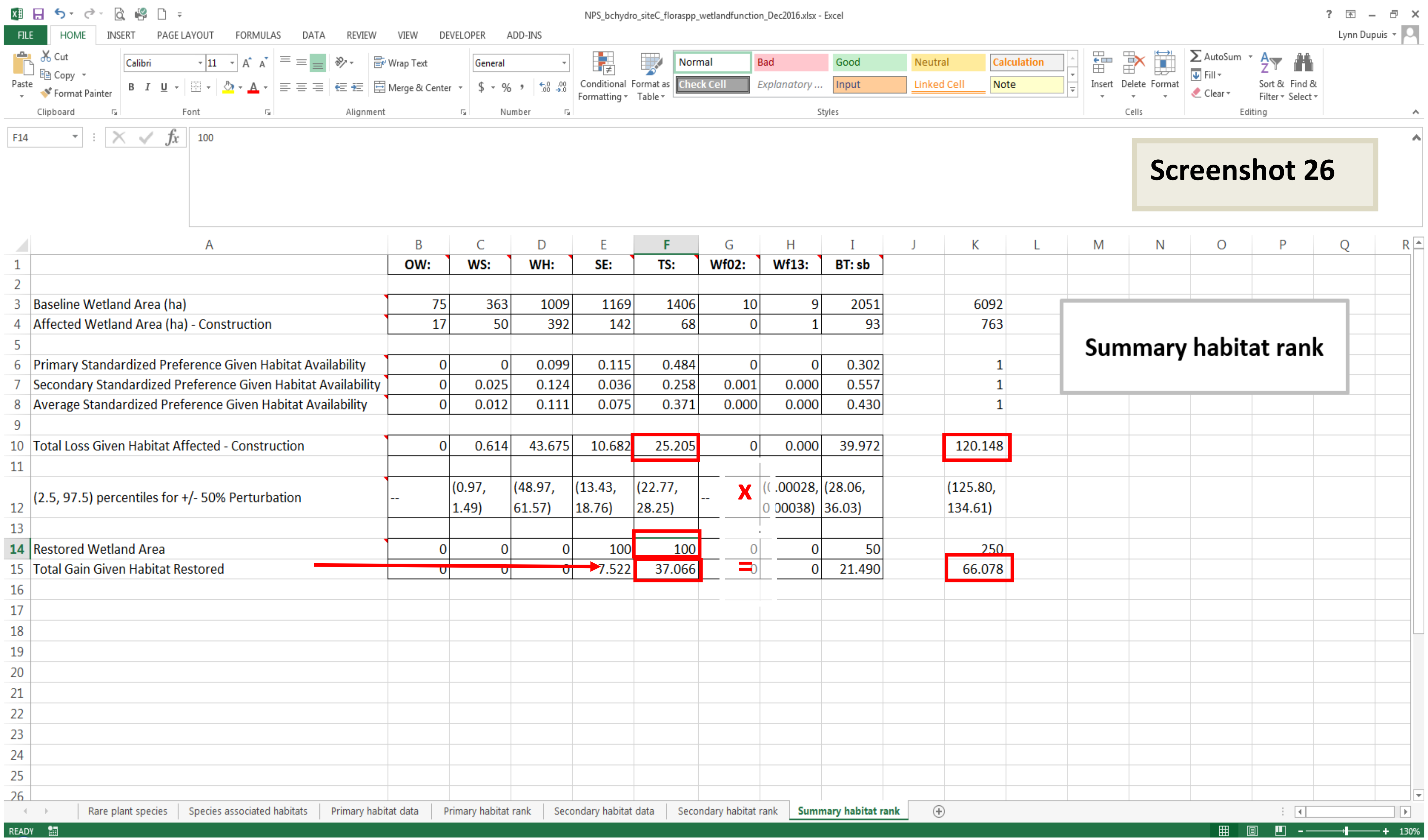
Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
Herzogiella turfacea	0	0	0	0	1	0	0	0	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1	8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367			1
Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631			0.2088
Standardized Preference Given Habitat Availability	0	[illegible]	0.0992	[illegible]	0.4836	0	0	0.3023			1



	A	B	C	D	E	F	G	H	I	J	K
1		OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2											
3	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
4	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
5											
6	Primary Standardized Preference Given Habitat Availability	0	0	0.099	0.115	0.484	[illegible]	[illegible]	0.30		1
7	Secondary Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	[illegible]	0.000	0.55		1
8	Average Standardized Preference Given Habitat Availability	0	0.012	0.111	0.075	0.371	0.000	0.000	0.430		1
9											
10	Total Loss Given Habitat Affected - Construction	0	0.614	43.675	10.682	25.205	0	0.000	39.972		120.148
11											
12	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(0.97, 1.49)	(48.97, 61.57)	(13.43, 18.76)	(22.77, 28.25)	--	(0.00028, 0.00038)	(28.06, 36.03)		(125.80, 134.61)
13											
14	Restored Wetland Area	0	0	0	100	100	0	0	50		250
15	Total Gain Given Habitat Restored	0	0	0	7.522	37.066	0	0	21.490		66.078



	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		K
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
Affected Wetland Area (ha) - Construction	17	50	392	142	68	[illegible]	1	93		763
Primary Standardized Preference Given Habitat Availability	0	0	0.099	0.115	0.484	0	0	0.302		1
Secondary Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	0.001	0.000	0.557		1
Average Standardized Preference Given Habitat Availability	0	0.012	0.111	0.075	0.371	[illegible]	0.000	0.430		1
Total Loss Given Habitat Affected - Construction	0	[illegible]	[illegible]	[illegible]	25.205	0	0.000	39.972		120.148
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(0.97, 1.49)	(48.97, 61.57)	(13.43, 18.76)	(22.77, 28.25)	--	(0.00028, 0.00038)	(28.06, 36.03)		(125.80, 134.61)
Restored Wetland Area	0	0	0	100	100	0	0	50		250
Total Gain Given Habitat Restored	0	0	0	7.522	37.066	0	0	21.490		66.078



	A	B	C	D	E	F	G	H	I	J	K
1		OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2											
3	Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051		6092
4	Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93		763
5											
6	Primary Standardized Preference Given Habitat Availability	0	0	0.099	0.115	0.484	0	0	0.302		1
7	Secondary Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	0.001	0.000	0.557		1
8	Average Standardized Preference Given Habitat Availability	0	0.012	0.111	0.075	0.371	0.000	0.000	0.430		1
9											
10	Total Loss Given Habitat Affected - Construction	0	0.614	43.675	10.682	25.205	0	0.000	39.972		120.148
11											
12	(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(0.97, 1.49)	(48.97, 61.57)	(13.43, 18.76)	(22.77, 28.25)	--	((.00028, 0 00038)	(28.06, 36.03)		(125.80, 134.61)
13											
14	Restored Wetland Area	0	0	0	100	100	0	0	50		250
15	Total Gain Given Habitat Restored	0	0	0	7.522	37.066	0	0	21.490		66.078

Appendix F: Sensitivity Analysis Results

Results of the sensitivity analysis on the wetland function assessment models are presented below (Tables E1 – E11). Shown are the baseline values for 'Total Loss Given Habitat Affected – Construction', as compared to the 95% confidence intervals for a +/- 20% and +/- 50% perturbation.

Table E1. Migratory bird nesting habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0	2.32	50.60	77.32	8.78	0	0.00124	13.77	152.79
(2.5, 97.5) percentiles for +/- 20% Perturbation	--	(2.00, 2.66)	(44.20, 56.71)	(74.44, 80.02)	(7.76, 9.85)	--	(0.0011, 0.0014)	(12.03, 15.59)	(147.73, 157.55)
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)	(139.99, 164.76)

Table E2. Migratory bird brood-rearing habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	2.72	0	0	118.01	0	0	0.00427	0	120.73
(2.5, 97.5) percentiles for +/- 20% Perturbation	(2.36, 3.18)	--	--	(113.90, 121.20)	--	--	(0.0034, 0.0053)	--	(117.08, 123.57)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(1.96, 4.18)	--	--	(104.92, 124.85)	--	--	(0.0023, 0.0073)	--	(109.10, 126.81)

Table E3. Migratory bird feeding habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	1.05	2.40	52.29	84.01	4.47	0	0.00143	8.91	153.13
(2.5, 97.5) percentiles for +/- 20% Perturbation	(0.90, 1.22)	(2.08, 2.77)	(45.26, 59.19)	(78.90, 88.88)	(3.85, 5.15)	--	(0.0012, 0.0017)	(7.75, 10.16)	(148.90, 157.45)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.72, 1.55)	(1.64, 3.43)	(36.10, 71.18)	(69.83, 95.39)	(2.99, 6.27)	--	(0.0009, 0.0021)	(6.06, 12.17)	(142.44, 163.95)

Table E4. Migratory bird migration habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	1.76	3.43	74.76	51.53	7.46	0	0.00186	14.88	153.83
(2.5, 97.5) percentiles for +/- 20% Perturbation	(1.64, 1.89)	(2.94, 3.96)	(65.42, 84.44)	(46.39, 56.82)	(6.24, 8.88)	--	(0.0016, 0.0022)	(12.51, 17.24)	(147.22, 160.53)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(1.48, 2.12)	(2.24, 4.81)	(51.48, 99.63)	(37.59, 63.95)	(4.51, 10.90)	--	(0.0012, 0.0027)	(9.15, 20.83)	(137.36, 170.71)

Table E5. Amphibian breeding habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0.45	2.12	46.10	58.04	11.14	0	0.00105	22.23	140.08
(2.5, 97.5) percentiles for +/- 20% Perturbation	(0.35, 0.55)	(1.79, 2.46)	(39.31, 53.38)	(51.04, 64.45)	(9.56, 12.83)	--	(0.0009, 0.0012)	(19.23, 25.24)	(135.92, 143.77)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.23, 0.75)	(1.35, 3.08)	(30.03, 65.43)	(39.18, 73.18)	(7.36, 15.59)	--	(0.0007, 0.0015)	(14.99, 30.32)	(128.61, 148.76)

Table E6. Amphibian feeding habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0	3.02	65.74	27.59	15.89	0	0.0015	31.70	143.93
(2.5, 97.5) percentiles for +/- 20% Perturbation	--	(2.68, 3.33)	(59.82, 71.82)	(25.07, 31.09)	(14.52, 17.26)	--	(0.0013, 0.0017)	(29.27, 34.02)	(139.33, 148.61)
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(2.21, 3.80)	(51.05, 81.21)	(21.31, 34.14)	(12.45, 19.29)	--	(0.0011, 0.0020)	(25.49, 37.37)	(132.49, 155.86)

Table E7. Amphibian wintering habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0.88	12.54	273.34	0	0	0	0	0	286.77
(2.5, 97.5) percentiles for +/- 20% Perturbation	(0.81, 0.97)	(9.21, 16.53)	(240.11, 301.15)	--	--	--	--	--	(257.61, 311.15)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.72, 1.13)	(5.13, 24.22)	(175.95, 335.19)	--	--	--	--	--	(201.30, 341.04)

Table E8. Bat feeding habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0.13	2.42	52.70	16.59	19.11	0	0.0009	38.12	129.07
(2.5, 97.5) percentiles for +/- 20% Perturbation	(0.12, 0.14)	(2.23, 2.62)	(49.04, 56.43)	(15.55, 17.61)	(16.94, 21.35)	--	(0.0008, 0.0010)	(34.57, 41.54)	(126.06, 131.83)
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.11, 0.15)	(1.96, 2.94)	(43.56, 62.18)	(14.01, 19.14)	(13.78, 24.83)	--	(0.0007, 0.0011)	(28.92, 46.49)	(121.60, 135.88)

Table E9. Bat roosting habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0	7.19	156.69	0	12.62	0	0	25.19	201.69
(2.5, 97.5) percentiles for +/- 20% Perturbation	--	(5.41, 9.22)	(128.85, 183.06)	--	(9.83, 15.57)	--	--	(20.06, 30.36)	(178.84, 223.33)
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(3.10, 12.83)	(84.05, 220.10)	--	(5.91, 20.31)	--	--	(12.46, 38.20)	(142.08, 253.72)

Table E10. Rare plant habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0	1.21	55.78	16.06	25.20	0	0.00033	32.43	130.68
(2.5, 97.5) percentiles for +/- 20% Perturbation	--	(1.11, 1.31)	(53.23, 58.20)	(14.99, 17.12)	(24.20, 26.32)	--	(0.00031, 0.00035)	(30.82, 33.90)	(128.90, 132.33)
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(0.97, 1.49)	(48.97, 61.57)	(13.43, 18.76)	(22.77, 28.25)	--	(0.00028, 0.00038)	(28.06, 36.03)	(125.80, 134.61)

Table E11. Species important to Aboriginal use habitat sensitivity analysis.

	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
Baseline	0	2.86	62.38	9.82	14.14	0	0.00053	47.01	136.21
(2.5, 97.5) percentiles for +/- 20% Perturbation	--	(2.33, 3.44)	(51.80, 72.86)	(7.75, 11.94)	(10.74, 17.92)	--	(0.0004, 0.0007)	(39.11, 54.31)	(128.85, 143.54)
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.62, 4.37)	(37.33, 89.45)	(4.75, 15.23)	(6.24, 24.47)	--	(0.0003, 0.0008)	(26.01, 64.30)	(117.16, 154.56)

Species Habitat Associations

Habitat Type

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Labrador Tea					X			X
Highbush Cranberry		X	X					X
Moose		X	X	X		X	X	

Aboriginal Use Functions

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
	Habitat Type								
Labrador Tea	0	0	0	0	0.5	0	0	0.5	1
Highbush Cranberry	0	0.33	0.33	0	0	0	0	0.33	1
Moose	0	0.20	0.20	0.20	0.00	0.20	0.20	0	1
Total relative preference	0.00	0.53	0.53	0.20	0.50	0.20	0.20	0.83	3
Proportional wetland type preference	0.00	0.18	0.18	0.07	0.17	0.07	0.07	0.28	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0000	0.0106	0.0294	0.0128	0.0385	0.0001	0.0001	0.0935	0
Standardized Preference Given Habitat Availability	0.0000	0.0573	0.1591	0.0691	0.2079	0.0006	0.0005	0.5054	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0.0000	2.8626	62.3830	9.8180	14.1369	0.0000	0.0005	47.0065	136
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.62, 4.37)	(37.33, 89.45)	(4.75, 15.23)	(6.24, 24.47)	--	(0.0003, 0.0008)	(26.01, 64.30)	(117.16, 154.56)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Resored	0	0	0	0	0	0	0	0	0

Species Habitat Use

Habitat Type

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Dabbling Ducks								
American Wigeon	X	X	X	X		X	X	
Green-winged Teal	X	X	X	X		X	X	
Diving Ducks								
Lesser Scaup	X	X	X	X		X	X	
Ring-necked Duck	X			X				
Cavity-nesting Ducks								
Bufflehead	X							
Common Goldeneye	X							
Swans and Geese								
Trumpeter Swan	X			X				
Deciduous Songbirds								
Alder Flycatcher		X	X					
Common Yellowthroat		X	X	X		X		
Northern Waterthrush		X	X					
Open Habitat Songbirds								
Le Conte's Sparrow				X		X	X	
Nelson's Sparrow				X		X	X	
Coniferous Songbirds								
Lincoln's Sparrow		X	X	X	X	X		X
Olive-sided Flycatcher					X			X
Rusty Blackbird		X	X		X	X		X
Forest-nesting Shorebirds								
Lesser Yellowlegs	X	X	X	X	X	X	X	X
Solitary Sandpiper	X			X	X			X
Marsh-nesting Shorebirds								
Wilson's Snipe		X	X	X		X	X	
Rails								
Sora				X		X	X	
Yellow Rail				X		X	X	
Gulls and Terns								
Black Tern	X			X				
Bonaparte's Gull	X			X	X			X
Waterbirds								
Common Loon	X			X				
Horned Grebe	X			X				
Aerial Insectivores								
Bank Swallow	X	X	X	X	X	X	X	
Common Nighthawk	X	X	X	X	X	X	X	X
Amphibians								
Boreal Chorus Frog	X	X	X	X	X	X	X	X
Columbia Spotted Frog	X	X	X	X	X	X	X	X
Western Toad	X	X	X	X	X	X	X	X
Bats								
Little Brown Myotis	X	X	X	X	X	X	X	X

Northern Myotis					X			X
Long-eared Myotis	X	X	X	X	X	X	X	X
Silver-haired Bat	X	X	X	X	X	X	X	X
Eastern Red Bat		X	X		X			X
Hoary Bat	X	X	X	X	X	X	X	X
Long-legged Myotis	X	X	X	X	X	X	X	X
Big Brown Bat	X	X	X	X	X	X	X	X
Species at Risk								
Aphrodite fritillary			X	X				
Assiniboine skipper			X	X				
Bronze copper				X				
Common ringlet			X					X
Common woodnymph			X	X				
Great spangled fritillary			X	X	X			
Tawny crescent			X		X			
Prairie bluet	X	X	X	X	X	X	X	
Western Toad	X	X	X	X	X	X	X	X
Surf scoter	X							
Common Nighthawk	X	X	X	X	X	X	X	X
Bank Swallow	X	X	X	X	X	X	X	
Barn swallow	X	X	X	X	X	X	X	X
Rusty Blackbird		X	X		X	X		X
Olive-sided Flycatcher					X			X
Nelson's Sparrow				X		X	X	
Yellow Rail				X		X	X	
Short-eared Owl		X	X	X	X			X

Functional Loss per Habitat

Migratory Birds	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Nesting		Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Diving Ducks Swans & Geese* Open Habitat Songbirds Marsh-nesting Shorebirds Rails Gulls & Terns Waterbirds* Aerial Insectivores	Coniferous Songbirds Forest-nesting Shorebirds Gulls & Terns Aerial Insectivores	Dabbling Ducks Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Dabbling Ducks Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Forest-nesting Shorebirds Gulls & Terns
Brood-rearing	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Waterbirds*			Dabbling Ducks Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails		Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	
Feeding	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Forest-nesting Shorebirds Gulls & Terns Waterbirds* Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Dabbling Ducks Swans & Geese* Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails Gulls & Terns Aerial Insectivores	Coniferous Songbirds Aerial Insectivores	Open Habitat Songbirds Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores
Migration	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Forest-nesting Shorebirds Gulls & Terns Waterbirds* Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Aerial Insectivores	Open Habitat Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores	Open Habitat Songbirds Deciduous Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Open Habitat Songbirds Marsh-nesting Shorebirds Rails Aerial Insectivores	Coniferous Songbirds Aerial Insectivores
Species Group Use	21	13	13	27	8	20	16	7

Fauna ranking step * Use of particular habitat by some spp. of the group is dependent on how large the associated waterbody is

Amphibians	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Feeding		Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad
Breeding	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Columbia Spotted Frog Western Toad	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Western Toad
Hibernation	Columbia Spotted Frog	Boreal Chorus Frog Western Toad	Boreal Chorus Frog Western Toad					
Species Group Use	4	7	7	6	5	5	5	5

Bats	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Feeding	Little Brown Myotis Long-eared Myotis Silver-haired Bat Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Long-eared Myotis Silver-haired Bat Eastern Red Bat Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Long-eared Myotis Silver-haired Bat Eastern Red Bat Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Long-eared Myotis Silver-haired Bat Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Northern Myotis Long-eared Myotis Silver-haired Bat Eastern Red Bat Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Long-eared Myotis Silver-haired Myotis Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Long-eared Myotis Silver-haired Myotis Hoary Bat Long-legged Myotis Big Brown Bat	Little Brown Myotis Northern Myotis Long-eared Myotis Silver-haired Bat Eastern Red Bat Hoary Bat Long-legged Myotis Big Brown Bat
Roosting		Eastern Red Bat Hoary Bat	Eastern Red Bat Hoary Bat		Hoary Bat			Hoary Bat
Species Group Use	6	9	9	6	9	6	6	9

Migratory Birds Nesting

Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Dabbling Ducks	0	0.20	0.20	0.20	0	0.20	0.20	0	1
Diving Ducks	0	0	0	1	0	0	0	0	1
Cavity-nesting Ducks	0	0	0	0	0	0	0	0	0
Swans & Geese	0	0	0	1	0	0	0	0	1
Waterbirds	0	0	0	1	0	0	0	0	1
Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33	1
Forest-nesting Shorebirds	0	0.20	0.20	0	0.20	0.20	0	0.20	1
Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0	1
Rails	0	0	0	0.33	0	0.33	0.33	0	1
Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0	1
Deciduous Songbirds	0	0.50	0.50	0	0	0	0	0	1
Coniferous Songbirds	0	0.20	0.20	0	0.20	0.20	0	0.20	1
Aerial Insectivores	0	0.20	0.20	0.20	0.20	0	0.20	0	1
Total relative preference	0.00	1.30	1.30	4.73	0.93	1.60	1.40	0.73	12
Proportional wetland type preference	0.00	0.11	0.11	0.39	0.08	0.13	0.12	0.06	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0	0.0065	0.0179	0.0757	0.0180	0.0002	0.0002	0.0206	0.1390
Standardized Preference Given Habitat Availability	0	0.0464	0.1291	0.5445	0.1291	0.0016	0.0012	0.1480	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0	2.3219	50.5999	77.3213	8.7813	0.00	0.00	13.7651	152.7909
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(1.53, 3.19)	(34.49, 65.88)	(70.11, 84.07)	(6.25, 11.49)	--	(0.0009, 0.0017)	(9.43, 18.35)	(139.99, 164.76)
Restored Wetland Area	0	100	0	100	0	0	0	100	300
Total Gain Given Habitat Restored	0	4.64	0	54.45	0	0	0	14.80	73.90

Migratory Birds Brood-Rearing

Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Dabbling Ducks	0.50	0	0	0.50	0	0	0	0	1
Diving Ducks	1	0	0	0	0	0	0	0	1
Cavity-nesting Ducks	1	0	0	0	0	0	0	0	1
Geese & Swans	1	0	0	0	0	0	0	0	1
Waterbirds	1	0	0	0	0	0	0	0	1
Terns & Gulls	0	0	0	0	0	0	0	0	0
Forest-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0	1
Marsh-nesting Shorebirds	0	0	0	0.33	0	0.33	0.33	0	1
Rails	0	0	0	0.33	0	0.33	0.33	0	1
Open Habitat Songbirds	0	0	0	0	0	0	0	0	0
Deciduous Songbirds	0	0	0	0	0	0	0	0	0
Coniferous Songbirds	0	0	0	0	0	0	0	0	0
Aerial Insectivores	0	0	0	0	0	0	0	0	0
Total relative preference	4.50	0	0	1.50	0	1	1	0	8
Proportional wetland type preference	0.56	0	0	0.19	0	0.13	0.13	0	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0069	0	0	0.0360	0	0.0002	0.0002	0	0.0433
Standardized Preference Given Habitat Availability	0.1600	0	0	0.8310	0	0.0047	0.0043	0	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	2.7192	0	0	118.0081	0	0	0.0043	0	120.7315
(2.5, 97.5) percentiles for +/- 50% Perturbation	(1.96, 4.18)	--	--	(104.92, 124.85)	--	--	(0.0023, 0.0073)	--	(109.10, 126.81)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Dabbling Ducks	0.50	0	0	0.50	0	0	0	0	1
Diving Ducks	1	0	0	0	0	0	0	0	1
Cavity-nesting Ducks	1	0	0	0	0	0	0	0	1
Geese & Swans	0.50	0	0	0.50	0	0	0	0	1
Waterbirds	1	0	0	0	0	0	0	0	1
Terns & Gulls	0.50	0	0	0.50	0	0	0	0	1
Forest-nesting Shorebirds	0.50	0	0	0.50	0	0	0	0	1
Marsh-nesting Shorebirds	0	0.20	0.20	0.20	0	0.20	0.20	0	1
Rails	0	0	0	0.33	0	0.33	0.33	0	1
Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0	1
Deciduous Songbirds	0	0.33	0.33	0	0	0.33	0	0	1
Coniferous Songbirds	0	0.17	0.17	0.17	0.17	0.17	0	0.17	1
Aerial Insectivores	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Total relative preference	5.13	0.83	0.83	3.16	0.29	1.49	0.99	0.29	13
Proportional wetland type preference	0.39	0.06	0.06	0.24	0.02	0.11	0.08	0.02	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0049	0.0038	0.0105	0.0466	0.0052	0.0002	0.0001	0.0076	0.0788
Standardized Preference Given Habitat Availability	0.0616	0.0480	0.1334	0.5916	0.0657	0.0024	0.0014	0.0959	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	1.0471	2.3994	52.2892	84.0120	4.4685	0	0.0014	8.9149	153.1326
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.72, 1.55)	(1.64, 3.43)	(36.10, 71.18)	(69.83, 95.39)	(2.99, 6.27)	--	(0.0009, 0.0021)	(6.06, 12.17)	(142.44, 163.95)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Migratory Birds Feeding

Migratory Birds Migration

Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Dabbling Ducks	1	0	0	0	0	0	0	0	1
Diving Ducks	1	0	0	0	0	0	0	0	1
Cavity-nesting Ducks	1	0	0	0	0	0	0	0	1
Geese & Swans	1	0	0	0	0	0	0	0	1
Waterbirds	1	0	0	0	0	0	0	0	1
Terns & Gulls	1	0	0	0	0	0	0	0	1
Forest-nesting Shorebirds	0.50	0	0	0.50	0	0	0	0	1
Marsh-nesting Shorebirds	0	0.20	0.20	0.20	0	0.20	0.20	0	1
Rails	0	0	0	0.33	0	0.33	0.33	0	1
Open Habitat Songbirds	0	0	0	0.33	0	0.33	0.33	0	1
Deciduous Songbirds	0	0.33	0.33	0	0	0.33	0	0	1
Coniferous Songbirds	0	0.25	0.25	0	0.25	0	0	0.25	1
Aerial Insectivores	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Total relative preference	6.63	0.91	0.91	1.49	0.38	1.33	0.99	0.38	13
Proportional wetland type preference	0.51	0.07	0.07	0.11	0.03	0.10	0.08	0.03	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.012311	0.059586	0.165627	0.191891	0.230794	0.001641	0.001477	0.336671	1
Preference Given Habitat Availability	0.006274	0.004163	0.011573	0.0220	0.006658	0.000167	0.000113	0.009712	0.0607
Standardized Preference Given Habitat Availability	0.103399	0.068615	0.190724	0.362873	0.10972	0.002757	0.001857	0.160054	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	1.7578	3.4308	74.7638	51.5280	7.4610	0.0000	0.0019	14.8850	153.8282
(2.5, 97.5) percentiles for +/- 50% Perturbation	(1.48, 2.12)	(2.24, 4.81)	(51.48, 99.63)	(37.59, 63.95)	(4.51, 10.90)	--	(0.0012, 0.0027)	(9.15, 20.83)	(137.36, 170.71)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Amphibian Breeding

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Boreal Chorus Frog	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Columbia Spotted Frog	0.50	0	0	0.50	0	0	0	0	1
Western Toad	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Total relative preference	0.75	0.25	0.25	0.75	0.25	0.25	0.25	0.25	3
Proportional wetland type preference	0.25	0.08	0.08	0.25	0.08	0.08	0.08	0.08	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0031	0.0050	0.0138	0.0480	0.0192	0.0001	0.0001	0.0281	0.1174
Standardized Preference Given Habitat Availability	0.0262	0.0423	0.1176	0.4087	0.1639	0.0012	0.0010	0.2390	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0.4458	2.1154	46.0988	58.0413	11.1431	0.0000	0.0010	22.2311	140.0766
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.23, 0.75)	(1.35, 3.08)	(30.03, 65.43)	(39.18, 73.18)	(7.36, 15.59)	--	(0.0007, 0.0015)	(14.99, 30.32)	(128.61, 148.76)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Amphibian Feeding

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Boreal Chorus Frog	0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	1
Columbia Spotted Frog	0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	1
Western Toad	0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	1
Total relative preference	0	0.43	0.43	0.43	0.43	0.43	0.43	0.43	3
Proportional wetland type preference	0	0.14	0.14	0.14	0.14	0.14	0.14	0.14	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0	0.0085	0.0237	0.0274	0.0330	0.0002	0.0002	0.0481	0.1411
Standardized Preference Given Habitat Availability	0	0.0603	0.1677	0.1943	0.2337	0.0017	0.0015	0.3409	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0	3.0165	65.7351	27.5882	15.8896	0	0.0015	31.7007	143.9315
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(2.21, 3.80)	(51.05, 81.21)	(21.31, 34.14)	(12.45, 19.29)	--	(0.0011, 0.0020)	(25.49, 37.37)	(132.49, 155.86)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Amphibian Hibernation

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Boreal Chorus Frog	0	0.50	0.50	0	0	0	0	0	1
Columbia Spotted Frog	1	0	0	0	0	0	0	0	1
Western Toad	0	0.50	0.50	0	0	0	0	0	1
Total relative preference	1	1	1	0	0	0	0	0	3
Proportional wetland type preference	0.33	0.33	0.33	0	0	0	0	0	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0041	0.0199	0.0552	0	0	0	0	0	0.0792
Standardized Preference Given Habitat Availability	0.0518	0.2509	0.6973	0	0	0	0	0	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0.8811	12.5432	273.3435	0	0	0	0	0	286.7678
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.72, 1.13)	(5.13, 24.22)	(175.95, 335.19)	--	--	--	--	--	(201.30, 341.04)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Bats Feeding

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Little Brown Myotis	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Northern Myotis	0	0	0	0	0.50	0	0	0.50	1
Long-eared Myotis	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Silver-haired Bat	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Eastern Red Bat	0	0.25	0.25	0	0.25	0	0	0.25	1
Hoary Bat	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Long-legged Myotis	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Big Brown Bat	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Total relative preference	0.75	1	1	0.75	1.50	0.75	0.75	1.50	8
Proportional wetland type preference	0.09	0.13	0.13	0.09	0.19	0.09	0.09	0.19	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0012	0.0074	0.0207	0.0180	0.0433	0.0002	0.0001	0.0631	0.1540
Standardized Preference Given Habitat Availability	0.0075	0.0484	0.1344	0.1168	0.2810	0.0010	0.0009	0.4099	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0.1274	2.4185	52.7037	16.5893	19.1095	0	0.0009	38.1245	129.0737
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.11, 0.15)	(1.96, 2.94)	(43.56, 62.18)	(14.01, 19.14)	(13.78, 24.83)	--	(0.0007, 0.0011)	(28.92, 46.49)	(121.60, 135.88)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Bats Roosting

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Little Brown Myotis	0	0	0	0	0	0	0	0	0
Northern Myotis	0	0	0	0	0	0	0	0	0
Long-eared Myotis	0	0	0	0	0	0	0	0	0
Silver-haired Bat	0	0	0	0	0	0	0	0	0
Eastern Red Bat	0	0.50	0.50	0	0	0	0	0	1
Hoary Bat	0	0.25	0.25	0	0.25	0	0	0.25	1
Long-legged Myotis	0	0	0	0	0	0	0	0	0
Big Brown Bat	0	0	0	0	0	0	0	0	0
Total relative preference	0	0.75	0.75	0	0.25	0	0	0.25	2
Proportional wetland type preference	0	0.38	0.38	0	0.13	0	0	0.13	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0	0.0223	0.0621	0	0.0288	0	0	0.0421	0.155388
Standardized Preference Given Habitat Availability	0	0.1438	0.3997	0	0.1857	0	0	0.2708	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0	7.1900	156.6861	0	12.6249	0	0	25.1872	201.6882
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(3.10, 12.83)	(84.05, 220.10)	--	(5.91, 20.31)	--	--	(12.46, 38.20)	(142.08, 253.72)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Species at Risk

Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Aphrodite fritillary, *manitoba* subspecies	0	0	0.50	0.50	0	0	0	0	1
Assiniboine skipper	0	0	0.50	0.50	0	0	0	0	1
Bronze copper	0	0	0	1	0	0	0	0	1
Common ringlet, *benjamini* subspecies	0	0	0.50	0	0	0	0	0.50	1
Common woodnymph, *nephele* subspecies	0	0	0.50	0.50	0	0	0	0	1
Great spangled fritillary, *pseudocarpenteri* subspecies	0	0	0.33	0.33	0.33	0	0	0	1
Tawny crescent	0	0	0.50	0	0.50	0	0	0	1
Prairie bluet	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0	1
Western Toad	0.04	0.26	0.26	0.09	0.09	0.09	0.09	0.09	1
Northern Myotis	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.50	1
Little Brown Myotis	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Surf scoter	1	0	0	0	0	0	0	0	1
Common Nighthawk	0.08	0.15	0.15	0.15	0.15	0.08	0.15	0.08	1
Barn swallow	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1
Rusty Blackbird	0	0.13	0.13	0	0.30	0.13	0	0.30	1
Olive-sided Flycatcher	0	0	0	0	0.50	0	0	0.50	1
Nelson's Sparrow	0	0	0	0.33	0	0.33	0.33	0	1
Yellow Rail	0	0	0	0.33	0	0.33	0.33	0	1
Short-eared Owl	0	0.20	0.20	0.20	0.20	0	0	0.20	1
Total relative preference	1.52	1.13	3.97	4.33	2.97	1.37	1.30	2.42	19.00
Proportional wetland type preference	0.08	0.06	0.21	0.23	0.16	0.07	0.07	0.13	1.00
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367	1
Preference Given Habitat Availability	0.0010	0.0036	0.0346	0.0438	0.0360	0.0001	0.0001	0.0429	0.1620
Standardized Preference Given Habitat Availability	0.0061	0.0219	0.2134	0.2700	0.2223	0.0007	0.0006	0.2649	1
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Total Loss Given Habitat Affected - Construction	0.1032	1.0957	83.6339	38.3456	15.1181	0	0.0006	24.6402	162.94
(2.5, 97.5) percentiles for +/- 50% Perturbation	(0.1020, 0.1214)	(0.83, 1.35)	(58.08, 110.87)	(30.85, 46.92)	(10.18 19.71)	--	(0.00046, 0.00081)	(16.63, 32.19)	(144.64, 182.84)
Restored Wetland Area	0	0	0	0	0	0	0	0	0
Total Gain Given Habitat Restored	0	0	0	0	0	0	0	0	0

Rare plant species

Scientific name	Common name
Carax heleonastes	Hudson Bay sedge
Chrysosplenium iowense	Iowa golden-saxifrage
Epilobium halleanum	Hall's willowherb
Glyceria pulchella	Slender mannagrass
Malaxis brachypoda	White Adder's-mouth Orchid
Pedicularis parviflora ssp. *parviflora*	Small-flowered lousewort
Salix petiolaris	Meadow willow
Sphenopholis intermedia	Slender wedgegrass
Utricularia ochroleuca	Ochroleucous bladderwort
Herzogiella turfacea	No common name
Epilobium saximontanum	Rocky Mountain Willowherb

									Associated Species Importance per habitat (Mackenzine and Moran, 2004)															Secondary habitat output														
	Common Name	**Scientific name**	**Associated species (common name)**	**Associated species (Scientific name)**	**Observation Occurrence**	**# of occurrences**	**% of associated species occurrence**	**Primary Habitat**	**Wb03 (BT)**	**Wb09 (BT)**	**Wb06 (TS)**	**Wf07 (TS)**	**Wf08 (TS)**	**Wf13**	**Wf01 (SE)**	**Wf02**	**Wm01 (SE)**	**Wm05 (SE)**	**Ws03 (WS)**	**Ws06 (WS)**	**Fl01 (WH)**	**Fl03 (WH)**	**Fl05 (WH)**	**Wb03 (BT)**	**Wb09 (BT)**	**Wb06 (TS)**	**Wf07 (TS)**	**Wf08 (TS)**	**Wf13**	**Wf01 (SE)**	**Wf02**	**Wm01 (SE)**	**Wm05 (SE)**	**Ws03 (WS)**	**Ws06 (WS)**	**Fl01 (WH)**	**Fl03 (WH)**	**Fl05 (WH)**
	Hudson Bay Sedge	***Carex heleonastes***		**Found in open wet habitats, such as moist meadows, marshy lowlands, and montane bogs and fens.**				(TS)																														
Observation 1		Open minerotrophic muskeg of old but short-stature trees																																				
		Species A	Tamarack	*Larix laricina*	1	1	1.0		0.45		0.80													0.45	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species B	Labrador tea	*Ledum groenlandicum*	1	1	1.0		0.80		0.60													0.80	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Black spruce	*Picea mariana*	1	1	1.0		0.95	0.80	0.60													0.95	0.80	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Golden fuzzy fen moss	*Tomentypnum nitens*	1	1	1.0		0.15		0.80	0.45	0.30	0.15										0.15	0.00	0.80	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																								0.59	**0.20**	**0.70**	**0.11**	**0.08**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Iowa Golden-saxifrage	***Chrysosplenium iowense***		**Grows in moist to wet montane environments, including marshes and wet meadows, bogs, seeps, and stream banks.**				Tufa seep																														
Observation 1		On exposed soil of cut-bank and on dry tufa above a large slough		*Mitella nuda, Plagiomnium sp., Alnus viridis ssp crispa, Betula papyrifera, Cinna latifolia*																																		
																								0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Hall's Willowherb	***Epilobium halleanum***		**Inhabits bogs, wet meadows, and open forests in the montane zone.**				(TS)																														
Observation 1		Open minerotrophic muskeg of old but short-stature trees																																				
Observation 2		*Small gully at edge of marsh, aspen grove:*																																				
		Species A	Tamarack	*Larix laricina*	1	1	1.0		0.45		0.80													0.45	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species B	Labrador Tea	*Ledum groenlandicum*	1	1	1.0		0.80		0.60													0.80	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Black spruce	*Picea mariana*	1	1	1.0		0.95	0.80	0.60													0.95	0.80	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Prickly rose	*Rosa acicularis*	2	1	1.0														0.15		0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.30
		Species E	Drummond's willow	*Salix drummondiana*	2	1	1.0												0.15		0.15		0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15	0.00	0.95
		Species F	Golden fuzzy fen moss	*Tomentypnum nitens*	1	1	1.0		0.15	0.45	0.80	0.45	0.30	0.15	0.15	0.6								0.15	0.45	0.80	0.45	0.30	0.15	0.15	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																								0.39	**0.21**	**0.47**	**0.08**	**0.05**	**0.03**	**0.03**	**0.10**	**0.00**	**0.00**	**0.03**	**0.00**	**0.05**	**0.00**	**0.21**
	Slender Mannagrass	***Glyceria pulchella***		**Inhabits marshes, bogs, irrigation ditches, stream banks, and shores of ponds and lakes in the wet montane areas.**																																		
Observation 1		***No Raw data**																						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	White Adder's-mouth Orchid	***Malaxis brachypoda***		**Found in moist forests, mud flats, along stream banks, and in bogs and fens from lowland to montane zones.**				BT																														
Observation 1		On mossy flat in relatively sparse canopy forest, ecotone of spruce/birch/aspen forest and muskeg																																				
		Species A	Glow moss	*Aulacomnium palustre*	1	1	1.0		0.30		0.80	0.15	0.15	0.45	0.15	0.45			0.15					0.30	0.00	0.80	0.15	0.15	0.45	0.15	0.45	0.00	0.00	0.15	0.00	0.00	0.00	0.00
		Species B	Black spruce	*Picea mariana*	1	1	1.0		0.95	0.80	0.60													0.95	0.80	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Balsam poplar	*Populus balsamifera*	1	1	1.0														0.30			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00
		Species D	Bilberry willow	*Salix myrtillifolia*	1	1	1.0		0.15	0.30	0.45													0.15	0.30	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species E	Golden fuzzy fen moss	*Tomentypnum nitens*	1	1	1.0		0.15	0.45	0.80	0.45	0.30	0.15	0.15	0.6								0.15	0.45	0.80	0.45	0.30	0.15	0.15	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																								0.31	**0.31**	**0.53**	**0.12**	**0.09**	**0.12**	**0.06**	**0.21**	**0.00**	**0.00**	**0.03**	**0.00**	**0.06**	**0.00**	**0.00**
	Small-flowered Lousewort	***Pedicularis parviflora* ssp. *parviflora***		**Found in wet montane and subalpine habitats such as bogs, fens, and meadows.**				BT																														
Observation 1		On large tussuck in muskeg																																				
		Species A	Crowberry	*Empetrum nigrum*	1	1	1.0		0.15	0.30	0.30													0.15	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species B	Tamarack	*Larix laricina*	1	1	1.0		0.45		0.80													0.45	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Labrador Tea	*Ledum groenlandicum*	1	1	1.0		0.80		0.60													0.80	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Black spruce	*Picea mariana*	1	1	1.0		0.95	0.80	0.60													0.95	0.80	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species E	Lingonberry	*Vaccinium vitis-idaea*	1	1	1.0		0.60	0.30	0.45													0.60	0.30	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																								0.59	**0.28**	**0.55**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Meadow Willow	***Salix petiolaris***		**Found in a variety of wet montane habitats, such as thickets, deciduous forests, sedge meadows, and lake margins.**																																		
Observation 1		*Edge of logging road surrounded by dense forest of Picea, Betula and Populus:*																																				
		Species A	Drummond's willow	*Salix drummondiana*	1	1	1.0												0.15				0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.95
		Species B	Pacific willow	*Salix lucida*	1	1	1.0													0.15	0.15	0.80		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.80	0.00
																								0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**0.08**	**0.08**	**0.40**	**0.48**
	Slender Wedgegrass	***Sphenopholis intermedia***		**This taxon grows along streambanks, in moist meadows, hot springs and around lakes and ponds in the steppe and montane zones.**				(WH)																														
Observation 1		On open mud at seepy outflow of a small spring, apparently iron-rich																																				
Observation 2		Open cobble bar near the upper edge of the daily high-water mark (water fluctuates daily due to upstream dams)																																				
Observation 3		Primarily submerged in wetland which may dry later in the summer. Associates																																				
		Species A	Bluejoint reedgrass	*Calamagrostis canadensis*	3	1	0.33					0.15	0.15	0.30		0.30			0.80	0.45	0.15	0.30	0.80	0.00	0.00	0.00	0.05	0.05	0.10	0.00	0.10	0.00	0.00	0.26	0.15	0.05	0.10	0.26
		Species B	Water sedge	*Carex aquatilis*	2,3	2	0.67		0.15	0.30	0.60	0.45	0.15	0.45	0.80	0.60	0.60		0.15	0.80				0.10	0.20	0.40	0.30	0.10	0.30	0.54	0.40	0.40	0.00	0.10	0.54	0.00	0.00	0.00
		Species C	Awned sedge	*Carex atherodes*	3	1	0.33																	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Nightshade	*Circaea ssp.*	3	1	0.33														0.15		0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05
		Species E	Tufted hairgrass	*Deschampsia cespitosa*	2	1	0.33																	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species F	Common horsetail	*Equisetum arvense*	1	1	0.33		0.30	0.95	0.15													0.10	0.31	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species H	Broadleaf cattail	*Typha latifolia*	3	1	0.33											0.80						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00
		Species I	Stinging nettle	*Urtica dioica*	3	1	0.33														0.30		0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.05
																								0.02	**0.06**	**0.06**	**0.04**	**0.02**	**0.05**	**0.07**	**0.06**	**0.05**	**0.03**	**0.05**	**0.09**	**0.02**	**0.01**	**0.05**
	Ochroleucous bladderwort	***Utricularia ochroleuca***		**Found floating or submerged in low nutrient lakes and ponds in the montane zone.**				(SE)																														
Observation 1		Located in a wetland immediately south of a powerling ROW, approx. 2 km south of the Peace River, near Fort Saint John.																																				
		Species A	Awned sedge	*Carex atherodes*	1	1	1.0																	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species B	Swamp horsetail	*Equisetum fluviatile*	1	1	1.0					0.30	0.30		0.15	0.15	0.15							0.00	0.00	0.00	0.30	0.30	0.00	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Hemlock water-parsnip	*Sium suave*	1	1	1.0										0.15							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Bluejoint reedgrass	*Calamagrostis canadensis*	1	1	1.0					0.15	0.15	0.30	0.15	0.30	0.30		0.80	0.45	0.30	0.30	0.80	0.00	0.00	0.00	0.15	0.15	0.30	0.15	0.30	0.30	0.00	0.80	0.45	0.30	0.30	0.80
																								0.00	**0.00**	**0.00**	**0.11**	**0.11**	**0.08**	**0.08**	**0.11**	**0.15**	**0.00**	**0.20**	**0.11**	**0.08**	**0.08**	**0.20**
	Herzogiella turfacea **No common name (new)**	***Herzogiella turfacea***		**Shrubby sphagnum fens, mostly growing in low spots between tussocks**				(TS)																														
Observation 1		Marsh/fen/muskeg mosaic on plateau in the Peace Lowlands																																				
		Species A	Bilberry Willow	*Salix myrtillifolia*	1	1	1.0		0.15	0.30	0.45													0.15	0.30	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species B	Labrador Tea	*Ledum groenlandicum*	1	1	1.0		0.8	0.6	0.6													0.80	0.60	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species C	Soft leaved sedge	*Carex disperma*	1	1	1.0		0.15	0.3	0.15													0.15	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species D	Tamarack	*Larix laricina*	1	1	1.0		0.45		0.95													0.45	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species E	Yellow star-moss	*Campylium stellatum*	1	1	1.0					0.15	0.15			0.15								0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Species F	Peat moss	*Sphagnum spp.*	1	1	1.0																	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																								0.26	**0.20**	**0.36**	**0.03**	**0.03**	**0.00**	**0.00**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Rocky Mountain Willow	***Epilobium saximontanum***		**Inhabits moist meadows, including bogs, fens, and stream banks in the montane zone.**																																		
Observation 1		***No Raw data**																																				
																								0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Species Importance Table	Rating
I - Infrequent	0.15
U - Uncommon	0.3
C - Common	0.45
A - Abundant	0.6
VA - Very Abundant	0.8
D - Dominant	0.95

Species associated habitats

Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge					1						1
Iowa Golden-saxifrage										1	1
Hall's Willowherb					1						1
Slender Mannagass											0
White Adder's-mouth Orchid								1			1
Small-flowered Lousewort					1			1			2
Meadow Willow											0
Slender Wedgegrass			1								1
Ochroleucous bladderwort				1							1
Herzogiella turfacea					1						1
Rocky Mountain Willowherb											0

Primary habitat data

Primary habitat rank

Species	**Primary habitat use**										
	OW	**WS**	**WH**	**SE**	**TS**	**Wf02**	**Wf13**	**BT**	**Marl Fen**	**Tufa Seep**	
Hudson Bay Sedge	0	0	0	0	1	0	0	0	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	1	1
Hall's Willowherb	0	0	0	0	1	0	0	0	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0	0	0	0	0	0	1	0	0	1
Small-flowered Lousewort	0	0	0	0	0.5	0	0	0.5	0	0	1
Meadow Willow	0	0	0	0	0	0	0	0	0	0	0
Slender Wedgegrass	0	0	1	0	0	0	0	0	0	0	1
Ochroleucous bladderwort	0	0	0	1	0	0	0	0	0	0	1
Herzogiella turfacea	0	0	0	0	1	0	0	0	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0	1	1	3.5	0	0	1.5	0	1	8
Proportional wetland type preference	0	0	0.125	0.125	0.438	0.000	0.000	0.188	0.000	0.125	1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.0123	0.0596	0.1656	0.1919	0.2308	0.0016	0.0015	0.3367			1
Preference Given Habitat Availability	0	0	0.0207	0.0240	0.1010	0	0	0.0631			0.2088
Standardized Preference Given Habitat Availability	0	0	0.0992	0.1149	0.4836	0	0	0.3023			1

Species

	Secondary habitat use								
	OW	WS	WH	SE	TS	Wf02	Wf13:	BT	
Hudson Bay Sedge		0.00	0.00	0.00	0.30	0.00	0.04	0.39	0.73
Iowa Golden-saxifrage		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hall's Willowherb		0.01	0.09	0.01	0.20	0.10	0.03	0.30	0.73
Slender Mannagass		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Adder's-mouth Orchid		0.02	0.02	0.02	0.25	0.21	0.12	0.31	0.94
Small-flowered Lousewort		0.00	0.00	0.00	0.18	0.00	0.00	0.44	0.62
Meadow Willow		0.08	0.32	0.00	0.00	0.00	0.00	0.00	0.39
Slender Wedgegrass		0.07	0.03	0.05	0.04	0.06	0.05	0.04	0.34
Ochroleucous bladderwort		0.16	0.12	0.08	0.08	0.11	0.08	0.00	0.61
Herzogiella turfacea		0.00	0.00	0.00	0.14	0.03	0.00	0.23	0.39
Rocky Mountain Willowherb		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Secondary habitat data

Species	Secondary habitat use ranking										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0	0	0	0	0.407	0	0.052	0.542	0	0	1
Iowa Golden-saxifrage	0	0	0	0	0	0	0	0	0	0	0
Hall's Willowherb	0	0.017	0.118	0.011	0.270	0.137	0.034	0.411	0	0	1
Slender Mannagass	0	0	0	0	0	0	0	0	0	0	0
White Adder's-mouth Orchid	0	0.016	0.021	0.021	0.262	0.223	0.127	0.329	0	0	1
Small-flowered Lousewort	0	0	0	0	0.296	0	0	0.704	0	0	1
Meadow Willow	0	0.191	0.809	0	0	0	0	0	0	0	1
Slender Wedgegrass	0	0.193	0.081	0.147	0.117	0.184	0.147	0.131	0	0	1
Ochroleucous bladderwort	0	0.256	0.191	0.123	0.123	0.184	0.123	0	0	0	1
Herzogiella turfacea	0	0	0	0	0.35	0.06	0	0.59	0	0	1
Rocky Mountain Willowherb	0	0	0	0	0	0	0	0	0	0	0
Total Relative Preference	0	0.67	1.22	0.30	1.82	0.79	0.48	2.70			8
Proportional wetland type preference	0	0.08	0.15	0.04	0.23	0.10	0.06	0.34			1
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051			6092
Percentage Baseline Wetland Area	0.012	0.060	0.166	0.192	0.231	0.002	0.001	0.337			1
Preference Given Habitat Availability	0	0.005	0.025	0.007	0.053	0.000	0.000	0.114			0.204
Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	0.001	0.000	0.557			1

Secondary habitat rank

	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	
Baseline Wetland Area (ha)	75	363	1009	1169	1406	10	9	2051	6092
Affected Wetland Area (ha) - Construction	17	50	392	142	68	0	1	93	763
Primary Standardized Preference Given Habitat Availability	0	0	0.099	0.115	0.484	0	0	0.302	1
Secondary Standardized Preference Given Habitat Availability	0	0.025	0.124	0.036	0.258	0.001	0.000	0.557	1
Average Standardized Preference Given Habitat Availability	0	0.012	0.111	0.075	0.371	0.000	0.000	0.430	1
Total Loss Given Habitat Affected - Construction	0	0.614	43.675	10.682	25.205	0	0.000	39.972	120.148
(2.5, 97.5) percentiles for +/- 50% Perturbation	--	(0.47, 0.83)	(39.98, 46.65)	(9.97, 11.41)	(22.13, 29.17)	--	(0.00018, 0.00027)	(34.17, 44.59)	(116.98, 122.35)
Restored Wetland Area	0	0	0	100	100	0	0	50	250
Total Gain Given Habitat Restored	0	0	0	7.522	37.066	0	0	21.490	66.078

Summary habitat rank

Appendix 8

Sharp-tailed Grouse Lek Mitigation

Appendix 8. Sharp-tailed Grouse Lek Mitigation.

The following text regarding Sharp-tailed Grouse Lek Mitigation was added to the Project's CEMP.

Process to determine if lek monitoring during construction is required

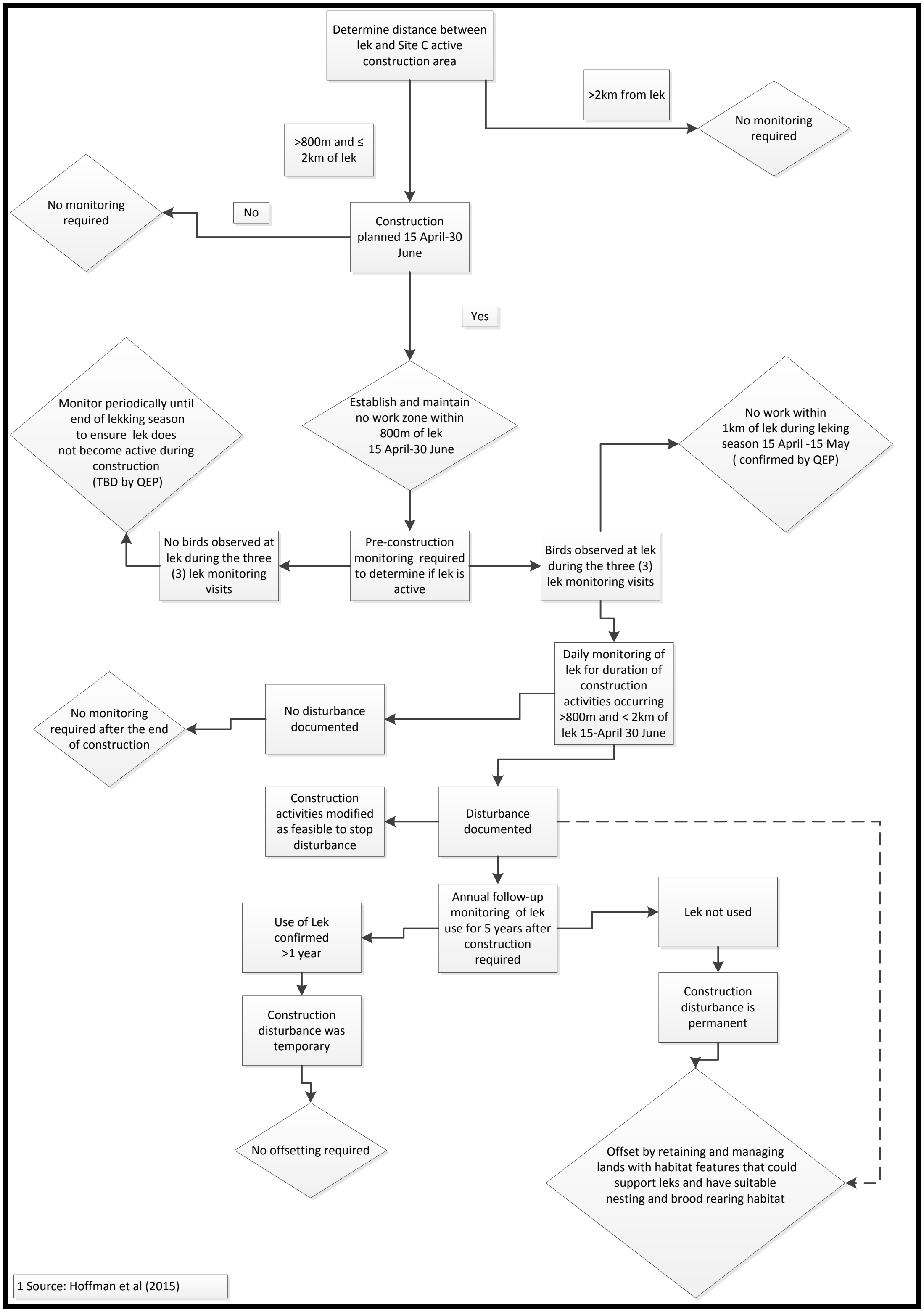
Figure 2 outlines the decision process that will be used to determine the need for, scope and duration of lek monitoring during and after construction.

Lek Monitoring methods

When needed, lek counts will be used to determine presence/absence of Sharp-tailed Grouse using leks adjacent to Construction activities. Counts will be conducted prior to the onset of construction, beginning in mid-April and continuing until the QEP determines lekking has ended. Counts will be repeated annually during construction and annually for up to five years after construction or until use of the lek is confirmed for > 1 breeding season. Counts will be conducted as per the methods outlined in the *Resource Inventory Standard Committee standards for Upland Game Birds* (RISC 1997):

- Leks will be surveyed three times each season in the early morning, surveys will not be conducted during periods with heavy wind, rain or snow.
- Leks will be surveyed by two observers, at least one observer will have experience in conducting Sharp-tailed Grouse lek surveys.
- Surveys will last for 10 minutes or until an accurate count of birds is obtained (Goddard 2010).
- The total number of birds using the lek will be recorded as will the number of males.
- Data collected during monitoring will be submitted to the provincial database.

Figure 2. Sharp-tailed Grouse monitoring decision tree



Monitoring during and after construction

If construction occurs within 2km of the lek between 15 April and 30 June and pre-construction monitoring confirmed the lek was active then:

- The lek will be monitored daily during the active lekking season, which is defined as 15 April to the date when a QEP determines the lek is no longer being used (normally mid-May), for the duration of the time construction activities occur within 2km of the lek
- Monitoring will be conducted by a QEP.
- If monitoring determines construction is negatively affecting the use of the lek, the QEP will work with the construction manager to determine how work activities could be adjusted given the constraints of the Project. Additional mitigation measures may include: installation of noise barriers, installation of additional visual buffers, adjustment of work times

If monitoring determined disturbance to the lek occurred due to construction activities, then after construction is complete the lek will be monitored for up to 5 years or until birds are observed using the lek for >1 breeding season. This monitoring will be managed by BC Hydro.

Surveys for leks

The following bullet will be added to the least-risk timing window section of the CEMP to provide added specificity to contractors regarding the requirement to conduct lek surveys in all suitable habitat (e.g. cultivated fields) potentially affected prior to initiation of construction activities

- Conduct Sharp-tailed Grouse lek surveys between approximately 15- April and mid-May (end date to be determined by a QEP) in suitable lek habitat along prior to initiation of construction activities (methodology provided in Appendix 1).

Appendix 9

Avoidance of Hibernacula at Portage Mountain

Appendix 9. Avoidance of hibernacula at Portage Mountain.

Memo

To:	Vegetation and Wildlife Technical Committee	Date:	December 21, 2016
From:	BC Hydro		
Subject:	Avoidance of Critical Bat Habitat at Portage Mountain		

Portage Mountain was identified as a potential source of rip-rap for the Site C Clean Energy Project in 2011. BC Hydro received a Licence of Occupation (LOO) for Portage Mountain on February 18, 2016 and an OLTC on March 11, 2016. A preliminary drilling program to test the rock was completed in September 2012 before the two bat species were added to Schedule 1 of the *Species at Risk Act* and before the exact locations of hibernacula were determined. The original quarry location (Figure 1) was chosen because:

- The drilling program found that the rock had the mechanical strength needed for use in highway construction and as armouring against erosion (the rock is competent) and could be produced via blasting (the rock is workable)
- An exposed area of bedrock would be removed
- A talus slope below the exposed bedrock would provide the required material for the first year of construction without blasting.
- Construction of an access road to the exposed bedrock and talus was straightforward and could achieve the required geometry for haul trucks moving produced riprap material to the adjacent sort and stock-pile area.

Baseline wildlife surveys were conducted within and around the proposed Portage Mountain LOC and quarry location in 2012. Bat surveys indicated the potential presence of bat hibernacula within and adjacent to the quarry (Figure 1). The identification of the potential hibernacula coincided with the completion of the EIS and confirmation of the presence of hibernacula could not be completed in time to be reported in the EIS. The EIS identified that destruction of bat hibernacula at Portage was possible.

BC Hydro conducted further work in 2013 to determine if there were bat hibernacula present and where they were in relation to the proposed quarry and the larger LOC. The surveys were conducted using remote detectors and emergence surveys in August and October. Sixteen (16) hibernacula, some of which were being used by *Myotis* bats were documented (Andrusiak 2013[1]). The northern myotis and the little brown myotis are the *Myotis* species most likely to hibernate in the Peace region. Eight of the hibernacula were within or immediately adjacent to the proposed extraction area.

[1] Andrusiak, L. 2013. Portage Mountain Bat Hibernacula Study

Northern Myotis and Little Brown Myotis were listed as Endangered under SARA in November 2014, on an emergency basis. The reason for the listing decision was sudden and dramatic population declines, due to the disease White Nose Syndrome. Both species were identified in the EIS for the Site C Clean Energy Project Environmental Assessment as being potentially affected by activities related to dam construction, though they were not SARA-listed at the time.

In December 2015, Environment Canada released the proposed SARA Recovery Strategy for Little Brown Myotis, Northern Myotis and Tri-colored Bat for a 60-day consultation period. The proposed Recovery Strategy identifies Critical Habitat (CH) for these bat species. Proposed CH includes all known hibernacula (winter hibernating habitats). The CH areas identified in BC in the proposed Recovery Strategy were based on data collected by BC Hydro between 2006 and 2012 to support the EIS and provided to the BC Conservation Data Center.

GIS data for the hibernacula locations at Portage Mountain were provided to the BC Conservation Data Center in 2016 at Environment Canada's request. It is expected that the hibernacula sites at Portage Mountain will be included as legally identified CH in the final bat Recovery Strategy. The final recovery strategy was due in April 2016 but has yet to be released by Environment Canada.

In order 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 $300m^2$ no activity/no access buffer around the 16 documented hibernacula. No personnel associated with quarry operations will be allowed within this buffer. This area was not originally selected as the quarry location because:

- The rock is covered by overburden (soil and vegetation) which needs to be removed prior to extraction
- Accessing the area requires the construction of a complex, steep road with multiple switch-backs
- There is no talus, all material required for Project construction must be produced through blasting

A small rock bluff runs throughout the re-located quarry. This bluff was identified by D. Nagorsen (a recognized bat specialist) as having low potential to support a hibernacula during a February 2016 site visit. To ensure this was true, spring and fall monitoring of the bluff was conducted. The monitoring confirmed that no bat hibernacula are present within the relocated quarry.

In February of 2016 the Province of BC released Best Management Practices Guidelines for Bats in British Columbia "Bat BMPs" (Ministry of Environment 2016). This document recommends a 100m buffer be established around the core area of bat habitat, which for

[2] 300m was identified in the EIS as an appropriate buffer around bat hibernacula. This buffer comes from the Whildlife Habitat Area recommendation for Keen's long-eared Myotis as identified in the Accounts and Measures for Managing Idnetified Wildlife-Accounts V. 2004 (available at: http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Mammals/m_keensmyotis.pdf).

Portage Mountain is defined as all the hibernacula entrances documented. Within this 100m no activities that modify the above or below ground habitat are allowed (MOE 2016).

Blasting activities within the 1km special management zone 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 decibels,
  - the shock wave is less than 15 p.s.i and
  - the peak particle velocity is less than 15mm/second

BC Hydro has established and will maintain a 300m core area buffer around the 16 hibernacula, this exceeds the 100m buffer recommended in the Bat BMPs. BC Hydro is not able to establish the recommended 1km special management zone around the hibernacula. In order to avoid disturbance to hibernating bats BC Hydro has prohibited blasting at Portage between September 15 and May 15, this window was established based on data collected at the hibernacula in 2013 (Andrusiak 2013) and in consultation with bat biologists.

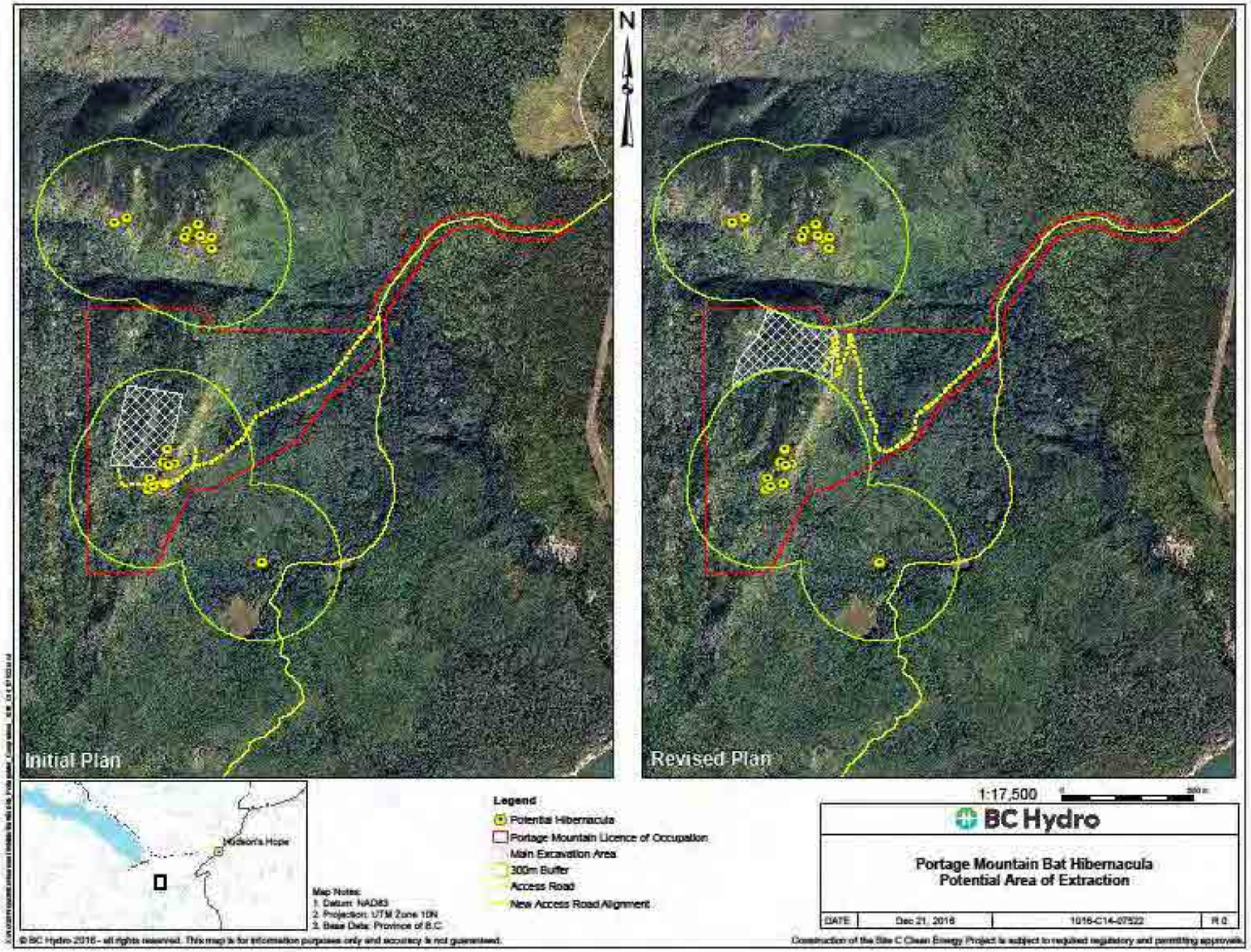
BC Hydro contacted a mining engineer to determine the sound concussion, shock wave and peak particle velocity that would be associated with the blasting proposed at Portage Mountain. Since the degree to which blasting sound and vibration propagate is atmospheric and site dependent, and no trial blast has been completed, this analysis was limited to the use of empirical formulae from blasting literature as well as applying typical blasting parameters for quarry operations in this geological setting to better understand the likelihood that the BMP thresholds would or would not be exceeded. Although it is not possible, based on this analysis, to provide complete confidence that the thresholds will not be exceeded based on typical blasting practice the values as determined are well under the BMP thresholds. It was determined that at 300m:

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

After each blast the rock will be moved to a sort/stock pile area located 175-200m downslope of the core area buffer (Figure 2). Material from this area may be required between October and April. When this occurs heavy equipment will be required to load and transport the rock from the quarry. Typical heavy equipment would include loaders and excavators, loading material into highway legal rock or gravel dump trucks. Similar equipment is being used to load and transport material from the Wuthrich Quarry outside of Fort St. John.

BC Hydro monitored the noise associated with moving and loading rock at the Wuthrich Quarry and through noise modeling determined that the generator associated with operation of the rock screen would be the highest noise contributor. To minimize the amount of noise reaching the hibernacula the generator used between September and April will have to be in a container with the opening oriented in an east-west direction away from the hibernacula. The noise modeling determined that the high frequency noise (frequencies greater than 8kHz) associated with rock sorting, loading and hauling that would not travel to the hibernacula.

Figure 1. Original and Revised location of the Portage Mountain Quarry



Appendix 10

Rare Plant Pre-construction Survey Report

Interim Report
Pre-construction Rare Plant Surveys
Site C Clean Energy Project

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December 5, 2016

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1.0 INTRODUCTION

1.1 Background

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

- *The EAC Holder must, with the use of a QEP, 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.*

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

- *16.1 The Proponent shall ensure that potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants are addressed and monitored.*
- *16.2. The Proponent shall develop, in consultation with Environment Canada, a plan setting out measures to address potential effects of the Designated Project on species at risk, at-risk and sensitive ecological communities and rare plants.*
- *16.3. The plan shall include:*
    - *16.3.3. measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;*
    - *16.3.4. conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation;*
    - *16.3.6. an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and*

- *16.3.7. an approach for tracking updates to the status of listed species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the Species at Risk Act, and implementation of additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species should the status of a listed species change during the life of the Designated Project.*

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

Data collected during these surveys will be added to the Project's environmental features map. This map is used during detailed design and construction to identify opportunities for avoidance, areas where extra care is needed and areas where losses will occur. The first season of pre-construction surveys was completed in the summer and fall of 2015, and the second season finished in the fall of 2016. This interim report documents the methods and results of the work completed through the end of the 2016 field season.

1.2 Scope

The goals of the study are:

- to determine the location of rare plant occurrences in previously unsurveyed areas that are proposed for ground or vegetation disturbance during construction and operation of the Project;
- to determine the location of rare plant occurrences within two mitigation parcels that will be used to compensate for project effects;
- to record detailed element occurrence data in the Project rare plant database on all rare plant populations found, and submit these data to the B.C. Ministry of Environment and—for taxa of federal concern—to Environment Canada; and
- to develop occurrence-specific mitigation measures to eliminate or reduce adverse effects to rare plant populations resulting from the Project.

1.3 Areas Targeted for Pre-construction Surveys

Pre-construction rare plant surveys are being conducted in:

- the proposed Project Access Road running from Jackfish Road to the Dam Site;
- the additional aggregate extraction area at the Portage Mountain site;
- the proposed access road extension at the Portage Mountain site;

- the Highway 29 realignment corridors;
- the proposed transmission line corridor;
- the proposed new or upgraded transmission line access roads;
- the proposed new or upgraded access roads into the reservoir clearing zone—excluding the reservoir footprint;
- the 85th Avenue industrial site;
- the proposed conveyor corridor from the 85th Avenue industrial site to the dam site;
- the 204 hectare (ha) Rutledge mitigation parcel along Highway 29 at Dry Creek; and
- the 423 ha Wilder Creek mitigation parcel located along the Peace River approximately six kilometres (km) downstream from Bear Flat.

Some of these areas were completed during the 2015 field season. The 2016 work focussed on the remaining areas: the Highway 29 realignment corridors, the proposed transmission line corridor, the proposed access roads, and the two mitigation parcels.

2.0 METHODS

2.1 Prefield Review

The investigation began with a prefield review designed to collect and analyze existing data. This information was used to create a field study plan and to identify data gaps in order to direct further research.

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

- species listed on Schedule 1 of the Canadian Species at Risk Act (SARA) as amended (Government of Canada 2002);
- species assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2016); and
- species on the B.C. Ministry of Environment’s provincial Red or Blue lists (BCCDC 2016).

Since 2005 BC Hydro has been performing rare plant surveys in the Project area—defined as the area within which Terrestrial Ecosystem Mapping was completed to support the Site C Environmental Impact Statement (Hilton, et al. 2013). As such, much is known about the rare flora of the area, and the prefield review was based heavily on element occurrence data collected over the last 11 years in the Project area. Currently, 45 different rare plant taxa are known to occur in the Project area. Consequently, these 33 vascular plants, 11 lichens, and 1 moss formed the basis of the target species list for the work, comprising the rare species with the highest likelihood of occurrence.

Before each of the 2015 and 2016 field seasons, the dataset of all B.C. vascular plants, mosses, and lichens was downloaded from the Ministry of Environment's Species and Ecosystem Explorer (BCCDC 2016) and added to the Project rare plant database. This dataset served as the reference for B.C. plant statuses, as well as providing the scientific and common plant names used in this report. Queries were run on the dataset to extract a list of the rare plant species considered to potentially occur in the Peace River Regional District and the Boreal Black and White Spruce Biogeoclimatic Zone. Each species on this list was further reviewed to determine its potential for occurrence within the areas targeted for survey.

Aerial imagery, contour information, and Project maps were reviewed to predict the habitat types present in the areas proposed for survey. General plant communities were determined, and the locations of possible high-suitability rare plant habitat were noted.

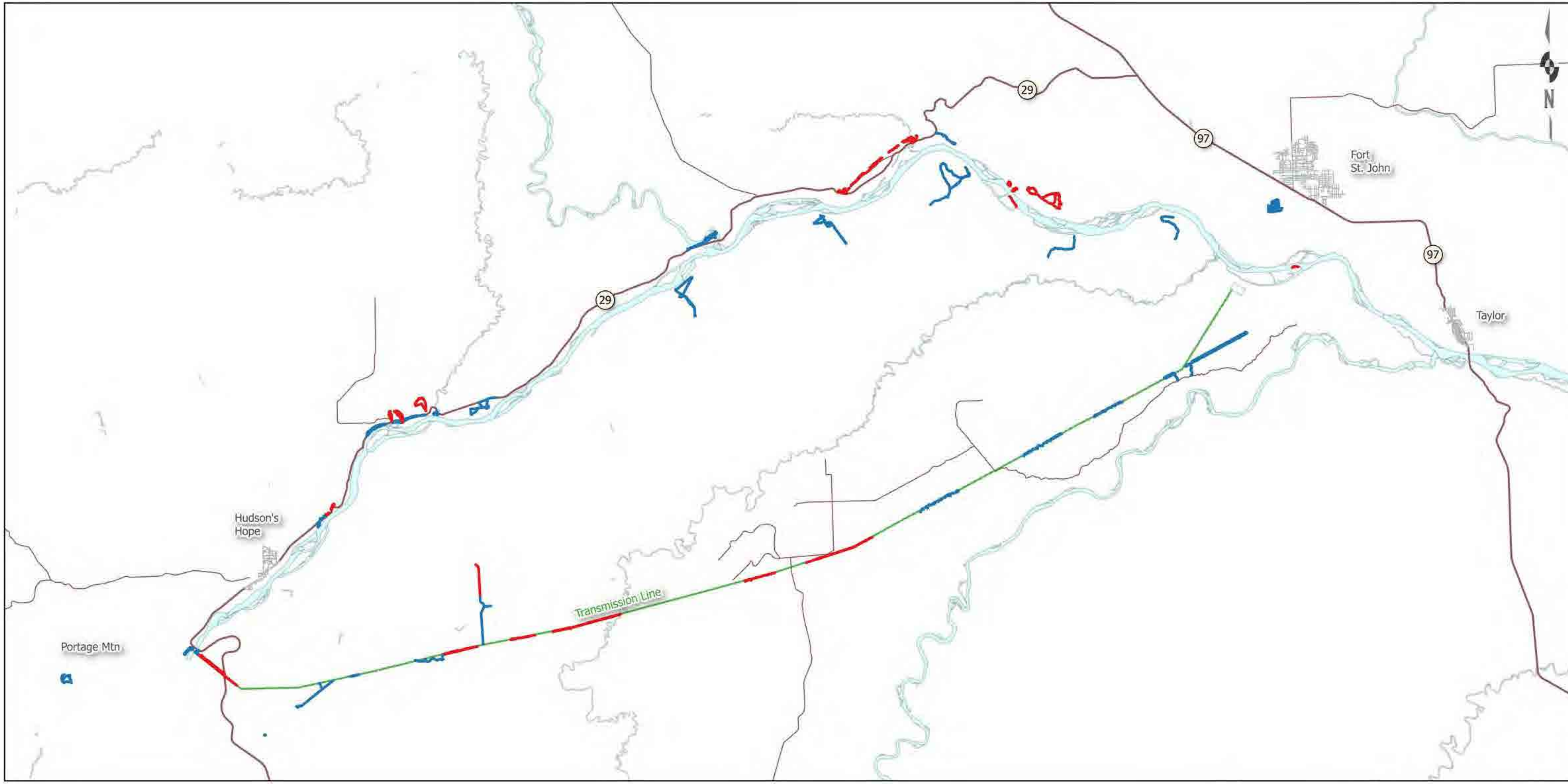
All the above data were compiled to produce a list of target rare plant species with potential for occurrence within the proposed survey areas. It should be noted that the target list is used as a working guideline and can never be an exhaustive list of all potential rare plants for a given area. For this reason, botanists consider all described plant taxa while conducting surveys.

In order to refine their search images for the target taxa, the surveyors studied photographs, herbarium specimens, and species descriptions in various published references (Hitchcock, et al. 1955; Cronquist, et al. 1977; Flora of North America Editorial Committee 1993; Goward, et al. 1994; McCune and Goward 1995; Douglas, et al. 1998a; Goward 1999a; Brodo, et al. 2001; CNALH 2016a) and online databases (Klinkenberg 2016; NatureServe 2016). In addition, they reviewed similar data for species that might be confused with the target taxa. Tables of summary identification characteristics were prepared for field use. The goals were to maximize detectability of the target species and to reduce observer bias during the surveys. The final field plan was designed to guide the methods, coverage, and timing of the rare plant surveys. Seasonal timing was based on the predicted phenologies of the target species.

2.2 Field Survey

In 2015, field surveys were performed between June 30 and September 7. A total of 42 botanist-survey-days were spent on the ground in 2015, covering a total survey distance of 209.8 km (Figure 1). In 2016, field surveys were conducted between June 20 and August 23. Field work consisted of 36 botanist-survey-days, covering a total survey distance of 165.6 km.

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



Map Notes:

1. Based on surveys completed through September 2015.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

Legend

Roads
- Highway
- Secondary Roads
- Urban

Rare Plant Survey Routes
- 2015
- 2016

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 1
Areas Surveyed for Rare Plants in 2015 and 2016

Date	October 17, 2016	DWG NO	2016-10-17-0001	Revision 0

When using the targeted-meander search pattern:

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

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

For certain linear corridors that traversed habitat with a low potential for rare plant occurrence, the botanists drove slowly along the corridor in a Utility Terrain Vehicle (UTV or side-by-side), scanning both sides for rare plants and pockets of high-suitability rare plant habitat. This procedure was only conducted in corridors where the majority of habitat was low-probability, and at a speed of approximately five kilometres per hour. If high-potential rare plant habitat was encountered—such as wetlands or rock outcrops—the surveyors exited the UTV and surveyed the habitat on foot. In 2015, 5.1% of the total 209.8 km traversed was surveyed from UTV—the rest was walked. In 2016 only 1.0% of the total 165.6 km survey distance was covered by UTV.

In 2016, surveys were conducted within the Rutledge and Wilder Creek mitigation parcels. These surveys were designed to provide a general overview of the rare plant populations present within the parcels, in order to inform mitigation planning. As such, these areas were surveyed at a lower intensity level, covering a smaller percentage of the suitable habitats, than in the areas proposed for disturbance. Although the targeted-meander survey technique described above was used in the mitigation parcels, certain areas of suitable habitat were not covered.

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

When target rare plants were found during the field work, element occurrence data were recorded on a B.C. Conservation Data Centre (BCCDC) rare plant survey form (BCCDC 2012). This information was later transcribed into digital format to facilitate analysis of the sites. Digital photographs were taken of both the individual plants and of the surrounding habitat. Consistent with both the B.C. Resource Information Standards Committee guidelines and the rare plant survey guidelines on the B.C. E-Flora website (RIC 1999; Penny and Klinkenberg 2012), a voucher specimen was collected when doing so would not compromise the viability of the population. At each vascular rare plant site, GPS units were used to record the boundary of the occurrence to facilitate mitigation planning.

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

3.0 RESULTS

3.1 Prefield Review

The 2016 prefield review identified 193 rare taxa thought to have potential for occurrence within the areas to be surveyed (Table 1). Of these, 103 are vascular plants, 51 are mosses, and 39 are lichens. All of the species are on the B.C. Ministry of Environment's Blue or Red Lists (109 Blue and 84 Red); 3 are considered to be of possible conservation concern by COSEWIC (all three Threatened); and 2 are listed in Schedule 1 of the Species at Risk Act (both Threatened).

Table 1: Rare plant taxa with potential for occurrence within the areas to be surveyed

Taxon	Common Name	BC List	COSEWIC	SARA
VASCULAR PLANTS				
Acorus americanus	American sweet-flag	Red	-	-
Alopecurus magellanicus	alpine meadow-foxtail	Red	-	-
Anemone canadensis	Canada anemone	Blue	-	-
Antennaria neglecta	field pussytoes	Blue	-	-
Arctophila fulva	pendantgrass	Blue	-	-
Artemisia alaskana	Alaskan sagebrush	Blue	-	-
Artemisia herriotii	Herriot's sage	Red	-	-
Astragalus umbellatus	tundra milk-vetch	Blue	-	-
Atriplex gardneri var. *gardneri*	Gardner's sagebrush	Red	-	-
Avenula hookeri	spike-oat	Blue	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Boechera sparsiflora	stretching suncress	Red	-	-
Botrychium ascendens	upswept moonwort	Blue	-	-
Botrychium crenulatum	dainty moonwort	Blue	-	-
Botrychium lineare	Linear-leaf moonwort	Blue	-	-
Botrychium montanum	mountain moonwort	Red	-	-
Botrychium paradoxum	two-spiked moonwort	Red	-	-
Botrychium simplex var. *compositum*	least moonwort	Blue	-	-
Botrychium spathulatum	spoon-shaped moonwort	Blue	-	-
Braya glabella ssp. *glabella*	smooth northern-rockcress	Red	-	-
Calamagrostis montanensis	plains reedgrass	Blue	-	-
Carex bicolor	two-coloured sedge	Blue	-	-
Carex heleonastes	Hudson Bay sedge	Blue	-	-
Carex lapponica	Lapland sedge	Red	-	-
Carex rupestris ssp. *rupestris*	curly sedge	Blue	-	-
Carex sprengelii	Sprengel's sedge	Red	-	-
Carex torreyi	Torrey's sedge	Blue	-	-
Carex xerantica	dry-land sedge	Blue	-	-
Castilleja septentrionalis	northern paintbrush	Blue	-	-
Chenopodium hians	gaping goosefoot	Red	-	-
Chrysosplenium iowense	Iowa golden-saxifrage	Red	-	-
Cirsium drummondii	Drummond's thistle	Blue	-	-
Descurainia sophioides	northern tansymustard	Blue	-	-
Drosera linearis	slender-leaf sundew	Red	-	-
Dryopteris cristata	crested wood fern	Blue	-	-
Eleocharis elliptica	elliptic spike-rush	Blue	-	-
Elymus lanceolatus ssp. *psammophilus*	sand-dune wheatgrass	Blue	-	-
Elymus sp. nov.	firm wildrye	Red	-	-
Epilobium halleanum	Hall's willowherb	Blue	-	-
Epilobium hornemannii ssp. *behringianum*	Hornemann's willowherb	Blue	-	-
Epilobium saximontanum	Rocky Mountain willowherb	Red	-	-
Erigeron pacalis	Peace daisy	Red	-	-
Gentianella tenella ssp. *tenella*	slender gentian	Red	-	-
Geum triflorum var. *triflorum*	old man's whiskers	Red	-	-
Glyceria pulchella	slender mannagrass	Blue	-	-
Helianthus nuttallii ssp. *rydbergii*	Nuttall's sunflower	Red	-	-
Hesperostipa spartea	porcupinegrass	Blue	-	-
Impatiens aurella	orange touch-me-not	Blue	-	-
Juncus albescens	whitish rush	Blue	-	-
Juncus stygius ssp. *americanus*	bog rush	Blue	-	-
Lomatium foeniculaceum var. *foeniculaceum*	fennel-leaved desert-parsley	Red	-	-
Lomatogonium rotatum	marsh felwort	Blue	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Lupinus kuschei	Yukon lupine	Blue	-	-
Malaxis brachypoda	white adder's-mouth orchid	Blue	-	-
Micranthes nelsoniana var. *carlottae*	dotted saxifrage	Blue	-	-
Ophioglossum pusillum	northern adder's-tongue	Blue	-	-
Oxytropis campestris var. *davisii*	Davis' locoweed	Blue	-	-
Oxytropis maydelliana	Maydell's locoweed	Blue	-	-
Packera ogotorukensis	Ogotoruk Creek butterweed	Red	-	-
Pedicularis parviflora	small-flowered lousewort	Red	-	-
Pedicularis verticillata	whorled lousewort	Blue	-	-
Penstemon gormanii	Gorman's penstemon	Blue	-	-
Penstemon gracilis	slender penstemon	Red	-	-
Physaria arctica	arctic bladderpod	Blue	-	-
Physaria didymocarpa ssp. *didymocarpa*	common twinpod	Blue	-	-
Pinguicula villosa	hairy butterwort	Blue	-	-
Plantago eriopoda	alkali plantain	Blue	-	-
Polemonium boreale	northern Jacob's-ladder	Blue	-	-
Polygala senega	Seneca-snakeroot	Red	-	-
Polypodium sibiricum	Siberian polypody	Red	-	-
Potamogeton perfoliatus	perfoliate pondweed	Blue	-	-
Potentilla arenosa ssp. *arenosa*	scree cinquefoil	Red	-	-
Potentilla furcata	forked cinquefoil	Red	-	-
Potentilla pulcherrima	pretty cinquefoil	Red	-	-
Prenanthes racemosa	purple rattlesnake-root	Red	-	-
Pyrola elliptica	shinleaf wintergreen	Blue	-	-
Ranunculus cardiophyllus	heart-leaved buttercup	Red	-	-
Ranunculus pedatifidus ssp. *affinis*	birdfoot buttercup	Blue	-	-
Ranunculus rhomboideus	prairie buttercup	Red	-	-
Rorippa calycina	persistent-sepal yellowcress	Red	-	-
Rorippa sinuata	spreading yellowcress	Red	-	-
Rosa arkansana	Arkansas rose	Blue	-	-
Rumex arcticus	arctic dock	Blue	-	-
Salix petiolaris	meadow willow	Blue	-	-
Salix raupii	Raup's willow	Red	-	-
Sarracenia purpurea ssp. *purpurea*	common pitcher-plant	Red	-	-
Saussurea angustifolia var. *angustifolia*	northern sawwort	Red	-	-
Schizachyrium scoparium	little bluestem	Red	-	-
Selaginella rupestris	rock selaginella	Red	-	-
Senecio sheldonensis	Mount Sheldon butterweed	Blue	-	-
Silene drummondii var. *drummondii*	Drummond's campion	Blue	-	-
Silene ostenfeldii	Taimyr campion	Blue	-	-
Silene repens	pink campion	Red	-	-
Sphaeralcea coccinea	scarlet globe-mallow	Red	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Sphenopholis intermedia	slender wedgegrass	Blue	-	-
Sphenopholis obtusata	prairie wedgegrass	Red	-	-
Stuckenia vaginata	sheathing pondweed	Blue	-	-
Symphyotrichum falcatum var. *commutatum*	white prairie aster	Red	-	-
Tephroseris palustris	marsh fleabane	Blue	-	-
Thalictrum dasycarpum	purple meadowrue	Red	-	-
Thermopsis rhombifolia	prairie golden bean	Red	-	-
Tofieldia coccinea	northern false asphodel	Blue	-	-
Townsendia hookeri	Hooker's townsendia	Red	-	-
Utricularia ochroleuca	ochroleucous bladderwort	Blue	-	-
MOSSES				
Acaulon muticum var. *rufescens*	[no common name]	Red	-	-
Amblyodon dealbatus	[no common name]	Blue	-	-
Atrichum tenellum	[no common name]	Red	-	-
Aulacomnium acuminatum	[no common name]	Blue	-	-
Barbula convoluta var. *gallinula*	[no common name]	Red	-	-
Bartramia halleriana	Haller's apple moss	Red	T	1-T
Brachythecium trachypodium	[no common name]	Blue	-	-
Bryobrittonia longipes	[no common name]	Blue	-	-
Bryum uliginosum	[no common name]	Blue	-	-
Cynodontium glaucescens	[no common name]	Blue	-	-
Dicranum majus var. *orthophyllum*	[no common name]	Red	-	-
Didymodon rigidulus var. *icmadophilus*	[no common name]	Blue	-	-
Didymodon subandreaeoides	[no common name]	Red	-	-
Encalypta brevicollis	[no common name]	Blue	-	-
Encalypta intermedia	[no common name]	Blue	-	-
Encalypta longicolla	[no common name]	Blue	-	-
Encalypta mutica	[no common name]	Blue	-	-
Encalypta spathulata	[no common name]	Blue	-	-
Grimmia teretinervis	[no common name]	Red	-	-
Haplodontium macrocarpum	Porsild's bryum	Red	T	1-T
Hygrohypnum alpestre	[no common name]	Blue	-	-
Hygrohypnum alpinum	[no common name]	Blue	-	-
Lescuraea saxicola	[no common name]	Blue	-	-
Meesia longiseta	[no common name]	Blue	-	-
Myurella sibirica	[no common name]	Red	-	-
Orthothecium strictum	[no common name]	Blue	-	-
Orthotrichum speciosum var. *elegans*	[no common name]	Blue	-	-
Philonotis yezoana	[no common name]	Blue	-	-
Plagiobryum demissum	[no common name]	Red	-	-
Pohlia bulbifera	[no common name]	Blue	-	-
Pseudocalliergon turgescens	[no common name]	Blue	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Schistidium boreale	[no common name]	Blue	-	-
Schistidium confertum	[no common name]	Red	-	-
Schistidium pulchrum	[no common name]	Blue	-	-
Schistidium robustum	[no common name]	Blue	-	-
Schistidium trichodon	[no common name]	Blue	-	-
Seligeria subimmersa	[no common name]	Red	-	-
Seligeria tristichoides	[no common name]	Blue	-	-
Sphagnum balticum	[no common name]	Blue	-	-
Sphagnum contortum	[no common name]	Blue	-	-
Sphagnum wulfianum	[no common name]	Blue	-	-
Splachnum vasculosum	[no common name]	Blue	-	-
Tayloria froelichiana	[no common name]	Blue	-	-
Tayloria splachnoides	[no common name]	Red	-	-
Tetraplodon urceolatus	[no common name]	Red	-	-
Timmia norvegica	[no common name]	Blue	-	-
Timmia sibirica	[no common name]	Red	-	-
Tortella humilis	[no common name]	Red	-	-
Trichostomum crispulum	[no common name]	Blue	-	-
Warnstorfia pseudostraminea	[no common name]	Blue	-	-
Weissia brachycarpa	[no common name]	Blue	-	-
LICHENS				
Anaptychia crinalis	electrified millepede	Red	-	-
Anaptychia ulotrichoides	amputated millepede	Blue	-	-
Cladonia grayi	gray's pixie-cup	Red	-	-
Cladonia parasitica	fence-rail pixie	Red	-	-
Collema bachmanianum	Caesar's tarpaper	Red	-	-
Collema coniophilum	crumpled tarpaper	Red	T	-
Collema multipartitum	protracted tarpaper	Red	-	-
Fulgensia bracteata	goldnugget sulphur	Blue	-	-
Fulgensia bracteata	goldnugget sulphur	Blue	-	-
Fulgensia desertorum	desert sulphur	Red	-	-
Heterodermia speciosa	smiling centipede	Red	-	-
Lempholemma polyanthes	mourning phlegm	Blue	-	-
Leptogium intermedium	fourty-five vinyl	Blue	-	-
Leptogium plicatile	starfish vinyl	Blue	-	-
Leptogium pseudofurfuraceum	concentric vinyl	Blue	-	-
Leptogium schraderi	collapsing vinyl	Red	-	-
Leptogium tenuissimum	birdnest vinyl	Red	-	-
Peltigera degenii	lustrous pelt	Red	-	-
Peltigera evansiana	peppered pelt	Red	-	-
Phaeophyscia adiastola	granulating shadow	Red	-	-
Phaeophyscia hirsuta	smiling shadow	Red	-	-

Taxon	Common Name	BC List	COSEWIC	SARA
Phaeophyscia hispidula	whiskered shadow	Red	-	-
Phaeophyscia kairamoi	five o'clock shadow	Blue	-	-
Phaeophyscia nigricans	least shadow	Red	-	-
Physcia biziana	frosted rosette	Blue	-	-
Physcia dimidiata	exuberant rosette	Red	-	-
Physcia stellaris	immaculate rosette	Blue	-	-
Physcia tribacia	beaded rosette	Red	-	-
Physciella chloantha	downside shade	Blue	-	-
Punctelia perreticulata	galactic speckleback	Red	-	-
Ramalina sinensis	threadbare ribbon	Blue	-	-
Squamarina cartilaginea	pea-green dimple	Red	-	-
Squamarina lentigera	snow-white dimple	Red	-	-
Thyrea confusa	candied gummybear	Blue	-	-
Usnea cavernosa	pitted beard	Blue	-	-
Usnea glabrata	lustrous beard	Blue	-	-
Usnea glabrescens	spotted beard	Blue	-	-
Usnea trichodea	deadman's beard	Red	-	-
Xanthoparmelia camtschadalis	rockfrog	Red	-	-

Table notes:

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

3.2 Field Survey

The 2015 field surveys found 34 new sites of 14 different rare plant species—11 vascular plants and 3 lichens (Table 2 and Figure 2). Some of these new sites were within one kilometre of other occurrences of the same species found in previous years, and so were considered to be extensions of these previously reported occurrences. Of the 14 rare species, 5 are on the B.C. Ministry of Environment's Red list, with the remaining 9 being on the Blue list. None of the taxa are listed on Schedule 1 of the Species at Risk Act, or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2016).

In 2016, 88 new sites of 13 different rare plant species were found—10 vascular plants and 3 lichens (Table 2 and Figure 2). As in 2015, some of the new sites were considered to be extensions of occurrences found in previous years. Of the 13 rare species found in 2016, 5 are on the B.C. Red list, while the remaining 8 are on the Blue list. None of the 2016 taxa are listed on Schedule 1 of the Species at Risk Act, or are considered to be Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (Government of Canada 2002; COSEWIC 2016).

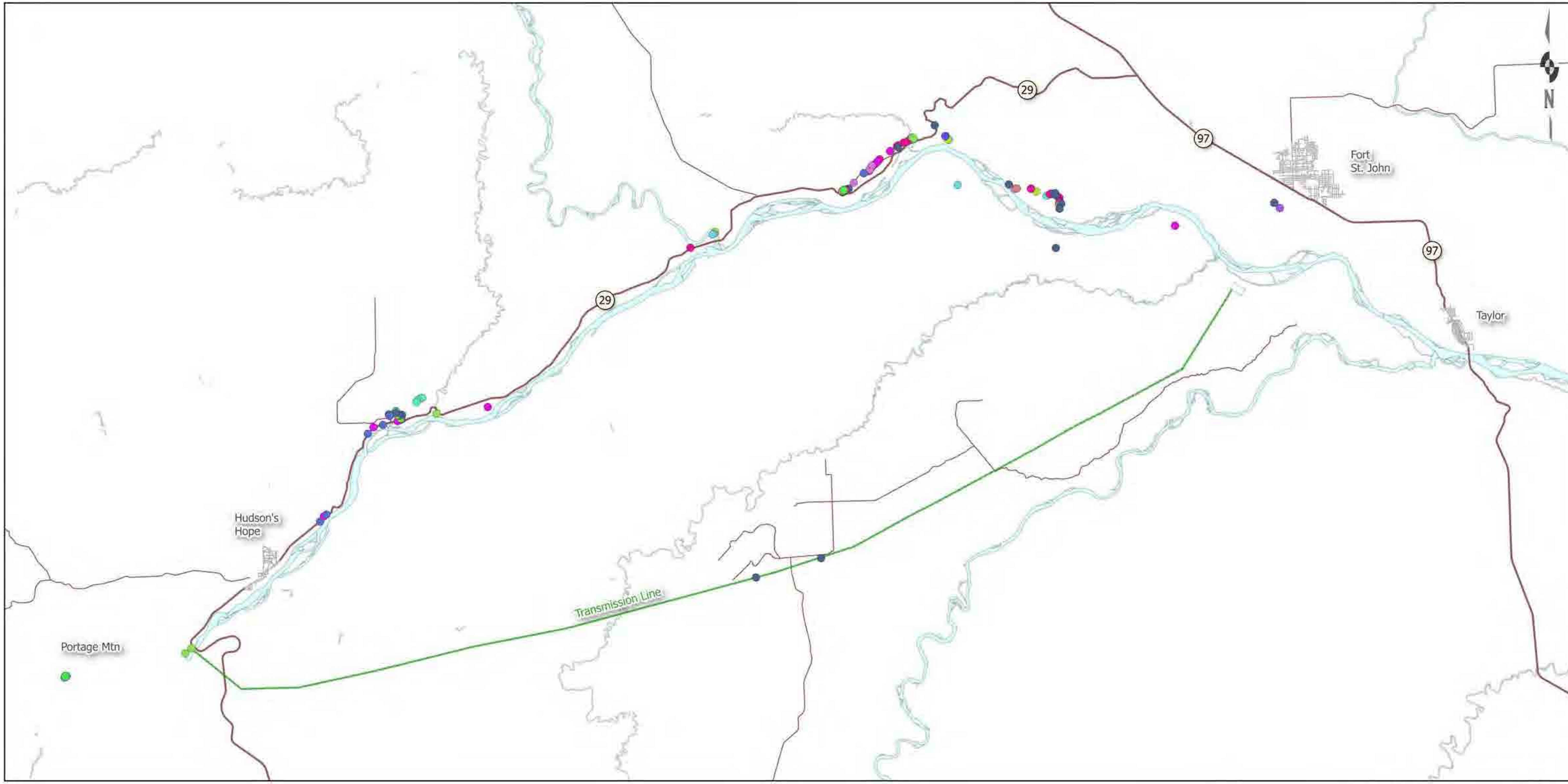
In total, 122 new sites of 16 rare plant taxa were documented. Over the course of the two survey years, the investigators recorded 441 vascular plant, bryophyte, and lichen taxa (Appendix 1). Note that some bryophyte and lichen identifications have not yet been completed as of the writing of this report.

Table 2: Rare plants found during the 2015 and 2016 Site C preconstruction surveys

Taxon	Common Name	2015 Sites	2016 Sites	BC List
VASCULAR PLANTS				
Artemisia herriotii	Herriot's sage	3	1	Red
Avenula hookeri	Spike-oat	-	1	Blue
Calamagrostis montanensis	plains reedgrass	2	12	Blue
Carex sprengelii	Sprengel's sedge	1	1	Red
Carex torreyi	Torrey's sedge	1	-	Blue
Carex xerantica	dry-land sedge	1	1	Blue
Geum triflorum var. *triflorum*	old man's whiskers	2	24	Red
Oxytropis campestris var. *davisii*	Davis' locoweed	1	-	Blue
Penstemon gracilis	slender penstemon	1	6	Red
Polypodium sibiricum	Siberian polypody	3	-	Red
Potentilla pulcherrima	pretty cinquefoil	-	9	Red
Silene drummondii var. *drummondii*	Drummond's campion	1	2	Blue
Sphenopholis intermedia	slender wedgegrass	4	8	Blue
LICHENS				
Physcia biziana	frosted rosette	3	15	Blue
Physcia stellaris	immaculate rosette	7	2	Blue
Ramalina sinensis	threadbare ribbon	4	6	Blue

Table notes:

- *2015 Sites = Number of patches found in 2015*
- *2016 Sites = Number of patches found in 2016*
- *B.C. List (B.C. Ministry of Environment): Red = Endangered, Threatened, or Extirpated; Blue = Special Concern*



Map Location

Map Notes:

1. Based on surveys completed through September 2016.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

- *Artemisia herriotii*
- *Avenula hookeri*
- *Calamagrostis montanensis*
- *Carex sprengelii*
- *Carex torreyi*
- *Carex xerantica*
- *Geum triflorum var. triflorum*
- *Oxytropis campestris var. davisii*
- *Penstemon gracilis*
- *Physcia biziana*
- *Physcia stellaris*
- *Potentilla pulcherrima*
- *Polypodium sibiricum*
- *Ramalina sinensis*
- *Silene drummondii var. drummondii*
- *Sphenopholis intermedia*

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 2
Rare Plant Sites
Found in 2015 & 2016

Date	December 2, 2016	DWG NO	2016-10-18-0002	Revision 0

Most of the rare taxa found in 2015 and 2016 had been documented previously in other occurrences during the baseline surveys performed for the Project environmental impact assessment. The Sprengel's sedge and frosted rosette finds, however, represent new rare species documented in the Project area. In addition, although old man's whiskers and pretty cinquefoil had been documented in the Project area during the baseline studies, they were not officially listed by the B.C. Conservation Data Centre at the time, and so were not treated in the impact assessment.

Species descriptions for the 16 rare plant taxa recorded in 2015 and 2016 are presented below. The sections also contain summary information on the new sites documented in 2015 and 2016. Information on additional occurrences located prior to 2015 can be found in the Project's Environmental Impact Statement (Hilton, et al. 2013) and on the B.C. Ecosystem Explorer website (BCCDC 2016).

3.2.1 *Artemisia herriotii (Herriot's sage)*

Herriot's sage (Figure 3) is an aromatic perennial herb in the Asteraceae (sunflower family) that grows on plains, dry ridges, and gravelly shores (Gray and Fernald 1950). In B.C., Herriot's sage is known only from the Peace River region (BCCDC 2016). The taxon ranges across northern Alberta, and south in the U.S. to Minnesota and South Dakota (Gray and Fernald 1950). Herriot's sage is ranked as an S2 (Imperilled) species in B.C., and is on the provincial Red list (BCCDC 2016). An assessment of global rank for Herriot's sage has not yet been published (see below).

Figure 3: *Artemisia herriotii* **(Herriot's sage)**

It should be noted that the taxonomy of Herriot's sage is uncertain, and little is known about the taxon's precise habitat requirements and global range. Herriot's sage is not recognized in Illustrated Flora of British Columbia. The best published description of Herriot's sage dates from 1950 (Gray and Fernald 1950), and the species is also briefly mentioned in the Flora of Canada (Scoggan 1979). The name Herriot's sage is listed as a synonym of Aleutian mugwort (*Artemisia tilesii* ssp. *elatior*) in Flora of Alberta (Moss and Packer 1983) and in Rare Vascular Plants of Alberta (Kershaw, et al. 2001). Herriot's sage is also listed as a synonym of western mugwort (*Artemisia ludoviciana* ssp. *ludoviciana)* in the Flora of North America (Shultz 2006), and on the NatureServe Explorer website (NatureServe 2016).

Four sites of Herriot's sage were recorded in the areas surveyed in 2015 and 2016 (Figure 2). Rare plant surveys in 2015 located one new occurrence of the taxon on loose open soil in a steep draw above the south shore of the Peace River. 50–250 plants were observed in an approximate area of 1,000 square metres (m^2). Herriot's sage was a dominant species at the site; associated species included prairie sagewort (*Artemisia frigida*) and various native shrubs.

Two other new sites discovered in 2015 were determined to be extensions of previously reported nearby occurrences. In the Halfway River Highway Realignment section, fewer than 50 Herriot's sage plants were found in scattered patches totaling some 20 m^2, extending from the open shoreline into shrubby riparian woodland. This site was found to be approximately 600 metres (m) from an occurrence reported in 2011. East of Bear Flat, a patch of Herriot's sage was observed in a seep on both sides of a proposed access road route. Here, 50–250 large plants dominated an area of roughly 200 m^2 within a shrubby opening in a recently burned grassland-woodland mosaic. This site was located approximately 340 m downslope of an occurrence first reported in 2005.

Finally, one new occurrence of Herriot's sage was found in 2016 in the Cache Creek Highway Realignment area. A single plant was discovered growing on an open gravel bar floodplain along Cache Creek. Associated species included low native shrubs and a mix of native and non-native herbs.

3.2.2 Avenula hookeri (spike-oat)

Spike-oat (Figure 4), a bristly-headed perennial grass, inhabits mesic to dry open slopes, meadows, and forest clearings, in the montane and subalpine zones (Douglas, et al. 1998a; Tucker 2007). In B.C., the species is found primarily in the Peace River area, but has also been reported from the far north near Liard River (BCCDC 2016). The native distribution of spike-oat extends north into Yukon and the Northwest Territories, east to Manitoba, and south in the U.S. through parts of Minnesota, South Dakota, Montana, Wyoming, Colorado, and New Mexico. The taxon is also found across much of Asia (Wu and Phillips 2006; Tucker 2007; NatureServe 2016). In addition, spike-oat is reported as an introduced species in Vermont and Québec (Magee and Ahles 2007; NatureServe 2016).

Spike-oat is ranked S3 (Vulnerable) by the B.C. Conservation Data Centre, and is on the province's Blue list (BCCDC 2016). NatureServe ranks spike-oat G5 (Secure) globally—although in Wyoming the species is ranked S1S2 (Critically Imperilled or Imperilled), in Yukon S2 (Imperilled), and Minnesota S3 (Vulnerable) (NatureServe 2016).

Figure 4: ***Avenula hookeri*** **(spike-oat)**

One new occurrence of spike-oat was located during the 2016 rare plant survey work (Figure 2). The species was collected in the Cache Creek Highway Realignment section in an open meadow of native herbs and low shrubs near the west edge of Cache Creek canyon.

3.2.3 Calamagrostis montanensis (plains reedgrass)

Plains reedgrass is a tufted perennial grass found on dry grassland slopes, shrub flats, and in open forests in the montane and steppe zones (Hitchcock, et al. 1969; Douglas, et al. 2001). The species is known from the southeast corner of B.C. as well as from the Peace River area, and is distributed across the prairie provinces to Manitoba, and south in the U.S. to Minnesota, South Dakota, Colorado and Idaho (BCCDC 2007; BCCDC 2016; NatureServe 2016).

Plains reedgrass is ranked S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2016). Across its global range, the taxon is considered Secure (G5), although Manitoba, Minnesota, and Wyoming also rank the species as S3 (Vulnerable) (NatureServe 2016).

Fourteen new sites of plains reedgrass were documented during the 2015 and 2016 rare plant surveys (Figure 2). In the Dry Creek Highway Realignment section, one occurrence covering approximately ten square metres containing fewer than 50 plants was found in an opening of native grassland in 2015. The following year three more patches of plains reedgrass, found roughly 600 metres to the northwest in the Rutledge mitigation parcel, were added to the 2015 Dry Creek occurrence. These three patches covered approximately 30 m^2 in total, and contained fewer than 50 plants. At all four sites, the terrain consisted of steep south- to southwest-facing slopes with moderate soil disturbance from animal trails. The dominant associated species included a variety of native herbs as well as low native shrubs. A similar occurrence was also recorded at the east end of the Rutledge mitigation parcel, where four patches of plains reedgrass were observed scattered across steep grassland slopes. Fewer than 50 plants were seen in a total area of approximately 112 m^2. More soil disturbance was evident in this occurrence, including a small excavated area at a seep; associated species consisted of a mix of native and non-native herbs as well as low native shrubs.

Figure 5: *Calamagrostis montanensis* **(plains reedgrass)**

Further east, another small occurrence was recorded in 2015, on a disturbed grassland slope approximately 15 m above a proposed access road route east of Bear Flat. Here, fewer than 50 plains reedgrass plants were found in scattered patches, covering a total approximate area of 20 m^2. The final two new occurrences were discovered just over one kilometre apart in the Wilder Creek mitigation parcel in 2016. Two very small patches, each roughly one square metre in size and containing fewer than 50 plains reedgrass plants, were located at the western end of the mitigation parcel. In the eastern end, three small patches were found, also containing fewer than 50 plants in total. Habitat and associated species were similar across the entire area: moderately sloped south-facing hillsides supporting a grass and shrubland community dominated by native plant species. Despite the road tracks and agricultural fields at the base of the hillside, disturbance across the slopes appeared limited to occasional animal trails.

3.2.4 *Carex sprengelii (Sprengel's sedge)*

Sprengel's sedge (Figure 6) is a perennial herb belonging to the Cyperaceae (sedge family); plants have tall stems with fibrous bases, and bear drooping seed heads. The species forms loose clumps in a variety of dry to wet habitats, including openings, slopes, and alluvial woodlands, often on calcareous substrates (Douglas, et al. 2001; Ball and Reznicek 2002). In B.C., Sprengel's sedge is reported from two locations near William's Lake, and one location in the Peace River region (prior to 2015) (BCCDC 2016; Klinkenberg 2016). The taxon ranges across North America as far east as New Brunswick, and as far south as Colorado, Missouri, and New Jersey. It is also reported from Alaska (Ball and Reznicek 2002; NatureServe 2016).

Figure 6: *Carex sprengelii* (Sprengel's sedge)

Sprengel's sedge has a rank of S2 (Imperilled) in B.C., and is on the provincial Red list (BCCDC 2016). Across much of North America the taxon is classed as Secure (G5) or Apparently Secure (G4), but is considered rare on the western, southern, and eastern edges of its range: S3 (Vulnerable) in Quebec, Pennsylvania, Illinois, Montana and Wyoming; S2 (Imperilled) in New Brunswick, Maine, Ohio, and Colorado; S1 (Critically Imperilled) in Missouri and Alaska, and SH (Possibly Extirpated) in Delaware (NatureServe 2016).

Two occurrences of Sprengel's sedge were located in the areas surveyed during 2015 and 2016 (Figure 2). Rare plant surveys in 2015 recorded the species east of Bear Flat in a proposed access road route through recently burned grassland-open woodland habitat. Several plants were observed in an area of less than one square metre, along a trail in an old road track near a calcareous seep. The area showed signs of moderate to heavy disturbance, and weedy plant species were abundant.

During the 2016 survey work, Sprengel's sedge was located in a shrubby, moist draw on a grassland slope in the Wilder Creek mitigation parcel. Many vigorous fruiting plants were found growing in an area of approximately eleven square metres in very wet soil in nearly full shade. The dominant associated species consisted of native plants, and the habitat appeared undisturbed except for a small animal trail.

3.2.5 *Carex torreyi (Torrey's sedge)*

Torrey's sedge (Figure 7) is a soft-hairy perennial in the Cyperaceae (sedge family) found growing in montane meadows, shrublands, and moist woods (Douglas, et al. 2001; Ball and Reznicek 2002). In B.C. the species is found only in the Peace River area, where it is known from a limited number of occurrences (BCCDC 2016; Klinkenberg 2016). Globally, Torrey's sedge is distributed east across Canada to Ontario, and south in the U.S. as far as Colorado, South Dakota, Minnesota, and Wisconsin (NatureServe 2016).

Figure 7: *Carex torreyi* **(Torrey's sedge)**

Torrey's sedge is ranked S2S3 (Imperilled or Vulnerable) in B.C. and is on the province's Blue list (BCCDC 2016). The species is ranked G4 (Apparently Secure) globally, although Colorado and Wisconsin rank it S1 (Critically Imperilled), Ontario and Wyoming rank it S2 (Imperilled), and Alberta and Montana rank it S3 (Vulnerable) (NatureServe 2016).

One site of Torrey's sedge—found to be an extension of a previously reported occurrence—was located in 2015 (Figure 2). A single plant was discovered in the Industrial 85th district south of Fort St. John, approximately 525 m from an occurrence documented in 2011. The Torrey's sedge plant was found growing under a small powerline by a road, in an open, weedy corridor. Non-native grasses and forbs were the dominant associated species at the site and many forms of soil and vegetation disturbance were observed in the area.

3.2.6 Carex xerantica (dry-land sedge)

Dry-land sedge (Figure 8), a perennial herb with silvery-gold heads, is found in xeric steppe and montane habitats such as dry grasslands and hillsides, open forests, and rock outcrops (Douglas, et al. 2001; Ball and Reznicek 2002). The sedge has been collected in the Peace River area in B.C., as well as scattered locations in the central interior and central Rocky Mountains (BCCDC 2016; Klinkenberg 2016). There is some disagreement on the taxon's global range. Douglas et al. (2001) note that dry-land sedge extends east from B.C. to Manitoba, and south to Minnesota and Nebraska; Ball & Reznicek (2002) show the species occurring as far east as Ontario and also in Wyoming; and NatureServe (2016) reports the sedge from as far north as Yukon and Alaska, and as far south as New Mexico.

Figure 8: *Carex xerantica* **(dry-land sedge)**

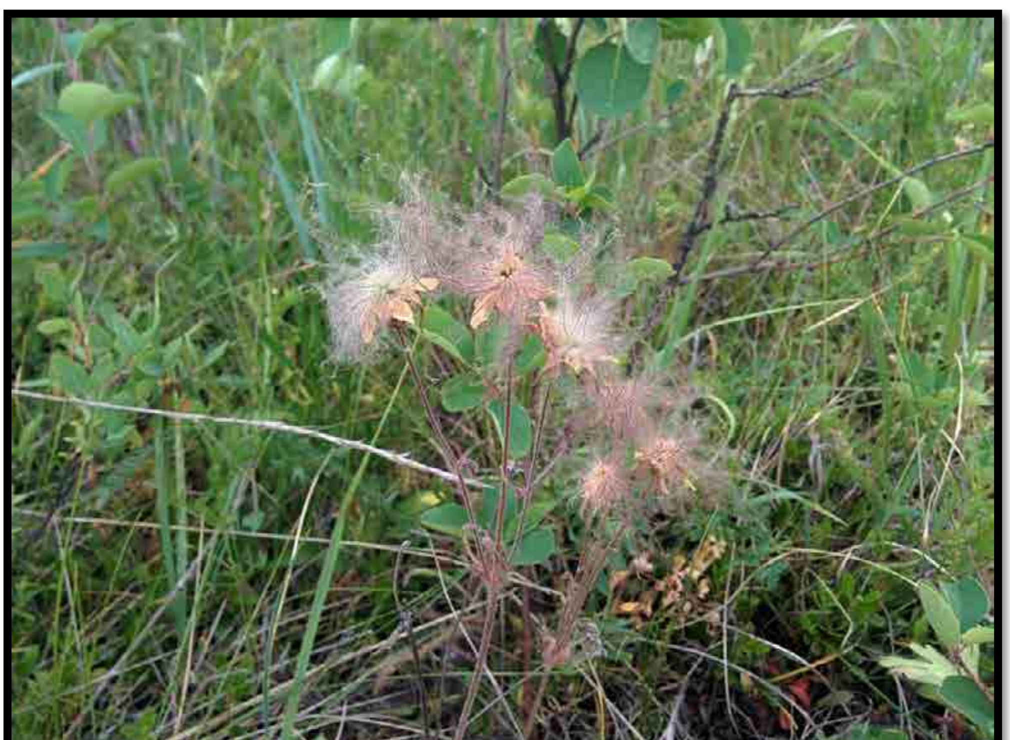
Dry-land sedge is classed as S2S3 (Imperilled or Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2016). Although globally the taxon is considered Secure (G5), most jurisdictions that provide a rank for the species indicate some degree of rarity: S1 (Critically Imperilled) in Alaska, Yukon and Wyoming; S2 (Imperilled) in Ontario, Nebraska, and New Mexico; and S3 (Vulnerable) in Alberta, Manitoba, and Minnesota. Saskatchewan ranks the species S4 (Apparently Secure) and the remaining six jurisdictions where it is reported to occur do not rank the sedge (Montana, North and South Dakota, Utah, Colorado, and Arizona) (NatureServe 2016).

Two occurrences of dry-land sedge were documented during rare plant survey work in 2015 and 2016 (Figure 2). East of Bear Flat, a small patch roughly 10 m^2 in size was found on a disturbed, dry grassland slope near a proposed access road route. Approximately 30 dry-land sedge plants were observed growing in a community of native and non-native herbs and native low shrubs. Further east, in the Wilder Creek mitigation parcel, a second occurrence was located on a hillcrest in a grassy opening within shrubby upland woods. Fewer than 50 dry-land sedge plants were found in an approximate area of 17 m^2. At this site, the plant community consisted of a mix of native herbs and low shrubs, and disturbance appeared relatively minimal.

3.2.7 *Geum triflorum* var. *triflorum (old man's whiskers)*

Old man's whiskers (Figure 9) is a low, soft-hairy perennial herb of the Rosaceae (rose family) that is found growing on dry to mesic slopes and bluffs, and in grasslands, meadows, prairies, and open woodlands (Douglas, et al. 1999; Rohrer 2014). Variety *triflorum* is differentiated from variety *ciliatum* by small differences in the leaves and style, and by geographic range (Rohrer 2014). In B.C., variety *triflorum* is restricted to the Peace River region, where it has been reported from eight locations prior to 2015, mostly on the dry grassland breaks above the Peace River (BCCDC 2016; Klinkenberg 2016). Old man's whiskers variety *triflorum* is distributed across North America as far east as New York state, and as far south as Arizona, New Mexico, and Illinois (Rohrer 2014; NatureServe 2016).

Figure 9: *Geum triflorum* var. *triflorum* (old man's whiskers)



Old man's whiskers variety *triflorum* is ranked S1S3 (Critically Imperilled or Vulnerable) in B.C., and is on the province's Red list (BCCDC 2016). The taxon is classed as S2 (Imperilled) in New York State, but otherwise is considered globally Secure (G5) or Apparently Secure (G4) (NatureServe 2016).

Seven occurrences (comprising 26 separate patches) of old man's whiskers variety *triflorum* were documented in the areas surveyed during the rare plant survey work in 2015 and 2016 (Figure 2).

The first occurrence was found on a bench near the west end of the Halfway River Highway Realignment section, where 50–250 plants were growing in an approximately 100 m^2 area of native low-shrub and dry meadow habitat.

The remaining six occurrences of old man's whiskers variety *triflorum* were located in an approximately 16-kilometre-long span along the south-facing breaks on the north shore of the Peace River, from above the west end of Watson Slough east through the Wilder Creek mitigation parcel. The six occurrences were found on dry, sloping to level open grass and shrubland, within a mosaic of upland aspen woodlands; all sites were subject to a variety of moderate disturbance types.

Three of these occurrences were recorded west of Cache Creek, in and near the Highway 29 Realignment section, where several hundred plants were observed in 13 patches covering approximately 11,154 m^2 in total. East of Bear Flat, in a proposed access road route, one occurrence of fewer than 50 plants was found in an area of approximately 10 m^2. Finally, in the Wilder Creek mitigation parcel, two occurrences of old man's whiskers variety *triflorum* were discovered. Many hundreds of plants were located in 11 patches covering a total approximate area of 903 m^2.

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

Davis' locoweed (Figure 10), also known as Davis' oxytrope, is a small perennial in the Fabaceae (pea family) that grows on stream gravels and in mesic to dry meadows and forest openings in the montane zone (Welsh 1991; Douglas, et al. 1999). Variety *davisii* is restricted to northeast B.C. and adjacent Alberta and the Northwest Territories, where it can be locally abundant (Welsh 1991; BCCDC 2016; NatureServe 2016).

Davis' locoweed is classed S3 (Vulnerable) by the BCCDC, and is on the provincial Blue list (BCCDC 2016). Globally, the variety is also ranked as Vulnerable (T3), due to its limited range. Alberta lists Davis' locoweed as S2? (Imperilled; uncertain ranking); and the Northwest Territories has not yet ranked the taxon (NatureServe 2016).

One new site of Davis' locoweed was discovered in the Halfway River Highway Realignment section during the 2015 rare plant survey work (Figure 2). The site was determined to be an extension of an occurrence reported in 2011, located approximately 900 m farther up the Halfway River. The 2015 site consisted of 50–250 Davis' locoweed plants covering roughly 100 m^2 in scattered clusters across a larger area of mixed woodland on the Halfway River floodplain. Associated species included native shrubs and trees and a variety of native and non-native herbs. Disturbance from past flood events and from recreational usage were observed.

Figure 10: *Oxytropis campestris* **var.** *davisii* **(Davis' locoweed)**

3.2.9 Penstemon gracilis (slender penstemon)

Slender penstemon (Figure 11) is a perennial herb of the Plantaginaceae (plantain family)—formerly of the Scrophulariaceae (figwort family)— that inhabits mesic to dry plains and grasslands (Hitchcock, et al. 1959; Douglas, et al. 2000; Freeman and Rabeler 2016). The species is commonly found throughout much of the Great Plains and Midwestern regions of Canada and the U.S., but in B.C. is restricted to the Peace River area in the northeast part of the province (Hitchcock, et al. 1959; BCCDC 2016; Klinkenberg 2016; NatureServe 2016).

Slender penstemon is ranked S2 (Imperilled) in B.C., and is on the province's Red list (BCCDC 2016). The species' global status is Secure (G5) (NatureServe 2016). Of the remaining 17 jurisdictions where it is known to occur, only four rank slender penstemon with any degree of rarity—Alberta and Wyoming as S3 (Vulnerable), and Iowa and Michigan as S1 (Critically Imperilled) (NatureServe 2016).

Seven sites of slender penstemon were recorded in 2015 and 2016 (Figure 2). East of Bear Flat, near a proposed access road route, a small patch approximately five square metres in size was found in 2015. The slender penstemon plants were growing near a stand of low native shrubs on a dry grassland slope. This site was found to be roughly 520 m west of—and therefore an extension to—an occurrence reported in 2005.

The remaining six sites of slender penstemon were documented during the 2016 rare plant survey work. Near the west end of the Cache Creek Highway Realignment section, one occurrence of four patches totalling approximately 126 m^2 was discovered. Here, 50–250 plants were observed growing with predominantly native graminoids and forbs in disturbed dry meadow openings near stands of low native shrubs. In the Wilder Creek mitigation parcel, two small occurrences were also located in shrub-grassland habitat: one occurrence consisted of a single slender penstemon plant, and three plants were found at the second occurrence.

Figure 11: *Penstemon gracilis* **(slender penstemon)**

3.2.10 Polypodium sibiricum (Siberian polypody)

Siberian polypody (Figure 12) is a leathery-leaved evergreen fern in the Polypodiaceae (polypody family). The taxon grows in montane regions on dry to mesic rock outcrops (Haufler, et al. 1993; Douglas, et al. 2000). In B.C. prior to 2011, Siberian polypody was only known from two unconfirmed reports to the north and west of Fort St. John: one near the Beatton River and one near Williston Reservoir (BCCDC 2016; Klinkenberg 2016). Rare plant surveys conducted for the Site C environmental impact assessment located additional populations on Bullhead and Portage Mountains west of Hudson's Hope (Hilton, et al. 2013). The fern's global range extends across large portions of the boreal regions of Canada, Alaska, and Asia. The species has also been found in southern Greenland (Haufler, et al. 1993).

Siberian polypody is on the Red list in B.C., and is ranked S2? (Imperilled; uncertain ranking) (BCCDC 2016). Although Siberian polypody is tentatively considered Secure globally (G5?), most of the North American jurisdictions that report a status for the taxon rank it as rare: SH (Possibly Extirpated) in Québec; S1 (Critically Imperilled) in Ontario; S2 (Imperilled) in Alaska and Yukon; and S3 (Vulnerable) in Alberta (NatureServe 2016).

Figure 12: *Polypodium sibiricum* **(Siberian polypody)**

Three new sites of Siberian polypody were recorded in 2015 near a proposed access road route on Portage Mountain (Figure 2). All three patches were determined to constitute an extension to an occurrence reported in 2012 that is mapped starting 120 m to the north, along the same cliff system. 50–250 additional plants were found growing in mixed upland forest on shaded boulders, rock outcrops and at the base of a dry cliff; the approximate total areal coverage of the three new patches was 21 m^2. Associated species included native trees, shrubs, and herbs, and evidence of disturbance was minimal.

3.2.11 Potentilla pulcherrima (pretty cinquefoil)

Pretty cinquefoil (Figure 13), a perennial herb of the Rosaceae (rose family), has distinctive two-toned leaf faces which are green above and white below. The species grows at moderate to higher elevations in a variety of open, dry to moist habitats including meadows, grasslands, woodlands, roadsides and waste places (Douglas, et al. 1998a; Ertter, et al. 2014). In B.C., pretty cinquefoil is documented from the Peace River region, and from sites in the south-central and south-east part of the province (Douglas, et al. 2002). The taxon ranges east into Ontario and Minnesota, and extends south through the western U.S. into mountainous regions of California, Arizona, New Mexico, Colorado and western South Dakota (NatureServe 2016).

In addition, pretty cinquefoil has been introduced into various disturbed sites in the eastern U.S., with populations reported from Connecticut and New Hampshire (Ertter, et al. 2014; NatureServe 2016).

Figure 13: *Potentilla pulcherrima* **(pretty cinquefoil)**

Pretty cinquefoil is currently ranked S2? (Imperilled; uncertain ranking) in B.C., and is on the Red list for the province (BCCDC 2016). The species is reported as Globally Secure (G5) and most other North American jurisdictions do not provide a rank. The exceptions are California S1 (Critically Imperilled), Ontario S2 (Imperilled), and Saskatchewan and Wyoming S4 (Apparently Secure) (NatureServe 2016).

Four occurrences (comprising nine patches) of pretty cinquefoil were documented during the rare plant survey work in 2016, all on the lower south-facing breaks of the north shore of the Peace River near Wilder and Cache Creeks (Figure 2).

Two of the occurrences were located in the Cache Creek Highway Realignment section. The largest consisted of four patches with an areal coverage of roughly 1,605 m^2, observed along a vegetated dirt road on a bench near a cultivated field. Some 250–1,000 pretty cinquefoil plants were growing in and along the road in open weedy meadow habitat. Associated species included native and non-native herbs as well as low native shrubs. The second occurrence from the Cache Creek Realignment section consisted of fewer than 25 plants in an area of approximately 31 m^2. This site was located at the interface between a fallow cultivated field and upland aspen woodland. Both the Cache Creek occurrences appeared to have moderate levels of disturbance, mostly due to agricultural activities.

The remaining two occurrences of pretty cinquefoil were discovered 10 km to the east in the Wilder Creek mitigation parcel. One occurrence of approximately 175 m^2 was found along a vegetated dirt road at the edge of a fallow hay field. Here, 50–250 pretty cinquefoil plants were growing in and near the road among non-native grasses and forbs. Vehicle disturbance appeared to be light at this location. A second occurrence was recorded on level to sloping shrubby grassland above a cultivated field. Fewer than 50 pretty cinquefoil plants were observed in three patches covering an approximate area of 42 m^2. Associated species included native and non-native herbs as well as low native shrubs.

3.2.12 Silene drummondii var. *drummondii (Drummond's campion)*

Drummond's campion (Figure 14) is a taprooted perennial herb in the Caryophyllaceae (pink family). It is found in dry shrubland, meadows, and woodland openings, and on hillsides and prairies, from the steppe to alpine zones (Douglas, et al. 1998b; Morton 2005). In B.C., Drummond's campion occurs in a number of locations east of the Coast-Cascade Mountains (BCCDC 2016; Klinkenberg 2016). Variety *drummondii* extends north into the Northwest Territories, east to Ontario and south through much of the U.S. Midwest and West, as far as Arizona and New Mexico (Morton 2005; NatureServe 2016; NHIC 2016). In addition, disjunct occurrences of the taxon are reported for Maryland (NatureServe 2016).

Figure 14: *Silene drummondii* **var.** *drummondii* **(Drummond's campion)**

Drummond's campion variety *drummondii* is ranked S3? (Vulnerable; uncertain ranking) by the BCCDC, and is on the provincial Blue list (BCCDC 2016). NatureServe classifies Drummond's campion variety *drummondii* as Secure globally (G5T5).

It should be noted that there is disagreement on the scientific naming of Drummond's campion, which creates confusion in terms of understanding the conservation rankings. The NatureServe website provides not only maps and ranks for the name *Silene drummondii*, but also for three varieties, including variety *drummondii* (NatureServe 2016). The BCCDC recognizes only the taxon *Silene drummondii* variety *drummondii* (BCCDC 2016). The Flora of North America recognizes two subspecies, of which subspecies *drummondii* is the more widespread prairie taxon (Morton 2005). Finally, the Ontario Natural Heritage Resource Centre follows the naming provided by the Flora of North America (NHIC 2016), but NatureServe displays the Ontario ranking only in their species information and omits it from their variety subset information (NatureServe 2016).

With this in mind, the following sub-national rankings apply for Drummond's campion: Ontario S1 (Critically Imperilled); Manitoba and Minnesota S3 (Vulnerable); and Alberta, Saskatchewan, and Wyoming S4 (Apparently Secure) (NatureServe 2016).

Three new sites of Drummond's campion were discovered during the rare plant survey work in 2015 and 2016 (Figure 2). The one site located in 2015, near a proposed access road route on Portage Mountain, was determined to be an extension of an occurrence reported in 2012. The new site, found approximately 900 m to the south along the same cliff system, consisted of fewer than 50 plants scattered at the base of a dry cliff in a small area of about five metres square. The site was in partially open upland forest, and supported a diverse variety of native shrubs and herbs.

In 2016, two occurrences were found in the Cache Creek Highway Realignment section. Near the west end of the section, fewer than 50 Drummond's campion plants were found scattered across a sloping area of approximately 19 m^2, in a grassy opening in shrubby upland woodland. Associated species were predominantly native low shrubs and herbs, although various disturbance types were noted in the nearby area. Farther east, in a narrow opening at the edge of disturbed, mixed upland forest, five Drummond's campion plants were found in an area of about three square metres. The immediate plant community consisted of native low shrubs and native herbs.

3.2.13 Sphenopholis intermedia (slender wedgegrass)

Slender wedgegrass (Figure 15), a perennial with long seed heads, is a member of the Poaceae (grass family). The species grows in moist meadows, along streambanks, and around lakes and ponds in the steppe and montane zones (Douglas, et al. 2001; Daniel 2007). It is known from numerous locations in eastern and southern B.C., and occurs in all Canadian and U.S. jurisdictions except Nunavut, Labrador, California, and Hawaii (Daniel 2007; BCCDC 2016; Klinkenberg 2016; NatureServe 2016).

Slender wedgegrass is ranked S3 (Vulnerable) in B.C. and is on the province's Blue list (BCCDC 2016). Other jurisdictions where the species is considered rare are Alaska, Newfoundland, and Prince Edward Island (S1 Critically Imperilled); Yukon, Montana, Wyoming, and North Carolina (S2 Imperilled); and Alberta, Illinois, and Québec (S3 Vulnerable). Globally the taxon is ranked as Secure (G5) (NatureServe 2016).

Twelve sites of slender wedgegrass were documented in 2015 and 2016 (Figure 2). One occurrence in two patches was located in the transmission line corridor at Peace Canyon Dam. Here, 50–250 plants were discovered on the banks of Portage Creek on both sides of a small road, and another 50–250 plants were observed along two other small unnamed creeks roughly 500 m to the southwest. Areal coverage for the sites totalled approximately 80 m^2. Associated species included a diverse mix of native shrubs and native and non-native herbs, and the surrounding plant community consisted of fragmented mixed upland forest.

Figure 15: *Sphenopholis intermedia* **(slender wedgegrass)**

Continuing east, one occurrence comprising seven patches was recorded along a roughly one-half kilometre section of Dry Creek in the Rutledge mitigation parcel. Here, 50–250 slender wedgegrass plants were found scattered and clumped in a weedy herbaceous riparian community shaded by native shrubs and bordered by mixed upland forest. Total areal coverage for all seven patches was approximately 167 m^2.

At the mouth of Farrell Creek, one occurrence of slender wedgegrass was discovered in the Highway Realignment section. At this site, 50–250 plants were observed on an open, active floodplain in an area of approximately 100 m^2. Associated species consisted of predominantly non-native herbs as well as native shrubs and tree seedlings. Similarly, a small occurrence of slender wedgegrass was recorded at the edge of the Halfway River Realignment section, on active floodplain near the mouth of the river. Fewer than 50 plants were found growing in a roughly 10 m^2 area, in and around a pile of woody debris. The floodplain plant community was composed of a mix of native and non-native herbs and scattered small native shrubs and saplings.

Finally, a small slender wedgegrass occurrence was also documented in the Cache Creek Highway Realignment section, above the mouth of Cache Creek. A patch of fewer than 50 plants were found scattered on an active gravel floodplain on the west side of the creek. Areal coverage for the slender wedgegrass was approximately 17 m^2. Associated species included native shrubs and saplings and predominantly non-native herbs.

3.2.14 Physcia biziana (frosted rosette)

Frosted rosette, a small grayish foliose lichen, is distinguished by the dense powdery coating that covers its entire upper surface (Figure 16). In addition, a chemical test aids in separating the taxon from morphologically similar species. Frosted rosette is found on bark or rock in open, dry habitats (Goward, et al. 1994; McCune and Goward 1995; Brodo, et al. 2001; Brodo 2016; CNALH 2016b). In B.C., frosted rosette is reported from numerous locations in the south-central section of the province, as well as two sites in the extreme southeast (Goward, et al. 1994; Brodo, et al. 2001; Klinkenberg 2016). Globally, the species has been collected throughout much of the central and western U.S. and northern and central Mexico, and has been documented from scattered locations in Eurasia and Africa. One occurrence has been observed in Vermont in the eastern U.S., and two sites have been reported in other parts of Canada: one occurrence on Lake Ontario, and one occurrence in the Rocky Mountains north of Jasper, Alberta (CNALH 2016b).

Figure 16: *Physcia biziana* (frosted rosette)

Frosted rosette has a rank of S3 (Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2016). The species is also considered rare in Alberta (S1S2 Critically Imperilled or Imperilled) and in Ontario (S1S3 Critically Imperilled or Vulnerable). Frosted rosette has not been ranked by other Canadian or U.S. jurisdictions; globally the taxon is considered Secure (G5) (NatureServe 2016).

Twelve occurrences (comprising 18 patches) of frosted rosette were observed in the areas surveyed (Figure 2). During rare plant surveys in 2015, the species was collected in three locations: one on the southern outskirts of the town of Fort St. John in the Industrial 85th district, and two on the south shore of the Peace River north of the Moberly River along proposed access road routes. At all three sites, the lichen was growing on the bark of live aspen trees (*Populus tremuloides*) in open, disturbed mixed upland woodlands along or near road tracks.

During the 2016 survey work, nine occurrences of frosted rosette were documented in 15 patches. Two sites were located south of the Peace River in the transmission line corridor near Jackfish Road. One frosted rosette lichen was collected off the bark of a live pussy willow tree (*Salix discolor*) in disturbed mesic shrubland at the south edge of the right-of-way. The second occurrence was recorded north of the right-of-way in a shady riparian woodland, where several frosted rosette thalli were observed on the bark of live alder trees (*Alnus* sp.).

The remaining seven occurrences were all found above the north shore of the Peace River, between Farrell Creek Road and Wilder Creek. At the Rutledge mitigation parcel, one occurrence was located in three patches in deciduous shrub woodland near hayfields and in Dry Creek canyon. Frosted rosette lichens were collected off the bark of live and dead deciduous trees and shrubs. In the Cache Creek Highway Realignment section, four occurrences (comprising five patches) were documented in disturbed upland woodland and shrubland habitats near fields and various roads including Highway 29. Frosted rosette thalli were collected off the bark of live aspen trees and also observed on the bark of dead choke cherry shrubs (*Prunus virginiana*).

Finally, in the Wilder Creek mitigation parcel, one large occurrence was found in an upland woodland and shrub-grassland mosaic on slopes above agricultural fields. This occurrence consisted of four patches containing numerous frosted rosette thalli, which were growing on live aspen trees as well as on the bark of live and dead deciduous shrubs. In addition, just to the west of the Wilder Creek mitigation parcel, a smaller occurrence was discovered. Here, four thalli were observed growing in similar open habitat on the same kinds of substrates.

This group of occurrences of frosted rosette in the B.C. Peace region represent a 400 km northward extension of the taxon's mapped global range, and a 700 km northward range extension in the province of B.C. (CNALH 2016b).

3.2.15 *Physcia stellaris (immaculate rosette)*

Immaculate rosette (Figure 17) is a small foliose lichen that forms light grey circular clusters bearing darker, round fruiting bodies. The taxon grows on tree bark, particularly of deciduous trees, in open woodlands. Immaculate rosette is morphologically very similar to, and sympatric with, both *Physcia aipolia* (hoary rosette) and *Physcia alnophila* (outward-looking rosette), and must be separated from these taxa by a chemical test (Goward, et al. 1994; McCune and Goward 1995; Brodo, et al. 2001; Brodo 2016; CNALH 2016c). In B.C., immaculate rosette is reported from a few scattered locations in the northwest, northeast, and south-central parts of the province (Goward, et al. 1994; Brodo, et al. 2001; Klinkenberg 2016; CNALH 2016c). The taxon's global range encompasses much of North America, and also extends to Eurasia, Australia, and South America (Brodo, et al. 2001; CNALH 2016c).

Figure 17: *Physcia stellaris* (immaculate rosette)

Immaculate rosette is ranked S3 (Vulnerable) in B.C., and is on the province's Blue list (BCCDC 2016). The taxon is also classed S3S4 (Vulnerable or Apparently Secure) in Saskatchewan, but otherwise is considered to be globally Secure (G5) (NatureServe 2016).

Eight occurrences (comprising 9 patches) of immaculate rosette were located in the areas surveyed during rare plant work in 2015 and 2016 (Figure 2). Four of the 2015 occurrences (totaling five patches) were discovered in the Highway Realignment sections near Lynx and Farrell Creeks. A fifth occurrence was recorded in the Industrial 85th site on the southwest outskirts of the town of Fort St. John. The final occurrence from the 2015 surveys was observed above the south shore of the Peace River north of the Moberly River, near a proposed access road route. The immaculate rosette individuals were all growing on the bark of live and dead deciduous trees and shrubs in disturbed mixed upland woodlands.

Two occurrences of the lichen were found during the 2016 survey work: immaculate rosette specimens were collected in the Cache Creek Highway Realignment section and also in the Wilder Creek mitigation parcel. At both sites the taxon was discovered growing on dead aspen bark in shrubby, mixed upland woodland near fields and road tracks.

3.2.16 Ramalina sinensis (threadbare ribbon)

Threadbare ribbon (Figure 18) is a small, pale green fruticose lichen. The thallus grows outward from a single point of attachment into a branching fan shape, which is tipped by cup-like fruiting bodies. The taxon is found on the bark of trees and shrubs in open habitats (Goward 1999b; Brodo, et al. 2001; CNALH

2016d). In B.C., threadbare ribbon is known from only a few locations in the northeast part of the province (Goward 1999b; Brodo, et al. 2001). Globally, the species is reported from across much of North America, as well as a few sites in Eurasia and one in Australia (Brodo, et al. 2001; CNALH 2016d).

Figure 18: *Ramalina sinensis* (threadbare ribbon)

Threadbare ribbon has a rank of S2S3 (Imperilled or Vulnerable) in B.C., and is on the provincial Blue list (BCCDC 2016). A few other Canadian jurisdictions also class the species as rare: S3S4 (Vulnerable or Apparently Secure) in Alberta; S3 (Vulnerable) in Northwest Territories; and S1S3 (Critically Imperilled or Vulnerable) in Yukon Territory (NatureServe 2016). The taxon's global rank is G4G5 (Apparently Secure or Secure) (NatureServe 2016).

Six occurrences (comprising ten patches) of threadbare ribbon were discovered in the areas surveyed in 2015 and 2016 (Figure 2). All the occurrences were located above the north shore of the Peace River. The largest site, west of Lynx Creek in Realignment sections on both sides of Highway 29, was nearly one kilometre in length and consisted of two patches. The main site was documented in 2015, and an extension to the occurrence was added in 2016. Many threadbare ribbon thalli were observed in disturbed upland woodland habitat at this location, on the bark and twigs of aspen, balsam poplar (*Populus balsamifera*), and white spruce (*Picea glauca*).

Further east, three occurrences of threadbare ribbon were recorded in the Rutledge mitigation parcel and adjacent Highway Realignment sections. The westernmost occurrence was found in a wet stream draw just north of Highway 29, where one specimen was collected off a balsam poplar trunk in 2015. The second occurrence consisted of four patches, scattered from a turnout on the south side of Highway 29 through the west end of the Rutledge mitigation parcel as far as Dry Creek canyon. Two of the patches were documented in 2015, and two in 2016. All threadbare ribbon individuals were observed growing on the dead twigs of aspen trees and various deciduous shrubs in highly fragmented mixed upland woodland near roads and fields. Finally, at the east end of the Rutledge mitigation parcel, one threadbare ribbon specimen was collected off a dead choke cherry twig on a south-facing slope in shrub-grassland habitat.

The remaining two occurrences of threadbare ribbon were found over 30 km east; one in the Cache Creek Highway Realignment section, and one in the Wilder Creek mitigation parcel. On a bench west of Cache Creek above Watson Slough, two individuals were observed on the trunk of a live aspen tree at the edge of disturbed mixed upland woods by a road track along a field. In the Wilder Creek mitigation parcel, one specimen was collected off an aspen branch in a small wooded draw below a large agricultural field.

4.0 DISCUSSION

4.1 Coverage

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

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

4.2 Timing

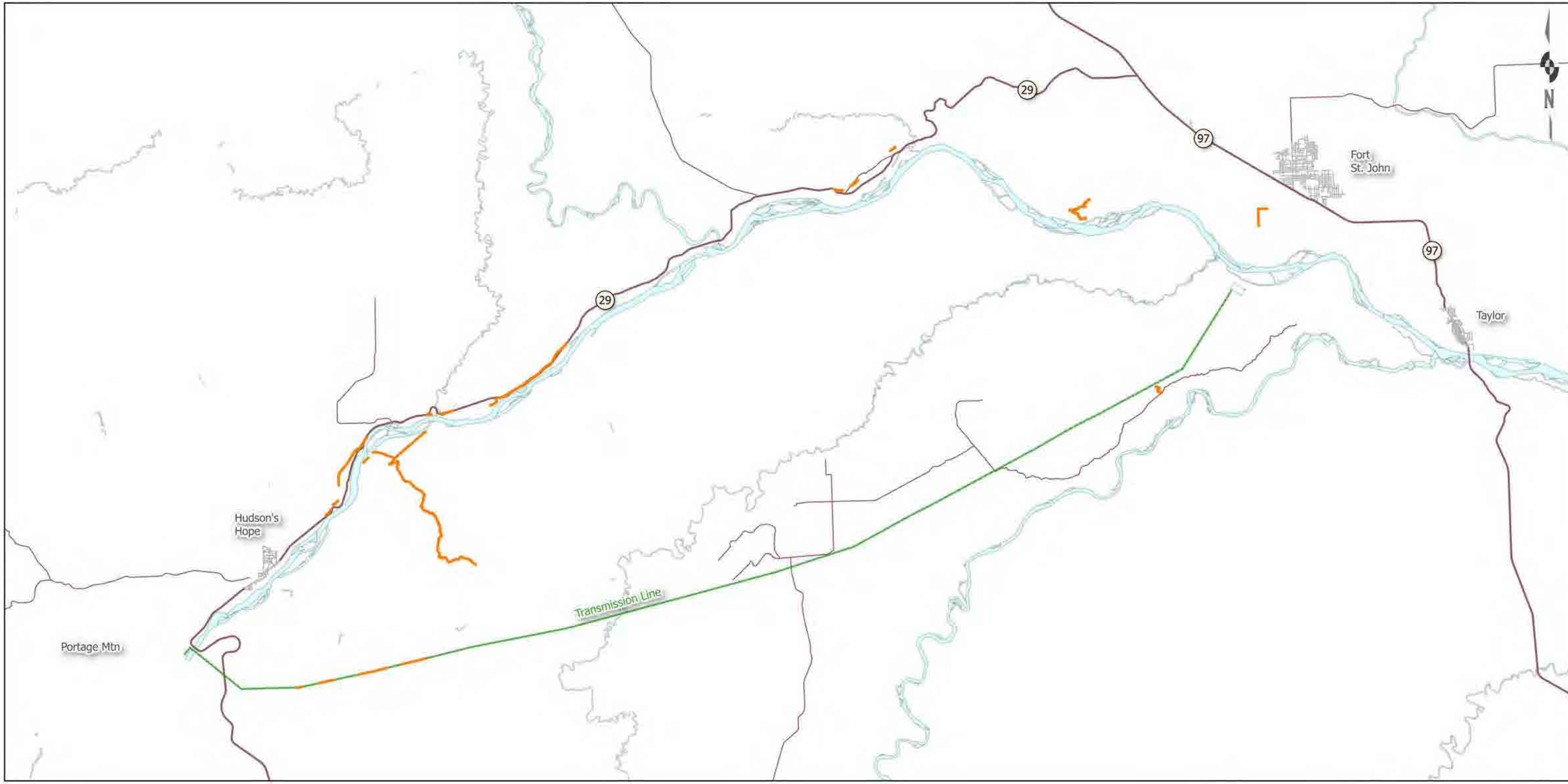
Based on the observed phenology of the plants in the areas surveyed and data gathered during previous years' survey work, the timing of the surveys was sufficient to identify all the target rare plants. The June and early July work focussed on sites north of the Peace River, where floodplain and grassland habitats make up the majority of the high-potential rare plant habitats present. Target species in these habitats often bloom early in the season, and then wither by later in the summer. The late summer and early fall surveys mainly focussed on areas south of the Peace River, where wetlands are the primary high-potential rare plant habitats. Many of these wetland-associated target rare plants bloom later in the season, and persist longer into the fall than those found in the upland areas.

4.3 Remaining Work

Private land access limitations and industrial fire restrictions during 2015 prevented field crews from surveying approximately 49 km of targeted corridor. That included 22 km of Highway 29 realignment areas, 17 km of Medicine Woman Road, and various other facilities corridors. Those areas were scheduled for survey in 2016.

In late 2015, BC Hydro requested that surveys of the Wilder Creek and Rutledge mitigation parcels be performed. Then in 2016 BC Hydro added additional proposed disturbance areas at the Cache Creek Highway Realignment which also required survey. These additional areas were added to the 2016 field study plan.

Private land access restrictions and impassible road conditions in 2016 prevented surveyors from accessing 39.9 km of corridor targeted for survey during the field season. This includes 20.5 km of access road, 13.2 km of highway realignment corridor, 4.6 km of transmission line corridor, and 1.6 km of conveyor corridor. These areas are scheduled to be surveyed during the 2017 field season (Figure 19).



Map Location

Prince George

Vancouver

Map Notes:

1. Based on surveys completed through September 2015.
2. Map Datum: NAD83
3. Map Projection: UTM Zone 10 N
4. Water Features Base Data from BC FreshwaterAtlas.
5. Road Base Data from the BC Digital Roads Atlas project.
6. Project-specific spatial data supplied by BC Hydro.

Legend

Roads
- Highway
- Secondary Roads
- Urban

Areas Planned for Survey
- 2017

Map Scale 1:250000

0 10 20 km

SITE C CLEAN ENERGY PROJECT

BC hydro

EAGLE CAP CONSULTING environmental consulting services

Figure 19
Areas to Survey for Rare Plants in 2017

Date	November 15, 2016	DWG NO	2016-11-15-0001	Revision 0

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6.0 APPENDICES

Appendix 1: Plant and lichen species recorded during the 2015–2016 surveys

VASCULAR PLANTS

Acer glabrum var. *douglasii*
Achillea alpina
Achillea millefolium var. *lanulosa*
Achnatherum nelsonii ssp. *dorei*
Achnatherum richardsonii
Aconitum delphiniifolium
Actaea rubra
Agropyron cristatum ssp. *pectinatum*
Agrostis capillaris
Agrostis exarata
Agrostis scabra
Alisma triviale
Allium cernuum var. *cernuum*
Allium schoenoprasum var. *sibiricum*
Alnus incana ssp. *tenuifolia*
Alnus viridis ssp. *crispa*
Alopecurus aequalis
Amelanchier alnifolia
Anaphalis margaritacea
Androsace septentrionalis
Anemone cylindrica
Anemone multifida var. *multifida*
Anemone patens ssp. *multifida*
Anemone virginiana var. *cylindroidea*
Antennaria howellii ssp. *canadensis*
Antennaria howellii ssp. *petaloidea*
Antennaria microphylla
Antennaria parvifolia
Antennaria racemosa
Antennaria rosea
Apocynum androsaemifolium var. *androsaemifolium*
Aralia nudicaulis
Arctostaphylos uva-ursi
Arnica chamissonis
Arnica cordifolia
Artemisia biennis
Artemisia campestris ssp. *pacifica*
Artemisia dracunculus
Artemisia frigida
Artemisia herriotii
Asparagus officinalis
Astragalus alpinus var. *alpinus*
Astragalus americanus
Astragalus canadensis
Astragalus eucosmus
Astragalus laxmannii var. *robustior*
Astragalus tenellus
Athyrium filix-femina ssp. *cyclosorum*
Avenula hookeri
Beckmannia syzigachne
Betula neoalaskana
Betula papyrifera
Bidens cernua
Boechera divaricarpa
Botrypus virginianus
Brassica rapa var. *rapa*
Bromus ciliatus
Bromus inermis
Bromus pumpellianus ssp. *pumpellianus*
Calamagrostis canadensis
Calamagrostis canadensis var. *langsdorfii*
Calamagrostis montanensis
Calamagrostis purpurascens var. *purpurascens*
Callitriche palustris
Campanula rotundifolia
Capsella bursa-pastoris
Cardamine oligosperma var. *oligosperma*
Carex aenea
Carex aquatilis var. *aquatilis*
Carex atherodes
Carex aurea
Carex bebbii
Carex brunnescens
Carex concinna
Carex crawfordii
Carex deweyana var. *deweyana*
Carex diandra
Carex disperma
Carex inops ssp. *heliophila*
Carex interior
Carex microptera
Carex obtusata
Carex pellita

Carex retrorsa
Carex rossii
Carex siccata
Carex sprengelii
Carex tenera
Carex torreyi
Carex utriculata
Carex vaginata
Carex xerantica
Castilleja miniata
Castilleja miniata var. *fulva*
Cerastium arvense
Cerastium nutans
Chenopodium album
Chenopodium album ssp. *striatum*
Chenopodium desiccatum
Chenopodium pratericola
Chenopodium simplex
Cicuta douglasii
Cicuta virosa
Cinna latifolia
Cirsium arvense
Cirsium foliosum
Clematis occidentalis ssp. *grosseserrata*
Coeloglossum viride var. *virescens*
Collomia linearis
Comandra umbellata var. *umbellata*
Conyza canadensis
Corallorhiza maculata
Corallorhiza striata var. *striata*
Corallorhiza trifida
Cornus canadensis
Cornus stolonifera
Corydalis aurea
Corylus cornuta
Crepis tectorum
Cystopteris fragilis
Dactylis glomerata
Danthonia spicata
Deschampsia cespitosa ssp. *cespitosa*
Descurainia sophia
Dracocephalum parviflorum
Dryas drummondii
Drymocallis convallaria
Dryopteris expansa
Elaeagnus commutata
Eleocharis mamillata ssp. *mamillata*
Eleocharis palustris
Elymus glaucus
Elymus glaucus ssp. *glaucus*
Elymus lanceolatus ssp. *lanceolatus*
Elymus repens
Elymus trachycaulus
Elymus trachycaulus ssp. *subsecundus*
Elymus trachycaulus ssp. *trachycaulus*
Epilobium angustifolium
Epilobium ciliatum ssp. *ciliatum*
Epilobium hornemannii ssp. *hornemannii*
Equisetum arvense
Equisetum fluviatile
Equisetum hyemale
Equisetum hyemale ssp. *affine*
Equisetum palustre
Equisetum pratense
Equisetum scirpoides
Equisetum sylvaticum
Equisetum variegatum ssp. *variegatum*
Erigeron caespitosus
Erigeron glabellus ssp. *pubescens*
Erigeron philadelphicus
Erysimum cheiranthoides
Eurybia conspicua
Eurybia sibirica
Fallopia convolvulus
Festuca rubra ssp. *rubra*
Festuca saximontana
Fragaria vesca var. *bracteata*
Fragaria virginiana
Fragaria virginiana var. *platypetala*
Galium boreale
Galium triflorum
Geocaulon lividum
Geum aleppicum
Geum macrophyllum ssp. *perincisum*
Geum triflorum var. *triflorum*
Glyceria grandis var. *grandis*
Glyceria striata
Gnaphalium uliginosum

Goodyera repens
Grindelia squarrosa var. *quasiperennis*
Gymnocarpium dryopteris
Hedysarum boreale
Heracleum maximum
Hesperostipa comata ssp. *comata*
Hesperostipa curtiseta
Heuchera richardsonii
Hieracium umbellatum ssp. *umbellatum*
Hierochloë hirta ssp. *arctica*
Hippuris vulgaris
Hordeum jubatum ssp. *jubatum*
Juncus alpinoarticulatus ssp. *americanus*
Juncus balticus ssp. *ater*
Juncus bufonius
Juncus dudleyi
Juncus nodosus
Juniperus communis
Koeleria macrantha
Lactuca serriola
Lappula occidentalis var. *occidentalis*
Lappula squarrosa
Lathyrus ochroleucus
Lecanora impudens
Lemna minor
Lepidium densiflorum var. *densiflorum*
Leucanthemum vulgare
Leymus cinereus
Leymus innovatus
Limosella aquatica
Linaria vulgaris
Linnaea borealis
Linum lewisii ssp. *lewisii*
Lithospermum incisum
Lonicera dioica var. *glaucescens*
Lonicera involucrata
Lotus corniculatus
Maianthemum canadense
Maianthemum racemosum ssp. *amplexicaule*
Maianthemum stellatum
Matricaria discoidea
Medicago lupulina
Medicago sativa
Medicago sativa ssp. *falcata*
Melica smithii
Melilotus alba
Melilotus officinalis
Mentha arvensis
Mertensia paniculata var. *paniculata*
Mitella nuda
Moehringia lateriflora
Monarda fistulosa var. *menthaefolia*
Monotropa uniflora
Muhlenbergia glomerata
Mulgedium pulchellum
Myriophyllum sibiricum
Nassella viridula
Oplopanax horridus
Opuntia fragilis
Orobanche fasciculata
Orthilia secunda
Orthilia secunda var. *secunda*
Orthocarpus luteus
Oryzopsis asperifolia
Osmorhiza berteroi
Oxytropis campestris var. *davisii*
Oxytropis sericea var. *speciosa*
Oxytropis splendens
Packera paupercula
Packera plattensis
Packera streptanthifolia
Pascopyrum smithii
Pedicularis groenlandica
Penstemon gracilis
Penstemon procerus var. *procerus*
Persicaria amphibia var. *emersa*
Persicaria lapathifolia
Petasites frigidus var. *palmatus*
Petasites frigidus var. *sagittatus*
Phalaris arundinacea
Phleum pratense
Picea glauca
Pinus contorta var. *latifolia*
Piptatherum pungens
Plantago major
Platanthera aquilonis
Platanthera huronensis
Platanthera orbiculata

Platanthera sp.
Poa compressa
Poa glauca
Poa glauca ssp. *glauca*
Poa nemoralis ssp. *interior*
Poa palustris
Poa pratensis ssp. *pratensis*
Poa secunda
Polygonum achoreum
Polygonum aviculare
Polygonum douglasii
Polypodium sibiricum
Populus balsamifera
Populus tremuloides
Potamogeton gramineus
Potamogeton pusillus ssp. *tenuissimus*
Potentilla gracilis var. *fastigiata*
Potentilla hippiana
Potentilla norvegica
Potentilla pensylvanica var. *pensylvanica*
Potentilla pulcherrima
Prosartes trachycarpa
Prunus pensylvanica
Prunus virginiana ssp. *melanocarpa*
Puccinellia distans
Puccinellia nuttalliana
Pyrola asarifolia
Pyrola chlorantha
Ranunculus aquatilis var. *diffusus*
Ranunculus cymbalaria
Ranunculus macounii
Ranunculus sceleratus var. *multifidus*
Rhinanthus minor
Rhododendron groenlandicum
Ribes oxyacanthoides ssp. *oxyacanthoides*
Rorippa palustris
Rorippa palustris ssp. *palustris*
Rosa acicularis ssp. *sayi*
Rubus idaeus ssp. *strigosus*
Rubus parviflorus var. *parviflorus*
Rubus pubescens
Rubus pubescens var. *pubescens*
Rumex crispus
Rumex occidentalis
Rumex triangulivalvis
Salix arbusculoides
Salix bebbiana
Salix discolor
Salix drummondiana
Salix interior
Salix lasiandra var. *lasiandra*
Salix planifolia
Salix prolixa
Salix pseudomonticola
Salix pseudomyrsinites
Salix pyrifolia
Salix scouleriana
Salix serissima
Sanicula marilandica
Saxifraga tricuspidata
Schizachne purpurascens
Schoenoplectus tabernaemontani
Scirpus microcarpus
Scutellaria galericulata
Selaginella sibirica
Senecio vulgaris
Shepherdia canadensis
Silene drummondii var. *drummondii*
Sisymbrium altissimum
Sisyrinchium montanum
Sium suave
Solidago lepida var. *salebrosa*
Solidago multiradiata
Solidago simplex var. *simplex*
Sonchus arvensis
Sonchus arvensis ssp. *uliginosus*
Sorbus scopulina var. *scopulina*
Sparganium emersum
Sparganium natans
Sphenopholis intermedia
Spiraea betulifolia ssp. *lucida*
Stachys palustris
Stellaria borealis
Stuckenia pectinata
Symphoricarpos albus
Symphoricarpos occidentalis
Symphyotrichum ciliolatum
Symphyotrichum ericoides var. *pansum*

Symphyotrichum lanceolatum var. *hesperium*
Symphyotrichum puniceum var. *puniceum*
Tanacetum vulgare
Taraxacum officinale
Thalictrum venulosum
Thinopyrum intermedium
Thlaspi arvense
Tragopogon dubius
Trifolium hybridum
Trifolium pratense
Tripleurospermum inodorum
Triticum aestivum
Turritis glabra
Typha latifolia
Urtica dioica ssp. *gracilis*
Vaccinium caespitosum
Vaccinium membranaceum
Vaccinium oxycoccos
Vaccinium vitis-idaea ssp. *minus*
Verbascum thapsus
Veronica beccabunga ssp. *americana*
Veronica peregrina var. *xalapensis*
Viburnum edule
Vicia americana
Viola adunca var. *adunca*
Viola canadensis var. *rugulosa*
Woodsia scopulina

BRYOPHYTES

Ceratodon purpureus
Hylocomium splendens
Marchantia polymorpha
Pleurozium schreberi
Preissia quadrata
Ptilium crista-castrensis

LICHENS

Bryoria fuscescens
Bryoria lanestris
Caloplaca cerina
Caloplaca holocarpa
Cetraria ericetorum
Cladonia carneola
Cladonia pocillum
Collema furfuraceum
Diploschistes muscorum
Enchylium tenax
Endocarpon pusillum
Evernia mesomorpha
Flavocetraria cucullata
Hypogymnia occidentalis
Hypogymnia physodes
Lathagrium undulatum var. *granulosum*
Leptogium saturninum
Lobaria pulmonaria
Melanelixia subaurifera
Melanohalea septentrionalis
Melanohalea subolivacea
Parmelia fraudans
Parmelia sulcata
Parmeliopsis ambigua
Parmeliopsis hyperopta
Peltigera aphthosa
Peltigera britannica
Peltigera elisabethae
Peltigera extenuata
Peltigera lepidophora
Peltigera leucophlebia
Peltigera neckeri
Phaeophyscia orbicularis
Phaeophyscia sciastra
Phaeophysia sp.
Physcia adscendens
Physcia aipolia
Physcia alnophila
Physcia biziana
Physcia caesia
Physcia phaea
Physcia stellaris
Physcia tenella
Physconia muscigena
Physconia perisidiosa
Platismatia glauca
Ramalina dilacerata
Ramalina obtusata
Ramalina sinensis
Rinodina sp.
Stereocaulon tomentosum
Tuckermannopsis americana
Umbilicaria americana

Usnea filipendula
Usnea lapponica
Usnea scabrata
Usnea sp.
Usnea substerilis
Vulpicida pinastri
Xanthomendoza fallax
Xanthoparmelia wyomingica

Appendix 11

2016 Regional Rare Plant Survey Report

BC Hydro Site C Clean Energy Project: 2016 Regional Rare Plant Surveys and Experimental Rare Plant Translocation Program

PRESENTED TO

BC Hydro and Power Authority

JANUARY 9, 2017
ISSUED FOR REVIEW
FILE: ENV.VENV03119-01

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EXECUTIVE SUMMARY

The Site C Clean Energy Project (Site C) received environmental approval from the federal and provincial governments in October 2014. As part of this approval, BC Hydro and Power Authority (BC Hydro) is required to fulfill Environmental Assessment Certificate ("EAC") Conditions 9, 10 and 14 and Decision Statement Conditions 16.3.2 and 16.3.4 These Conditions outline the requirements for the inventory and management of rare plants within a Regional Assessment Area (RAA) and a Local Assessment Area (LAA) surrounding Site C.

Saulteau EBA Environmental Services Joint Venture (SEES JV) was retained and two programs: the Regional Rare Plant Survey Program and the Experimental Rare Plant Translocation (ERPT) Program were implemented to address in part the requirements outlined in the EAC Conditions and the Decision Statement.

The Rare Plant Survey Program consists of two years of study: 2016 (Year 1) and 2017 (Year 2). In 2016, qualified environment professionals (botanists) conducted rare plant surveys from August 11 to 18 according to the guidelines outlined by the Alberta Native Plant Council (2012) and the U.S. Department of the Interior 'intuitive meander protocol' (2009). Voucher specimens were collected and prepared in accordance with standard herbarium procedures (Brayshaw 1996). Voucher specimens will be submitted to the herbarium at the Beaty Biodiversity Centre, University of British Columbia.

Botanists identified occurrences of 352 species of vascular plants, including 293 native and 11 exotic species. Fourteen of these plant species were designated as rare by the BC Conservation Data Centre (BC CDC), 11 of which were targets of the surveys within the RAA and 3 of which were not target species. Information collected during the Rare Plant Survey Program will be submitted to FLNR and British Columbia Ministry of Environment (MOE) (BC CDC).

The experimental rare plant translocation program is currently in the design phase. Rare plant translocation programs are becoming increasingly important as methods for conserving species that are threatened by various activities, including dam development and subsequent loss of populations and associated habitat. The study design and methodology for the ERPT Program follows the guidance outlined in Maslovat (2009). As the program evolves, new information and findings will be incorporated and used to shape the detailed design.

To date, the ERPT Program consists of seven years of study: 2016 (Year 1) to 2022 (Year 7). The proposed plan is divided into eight phases: 1) research, program development, and monitoring program development; 2) field work and data collection; 3) ex situ propagation; 4) data analysis; 5) translocation site selection; 6) translocation implementation; 7) post-translocation care and maintenance; and 8) monitoring translocated plants.

Information collected during the ERPT Program will be submitted to the MOE (BC CDC) and will provide additional knowledge about translocation, management techniques, and monitoring methods for rare plant species.

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APPENDICES

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Appendix B Regional Assessment Area and Local Assessment Area
Appendix C Qualified Environmental Professional Profiles
Appendix D 2016 Species List for the Regional Assessment Area
Appendix E Rare Plant Species Accounts
Appendix F BC Conservation Data Centre: Plant Observation Forms

ACRONYMS & ABBREVIATIONS

ACRONYM	DEFINITION
ANPC	Alberta Native Plant Council
BC CDC	British Columbia Conservation Data Centre
EAC	Environmental Assessment Certificate
ERPT	Experimental Rare Plant Translocation
EIS	Environmental Impact Statement
FLNR	Forest, Lands, and Natural Resources
LAA	Local Assessment Area
MOE	British Columbia Ministry of Environment
QEP	Qualified Environmental Professional
RAA	Regional Assessment Area
SEES JV	Saulteau EBA Environmental Services Joint Venture
Site C	A dam and hydroelectric generating station under construction on the Peace River in northeastern British Columbia.
UTM	Universal Transverse Mercator

1.0 PROJECT OVERVIEW

The Site C Clean Energy Project (Site C) is a dam and hydroelectric generating station under construction on the Peace River in northeast British Columbia (BC). The Project will be the third dam and hydroelectric generating station on the Peace River in British Columbia, and is downstream of BC Hydro and Power Authority's (BC Hydro) existing generating facilities at G.M. Shrum on the Williston Reservoir and Peace Canyon at the Dinosaur Reservoirs.

2.0 PROJECT CONDITIONS

Site C received environmental approval from the federal and provincial governments in October 2014. As part of this approval, the provincial government issued Certificate E14-02 (Certificate) and the federal government issued the Decision Statement under Section 54 of the Canadian *Environmental Assessment Act* (2012). These documents outline the Conditions associated with the approval of the project, which include the mitigation measures and follow-up program that proponent must fulfil to proceed with the project.

This document summarizes the work completed in 2016 by BC Hydro in partial fulfillment of these Conditions.

2.1 Environmental Assessment Certificate Conditions

EAC Conditions 9, 10 and 14 (Table 2.1) issued by the province of British Columbia to BC Hydro are relevant to the 2016 rare plant program (Table 2-1).

Table 2-1. Environmental Assessment Certificate Conditions issued to BC Hydro Relevant to the 2016 Rare Plant Program

Condition Number	Condition Detail
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 British Columbia Ministry of Environment (BC MOE) using the MOE's Guidelines for Translocation of Plant Species at Risk in British Columbia (Maslovat, 2009).
10	The EAC Holder must fund or undertake directly with the use of a Rare Plant Botanist the following, during construction: Targeted surveys in the [Regional Assessment Area] RAA[1] (as defined in the amended EIS) to identify occurrences of the 18[2] directly affected rare plant species (as defined in the amended EIS), and rare plant species identified by the MOE's Conservation Framework requiring additional inventories. The EAC Holder must provide Forest, Lands, and Natural Resources (FLNR) and BC Conservation Data Centre (BC CDC) with the findings and analysis of results from the surveys and taxonomic study.
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.

Condition Number	Condition Detail
	▪ 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.

[1]See Appendix B for the EIS Study Areas (Regional Assessment Area and Local Assessment Area)

[2]*Erigeron pacalis* (peace daisy) and *Rorippa calycina* (persistent-sepal yellowcress) were added to the list of target species based on comments received from MOE on the the Draft Vegetation and Wildlife Mitigation and Monitoring Plan (April 7th, 2015).

2.2 Decision Statement Conditions

Several Decision Statement Conditions 16.1, 16.2, and 16.3 issued under Section 54 of the Canadian *Environmental Assessment Act* (2012) to BC Hydro are relevant to the 2016 rare plant program (Table 2-2).

Table 2-2. Decision Statement Conditions issued to BC Hydro Relevant to the 2016 Rare Plant Program

Condition Number	Condition Detail	
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	16.3.1.	Measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities, and rare plants.
	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.
	16.3.4.	Conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation.
	16.3.6.	An approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities, and rare plants.

Saulteau EBA Environmental Services Joint Venture (SEES JV) was retained to address in part the requirements outlined in EAC Conditions 9, 10, and 14 and the Decision Statement 16.3.2 and 16.3.4. Two programs were created to address the requirements outlined in these Conditions:

1. Regional Rare Plant Survey Program; and
2. Experimental Rare Plant Translocation Program.

The following sections summarize the work completed in 2016 for the Regional Rare Plant Survey program (Section 4.0) and the Experimental Rare Plant Translocation Program (Section 5.0).

3.0 CONSERVATION FRAMEWORK

In British Columbia, at risk plants are ranked according to factors such as rarity, intrinsic vulnerability, environmental specificity, threats, and long- and short term trends in population size by the British Columbia Conservation Data Centre (BC CDC). The BC CDC categorizes at risk plants as either Red-listed or Blue-listed depending on their rank status, location, and level of protection (Table 3.1-1; MOE 2016). Plants that are common and secure within the province are categorized as Yellow-listed.

Table 3-1. NatureServe National and Subnational Conservation Status Ranks and Definitions

Rank Status	Definition
Red-listed	Plants that have, or are candidates for, Extirpated, Endangered or Threatened status in BC. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered, or Threatened under the *Wildlife Act* 1996).
Blue-listed	Plants of "special concern" (formerly vulnerable) status in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events.
Yellow-listed	Plants that are common and demonstrably secure.

In addition to the BC CDC Conservation Rank Status, plant species are assigned a conservation rank by NatureServe. Conservation status assessment are completed to produce conservation status ranks that measure extinction or extirpation risk at three geographic scales: Global (G-Ranks), National (N-Ranks) and Subnational (S-Ranks; Table 3.1-2).

Table 3-2. NatureServe Subnational Conservation Status Ranks and Definitions

NatureServe Subnational Rank[1]	Definition	BC CDC Rank Equivalent
S1	Extremely rare at the provincial level; five or fewer occurrences, or very few remaining individuals; critically imperiled and susceptible to extirpation due to a factor of its biology	Red-listed
S2	Rare at the provincial level; six to 20 occurrences, or few remaining individuals; imperiled, may be susceptible to extirpation due to some factor of its biology	
S1S2[2]	Extremely rare to rare at the provincial level	
S3	Vulnerable at the provincial level; 21 to 100 occurrences; may be rare and local throughout the province or may occur in a restricted provincial range (may be abundant in some places); may be susceptible to extirpation by large scale disturbances	Blue-listed
S2S3	Rare to vulnerable at the provincial level	
S3S4	Vulnerable to common at the provincial level	
S4	Common at the provincial level; more than 100 occurrences; generally widespread and abundant but may be rare in parts of its range; apparently secure	Yellow-listed
S5	Very common and demonstrably secure at the provincial level; more than 100 occurrences;	

[1]*The NatureServe ranks and definitions at the national (N ranks) and global level (G ranks) are available on their website (NatureServe 2016).*
[2] *A Range Rank (i.e., S2S3) is used when existing information on an element straddles the criteria defining two separate ranks*

4.0 REGIONAL RARE PLANT SURVEY PROGRAM

The rare plant survey program consists of two years of study: 2016 (Year 1) and 2017 (Year 2). Information collected will be submitted to FLNR and MOE (BC CDC). This following sections summarizes the objectives, method and results of the Year 1 Rare Plant Survey Program.

4.1 Objectives

The objectives of the Regional Rare Plant Survey Program are as follows:

1. Conduct 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 by the MOEs Conservation Framework requiring additional inventories to confirm or determine the status rank (Table 4.1-1).

2. Determine if the critically imperiled rare plant species; *Erigeron pacalis* (Peace daisy) and *Rorippa calycina* (persistent-sepal yellowcress) occur elsewhere in the region (Table 4.1-1).

3. Provide FLNR and MOE (BC CDC) with the full element occurrence data and any other relevant findings for each rare plant documented.

Table 4.1-1. At Risk Plant Species identified by the Conservation Framework that Require Additional Inventories to Confirm or Determine their Status Rank

Scientific Name	Common Name	Historic Conservation Status Information as defined in the amended EIS[1]			Current Conservation Status Information	
		BC CDC and NatureServe Conservation Status Rank (2013[1])	BC CDC and NatureServe Conservation Framework Priority [b](2013)	Conservation Framework Action Groups [c](2013)	BC CDC and NatureServe Conservation Status Rank (2016)	Rank Status Designation Year
RED-LISTED PLANTS						
Artemisia herriotii	White sagebrush	Red (S2)	2	Inventory	Red (S2)	2015
Atriplex gardneri var. *gardneri*	Gardner's sagebrush	Red (S1)	2	Inventory	Red (S2)	2016
Chrysosplenium iowense	Iowa golden-saxifrage	Blue (S2S3)	2	Inventory	Red (S2?)	2015
Epilobium saximontanum	Rocky Mountain willowherb	Red (S1S3)	2	Inventory	Red (S1S3)	2015
Erigeron pacalis	Peace daisy	Red – status report available mid-2016	2	Inventory	Red (S1)	2015
Penstemon gracilis	slender penstemon	Red (S2)	2	Inventory; Status Report; *Wildlife Act*	Red (S2)	2015
Polypodium sibiricum	Siberian polypody	Red (SH)	2	Inventory	Red (S2?)	2015
Rorippa calycina	persistent-sepal yellowcress		2	Inventory	Red (S1)	2015
Schizachyrium scoparium	little bluestem	Red (S1)	2	Inventory	Red (S1)	2000
BLUE-LISTED PLANTS						
Avenula hookeri	spike-oat	Blue (S3)	2	Inventory	Blue (S3)	2015
Calamagrostis	plains reedgrass	Blue (S3)	4	Inventory	Blue (S3)	2015

Scientific Name	Common Name	Historic Conservation Status Information as defined in the amended EIS[1]			Current Conservation Status Information	
		BC CDC and NatureServe Conservation Status Rank (2013[1])	BC CDC and NatureServe Conservation Framework Priority [b](2013)	Conservation Framework Action Groups [c](2013)	BC CDC and NatureServe Conservation Status Rank (2016)	Rank Status Designation Year
montanensis						
Carex torreyi	Torrey's sedge	Blue (S2S3)	2	Inventory	Blue (S2S3)	2015
Carex xerantica	dry-land sedge	Red (S2)	2	Inventory	Blue (S2S3)	2015
Cirsium drummondii	Drummond's thistle	Red (S2)	2	Inventory	Blue (S3)	2015
Epilobium halleanum	Hall's willowherb	Blue (S2S3)	2	Inventory	Blue (S2S3)	2012
YELLOW-LISTED PLANTS[2]						
Anemone virginiana var. *cylindroidea*	riverbank anemone	Blue (S3)	2	Inventory	Yellow (S4)	2015
Galium labradoricum	northern bog bedstraw	Blue (S3)	2	Inventory	Yellow (S3S4)	2015
Salix serissima	autumn willow	Blue (S2S3)	2	Inventory	Yellow (S3S4)	2015
Juncus confusus	Colorado rush	Red (S1)	2	Inventory	Yellow (S4)	2016
Muhlenbergia glomerata	marsh muhly	Blue (S3)	4	Inventory	Yellow (S4)	2015
Symphyotrichum puniceum var. *puniceum*	purple-stemmed aster var. gardneri	Blue (S3)	2	Inventory	Yellow (S3S4)	2016

1. As per Table 3.1.1 EIS, Volume 2, Appendix R, Part 1
2. In 2015/ 2016, the BC CDC down-listed the conservation status ranks (from Red or Blue to Yellow) for 6 of the 20 species listed in Table 4.1-1 as these species are more abundant and/or less threatened than previously ranked (BC CDC 2016)

4.2 Methods

The study design and methodology for the regional rare plant survey program follows the guidance outlined in the Alberta Native Plant Council (ANPC 2012) and the protocols described by the U.S. Department of the Interior (2009).

4.2.1 Site Selection

Survey sites were selected *a priori* from satellite imagery, and included lands within the RAA that meet the following criteria:

- supported habitats that appear consistent with those of the target species;
- occurred on land that is not privately owned;
- occurred on land that is reasonably accessible;
- had not been surveyed in detail previously by botanists and contain few or no known occurrences of rare species, based on the information provided by the BC Conservation Data Centre (BC CDC 2016); and
- had not been surveyed as part of any of the prior BC Hydro rare plant surveys related to Site C.

Based on the above criteria, six sites were selected for further investigation (Figure 4.2-1).

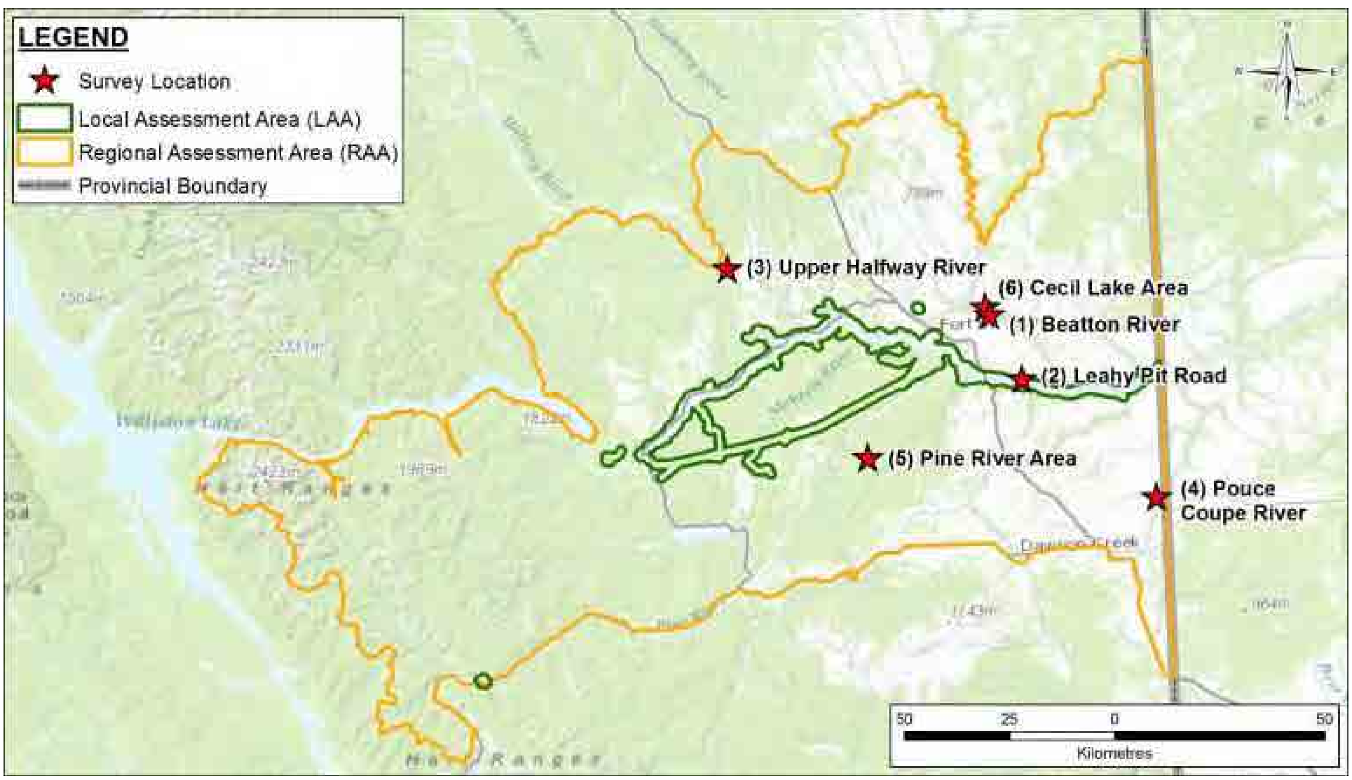


Figure 4.2-1. Survey Locations in the Greater Peace Region during the 2016 Survey Period

(1) Beatton River; (2) Leahy Pit Road; (3) Upper Halfway River; (4) Pouce Coupé River; (5) Pine River Area; and (6) Cecil Lake Area

4.2.2 Survey Timing and Locations

Field surveys were conducted from August 11 to 18, 2016. Individual sites were surveyed on the following dates: Beatton River on August 11 and 12, Leahy Pit Road on August 13 and 16, Upper Halfway River on August 14, Pouce Coupé River on August 15, Pine River area on August 17, and Cecil Lake area on August 18.

4.2.3 Qualifications of Surveyors

The rare plant surveys were conducted by botanists Dr. Terry McIntosh and Jamie Fenneman (Ph.D Candidate; bios provided in Appendix C).

4.2.4 Field Survey Methods

The 2016 surveys were conducted according to the U.S. Department of the Interior 'intuitive meander protocol' (2009). This method focuses on the habitats where target species are most likely to be found based on the known ecological requirements of each species and supported by the experience of the field botanists.

Field botanists walked 10 to 20 m apart and traversed as many habitats as possible within a particular site. Photographs were taken of the focal plants and the surrounding habitats whenever rare plant populations were encountered. Field notes were compiled for most populations (avoided for some subpopulations that were less than 20 m apart) describing the general habitat, associated plant species, general soil type, number of individuals present, areal extent of the population, population vigour and health, and any potential threats. Notes regarding growth and reproductive stage (phenology) were also made. Each population and subpopulation was georeferenced.

Concurrent with the rare plant surveys for target rare plant species, field botanist collected a full plant inventory (i.e., a floristic survey) for each site. These types of surveys are important so that all associates of rare plants are determined and their habitats better understood, which will be used to inform future translocation work. Full Element Occurrence data was submitted to MOE (BC CDC) on December 30th, 2016.

4.2.5 Voucher Specimen Collection and Verification

Voucher specimens were collected from select populations when population size was large enough to permit, as determined based on population size (i.e., > 20 plants) and the biology of the species. For sites with numerous subpopulations of a particular rare species, a single voucher was collected from the entire site (rather than each subpopulation) in order to minimize the impacts on the metapopulation. Voucher specimens were prepared in accordance with standard herbarium procedures (Brayshaw 1996). Voucher specimens were submitted to the herbarium at the Beaty Biodiversity Centre, University of British Columbia in January, 2017.

4.2.6 Survey Limitations

The following limitations were present during the 2016 rare plant surveys:

1. Access to some habitats was restricted by terrain; for example, in the Beatton River site the river and shoreline habitats could not be accessed due to steep cliffs that bordered the grassland slopes that were surveyed.
2. Access to some habitats was restricted by possible private land ownership; for example, at the Upper Halfway River site fences were marked with 'No Trespassing' signs, even though earlier research showed these lands as being owned by the Crown.

3. Late-season survey: the 2016 survey was at the end of the growing period and this put a constraint on the number of species that could be detected (i.e., early season plants may have been missed as they would have passed the flowering and fruiting stage by late summer).

4.3 Results

The rare plant surveys carried out in the RAA in 2016 documented the occurrence of 352 species of vascular plants, including 293 native and 11 exotic species (Appendix D). Of these, 14 species were designated as rare by the BC CDC, 11 of which were targets of these surveys (Table 4.3-1; Figure 4.3-1 and Appendix E). None of the species are considered at risk federally (i.e., listed in SARA).

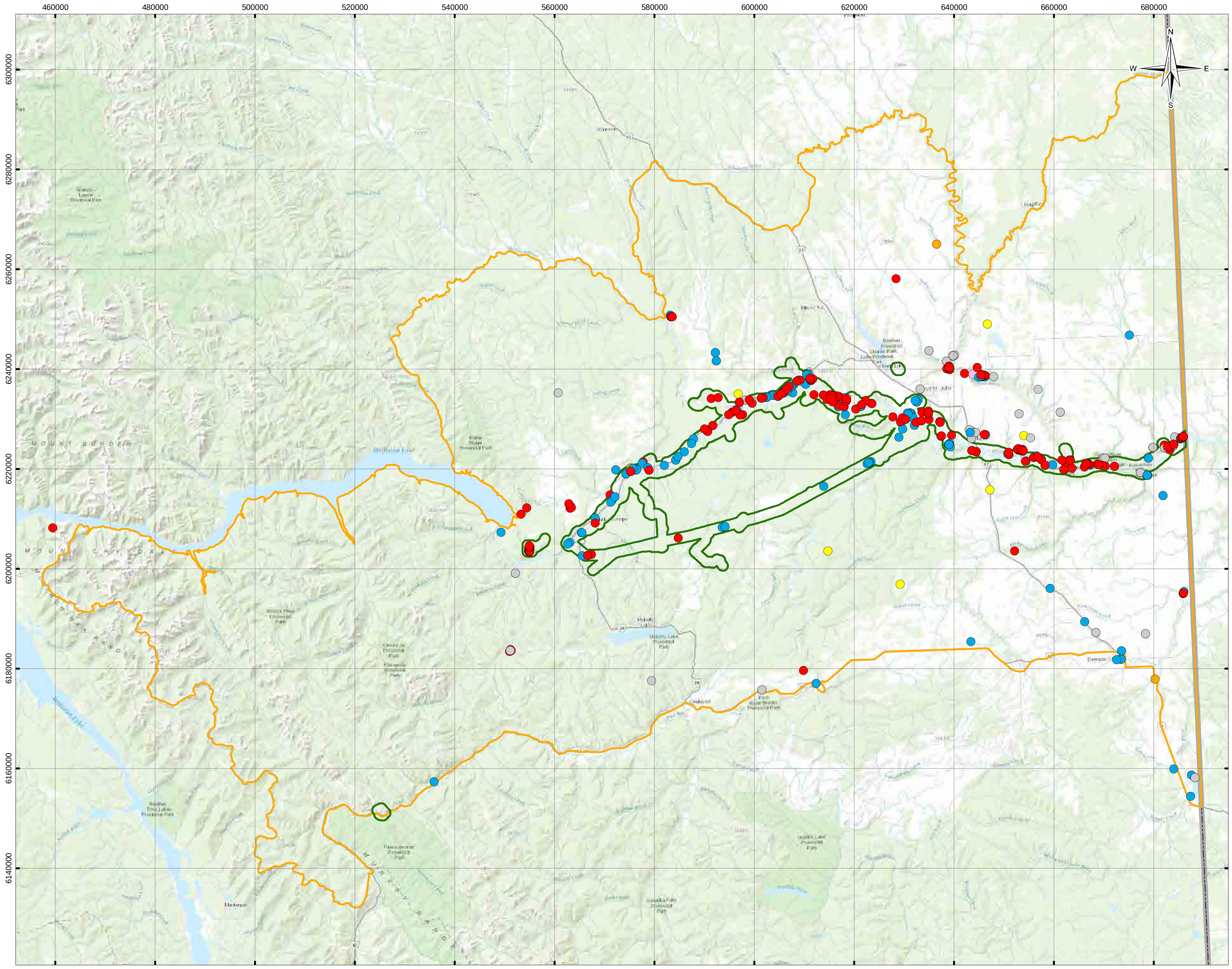
Survey site #1 (Beatton River) was found to support the highest diversity of species (194), followed by Leahy Pit Road (153). Survey site #2 (Leahy Pit Road) supported the greatest diversity of rare (eight) and target (six) species. Complete plant lists were not derived for either the Pine River or Cecil Lake sites since these areas were too large and only a few small sites were surveyed.

Table 4.3-1. Species Number, Native and Exotic Species, Rare Species, and Target Species Observed in Each Survey Area

Survey Site	No. of Species	No. of Native Species	No. of Exotic Species	No. of Rare Species	No. of Target Species
Overall	**352**	**293**	**59**	**14**	**11**
1. Beatton River	194	159	35	5	3
2. Leahy Pit Road	153	126	27	8	6
3. Upper Halfway River	142	122	20	6	2
4. Pouce Coupé River	124	100	24	3	2
5. Pine River area	*	*	*	0	1
6. Cecil Lake area	*	*	*	1	3

* Complete species lists were not compiled for these areas.

Table 4.3-2 shows the number of populations/subpopulations of rare and target species per survey site. The most frequently detected rare species among the six survey areas, with 11 total populations distributed among three sites, was the non-target *Geum triflorum* var. *triflorum* (old man's whiskers), followed by two target species: *Penstemon gracilis* (slender penstemon; nine populations at two sites) and *Calamagrostis montanensis* (plains reedgrass; seven populations at two sites). Other frequently encountered rare species included the non-target *Antennaria neglecta* (field pussytoes; five populations at two sites) and the target species *Avenula hookeri* (spike oat; five populations at two sites). The target species *Symphyotrichum puniceum* var. *puniceum* (purple-stemmed aster; five populations) and *Artemisia herriotii* (Herriot's sage; five populations), and non-target *Symphyotrichum lanceolatum* var. *lanceolatum* (western willow aster; four populations), were also encountered frequently, although most populations of these three species were encountered outside of the survey areas while driving to or from some of the six primary survey areas. Figure 4.3-2 shows the locations of these incidental populations and Table 4.3-3 lists their conservation and habitat details. Species accounts of all of the CDC-listed rare species that were observed during the 2016 surveys are provided in Appendix F



LEGEND

Rare Plants by Rank

- Red-Listed
- Blue-Listed
- Yellow-Listed
- Historical
- Not Ranked
- Unknown
- Local Assessment Area (LAA)
- Regional Assessment Area (RAA)
- Provincial Boundary

NOTES
Data source:
Rare plants shown compiled from data provided by BC Hydro and the B.C. Conservation Data Centre as well as EcoLogic Consultants.

STATUS
ISSUED FOR REVIEW

BC HYDRO SITE C CLEAN ENERGY PROJECT: 2016 REGIONAL RARE PLANT SURVEYS AND EXPERIMENTAL RARE PLANT TRANSLOCATION PROGRAM

Distribution of Target Rare Plant Species within the Regional Assessment Area

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:750,000
10 5 0 10
Kilometres

TETRA TECH

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Figure 4.3-1

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Table 4.3-2. Number of Populations/Subpopulations of Rare and Target Species per Survey

Scientific Name	Common Name	BC Status	Target	Survey Site					
				1	2	3	4	5	6
Anemone virginiana* var. *cylindroidea	riverbank anemone	Yellow (S4) [delisted 2015]	Y	0	1	0	0	0	0
Antennaria neglecta	field pussytoes	Blue (S2S3)	N	0	2	3	0	0	0
Artemisia herriotii	white sagebrush	Red (S2)	Y	0	0	0	3	0	1
Avenula hookeri	spike oat	Blue (S3)	Y	0	2	3	0	0	0
Calamagrostis montanensis	plains reedgrass	Blue (S3)	Y	1	6	0	0	0	0
Carex sychnocephala	many-headed sedge	Yellow (S3S4) [delisted 2015]	Y	0	0	0	0	0	1
Carex torreyi	Torrey's sedge	Blue (S2S3)	Y	0	1	0	0	0	0
Carex xerantica	dry-land sedge	Blue (S2S3)	Y	0	1	0	1	0	0
Elymus albicans	Montana wildrye	Red (S1S2)	N	0	1	0	0	0	0
Elymus lanceolatus ssp. *psammophilus*	sand- dune wheatgrass	Blue (S2S3)	N	0	0	1	0	0	0
Geum triflorum var. *triflorum*	old man's whiskers	Red (S1S3)	N	3	7	1	0	0	0
Penstemon gracilis	slender penstemon	Red (S2)	Y	2	7	0	0	0	0
Potentilla pulcherrima	pretty cinquefoil	Red (S2)	N	0	0	1	0	0	0
Silene drummondii* var. *drummondii	Drummond's campion	Blue (S3)	Y	1	0	2	0	0	0
Symphyotrichum lanceolatum var. *lanceolatum*	western willow aster	to be ranked in 2017	N	0	0	0	2	0	0
Symphyotrichum puniceum* var. *puniceum	purple stemmed aster	Yellow (S3S4) [delisted 2016]	Y	0	0	0	0	2	1

Site 1 = Beatton River; Site 2 = Leahy Pit Road; Site 3 = Upper Halfway River; Site 4 = Pouce Coupé River; Site 5 = Pine River area; Site 6 = Cecil Lake area. Rare and target species located outside of these six survey sites are presented in Table 4.3-3.

Figure 4.3-2. 2016 Survey Locations in the Regional Assessment Area (yellow circles/polygons; numbered).

1 = Beatton River; 2 = Leahy Pit Road; 3 = Upper Halfway River; 4 = Pouce Coupé River; 5 = Pine River area; 6 = Cecil Lake area.

Also included are incidental observations of rare taxa that fell outside of these six survey areas: orange stars = *Artemisia herriotii* (target species); dark blue circles = *Symphyotrichum lanceolatum* var. *lanceolatum* (non-target species); open black circles = *Symphyotrichum puniceum* var. *puniceum* (target species; subsequently delisted).

Table 4.3-3. Incidental Observations of Rare Vascular Plant Taxa in the RAA Outside of the Six Primary Survey Areas

Scientific Name	Common Name	Target	BC Status	EO[1]	UTM[2]	Habitat
Artemisia herriotii	Herriot's sage	Y	Red (S2)	1	638554 6240094	riverbanks; disturbed areas
Symphyotrichum lanceolatum var. *lanceolatum*	western willow aster	N	to be ranked in 2017	1	644476 6223500	stabilized riverbanks
				2	638554 6240094	stabilized riverbanks
Symphyotrichum puniceum **var. *puniceum***	purple stemmed aster	Y	Yellow (S3S4) [delisted 2016]	1	653953 6226679	marshy roadside verge
				2	596779 6235043	marshy roadside verge
				3	647172 6215832	marshy roadside verge

[1] EO = Element Occurrence
[2] All UTMs are in zone 10V.

4.3.1 Survey Site #1: Beatton River

This site was surveyed on August 11 and 12, 2016, during which time 194 species of vascular plants, including 159 native species and 35 exotic species, were documented (Appendix D: Species List). Two separate areas were surveyed: a western component that primarily sampled riverbank habitats along the Beatton River and an eastern component that sampled a mosaic of south-facing grassland slopes and deciduous woodlands. The extensive south-facing grassland slopes were dominated by grasses such as *Hesperostipa curtiseta* (short-awned porcupinegrass), *Achnatherum nelsonii* ssp. *Dorei* (Columbia needlegrass), *Poa pratensis* ssp. *agassizensis*, (Kentucky bluegrass) and *Koeleria macrantha* (junegrass) and supported a diverse assemblage of herbaceous species. Both stable grassland benches and steep, eroding, sparsely-vegetated slopes were sampled, as each supported distinct plant communities. Aspen (*Populus tremuloides*) copses and shrub [*Rosa woodsii* ssp. *woodsii* (Wood's rose), *Symphoricarpos occidentalis* (western snowberry), *Elaeagnus commutata* (silverberry)] thickets were widespread throughout the survey area and were extensively surveyed. Localized habitats within the survey area included a single eutrophic, densely-vegetated marsh in the eastern portion of the survey area (largely dry during the survey period), and riverbank habitats along the Beatton River in the western portion of the survey area.

Five rare vascular plant species, including three target species [*Penstemon gracilis* (slender penstemon), *Silene drummondii* var. *drummondii* (Drummond's campion), and *Calamagrostis montanensis* (plains reedgrass)], were documented at Beatton River. All three target species occurred on south-facing grassland slopes, although *Calamagrostis montanensis* was restricted to very steep, silty, actively eroding sites and the other two target taxa occurred on less steeply inclined, more stable, and more densely vegetated grassland slopes. Two non-target rare vascular plants, the currently unranked *Symphyotrichum lanceolatum* var. *lanceolatum* (western willow aster) and the red-listed *Geum triflorum* var. *triflorum* (old man's whiskers), were also detected in the survey area, the former occurring along the stabilized banks of the Beatton River and the latter on stable grassland benches in the eastern portion of the survey area. *Symphyotrichum lanceolatum* var. *lanceolatum* is considered 'rare' by provincial botanists familiar with the species, including J. Fenneman and will be listed as Blue or Red by the CDC in the future; meetings to determine the rank status of plant species are held bi-annually, with the next meeting scheduled for 2017) Table 4.3-4 summarizes the results of the rare plant surveys at Beatton River; see Appendix F for more detail on these populations. Locations of the rare taxa observed at the Beatton River site are shown in Figure 4.3-3.

Table 4.3-4. Rare Vascular Plant Taxa Documented at Beatton River

Species	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Calamagrostis montanensis	plains reedgrass	Y	Blue (S3)	1	646183 6238410	steep, eroding south-facing slope
Geum triflorum var. *triflorum*	old man's whiskers	N	Red (S1S3)	1	646281 6238649	south-facing grassland slope
				2	645503 6238523	south-facing grassland slope
				3	645467 6238537	south-facing grassland slope
Penstemon gracilis	slender penstemon	Y	Red (S2)	1	645510 6238847	south-facing grassland slope
				2	646026 6238793	south-facing grassland slope
Silene drummondii* var. *drummondii	Drummond's campion	Y	Blue (S3)	1	645535 6238501	south-facing grassland slope
Symphyotrichum lanceolatum var. *lanceolatum*	western willow aster	N	to be ranked in 2017	1	643764 6238972	stabilized riverbank

[1] EO = Element Occurrence
[2] All UTMs are in zone 10V.

Figure 4-3-3. Locations of Rare and Target Plant Species at Beatton River

The area surveyed is denoted by the yellow polygons. Stars = target taxa; circles = non-target rare taxa. Red stars = *Penstemon gracilis*; dark blue stars = *Calamagrostis montanensis*; yellow stars = *Silene drummondii* var. *drummondii*; dark blue circles = *Symphyotrichum lanceolatum* var. *lanceolatum*; white circles = *Geum triflorum* var. *triflorum*.

4.3.2 Survey Site #2: Leahy Pit Road

This site was surveyed on August 13 and 16, 2016, during which time 153 species of vascular plants, including 126 native species and 27 exotic species, were documented (Appendix D: Species List). The habitats sampled during these surveys included extensive south-facing grassland slopes, aspen copses, deciduous woodlands, shrub thickets, and disturbed areas (roadsides, pipeline right-of-way). Grasslands at this site were particularly rich in species diversity, and were dominated by species such as *Achnatherum nelsonii* ssp. *dorei*, (Columbia needlegrass) *Carex obtusata* (blunt sedge), *Poa pratensis* ssp. *agassizensis* (Kentucky bluegrass), *Elymus lanceolatus* ssp. *lanceolatus* (thickspike wildrye), *Hesperostipa curtiseta* (short-awned porcupinegrass), and *Koeleria macrantha* (junegrass). A feature of note at this survey site is the presence of a deep, steep-sided, forested ravine between the two primary grassland slopes.

Eight rare or recently delisted vascular plant species, including five target species [*Penstemon gracilis* (slender penstemon, *Carex xerantica* (dry-land sedge), *Carex torreyi* (Torrey's sedge), *Calamagrostis montanensis* (plains reedgrass), *Avenula* hookeri (spike-oat), were documented at Leahy Pit Road. The five target species all occurred on south-facing grassland slopes, particularly near slope crests or, in the case of *Carex torreyi*, in shallow, grassy swales. Three non-target rare vascular plants, the blue-listed *Antennaria* neglecta (field pussytoes), the red-listed *Geum triflorum* var. *triflorum* (old man's whiskers) and *Elymus albicans* (Montana wildrye), were also detected in the survey area; as with the target taxa, all three species occurred on open south-facing grassland slopes. One target species, *Anemone virginiana* var. *cylindroidea* (riverbank anemone), was documented from this site; this species was delisted as a species of concern in British Columbia in 2015. According to the BC CDC, there are at least 11 element occurrences and a population of at least 3,700 Anemone *virginiana* var. *cylindroidea* plants in B.C. with further inventory likely to reveal more collections (BC CDC 2016). Table 4.3-5 summarizes the results of the rare plant surveys at Leahy Pit Road; see Appendix F for more detail on these populations. Locations of the rare taxa observed at the Leahy Pit Road Site are shown in Figure 4.3-4.

Table 4.3-5. Rare Vascular Plant Taxa Documented at Leahy Pit Road

Scientific Name	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Anemone virginiana* var. *cylindroidea	riverbank anemone	Y	Yellow (S4) [delisted 2015]	1	653015 6223705	shrubby aspen thicket
Antennaria neglecta	field pussytoes	N	Blue (S2S3)	1	652770 6223893	south-facing grassland slope
				2	653511 6223773	south-facing grassland slope
Avenula hookeri	spike-oat	Y	Blue (S3)	1	653540 6223805	south-facing grassland slope
				2	653810 6223721	south-facing grassland slope
Calamagrostis montanensis	plains reedgrass	Y	Blue (S3)	1	653534 6223788	south-facing grassland slope
				2	653550 6223806	south-facing grassland slope
				3	653587 6223808	south-facing grassland slope
				4	653712 6223853	south-facing grassland slope
				5	653745 6223792	south-facing grassland slope
				6	653863 6223662	south-facing grassland slope
Carex torreyi	Torrey's sedge	Y	Blue (S2S3)	1	652831 6224006	grassy swale on grassland slope
Carex xerantica	dry-land sedge	Y	Blue (S2S3)	1	653775 6223746	south-facing grassland slope
Elymus albicans	Montana wildrye	N	Red (S1S2)	1	not georeferenced[3]	south-facing grassland slope

Scientific Name	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Geum triflorum var. *triflorum*	old man's whiskers	N	Red (S1S3)	1	652750 6223916	south-facing grassland slope
				2	652898 6224044	south-facing grassland slope
				3	653045 6223964	south-facing grassland slope
				4	653706 6223854	south-facing grassland slope
				5	653743 6223820	south-facing grassland slope
				6	653879 6223705	south-facing grassland slope
				7	653814 6223529	south-facing grassland slope
Penstemon gracilis	slender penstemon	Y	Red (S2)	1	652770 6223893	south-facing grassland slope
				2	652744 6223962	south-facing grassland slope
				3	652885 6224043	south-facing grassland slope
				4	653474 6223716	south-facing grassland slope
				5	653556 6223786	south-facing grassland slope
				6	653863 6223708	south-facing grassland slope
				7	653881 6223697	south-facing grassland slope

[1] EO = Element Occurrence
[2] All UTMs are in zone 10V.
[3] Species was identified from a collected specimen following the field session.

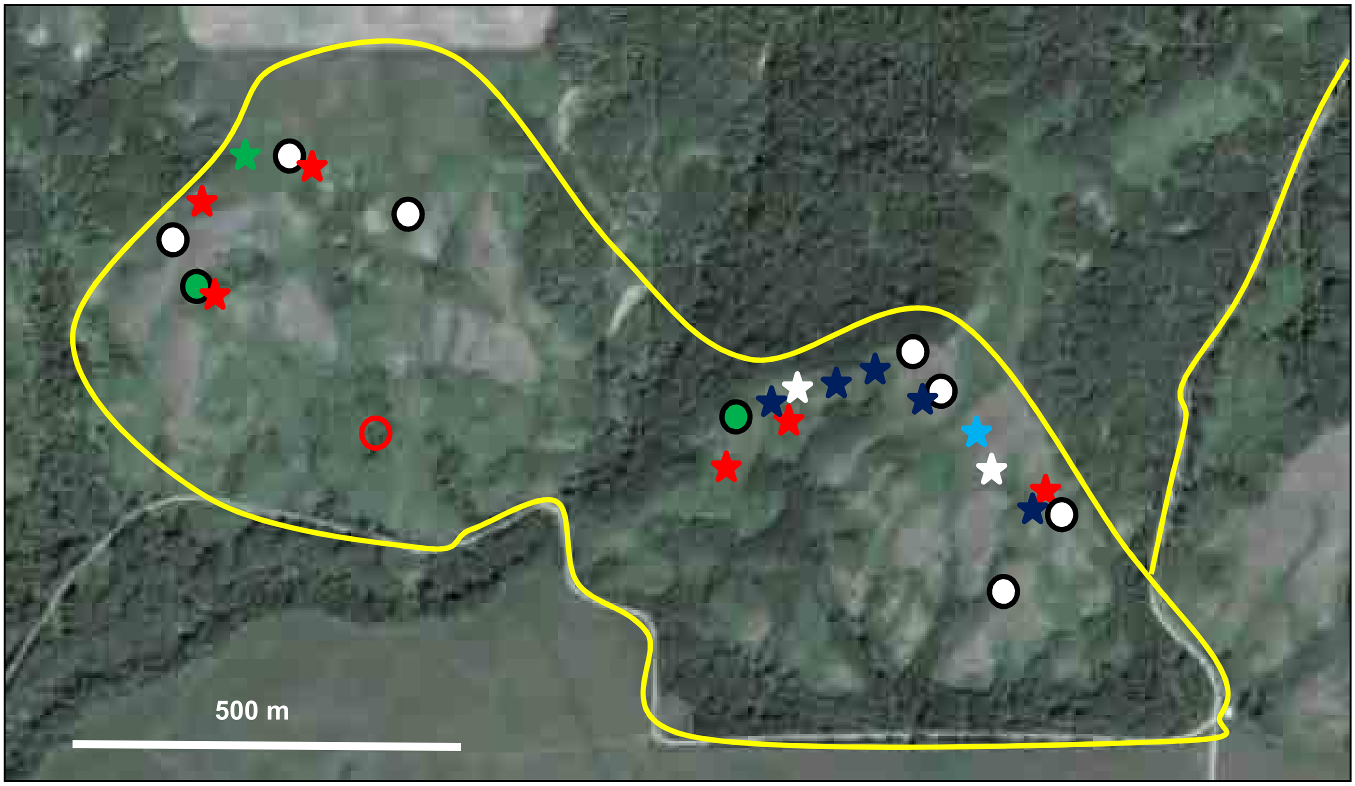

Figure 4.3-4. Locations of Rare and Target Plant Species at Leahy Pit Road

The area surveyed is denoted by the yellow polygon. Stars = target taxa; circles = non-target rare taxa. Red stars = *Penstemon gracilis*; dark blue stars = *Calamagrostis montanensis*; light blue stars = *Carex xerantica*; green stars = *Carex torreyi*; white stars = *Avenula hookeri*; white circles = *Geum triflorum* var. *triflorum*; green circles = *Antennaria neglecta*. The open red circle denotes the location of *Anemone virginiana* var. *cylindroidea*, which was a target species for this survey but was subsequently delisted. An additional non-target red-listed species, *Elymus albicans*, was recorded at this site, but was identified from collected material after the field surveys and was therefore not georeferenced in the field.

4.3.3 Survey Site #3: Upper Halfway River

This site was surveyed on August 14. 2016, during which time 142 species of vascular plants, including 122 native species and 20 exotic species, were documented (Appendix D: Species List). The primary habitat sampled during this survey was a steep, open, southwest-facing grassland slope that was dominated by grasses such as *Poa pratensis* ssp. *agassizensis* (Kentucky bluegrass), *Achnatherum nelsonii* ssp. *Dorei* (Columbia needlegras), *Festuca saximontana* var. *saximontana* (Rocky Mountain fescue), and *Hesperostipa curtiseta* (short-awned porcupinegrass). The surveys also sampled mixed boreal forests [dominated by trees such as *Populus tremuloides* (trembling aspen), *Betula neoalaskana* (Alaska paper birch), and *Picea glauca* (white spruce)] and wet disturbed areas, although these habitats were sampled while accessing the primary survey site rather than at the survey site itself.

Six rare vascular plant taxa, including two target species [*Avenula* hookeri (spike-oat), *Silene drummondii* var. *drummondii (*Drummond's campion)], were documented at the Upper Halfway River survey site. Both target species were restricted to the extensive, open grassland slopes that characterized most of the survey area. Four non-target rare vascular plants, the blue-listed *Antennaria neglecta* (field pussytoes) and *Elymus lanceolatus* ssp. *psammophilus* (sand-dune wheatgrass) and the red-listed *Potentilla pulcherrima* (pretty cinquefoil) and *Geum* *triflorum* var. *triflorum* (old man's whiskers), were also detected in the survey area. These four species also occurred solely in natural or somewhat disturbed grassland habitats, although *Elymus lanceolatus* ssp. *psammophilus* was restricted to rock outcrops in this habitat.

Table 4.3-6 summarizes the results of the rare plant surveys at Leahy Pit Road; see Appendix F for more detail on these populations. Locations of the rare taxa observed at the Upper Halfway River site are shown in Figure 4.3-5.

Table 4.3-6. Rare Vascular Plant Taxa Documented at Upper Halfway River

Scientific Name	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Antennaria neglecta	field pussytoes	N	Blue (S2S3)	1	583356 6250491	disturbed grassland margin
				2	583331 6250510	upper grassland slope
				3	583298 6250570	upper grassland slope
Avenula hookeri	spike-oat	Y	Blue (S3)	1	583300 6250543	open grassland slope
				2	583222 6250740	open grassland slope
				3	583298 6250570	upper grassland slope
Elymus lanceolatus ssp. *Psammophilus*	sand-dune wheatgrass	N	Blue (S2S3)	1	583211 6250810	rocky outcrop on grassland slope
Geum triflorum var. *triflorum*	old man's whiskers	N	Red (S1S3)	1	583351 6250488	disturbed grassland margin
Potentilla pulcherrima	pretty cinquefoil	N	Red (S2)	1	583580 6250504[3]	remnant grassland verge
Silene drummondii* var. *drummondii	Drummond's campion	Y	Blue (S3)	1	583300 6250543	open grassland slope
				2	583298 6250570	open grassland slope

[1] EO = Element Occurrence
[2] All UTMs are in zone 10V.
[3] Population had a large areal extent (ca. 200 x 20 m); UTM provided is representative.

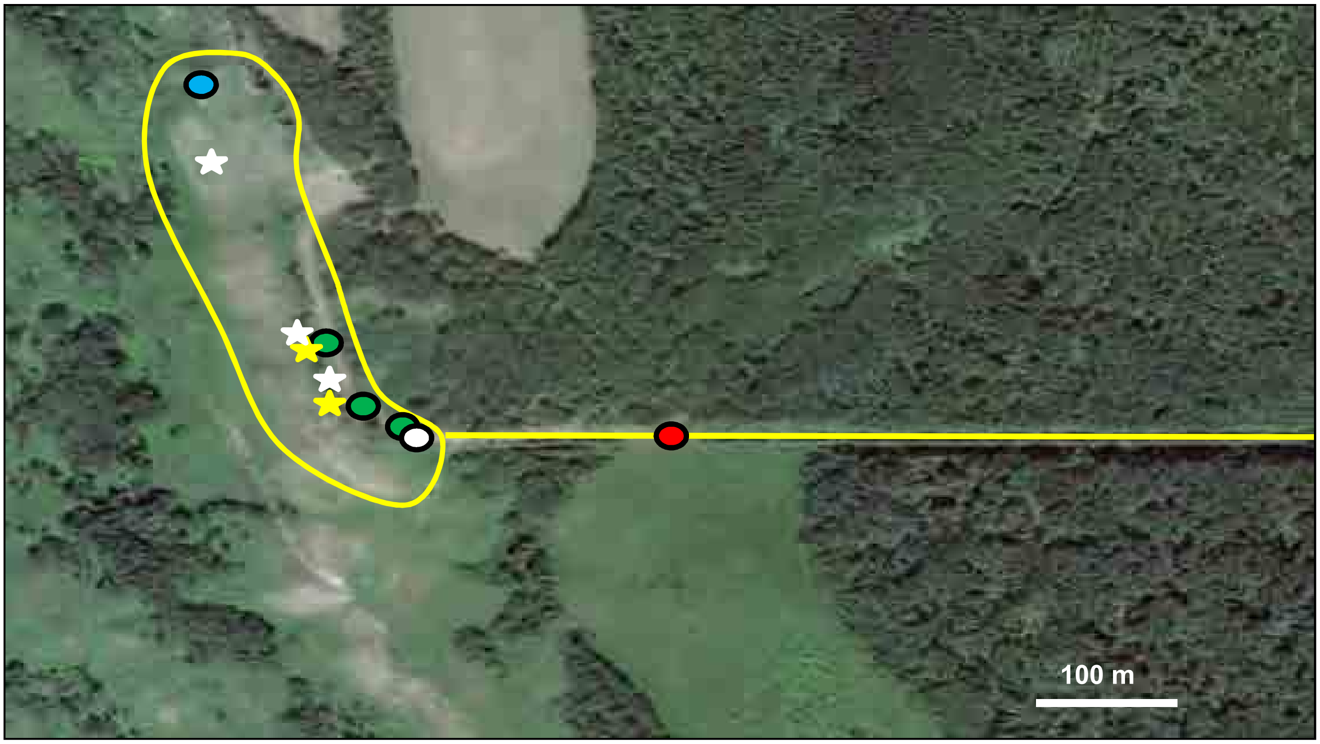

Figure 4.3-5. Locations of Rare and Target Plant Species at Upper Halfway River

The survey area is denoted by the yellow polygon. Stars = target taxa; circles = non-target rare taxa. White stars = *Avenula hookeri*; yellow stars = *Silene drummondii* var. *drummondii*; white circles = *Geum triflorum* var. *triflorum*; green circles = *Antennaria neglecta*; red circles = *Potentilla pulcherrima*; light blue circles = *Elymus lanceolatus* ssp. *Psammophilus*.

4.3.4 Survey Site #4: Pouce Coupé River

This site was surveyed on August 15, 2016, during which time 124 species of vascular plants, including 100 native and 24 exotic species, were documented (Appendix D: Species List). Several habitat types were sampled at this survey site, including steep south-facing grassland slopes, riparian mixed and deciduous woodlands, and highly dynamic riverine shoreline areas including back channels, sandy and silty depositional areas, and eroding slopes. Grassland habitats were dominated by species such as *Achnatherum nelsonii* ssp. *dorei* (Columbia needlegrass), *Bromus marginatus* (mountain brome), *Elymus lanceolatus* ssp.*lanceolatus* (thickspike wildrye), *Elymus trachycaulus* ssp. *trachycaulus* (slender wheatgrass), and *Koeleria macrantha* (junegrass). Wooded areas supported *Populus tremuloides* (trembling aspen), *Populus balsamifera* (balsam poplar), and *Picea glauca* (white spruce). The riverine habitats along the Pouce Coupé River had been substantially altered during extensive flooding earlier in the year, resulting in extensive scouring, erosion, and deposition. Nonetheless, these habitats supported a diverse assemblage of herbaceous plants, including species that were locally rare or otherwise not detected during the surveys, such as *Limosella aquatica* (water mudwort), *Alisma triviale* (American water-plantain), *Chenopodium capitatum* (strawberry-blite), and *Callitriche palustris* (spring water-starwort).

Three rare vascular plant taxa, including two target species [*Artemisia herriotii* (Herriot's sage), *Carex xerantica* (dry-land sedge), were documented at the Pouce Coupé River survey site. An additional non-target rare species, the currently unranked *Symphyotrichum lanceolatum* var. *lanceolatum* (western willow aster), was also detected in the survey area (this species is considered 'rare' by provincial botanists familiar with the species, including J. Fenneman, and will be listed as Blue or Red by the CDC in the future; meetings to determine the rank status of plant species are held bi-annually, with the next meeting expected in 2017). Both *Artemisia herriotii* and

Symphyotrichum lanceolatum var. *lanceolatum* (western willow aster) occurred along the immediate shoreline of the Pouce Coupé River, although *Artemisia herriotii* (Herriot's sage) occurred on more dynamic, heavily eroded sites, while *Symphyotrichum lanceolatum* var. *lanceolatum* occurred on more stabilized banks. The single *Carex xerantica* (dry-land sedge) population occurred along the crest of a steep, south-facing grassland slope, along the margins of adjacent deciduous thickets. Table 4.3-7 summarizes the results of the rare plant surveys at Pouce Coupé River; see Appendix F for more detail on these populations. Locations of the rare taxa observed at the Pouce Coupé River site are shown in Figure 4.3-6.

Table 4.3-7. Rare Vascular Plant Taxa Documented at Pouce Coupé River

Scientific Name	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Artemisia herriotii	Herriot's sage	Y	Red (S2)	1	685931 6195078	eroding sandy riverbank
				2	685941 6195080	eroding sandy riverbank
				3	685958 6195090	sandy alluvial deposition area
Carex xerantica	Dry-land sedge	Y	Blue (S2S3)	1	686069 6195410	upper grassland slope/thickets
Symphyotrichum lanceolatum var. *lanceolatum*	Western willow aster	N	To be ranked in 2017	1	685896 6195033	sandy riverbank
				2	685941 6195080	sandy riverbank

[1] EO = Element Occurrence
[2] All UTMs are in zone 10U.

Figure 4.3-6. Locations of Rare and Target Plant Species at Pouce Coupé River

The survey area is denoted by the yellow polygon. Stars = target taxa; circles = non-target rare taxa. Orange stars = *Artemisia herriotii*; light blue stars = *Carex xerantica*; dark blue circles = *Symphyotrichum lanceolatum* var. *lanceolatum.*

4.3.5 Survey Site #5: Pine River Area

This area was surveyed on August 17, 2016. A complete species list was not created for this survey area due to the large size of the area and limited time available for surveying. Rare species detected at this site that had not been detected at other survey sites were incorporated into the overall project species list as "Incidental Observations" (Appendix D: Species List). This area supported a number of habitat types that were not present at most other survey sites, including dense mixed and coniferous forests, freshwater lakes, streams and creeks, wet meadows and thickets, and agricultural environments, and as such was expected to support species not present elsewhere in the survey area.

Only a single target species, *Symphyotrichum puniceum* var. *puniceum*, was documented in this survey area. A relatively large population of this species occurred along the boggy shoreline of Stewart Lake, while a few plants were also detected in a moist draw in the understory of a mixed upland forest – the latter being a rather unusual habitat for this normally wetland-associated taxon. Although first documented in British Columbia as recently as 1997, and subsequently considered rare in the province, this species is now known to be much more common and widespread in northeastern B.C. than previously thought (as supported by the numerous populations discovered during this survey). As a result, it was recently (2015) down-listed from blue-listed (rare) to yellow-listed (not rare) by the BC Conservation Centre.

Table 4.3-8 summarizes the results of the rare plant surveys in the Pine River/Stewart Lake survey area; see Appendix F for more detail on these populations. Locations of the rare taxa observed in the Pine River area are shown in Figure 4.3-7.

Table 4.3-8. Target Vascular Plant Taxon Documented in the Pine River Area

Species	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Symphyotrichum puniceum var. *puniceum*	Purple-stemmed aster	Y	Yellow (S3S4) [*delisted 2016*]	1	629208 6196905	moist depression in mixed forest
				2	614709 6203544	grassy lakeshore thickets

[1] EO = Element Occurrence
[2] All UTMs are in zone 10V.

Figure 4.3-7. Locations of the Target Plant Species in the Pine River/Stewart Lake Area

Open black circles denote locations of *Symphyotrichum puniceum* var. *puniceum*, which was a target species for this survey but was subsequently delisted.

4.3.6 Survey Site #6: Cecil Lake area

This area was surveyed on August 18, 2016. A complete species list was not created for this survey area due to the large size of the area and limited time available for surveying. However, species that were detected here that were not detected at other survey sites were incorporated into the overall project species list as "Incidental Observations" (Appendix D). The habitats that were surveyed in this area included roadside ditches, deciduous woodlands, agricultural environments, disturbed areas, eroding bluffs, and a eutrophic, largely dry freshwater marsh that was dominated by *Typha latifolia* (common cattail). The majority of the surveying occurred along the roadside areas to avoid to private land.

Three rare species, all of which were target species for this survey, were documented in the Cecil Lake area: the red-listed *Artemisia herriotii* (Herriot's sage) and the formerly blue-listed (now delisted [see above]) *Symphyotrichum puniceum* var. *puniceum* (purple-stemmed aster) and *Carex sychnocephala* (many-headed sedge). The population of *Artemisia herriotii* occurred primarily on exposed, eroding slopes atop a large, steep cutbank above the Beatton River, with additional plants spreading onto disturbed roadside habitats adjacent to this population. The population of *Symphyotrichum puniceum* var. *puniceum* occurred in a wet roadside verge, alongside a variety of wetland grasses, sedges, and willows, while the single population of *Carex sychnocephala* occurred around the margins of the eutrophic Typha-dominated wetland. Table 4.3-9 summarizes the results of the rare plant surveys in the Cecil Lake survey area; see Appendix F for more detail on these populations. Locations of the rare taxa observed in the Cecil Lake area are shown in Figure 4.3-8.

Table 4.3-9. Rare Vascular Plant Taxa Documented in the Cecil Lake Survey Area

Scientific Name	Common Name	Target (Y or N)	BC Status	EO[1]	UTM[2]	Habitat
Artemisia herriotii	Herriot's sage	Y	Red (S2)	1	644663 6240324	steep, eroding bank; disturbed roadsides
Carex sychnocephala	Many- headed sedge	Y	Yellow (S3S4) [*delisted 2015*]	1	644665 6240325	eutrophic wetland margins
Symphyotrichum puniceum* var. *puniceum	Purple-stemmed aster	Y	Yellow (S3S4) [*delisted 2016*]	1	646697 6248995	wet roadside verge

[1] EO = Element Occurrence, [2] All UTMs are in zone 10V.

Figure 4.3-8. Locations of Rare and Target Plant Species in the Cecil Lake Area

Orange stars = *Artemisia herriotii*. Open black circles denote locations of *Symphyotrichum puniceum* var. *puniceum* and open dark blue circles denote locations of *Carex sychnocephala*; these two taxa were target species for this survey, but both were subsequently delisted.

4.4 Discussion and Recommendations

The 2016 rare plant surveys in the Peace River area, although initiated relatively late in the season, achieved the program objectives. A total of 352 species of vascular plants, including 293 native and 59 exotic species were observed. Of the native taxa, 14 species were designated as rare by the B.C. Conservation Data Centre. Eleven of these species were targets of the 2016 surveys.

Recommendations to improve the effectiveness of 2017 surveys include:

1. use of a boat to increase site accessibility and increase the number of sites that can be surveyed; and

2. obtain access to relevant private lands.

In 2017 surveys will be conducted during the late spring/early summer (late May to mid-June) and mid-summer (late June to mid-July) and early autumn (late summer to early fall) surveys, to correspond with greater botanical diversity and increase the number of species that can be detected. Sites surveyed in 2016 will be revisited, time permitting.

5.0 EXPERIMENTAL RARE PLANT TRANSLOCATION PROGRAM

This section outlines the work conducted in 2016 toward development of the experimental rare plant translocation program (ERPT). Rare plant translocation programs are becoming increasingly important as methods for conserving species that are threatened by various activities, including dam development and subsequent loss of populations and associated habitat (Liu et al. 2015).

The program is deemed experimental due to the low success rates of previous rare plant translocation programs (Birkinshaw 1991; Coumbe and Dopson 2001; Vallee et al. 2004; McKay et al. 2005, Fiedler 1991 cited in Maslovat 2009).

5.1 Goals and Objectives

The goals of the ERPT Program are the following:

1. Design and implement an experimental rare plant translocation program in consultation with MOE using the MOE's Guidelines for Translocation of Plant Species at Risk in BC (Maslovat, 2009). Including the design and implementation of a seed recovery and plant relocation program.

The objectives of the Program are the following:

1. Translocate rare plant species through plant salvage, collection of vegetative propagules and/ or seeds from populations that will or may[1] be lost due to the creation of the reservoir to recipient sites on BC Hydro fee simple lands and/or Crown lands with suitable habitat based on the ecological requirements of the candidate rare species.

2. Document the survival of the translocated rare plants through monitoring of population size, extent, threats, resilience, and persistence at re-location sites (Pavlik 1996; Vallee *et al.* 2004, Maslovat 2009, Weeks *et al.* 2011) and determine the effectiveness of the translocation in term of survival and successful reproduction.

[1] Rare plants that may be lost are those that are within in the erosion zone along the banks of the reservoir.

3. Adaptively manage translocated populations for up to four years after translocation (if necessary) to respond to declines in survival or fitness of the plants and ensure efficacy of the translocation and propagation efforts in accordance with the timeline indicated in Condition 14 of the EAC.
4. Determine the effectiveness of the translocation program in terms of increasing knowledge about a species at risk, propagation methods, developing effective management techniques for the species.

5.2 Translocation Plant Species Selection

In 2014, BC Hydro selected twelve at risk plant species for the ERPT program. These plant species were selected because they are considered rare and/ or threatened within the province by the BC CDC/ NatureServe and because they will be lost due to the creation of the Site C reservoir or due to clearing activities in material source areas where avoidance is not feasible (Table 5.2-1).

In 2015 and 2016, the BC CDC and NatureServe reviewed and updated the conservation rank status for a variety of species, including three of the species selected for the ERPT program, including, *Carex sychnocephala* (many-headed sedge), *Juncus arcticus* ssp. *Alaskanus* (Arctic rush), *and Trichophorum pumilum* (dwarf clubrush). Based on the BC CDC and NatureServe review, these species are considered more widespread and common than previously known and are therefore no longer considered at risk.

In addition, the authoritative Flora of North America does not recognize any subspecies for *Arnica chamissonis* (meadow arnica in BC (LGL 2006; Wolf 2006; KWR 2011). Botanists working on the Site C Project have also questioned the validity of the taxon within BC (J. Fenneman, pers. comm, December 27, 2016).

Based on this information, these four species will not be included in the ERPT program.

Table 5.2-1. Candidate Rare Plant Translocation Species

Scientific Name	Common Name	BC CDC Conservation Rank	NatureServe SubNational Rank	NatureServe Global Rank
Arnica chamissonis ssp. Incana[1]	Meadow arnica	not provided	SNR/SU[2]	G5T3T5 (2002)
Carex sychnocephala	Many-headed sedge	Yellow	S3S4 (2015)	G4 (1988)
Carex heleonastes	Hudson's Bay sedge	Blue	S3 (2015)	G4 (1992)
Carex torreyi	Torrey's sedge	Blue	S2S3 (2015)	G4 (1998)
Chrysosplenium iowense	Iowa golden-saxifrage	Red	S2? (2015)	G3? (2006)
Erigeron pacilis	Peace daisy	Red	S1	G1
Epilobium halleanum	Hall's willowherb	Blue	S2S3 (2012)	G5 (1980)
Epilobium saximontanum	Rocky mountain willowherb	Red	S1S3 (2015)	G5 (1984)
Juncus arcticus ssp. alaskanus	Arctic rush	Yellow	S4 (2015)	G5T4T5 (2005)

Scientific Name	Common Name	BC CDC Conservation Rank	NatureServe SubNational Rank	NatureServe Global Rank
Oxytropis campestris* var. *davisii	Davis' locoweed	Blue	S3 (2001)	G5T3 (2015)
Rorippa calycina	Persistent-sepal yellowcress	Red	S1 (2015)	G3 (1997)
Trichophorum pumilum	Dwarf clubrush	Yellow	S3S4 (2015)	G5 (1997)

[1] The four occurrences documented during baseline surveys represent the only records of this taxon in the BC Peace region (BC CDC 2013). All four sites are located within the Direct Effects polygon, and two are within the reservoir footprint.

[2] Not ranked or under review by the province.

5.3 Overview

Plant translocation is the deliberate transfer of material from one area to another for the purpose of conservation (survival, recovery, or maintenance of the species). It is an important tool used to assist in the conservation of plants that face a high risk of extinction in natural areas in the near to immediate future (Government of West Australia 2016). Numerous references are available regarding the definition and importance of translocations of at risk plants.

Translocation may involve introduction (including conservation introduction), augmentation, and reintroduction, which are defined as follows:

- **Introduction** is the establishment of new populations through planting in areas that have greater long-term security, are within the known distribution range for the plant species, and have similar habitat.
- **Conservation** is the establishment of new populations in areas that have greater long-term security and are not within the known distribution range for the plant species, but have similar habitat.
- **Augmentation** is the restocking of declining populations through planting more plants at a site where the species already occurs.
- **Reintroduction** is the restoring of an extirpated population through planting at a site where the species used to occur but is now believed to have been lost.

Maslovat (2009) recommends using a solid experimental design that will allow even translocation "failures" to increase our understanding of the species and inform any future attempts. To develop an experimental design, different treatments are applied to plants, with some plants given a treatment and others receiving no treatment and designated as controls. The information gained from an experimental approach will not only provide improved data on the relative success or failure of the translocated populations, but will better prepare monitors to identify opportunities for adaptive management for populations that are struggling. Importantly, this information can also help inform other translocation projects, thereby improving the overall success of translocation mitigation.

Three translocation techniques are relevant to this project:

1. collection of mature plants, cuttings, or seedlings from extant populations and direct transplantation to new locations;
2. collection of seed from extant populations and sowing of seeds at new locations; and

3. collection of mature plants, cuttings, or seedlings from extant populations, followed by off-site propagation (which may include tissue culture), and planting of propagated material to new locations.

Although Maslovat (2009) discourages removal of seedlings or plants from an *in situ* population because of potential harm to extant populations, this activity is supported if the source population is certain to be eliminated by approved construction, as is the case with this program. Thus, it is considered appropriate for use in this program.

5.4 Study Design

The study design and methodology for the ERPT Program follows the guidance outlined in Maslovat (2009). The ERPT Program is currently in the design phase and the detailed methods are in progress. This document provides an outline of the current proposed program design.

The ERPT Program consists of seven years of study: 2016 (Year 1) to 2022 (Year 7). A summary of the proposed plan is divided into seven phases:

1. research, development, and monitoring program development (2016-2017);
2. field work and data collection (2017);
3. ex situ propagation (2017 and 2018);
4. data analysis (2017 and 2018)
5. translocation implementation (2018 and 2019);
6. post-translocation care and maintenance (2018-2022); and
7. monitoring (2018-2022).

The following sections outline the tasks associated with each phase.

5.4.1 Phase 1. Research, Development, and Monitoring 2016-2017 (Summer-Winter)

Research and Development

- Create plant and habitat profiles that summarize the known abiotic and biotic ecological requirements of the candidate species.
- Research and document methods for asexual and sexual propagation, including collection of propagules of both stem and roots, plant divisions, and seeds for ex situ plant propagation.
- Identify and document potential seed collection timing (i.e., optimal seed development stage for each candidate species).
- Identify and document seed and processing methods (e.g., sampling, labelling, cleaning, processing, stratification, sowing, provenance).
- Identify any relevant translocation history, potential asexual/sexual propagation methods, and recovery strategies for each candidate species.
- Identify methodology for baseline characterization of donor and recipient sites.

Monitoring

- Identify parameters for short and long term monitoring.
- Create database framework.
- Determine frequency of monitoring.

5.4.2 Phase 2. Field Work and Data Collection 2017 (Spring-Fall)

Field work and further research will be conducted to help refine the translocation program for the species identified for translocation. The information collected will be used to identify and/or verify the following:

- location of rare plants that will be translocated or used to provide source material (asexual and sexual methods including collection of propagules both stem and roots, plant divisions and seeds) for *ex situ* plant propagation;
- description of habitat and ecological attributes for each candidate rare plant species based on existing conditions at source locations;
- potential recipient sites;
- abundance of source populations (# of plants);
- pre-translocation baseline survey of the recipient sites to determine the species composition of the recipient site and determine their suitability for receiving translocated plants (including material propagated *ex situ*) and to allow for evaluation of species changes during the program monitoring period (through first 10 years of Project operations);
- determine which of the candidate species will be translocated and describe rationale for selection; and
- identify and organize training required for support staff.

5.4.3 Phase 3. Ex-situ Propagation 2017-2018 (Summer-Fall)

The results of the field analyses will be reviewed throughout the spring and summer and will be used to select sites for collection of plant materials. The field analyses will be reviewed to determine the following:

- Number and type of plant materials, (stem and roots, plant divisions, and seeds for *ex situ* plant propagation) to be collected and/or translocated; and
- Mechanics of the translocation including how each specific candidate plant will be collected, propagated, and/or translocated and replanted.

5.4.4 Phase 4. Data Analysis 2017-2018 (Fall-Winter)

Data collected in the field and during the research and design phase will be analyzed and used to determine the following:

- most appropriate recipient sites for translocation (e.g., in relation to soil pH, aspect, elevation, moisture);

- identification of species with the highest likelihood of success in establishing self-sustaining populations in recipient sites based on criteria such as habitat availability, ecological requirements, plant specificity, and pollination biology;
- mechanics of the translocation including refinement of how and which parts of the plants will be collected, propagated, translocated, and replanted in subsequent years; and
- timing of translocation.

5.4.5 Phase 5. Translocation Implementation 2018 (Spring-Fall) and/ or 2019 (Spring-Fall)

The implementation phase includes the following tasks:

- Training, by a QEP, of field personnel who will assist in the translocation in the identification of target species, site preparation techniques, and proper translocation and propagation techniques and methodology;
- Site preparation for translocation plants and collection of propagules; and
- Translocating whole plants, cuttings, or seeds to recipient sites.

5.4.6 Phase 6. Post-Translocation Care and Maintenance 2018-2022

Post-translocation plant care and site management will include several follow-up site visits in the first two to four years after translocation to assess the health and establishment of the translocated populations and identify and address any issues of concern. The frequency and level of effort of post-translocation care will be determined based on data collected (see below) during the follow-up site visits.

5.4.7 Phase 7. Monitoring 2018-2022[2]

The monitoring program will document a suite of measurable parameters designed to evaluate the efficacy of translocation methods and management in relation to the stated objectives of the program (IUCN 1995; Vallee et al. 2004). Specifically, the monitoring program will measure, document, and evaluate the following:

1. the efficacy of the methods used to 1) collect and store plant parts; 2) conduct ex situ propagation; 3) translocate the rare plant species from the host site to the recipient sites; 4) collect data;
2. 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
3. the follow-up procedures applied to address any declines in survival or fitness of the translocated plants/populations.

5.5 Discussion

As the program evolves, new information and findings will be incorporated and used to shape the detailed design. Information collected during the ERPT program will be submitted to the MOE (BC CDC) and used to increase the knowledge about translocation, management techniques, and monitoring methods for rare plant species.

[2] Note: this plan covers the construction period only.

6.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech EBA Inc.

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Personal Communications

Fenneman, J. 2016. Botanist, Technical Advisor.

APPENDIX A

SAULTEAU EBA ENVIRONMENTAL SERVICES JOINT VENTURE'S GENERAL CONDITIONS

GENERAL CONDITIONS

NATURAL SCIENCES

This report incorporates and is subject to these “General Conditions”.

1.1 USE OF REPORTS AND OWNERSHIP

This report pertains to a specific site, a specific development or activity, and/or a specific scope of work. The report may include plans, drawings, profiles and other supporting documents that collectively constitute the report (the “Report”).

The Report is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contract entered into with the Client (either of which is termed the “Services Agreement” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Report when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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1.2 ALTERNATIVE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of the Report or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH ’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive the original signed and/or sealed version for a maximum period of 10 years.

Both electronic file and hard copy versions of TETRA TECH ’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH ’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH 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 TETRA TECH for the Report have been conducted in accordance with the Services Agreement, 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 Report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Report.

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

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 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.

1.5 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Services Agreement, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.6 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Report, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.7 GENERAL LIMITATIONS OF REPORT

This Report is based solely on the conditions present and the data available to TETRA TECH at the time the data were collected in the field or gathered from publically available databases.

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

The Report 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 at or the development proposed as of the date of the Report requires a supplementary investigation and assessment.

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.

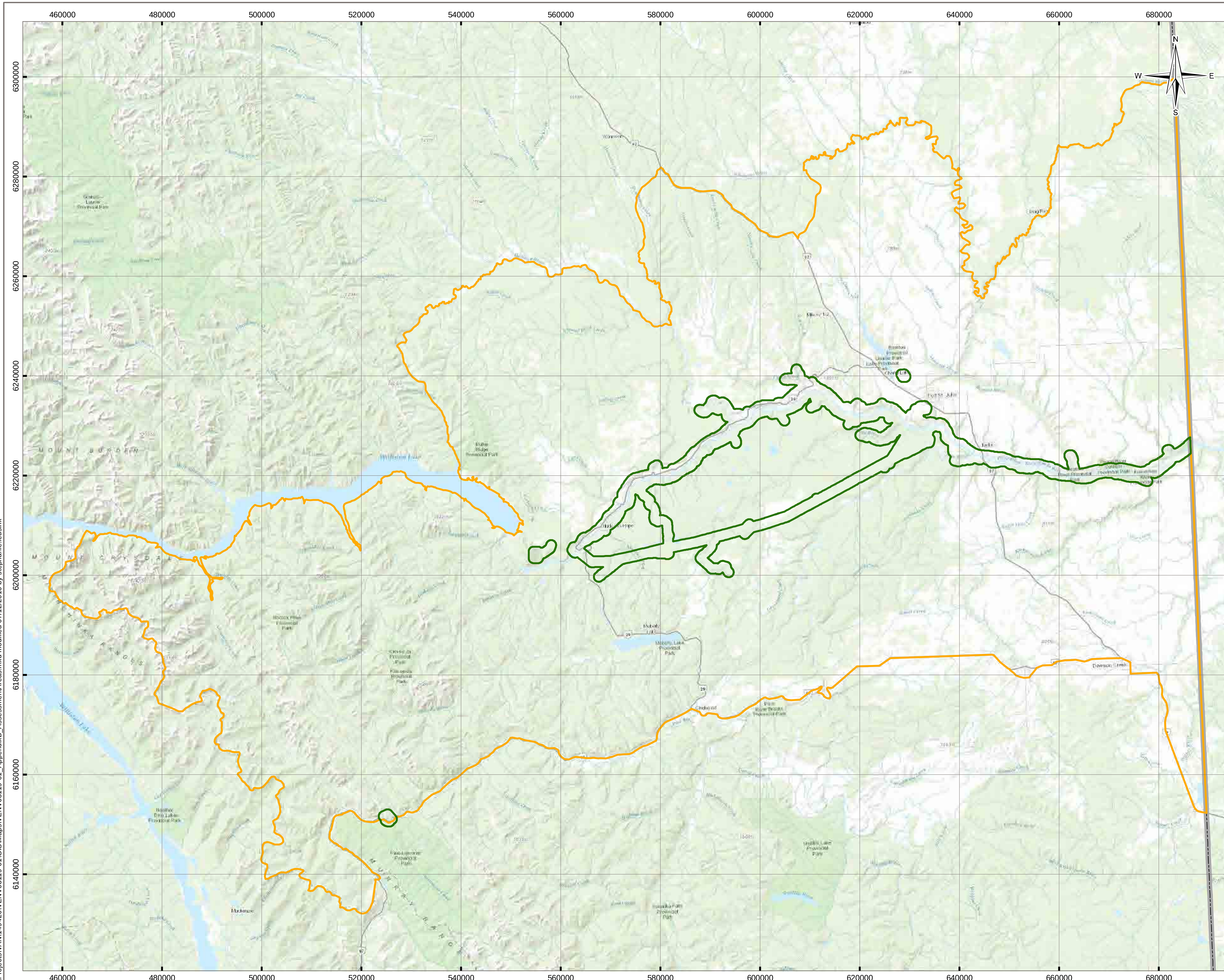
The Client acknowledges that TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of property, the decisions on which are the sole responsibility of the Client.

1.8 JOB SITE SAFETY

TETRA TECH is only responsible for the activities of its employees on the job site and was not and will not be responsible for the supervision of any other persons whatsoever. The presence of TETRA TECH personnel on site shall not be construed in any way to relieve the Client or any other persons on site from their responsibility for job site safety.

APPENDIX B

REGIONAL ASSESSMENT AREA AND LOCAL ASSESSMENT AREA



LEGEND

- Local Assessment Area (LAA)
- Regional Assessment Area (RAA)
- Provincial Boundary

NOTES
Data source:
Rare plants shown compiled from data provided by BC Hydro and the B.C. Conservation Data Centre as well as EcoLogic Consultants.

STATUS
ISSUED FOR REVIEW

BC HYDRO SITE C CLEAN ENERGY PROJECT: 2016 REGIONAL RARE PLANT SURVEYS AND EXPERIMENTAL RARE PLANT TRANSLOCATION PROGRAM

Regional Assessment Area and Local Assessment Area

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	BC hydro

Scale: 1:750,000
10 5 0 10
Kilometres

TETRA TECH

FILE NO.
VENV03119-01_AppendixB_AssessmentAreas.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	MEZ	NB	0

DATE
December 7, 2016

PROJECT NO.
ENV.VENV03119-01

Appendix B

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APPENDIX C
QUALIFIED ENVIRONMENTAL PROFESSIONAL PROFILES

Terry McIntosh Ph.D. (Program Technical Advisor and Botanist)

Terry McIntosh has had over 35 years of experience in botanical research, ecological consulting, and public education. He has completed numerous vascular plant and bryophyte surveys in British Columbia, in particular in arid land ecosystems, including the Okanagan, Similkameen, and Thompson River Valleys, the Cariboo, and coastal BC. He has also completed projects in the Yukon, around Whitehorse and along the north coast to adjacent Alaska, Saskatchewan, and Alberta, as well as in Washington and Oregon States. His more recent work has focused mainly on at-risk plant and habitat surveys. Dr. McIntosh has prepared 10 COSEWIC Status Reports and 8 Recovery Strategies. He has worked with 24 First Nations bands in British Columbia, mainly assisting restoration projects and plant inventories. He is a Research Associate in the Botany department at UBC and is a board member and a principal editor for the Flora of North America (FNA) project. He has written FNA treatments for 11 moss genera and one family (Mniaceae).

Jamie Fenneman, Ph.D. candidate, R.P.Bio. (Program Technical Advisor and Botanist)

Jamie Fenneman has more than 20 years of experience studying and surveying for vascular plants in British Columbia, including more than 10 years as a botanical consultant. He has sampled vegetation throughout most regions of the province, including the Peace River area, as well as in surrounding jurisdictions such as Alberta, Alaska, the Yukon Territory, and Washington. He is familiar with the entirety of the B.C. flora, both in the herbarium and the field, and is fully versed in the identification of specimens, including those from the most complex and confusing genera. As part of his consulting career, he has been surveying specifically for rare plants in BC for nearly a decade, and is familiar with the protocols that are required for the successful completion of such work. He is currently working on a Ph.D. in the Botany Department at UBC, focusing on plant taxonomy, and is closely associated with both major herbaria in the province (UBC, Royal BC Museum). He also works closely with the BC Conservation Data Centre (CDC), and has been a major contributor to their efforts to standardize rare plant survey protocols in the province and put in place measures to maximize the quality of these surveys.

APPENDIX D

2016 SPECIES LIST FOR THE REGIONAL ASSESSMENT AREA

Appendix D. 2016 Species List for the Regional Assessment Area

Jamie Fenneman and Terry McIntosh; August 2016

Items bolded in red or blue are of conservation concern.

** indicates first collection for BC.*

Scientific Name	Common Name	Family	Native/Exotic	Beatton River	Leahy Pit Road	Upper Halfway River	Pouce Coupé	Incidentals
Achillea alpina	Siberian Yarrow	Asteraceae	N	X	X		X	
Achillea millefolium	Common Yarrow	Asteraceae	N	X	X	X	X	
Achnatherum nelsonii ssp. dorei	Columbian Needlegrass	Poaceae	N	X	X	X	X	
Achnatherum richardsonii	Spreading Needlegrass	Poaceae	N	X				
Actaea rubra	Baneberry	Ranunculaceae	N	X	X	X	X	
Agoseris glauca var. glauca	Short-beaked Agoseris	Asteraceae	N	X				
Agropyron cristatus	Crested Wheatgrass	Poaceae	E					X
Agrostis exarata	Spike Bentgrass	Poaceae	N			X		
Agrostis gigantea	Redtop	Poaceae	E					X
Agrostis scabra	Hair Bentgrass	Poaceae	N	X	X			
Alisma triviale	American Water-plantain	Alismataceae	N				X	
Allium cernuum	Nodding Onion	Alliaceae	N	X	X	X	X	
Alnus crispa ssp. viridis	Green Alder	Betulaceae	N					X
Alnus incana ssp. tenuifolia	Mountain Alder	Betulaceae	N	X		X	X	
Alopecurus aequalis	Shortawn Foxtail	Poaceae	N	X				
Amaranthus retroflexus	Rough Pigweed	Amaranthaceae	E					X
Amelanchier alnifolia var alnifolia	Saskatoon	Rosaceae	N	X	X	X	X	
Androsace septentrionalis	Northern Fairy-candelabra	Primulaceae	N	X	X	X		
Anemone cylindrica	Long-headed Anemone	Ranunculaceae	N	X	X	X		
Anemone multifida var. multifida	Cut-leaved Anemone	Ranunculaceae	N	X	X	X		
Anemone patens ssp. multifida	Prairie-crocus	Ranunculaceae	N	X	X	X		
Anemone virginiana var. cylindroidea	Streambank Anemone	Ranunculaceae	N		X			
Angelica genuflexa	Kneeling Angelica	Apiaceae	N					X
Antennaria neglecta	**Field Pussytoes**	Asteraceae	N		X	X		
Antennaria parvifolia	Nuttall's Pussytoes	Asteraceae	N		X	X		
Antennaria rosea	Rosy Pussytoes	Asteraceae	N	X	X	X		
Apocynum androsaemifolium var. androsaemifolium	Spreading Dogbane	Apocynaceae	N	X	X	X		
Arabis eschscholtziana	Eschscholtz's Rockcress	Brassicaceae	N	X		X		
Aralia nudicaulis	Wild Sarsaparilla	Araliaceae	N	X	X	X	X	
Arctostaphylos uva-ursi	Kinnikinnick	Ericaceae	N			X		
Arnica chamissonis	Meadow Arnica	Asteraceae	N					X
Artemisia biennis	Biennial Wormwood	Asteraceae	E	X			X	
Artemisia campestris ssp. pacifica	Northern Wormwood	Asteraceae	N			X		
Artemisia dracunculus	Tarragon	Asteraceae	N	X	X			
Artemisia frigida	Prairie Sagewort	Asteraceae	N	X	X	X	X	
Artemisia herriotii	**Herriot's Mugwort**	Asteraceae	N				X	
Astragalus agrestis	Field Milk-vetch	Fabaceae	N	X	X			
Astragalus cicer	Chick-pea Milk-vetch	Fabaceae	E					X

Scientific Name	Common Name	Family	Native/Exotic	Beatton River	Leahy Pit Road	Upper Halfway River	Pouce Coupé	Incidentals
Astragalus laxmannii var. robustior	Standing Milk-vetch	Fabaceae	N			X	X	
Astragalus tenellus	Pulse Milk-vetch	Fabaceae	N	X	X			
Athyrium filix-femina var. cyclosorum	Lady Fern	Dryopteridaceae	N					X
Atriplex patula	Common Orache	Amaranthaceae	E	X				
Avena fatua	Wild Oat	Poaceae	E	X				
Avenula hookeri	**Spike-oat**	Poaceae	N		X	X		
Beckmannia syzigachne	American Sloughgrass	Poaceae	N	X	X	X	X	
Betula glandulosa	Dwarf Birch	Betulaceae	N					X
Betula neoalaskana	Alaska Paper Birch	Betulaceae	N			X		
Betula papyrifera	Paper Birch	Betulaceae	N	X				
Bidens cernua	Nodding Beggarticks	Asteraceae	N	X			X	
Boechera calderi	Calder's Suncress	Brassicaceae	N			X		
Boechera grahamii	Graham's Suncress	Brassicaceae	N	X	X			
Bolboschoenus maritimus var. paludosus	Seacoast Bulrush	Cyperaceae	N	X				
Botrypus virginianus	Rattlesnake Fern	Ophioglossaceae	N				X	
Brassica rapa var. rapa	Field Mustard	Brassicaceae	E	X	X		X	
Bromus ciliatus	Fringed Brome	Poaceae	N		X			
Bromus inermis	Smooth Brome	Poaceae	E	X	X	X	X	
Bromus marginatus	Mountain Brome	Poaceae	N		X		X	
Bromus pumpellianus	Pumpelly Brome	Poaceae	N				X	
Calamagrostis canadensis	Bluejoint Reedgrass	Poaceae	N	X	X			
Calamagrostis montanensis	**Plains Reedgrass**	Poaceae	N	X	X		X	
Calamagrostis stricta ssp. stricta	Slimstem Reedgrass	Poaceae	N	X				
Calla palustris	Wild Calla	Araceae	N					X
Callitriche palustris	Spring Water-starwort	Plantaginaceae	N	X			X	
Camelina microcarpa	Littlepod-flax	Brassicaceae	E		X			
Campanula rotundifolia	Common Harebell	Campanulaceae	N	X	X	X		
Canadanthus modestus	Great Northern Aster	Asteraceae	N					X
Capsella bursa-pastoris	Shepherd's-purse	Brassicaceae	E		X	X		
Cardamine pensylvanica	Pennsylvania Bitter-cress	Brassicaceae	N	X				
Carex aquatilis var. aquatilis	Water Sedge	Cyperaceae	N	X				
Carex atherodes	Awned Sedge	Cyperaceae	N	X				
Carex crawfordii	Crawford's Sedge	Cyperaceae	N					X
Carex diandra	Lesser Panicled Sedge	Cyperaceae	N					X
Carex filifolia	Thread-leaved Sedge	Cyperaceae	N	X		X		
Carex inops ssp. heliophila	Long-stoloned Sedge	Cyperaceae	N		X	X		
Carex obtusata	Blunt Sedge	Cyperaceae	N		X	X	X	
Carex praticola	Meadow Sedge	Cyperaceae	N		X			
Carex sychnocephala	Many-headed Sedge	Cyperaceae	N					X
Carex tenera	Tender Sedge	Cyperaceae	N	X				
Carex torreyi	**Torrey's Sedge**	Cyperaceae	N		X			

Scientific Name	Common Name	Family	Native/Exotic	Beatton River	Leahy Pit Road	Upper Halfway River	Pouce Coupé	Incidentals
Carex utriculata	Beaked Sedge	Cyperaceae	N	X				
Carex xerantica	**Dryland Sedge**	Cyperaceae	N		X		X	
Castilleja miniata var. miniata	Scarlet Paintbrush	Orobanchaceae	N			X		
Castilleja septentrionalis	Northern Paintbrush	Orobanchaceae	N					X
Cerastium fontanum ssp. vulgare	Mouse-ear Chickweed	Caryophyllaceae	E			X		
Ceratophyllum demersum	Common Hornwort	Ceratophyllaceae	N					X
Chamerion angustifolium	Fireweed	Onagraceae	N		X	X	X	
Chenopodium album	Lamb's-quarters	Amaranthaceae	E	X	X	X	X	
Chenopodium berlandieri var. zschakei	Pitseed Goosefoot	Amaranthaceae	N					X
Chenopodium capitatum	Strawberry-blite	Amaranthaceae	N				X	
Chenopodium glaucum var. salinum	Rocky Mountain Goosefoot	Amaranthaceae	N	X			X	
Chenopodium pratericola	Desert Goosefoot	Amaranthaceae	N	X	X		X	
Chenopodium rubrum var. rubrum	Red Gooosefoot	Amaranthaceae	N				X	
Chenopodium simplex	Maple-leaved Goosefoot	Amaranthaceae	N		X	X		
Chenopodium standleyanum	Standley's Goosefoot	Amaranthaceae	E*		X			
Cicuta bulbifera	Bulbous Water-hemlock	Apiaceae	N					X
Cicuta maculata var. angustifolia	Spotted Water-hemlock	Apiaceae	N	X				
Cicuta virosa	European Water-hemlock	Apiaceae	N					X
Cinna latifolia	Nodding Wood-reed	Poaceae	N		X	X		
Circaea alpina ssp. alpina	Enchanter's-nightshade	Onagraceae	N			X		
Cirsium arvense	Canada Thistle	Asteraceae	E	X	X	X	X	
Cirsium vulgare	Bull Thistle	Asteraceae	E	X				
Clematis occidentalis ssp. grosseserrata	Blue Clematis	Ranunculaceae	N		X			
Coeloglossum viride var. virescens	Long-bracted Frog-orchid	Orchidaceae	N	X				
Collomia linearis	Narrow-leaved Collomia	Polemoniaceae	N		X			
Comandra umbellata var. umbellata	Eastern Bastard-toadflax	Santalaceae	N	X	X		X	
Comarum palustre	Marsh Cinquefoil	Rosaceae	N					X
Corallorhiza striata var. striata	Striped Coralroot	Orchidaceae	N					X
Cornus canadensis	Canada Bunchberry	Cornaceae	N		X	X		
Cornus stolonifera	Red-osier Dogwood	Cornaceae	N	X	X	X	X	
Crepis tectorum	Annual Hawksbeard	Asteraceae	E	X	X	X	X	
Danthonia intermedia	Timber Oatgrass	Poaceae	N	X				
Delphinium glaucum	Tall Larkspur	Ranunculaceae	N		X			
Deschampsia cespitosa ssp. cespitosa	Tufted Hairgrass	Poaceae	N	X		X	X	
Descurainia sophia	Flixweed	Brassicaceae	E		X			
Dracocephalum parviflorum	American Dragonhead	Menthaceae	N		X			
Drymocallis arguta	Tall Cinquefoil	Rosaceae	N	X	X			
Dryopteris carthusiana	Toothed Wood Fern	Dryopteridaceae	N			X		
Elaeagnus commutata	Silverberry	Elaeagnaceae	N	X	X		X	
Eleocharis erythropoda	Bald Spike-rush	Cyperaceae	N	X				
Eleocharis palustris	Common Spike-rush	Cyperaceae	N					X

Scientific Name	Common Name	Family	Native/Exotic	Beatton River	Leahy Pit Road	Upper Halfway River	Pouce Coupé	Incidentals
Elymus albicans	**Montana Wildrye**	Poaceae	N		X			
Elymus glaucus ssp. glaucus	Blue Wildrye	Poaceae	N	X	X	X	X	
Elymus lanceolatus ssp. lanceolatus	Thickspike Wildrye	Poaceae	N	X	X	X	X	
Elymus lanceolatus ssp. psammophilus	**Sand-dune Wildrye**	Poaceae	N			X		
Elymus repens	Quackgrass	Poaceae	E	X	X	X	X	
Elymus riparius	Eastern Riverbank Wildrye	Poaceae	E*	X				
Elymus trachycaulus ssp. subsecundus	One-sided Wildrye	Poaceae	N		X			
Elymus trachycaulus ssp. trachycaulus	Slender Wildrye	Poaceae	N	X	X		X	
Epilobium ciliatum ssp. ciliatum	Purple-leaved Willowherb	Onagraceae	N	X		X	X	
Epilobium palustre	Swamp Willowherb	Onagraceae	N	X				
Equisetum arvense	Field Horsetail	Equisetaceae	N	X	X	X	X	
Equisetum fluviatile	Swamp Horsetail	Equisetaceae	N	X				
Equisetum hyemale ssp. affine	Common Scouring-rush	Equisetaceae	N	X				
Equisetum palustre	Marsh Horsetail	Equisetaceae	N				X	
Equisetum pratense	Meadow Horsetail	Equisetaceae	N			X		
Equisetum sylvaticum	Wood Horsetail	Equisetaceae	N					X
Equisetum variegatum ssp. alaskanum	Northern Scouring-rush	Equisetaceae	N	X				
Erigeron caespitosus	Tufted Fleabane	Asteraceae	N	X	X			
Erigeron glabellus var. pubescens	Smooth Fleabane	Asteraceae	N	X	X	X	X	
Erigeron philadelphicus var. philadelphicus	Philadelphia Fleabane	Asteraceae	N				X	
Erigeron strigosus var. strigosus	Rough-leaved Fleabane	Asteraceae	N		X			
Eriophorum gracile	Slender Cotton-grass	Cyperaceae	N					X
Erysimum cheiranthoides	Wormseed Mustard	Brassicaceae	N	X				
Eurybia conspicua	Showy Aster	Asteraceae	N	X	X	X	X	
Eurybia sibirica	Siberian Aster	Asteraceae	N	X				
Fallopia convolvulus	Black Bindweed	Polygonaceae	E		X		X	
Festuca rubra ssp. rubra	Red Fescue	Poaceae	E	X		X		
Festuca saximontana var. saximontana	Rocky Mountain Fescue	Poaceae	N		X	X		
Fragaria vesca ssp. americana	Wood Strawberry	Rosaceae	N		X	X	X	
Fragaria virginiana ssp. glauca	Wild Strawberry	Rosaceae	N	X	X	X	X	
Galeopsis tetrahit	Common Hemp-nettle	Menthaceae	E			X		
Galium boreale	Northern Bedstraw	Rubiaceae	N	X	X	X	X	
Galium trifidum ssp. trifidum	Small Bedstraw	Rubiaceae	N	X		X		
Galium triflorum	Sweet-scented Bedstraw	Rubiaceae	N	X	X	X		
Gentianella amarella ssp. acuta	Northern Gentian	Gentianaceae	N	X		X	X	
Geranium bicknellii	Bicknell's Geranium	Geraniaceae	N		X			
Geum aleppicum	Yellow Avens	Rosaceae	N			X		
Geum macrophyllum ssp. macrophyllum	Large-leaved Avens	Rosaceae	N	X	X	X		
Geum rivale	Water Avens	Rosaceae	N					X
Geum triflorum var. triflorum	**Old Man's Whiskers**	Rosaceae	N	X	X	X		
Glechoma hederacea	Ground-ivy	Menthaceae	E					X

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Glyceria grandis var. grandis	Tall Mannagrass	Poaceae	N	X				
Glyceria striata	Fowl Mannagrass	Poaceae	N			X		
Gnaphalium uliginosum	Marsh Cudweed	Asteraceae	E				X	
Hackelia deflexa ssp. americana	Nodding Stickseed	Boraginaceae	N	X				
Hedysarum alpinum	Alpine Sweet-vetch	Fabaceae	N			X		
Helianthus annuus	Common Sunflower	Asteraceae	E					X
Heracleum maximum	Cow-parsnip	Apiaceae	N		X	X	X	
Hesperostipa curtiseta	Short-awned Porcupine-gras	Poaceae	N	X	X	X		
Heuchera richardsonii	Richardson's Alumroot	Saxifragaceae	N	X	X	X		
Hieracium canadense	Canadian Hawkweed	Asteraceae	N	X	X	X	X	
Hordeum jubatum ssp. jubatum	Foxtail Barley	Poaceae	N	X	X	X	X	
Impatiens noli-tangere	Common Touch-me-not	Balsaminaceae	N			X		
Juncus alpinoarticulatus	Northern Green Rush	Juncaceae	N					X
Juncus articulatus	Jointed Rush	Juncaceae	N					X
Juncus balticus ssp. ater	Baltic Rush	Juncaceae	N	X				
Juncus bufonius	Toad Rush	Juncaceae	N	X		X	X	
Juncus dudleyi	Dudley's Rush	Juncaceae	N					X
Juncus nodosus	Knotted Rush	Juncaceae	N			X	X	
Juniperus communis var. depressa	Common Juniper	Cupressaceae	N	X				
Juniperus horizontalis	Creeping Juniper	Cupressaceae	N			X		
Kochia scoparia	Summer-cypress	Amaranthaceae	E	X				
Koeleria macrantha	American Junegrass	Poaceae	N	X	X	X	X	
Lactuca biennis	Tall Blue Lettuce	Asteraceae	N	X				
Lactuca serriola	Prickly Lettuce	Asteraceae	E	X	X		X	
Lappula squarrosa	Blue Stickseed	Boraginaceae	E	X				
Larix laricina	Tamarack	Pinaceae	N					X
Lathyrus ochroleucus	Creamy Peavine	Fabaceae	N	X			X	
Lemna minor	Common Duckweed	Araceae	N	X				
Lemna trisulca	Ivy-leaved Duckweed	Araceae	N					X
Lepidium densiflorum	Prairie Pepper-grass	Brassicaceae	N		X	X	X	
Leymus innovatus	Fuzzy-spiked Wildrye	Poaceae	N	X		X	X	
Limosella aquatica	Water Mudwort	Scrophulariaceae	N				X	
Linaria vulgaris	Common Toadflax	Plantaginaceae	E					X
Linnaea borealis ssp. longiflora	Twinflower	Caprifoliaceae	N			X	X	
Linum lewisii ssp. lewisii	Western Blue Flax	Linaceae	N	X	X		X	
Lonicera dioica var. glaucescens	Glaucous-leaved Honeysuckl	Caprifoliaceae	N	X	X		X	
Lonicera involucrata	Black Twinberry	Caprifoliaceae	N	X				
Lonicera tatarica	Tatarian Honeysuckle	Caprifoliaceae	E	X				
Lotus corniculatus	Bird's-foot Trefoil	Fabaceae	E	X		X		
Luzula comosa var. laxa	Pacific Wood-rush	Juncaceae	N					X
Maianthemum canadense	Wild Lily-of-the-valley	Ruscaceae	N	X	X	X		

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Maianthemum racemosum ssp. amplexicaule	Large False Solomon's-seal	Ruscaceae	N					X
Maianthemum stellatum	Star-flowered False Solomon	Ruscaceae	N	X	X	X	X	
Matricaria discoidea	Pineapple-weed	Asteraceae	N	X		X		
Medicago sativa	Alfalfa	Fabaceae	E	X	X		X	
Melilotus albus	White Sweet-clover	Fabaceae	E	X	X		X	
Melilotus officinalis	Yellow Sweet-clover	Fabaceae	E	X	X		X	
Mentha arvensis	Field Mint	Menthaceae	N					X
Mertensia paniculata var. paniculata	Tall Bluebells	Boraginaceae	N	X	X	X	X	
Mitella nuda	Common Mitrewort	Saxifragaceae	N			X		
Monarda fistulosa var. menthifolia	Wild Bergamot	Menthaceae	N	X	X	X		
Mulgedium pulchellum	Wild Blue Lettuce	Asteraceae	N	X			X	
Myriophyllum sp.	water-milfoil sp.	Haloragaceae	N					X
Nassella viridula	Green Needlegrass	Poaceae	N		X			
Oplopanax horridus	Devil's-club	Araliaceae	N					X
Opuntia fragilis	Brittle Prickly-pear	Cactaceae	N	X	X			
Orthilia secunda	One-sided Wintergreen	Ericaceae	N		X			
Orthocarpus luteus	Yellow Owl-clover	Orobanchaceae	N	X	X	X		
Osmorhiza berteroi	Mountain Sweet-cicely	Apiaceae	N			X		
Oxytropis sericea var. speciosa	Silky Locoweed	Fabaceae	N	X				
Oxytropis splendens	Showy Locoweed	Fabaceae	N	X	X	X	X	
Parnassia palustris	Northern Grass-of-Parnassus	Celastraceae	N					X
Pedicularis groenlandica	Elephant's-head Lousewort	Orobanchaceae	N					X
Penstemon gracilis	**Slender Penstemon**	Plantaginaceae	N	X	X			
Penstemon procerus var. procerus	Small-flowered Penstemon	Plantaginaceae	N	X		X		
Persicaria amphibia var. emersa	Water Smartweed	Polygonaceae	N	X				
Persicaria lapathifolia	Willow-weed	Polygonaceae	N	X				
Persicaria maculosa	Lady's-thumb	Polygonaceae	E				X	
Persicaria pensylvanica	Pennsylvania Smartweed	Polygonaceae	E					X
Petasites palmatus	Palmate Coltsfoot	Asteraceae	N	X		X	X	
Petasites sagittatus	Arrow-leaved Coltsfoot	Asteraceae	N	X				
Petasites x vitifolius	Grape-leaved Coltsfoot	Asteraceae	N					X
Phalaris arundinacea	Reed Canarygrass	Poaceae	N	X	X		X	
Phleum pratense	Timothy	Poaceae	E	X	X	X	X	
Picea glauca	White Spruce	Pinaceae	N	X	X	X	X	
Picea mariana	Black Spruce	Pinaceae	N					X
Pinus contorta var. latifolia	Lodgepole Pine	Pinaceae	N					X
Plantago major	Common Plantain	Plantaginaceae	E	X	X	X	X	
Platanthera aquilonis	Northern Green Bog-orchid	Orchidaceae	N					X
Poa annua	Annual Bluegrass	Poaceae	E			X		
Poa compressa	Canada Bluegrass	Poaceae	E		X			
Poa glauca ssp. glauca	Glaucous Bluegrass	Poaceae	N			X		

Scientific Name	Common Name	Family	Native/Exotic	Beatton River	Leahy Pit Road	Upper Halfway River	Pouce Coupé	Incidentals
Poa palustris	Fowl Bluegrass	Poaceae	E	X	X	X	X	
Poa pratensis ssp. agassizensis	Kentucky Bluegrass	Poaceae	N	X	X	X		
Polygonum achoreum	Blake's Knotweed	Polygonaceae	N	X	X			
Polygonum aviculare	Common Knotweed	Polygonaceae	E		X	X		
Polygonum douglasii	Douglas' Knotweed	Polygonaceae	N	X	X			
Populus balsamifera	Balsam Poplar	Salicaceae	N	X	X	X	X	
Populus tremuloides	Trembling Aspen	Salicaceae	N	X	X	X	X	
Potamogeton obtusifolius	Blunt-leaved Pondweed	Potamogetonaceae	N					X
Potamogeton richardsonii	Richardson's Pondweed	Potamogetonaceae	N					X
Potentilla anserina ssp. anserina	Common Silverweed	Rosaceae	N	X			X	
Potentilla hippiana	Woolly Cinquefoil	Rosaceae	N			X		
Potentilla norvegica	Norwegian Cinquefoil	Rosaceae	N	X	X	X	X	
Potentilla pensylvanica	Pennsylvanian Cnquefoil	Rosaceae	N		X	X	X	
Potentilla pulcherrima	**Pretty Cinquefoil**	Rosaceae	N			X		
Prosartes trachycarpa	Rough-fruited Fairybells	Liliaceae	N	X	X	X		
Prunus pensylvanica	Pin Cherry	Rosaceae	N		X			
Prunus virginiana var. virginiana	Choke Cherry	Rosaceae	N	X	X	X	X	
Puccinellia distans	Weeping Alkaligrass	Poaceae	E	X				
Puccinellia nuttalliana	Nuttall's Alkaligrass	Poaceae	N	X				
Pyrola asarfolia ssp. asarifolia	Pink Wintergreen	Ericaceae	N	X	X	X	X	
Ranunculus aquatilis var. diffusus	White Water-buttercup	Ranunculaceae	N					X
Ranunculus cymbalaria	Shore Buttercup	Ranunculaceae	N					X
Ranunculus gmelinii	Small Yellow Water-buttercu	Ranunculaceae	N	X				
Ranunculus macounii	Macoun's Buttercup	Ranunculaceae	N	X	X	X		
Ranunculus pensylvanica	Pennsylvania Buttercup	Ranunculaceae	N	X				
Ranunculus sceleratus var. multifidus	Celery-leaved Buttercup	Ranunculaceae	N				X	
Rhinanthus minor	Yellow-rattle	Orobanchaceae	N			X		
Ribes glandulosum	Skunk Currant	Grossulariaceae	N					X
Ribes hudsonianum var. hudsonianum	Northern Black Currant	Grossulariaceae	N			X		
Ribes oxyacanthoides	Northern Gooseberry	Grossulariaceae	N	X	X	X	X	
Ribes triste	Red Swamp Currant	Grossulariaceae	N		X			
Rorippa palustris ssp. palustris	Marsh Yellow-cress	Brassicaceae	N	X			X	
Rosa acicularis ssp. sayi	Prickly Rose	Rosaceae	N	X	X	X	X	
Rosa woodsii ssp. woodsii	Prairie Rose	Rosaceae	N	X	X	X	X	
Rubus idaeus ssp. strigosus	Red Raspberry	Rosaceae	N	X	X	X	X	
Rubus parviflorus	Thimbleberry	Rosaceae	N					X
Rubus pubescens	Dwarf Red Raspberry	Rosaceae	N	X	X	X	X	
Rumex crispus	Curled Dock	Polygonaceae	E					X
Rumex fueginus	American Golden Dock	Polygonaceae	N	X			X	
Rumex occidentalis	Western Dock	Polygonaceae	N					X
Rumex triangulivalvis	Common Willow Dock	Polygonaceae	N	X		X	X	

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Sagittaria cuneata	Arum-leaved Arrowhead	Araceae	N	X				
Salix arbusculoides	Northern Bush Willow	Salicaceae	N		X			
Salix bebbiana	Bebb's Willow	Salicaceae	N	X		X	X	
Salix discolor	Pussy Willow	Salicaceae	N	X				
Salix drummondiana	Drummond's Willow	Salicaceae	N					X
Salix glauca var. villosa	Grey-leaved Willow	Salicaceae	N					X
Salix interior	Narrow-leaved Willow	Salicaceae	N	X	X		X	
Salix lasiandra var. lasiandra	Pacific Willow	Salicaceae	N		X		X	
Salix pedicellaris	Bog Willow	Salicaceae	N					X
Salix planifolia	Plane-leaved Willow	Salicaceae	N					X
Salix prolixa	Mackenzie Willow	Salicaceae	N	X			X	
Salix pseudomonticola	Serviceberry Willow	Salicaceae	N				X	
Salix pyrifolia	Balsam Willow	Salicaceae	N					X
Salix scouleriana	Scouler's Willow	Salicaceae	N	X	X	X	X	
Sanicula marilandica	Black Sanicle	Apiaceae	N	X	X			
Schizachne purpurascens	False-melic	Poaceae	N	X			X	
Schoenoplectus tabernaemontani	Soft-stemmed Bulrush	Cyperaceae	N	X				
Scirpus microcarpus	Small-flowered Bulrush	Cyperaceae	N				X	
Scolochloa festucacea	Rivergrass	Poaceae	N					X
Scutellaria galericulata	Marsh Skullcap	Menthaceae	N	X				
Senecio eremophilus var. eremophilus	Dryland Ragwort	Asteraceae	N	X	X			
Senecio vulgaris	Common Groundsel	Asteraceae	E	X				
Setaria viridis	Green Bristlegrass	Poaceae	E	X				
Shepherdia canadensis	Soopolallie	Elaeagnaceae	N	X	X	X	X	
Silene drummondii var. drummondii	**Drummond's Campion**	Caryophyllaceae	N	X		X		
Sisymbrium loeselii	Loesel's Tumble-mustard	Brassicaceae	E		X			
Sisyrinchium montanum	Mountain Blue-eyed-grass	Iridaceae	N		X			
Sium suave	Water-parsnip	Apiaceae	N	X				
Solidago altissima ssp. gilvocanescens	Tall Goldenrod	Asteraceae	N	X	X		X	
Solidago missouriensis	Missouri Goldenrod	Asteraceae	N	X	X			
Solidago simplex var. simplex	Spike-like Goldenrod	Asteraceae	N	X	X	X		
Sonchus arvensis ssp. uliginosus	Perennial Sow-thistle	Asteraceae	E	X	X		X	
Sonchus asper	Prickly Sow-thistle	Asteraceae	E	X				
Sorbus sitchensis var. sitchensis	Sitka Mountain-ash	Rosaceae	N					X
Sparganium emersum	Emersed Bur-reed	Sparganiaceae	N					X
Sparganium natans	Small Bur-reed	Sparganiaceae	N					X
Spiraea lucida	Birch-leaved Spiraea	Rosaceae	N		X	X		
Stachys palustris ssp. pilosa	Marsh Hedge-nettle	Menthaceae	N		X			
Stellaria crassifolia	Thick-leaved Starwort	Caryophyllaceae	N	X		X		
Stellaria longipes	Long-stalked Starwort	Caryophyllaceae	N			X		
Stellaria media	Common Chickweed	Caryophyllaceae	E			X		

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Symphoricarpos albus var. laevigatus	Common Snowberry	Caprifoliaceae	N	X	X	X	X	
Symphoricarpos occidentalis	Western Snowberry	Caprifoliaceae	N	X	X	X	X	
Symphyotrichum ciliatum	Rayless Alkali Aster	Asteraceae	N	X				
Symphyotrichum ciliolatum	Lindley's Aster	Asteraceae	N		X	X	X	
Symphyotrichum ericoides var. pansum	Heath Aster	Asteraceae	N	X				
Symphyotrichum falcatum var. falcatum	Western Heath Aster	Asteraceae	N	X				
Symphyotrichum laeve var. geyeri	Smooth Aster	Asteraceae	N	X	X		X	
Symphyotrichum lanceolatum ssp. lanceolatum	**Panicled Aster**	Asteraceae	N	X			X	
Symphyotrichum puniceum	**Purple-stemmed Aster**	Asteraceae	N					X
Taraxacum officinale	Common Dandelion	Asteraceae	E	X	X	X	X	
Thalictrum occidentale	Western Meadowrue	Ranunculaceae	N	X	X	X	X	
Thlaspi arvense	Field Pennycress	Brassicaceae	E		X		X	
Tragopogon dubius	Yellow Salsify	Asteraceae	E	X	X		X	
Trifolium hybridum	Alsike Clover	Fabaceae	E	X	X	X		
Trifolium pratense	Red Clover	Fabaceae	E	X	X	X	X	
Trifolium repens	White Clover	Fabaceae	E	X		X	X	
Triglochin palustris	Marsh Arrow-grass	Juncaginaceae	N					X
Tripleurospermum inodorum	Scentless Mayweed	Asteraceae	E	X			X	
Triticum aestivum	Cultivated Wheat	Poaceae	E	X				
Typha latifolia	Common Cattail	Typhaceae	N	X			X	
Urtica dioica ssp. gracilis	Stinging Nettle	Urticaceae	N	X	X	X		
Veronica beccabunga var. americana	American Brooklime	Plantaginaceae	N			X		
Viburnum edule	Highbush-cranberry	Adoxaceae	N	X	X	X	X	
Vicia americana	American Vetch	Fabaceae	N	X	X	X	X	
Viola adunca var. adunca	Early Blue Violet	Violaceae	N			X	X	
Viola canadensis var. rugulosa	Canada Violet	Violaceae	N	X	X	X	X	
Viola renifolia	Kidney-leaved Violet	Violaceae	N			X	X	

APPENDIX E
RARE PLANT SPECIES ACCOUNTS

Name and Conservation Rank:
Antennaria neglecta (field pussytoes)
Blue (S2S3)

Habitat: south-facing grassland slope; disturbed grassland margin; upper grassland slope

Typic Site Information[3]	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	7	1086	2854
Slope Gradient (%)	0	25	200
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	0	190	360
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	0	2	7
Modal Nutrient Regime Class	C		
Number of field plots species was recorded in:	1299		
Modal BEC Zone Class	IDF		
All BEC Zones (# of stations/zone) species was recorded in:	AT (2), BAFA (4), BG (5), BWBS (27), CWH (9), ESSF (140), ICH (141), IDF (517), IMA (1), MH (1), MS (155), PP (55), SBPS (75), SBS (120)		

<table>
<tr><td>Name and Conservation Rank:
Artemisia herriotii (white sagebrush)
Red (S2)</td><td rowspan="2"></td></tr>
<tr><td>Habitat: riverbanks; disturbed areas; eroding sandy riverbank; sandy alluvial deposition area; steep, eroding bank; disturbed roadsides</td></tr>
<tr><td colspan="2">Typic Site Information[3]</td></tr>
<tr><td colspan="2">Not provided</td></tr>
</table>

Name and Conservation Rank:
Avenula hookeri (spike-oat)
Blue (S3)

Habitat: south-facing grassland slope; open grassland slope

Typic Site Information[3]

Mesic to dry forest openings, grassy slopes and meadows in the montane and subalpine zones; rare in N BC; N to SW YT and SW NT, E to S MB, disjunct in SW PQ and S to MN, SD and NM.

Name and Conservation Rank:

Calamagrostis montanensis (plains reedgrass)

Blue (S3)

Habitat: steep, eroding south-facing slope; south-facing grassland slope, most common upslope along eroding wildlife (possibly livestock) trail.

Typic Site Information[3]	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	1311	1768	2390
Slope Gradient (%)	20	44	70
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	90	162	270
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	0	2	3
Modal Nutrient Regime Class	B		
Number of field plots species was recorded in:	5		
Modal BEC Zone Class	ESSF		
All BEC Zones (# of stations/zone) species was recorded in:	AT(1), ESSF(1), IDF(1), MS(1)		

Name and Conservation Rank: *Carex torreyi* (Torrey's sedge) Blue (S2S3)	
Habitat: grassy swale on grassland slope.	

Typic Site Information[3]
Mesic to moist meadows and shrublands in the montane zone; rare in NE BC, known only from the Peace River area; E to MB and S to WI, MN, SD and CO.

Name and Conservation Rank:
Carex xerantica (dry-land sedge)
Blue (S2S3)

Habitat: south-facing grassland slope; upper grassland slope/thickets

Typic Site Information[3]

Dry slopes and open forests in the steppe and montane zones; rare in SC, SE and NE BC; E to S MB and S to MN and NE.

Site Information	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	299	1012	1600
Slope Gradient (%)	0	7	25
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	28	107	350
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	1	4	7
Modal Nutrient Regime Class	D		
Number of field plots species was recorded in:	18		
Modal BEC Zone Class	IDF		
All BEC Zones (# of stations/zone) species was recorded in:	BG(2), IDF(7), MS(4), PP(3)		

Name and Conservation Rank: *Elymus albicans* (Montana wildrye) Red (S1S2)	no photo (identified post fieldwork)
Habitat: south-facing grassland slope	

Typic Site Information[3]
Dry alkaline flats, sand dunes, gravelly sites and open forests in the steppe and montane zones; common in NE, SC and SE BC; E to AB and S to NE, CO, UT, ID and WA.

Site Information	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	46	999	2378
Slope Gradient (%)	0	17	75
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	73	179	328
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	0	3	7
Modal Nutrient Regime Class	D		
Number of field plots species was recorded in:	44		
Modal BEC Zone Class	SBS		
All BEC Zones (# of stations/zone) species was recorded in:	AT(1), BG(6), BWBS(3), CDF(2), CWH(2), ESSF(6), ICH(1), IDF(5), MS(6), SBS(10)		

Name and Conservation Rank: *Elymus lanceolatus* ssp. *psammophilus* (sand-dune wheatgrass) Blue (S2S3)	no photo (identified post fieldwork)
Habitat: rocky outcrop on grassland slope	
Typic Site Information[3]	
Not provided.	

Name and Conservation Rank: *Geum triflorum* var. *triflorum* (old man's whiskers) Red (S1S3)	
Habitat: south-facing grassland slopes; disturbed grassland margin	
Typic Site Information[3]	
Dry to mesic grasslands, meadows, rocky slopes and open forests in the steppe, montane and subalpine zones; common in S BC east of the Coast-Cascade Mountains, infrequent in the Peace River valley; N to YT and NT, E to NF and S to CA, NM, NE, IL and NY.	

Name and Conservation Rank:
Penstemon gracilis (slender penstemon)
Red (S2)

Habitat: south-facing grassland slopes

Typic Site Information[3]

Dry to moist, sandy or rocky grasslands; rare in NE BC, known only from the Peace River area; E to ON and S to IN, IL, NE and NM.

Site Information	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	360	1097	2330
Slope Gradient (%)	0	14	40
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	226	292	360
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	3	4	6
Modal Nutrient Regime Class	B		
Number of field plots species was recorded in:	4		
Modal BEC Zone Class	ICH		
All BEC Zones (# of stations/zone) species was recorded in:	ICH(2), IDF(1)		

Name and Conservation Rank: *Potentilla pulcherrima* (pretty cinquefoil) Red (S2)	no photo (identified after fieldwork)
Habitat: remnant grassland verge	

Typic Site Information[3]
Dry to moist meadows, grasslands, rocky slopes, open forests, and roadsides and waste places in the montane zone; frequent in SE BC, E to AB and S to NV, AZ, NM and MX.

Site Information	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	1165	1719	2216
Slope Gradient (%)	0	21	65
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	28	217	279
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	0	3	8
Modal Nutrient Regime Class	C		
Number of field plots species was recorded in:	10		
Modal BEC Zone Class	ESSF		
All BEC Zones (# of stations/zone) species was recorded in:	AT(1), BAFA(1), ESSF(4), ICH(2), MS(2)		

Name and Conservation Rank:
Silene drummondii var. *drummondii* (Drummond's campion)
Blue (S3)

Habitat: south-facing grassland slopes; open grassland slope

Typic Site Information[3]

Dry shrublands, meadows and forest openings in the steppe to alpine zones; rare at scattered locations throughout BC east of the Coast-Cascade Mountains; E to S MB and S to NE, CO, AZ and NV.

Site Information	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	520	994	2380
Slope Gradient (%)	0	12	65
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	13	194	360
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	0	3	5
Modal Nutrient Regime Class	C		
Number of field plots species was recorded in:	75		
Modal BEC Zone Class	IDF		
All BEC Zones (# of stations/zone) species was recorded in:	BAFA(3), BG(21), ICH(1), IDF(43), IMA(1), MS(1), PP(2), SBPS(1), SBS(2)		

Name and Conservation Rank:

Symphyotrichum lanceolatum var. *lanceolatum* (western willow-aster)

to be ranked in 2016

Habitat: stabilized riverbanks; sandy riverbank

Typic Site Information[3]	Value / Class		
	Minimum	Average	Maximum
Elevation (metres)	1970	1970	1970
Slope Gradient (%)	15	15	15
Aspect (degrees) [0 - N; 90 - E; 180 - S; 270 - W]	22	21	22
Soil Moisture Regime (SMR) [0 - very xeric; 4 - mesic; 8 - hydric]	1	1	1
Modal Nutrient Regime Class	B		
Number of field plots species was recorded in:	1		
Modal BEC Zone Class	ESSF		
All BEC Zones (# of stations/zone) species was recorded in:	ESSF(1)		

APPENDIX F
BC CONSERVATION DATA CENTRE: PLANT OBSERVATION FORMS

B.C. Conservation **Contact name** Jamie Fenneman Terry McIntosh

Contact E-mail botrychiophile@gmail.c ttmcintosh@shaw.ca

Essential fields are

Guidance is available by moving the cursor over the red triangle in the top right hand corner of a field with a comment. * Fields data will not be shared. If waypoint file available, indicate waypoint #s to cross-reference waypoints to CDC observations.

Observations in columns	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Observer	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh
Taxon name	*Antennaria neglecta*	*Antennaria neglecta*	*Antennaria neglecta*	*Antennaria neglecta*	*Antennaria neglecta*	*Artemisia herriotii*	*Artemisia herriotii*	*Artemisia herriotii*	*Artemisia herriotii*	*Avenula hookeri*
Source of Report	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo
Location/Directions	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Pouce Coupé River, SE	Pouce Coupé River, SE	Fish Creek, NE of Ft. St John	E of Pine River, NE of Ft. St John	Upper Halfway River area, W. of Ft. St. John
Habitat type	Grassland/shrub steppe	Grassland/shrub steppe	forest / grassland	Grassland/shrub steppe	forest / grassland	Riparian	Riparian	Riparian	Forest	Grassland/shrub steppe
Habitat	in grassland-shrub matrix on open slope	in grassland-shrub matrix on open slope	along edge of open track near fence along	at edge of grassland-shrub matrix on open	grassland at edge of forest	eroding silty-sandy riverbank	silty-sandy alluvial deposition area	eroding silty-sandy riverbank and along	steep, eroding bank in open young forest;	south-west facing grassland slope
Associated spp.	Symphoricarpos occidentalis, Rosa woodsii, Hesperostipa curtiseta	Elymus glaucus, Hesperostipa curtiseta, Comandra umbellata, near Prunus virginiana patch	Populus tremuloides, Festuca rubra, Spiraea betulifolia, Fragaria virginiana, Potentilla hippiana	Hesperostipa comata, Symphoricarpos occidentalis	Hesperostipa comata, Achillea millefolium, Symphoricarpos occidentalis	Equisetum palustre, Phalaris arundinacea, Salix interior, Poa palustris, Achillea alpina	Equisetum palustre, Phalaris arundinacea, Achillea alpina	Salix spp., numerous forbs and various grasses (e.g., Elymus sp., Phalaris arundinacea)	Populus balsamifera, Salix spp., numerous other herbs, forbs, and shrubs	Poa pratensis, Amelanchier alnifolia, Rosa acicularis, Stellaria longipes, Festuca rubra, Campanula rotundifolia, Achnatherum nelsonii, Koeleria macrantha
***Landowner Name**	Crown land	Crown land		Crown Land	Crown Land	Crown Land	Crown Land	unknown	unknown	Crown
***Landowner permissions**	Permission to survey/collect/share	Permission to survey/collect/share	Landowner name unknown	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Landowner name unknown	Landowner name unknown	Permission to survey/collect/share
Survey Date (yyyy/mm/dd)	13/08/2016 and	16/08/2016 and	8/14/2016	8/14/2016	8/14/2016	8/15/2016	8/15/2016	8/18/2016	8/18/2016	8/14/2016
Zone	10	10	10	10	10	10	10	10	10	10
Easting	652770	653511	583356	583331	583298	685931/685941	685958	638662, 638554	641436	583300
Northing	6223893	6223773	6250491	6250510	6250570	6195078/6195080	6195090	6240047, 6240094	6242312	6250543
Source for coordinate	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS
Waypoint numbers (if applicable)	50	83	58	3m NE of 60	65	70/71	72	121 to 125	127-128	61
# of Individuals (exact)						4	about 23			20
# of Individual (range estimates)	1- 50	1- 50	1- 50	1- 50	1- 50		1- 50	50-250	250-1000	
Area Occupied: Length (m)	4	5	3	>1	1	10	20	140	40	10
Area Occupied: Width (m)	3	4	2	>1	0.5	2	5	25	40	10
Area Occupied (m^2)	12	20	12	>1	0.5	20	100	3500	1600	100
Description of Area Occupied	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat with one large cluster at west end along bank	scattered in area of unsuitable habitat along road but with one large cluster on eroding steep bank	scattered in area of suitable habitat
Condition of Population (& potential threats to plants within occupied area)	excellent condition; no threats observed; past flowering	excellent condition; no threats observed; past flowering	excellent condition; no threats observed (although this site might be threatened by ROW clearing); past flowering	excellent condition; no threats observed; past flowering	excellent condition; no threats observed; past flowering	fair condition, typical riverine disturbance; no threats other than river erosion etc. which was severe at this site in 2016); flowering	good condition; typical riverine disturbance; no threats other than river erosion etc. which was severe at this site in 2016); flowering	typical riverine disturbance; no threats other than river erosion etc. which was severe at this site in 2016); flowering	plants along road have been driven over at times but large cluster on slope is composed of large, healthy individuals; this steep slope is eroding but this does not appear to negatively affect the population; flowering	excellent condition; no threats observed; fruiting
Condition of Landscape (& potential threats at landscape level)	excellent condition; no threats observed	excellent condition; no threats observed	excellent condition; no threats observed (although habitat might be threatened by ROW clearing)	excellent condition; no threats observed; past flowering	excellent condition; no threats observed	fair condition; probable river erosion	good condition; probable river erosion	good condition; probable river erosion	mainly excellent condition to poor (along road); vehicle traffic is the main threat to a few plants	excellent condition; no threats observed
Recent (20-40 yrs) Landscape Disturbance	Grazing	Grazing	Grazing	Grazing	Grazing	Other	Other	Other	Other	Grazing
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Excellent	Fair	Good	Good	Excellent	Excellent
Elevation (m)	567	553	834	837	841	547 - 549	550	458	705	834
Slope (%)										
Slope (°)	3-5	3-5	0-3	3-8	0-3	0	0 - 30 (along a bank and on flat)	0 - 40 (along a bank and on flat)	0 (along road) to 50	20
Aspect	south	south	south	south-west	south-west	none	none to north west	none to south	north-north-west	south-west
Crown closure	Open	Open	Partial	Open	Partial	Open	Open	Open	Partial	Open
Slope Position	Upper slope	Upper slope	Crest	Upper slope	Upper slope	Toe	Toe	Toe	Upper slope	Upper slope
Moisture	Dry	Dry	Dry	Dry	Dry	Mesic(moist)	Mesic(moist)	Mesic(moist)	Dry	Very dry
Substrate/soil	silty loam	silty loam	silty loam	silty loam	silty loam	sandy silt	sandy silt	sandy silt	sandy silt	compact sandy-silt
General Notes	because this slope is extensive and only a relatively small portion was surveyed in detail, more patches are expected	because this slope is extensive and only a relatively small portion was surveyed in detail, more patches are expected		because this slope is extensive and only a relatively small portion was surveyed in detail, more patches are expected	because this slope is extensive and only a relatively small portion was surveyed in detail, more patches are expected	probably more plants along stream	probably more plants along stream	probably more plants along stream	probably more plants along slope	probably more plants along slope
Collector name (if different from observer)										
Herbarium and Specimen Collection #	to be deposited into UBC	no specimen collected	no specimen collected	no specimen collected	no specimen collected	to be deposited into UBC	no specimen collected	to be deposited into UBC	no specimen collected	no specimen collected
Plot # (if applicable)										
Photo details	available	available	available	available	available	available	photos of habitat available	available	available	available

Observations in columns	**11**	**12**	**13**	**14**	**15**	**16**	**17**	18	**19**
Observer	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh
Taxon name	*Avenula hookeri*	*Avenula hookeri*	*Avenula hookeri*	*Avenula hookeri*	*Calamagrostis montan*	*Calamagrostis montan*	*Calamagrostis montan*	*Calamagrostis montan*	*Calamagrostis montan*
Source of Report	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo
Location/Directions	Upper Halfway River area, W. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Beatton River area, E of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John
Habitat type	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe
Habitat	south-west facing grassland slope	south-west facing grassland slope	south-facing grassland slope	south-facing grassland slope	steep, eroding south-facing slope	south-facing grassland slope	along wildlife/livestock trail	south-facing grassland slope	south-facing grassland slope
Associated spp.	none recorded	none recorded	Hesperostipa curtiseta, Rosa woodsi, Carex sp.	Hesperostipa curtiseta	Elymus lanceolatus, Artemisia frigida, Symphoricarpos occidentalis, Rosa woodsii (although plant cover is ~only 10 %)	Hesperostipa curtiseta, Elymus glauca	few associates (some Hesperostipa curtiseta)	few associates (some Hesperostipa curtiseta)	few associates (some Hesperostipa curtiseta)
***Landowner Name**	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown
***Landowner permissions**	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share
Survey Date (yyyy/mm/dd)	8/14/2016	8/14/2016	8/16/2016	8/16/2016	8/12/2016	8/16/2016	8/16/2016	8/16/2016	8/16/2016
Zone	10	10	10	10	10	10	10	10	10
Easting	583222	583222	653540	653810	646183	653534	653550	653587	653712
Northing	6250740	6250740	6223805	6223721	6238410	6223788	6223806	6223808	6223853
Source for coordinate	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS
Waypoint numbers (if applicable)	65	62	92	102	38	90	93	94	97
# of Individuals (exact)			10	10	55				20
# of Individual (range estimates)	1- 50	1- 50				1- 50	50-250	1- 50	
Area Occupied: Length (m)	1	1	4	5	10	1	16	14	10
Area Occupied: Width (m)	1	1	3	5	3	1	0.5	0.5	0.5
Area Occupied (m^2)	1	1	12	25	30	1	8	7	5
Description of Area Occupied	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)
Condition of Population (& potential threats to plants within occupied area)	excellent condition; no threats observed; fruiting	excellent condition; no threats observed; fruiting	excellent condition; no threats observed; fruiting	excellent condition; no threats observed; flowering	fair condition; adjacent steep bank shows heavy erosion and may impact the cluster; fruiting	excellent condition, no disturbance; no threats; fruiting	excellent condition, and trail eroding which may benefit species; fruiting	excellent condition, and trail eroding which may benefit species; fruiting	excellent condition, and trail eroding which may benefit species; fruiting
Condition of Landscape (& potential threats at landscape level)	excellent condition; no threats observed	excellent condition; no threats observed	excellent condition; no threats observed	excellent condition; no threats observed	fair condition; adjacent steep bank shows heavy erosion and may impact the habitat	excellent condition, no disturbance; no threats	excellent condition, although trail eroding which may benefit species	excellent condition, although trail eroding which may benefit species	excellent condition, although trail eroding which may benefit species
Recent (20-40 yrs) Landscape Disturbance	Grazing	Grazing	Grazing	Grazing	Other	Grazing	Grazing	Grazing	Grazing
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Fair	Excellent	Excellent	Excellent	Excellent
Elevation (m)	841	826	558	586	518	553	559	564	602
Slope (%)									
Slope (°)	20	20	20	20	60	20	35	35	35
Aspect	south-west	south-west	south-east	south-west	south-east	south	south	south	south
Crown closure	Open	Open	Open	Open	Open	Open	Open	Open	Open
Slope Position	Upper slope	Mid-slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope
Moisture	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry
Substrate/soil	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact stony, sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt
General Notes	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope
Collector name (if different from observer)									
Herbarium and Specimen Collection #	to be deposited into UBC	no specimen collected	to be deposited into UBC	no specimen collected	to be deposited into UBC	to be deposited into UBC	no specimen collected	no specimen collected	no specimen collected
Plot # (if applicable)									
Photo details	available	available	available	available	available		available	available	available

Observations in columns	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Observer	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh
Taxon name	*Calamagrostis montan*	*Calamagrostis montan*	*Carex torreyi*	*Carex xerantica*	*Carex xerantica*	*Elymus albicans*	*Elymus lanceolatus ssp*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*
Source of Report	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo
Location/Directions	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Pouce Coupé River, SE	Leahy Pit area, E. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Beatton River area, E of Ft. St. John	Beatton River area, E of Ft. St. John
Habitat type	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe
Habitat	south-facing grassland slope	south-facing grassland slope	grassy swale on grassland slope	south-facing grassland slope	in thicket in grassland	south-facing grassland slope	rocky outcrop on grassland slope	south-facing grassland slope	south-facing grassland slope
Associated spp.	few associates (some Hesperostipa curtiseta)	Hesperostipa curtiseta	Symphoricarpos occidentalis, Drymocallis arguta, Monarda fistulosa var. menthifolia, Amelanchier alnifolia, Eurybia conspicua, Bromus inermis	Elymus sp., Achillea millefolium, Symphoricarpos occidentalis, Carex obtusata	Elaeagnus commutata, Prunus virginiana, Amelanchier alnifolia	none recorded	none recorded	Elymus lanceolatus, Achnatherum nelsonii spp. dorei, Comandra umbellata	Hesperostipa curtiseta, Solidago missouriensis, Antennaria cf rosea, Artemsia dracunculus, Artemsia frigida, Comandra umbellata
***Landowner Name**	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown
***Landowner permissions**	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share
Survey Date (yyyy/mm/dd)	8/16/2016	8/16/2016	8/13/2016	8/13/2016	8/15/2016	8/13/2016	8/14/2016	8/12/2016	8/12/2016
Zone	10	10	10	10	10	10	10	10	10
Easting	653745	653863	652831	653775	686021	653779	583202	646281	645503
Northing	6223792	6223708	6224006	6223746	6195425	6226302	6250810	6238649	6238523
Source for coordinate	GPS	GPS	GPS	GPS	GPS	Google Earth	GPS	GPS	GPS
Waypoint numbers (if applicable)	100	103	55	101	75	NA	63	34	44
# of Individuals (exact)	1	8		3		1	1	8 - 10	3 - 4
# of Individual (range estimates)			1- 50		1- 50	1- 50	1- 50	1- 50	1- 50
Area Occupied: Length (m)	0.1	3	8	2	1	1	1	3	4
Area Occupied: Width (m)	0.1	2	3	0.25	1	1	1	2	3
Area Occupied (m²)	0.01	6	24	0.5	1	1	1	6	12
Description of Area Occupied	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of mostly unsuitable habitat (appears to favour disturbed sites)	scattered in area of suitable habitat (patches of shrubs in the grasslands)	in area of suitable habitat	in area of suitable habitat	in area of suitable habitat	in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat
Condition of Population (& potential threats to plants within occupied area)	excellent condition, and trail eroding which may benefit species; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats	excellent condition; no threats
Condition of Landscape (& potential threats at landscape level)	excellent condition, although trail eroding which may benefit species	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats
Recent (20-40 yrs) Landscape Disturbance	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Elevation (m)	588	581		583	590	550	828	534	621
Slope (%)									
Slope (°)	35	25	10	20	20	NA	NA	15	15
Aspect	south	south	south	south	south	south	south	south	south
Crown closure	Open	Open	Open	Open	Open	Open	Open	Open	Open
Slope Position	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Mid-slope	Upper slope	Upper slope	Upper slope
Moisture	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry
Substrate/soil	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	sandy/rocky	compact sandy-silt	compact sandy-silt
General Notes	probably more plants along slope	probably more plants along slope	probably more plants along slope but too late in the year and most perigynia lost	probably more plants along slope but too late in the year and most perigynia lost	one plant was collected and identified as this species at a later dat so little information is available; probably more plants along slope but too late in	one plant was collected and identified as this species at a later date so little information is available; probably more plants along slope	one plant was collected and identified as this species at a later date so little information is available; probably more plants along slope	probably more plants along slope	probably more plants along slope
Collector name (if different from observer)									
Herbarium and Specimen Collection #	no specimen collected	no specimen collected	to be deposited into UBC	to be deposited into UBC	to be deposited into UBC	to be deposited into UBC	to be deposited into UBC	no specimen collected	no specimen collected
Plot # (if applicable)									
Photo details			available	available				available	

Observations in columns	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
Observer	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh
Taxon name	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Geum triflorum* var. *tri*	*Penstemon gracilis*
Source of Report	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo
Location/Directions	Beatton River area, E of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Beatton River area, E of Ft. St. John
Habitat type	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe
Habitat	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope
Associated spp.	Poa pratensis, Hesperostipa curtiseta, Solidago missouriensis, Hieracium canadensis, Achillea millefolium	Hesperostipa curtiseta	Hesperostipa curtiseta	Hesperostipa curtiseta	Hesperostipa curtiseta	Hesperostipa curtiseta Solidago missouriensis, Koeleria macrantha, Oxytropis splendens	Hesperostipa curtiseta	Hesperostipa curtiseta	Hesperostipa curtiseta	Poa pratensis, (Hesperostipa curtiseta)/(Danthonia intermedia)
***Landowner Name**	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown
***Landowner permissions**	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share
Survey Date (yyyy/mm/dd)	8/12/2016	8/13/2016	8/13/2016	8/13/2016	8/16/2016	8/16/2016	8/16/2016	8/16/2016	8/13/2016	8/12/2016
Zone	10	10	10	10	10	10	10	10	10	10
Easting	645467	652750	652898	653045	653706	653743	653879	653814	583351	645510
Northing	6238537	6223916	6224044	6223964	6223854	6223820	6223705	6223529	6250488	6238847
Source for coordinate	GPS	GPS	Google Earth	Google Earth	GPS	GPS	GPS	GPS	GPS	GPS
Waypoint numbers (if applicable)	46	51			96	99	104	107	59	14
# of Individuals (exact)	>20		>10	>50	about 30	1	~20		1	>20
# of Individual (range estimates)	1- 50	1- 50	1- 50	50-250	1- 50	1- 50	1- 50	1- 50	1- 50	1- 50
Area Occupied: Length (m)	4	3	4	5	3	0.25	5	5	0.25	20
Area Occupied: Width (m)	3	3	3	5	2	0.25	3	3	0.25	10
Area Occupied (m²)	12	9	12	25	6	0.0625	15	15	0.0625	200
Description of Area Occupied	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat
Condition of Population (& potential threats to plants within occupied area)	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats; fruiting
Condition of Landscape (& potential threats at landscape level)	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats
Recent (20-40 yrs) Landscape Disturbance	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Elevation (m)	627	573	605	595	600	600	581	532	834	617
Slope (%)										
Slope (°)	10	15	15	15	10	10	15	15	10	15
Aspect	south	south	south	south	south	south	south	south	south	south-east
Crown closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Slope Position	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope
Moisture	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry
Substrate/soil	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt
General Notes	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed
Collector name (if different from observer)										
Herbarium and Specimen Collection #	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	to be deposited into UBC	to be deposited into UBC
Plot # (if applicable)										
Photo details			available		available			available		available

Observations in columns	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	49	50	51
Observer	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh	J. Fenneman/T. McIntosh
Taxon name	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Penstemon gracilis*	*Potentilla pulcherrima*	*Silene drummondii var. drummondii*	*Silene drummondii var. drummondii*	*Silene drummondii var. drummondii*
Source of Report	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo	Observation form/specimen/photo
Location/Directions	Beatton River area, E of Ft. St. John	Beatton River area, E of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Leahy Pit area, E. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Beatton River area, E of Ft. St. John	Upper Halfway River area, W. of Ft. St. John	Upper Halfway River area, W. of Ft. St. John
Habitat type	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe	Grassland/shrub steppe
Habitat	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	south-facing grassland slope	remnant grassland verge	south-facing grassland slope	open grassland slope	open grassland slope
Associated spp.	Poa pratensis, (Hesperostipa curtiseta	Poa pratensis, Hesperostipa curtiseta, Antennaria cf rosea, Comandra umbellata	Comandra umbellata, Amelanchier alnifolia, Allium cernuum, Carex obtusata, Orthocarpus luteus, Elymus glaucus	Hesperostipa curtiseta, Comandra umbellata	Hesperostipa curtiseta	Hesperostipa curtiseta, Allium cernuum, Achillea millefolium, Comandra umbellata	Hesperostipa curtiseta, Elymus glauca	Hesperostipa curtiseta	Hesperostipa curtiseta	Potentilla hippiana	Hesperostipa curtiseta, Antennaria cf rosea, Comandra umbellata	Poa pratensis, Amelanchier alnifolia, Rosa acicularis, Stellaria longipes, Festuca rubra, Campanula rotundifolia, Achnatherum nelsonii, Koeleria macrantha	none recorded
***Landowner Name**	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	Crown	pipeline ROW	Crown	Crown	Crown
***Landowner permissions**	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Permission to survey/collect/share	Landowner name unknown	Permission to survey/collect/share	Permission to survey/collect/share data obtained	Permission to survey/collect/share data
Survey Date (yyyy/mm/dd)	8/12/2016	8/12/2016	8/13/2016	8/13/2016	8/13/2016	8/16/2016	8/16/2016	8/16/2016	8/16/2016	8/14/2016	8/12/2016	8/14/2016	8/14/2016
Zone	10	10	10	10	10	10	10	10	10	10	10	10	10
Easting	645484	646026	652770	652744	652898	653474	653556	653863	653881	583580	645535	583300	583298
Northing	6238871	6238793	6223893	6223962	6224044	6223716	6223786	6223708	6223697	6250504	6238501	6250543	6250570
Source for coordinate	GPS	GPS	GPS	GPS	Google Earth	GPS	GPS	GPS	GPS	Google Earth	GPS	GPS	GPS
Waypoint numbers (if applicable)	15	20	50	53		81	91	103	105		43	61	65
# of Individuals (exact)	about 10	5	>20	10		3	5	2	6		2	8	2
# of Individual (range estimates)	1- 50		1- 50		1- 50					50-250			
Area Occupied: Length (m)	1	2	5	2	1	2	8	3	1	200	0.5	3	0.25
Area Occupied: Width (m)	1	1	2	2	1	2	2	2	1	20	0.1	0.5	0.25
Area Occupied (m^2)	1	2	10	4	1	4	16	1	1	4000	0.05	1.5	0.0625
Description of Area Occupied	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat	scattered in area of suitable habitat
Condition of Population (& potential threats to plants within occupied area)	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; probable disturbance by vehicles and ROW clearing; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting	excellent condition; no threats; fruiting
Condition of Landscape (& potential threats at landscape level)	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats	excellent condition; probable disturbance by vehicles and ROW clearing	excellent condition; no threats	excellent condition; no threats	excellent condition; no threats
Recent (20-40 yrs) Landscape Disturbance	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing	Other	Grazing	Grazing	Grazing
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Elevation (m)	624	595	567	579	605	543	555	581	577	810	601	834	841
Slope (%)													
Slope (°)	15	15	15	15	15	15	15	15	15	0	15	15	15
Aspect	south-east	south	south	south	south	south	south	south	south	none	south	south	south
Crown closure	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Slope Position	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Upper slope	Crest	Upper slope	Upper slope	Upper slope
Moisture	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Very dry	Mesic(moist)	Very dry	Very dry	Very dry
Substrate/soil	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	compact sandy-silt	silty loam	compact sandy-silt	compact sandy-silt	compact sandy-silt
General Notes	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed	probably more plants along slope; the plants were almost finished (dried up) so many were probably missed		probably more plants along slope; the plants were almost finished (dried up) so some were probably missed	probably more plants along slope; the plants were almost finished (dried up) so some were probably missed	probably more plants along slope; the plants were almost finished (dried up) so some were probably missed
Collector name (if different from observer)													
Herbarium and Specimen Collection #	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	no specimen collected	to be deposited into UBC	to be deposited into UBC	to be deposited into UBC	no specimen collected
Plot # (if applicable)													
Photo details	available			available		available						available	

Appendix 12

Songbird Survey Report

Site C Clean Energy Project
Breeding Bird Follow-up Monitoring
2016 Annual Report

PRESENTED TO
BC Hydro and Power Authority

2017-02-06T00:00:00
ISSUED FOR REVIEW
FILE: 704-ENV.VENV03095-01.002

This "Issued for Review" document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an "Issued for Use" document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the "Issued for Review" document should be either returned to Saulteau EBA Environmental Services Joint Venture or destroyed.

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 2016 Annual Report

FILE: 704-ENV.VENV03095-01.002
January 11, 2017

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Operations Manager, SEES JV

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 2016. The surveys were part of BC Hydro's Breeding Bird Follow-up Monitoring Program. The breeding birds covered by this monitoring program component is focussed on passerines (songbird perching birds), hummingbirds, swifts, doves, kingfisher, and pigeons (all members of the orders *Passeriformes*, *Apodiformes*, *Columbiformes*, and *Coraciiformes*) and are collectively referred to in this program as songbirds. This report describes the methods used to conduct the surveys and provides a summary of the results.

Birds were surveyed using 100 m fixed-radius point counts conducted May 11 to July 9, 2016. Survey stations were located within three zones: Upstream Peace River Valley, Downstream Peace River Valley and Plateau (the area between the Upstream Peace River Valley and the transmission line). Stations were stratified by Broad Habitat Mapping unit. Surveys were conducted at 143 stations and 275 surveys were conducted, including revisits to the same stations.

A total of 2049 birds of 68 songbird species were recorded during the point count surveys. The Upstream Valley had the largest number of species and the highest average station species richness; the Plateau had the lowest. Nine 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. Point count stations were located within two of three BC Hydro Compensation properties. Surveys in the Marl Fen property and the Wilder Creek property found 27 and 34 songbird species respectively.

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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 2016. 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 surveys and provides a summary of the results.

The breeding birds covered by this monitoring program component is focussed on passerines (songbird perching birds), hummingbirds, swifts, doves, kingfisher, and pigeons (all members of the orders *Passeriformes*, *Apodiformes*, *Columbiformes*, and *Coraciiformes*) and are collectively referred to in this program as songbirds. Other bird species were recorded as incidental observations and are provided in Appendix B.

2.0 METHODS

2.1 Study Area

The boundary of the Breeding Bird Follow-up Monitoring Study Area (Figure 1) was defined as follows:

- Three kilometre buffer on the Peace River plus the transmission line.
- Includes the area between the transmission line and the Peace River.
- Includes the Marl Fen compensation property (which is greater than 3 km from the Peace River).
- A portion of the south boundary follows the Pine River rather than the 3 km buffer in order to avoid cutting the river with the boundary.

The Study Area was comprised of three sub areas:

- Upstream Valley: The Peace River valley upstream of the dam (the lowland areas along the Peace River and on valley slopes) to Hudson's Hope.
- Downstream Valley: The Peace River valley downstream of the dam to the Alberta border.
- Plateau: The area outside of the Peace River valley between Hudson's Hope and the Alberta border.

Figure 1. Breeding Bird Follow-up Monitoring Study Area and point count station locations.

2.2 Selection of Survey Station Locations

Candidate survey stations were preselected in advance of the field surveys. Approximately 68 candidate stations were identified in each of the three sub areas. Within each sub area, station locations were stratified by habitat. The Broad Habitat Mapping that was developed for the Site C Environmental Impact Statement (see Hilton *et al.* 2012a) was selected because it covers the entire Study Area. The Broad Habitat Mapping units are:

- **Aspen shrubland**: xeric to submesic aspen forests on warm aspects.
- **Grassland**: xeric to submesic sparsely vegetated warm aspect sites with no trees.
- **Cultivated fields**: areas under agricultural cultivation.
- **Wetland**: level to depressional wetlands dominated with extensive herbaceous or shrubby vegetation.
- **Riparian forest**: submesic to hygric level or gently sloping forests, sometimes associated with medium bench floodplains
- **Riparian wetland**: low bench floodplain with coarse to fine-textured fluvial soils.
- **Forested wetland**: subhygric to hydric forested sites with deep peaty soils.
- **Upland forest seral**: subxeric to subhygric aspen forested sites.
- **Upland forest non-seral**: subxeric to subhygric coniferous forested sites.

Selection of an equal number of survey locations within each Broad Habitat Mapping unit was initially attempted but was not possible as some units in some sub areas are small in area, absent, or are inaccessible. Stations locations were generally located along transects so that a series of stations could be sampled by foot. Stations were located to be accessible by automobile, by boat along the Peace River and by foot.

2.3 Bird Surveys

Birds were surveyed using 100m fixed-radius point counts conducted according to Resources Information Standards Committee (Resources Inventory Committee 1999). Surveys were conducted May 11 to July 9, 2016 by two biologists with extensive experience with bird point count surveys (Appendix B). Surveys took place from sunrise to approximately four hours after sunrise in suitable weather only (wind up to light breeze and precipitation up to light drizzle).

At each station, the surveyors waited at least one minute upon arriving, then commenced a five minute survey recording all birds observed and/or heard. Species, number of individuals, and distance from station centre were recorded. Detections outside the 100 m survey radius were recorded as incidental observations. Data was recorded on a standardized data form. In addition to bird observations, time of day, weather conditions and Broad Habitat Mapping unit was recorded and site photographs taken.

Stations were initially intended to be surveyed three times (early-May, late-May/early-June and late-June/early-July) in order to maximise the potential to encounter all birds present over the breeding season. Due to property access limitations, inaccessibility, and poor weather, some stations were surveyed once (see Appendix A).

The results of multiple visits at each station were pooled using maximum detection (the largest number of each species found over all 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.

3.0 RESULTS

3.1 Surveys

A summary of the number of point count stations surveyed and the total number of point counts conducted, including revisits is provided below (Table 1). Point count station locations are shown in Figure 1. Point count station information and dates of point counts are provided in Appendix A. Approximately 40% of stations were surveyed once and 60% more than once in 2016.

Survey production rate in 2016 was affected by:

- Timing of obtaining property access permissions from private landowners and crown land leaseholders.
- Inability to access preselected stations due to difficult or unsafe terrain, poor road conditions and long walking distances.
- Unsuitable weather conditions for completing point count surveys (rain and snow) in May and early June.
- Forest fire restrictions associated with high forest danger ratings and local forest fires.

Table 1. Number of point count stations established and number of point counts conducted

Sub Area	Number of Stations	Number of Point Counts
Upstream Valley	62	152
Downstream Valley	40	74
Plateau	41	49
Total	**143**	**275**

The number of stations surveyed in each Broad Habitat Mapping unit by sub area is provided below (Table 2). The fewest surveys were conducted in Forested Wetlands due to their limited distribution and access difficulty followed by Upland Forest Non-seral. Much of the conifer-dominated forest stands are on the south side of the Peace River where there are few roads to provide access. These stands are also located too far upslope to efficiently access them from the river.

Table 2. Number of point count stations in each Broad Habitat Mapping unit.

Broad Habitat Mapping Unit	Upstream Valley	Downstream Valley	Plateau	Total
Aspen Shrubland	5	8	5	**18**
Cultivated Field	9	3	1	**13**
Forested Wetland	1	0	1	**2**
Grassland	10	0	7	**17**
Riparian Forest	12	8	6	**26**
Riparian Wetland	9	9	0	**18**
Upland Forest Non-seral	3	5	1	**9**
Upland Forest Seral	5	6	4	**15**
Wetland	8	1	16	**25**
Total	**62**	**40**	**41**	**143**

3.2 Birds

A total of 2049 birds of 68 species were recorded during the point count surveys (excluding incidental species outside survey times, in between survey stations, or flying over the station; Table 3).

Table 3. Point count survey summary.

Metric	Upstream Valley	Downstream Valley	Plateau	Total
Number of Survey Stations	62	40	41	143
Number of Point Counts	152	74	49	275
Total Number of Species	62	50	44	68
Number of Species of Management Concern	7	6	3	9
Total Birds Observed (based on maximum count)	1100	579	370	2049
Mean Species Richness per Station	11.9	10.5	7.7	10.2
Mean Abundance per Station	17.7	14.5	9.0	14.3

The songbird species observed during the 2016 point count surveys are provided below (Table 4). The 10 most common species, in descending order of incidence frequency, were:

- White-throated Sparrow (*Zonotrichia albicollis*) – 114
- American Robin (*Turdus migratorius*) – 90
- Yellow Warbler (*Setophaga petechial*) – 89
- Red-eyed Vireo (*Vireo olivaceus*) – 81
- Swainson's Thrush (*Catharus ustulatus*) – 65
- Least Flycatcher (*Empidonax minimus*) – 57
- Common Raven (*Corvus corax*) – 57
- Cedar Waxwing (*Bombycilla cedrorum*) – 57
- Hermit Thrush (*Catharus guttatus*) – 53
- Clay-colored Sparrow (*Spizella pallida*) – 50

Species of Management Concern were considered those species listed under British Columbia's Red/Blue list, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and *Species at Risk Act* (SARA). Nine of the thirteen Species of Management Concern that have been recorded in previous surveys in the region were found during the 2016 surveys.

Table 4. Bird species observed during the 2016 point count surveys.

Total abundance and incidence frequency are listed for each sub area. For stations surveyed more than once, total abundance was calculated as the maximum count of each species over all surveys. Incidence frequency is the number of stations in which the species occurred. Species are listed in taxonomic order. (UV = Upstream Valley; DV = Downstream Valley; PL = Plateau)

English Name	Scientific Name	BC List	COSEWIC/ SARA[1]	Total Station Abundance				Station Incidence Frequency			
				UV	DV	PL	Total	UV	DV	PL	Total
Mourning Dove	*Zenaida macroura*	Yellow		1			**1**	1			**1**
Olive-sided Flycatcher	*Contopus cooperi*	Blue	Threatened/ Schedule 1 Threatened	8		4	**12**	8		4	**12**
Western Wood-Pewee	*Contopus sordidulus*	Yellow		10		5	**15**	10		5	**15**
Alder Flycatcher	*Empidonax alnorum*	Yellow		33	8	2	**43**	31	8	2	**41**
Hammond's Flycatcher	*Empidonax hammondii*	Yellow		3			**3**	2			**2**
Least Flycatcher	*Empidonax minimus*	Yellow		20	24	30	**74**	18	21	18	**57**
Eastern Phoebe	*Sayornis phoebe*	Yellow		1			**1**	1			**1**
Eastern Kingbird	*Tyrannus tyrannus*	Yellow		1		3	**4**	1		3	**4**
Warbling Vireo	*Vireo gilvus*	Yellow		12	9	15	**36**	11	9	15	**35**
Red-eyed Vireo	*Vireo olivaceus*	Yellow		46	30	14	**90**	41	27	13	**81**
Blue-headed Vireo	*Vireo solitarius*	Yellow		11	3		**14**	11	3		**14**
American Crow	*Corvus brachyrhynchos*	Yellow		7			**7**	3			**3**
Common Raven	*Corvus corax*	Yellow		110	22	3	**135**	38	16	3	**57**
Blue Jay	*Cyanocitta cristata*	Yellow		7		1	**8**	6		1	**7**
Gray Jay	*Perisoreus canadensis*	Yellow		7		5	**12**	5		5	**10**
Black-billed Magpie	*Pica hudsonia*	Yellow		13	4		**17**	9	3		**12**
Cedar Waxwing	*Bombycilla cedrorum*	Yellow		33	31	15	**79**	28	17	12	**57**

English Name	Scientific Name	BC List	COSEWIC/ SARA[1]	Total Station Abundance				Station Incidence Frequency			
				UV	DV	PL	Total	UV	DV	PL	Total
Black-capped Chickadee	*Poecile atricapillus*	Yellow		9	9	5	**23**	8	6	4	**18**
Boreal Chickadee	*Poecile hudsonicus*	Yellow			4		**4**		1		**1**
Barn Swallow	*Hirundo rustica*	Blue			3		**3**		1		**1**
Tree Swallow	*Tachycineta bicolor*	Yellow		15	23	10	**48**	8	4	7	**19**
Violet-green Swallow	*Tachycineta thalassina*	Yellow		1	1		**2**	1	1		**2**
Ruby-crowned Kinglet	*Regulus calendula*	Yellow		6	1	2	**9**	6	1	2	**9**
Marsh Wren	*Cistothorus palustris*	Yellow		1			**1**	1			**1**
Red-breasted Nuthatch	*Sitta canadensis*	Yellow		4	3		**7**	4	3		**7**
House Wren	*Troglodytes aedon*	Yellow		3	4	1	**8**	2	4	1	**7**
Winter Wren	*Troglodytes hiemalis*	Blue		1	2		**3**	1	1		**2**
Gray Catbird	*Dumetella carolinensis*	Yellow		6			**6**	6			**6**
Hermit Thrush	*Catharus guttatus*	Yellow		32	14	11	**57**	29	14	10	**53**
Swainson's Thrush	*Catharus ustulatus*	Yellow		22	25	29	**76**	21	19	25	**65**
American Robin	*Turdus migratorius*	Yellow		60	39	24	**123**	49	24	17	**90**
Wilson's Warbler	*Cardellina pusilla*	Yellow		4	4	1	**9**	4	4	1	**9**
MacGillivray's Warbler	*Geothlypis tolmiei*	Yellow		1			**1**	1			**1**
Common Yellowthroat	*Geothlypis trichas*	Yellow		16	7	14	**37**	14	6	12	**32**
Black-and-white Warbler	*Mniotilta varia*	Yellow		14	7	1	**22**	13	7	1	**21**
Connecticut Warbler	*Oporornis agilis*	Blue		5	2	1	**8**	5	2	1	**8**
Orange-crowned Warbler	*Oreothlypis celata*	Yellow		5	5	5	**15**	4	5	5	**14**
Tennessee Warbler	*Oreothlypis peregrina*	Yellow				1	**1**			1	**1**

English Name	Scientific Name	BC List	COSEWIC/ SARA[1]	Total Station Abundance				Station Incidence Frequency			
				UV	DV	PL	Total	UV	DV	PL	Total
Northern Waterthrush	*Parkesia noveboracensis*	Yellow		12	4	6	**22**	11	4	6	**21**
Ovenbird	*Seiurus aurocapilla*	Yellow		12	14	7	**33**	11	11	7	**29**
Bay-breasted Warbler	*Setophaga castanea*	Red		1			**1**	1			**1**
Yellow-rumped Warbler	*Setophaga coronata*	Yellow		13	8	4	**25**	12	7	3	**22**
Magnolia Warbler	*Setophaga magnolia*	Yellow		6	2	4	**12**	6	2	3	**11**
Yellow Warbler	*Setophaga petechia*	Yellow		52	40	28	**120**	41	29	19	**89**
American Redstart	*Setophaga ruticilla*	Yellow		24	20	4	**48**	22	18	4	**44**
Cape May Warbler	*Setophaga tigrina*	Blue		1	1	1	**3**	1	1	1	**3**
Black-throated Green Warbler	*Setophaga virens*	Blue		1	2		**3**	1	2		**3**
Red-winged Blackbird	*Agelaius phoeniceus*	Yellow		150	11	2	**163**	13	4	2	**19**
Brewer's Blackbird	*Euphagus cyanocephalus*	Yellow		1	5	5	**11**	1	4	2	**7**
Baltimore Oriole	*Icterus galbula*	Blue			4		**4**		4		**4**
Brown-headed Cowbird	*Molothrus ater*	Yellow		5	4	2	**11**	5	4	2	**11**
Western Meadowlark	*Sturnella neglecta*	Yellow			1		**1**		1		**1**
Dark-eyed Junco	*Junco hyemalis*	Yellow		13	8	4	**25**	11	4	3	**18**
Swamp Sparrow	*Melospiza georgiana*	Yellow		15		14	**29**	10		11	**21**
Lincoln's Sparrow	*Melospiza lincolnii*	Yellow		24	10	26	**60**	19	9	17	**45**
Song Sparrow	*Melospiza melodia*	Yellow		15	16		**31**	12	10		**22**
Savannah Sparrow	*Passerculus sandwichensis*	Yellow		19	12	2	**33**	13	8	1	**22**
Fox Sparrow	*Passerella iliaca*	Yellow			3		**3**		3		**3**
Vesper Sparrow	*Pooecetes gramineus*	Yellow		35	11	3	**49**	25	9	3	**37**

English Name	Scientific Name	BC List	COSEWIC/ SARA[1]	Total Station Abundance				Station Incidence Frequency			
				UV	DV	PL	Total	UV	DV	PL	Total
Clay-colored Sparrow	*Spizella pallida*	Yellow		46	27	4	**77**	29	19	2	**50**
Chipping Sparrow	*Spizella passerina*	Yellow		8	1	3	**12**	7	1	3	**11**
White-throated Sparrow	*Zonotrichia albicollis*	Yellow		76	50	38	**164**	53	33	28	**114**
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Yellow		10	13	9	**32**	10	12	7	**29**
Evening Grosbeak	*Coccothraustes vespertinus*	Yellow	Special Concern	1			**1**	1			**1**
Purple Finch	*Haemorhous purpureus*	Yellow		3			**3**	3			**3**
Red Crossbill	*Loxia curvirostra*	Yellow		3			**3**	2			**2**
Pine Siskin	*Spinus pinus*	Yellow		11	16		**27**	4	2		**6**
Western Tanager	*Piranga ludoviciana*	Yellow		15	12	2	**29**	15	11	2	**28**

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada. SARA – Species at Risk Act

3.3 Compensation Properties

Point count surveys were conducted in two of the three BC Hydro Compensation Properties: Marl Fen and Wilder Creek. Four point count stations were established in Marl Fen and 16 in Wilder Creek. No surveys were completed in the Rutledge Property. At the time of the 2016 survey program, the valley bottom portions of the Rutledge Property were recently tilled and offered very limited potential for nesting birds and were not surveyed. As well, the vegetated slopes in the northeast portion of the property were not surveyed because of access constraints. Further surveys of this property in 2017 must be a priority. The results of the Compensation Property surveys are provided below (Table 5).

Table 5. Bird species observed at the BC Hydro Compensation Properties during the 2016 songbird point count surveys.

Name	BC List	COSEWIC/ SARA	Total Station Abundance		Station Incidence Frequency	
			Marl Fen	Wilder Creek	Marl Fen	Wilder Creek
Olive-sided Flycatcher	Blue	Threatened/ Schedule 1 Threatened		2		2
Western Wood-Pewee	Yellow			2		2
Alder Flycatcher	Yellow		1	9	1	9
Eastern Phoebe	Yellow			1		1
Warbling Vireo	Yellow		3	2	3	2
Red-eyed Vireo	Yellow		3	15	3	15
Blue-headed Vireo	Yellow			4		4
Common Raven	Yellow		2	54	2	14
Gray Jay	Yellow		2		2	
Black-billed Magpie	Yellow			8		5
Cedar Waxwing	Yellow		2	5	2	5
Black-capped Chickadee	Yellow			1		1
Tree Swallow	Yellow		1	1	1	1
Violet-green Swallow	Yellow			1		1
Ruby-crowned Kinglet	Yellow		2		2	
House Wren	Yellow			3		2
Gray Catbird	Yellow			4		4
Hermit Thrush	Yellow		5	6	4	6
Swainson's Thrush	Yellow		4	2	3	2
American Robin	Yellow		3	13	3	12

Name	BC List	COSEWIC/ SARA	Total Station Abundance		Station Incidence Frequency	
			Marl Fen	Wilder Creek	Marl Fen	Wilder Creek
MacGillivray's Warbler	Yellow			1		1
Common Yellowthroat	Yellow		2		2	
Black-and-white Warbler	Yellow			1		1
Orange-crowned Warbler	Yellow		3	1	3	1
Northern Waterthrush	Yellow		2	2	2	1
Ovenbird	Yellow		1	1	1	1
Yellow-rumped Warbler	Yellow		2	1	2	1
Yellow Warbler	Yellow		1	17	1	13
American Redstart	Yellow			3		3
Red-winged Blackbird	Yellow		1	10	1	2
Brewer's Blackbird	Yellow		2		1	
Dark-eyed Junco	Yellow			1		1
Swamp Sparrow	Yellow		2		2	
Lincoln's Sparrow	Yellow		6		3	
Savannah Sparrow	Yellow		2	8	1	7
Vesper Sparrow	Yellow		1	25	1	16
Clay-colored Sparrow	Yellow		1	25	1	15
Chipping Sparrow	Yellow		2	1	2	1
White-throated Sparrow	Yellow		2	24	2	15
Rose-breasted Grosbeak	Yellow			1		1
Western Tanager	Yellow		1		1	

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada. SARA – Species at Risk Act

4.0 RECOMMENDATIONS

The songbird point count surveys conducted in 2016 are part of a long-term monitoring program. Surveys in future years should consider the following.

- Ground access by automobile was found to be very difficult in many areas. Future survey stations will need to be more carefully selected based on knowledge of access limitations gained in 2016. Increased use of boat and all-terrain vehicle (ATV) in some areas will be beneficial.
- Lack of or delayed permission to access private property and Crown lands limited the number of surveys that could be completed. While this challenge is likely to continue to some degree, earlier selection of candidate sampling areas and earlier contact with landowners/leaseholders will allow for better selection of alternate sampling areas if access is not granted.
- The Broad Habitat Mapping was found to be accurate when comparing the expected unit from the station preselection with the actual unit encountered during the surveys. However, the Broad Habitat Mapping units may be too broad to adequately capture the range of habitats that may be important to the distribution of songbirds. Future surveys should make use of the Terrestrial Ecosystem Mapping to stratify sampling. Furthermore, the ecosystem unit (as defined in the Terrestrial Ecosystem Mapping expanded legend) should be recorded for each future station based on completion of a ground observation form.

5.0 REFERENCES

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APPENDIX A

2016 POINT COUNT STATION AND SURVEY INFORMATION

Table A.1: Point count station locations, associated Broad Habitat Mapping unit and survey dates.

The Broad Habitat Mapping unit codes are as follows: AS, Aspen Shrubland, CF, Cultivated Field; FW, Forested Wetland; GR, Grassland; RF, Riparian Forest; RW, Riparian Wetland; UFN, Upland Forest Non-seral; UFS, Upland Forest Seral; WE, Wetland

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
001	10	684633	6225312	AS	26-May-16		
001A	10	684641	6225310	AS	11-Jun-16	29-Jun-16	
002	10	684633	6225312	AS	11-Jun-16	29-Jun-16	
002A	10	684386	6225079	AS	26-May-16		
003	10	684178	6224973	AS	11-Jun-16	29-Jun-16	
003A	10	684174	6224974	AS	26-May-16		
004	10	684044	6224818	AS	26-May-16	11-Jun-16	29-Jun-16
005	10	683805	6224720	AS	26-May-16	16-Jun-16	29-Jun-16
006	10	684271	6224579	RF	26-May-16	16-Jun-16	29-Jun-16
007	10	684034	6224424	RF	26-May-16	11-Jun-16	29-Jun-16
008	10	683753	6224343	RW	26-May-16	11-Jun-16	29-Jun-16
009	10	682746	6224238	UFN	26-May-16	16-Jun-16	29-Jun-16
013	10	682527	6224125	UFN	26-May-16	11-Jun-16	29-Jun-16
014	10	682337	6224022	UFN	26-May-16	11-Jun-16	29-Jun-16
015	10	681920	6224174	UFS	26-May-16	11-Jun-16	29-Jun-16
016	10	681842	6224068	UFN	26-May-16	11-Jun-16	29-Jun-16
017	10	677353	6222182	CF	26-May-16	11-Jun-16	29-Jun-16
018	10	676937	6221839	CF	26-May-16	29-Jun-16	
019	10	676590	6221685	CF	26-May-16	29-Jun-16	
023	10	653925	6221914	RW	04-Jul-16		
024	10	653673	6221840	RW	04-Jul-16		
025	10	653431	6221774	RW	04-Jul-16		
034	10	651971	6221396	RF	04-Jul-16		
036	10	651590	6221739	UFS	04-Jul-16		
037	10	651382	6221830	UFS	04-Jul-16		

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
039	10	648453	6223107	RW	04-Jul-16		
040	10	648209	6223117	RW	04-Jul-16		
041	10	647974	6223059	WE	04-Jul-16		
042	10	647680	6223327	RF	04-Jul-16		
043	10	647328	6223251	RF	04-Jul-16		
044	10	647004	6222938	RW	04-Jul-16		
045	10	646763	6222858	RW	04-Jul-16		
046	10	646546	6222966	RW	04-Jul-16		
047	10	643605	6222981	UFS	21-Jun-16	09-Jul-16	
048	10	643320	6222941	UFS	21-Jun-16	09-Jul-16	
049	10	642994	6222858	UFS	21-Jun-16	09-Jul-16	
050	10	643284	6223329	RF	21-Jun-16	09-Jul-16	
051	10	642650	6223586	RF	21-Jun-16	09-Jul-16	
052	10	642604	6223179	RF	21-Jun-16	09-Jul-16	
070	10	633644	6225669	GR	21-May-16		
071	10	633425	6225504	GR	21-May-16		
072	10	633187	6225400	GR	21-May-16		
073	10	632920	6225272	AS	21-May-16		
078	10	632712	6225018	GR	21-May-16		
079	10	632627	6224854	GR	21-May-16		
082	10	632406	6224646	AS	08-Jun-16		
083	10	632253	6224405	GR	08-Jun-16		
084	10	632251	6224226	AS	08-Jun-16		
085	10	632232	6224041	AS	08-Jun-16		
086	10	633307	6224037	RF	08-Jun-16		
087	10	632966	6223892	RF	08-Jun-16		
088	10	632465	6223776	AS	08-Jun-16		
089	10	633213	6223611	RF	08-Jun-16		
090	10	632854	6223611	RF	08-Jun-16		

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
091	10	633035	6223303	RF	08-Jun-16		
092	10	632728	6223242	RF	08-Jun-16		
093	10	624464	6233321	RF	14-Jun-16	05-Jul-16	
094	10	624125	6233165	RF	14-Jun-16	05-Jul-16	
095	10	623485	6233175	RW	14-Jun-16	05-Jul-16	
096	10	623253	6233071	RW	19-Jun-16	05-Jul-16	
097	10	622872	6232870	RF	14-Jun-16	05-Jul-16	
098	10	622564	6232711	RF	14-Jun-16	05-Jul-16	
099	10	621825	6232352	RF	14-Jul-16	05-Jul-16	
100	10	621341	6232351	RF	14-Jun-16	05-Jul-16	
101	10	620543	6232180	RW	14-Jun-16	05-Jul-16	
102	10	620408	6232155	RW	14-Jun-16	05-Jul-16	
103	10	620297	6232220	RW	14-Jun-16	05-Jul-16	
104	10	619872	6232162	RW	14-Jun-16	05-Jul-16	
105	10	618947	6231965	RF	14-Jun-16	05-Jul-16	
106	10	618619	6231982	RF	14-Jun-16	05-Jul-16	
107	10	618279	6232375	RW	06-Jul-16		
108	10	618055	6232385	RW	06-Jul-16		
109	10	617824	6232397	RW	06-Jul-16		
110	10	614796	6233381	UFN	06-Jul-16		
111	10	614548	6233560	UFN	06-Jul-16		
117	10	616801	6233677	CF	16-May-16	12-Jun-16	02-Jul-16
118	10	616296	6233911	CF	27-May-16	12-Jun-16	02-Jul-16
119	10	616061	6234137	CF	27-May-16	12-Jun-16	02-Jul-16
120	10	615867	6234298	CF	27-May-16	12-Jun-16	02-Jul-16
121	10	616001	6234780	GR	27-May-16	12-Jun-16	02-Jul-16
122	10	617217	6234328	GR	27-Jun-16	12-Jun-16	
123	10	617050	623443	GR	27-May-16	12-Jun-16	02-Jul-16
124	10	616914	6234542	GR	27-May-16	12-Jun-16	

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
125	10	616676	6234606	GR	27-May-16	12-Jun-16	02-Jul-16
126	10	616561	6234831	GR	27-May-16	12-Jun-16	02-Jul-16
127	10	616316	6234940	GR	27-May-16	12-Jun-16	02-Jul-16
138	10	607630	6236572	WE	11-May-16	17-Jun-16	01-Jul-16
139	10	607382	6236449	WE	11-May-16	17-Jun-16	01-Jul-16
140	10	607217	6236248	WE	11-May-16	17-Jun-16	01-Jul-16
141	10	607039	6236079	WE	11-May-16	17-Jun-16	01-Jul-16
142	10	606839	6235911	FW	11-May-16	17-Jun-16	01-Jul-16
143	10	606701	6235701	WE	11-May-16	17-Jun-16	01-Jul-16
144	10	606540	6235543	WE	11-May-16	17-Jun-16	01-Jul-16
145	10	605816	6234976	WE	18-May-16	17-Jun-16	01-Jul-16
146	10	605637	6234838	WE	18-May-16	17-Jun-16	01-Jul-16
157	10	597381	6231230	RF	11-May-16	10-Jun-16	28-Jun-16
158	10	597118	6231151	RF	11-May-16	10-Jun-16	28-Jun-16
159	10	595547	6230740	RF	18-May-16	10-Jun-16	28-Jun-16
160	10	595288	6230596	RF	18-May-16	10-Jun-16	28-Jun-16
161	10	593194	6229560	AS	18-May-16	10-Jun-16	28-Jun-16
162	10	593051	6229344	AS	18-May-16	10-Jun-16	28-Jun-16
163	10	592885	6229194	AS	18-May-16	10-Jun-16	28-Jun-16
164	10	592708	6229029	AS	18-May-16	10-Jun-16	
165	10	592512	6228878	AS	18-May-16	10-Jun-16	28-Jun-16
166	10	592373	6228544	CF	18-May-16	10-Jun-16	28-Jun-16
167	10	591934	6228293	CF	18-May-16	10-Jun-16	28-Jun-16
168	10	591639	6228060	CF	10-Jun-16		
197	10	581970	6220929	UFS	25-May-16	13-Jun-16	03-Jul-16
198	10	581765	6221264	UFS	25-May-16	13-Jun-16	03-Jul-16
199	10	581589	6220833	UFS	25-May-16	13-Jun-16	03-Jul-16
200	10	581389	6221230	UFS	25-May-16	13-Jun-16	03-Jul-16
202	10	564220	6212070	UFS	25-May-16	13-Jun-16	30-Jun-16

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
203	10	563622	6212058	CF	25-May-16	13-Jun-16	30-Jun-16
204	10	563441	6212263	WE	25-May-16	13-Jun-16	30-Jun-16
205	10	563116	6212142	GR	25-May-16	13-Jun-16	30-Jul-16
300	10	617774	6233789	GR	25-May-16	12-Jun-16	02-Jul-16
301	10	617550	6233972	GR	25-May-16	12-Jun-16	02-Jul-16
302	10	617396	6234135	GR	27-May-16	12-Jun-16	02-Jul-16
303	10	617303	6233642	CF	12-Jun-16	02-Jul-16	
304	10	617828	6233613	CF	27-May-16	12-Jun-16	02-Jul-16
305	10	643846	6222913	UFN	21-Jun-16	09-Jul-16	
306	10	597812	6234796	UFS	03-Jul-16		
307	10	597995	6234973	UFS	03-Jul-16		
308	10	598182	6235149	WE	03-Jul-16		
309	10	598375	6235325	WE	03-Jul-16		
310	10	598554	6235498	WE	03-Jul-16		
311	10	598745	6235677	UFS	03-Jul-16		
312	10	598921	6235837	FW	03-Jul-16		
313	10	599083	6235986	UFN	03-Jul-16		
314	10	615247	6233175	UFN	06-Jul-16		
315	10	615014	6233247	UFS	06-Jul-16		
316	10	622620	6221086	WE	07-Jul-16		
317	10	622629	6221328	WE	07-Jul-16		
318	10	622608	6221563	WE	07-Jul-16		
319	10	622584	6221806	WE	07-Jul-16		
320	10	622552	6222007	WE	07-Jul-16		
321	10	622597	6222252	WE	07-Jul-16		
322	10	622599	6222505	WE	07-Jul-16		
323	10	622630	6222755	WE	07-Jul-16		
324	10	622629	6222998	WE	07-Jul-16		
325	10	622665	6223252	WE	17-Jul-16		

Station	UTM Zone	UTM Easting	UTM Northing	Broad Habitat Mapping Unit	Date of First Survey	Date of Second Survey	Date of Third Survey
326	10	622521	6223469	WE	07-Jul-16		
327	10	622586	6223703	WE	07-Jul-16		

APPENDIX B
INCIDENTAL BIRD OBSERVATIONS

Table B.1: Incidental observations of birds recorded outside of point count surveys, beyond the 100m fixed station radius and species that are not songbirds. (UV = Upstream Valley; DV = Downstream Valley; PL = Plateau)

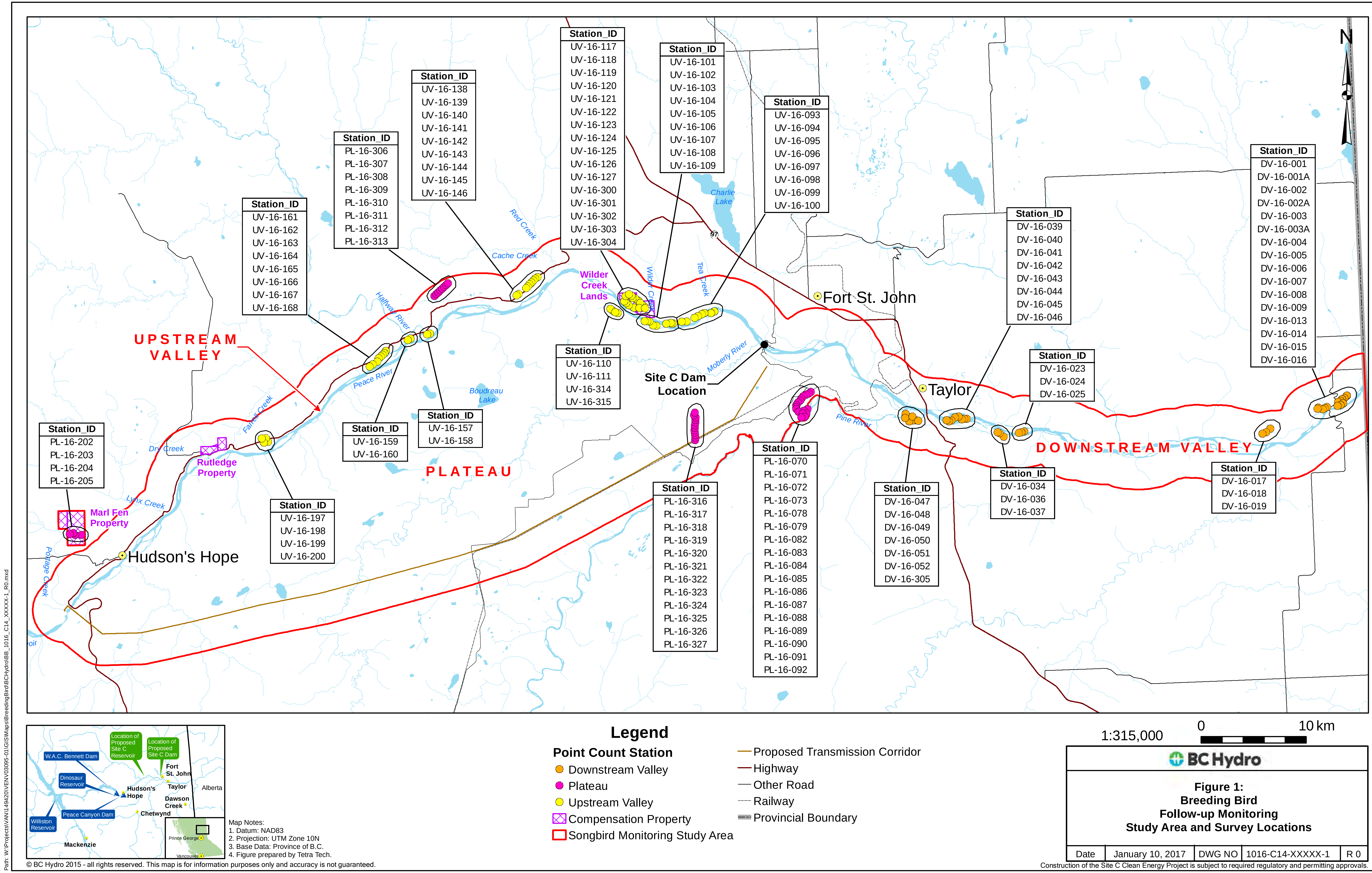
English Name	Scientific Name	Songbird	BC List	COSEWIC/ SARA [1]	UV	DV	PL
Ruffed Grouse	*Bonasa umbellus*	No	Yellow		8	2	4
American Wigeon	*Anas americana*	No	Yellow		6		
Green-winged Teal	*Anas crecca*	No	Yellow		4		
Cinnamon Teal	*Anas cyanoptera*	No	Yellow		1		
Blue-winged Teal	*Anas discors*	No	Yellow				5
Mallard	*Anas platyrhynchos*	No	Yellow		7		
Canada Goose	*Branta canadensis*	No	Yellow		13	12	1
Common Loon	*Gavia immer*	No	Yellow		1		
Northern Goshawk	*Accipiter gentilis*	No	Yellow		1		
Sharp-shinned Hawk	*Accipiter striatus*	No	Yellow		1		
Red-tailed Hawk	*Buteo jamaicensis*	No	Yellow			1	2
Bald Eagle	*Haliaeetus leucocephalus*	No	Yellow			1	
Sora	*Porzana carolina*	No	Yellow		13		
Sandhill Crane	*Antigone canadensis*	No	Yellow				2
Killdeer	*Charadrius vociferus*	No	Yellow			1	
American Avocet	*Recurvirostra americana*	No	Blue			1	
Spotted Sandpiper	*Actitis macularius*	No	Yellow		3	3	
Upland Sandpiper	*Bartramia longicauda*	No	Red				1
Wilson's Snipe	*Gallinago delicata*	No	Yellow		31		9
Solitary Sandpiper	*Tringa solitaria*	No	Yellow		1		6
Great Gray Owl	*Strix nebulosa*	No	Yellow		1		
Barred Owl	*Strix varia*	No	Yellow		1		
Common Nighthawk	*Chordeiles minor*	No	Yellow	Threatened / Schedule 1	1		
Northern Flicker	*Colaptes auratus*	No	Yellow		14	7	4

English Name	Scientific Name	Songbird	BC List	COSEWIC/ SARA [1]	UV	DV	PL
Pileated Woodpecker	*Dryocopus pileatus*	No	Yellow		2		
American Three-toed Woodpecker	*Picoides dorsalis*	No	Yellow				2
Downy Woodpecker	*Picoides pubescens*	No	Yellow		1	5	
Hairy Woodpecker	*Picoides villosus*	No	Yellow		1		
Yellow-bellied Sapsucker	*Sphyrapicus varius*	No	Yellow		20	12	11
Merlin	*Falco columbarius*	No	Yellow		3		
American Kestrel	*Falco sparverius*	No	Yellow		1		
Common Raven	*Corvus corax*	Yes	Yellow		1	3	1
Red-breasted Nuthatch	*Sitta canadensis*	Yes	Yellow		1		
Gray Catbird	*Dumetella carolinensis*	Yes	Yellow		10		
Hermit Thrush	*Catharus guttatus*	Yes	Yellow		1	1	
American Robin	*Turdus migratorius*	Yes	Yellow		1	2	
White-throated Sparrow	*Zonotrichia albicollis*	Yes	Yellow		1		

APPENDIX C
PROJECT QUALIFIED ENVIRONMENTAL PROFESSIONALS

Name and Affiliation	Project Role
Jeff Matheson, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Project manager, report author
Nick Bartok, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Technical advisor, senior reviewer
Kayla Hatzel, B.Sc., B.I.T. Tetra Tech Canada Inc.	Field data collection, data entry
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection

APPENDIX D
GENERAL CONDITIONS



N
Station_ID
UV-16-117
UV-16-118
UV-16-119
UV-16-120
UV-16-121
UV-16-122
UV-16-123
UV-16-124
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UV-16-302
UV-16-303
UV-16-304
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UV-16-106
UV-16-107
UV-16-108
UV-16-109
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UV-16-095
UV-16-096
UV-16-097
UV-16-098
UV-16-099
UV-16-100
Station_ID
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UV-16-139
UV-16-140
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UV-16-145
UV-16-146
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PL-16-309
PL-16-310
PL-16-311
PL-16-312
PL-16-313
Station_ID
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UV-16-163
UV-16-164
UV-16-165
UV-16-166
UV-16-167
UV-16-168
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DV-16-002A
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DV-16-009
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DV-16-016
Station_ID
DV-16-039
DV-16-040
DV-16-041
DV-16-042
DV-16-043
DV-16-044
DV-16-045
DV-16-046
Charlie Lake
Red Creek
Cache Creek
Wilder Creek Lands
Wilder Creek
Tea Creek
Fort St. John
Halfway River
UPSTREAM VALLEY
Station_ID
UV-16-110
UV-16-111
UV-16-314
UV-16-315
Site C Dam Location
Moberly River
Taylor
Station_ID
DV-16-023
DV-16-024
DV-16-025
Peace River
Boudreau Lake
Farrell Creek
Station_ID
UV-16-157
UV-16-158
Station_ID
UV-16-159
UV-16-160
Pine River
Station_ID
PL-16-202
PL-16-203
PL-16-204
PL-16-205
Dry Creek
Rutledge Property
PLATEAU
DOWNSTREAM VALLEY
Station_ID
PL-16-070
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PL-16-072
PL-16-073
PL-16-078
PL-16-079
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PL-16-092
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DV-16-018
DV-16-019
Lynx Creek
Station_ID
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UV-16-198
UV-16-199
UV-16-200
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PL-16-322
PL-16-323
PL-16-324
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PL-16-326
PL-16-327
Station_ID
DV-16-047
DV-16-048
DV-16-049
DV-16-050
DV-16-051
DV-16-052
DV-16-305
Marl Fen Property
Hudson's Hope
Portage Creek
97
W.A.C. Bennett Dam
Location of Proposed Site C Reservoir
Location of Proposed Site C Dam
Fort St. John
Dinosaur Reservoir
Hudson's Hope
Taylor
Alberta
Dawson Creek
Peace Canyon Dam
Chetwynd
Williston Reservoir
Mackenzie
Prince George
Vancouver
Legend
Point Count Station
Downstream Valley
Plateau
Upstream Valley
Compensation Property
Songbird Monitoring Study Area
Proposed Transmission Corridor
Highway
Other Road
Railway
Provincial Boundary
Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Figure prepared by Tetra Tech.
1:315,000
0
10 km
BC Hydro
Figure 1:
Breeding Bird
Follow-up Monitoring
Study Area and Survey Locations
Date
January 10, 2017
DWG NO
1016-C14-XXXXX-1
R 0
Path: W:\Projects\VAN\149420\VENV03095-01\GIS\Maps\BreedingBird\BCHydroBB_1016_C14_XXXXX-1_R0.mxd
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Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Appendix 13

Ground Nesting Raptor Survey Report

Site C Clean Energy Project
Ground Nesting Raptor Monitoring
2016 Annual Report

PRESENTED TO

BC Hydro and Power Authority

JANUARY 13, 2017
ISSUED FOR REVIEW
FILE: 704-ENV.VENV03095-01.002

This "Issued for Review" document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an "Issued for Use" document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the "Issued for Review" document should be either returned to Saulteau EBA Environmental Services Joint Venture or destroyed.

Saulteau EBA Environmental Services Joint Venture.
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Edmonton, AB T5V 1B4 CANADA
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Site C Clean Energy Project Ground Nesting Raptor Monitoring – 2016 Annual Report

FILE: 704-ENV.VENV03095-01.001
January 13, 2017

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Authorized by:

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Operations Manager, SEES JV

EXECUTIVE SUMMARY

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground nesting raptors (Short-eared Owl [*Asio flammeu]* and Northern Harrier [*Circus cyaneus*]) in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2016. The surveys were part of BC Hydro's Ground Nesting Raptor Follow-up Monitoring Program. This report describes the methods used to conduct the surveys and provides a summary of the results.

The ground nesting surveys were completed in three BC Hydro compensation properties (Marl Fen, Rutledge Property and Wilder Creek). Surveys were also intended to be completed in cleared portions of the Site C dam headpond area however no clearing had occurred prior to the 2016 surveys.

Ground nesting raptor surveys were completed three times between May and June 2016. The surveys were conducted using a combination of encounter transects walked on foot and stationary standwatches. Ground nesting raptors were observed at each of the three properties. One Short-eared Owl was observed at Marl Fen. The remaining observations were Northern Harrier: six at Marl Fen and one observation each at Rutledge and Wilder Creek. No nests or evidence of nesting were observed.

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1.0 INTRODUCTION

Saulteau EBA Environmental Services Joint Venture (SEES JV) completed surveys of ground nesting raptors in the area of BC Hydro and Power Authority's (BC Hydro) Site C Clean Energy Project ("Site C") in spring and summer 2016. The surveys were part of BC Hydro Ground Nesting Raptor Follow-up Monitoring Program (BC Hydro 2016). This report describes the methods used to conduct the surveys and provides a summary of the results.

The Ground Nesting Raptor Follow-up Monitoring Program is specifically focussed on two ground nesting raptor species: Short-eared Owl (*Asio flammeus)* and Northern Harrier (*Circus cyaneus)* (Table 1). Other species were recorded during surveys and are reported in Appendix A.

Table 1. Species covered in the Ground Nesting Raptor Follow-up Monitoring program.

Common Name	Scientific Name	BC List	COSEWIC [1] Status	SARA [2] Status
Short-eared Owl	*Asio flammeus*	Blue	Special Concern	Schedule 1 – Special Concern
Northern Harrier	*Circus cyaneus*	Yellow	-	-

[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada.
[2] SARA – *Species at Risk Act*.

The objectives of the ground nesting raptor monitoring program are to determine:

- The number of Northern Harrier and Short-eared Owl nesting in areas cleared within the construction headpond during construction prior to reservoir filling;
- The effects of seasonal headpond flooding on Northern Harrier and Short-eared Owl nests; and
- Use of open fields within mitigation properties being managed to provide nesting habitat for Northern Harrier and Short-eared Owl.

This document reports on the ground nesting raptor surveys that were conducted in 2016.

2.0 METHODS

2.1 Survey Areas

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

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

No clearing was conducted in the headpond area prior to the 2016 surveys and ground nesting raptor surveys within the reservoir were therefore not conducted. Surveys were completed in the three compensation properties (Figure 1).

Figure 1. Ground Nesting Raptor Follow-up Monitoring Survey Locations in 2016.

2.2 Ground-Nesting Raptor Surveys

Ground nesting raptors were surveyed three times between May and June 2016. The surveys were conducted using a combination of encounter transects walked on foot and stationary standwatches. Methods followed *Inventory Methods for Raptors* (Resources Inventory Committee 2001).

The surveys along transects were conducted by walking at a speed of 0.5 – 2 km/hr, looking and listening for birds. Surveyors stopped whenever required in order to confirm identification and to record data. The walking transects were located only in suitable habitat (old pastures, old field, hayfields, grasslands, bogs and marsh). Surveyors walked in such a way to ensure visual coverage of the entire portion of suitable habitat in each property. Surveyors were not required to walk the precise transect as walked in previous visits.

The standwatch stations were located along the walking transects and also only in suitable habitat. The standwatches served three purposes:

- Allowed surveyors to observe areas for longer periods to increase the potential to observe bird activity;
- Allowed surveyors to carefully observe areas that cannot be visited by foot due to impassable terrain using binoculars and spotting scope; and
- To monitor potential nesting behaviour for the purpose of locating nests of Short-eared Owl and Northern Harrier.

Standwatches were conducted by remaining stationary for approximately 20 minutes. All surveys were conducted during daylight hours. Surveys were not completed during periods of high wind (greater than Beaufort 3, 12 – 19 km/hr), rain or fog. The order that the stations were visited were different on each of the three survey days.

For all raptor observations, species, sex, age, activity, distance and compass direction were recorded. Other species were recorded as incidental observations. For Northern Harrier or Short-eared Owl observations, if a pair was observed or there was evidence of nesting behaviour, a nest search was to be conducted to attempt to locate any nest that might be present in the area. Since ground nesting raptors are sensitive to disturbance and ground nests can easily be destroyed by human traffic, surveyors were instructed to observe rather than conduct intensive foot searches to locate a nest.

Surveys were completed by two teams of two observers. Each team was composed of a biologist with raptor survey experience and an assistant.

3.0 RESULTS

3.1 Surveys

The survey dates for each property are provided below (Table 2).

Table 2. Survey dates for ground-nesting raptors.

Visit	Marl Fen	Rutledge Property	Wilder Creek
First Visit	May 7, 2016	May 8, 2016	May 10, 2016
Second Visit	May 23, 2016	May 22, 2016	May 24, 2016
Third Visit	June 18-19, 2016	June 19, 2016	June 20, 2016

The Global Positioning System (GPS) tracks for each walking transect and the standwatch station locations are shown in Figures 1, 2, and 3. Not all standwatch stations were initially surveyed; after the first visit to each property, surveyors added new standwatches to provide better observational coverage. The standwatch stations and their visit dates are provided below (Table 3).

3.2 Ground Nesting Raptors

Ground nesting raptors were observed at each of the three properties (Table 4 and Figures 2, 3 and 4). One Short-eared Owl was observed at Marl Fen. The remaining observations were Northern Harrier: six at Marl Fen and one each at Rutledge and Wilder Creek. No nests were observed and no courtship or nesting behaviours were observed.

Table 3. Standwatch stations with number of visits for each property.

Standwatch Station	Visit 1	Visit 2	Visit 3
Marl Fen			
MFSW01	X	X	X
MFSW02	X	X	X
MFSW03	X	X	X
MFSW04	X	X	X
MFSW05		X	X
MFSW06		X	X
MFSW07		X	X
MFSW08		X	X
MFSW09		X	X
MFSW10		X	X
Rutledge			
RUSW01	X	X	X
RUSW02	X	X	X
RUSW03	X	X	X
RUSW04		X	X
RUSW05		X	X
RUSW06		X	X
RUSW07		X	X
RUSW08		X	X
Wilder Creek			
WCSW01	X	X	X
WCSW02	X	X	X
WCSW03	X		X
WCSW04	X	X	
WCSW05		X	X
WCSW06			X
WCSW07			X
WCSW08			X

Table 4. Ground nesting raptor observations.

Location	Species	Date	Activity	Sex	Age Class	Comments
Marl Fen	Short-eared Owl	23-May-2016	Flushed	Female	Adult	Flushed from grass. No obvious nest detected - likely day roost. Flew to forest to east. Watched for half hour but did not return to site.
Marl Fen	Northern Harrier	7-May-2016	Foraging	Unknown	-	-
Marl Fen	Northern Harrier	23-May-2016	Foraging	Female	Adult	Observed heading eastbound over tilled field.
Marl Fen	Northern Harrier	23-May-2016	Foraging	Male	Adult	Foraging over fallow fields.
Marl Fen	Northern Harrier	23-May-2016	Foraging	Female	Adult	Hunting eastbound then flew over forest and began soaring.
Marl Fen	Northern Harrier	18-Jun-2016	Foraging	Female	Adult	Foraging over field then flew east.
Marl Fen	Northern Harrier	19-Jun-2016	Foraging	Male	Adult	Observed foraging around eastern and north side of property for 15 minutes then flew west.
Rutledge	Northern Harrier	22-May-2016	Foraging	Unknown	Adult	Hunted eastbound above field then flew up at treeline then began to soar approximately 500m above.
Wilder Creek	Northern Harrier	10-May-2016	Directional Flight	Female	Adult	Soaring at 30-45 m above ground level.

Figure 2. Marl Fen Property Ground Nesting Raptor Follow-up Monitoring Surveys

Figure 3. Rutledge Property Ground Nesting Raptor Follow-up Monitoring Surveys

Figure 4. Wilder Creek Property Ground Nesting Raptor Follow-up Monitoring Surveys

4.0 RECOMMENDATIONS

The ground nesting raptor surveys conducted in 2016 are part of a long-term monitoring program. Surveys in future years should consider the following:

- Surveys should begin in early April to capture the earlier part of the breeding season for Short-eared Owl and Northern Harrier.
- The standwatch stations should be surveyed in a different order for each visit in order to minimize the effect of time of day on raptor activity.

5.0 REFERENCES

BC Hydro. 2016. Ground Nesting Raptor Follow-up Monitoring Program Plan. Prepared for BC Hydro's Site C Clean Energy Project.

Resources Inventory Committee. 2001. Inventory Methods for Raptors. Standards for Components of British Columbia's Biodiversity No. 11. BC Ministry of Sustainable Resource Management, Environment Inventory Branch, Victoria, BC.

APPENDIX A
WILDLIFE OBSERVATIONS

Table A.1: List of all wildlife observed during ground nesting raptor surveys.

Common Name	Scientific Name	BC List	COSEWIC/ SARA [1]	Marl Fen	Rutledge	Wilder Creek
Amphibians						
Boreal Chorus Frog	*Pseudacris maculata*	Yellow		5		
Birds						
Ruffed Grouse	*Bonasa umbellus*	Yellow		4		2
American Wigeon	*Anas americana*	Yellow				2
Mallard	*Anas platyrhynchos*	Yellow		17		2
Canada Goose	*Branta canadensis*	Yellow		2	2	
Sharp-shinned Hawk	*Accipiter striatus*	Yellow		1		
Red-tailed Hawk	*Buteo jamaicensis*	Yellow		3	2	7
Northern Harrier	*Circus cyaneus*	Yellow		6	1	1
Bald Eagle	*Haliaeetus leucocephalus*	Yellow		1	2	
Killdeer	*Charadrius vociferus*	Yellow		1		
Upland Sandpiper	*Bartramia longicauda*	Red		3		
Wilson's Snipe	*Gallinago delicata*	Yellow		4		
Greater Yellowlegs	*Tringa melanoleuca*	Yellow		7		
Short-eared Owl	*Asio flammeus*	Blue	Special Concern/ Schedule 1	1		
Northern Flicker	*Colaptes auratus*	Yellow		2	6	2
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Yellow		1		
American Kestrel	*Falco sparverius*	Yellow		4	3	4
Olive-sided Flycatcher	*Contopus cooperi*	Blue	Threatened/ Schedule 1			1
Alder Flycatcher	*Empidonax alnorum*	Yellow		3	1	
Least Flycatcher	*Empidonax minimus*	Yellow			2	4
Warbling Vireo	*Vireo gilvus*	Yellow			5	
Red-eyed Vireo	*Vireo olivaceus*	Yellow		3	5	8
Blue-headed Vireo	*Vireo solitarius*	Yellow			2	

Common Name	Scientific Name	BC List	COSEWIC/ SARA [1]	Marl Fen	Rutledge	Wilder Creek
American Crow	*Corvus brachyrhynchos*	Yellow		2		
Common Raven	*Corvus corax*	Yellow		11	11	8
Blue Jay	*Cyanocitta cristata*	Yellow		1		
Black-billed Magpie	*Pica hudsonia*	Yellow		5	4	6
Cedar Waxwing	*Bombycilla cedrorum*	Yellow		1	2	6
Black-capped Chickadee	*Poecile atricapillus*	Yellow		1		1
Barn Swallow	*Hirundo rustica*	Blue	Threatened	3	1	
Tree Swallow	*Tachycineta bicolor*	Yellow		4	1	
Violet-green Swallow	*Tachycineta thalassina*	Yellow				2
Ruby-crowned Kinglet	*Regulus calendula*	Yellow		6		1
Hermit Thrush	*Catharus guttatus*	Yellow		7	5	2
Swainson's Thrush	*Catharus ustulatus*	Yellow		2		
Mountain Bluebird	*Sialia currucoides*	Yellow		2		
American Robin	*Turdus migratorius*	Yellow		11	13	7
Wilson's Warbler	*Cardellina pusilla*	Yellow		4	2	
Common Yellowthroat	*Geothlypis trichas*	Yellow		2		
Black-and-white Warbler	*Mniotilta varia*	Yellow		4	4	
Orange-crowned Warbler	*Oreothlypis celata*	Yellow		2	4	5
Tennessee Warbler	*Oreothlypis peregrina*	Yellow			1	
Northern Waterthrush	*Parkesia noveboracensis*	Yellow		9		
Ovenbird	*Seiurus aurocapilla*	Yellow		2	1	
Bay-breasted Warbler	*Setophaga castanea*	Red		1		
Yellow-rumped Warbler	*Setophaga coronata*	Yellow		7	4	2

Common Name	Scientific Name	BC List	COSEWIC/ SARA [1]	Marl Fen	Rutledge	Wilder Creek
Yellow Warbler	*Setophaga petechia*	Yellow		6	7	12
Cape May Warbler	*Setophaga tigrina*	Blue		1		
Red-winged Blackbird	*Agelaius phoeniceus*	Yellow				2
Brewer's Blackbird	*Euphagus cyanocephalus*	Yellow		1	2	
Dark-eyed Junco	*Junco hyemalis*	Yellow		1	3	
Swamp Sparrow	*Melospiza georgiana*	Yellow		1		
Lincoln's Sparrow	*Melospiza lincolnii*	Yellow		7	9	1
Song Sparrow	*Melospiza melodia*	Yellow			1	3
Savannah Sparrow	*Passerculus sandwichensis*	Yellow		23	12	11
Fox Sparrow	*Passerella iliaca*	Yellow				1
Vesper Sparrow	*Pooecetes gramineus*	Yellow				12
Clay-colored Sparrow	*Spizella pallida*	Yellow		6	14	14
Chipping Sparrow	*Spizella passerina*	Yellow		2	1	1
White-throated Sparrow	*Zonotrichia albicollis*	Yellow		2	10	10
Purple Finch	*Haemorhous purpureus*	Yellow			2	1
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Yellow		1	1	2
Western Tanager	*Piranga ludoviciana*	Yellow		1	1	1
Mammals						
Red Squirrel	*Tamiasciurus hudsonicus*	Yellow		1		
Coyote	*Canis latrans*	Yellow		2		
American Black Bear	*Ursus americanus*	Yellow				1
Moose	*Alces americanus*	Yellow		1		
Elk	*Cervus elaphus*	Yellow			1	
Mule Deer	*Odocoileus hemionus*	Yellow		3	2	
White-tailed Deer	*Odocoileus virginianus*	Yellow		1	1	

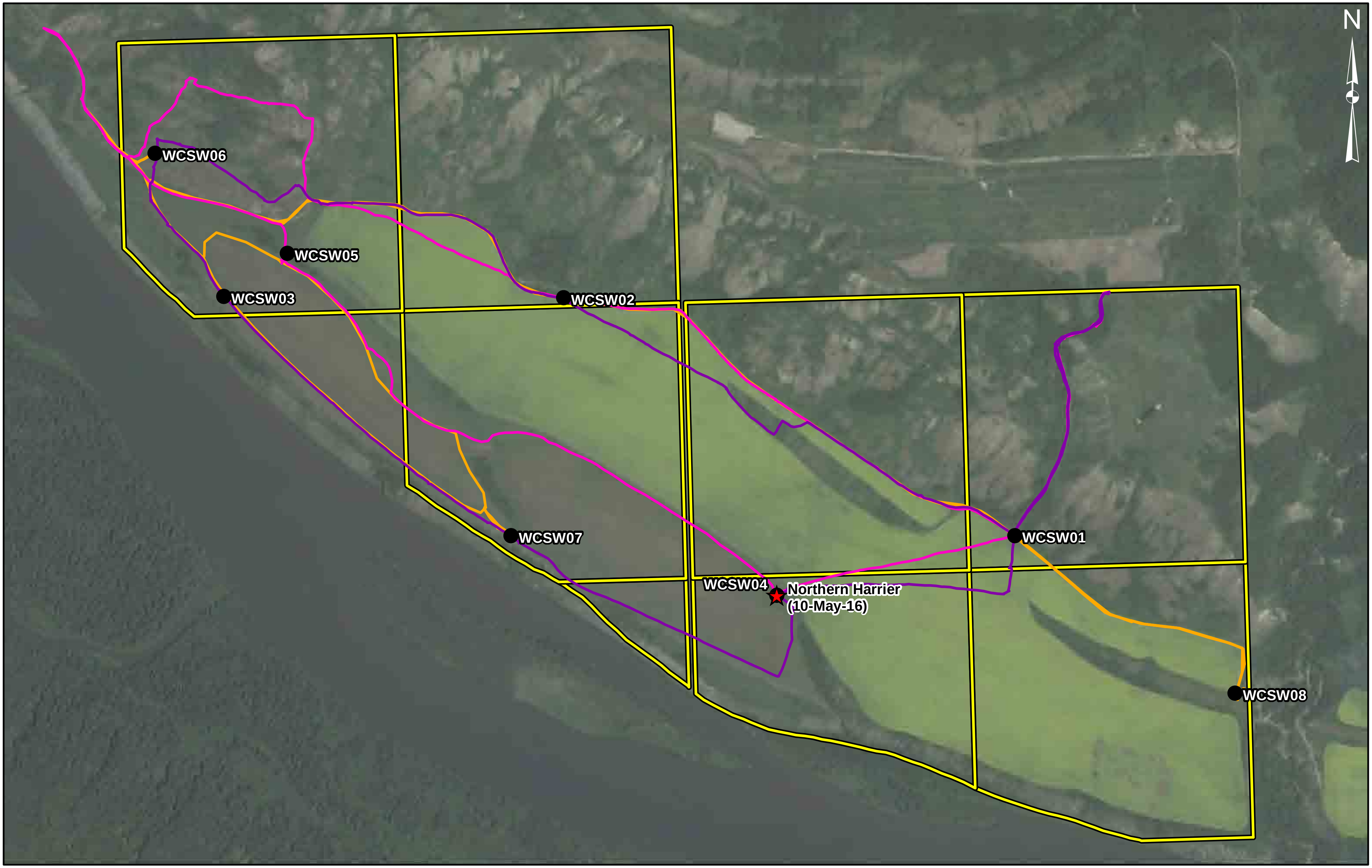
Common Name	Scientific Name	BC List	COSEWIC/ SARA [1]	Marl Fen	Rutledge	Wilder Creek

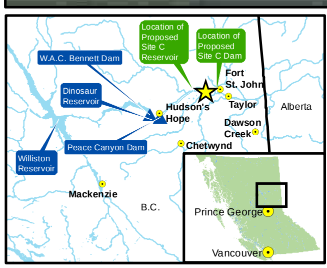
[1] COSEWIC – Committee on the Status of Endangered Wildlife in Canada. SARA – Species at Risk Act

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
Nick Bartok, M.Sc., R.P.Bio. Tetra Tech Canada Inc.	Technical advisor, senior reviewer
Kayla Hatzel, B.Sc., B.I.T. Tetra Tech Canada Inc.	Field data collection, data entry
Claudio Bianchini, R.P.Bio. Bianchini Biological Services	Field data collection

APPENDIX C
GENERAL CONDITIONS





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3. Base Data: Province of B.C.
4. Prepared by: Tetra Tech.
5. Imagery from Microsoft Bing Imagery Service..
6. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.

Legend

Observation Point
Standwatch Station
Compensation Property

Transects
May 10, 2016
May 24, 2016
June 20, 2016

1:15,000
0 400 m

BC Hydro

Figure 4:
Wilder Creek Lands
Ground Nesting Raptor
Follow-up Monitoring Surveys

DATE	January 12, 2017	1016-C14-XXXXX-4	R 0

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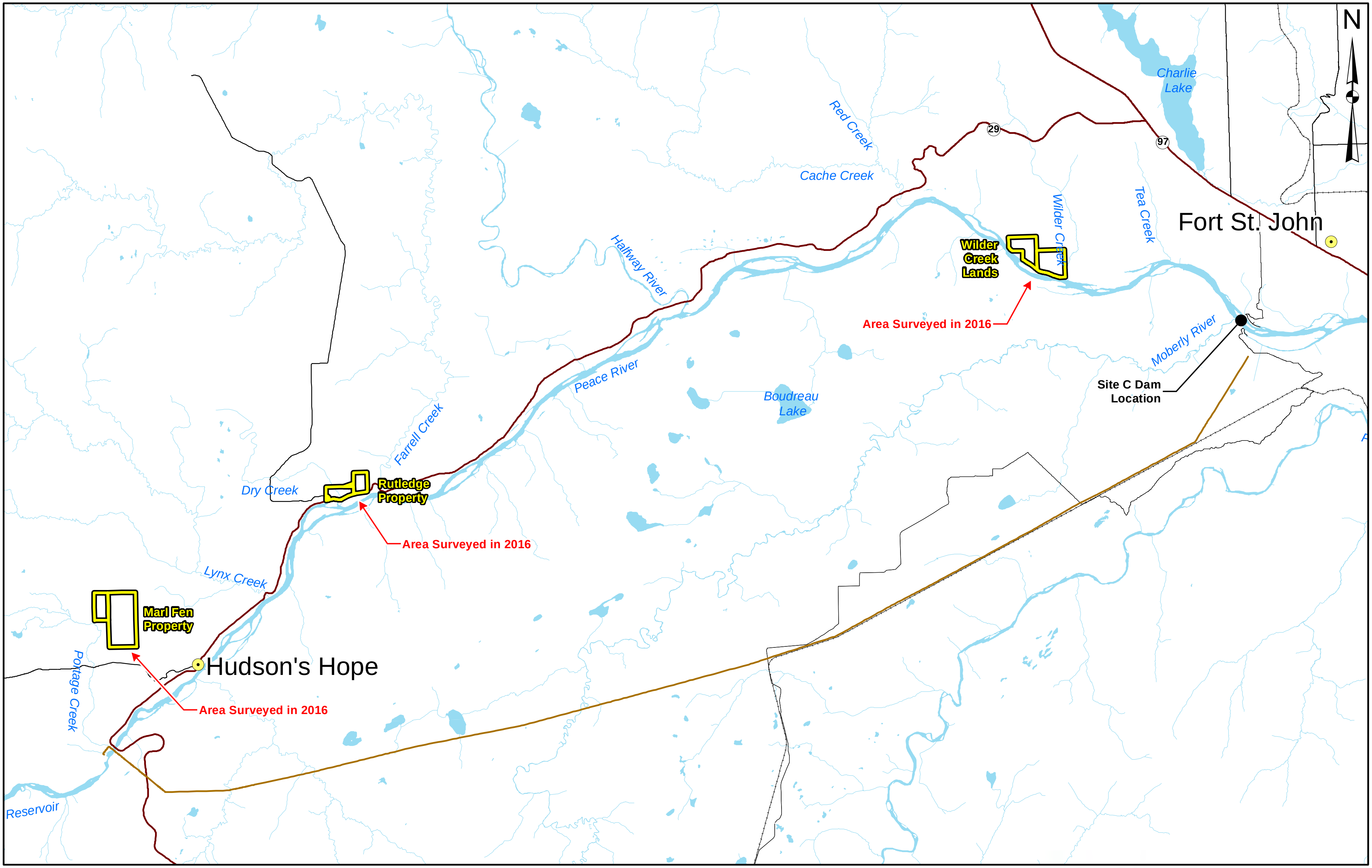
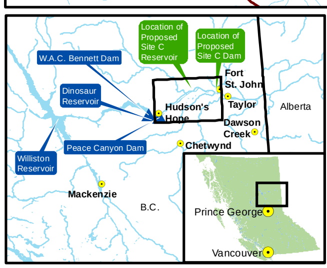
Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.





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3. Base Data: Province of B.C.
4. Prepared by: Tetra Tech.
5. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.

Legend

- Compensation Property
- Proposed Transmission Corridor
- Railway
- Highway
- Other Road
- Watercourse
- Waterbody

1:300,000

0 8 km

BC Hydro

Figure 1:
Ground Nesting Raptor Follow-up Monitoring Survey Locations in 2016

DATE	January 12, 2017	1016-C14-XXXXX-1	R 0

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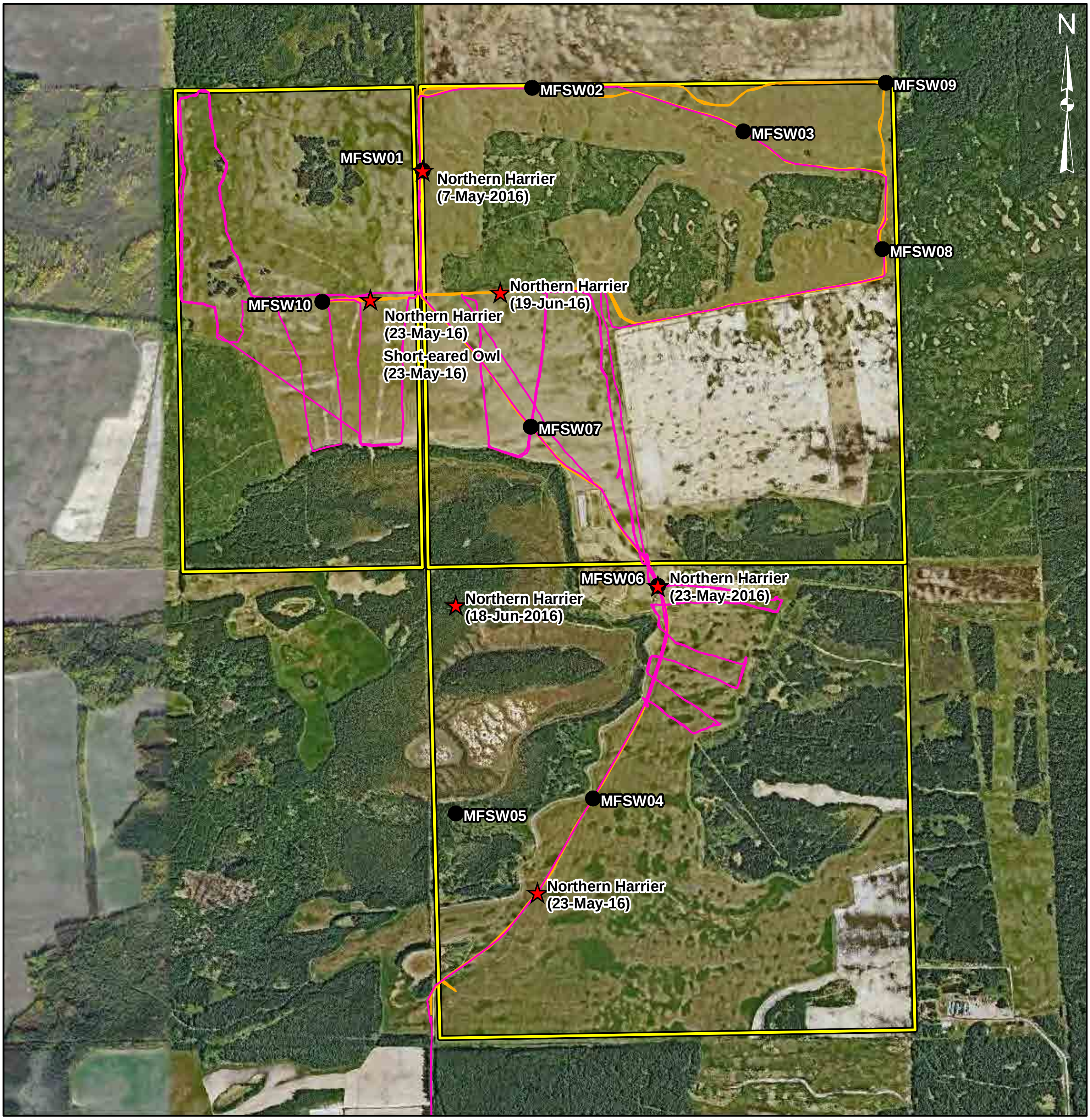

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Observation Point

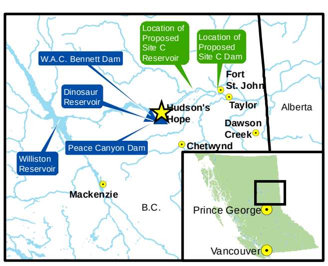
Standwatch Station

Compensation Property

Transects

May 7 & 23, 2016

June 18-19, 2016



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4. Prepared by: Tetra Tech.
5. Imagery from Google; DigitalGlobe.
6. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.

1:18,000

0 400 m

BC Hydro

Figure 2:
Marl Fen Property
Ground Nesting Raptor
Follow-up Monitoring Surveys

DATE	January 12, 2017	1016-C14-XXXXX-2	R 0

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

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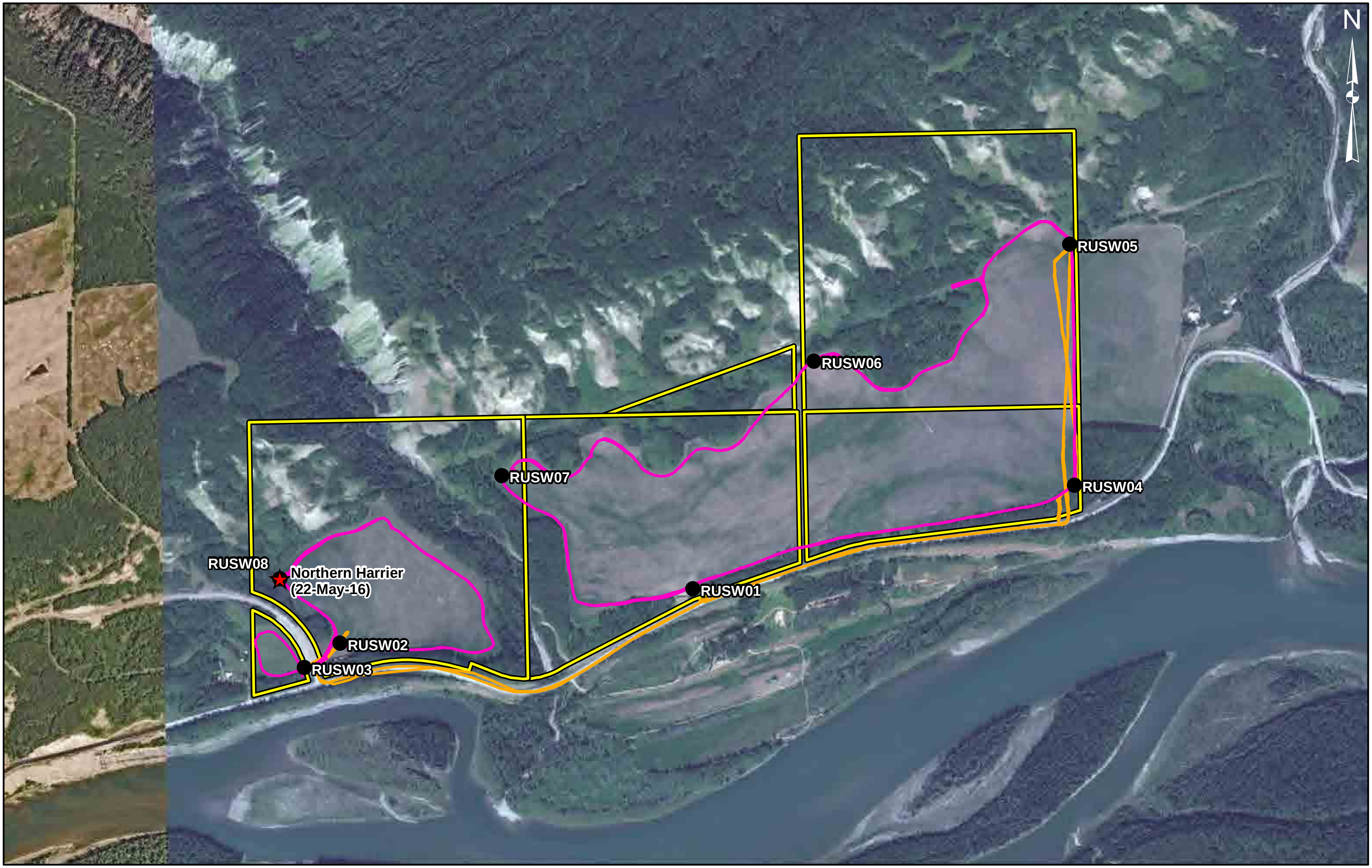

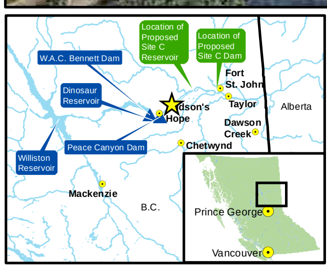

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★ Observation Point

● Standwatch Station

Compensation Property

Transects

May 8 & 22, 2016

June 19, 2016

Map Notes:
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3. Base Data: Province of B.C.
4. Prepared by: Tetra Tech.
5. Imagery from Microsoft Bing Imagery Service.
6. Property boundary locations are best available but should be considered approximate. Property information provided by BC Hydro on March 10, 2016.

1:15,000

0 400 m

BC Hydro

Figure 3:
Rutledge Property
Ground Nesting Raptor
Follow-up Monitoring Surveys

DATE	January 12, 2017	1016-C14-XXXXX-3	R 0

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