Vegetation and Wildlife Mitigation and Monitoring Plan

Site C Clean Energy Project

Version 1: June 5, 2015

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Glossary

CEAA Agency	Canadian Environmental Assessment Agency
CDC	BC Conservation Data Centre
CWS	Canadian Wildlife Service
EAO	BC Environmental Assessment Office
MFLNRO	BC Ministry of Forests Lands and Natural Resource Operations
MOE	BC Ministry of Environment

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.

1.2 Project Benefits

The Project will provide important benefits to British Columbia and Canada. It will serve the public interest by delivering long term, reliable electricity to meet growing demand; contribute to employment, economic development, ratepayer, taxpayer and community benefits; meet the need for electricity with lower GHG impact than other resource options; contribute to sustainability by optimizing the use of existing hydroelectric facilities, delivering approximately 35 per cent of the energy produced at the W.A.C. Bennett Dam, with only five per cent of the reservoir area; and include an honourable process of engagement with First Nations and the potential for accommodation of their interests.

1.3 Environmental Assessment Process

The environmental assessment of the Project has been 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 CEA Agency and 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.

1.4 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.

1.5 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.

1.6 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, and the Report of the Joint Review Panel on the Project. 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.

2.0 Vegetation and Wildlife Mitigation and Monitoring Plan

2.1 Objective and Scope

The objective of the Vegetation and Wildlife Mitigation and Monitoring Plan (the Plan) is to describe the mitigation and monitoring measures that will be implemented 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 the Vegetation and Wildlife Mitigation and Monitoring Plan.

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.

The purpose of the monitoring and follow-up programs is to determine the success of implemented mitigation measures (for example, monitoring the use of mitigation structures by target species). The monitoring results can be used to provide lessons learned and advance the suite of mitigation measures available for the target species for future projects.

Table 1. Federal Decision Statement Conditions and Relevant Plan Section

Decision Statement Condition	Condition	Plan Reference
9.	Disturbance and destruction of migratory birds	Section 7.1 Decision Statement Condition 9: Migratory Bird Mitigation and Monitoring
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 7.1.1 Avoid and Reduce Risk of 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.	Section 7.1.2 Annual Schedule
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 7.1.1 Avoid and Reduce Risk of Mortality and Disturbance of Migratory Birds and their Nest
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	Section 7.1.1 Avoid and Reduce Risk of Mortality and Disturbance

Decision Statement Condition	Condition	Plan Reference
	mortality to migratory birds and their nests.	of Migratory Birds and their Nest
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	Section 7.1.3 Consultation of Environment Canada Policies and Guidelines
9.5.2.	Environment Canada's avoidance guidelines on General Nesting Periods of Migratory Birds in Canada.	Section 7.1.3 Consultation of Environment Canada Policies and Guidelines
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.	Section 7.1.4 Submission of Draft and Final Plans
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.	Section 7.1.4 Submission of Draft and Final Plans
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.	Section 7.1.5 Plan Implementation and Analysis of Plan Implementation
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 7.1.6 Risk of Bird Collisions with the Transmission

Decision Statement Condition	Condition	Plan Reference
		Line
9.9.2.	determining if additional mitigation measures could be implemented to reduce the risk of bird collisions; and	Section 7.1.6 Risk of Bird Collisions with the Transmission Line
9.9.3.	implementing any additional mitigation measures (e.g. line marking and diversions), to minimize impacts.	Section 7.1.6 Risk of Bird Collisions with the Transmission Line
10.	**Non-wetland migratory bird habitat**	Section 7.2 Decision Statement Condition 10: Non-Wetland Migratory Bird Habitat Mitigation and Monitoring
10.1.	The Proponent shall mitigate the potential effects of the Designated Project on non- wetland migratory bird habitat.	Section 7.2.1 Objective and Context, Non-Wetland Migratory Bird Habitat Mitigation and Monitoring
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;	Section 7.2.2 Non-Wetland Bird Habitat Baseline Conditions
10.3.2.	migratory bird abundance, distribution and use of non-wetland habitat;	Section 7.2.3 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;	Section 7.2.4 Mitigation for Changes in Aquatic and Riparian-Related Food Resources

Decision Statement Condition	Condition	Plan Reference
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 7.2.5 Compensation for Loss of Non-Wetland Migratory Bird Habitat
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 7.2.6 Analysis of Effects of Compensation for Loss of Non-Wetland Migratory Bird Habitat
10.3.6.	an approach to monitor and evaluate the effectiveness of the mitigation or compensation measures to be implemented and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory bird habitat, including migratory bird use of that habitat.	Section 7.2.7 Evaluation of Effectiveness of Mitigation and Compensation Measures
10.4	The Proponent shall submit to the Agency and Environment Canada a draft copy of the plan for review:	Section 7.2.8 Draft and Final Copies of Plan Submitted to the Agency and Environment Canada
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	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	

Decision Statement Condition	Condition	Plan Reference
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.	Section 7.2.9 Implementation of Plan and Analysis of Plan Implementation
10.8	The Proponent shall implement each component of the plan and provide to the Agency a n 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.	Section 7.2.9 Implementation of Plan and Analysis of Plan Implementation
11.	**Wetlands used by migratory birds and for current use of lands and resources for traditional purposes**	Section 7.3 Decision Statement Condition 11: Wetland Mitigation and Monitoring
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 7.3.1 Objective of Wetland Mitigation and Monitoring
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	Section 7.3.1 Objective of Wetland Mitigation and Monitoring

Decision Statement Condition	Condition	Plan Reference
	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.	Section 7.3.2 Wetland Mitigation Hierarchy / No Net Loss of Wetland Functions
11.4.	The plan shall include:	
11.4.1.	baseline data on the biogeochemical, hydrological and ecological functioning of the wetlands and associated riparian habitat in the area affected by the Designated Project, including: ground and surface water quality and quantity; vegetation cover; biotic structure and diversity; migratory bird abundance, density, diversity and use; species at risk abundance, density, diversity and use; and current use of the wetlands for traditional purposes by Aboriginal people, including the plant and wildlife species that support that use;	Section 7.3.3 Baseline Data for Wetlands and Riparian Habitat
11.4.2.	mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost;	Section 7.3.4 Mitigation Measures to Maintain Baseline Wetland Functions
11.4.3.	an approach to monitor and evaluate any changes to baseline conditions, as defined in condition 11.4.1 and identify improvements based on monitoring data;	Section 7.3.5 Evaluating Changes in Baseline Conditions
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 7.3.6 Compensation Measures for Loss of Wetland Areas and Functions
11.4.5.	an analysis of the effects of any compensation	Section 7.3.7 Analysis of

Decision Statement Condition	Condition	Plan Reference
	measures identified in condition 11.4.4 on the current use of lands and resources for traditional purposes by Aboriginal peoples.	Compensation Measures for Loss of Wetland Areas and Functions
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:	Section 7.3.8 Draft and Final Copies of Plan to Agency, Environment Canada and Aboriginal Groups
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.	Section 7.3.8 Draft and Final Copies of Plan to Agency, Environment Canada and 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.	Section 7.3.9 Schedule
11.9	The Proponent shall implement each component of the plan and provide to the Agency a n analysis and summary of the implementation of the plan, as well as	Section 7.3.10 Implementation of Plan and Analysis of

Decision Statement Condition	Condition	Plan Reference
	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.	Implementation of Plan
16	**Species at risk, at-risk and sensitive ecological communities and rare plants**	Section 7.4 Decision Statement Condition 16: Species at risk, at risk and sensitive ecological communities and rare plant
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.	Section 7.4.1 Objective: Species at Risk, At-risk and Sensitive Ecological Communities and Rare Plants
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.	Section 7.4.1 Objective: 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;	Section 7.4.2 Verification of Modeled Results for Surveyed Species at Risk
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;	Section 7.4.3 Rare Plant Surveys
16.3.3.	measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants;	Section 7.4.4 Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Plants
16.3.4.	conservation measures to ensure the viability of	Section 7.4.5 Conservation

Decision Statement Condition	Condition	Plan Reference
	rare plants, such as seed recovery and plant relocation;	Measures for Rare Plants
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 7.4.6 Avoid or Minimize Use of Herbicides and Pesticides
16.3.6.	an approach to monitor and evaluate the effectiveness of mitigation measures and to verify the accuracy of the predictions made during the environmental assessment on species at risk, at-risk and sensitive ecological communities and rare plants; and	Section 7.4.7 Effectiveness of Mitigation Measures
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 7.4.8 Tracking Updates to Status of Listed Species
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.	Section 7.4.9 Draft and Final Plan Submission
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.	
16.6	The Proponent shall implement the plan and provide to the Agency analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the	Section 7.4.10 Implementation of the Plan and Analysis of Implementation of the Plan

Decision Statement Condition	Condition	Plan Reference
	results, on an annual basis during construction and for the first 10 years of operation, with the exception of condition 16.3.7 for which reporting will continue for the life of the Designated Project, as appropriate.	

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 8.1 Condition 9: Vegetation and Invasive Plant Management
	The Vegetation and Invasive Plant Management Plan must be developed by a QEP.	Section 8.1.1 Objective of Vegetation and Plant Management
	The Vegetation and Invasive Plant Management Plan must include at least the following:	
	Invasive Species	
	• Surveys of existing invasive species populations prior to construction.	Section 8.1.2 CEMP
	• Invasive plant control measures to manage established invasive species populations and to prevent invasive species establishment.	Section 8.1.2 CEMP
	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	Section 8.1.3.1 Rare and Sensitive Community Identification Program

EAC Condition	Condition	Plan Reference
	any Project activities that may affect these rare or sensitive plant communities	
	• The EAC Holder must, with the use of a QEP, complete an inventory in areas not already surveyed and use rare plant location information as inputs to final design of access roads and transmission lines. These pre-construction surveys must target rare plants as defined in Section 13.2.2 of the EIS —including vascular plants, mosses, and lichens.	Section 8.1.3.2 Inventory of Areas Not Already Surveyed
	• The EAC Holder must create and maintain a spatial database of known rare plant occurrences in the vicinity of Project components that must be searched to avoid effects to rare plants during construction activities. The database must be updated as new information becomes available and any findings of new rare plant species occurrences must be submitted to Environment Canada and MOE using provincial data collection standards.	Section 8.1.3.3 Spatial Database of Known Rare Plant Occurrences
	• The EAC Holder must implement construction methods to reduce the impact to rare plants, maximize use of existing access corridors, and construct transmission towers and temporary roads away from wetlands and known rare plant occurrences.	Section 8.1.2 CEMP
	• 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 8.1.2 CEMP
	• The EAC Holder will engage the services of a Rare Plant Botanist during construction to design and implement an experimental rare plant translocation program in consultation with MOE using the BC MOE's Guidelines for Translocation of Plant Species at Risk in BC (Maslovat, 2009).	Section 8.1.3.4 Rare Plant Translocation Program
	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	Section 8.1.4 Submission of Draft and Final Plans

EAC Condition	Condition	Plan Reference
	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.	Section 8.1.5 Implementation and Adherence to Final Plan
10	The EAC Holder must fund or undertake directly with the use of a Rare Plant Botanist the following, during construction:	Section 8.2 Environmental Assessment Certificate Condition 10: Rare Plant Surveys and Section 8.2.1 Objective of Rare Plant Surveys
	• 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 8.2.2 Targeted Surveys for Rare Plant Species in the RAA
	• 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).	Section 8.2.3 Taxonomy of Ochroleucus bladderwort
	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.	Section 8.2.4 Submission of Survey and Study Findings
11	EAC Holder must compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants by developing, or funding the development and implementation of a compensation program, during construction, that includes:	Section 8.3 Environmental Assessment Certificate Condition 11: Rare and Sensitive Habitats and Rare Plants
	• Assistance (financial or in-kind) to the managing	

EAC Condition	Condition	Plan Reference
	organization of suitable habitat enhancement projects in the RAA (RAA as defined in the amended EIS).	
	• Direct purchase of lands in the RAA and manage these lands and suitable existing properties owned by the EAC Holder to enhance or retain rare plant values where opportunities exist.	
	The EAC Holder must engage with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.	
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.	Section 8.4 Environmental Assessment Certificate Condition 12: Wetland Mitigation and Monitoring
	The Wetland Mitigation and Compensation Plan must include at least the following:	
	• Information on location, size and type of wetlands affected by the Project;	Section 8.4.3 Wetland Mitigation and Monitoring Measures (Guide to Section 7.3)
	• If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;	Section 8.4.2 CEMP
	• 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	

EAC Condition	Condition	Plan Reference
	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:	Section 8.4.3 Wetland Mitigation and Monitoring Measures (Guide to Section 7.3)
	o Avoid direct effects where feasible;	
	o Minimize direct effects where avoidance is not feasible;	
	o Maintain or improve hydrology where avoidance is not feasible;	
	o Replace like for like where wetlands will be lost, in terms of functions and compensation in terms of area;	
	o Improve the function of existing wetland habitats; and	
	o 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.	Section 8.4.4 Submission of Draft and Final Plans

EAC Condition	Condition	Plan Reference
	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.	Section 8.4.5 Implementation of Final Plan
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.	Section 8.0 Environmental Assessment Certificate Condition 14: Vegetation and Ecological Communities Monitoring and Follow-up Program Section 8.5.1 Objective: Vegetation and Ecological Communities and Follow-up Program
	The Vegetation and Ecological Communities Monitoring and Follow-up Program must be developed by a QEP.	Section 8.5.1 Objective: Vegetation and Ecological Communities and Follow-up Program
	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).	Section 8.5.2 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.	
	• 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.	

EAC Condition	Condition	Plan Reference
	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.	Section 8.5.4 Implementation of Plan and Reporting Requirements
	The EAC Holder must provide this draft Vegetation and Ecological Communities Monitoring and Follow-up Program to Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John and Aboriginal Groups for review within 90 days after the commencement of construction.	Section 8.5.3 Submission of Draft and Final Plans
	The EAC Holder must file the final Vegetation and Ecological Communities Monitoring and Follow-up Program with EAO, Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John, and Aboriginal Groups, within 150 days after commencement of construction.	
	The EAC Holder must develop, implement and adhere to the final Vegetation and Ecological Communities Monitoring and Follow-up Program, and any amendments, to the satisfaction of EAO.	Section 8.5.4 Implementation of Plan and Reporting Requirements
WILDLIFE RESOURCES		
15	The EAC Holder must develop a Wildlife Management Plan.	Section 8.6 Environmental Assessment Certificate Condition 15: Wildlife Management Section 8.6.1 Objective: Wildlife Management
	The Wildlife Management Plan must be developed by a QEP.	Section 8.6.1 Objective: Wildlife Management
	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	Section 8.6.3 Wildlife Management Measures

EAC Condition	Condition	Plan Reference
	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.	Section 8.6.2 CEMP
	• 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.	Section 8.6.4 Submission of Draft and Final Plans
	The EAC Holder must file the final Wildlife Management Plan with EAO, Environment Canada,	

EAC Condition	Condition	Plan Reference
	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.	Section 8.6.5 Implementation of Final Plan
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 8.7 Environmental Assessment Certificate Condition 16: Compensation for Loss of Wetland Habitat. Section 8.7.1 Objective: Compensation for Loss of Wetland Habitat
	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.	Section 8.7.2 Fish-Free Areas in Wetlands
	• Mitigation for the loss of snake hibernacula, artificial dens must be included during habitat compensation.	Section 8.7.3 Mitigation for Loss of Snake Hibernacula
	• Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.	Section 8.7.4 Lands for 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.	Section 8.7.5 Nest Boxes for Cavity-Nesting Waterfowl
	• A design for bat roosting habitat in HWY 29 bridges to BC Ministry of Transportation and Infrastructure (MOTI) for consideration into new bridge designs located within the Peace River	Section 8.7.6 Bat Hibernating and Roosting Habitat Section 8.7.6 Bat Hibernating and

EAC Condition	Condition	Plan Reference
	valley.	Roosting Habitat
	• 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.	Section 8.7.7 Fisher Dens and Rest Site Installation and Monitoring
	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.	Section 8.7.8 Submission of draft and Final Plans
	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.	Section 8.7.9 Implementation and Plan
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 8.8 Environmental Assessment Certificate Condition 19: Avoid and Reduce Injury and Mortality to Amphibians and Snakes
	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	Section 8.9 Environmental

EAC Condition	Condition	Plan Reference
	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.	Assessment Certificate Condition 21: Monitoring of Wildlife Mitigation Measures Section 8.9.1 Objective: Monitoring of Wildlife Mitigation Measures
	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.	Section 8.9.2 Bald Eagle Nesting Population Monitoring Program
	• Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.	Section 8.9.3 Waterfowl and Shorebird Population Monitoring
	• Monitor amphibian use of migration crossing structures installed along Project roads.	Section 8.9.4 Monitoring Amphibian Use of Migration Crossing Structures
	• Survey songbird and ground-nesting raptor populations during construction and operations.	Section 8.9.5 Songbird and Ground-nesting Raptor Surveys
	• Survey the distribution of western toad and garter snake populations downstream of the Site C dam to the Pine River.	Section 8.9.6 Western Toad and Garter Snake Population Surveys
	• 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 8.9.8 Implementation of Plan and Reporting Requirements
	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.	Section 8.9.7 Submission of Draft and Final Plans
	The EAC Holder must file the final Vegetation and Wildlife Mitigation and Monitoring Plan must with EAO, FLNR, MOE, Environment Canada	

EAC Condition	Condition	Plan Reference
	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.	
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 8.10 Environmental Assessment Certificate Condition 23: Track Changes in the Status of Listed Species Section 8.10.1 Tracking Updates for Species at Risk
	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.	Section 8.10.2 Assessment of Management and Monitoring Plans Based on Species at Risk
24	The EAC Holder must identify suitable lands for ungulate winter range by the end of the first year of construction, on BC Hydro-owned lands, or Crown lands, in the vicinity of the Project in consultation with FLNR. If FLNR determines that identified winter range is required, the EAC Holder must identify and maintain suitable BC Hydro- owned lands for ungulate winter range to the satisfaction of FLNR and for the length of time determined by FLNR.	Section 8.11 Environmental Assessment Certificate Condition 24: Ungulate Winter Range

2.2 Consultation

Many of the conditions require BC Hydro to consult or collaborate with certain government agencies and Aboriginal groups in respect of measures and plans required by the conditions.

BC Hydro began consultation on the Project in late 2007, before any decision to advance the Project to an environmental assessment. BC Hydro’s consultation with the public, stakeholders, regional and local governments, regulatory agencies, and Aboriginal groups is described in EIS Section 9, Information Distribution and Consultation.

Additional information on the consultation process and a summary of issues and concerns raised during consultation are provided in:

- Volume 1 Appendix G, Public Information Distribution and Consulting Supporting Documentation
- Volume 1 Appendix H, Aboriginal Information Distribution and Consultation Supporting Documentation
- Volume 1 Appendix I, Government Agency Information Distribution and Consultation Supporting Documentation
- Volume 5, Appendix A01 to A29, Parts 2 and 2A, Aboriginal Consultation Summaries
- Technical Memo: Aboriginal Consultation

Draft versions of a number of the mitigation, management and monitoring plans required by the conditions were submitted to applicable government agencies and Aboriginal groups for comment on October 17, 2014.

Comments on these draft plans were received from various government agencies and Aboriginal groups during November and December 2014, and were considered in the revisions to these plans. BC Hydro's consideration of these comments is provided in the consideration tracking tables that accompany each plan.

On December 15, 2014, Treaty 8 Tribal Association (T8TA), on behalf of West Moberly, Saulteau and Prophet River First Nations, submitted to BC Hydro a letter in response to BC Hydro's request for comment on the Plans sent on October 17, 2014. The letter included several appendices, including the Joint Review Panel (JRP) Report and transcripts from the JRP hearings in December 2013 and January 2014. BC Hydro responded to the three First Nations on January 21, 2015 noting that the October 17 2014 request for comments on the plans was to provide an opportunity to the First Nations to submit to BC Hydro any information they wanted to provide in relation to the Plans. BC Hydro advised that it was aware of the information referred to in T8TA's letter when the plans were prepared, and advised that it was preparing a table setting out where any mitigation measures identified by representatives of the three First Nations during the hearings are considered in the draft plans and would provide that to the First Nations once complete. Accordingly BC Hydro's responses to those mitigation measures identified by the representatives of the three First Nations during the JRP hearings were provided to the EAO in a separate table by letter dated May 19, 2015. Aside from the December 15, 2014 letter, BC Hydro has not received further comments from these First Nations. A letter of understanding dated April 30, 2015 respecting provision of capacity funding to support review of the plans was entered into by BC Hydro and Saulteau First Nations (on behalf of Saulteau, West Moberly and Prophet River First Nations).

New draft plans (i.e., Housing Plan and Housing Monitoring and Follow-Up Program, and the quarry/pit development plans) were provided to the entities identified in the EAC conditions on April 7, 2015. The Vegetation and Wildlife Mitigation and Monitoring Plan was revised based on comments received on the October 17, 2014 version and based on discussions with Environment Canada and the BC Ministry of Environment, and was re-submitted to applicable entities on April 7, 2015.

Comments on the revised plans were requested by May 11, 2015 to allow for review, consideration of comments and finalization of the plans 30 days prior to the commencement of construction.

Comments were received by this requested date from:

- Fort Nelson First Nation
- Ministry of Forests, Lands and Natural Resource Operations (FLNRO), and
- Métis Nation British Columbia.

The Peace River Regional District submitted their comments on the plan on May 14, 2015. FLNRO submitted additional comments on May 15, 2015, including comments from the BC Ministry of Environment.

BC Hydro considered the comments provided and prepared final plans. On May 19, 2015, BC Hydro submitted the following mitigation, management and monitoring plans to the BC Environmental Assessment Office (BC EAO) for review:

- Construction Environmental Management Plan, including Construction Communication Plan and Aboriginal Communication Plan
- Construction Safety Management Plan
- Fisheries and Aquatic Habitat Management Plan
- Vegetation and Wildlife Mitigation and Monitoring Plan
- Vegetation Clearing and Debris Management Plan
- Aboriginal Plant Use Mitigation Plan
- Aboriginal Training and Inclusion Plan
- Business Participation Plan
- Emergency Services Plan
- Healthcare Services Plan
- Labour and Training Plan
- Cultural Resources Mitigation Plan
- Heritage Resources Management Plan
- Housing Plan and Housing Monitoring and Follow-Up Program
- Wuthrich Quarry Development Plan
- West Pine Quarry Development Plan; and
- Del Rio Pit Development Plan.

The CEA Agency and Environment Canada submitted comments on the revised plan on May 22, 2015. These comments were considered and the final plans were revised accordingly and submitted on June 5, 2015 to the entities identified in the EAC conditions.

2.3 Qualified Professionals

The following Qualified Professionals prepared the Vegetation and Wildlife Mitigation and Monitoring Plan:

Qualified Individual	Expertise
K. Anré McIntosh, R.P.Bio. P.Ag, PMP BC Hydro	Vegetation and Wildlife
David Nagorsen, M. Sc., Mammalia Biological Consulting	Bats
Mike Sarell, Ophiuchus Consulting	Snakes
Toby Jones, R.P. Bio., Keystone Wildlife Research	Breeding birds
Lisette Ross, M.Sc., Native Plant Solutions	Wetlands
Darryl Kroeker, M.Sc., Ducks Unlimited Canada	Wetlands, wetland birds
Claudio Bianchini, R.P. Bio., Bianchini Biological Services	Species Model verification, Kingfisher
Rick Matthe, Ba Hon. Pathfinder Endeavours	Noxious Weeds

3.0 Regulatory Context

The federal *Species at Risk Act*, *Migratory Birds Convention Act* and the provincial *Wildlife Act* were consulted in development of this plan as was Environment Canada's policy on *Incidental Take of Migratory Birds in Canada*.

The federal *Species at Risk Act*, *Migratory Birds Convention Act* and the provincial *Wildlife Act* will guide project construction activities and permit requirements, and will apply as relevant to the development and implementation of specific mitigation measures, including monitoring where appropriate, for vegetation and wildlife.

The BC Resources Information Standards Committee (RISC) has developed standards for natural resource inventories, including collection, storage, analysis, interpretation, and reporting of vegetation and wildlife data. RISC standards and guidelines will be applied, where available and relevant, to vegetation and wildlife programs. In the absence of applicable RISC standards or guidelines, data collection protocols and guidelines will be sourced from other relevant jurisdictions or scientific practices.

The tools, standards and guidelines that will be implemented to meet the regulatory requirements listed above are described in Section 6 (Structure and Content of the Vegetation and Wildlife Mitigation and Monitoring Plan), Section 7 (Mitigation and Monitoring Measures – Federal Conditions) and Section 8 (Mitigation and Monitoring Measures – Environmental Assessment Certificate Conditions) of this Plan.

4.0 Baseline Conditions

Baseline conditions for Vegetation and Ecological Communities are described in the EIS in Volume 2, Section 13 and in Appendix R, Part 1 (BC Hydro 2013). A summary is provided in Appendix A of this Plan. Baseline conditions for Wildlife Resources are described in the EIS in Volume 2, Section 14 and Appendix R, Parts 2 through 7 (BC Hydro 2013). A summary is provided in Appendix B of this Plan.

5.0 Potential Project Effects

Potential effects of the Project on Vegetation and Ecological Communities are described in the EIS in Volume 2, Section 13 and in Appendix R, Part 1. A summary is provided in Appendix A of this Plan. Potential effects of the Project on Wildlife Resources are described in the EIS in Volume 2, Section 14 and Appendix R, Parts 2 through 7. A summary is provided in Appendix B of this Plan.

6.0 Structure and Content of the Vegetation and Wildlife Mitigation and Monitoring Plan

6.1 Structure of Plan

The mitigation and monitoring measures described in this Plan are organized into two parts: Section 7.0 describes those mitigation and monitoring measures that meet the requirements of the Decision Statement conditions; Section 8.0 describes those measures that meet the requirements of the Environmental Assessment Certificate conditions. Cross-references are provided in Section 8.0 where information provided to meet the Environmental Certificate conditions is the same as that provided for the Decision Statement conditions.

6.2 Implementation Tools

All mitigation and monitoring measures described in this Plan will be implemented through the requirements of the following:

- The Construction Environmental Management Plan (CEMP). The CEMP sets out the standard environmental measures that will be implemented throughout construction of the Project. The CEMP provides the specifications for the Environmental Protection Plans (EPPs) that must be prepared by a contractor's Qualified Professional prior to undertaking construction activities at a particular site. Each EPP will provide details on how potential adverse effects will be avoided, mitigated or compensated at a particular construction site.
- The Vegetation Clearing and Debris Management Plan. This plan sets how vegetation clearing and debris management will be undertaken within the Project Activity Zone as defined in Decision Statement Definition 1.15.
- The vegetation and wildlife mitigation and monitoring measures described in this Plan. These are the non-standard mitigation and monitoring measures that will be implemented to mitigate the effects of the Project on vegetation and ecological communities and wildlife resources.

Figure 1 provides an overview of the relationship between mitigation and monitoring measures and their respective implementation methods.

6.3 Spatial Extent of Plan

All mitigation and monitoring programs will be implemented in one of the four areas described below and shown in Figure 2. :

Area 1: The Project Activity Zone. This area is defined in Decision Statement Definition 1.15 as the "area within which the Project components will be found or will occur, but not including existing transportation infrastructure that will be used without modification to transport materials or personnel required for the Project."

Area 2: Local Assessment Area (LAA). This area is defined in the EIS 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. This buffer extends far enough to include all potential direct and indirect effects at all construction sites and during operations. This includes new roads, roads requiring sizable upgrades, quarries, the dam site, and the transmission line. For the proposed reservoir, the erosion impact line has a 1,000 m buffer.

Area 3: Regional Assessment Area (RAA). The RAA is defined in the EIS as the area within which projects and activities – the residual effects of which may combine with residual effects of the Project – are identified and taken into account in the cumulative effects assessment. The boundary includes most of the Peace Lowlands ecosection and incorporates all Project components and activities.

Area 4: Downstream of the Dam to the Pine River. This area is defined in the EIS as being part of the LAA, but is described separately in the Vegetation and Wildlife Mitigation and Monitoring Plan to more precisely identify mitigation/monitoring sites. Specifically, this is the area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

6.4 Timeline of Plan

Figure 3 provides an overview of the timeline for the mitigation and monitoring measures described in this Plan. As shown in the figure, the implementation of mitigation and monitoring measures covers approximately 30 years: measures are being implemented, and may be completed, prior to the start of construction (e.g., survey for rare plants potentially extirpated), while other measures will be implemented through the construction phase and for approximately 20 years after the commencement of Project operations (e.g., wetland mitigation and compensation).

Sections 7.0 and 8.0 of this Plan describe and provide the findings from the pre-construction mitigation and monitoring activities undertaken prior to construction, in 2014, to meet the requirements of Decision Statement and Environmental Assessment Certificate Conditions. Sections 7.0 and 8.0 also set out the process by which future surveys and mitigation and monitoring measures will be implemented.

Because the Vegetation and Wildlife Mitigation and Monitoring Plan covers approximately 30 years, it is reasonable to anticipate that some plan details may develop or change over time. For example, results from early studies may lead to new information and recommendations for follow-up studies or other mitigation and monitoring measures. In addition, as qualified professionals are engaged for specific studies or the implementation of certain mitigation/monitoring measures, they will develop detailed field plans and may provide recommendations that will lead to the amendment of this Plan.

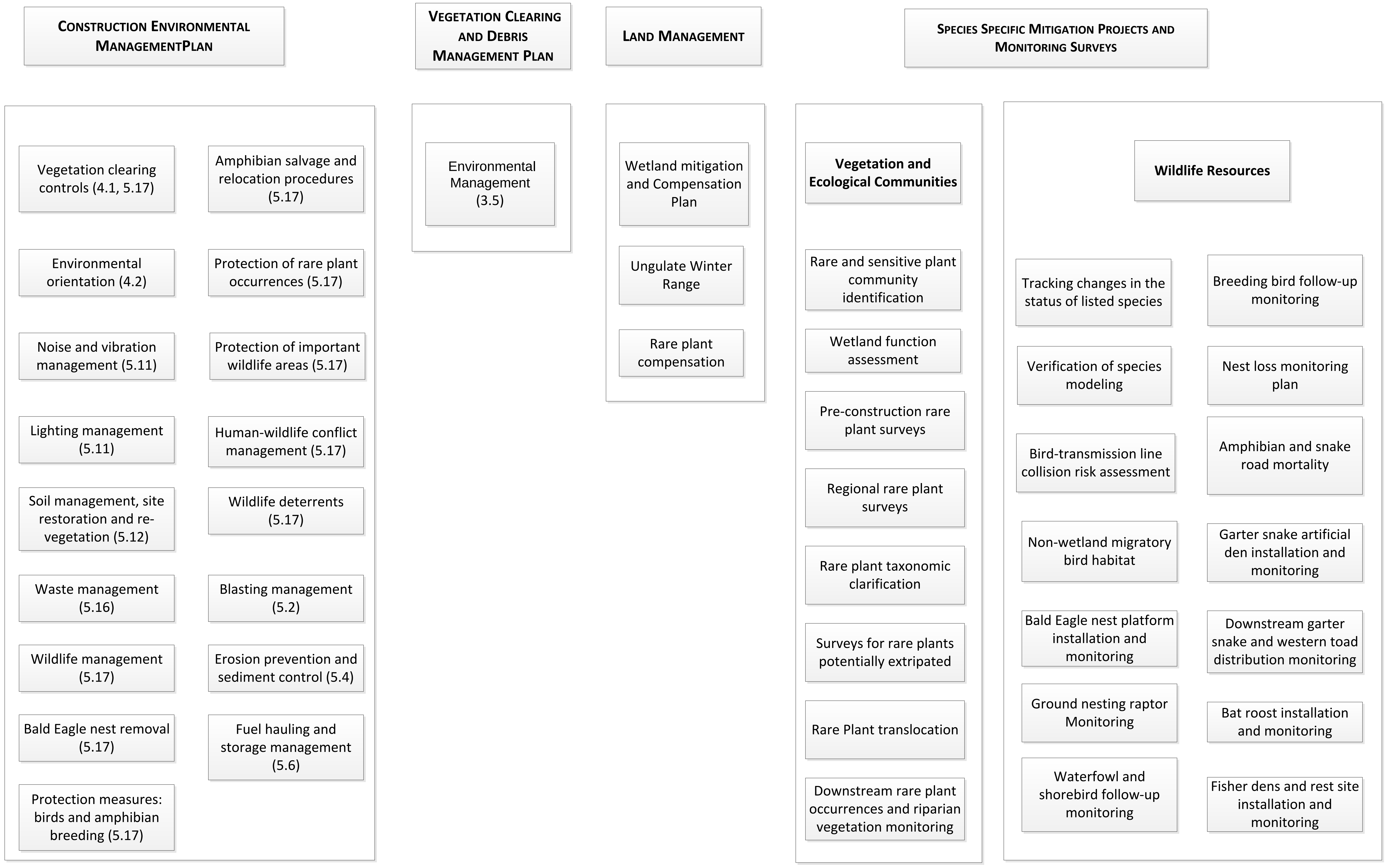
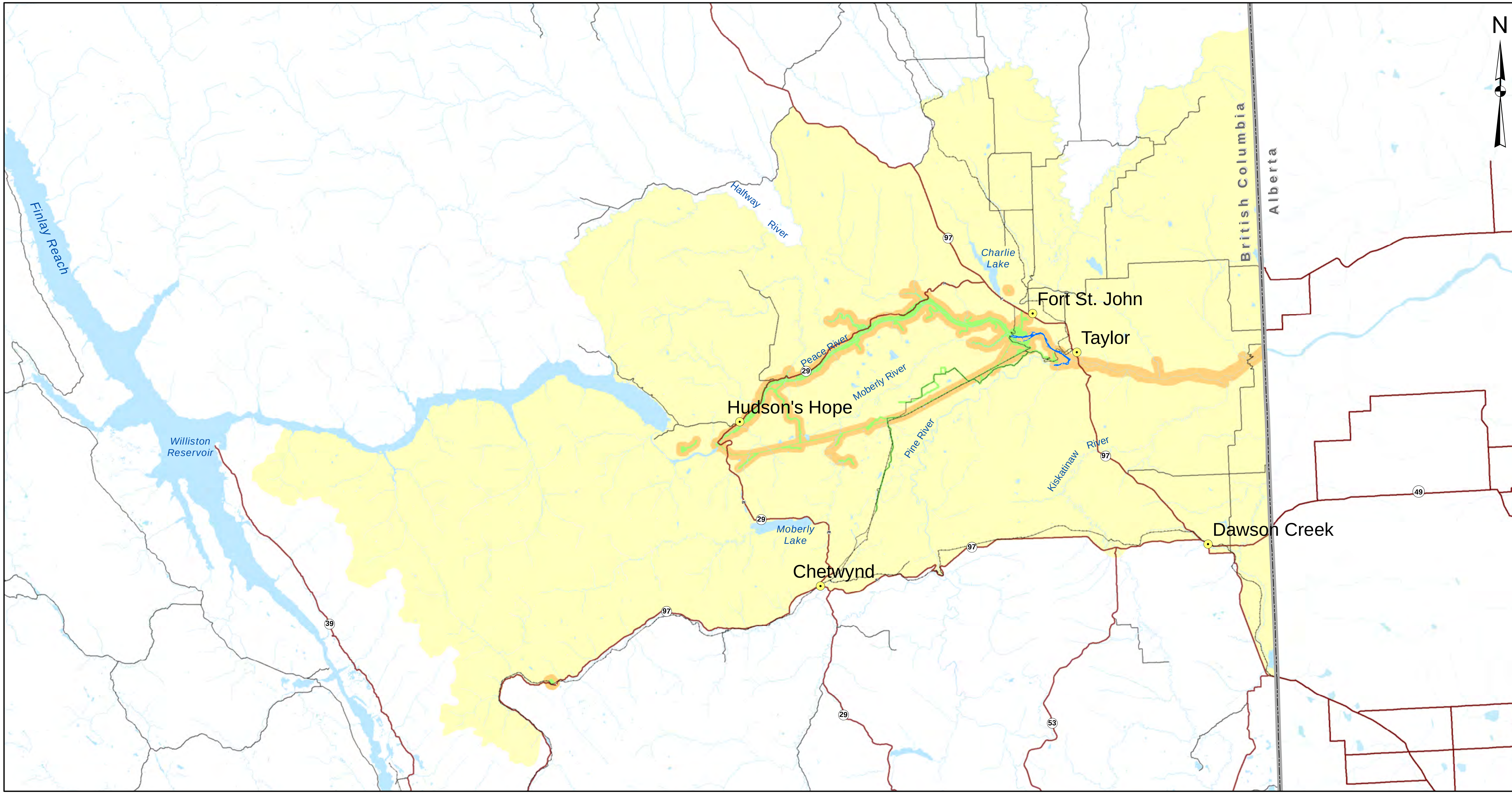
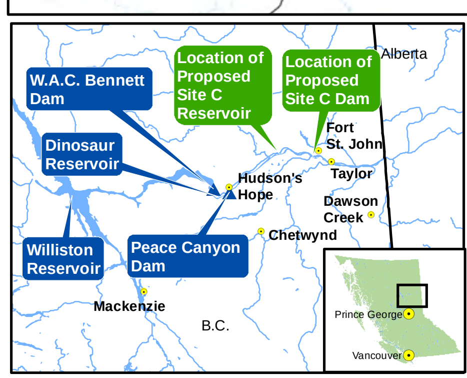


Figure 1. Organization of Vegetation and Wildlife Mitigaton and Monitoring Measures





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.

Legend

- Area 1: Project Footprint
- Area 2: LAA
- Area 3: RAA
- Area 4: Dam Site to Pine River Confluence
- Road
- Highway
- Railway

1:850,000

0 — 34 km

BC hydro

SITE C CLEAN ENERGY PROJECT

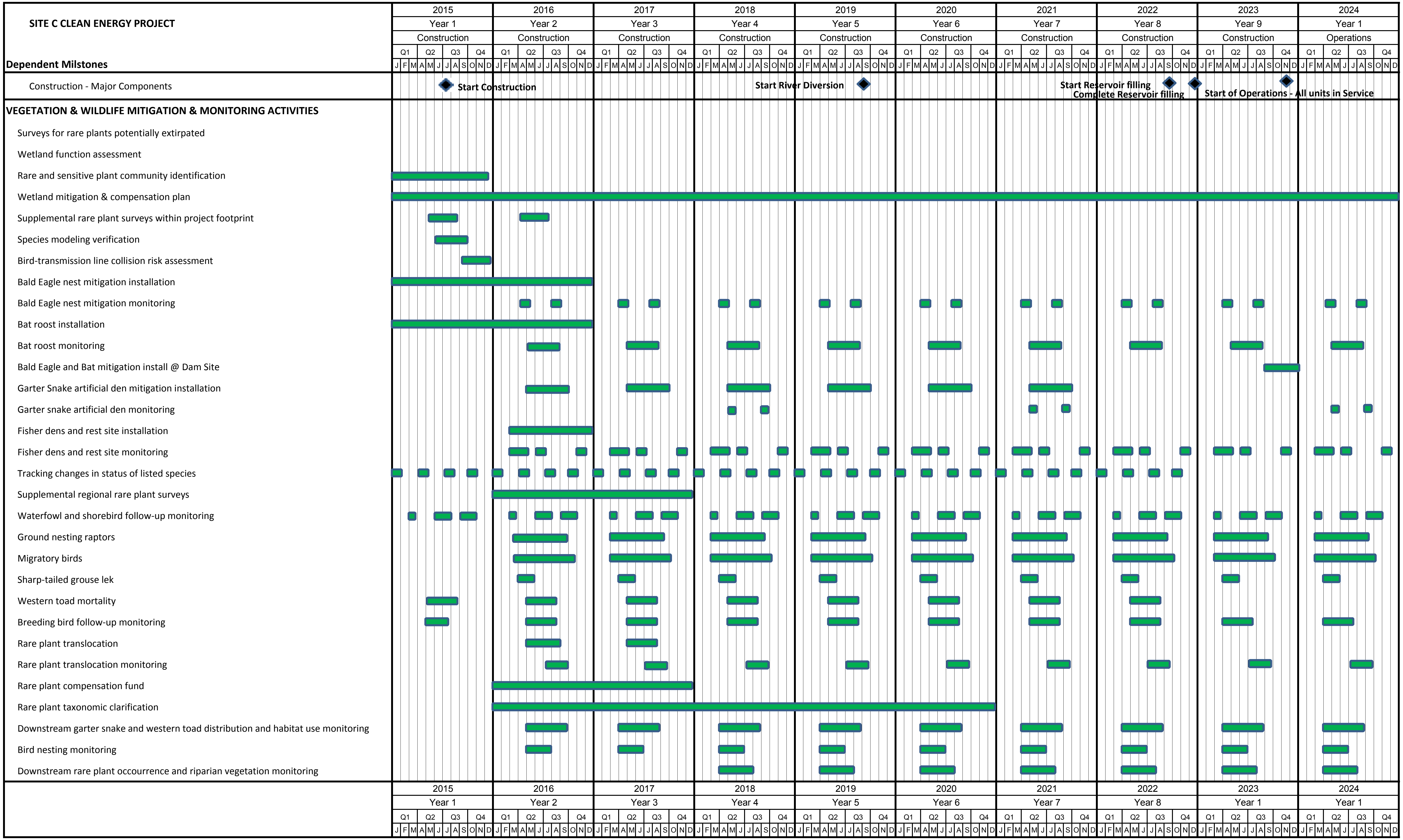
Figure 2. Mitigation Areas

Date	December 5, 2014	DWG NO	1016-C14-B7794	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

Path: X:\ArcGIS\Projects\Mitigation\MitigationAreas_1016_C14_B7794.mxd

Figure 3. MITIGATION and MONITORING TIMELINE



7.0 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, not-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 requirements for each of these conditions are described in the following:

- **Section 7.1**: Migratory Bird Mitigation and Monitoring (Decision Statement Condition 9)
- **Section 7.2**: Non-Wetland Migratory Bird Habitat Mitigation and Monitoring (Decision Statement Condition 10)
- **Section 7.3**: Wetland Mitigation and Monitoring (Decision Statement Condition 11)
- **Section 7.4**: Species and Ecological Communities at Risk Mitigation and Monitoring (Decision Statement Condition 16)

7.1 Decision Statement Condition 9: Migratory Bird Mitigation and Monitoring

The purpose of the Migratory Bird Mitigation and Monitoring section is to describe the mitigation and monitoring measures that will be implemented to ensure the Project is carried out in a manner that avoids mortality and disturbance of migratory birds and their nests. This section has been developed 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.

7.1.1 Avoid and Reduce Risk of Mortality and Disturbance of Migratory Birds and their Nests

This section has been developed in accordance with **Conditions 9.1, 9.3 and 9.4** of the Decision Statement:

- ***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.*
- ***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.*
- ***Condition 9.4*** *of the federal Decision Statement: 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.*

During construction, BC Hydro will meet the requirements of Conditions 9.1and 9.4 through the implementation of environmental management measures set out in the CEMP, the Vegetation Clearing and Debris Management Plan, and other mitigation activities described in this Plan. These measures are described in Section 7.1.1.1 below.

The requirements of Condition 9.3 will be meet through the implementation of the following monitoring programs during construction, reservoir filling and operation of the Project:

- Breeding Bird Follow-Up Monitoring Program,
- Bird Nesting Monitoring Program, and
- Waterfowl and Shorebird Follow-up Monitoring Program.

These programs are described in Section 7.1.1.2 below.

7.1.1.1 Mitigation Measures to be Implemented during Construction

A. CEMP

As described in Section 6.2, the CEMP provides the environmental specifications for the EPPs that must be prepared by a contractor's Qualified Professional prior to undertaking construction activities at a particular site. Each EPP will provide details on how potential adverse effects will be avoided, mitigated, or compensated for at a particular construction site.

In order to meet the requirements of Decision Statement Conditions 9.1 and 9.4 -- to ensure that the Project is carried out in a manner that "avoids mortality and disturbance of migratory birds and their nests" and 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" – construction activities must be undertaken in accordance with the CEMP. Section 4.17, Wildlife Management, in particular, requires that the EPPs include:

- mitigation measures such as clearing within the Peace Region terrestrial wildlife least-risk windows
- a nest and lek search protocol where clearing cannot be undertaken during during least-risk windows
- measures to protect wildlife habitat and important wildlife areas
- measures for wildlife deterrence

Each of these required specifications is described more fully below.

Clearing within Least-risk Timing Windows

Section 4.17 of the CEMP states that "where feasible, vegetation clearing will take place during the Peace Region terrestrial wildlife least-risk windows", as provided for in Peace Region Selected Terrestrial and Aquatic Wildlife Least-Risk Windows (BC Ministry of Forests, Lands, and Natural Resource Operations, 2011) and Environment Canada Region 6 General Nesting Period (Environment Canada 2014). The terrestrial wildlife least-risk windows have been copied from the CEMP below for reference.

Terrestrial Wildlife Least-Risk Windows

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Songbirds				19	1	-	31	-	1				
Raptors & Owls			1	1	-	-	31	-	30				
Trumpeter Swans				1	-	-	31	31					
Moose & Elk					15		15						

Low Risk	Restrictions would not normally apply. Where ground conditions permit, plan development activities within these timeframes.
Caution	Operators should avoid development activities during these timeframes. http://www.env.gov.bc.ca/esd/distdata/Peace_Region_Wildlife_Values/Industrial_Sectors/Best_Management_Practices/AircraftBMPJul%2015'08.pdf
Critical	Development activities are not appropriate during this timeframe. Aerial activities should adhere to guidelines. In the event that working within a critical window is unavoidable, proponent should contact an appropriate qualified professional (e.g. Registered Professional Biologist with BC accreditation) to discuss alternatives, and potential mitigation and monitoring plans.

Nest and Lek Search Protocol

Section 4.17 of the CEMP stipulates that if clearing is to take place outside of the least-risk windows or inside the General Nesting Period, the contractor shall inform BC Hydro and retain a Qualified Environmental Professional to develop a nest and lek search protocol. The protocol will be developed in consultation with the Canadian Wildlife Service (Environment Canada) and the BC Ministry of Forests, Lands and Natural Resource Operations. The protocol will outline survey procedures that will be used to determine the presence of active nests and buffers required around active nest sites. Trees would be removed once nests are confirmed unoccupied.

Measures to Protect Wildlife Habitat and Important Wildlife Areas

Habitat protection specifications in Section 4.17 of the CEMP will also support the requirement that mortality and disturbance of migratory birds and their nests be avoided, and that the risk of mortality and disturbance be minimized. EPPs must include the following measures, where relevant:

- Control permanent habitat loss by carefully flagging and restricting clearing to those areas required for construction and the safe and reliable operation of the Project
- Outside the reservoir area, control riparian vegetation clearing including clearing around wetlands, and retain wildlife trees when possible, and safe to do so

- Where live or dead large trees must be removed within the transmission line fall zone, leave tall stumps where feasible and safe to do so
- Focus lighting on work sites and away from surrounding areas to minimize light pollution and disturbance to wildlife
- Take measures to mitigate against harming migratory birds, nests and eggs as described in *Incidental Take of Migratory Birds in Canada*
- Use the Environmental Features Map, which shows Important Wildlife Areas, when planning construction activities to identify potential interactions with Important Wildlife Areas and guide avoidance and mitigation planning associated with these areas
- Except within the dam site area, on designated access roads and during clearing, prohibit construction activities within 15 m of the Ordinary High Water Mark of streams or wetland, unless the activity was described in the EIS and is accepted by BC Hydro
- Avoid construction activity within Important Wildlife Areas, including designated set-back buffers, where feasible
- Designate set-back buffers as follows:
    - If construction activities must be undertaken within a setback buffer, develop and implement an appropriate mitigation and monitoring program in consultation with BC Hydro, Ministry of Forests Lands and Natural Resources and Canadian Wildlife Service
    - If a bird builds or occupies a nest in an active construction zone a 5m buffer will be established around the nest to protect the nest and allow construction activities to proceed

<u>Measures for Wildlife Deterrence</u>

Implementing measures that will deter wildlife, as described in Section 4.17 of the CEMP, will further support the requirement that mortality and disturbance of migratory birds and their nests be avoided, and that the risk of mortality and disturbance be minimized. Such activities may be employed within the Project Activity Zone, and in areas adjacent to the Project Activity Zone where there is a risk of nest occupation by breeding birds.

Deterrent systems may include a combination of animal detection systems, physical barriers, auditory deterrents, and visual deterrents (e.g. airborne devices, kites, balloons, lights, laser deterrents, trained animals (dogs or birds of prey such as hawks or falcons), and models (injured birds or predators). Deterrent type will vary depending on target species, habituation, site conditions and effectiveness of deterrent activities.

Materials will also be placed, stored and stockpiled in a manner that limits their potential to attract wildlife.

B. Vegetation Clearing and Debris Management Plan

In addition to the requirements set out in the CEMP, clearing activities must be undertaken in accordance with the Vegetation Clearing and Debris Management Plan. Note that the development of the Vegetation Clearing and Debris Management Plan is a requirement under Condition 13 of the Environmental Assessment Certificate. This plan makes reference to Section 4.17, Wildlife Management, of the CEMP (described above) to mitigate potential effects of the Project on migratory birds and their nests.

Like the CEMP, Section 3.5.1 (Bird Nests) of the Vegetation Clearing and Debris Management Plan states that vegetation clearing will take place during the Peace Region terrestrial wildlife least-risk windows for birds. The plan also indicates bird nest surveys will be required (in accordance with EPPs) that for clearing activities that occur between 1 March and 30 September, bird nest surveys will be required to be conducted in accordance with an established procedure specified in the Environmental Protection Plans associated with clearing activities. An onsite bird biologist will be engaged to determine or confirm, in accordance with nest survey protocols, which nesting period, if any, is currently underway during field surveys.

C. Other Mitigation Activities

Where pre-clearing nest survey identify nests of migratory birds or species at risk that could be destroyed or disturbed by changes in water levels during construction, BC Hydro may undertake salvages of pre-fledgling nestlings. Salvaged nestlings would be sent to a pre-determined wildlife rescue center, then returned and released on site once they reach the fledgling stage. Salvages of pre-fledgling nestlings would be conducted in consultation with Environment Canada.

7.1.1.2 Monitoring and Follow-Up Measures to be Implemented during Construction, Reservoir Filling and Operations

As noted above, the requirements of Condition 9.3 will be meet through the implementation of the following monitoring programs during construction, reservoir filling and operation of the Project:

(A) Breeding Bird Follow-Up Monitoring Program,
(B) Bird Nesting Monitoring Program, and
(C) Waterfowl and Shorebird Follow-up Monitoring Program.

The timeline for the implementation of each of the monitoring programs is provided in Figure 3. Each program is described below.

A) Breeding Bird Follow-Up Monitoring Program

<u>Objectives</u>

The objectives of the breeding bird follow-up monitoring program are to survey songbird populations during construction, reservoir filling, and operations, and monitor changes in species richness and relative abundance, with a focus on species at risk. Results of monitoring will verify predicted effects of habitat alteration and fragmentation and will determine how targeted species respond to changes in food resources, habitat availability and disturbance and displacement as a result of the Project. Surveys will also document songbird use of habitats acquired, created or enhanced through mitigation.

<u>Spatial area</u>

Area 1: The Project Activity Zone and in Area 4: The area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

<u>Scope</u>

Breeding birds that will be covered by the monitoring program include passerines[1], hummingbirds, swifts, doves and pigeons.

<u>Schedule</u>

Annual monitoring will commence during the first year of construction (year 2) and will continue through the first ten years of operations.

<u>Monitoring Approach</u>

The following approach will be used to document which species of songbirds (including species at risk) change in relative abundance during the breeding season within the Project Activity Zone and surrounding upland Plateau areas as a result of the Project:

- Conduct breeding bird point-count surveys based on the *Inventory Methods for Forest and Grassland Songbirds* (Resources Inventory Committee 1999c). Sampling effort will

[1]Passerines are birds that have feet specialized for holding onto a horizontal branch—three toes pointing forward and one pointing back—and include thrushes, warblers, vireos, flycatchers, swallows, sparrows, blackbirds, crows, jays, nuthatches, wrens, finches, chickadees, tanagers, orioles, grosbeaks, waxwings, starlings, catbirds, creepers, pipits, weavers, shrikes, kinglets and larks.

concentrate on three geographic sites: upstream Peace River Valley, downstream Peace River Valley, and upland Plateau.

- The Peace River Valley, as defined by BC Hydro for the Project, will be used to delineate the upstream and downstream survey areas. The Plateau is defined as the extent of the habitat mapping within the BWBSmw1 variant, excluding the Peace River Valley. The Plateau does contain some river valley habitats associated with tributaries. Survey sites downstream in the Peace River Valley and on the Plateau will act as a control, as the impact of the Project is expected to be minimal in these areas (BC Hydro 2013).
- Bird observations will be associated with general habitat types created from specific ecosystem habitats occurring within the mapped area. The general habitat types will include:

aspen shrubland: xeric to submesic aspen forests on warm aspects

forested wetland: subhygric to hydric forested sites with deep peaty soils

grassland: xeric to submesic sparsely vegetated warm aspect sites with no trees

non-vegetated/anthropogenic: bedrock, cutbank, or areas with continual human disturbance

cultivated fields: areas under agricultural cultivation

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

upland forest seral: subxeric to subhygric aspen forested sites

upland forest non-seral: subxeric to subhygric coniferous forested sites

wetland: level to depressional wetlands dominated with extensive herbaceous or shrubby vegetation.

river: the Peace Mainstem between the Site C dam and the Alberta border

reservoir: the Site C reservoir

An estimated 200 point count surveys will be required in each sub area. The number of point counts per site was selected based upon the species accumulation curves calculated from data collected in 2006 and 2008 (Hilton et al. 2013). This analysis determined that 97% of the total species were detected after 204 point counts. Point count stations will be as evenly distributed between the general habitat types described above as possible based on habitat occurrence within sub area and access to crown and BC Hydro-owned lands (not all habitat types are present in each sub-area).

- Point count surveys will start at the onset of construction and continue annually through the first 10 years of operations. Permanent transects will be used within each site, and a 100m radius buffer will be applied to ensure that each point count will sample only one general habitat type. Each point count along the transect will be spaced at a minimum of 200-metre intervals.

- At each point count station, all bird species seen or heard within a five-minute listening period will be recorded. Distance and direction to each detection will be recorded. Transects will be accessible by truck, all-terrain vehicle, boat, or foot. Surveys will be completed in the first four hours after sunrise when birds are the most active. Transects will be repeated three times over the breeding season—May 1 to July 10 (Resources Inventory Committee 1999). Several transects in the upstream Peace River Valley site will be placed in the reservoir footprint, and will consequently be lost once the reservoir is filled. These transects will not be replaced.

A variety of habitat types will be created through reclamation, enhanced or acquired as part of compensation for the Project. Point count surveys in these habitats will be completed. The detail on the number, frequency and location of point count surveys in these areas will be determined as site work is complete and the type of habitat (i.e. grassland, wetland, etc.), the size and configuration of the area and the expected rare species that may occur can be determined. These surveys will inform mitigation and compensation measures.

Data collected will be used to answer the following questions:

- How does the Project impact the relative abundance of songbirds (including species at risk) during the breeding season within the Project Activity Zone and surrounding upland Plateau sites?
- How are properties BC Hydro acquired for its vegetation and wildlife mitigation/ compensation used by rare songbirds?
- How do songbirds respond to changes in aquatic and riparian-related food resources (insects) associated with the change from a fluvial to a reservoir system?

Abundance estimates will be determined as the number of species per unit area of each habitat type and as the total count per unit area of each habitat type. Repeated visits over multiple years will allow us to determine the abundance in each of the 10 generalized habitat types. Data collected in each habitat type over multiple visits would be pooled.

- o Unit area would be equal the total area of each habitat type that was sampled [~Area (m^2) of 200m point count * number of point counts in each habitat type]. Assuming point counts are entirely within each habitat type.
- o Number of species or total count would be the number detected within each fixed-width point count in each habitat type.

Abundance estimates will be determined for rare species where there are a sufficient number of observations to do so. Abundance would be expressed as a total count per unit area of each habitat type.

These abundance estimates could then be extrapolated to the landscape to get an estimate of the population effected by the Project and the population being supported by lands retained and managed to provide habitat for migratory birds and bird species at risk.

Qualifications

Monitoring will be undertaken by an environmental professional with experience in conducting breeding bird surveys and familiarity with birds of the Peace Region.

B) Bird Nest Monitoring Plan

Objectives

The objective of the bird nest monitoring plan is to monitor potential disturbance of breeding migratory birds in and adjacent to the Project Activity Zone during construction, reservoir filling and operation along the reservoir/Peace River downstream to the Pine River.

Spatial Area

Area 2: The Local Assessment Area and Area 4: The area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

Scope

The nest loss monitoring program will document if changes in water levels observed during construction and operations in the reservoir and downstream of the dam to the Pine River result in the loss of active migratory bird nests.

During construction, data collected will document:

- The number of nests and migratory bird species nesting within the area of the construction headpond;
- The number of nests and migratory bird species nesting within the zone subject to water level changes during construction downstream of the dam site and the Pine river[2]; and
- The impact of changing water levels within the construction headpond and downstream to the Pine River on known nests.

During operations data collected will document:

- The number of nests and migratory bird species nesting within the reservoir drawdown zone;
- The number of nests and migratory bird species nesting between the dam site and the Pine river within the area subject to water level changes; and,
- The impact of changing water levels within the reservoir and downstream to the Pine River on known nests.

Schedule

Sample site selection will begin the year prior to river diversion.

Annual surveys will begin during the breeding season after reservoir diversion, and will continue through construction and the first 10 years of operations.

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[2] The Pine River is a large watershed. Below its confluence its outflows will determine water levels in the Peace River.

Monitoring Approach

The following approach will be used to document which species nest within areas that could be subject to changing water levels in the reservoir and downstream to the Confluence of the Pine River during Project construction, reservoir filling and operations.

Use hydraulic modeling to define the survey area through delineating:

- areas within the reservoir which will be subject to 90% headpond flooding during construction;
- the reservoir drawdown zone: the difference between maximum and minimum reservoir elevations;
- areas downstream of the dam to the Pine River that will be subject changes in water levels during construction and operations: using flow modeling to map maximum Peace Canyon flows (existing conditions) and Site C maximum flows (post-project conditions);

Layout nest survey transects.

  - Transects will be established to sample the range of habitats (as feasible) that occur within the study areas (head pond, downstream, reservoir drawdown zone).

Conduct nest searches (active and passive): May-August

- Monitor active nests to determine if young fledge are lost due to predation or lost due to flooding
- Active nests will be re-visited every 2-3 days, visits will increase to daily when chicks are within 2-3 days of fledging
- Methodology will follow that outlined in: *Inventory Methods for Forest and Grassland Songbirds* (Resources Inventory Committee 1999), *Inventory Methods for Nighthawks and Poorwills*. Version 2.0. (Resources Inventory Committee 1998).

Monitoring will occur annually during construction and the first 10 years of operations

Qualifications

- R.P. Bio and wildlife technicians with experience in conducting breeding bird surveys and familiarity with birds of the Peace Region

C) Waterfowl and Shore Bird Follow-up Monitoring

Objectives

The objectives of the waterfowl and shore bird follow-up monitoring program are to monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features. Data collected will be used to:

- Document changes in species composition and numbers as a result of Project construction and operations.
- Compare waterfowl and shorebird use data to pre-project baseline data

- Document the extent of ice on the Peace River and reservoir in spring and how waterfowl and shorebird distribution changes in response to ice
- Document 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.
- Collect baseline data on the nesting population of Belted Kingfisher along the reservoir and downstream to the Alberta border, and conduct periodic sampling during early operations to identify if the nesting population has declined.

<u>Spatial area</u>

Area 2: The Local Assessment Area and in Area 3: The Regional Assessment Area. Specifically, the reservoir and Peace River downstream to the Alberta border, natural wetlands within the LAA and wetland mitigation sites.

<u>Schedule</u>

- Waterfowl and shorebird surveys will be annual, beginning in the first year of construction and continue through the first 10 years of operations.
- Kingfisher surveys will be conducted in the year before river diversion and in years 6 and 10 of operations. This timing aligns with the mercury sampling plan.
- Surveys to be completed in March (spring migration), May-July (Kingfisher nesting, use of wetlands for breeding) and September-October (fall migration)

<u>Monitoring Approach</u>

- BC Hydro will retain a wildlife biologist with experience in conducting waterfowl and shorebird surveys to develop a sampling plan to document waterfowl and shorebird use of the reservoir and wetlands in the LAA. Surveys will be completed by environmental professionals with experience in conducing waterfowl and shorebird surveys.
- Waterfowl and shorebird monitoring will occur annually during construction and the first 10 years of operations.

The waterfowl surveys will be based on the following:

- Use *Inventory Methods for Waterfowl and Allied Species. Version 2.0.* (Resources Inventory Committee 1999) to complete surveys and analyses data.
- Conduct multiple aerial surveys within each season to account for, as feasible, the expected natural high variability in waterfowl and shorebird populations.
- Have flexibility in scheduling surveys for early migrants to account for variability (early or late) in the onset of spring.
- Map the extent of ice formation along the reservoir during early spring surveys
- Use brood or pair counts to document and confirm the effectiveness of wetland mitigation sites and nest boxes.

The Kingfisher sampling plan will document the breeding Kingfisher population along the Peace River from Hudson's Hope to the Alberta border. A draft work plan is provided in Appendix C.

Qualifications

- Environmental professional with experience in conducting waterfowl surveys and familiarity with birds of the Peace Region

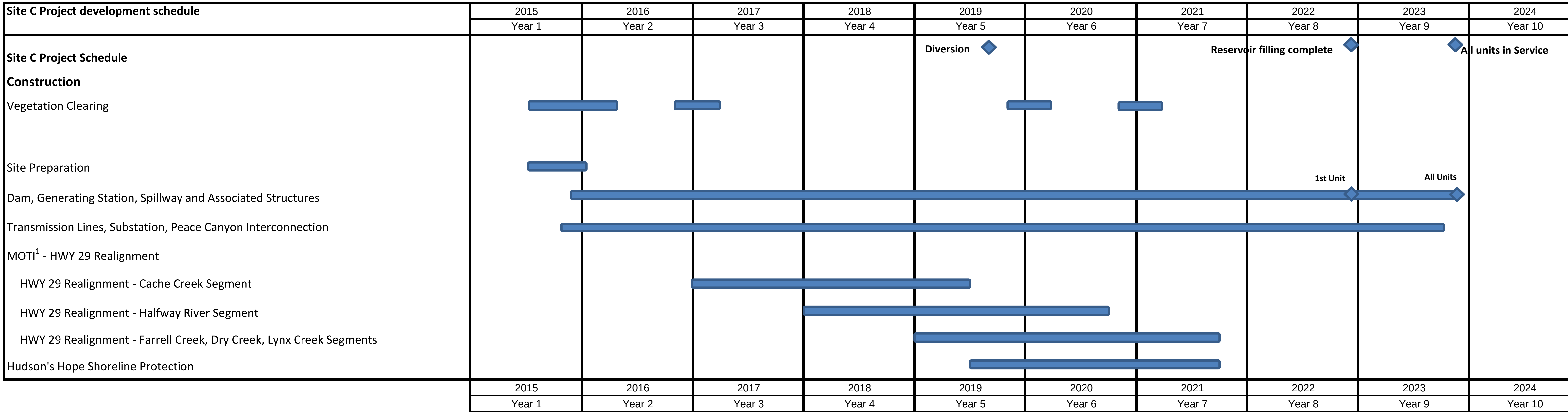
7.1.2 Annual Schedule

This section has been developed in accordance with **Condition 9.2** of the Decision Statement: *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.*

On October 17, 2014, BC Hydro provided the Agency with a schedule describing the timing for construction activities. A general clearing schedule was provided in the draft Vegetation Clearing and Debris Management Plan, submitted to the Agency on October 17, 2014.

Figure 4 below provides an updated construction schedule. This figure focuses on construction activities that may affect migratory birds and their nests. Figures 5 and 6 are also provided to show the locations of the construction activities described in Figure 4.

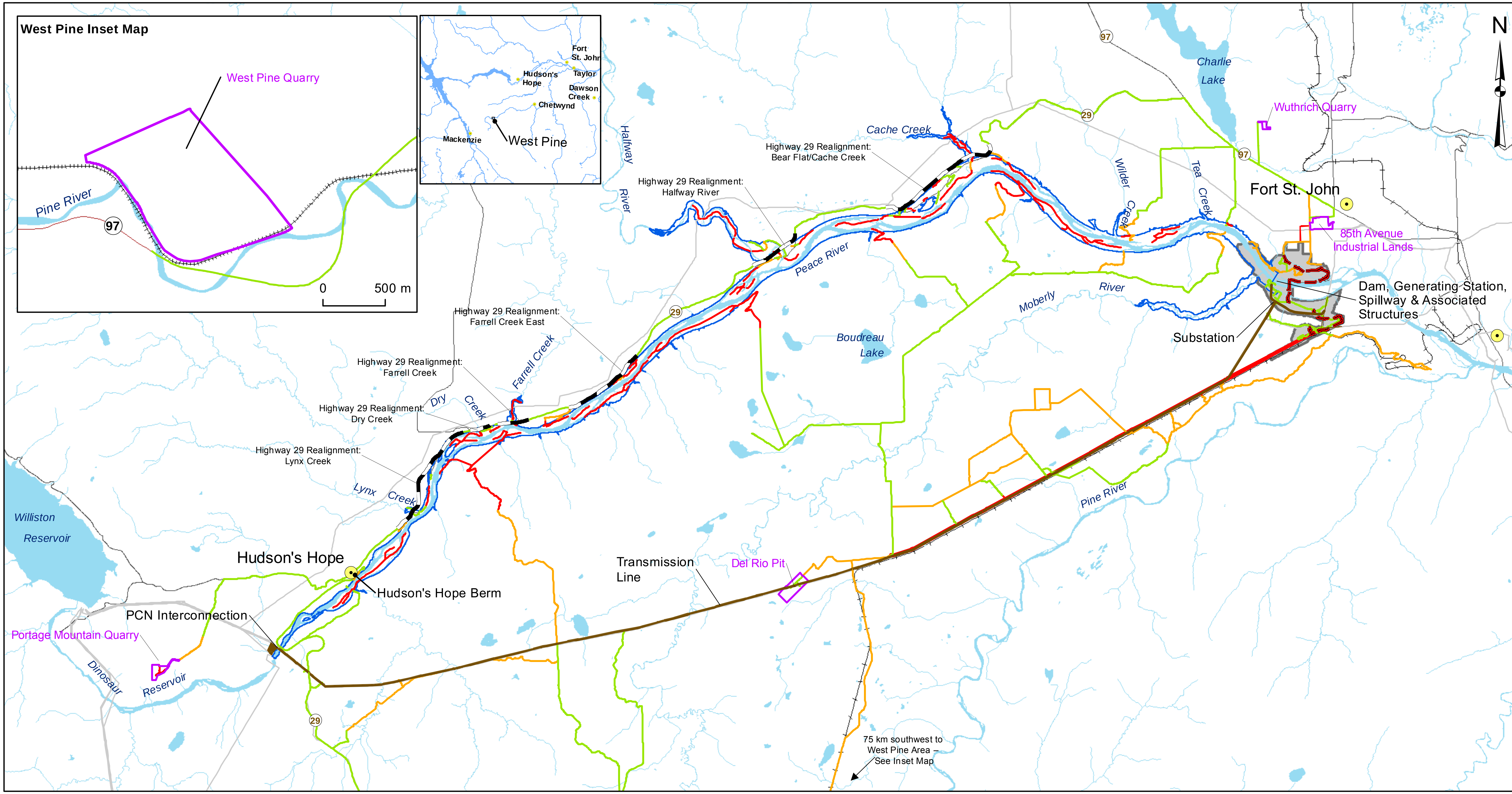
Figure 4. 2015 Construction Activities That May Affect Migratory Birds and Their Nests

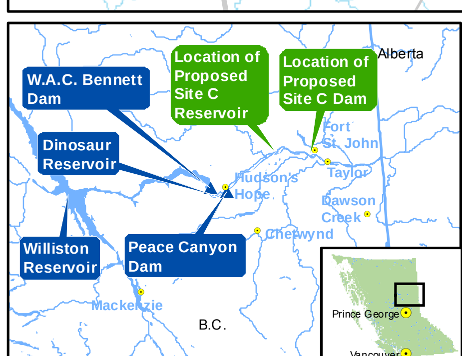


[1] Ministry of Transportation and Infrastructure Works

Construction of Site C is subject to environmental regulatory approvals and ensuring that the Crown's constitutional duties to First Nations are met.

The Site C project schedule is indicative only and may change as a result of procurement and project planning advancements





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Proposed reservoir area (461.8 m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August 2006.

Legend

- Maximum Normal Reservoir Level (461.8 m)
- Dam, Generating Station, Spillway & Associated Structures
- Transmission Corridor
- Existing Transmission Line
- Source Area (With Development Plan)
- City/District Municipality

Project Transportation Routes

- Existing Access
- Existing Access — To Be Upgraded
- Proposed New Access
- Dam Site Roads
- Highway Realignment
- Existing Railway
- Existing Road

1:250,000

0 10 km

BC hydro

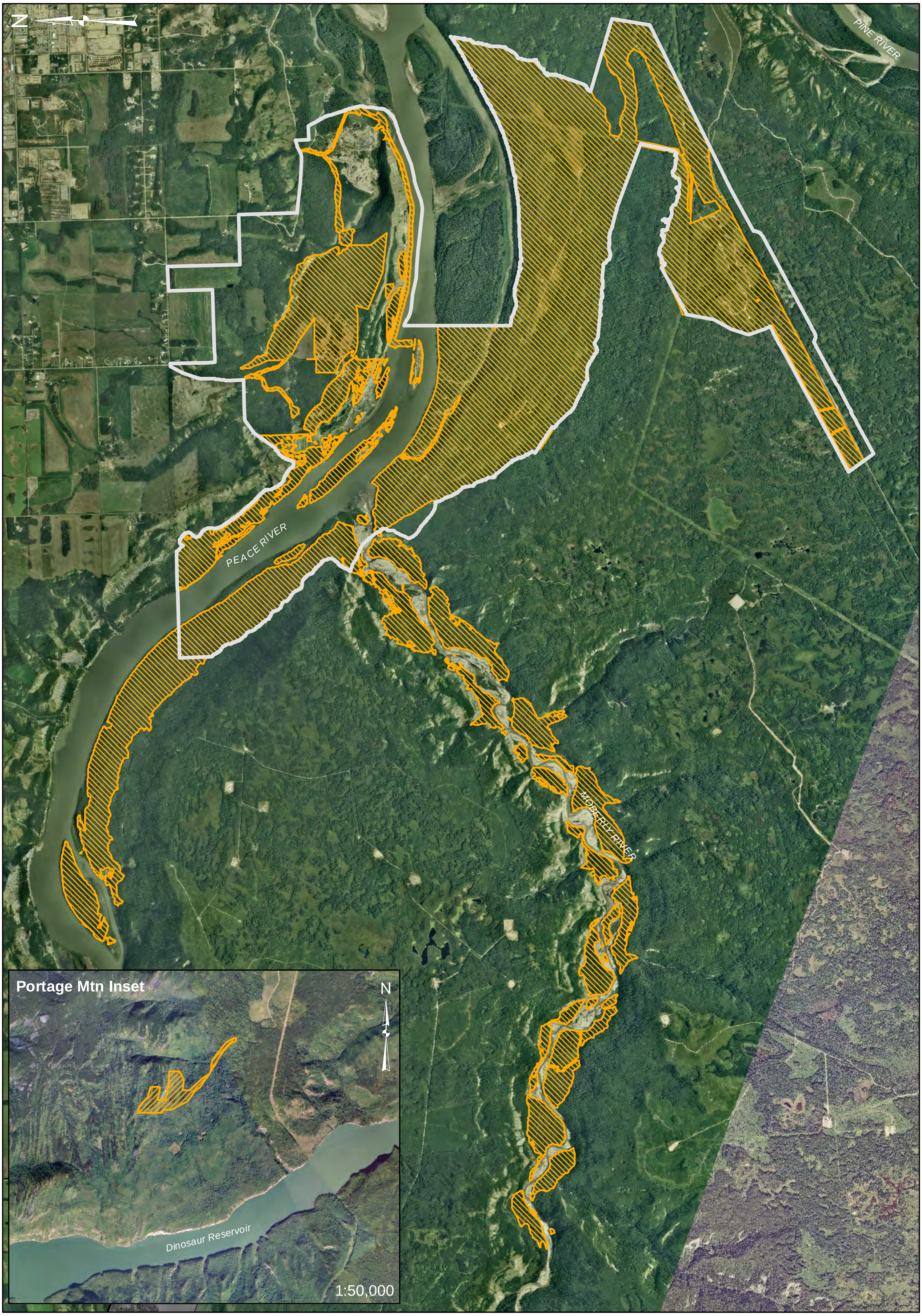
SITE C CLEAN ENERGY PROJECT

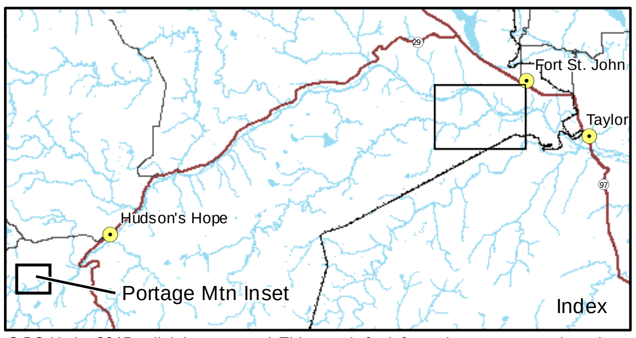
Figure 5. Construction Activity Locations

Date	June 1, 2015	DWG NO	1016-C14-B7880	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

Path: X:\ArcGIS\Projects\Regulatory\Construction_Plans\Project_Activity_Zone_Construction_1016_C14_B7880.mxd





1:40,000

0 0.75 1.5 km

2015 Clearing Area

Dam Site Area

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:15,000 photos taken Aug. 2011, and TRIM.

BC hydro

SITE C CLEAN ENERGY PROJECT

Figure 6. Planned Work Areas -Site Preparation Clearing Activities

Date	June 1, 2015	DWG NO	1016-C14-B7805-1	R 2

Path: X:\ArcGIS\Projects\ProjectManageOffice\Year1_PlannedActivities\1016_C14_B7805-1.mxd

7.1.3 Consultation of Environment Canada Policies and Guidelines

This section has been developed in accordance with **Conditions 9.5.1 and 9.5.2** of the Decision Statement: *The Proponent shall, in preparing the plan, consult: Environment Canada's policy on Incidental Take of Migratory Birds in Canada, and Environment Canada's avoidance guidelines on General Nesting Periods of Migratory Birds in Canada, respectively.*

Sections 3.0 and 7.1.1 describe how the Plan has been developed in accordance with Conditions 9.5.1 and 9.5.2 of the Decision Statement.

7.1.4 Submission of Draft and Final Plans

This section has been developed in accordance with **Conditions 9.6 and 9.7** of the Decision Statement:

- *Condition 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; and*
- *Condition 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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 9.6), and consultation undertaken for development of the Plan.

7.1.5 Plan Implementation and Analysis of Plan Implementation

This section has been developed in accordance with **Condition 9.8** of the federal Decision Statement: *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.*

BC Hydro will implement the migratory bird mitigation and monitoring plan as described in the sections above. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of this Plan.

7.1.6 Risk of Bird Collisions with the Transmission Line

This section has been developed in accordance with **Conditions 9.9.1, 9.9.2, and 9.9.3** of the federal Decision Statement: *The Proponent shall address potential risks of bird collisions with the transmission line, in consultation with Environment Canada, by:*

- *Condition 9.9.1: conducting a risk assessment for bird collisions under the current* *transmission line design;*

- *Condition 9.9.2: determining if additional mitigation measures could be implemented to reduce the risk of bird collisions; and*
- *Condition 9.9.3: implementing any additional mitigation measures (e.g. line marking and diversions), to minimize impacts.*

In meeting the requirements of Decision Statement conditions 9.9.1, 9.9.2 and 9.9.3, BC Hydro has considered the design of the 500 kV transmission lines.

Bird strikes (electrical contacts with birds) on overhead transmission and distribution lines are the result of either birds simultaneously touching two separate energized phases of a three-phase circuit with their body (usually wings) or simultaneously touching an energized line and a grounded portion of the pole; causing a phase-to-ground electrical fault. On BC Hydro's 500 kV transmission lines, the phases of the circuit will be spaced approximately 12 m apart, eliminating the potential for a phase to phase electrical contact. Phase to ground contacts are also very unlikely as the distance from the circuit to the grounded support structure will be approximately 4 meters, which is much longer than the wingspan of a bird.

In addition to preventing electrical faults, 500 kV transmission lines are also much more visible to birds, due to the conductors (wires) being relatively large (greater than 1 inch in diameter) and being strung together in a bundle of four. The bundle is separated by large aluminum spacers (400 mm x 400 mm) and is much easier for a bird to see than a single wire.

A risk assessment for bird collision will be completed in the late summer-fall of 2015. In conducting the risk assessment, the following information will be reviewed:

- outage information for the existing 138kV lines currently installed along the right-of-way to gain an understanding of whether birds collide with the existing line, the time of year collisions occur and area(s) of the line where collisions occur.
- outage information for the existing 500kV lines in the Peace to gain an understanding of whether birds collide with the existing line, the time of year collisions occur and area(s) of the line where collisions occur.

Field surveys of sections of the existing 500kv lines running between GM Shrum Generating Station and Williston Substation in Prince George will be conducted to collect data on whether birds are colliding with the lines and where collisions occur. This line is the closest 500kV line to the Project. Sections surveyed will support similar terrain and vegetation as the Project line. These surveys will provide data on the current bird collisions with 500kv lines in the Local Assessment Area. Survey work will be undertaken by an environmental professional with experience in conducting bird-transmission line collision risk assessments.

Using the above information biologists will work with the transmission line design team to determine whether any further adjustments or additional migration measures could be incorporated into the line design.

Please refer to Section 2.2 for a description of BC Hydro's engagement with Environment Canada in the development of this Plan.

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

7.2.1 Objective and Context, Non-Wetland Migratory Bird Habitat Mitigation and Monitoring

This section has been developed in accordance with **Conditions 10.1 and 10.2** of the Decision Statement:

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

In issuing the Decision Statement and the Environmental Assessment Certificate, the federal and provincial Ministers acknowledged that it will not be possible to fully mitigate the effects of the Project on Wildlife Resources resulting from, in particular, the loss of habitat for certain migratory birds. Given this context, BC Hydro has developed non-wetland migratory bird habitat mitigation measures that will be implemented to support (but cannot fully mitigate for the effects on) non-wetland migratory bird habitat. These measures have been developed in accordance with the requirements of Decision Statement Condition 10, shown below.

Please refer to Section 2.2 Consultation for information on BC Hydro's consultation with Environment Canada.

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.

7.2.2 Non-Wetland Bird Habitat Baseline Conditions

This section has been developed in accordance with **Condition10.3.1** of the federal Decision Statement: *[The Plan shall include]: non-wetland migratory bird habitat baseline conditions for habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact.*

The table below summarizes the non-wetland migratory bird baseline conditions for habitat that would be permanently lost, habitat that would be fragmented and habitat that would remain intact. The data in this table has been extracted from Volume 2, Appendix R, Part 1 of the EIS and is based on Terrestrial Ecosystem Mapping completed for the Project (see Appendix D for table legend). Terrestrial Ecosystem Mapping was competed using the Province of BC's Resources Inventory Committee (1998a) standards. Mapping was completed between 2005 and 2011. There are 7,295 polygons on the map; field plots were completed in 2,673 polygons for a visitation level of 37%, exceeding the target survey intensity of 15 to 25% for level 4 sampling (Resources Inventory Committee 1998a). A detailed description of the mapping can be found in Volume 2, Appendix R, Part 1 of the EIS.

Table 3. Summary of habitat that would be lost, fragmented or remained intact as a result of construction of the Project

Habitat	Total in LAA (ha)	Permanently Lost (ha)	Fragmented (ha)	Remain intact (ha)
BWBSmw1				
White spruce-Trembling aspen- Soopolallie (00/AS)	1771.6	150.60	0	1621.00
Cutbank (00/CB)	1092.4	326.00	3.00	763.40
Cultivated field (00/CF)	9260.2	1126	159	7975.20
Exposed soil (00/ES)	70.3	9.4	5.4	55.50
Gravel pit (00/GP)	172.3	18.7	0	153.60
Rock (00/RO)	0.3	0.02	0	0.28
Rural (00/RW)	204	15.8	0	188.20
Urban (00/UR)	730	13.1	12	704.90
Fuzzy-spiked Wildrye -Wolf-willow (00/WW)	2667.1	261.80	15.80	2389.50
White spruce-Trembling aspen- Step moss (01/AM)	5586.4	602.1	53.2	4931.10
Trembling aspen- Creamy peavine ($01/AM:ap)	25734.5	2615.1	769	22350.40
Lodgepole pine - Lingonberry - Velvet-leaved blueberry (02/LL)	620.3	42.9	32.1	545.30
Trembling aspen- Kinnikinnick ($02/LL:ak)	501.5	83.3	15.6	402.60

Habitat	Total in LAA (ha)	Permanently Lost (ha)	Fragmented (ha)	Remain intact (ha)
White spruce- Wildrye - Peavine (03/SW)	2343.3	326.3	73.8	1943.20
Trembling aspen- Soopolallie ($03/SW:as)	4209.3	425.3	82.3	3701.70
Black spruce- Lingonberry - Coltsfoot (04/BL)	2322.8	47.7	77.8	2197.30
Trembling aspen- Labrador tea ($04/BL:al)	1410.9	79.3	176.8	1154.80
Trembling aspen- Black Twinberry (05/SC:ab)	2618.4	128.7	16	2473.70
Paper birch- Red-osier dogwood ($05/SC:ep)	345.6	69.8	2.9	272.90
White spruce- Currant - Oak fern (05/SO)	1214.7	440.8	7.9	766.00
White spruce- Currant – Bluebells (06/SC)	2942.2	129.1	0	2813.10
White spruce- Currant – Horsetail (07/SH)	1698.6	755.4	10.3	932.90
Cottonwood- Cow parsnip ($07/SH:ac)	1413.2	408.6	8	996.60
Ep – Ep-Dogwood ($07/SH:ep)	16.3	1.4	1.3	13.60
Trembling aspen-White spruce - Red-osier dogwood (09/Fm02)	2663.6	1134.5	0	1529.10
BWBSwk1				
White spruce- Wildrye - Peavine (04/SW)	51.9	23.1	0	28.80
At - Soopolallie - Sarsaparilla ($04/SW:ss)	106.3	24.6	0	81.70
ESSFmv2				
Subalpine fir- Rhododendron - Feathermoss (01/FR)	153	13.2	0	139.80
SBSwk2				
Cottonwood-Spruce-Red-osier dogwood (00/Fm02)	35.6	3.5	0	32.10

Habitat	Total in LAA (ha)	Permanently Lost (ha)	Fragmented (ha)	Remain intact (ha)
Gravel pit (00/GP)	12.4	12.3	0	0.10
Rock (00/RO)	3.1	2.5	0	0.60
Spruce-Oak fern (01/SO)	231	19.9	0	211.10
Lodgepole pine-Huckleberry-Cladina (02/LH)	70.4	25.3	0	50.50
Spruce – Huckleberry – Highbush cranberry (03/SC)	68	6.9	0	42.70
Black spruce-Lodgepole pine-Feathermoss (04/BF)	67.3	30.2	0	60.40
Spruce-Devil's club (05/SD)	74.3	7	0	44.10
Spruce-Horsetail (06/SH)	57.3	8.2	0	50.30
Trembling aspen- Kinnikinnick ($02/LL:ak)	501.5	83.3	15.6	402.60
White spruce - Wildrye – Peavine (03/SW)	2343.3	326.3	73.8	1943.20
Trembling aspen- Soopolallie ($03/SW:as)	4209.3	425.3	82.3	3701.70
Black spruce - Lingonberry - Coltsfoot (04/BL)	2322.8	47.7	77.8	2197.30
Trembling aspen- Labrador tea ($04/BL:al)	1410.9	79.3	176.8	1154.80
Trembling aspen- Black Twinberry (05/SC:ab)	2618.4	128.7	16	2473.70
Cottonwood- Red-osier dogwood ($05/SC:ep)	345.6	69.8	2.9	272.90
White spruce- Currant - Oak fern (05/SO)	1214.7	440.8	7.9	766.00
White spruce- Currant – Bluebells (06/SC)	2942.2	129.1	0	2813.10
White spruce- Currant – Horsetail (07/SH)	1698.6	755.4	10.3	932.90
Cottonwood- Cow parsnip ($07/SH:ac)	1413.2	408.6	8	996.60

Habitat	Total in LAA (ha)	Permanently Lost (ha)	Fragmented (ha)	Remain intact (ha)
Paper birch-Dogwood ($07/SH:ep)	16.3	1.4	1.3	13.60
Cottonwood-White spruce - Red-osier dogwood (09/Fm02)	2663.6	1134.5	0	1529.10
BWBSwk1				
White spruce- Wildrye - Peavine (04/SW)	51.9	23.1	0	28.80
Trembling aspen- Soopolallie - Sarsaparilla ($04/SW:ss)	106.3	24.6	0	81.70
ESSFmv2				
Subalpine fir- Rhododendron - Feathermoss (01/FR)	153	13.2	0	139.80
SBSwk2				
Cottonwood-Spruce-Red-osier dogwood (00/Fm02)	35.6	3.5	0	32.10
Gravel pit (00/GP)	12.4	12.3	0	0.10
Rock (00/RO)	3.1	2.5	0	0.60
Spruce-Oak fern (01/SO)	231	19.9	0	211.10
Lodgepole pine-Huckleberry-Cladina (02/LH)	70.4	25.3	0	50.50
Spruce – Huckleberry – Highbush cranberry (03/SC)	68	6.9	0	42.70
Black spruce-Lodgepole pine-Feathermoss (04/BF)	67.3	30.2	0	60.40
Spruce-Devil's club (05/SD)	74.3	7	0	44.10
Spruce-Horsetail (06/SH)	57.3	8.2	0	50.30

7.2.3 Migratory Bird Abundance, Distribution and Use of Non-Wetland Habitat

This section has been developed in accordance with **Condition 10.3.2** of the Decision Statement: *[The Plan shall include]: migratory bird abundance, distribution and use of non-wetland habitat.*

Resident migratory birds use habitats for general living, foraging and breeding. Migratory birds either travel through the Local Assessment Area on their way to and from breeding grounds, or remain in the LAA to breed.

Table 4 summarizes non-wetland migratory bird abundance, distribution and use of non-wetland habitats. Habitats listed in the table are the non-wetland habitats identified in the LAA on the Terrestrial Ecosystem Map (see EIS Volume 2, Appendix R, Part 1). These habitats are also described in the expanded legend provided in Appendix D. Distribution of birds by habitat is based on data collected during baseline surveys (2006-2008 and 2011-2012) (see EIS Volume 2, Appendix R, Part 4), and augmented by information on habitat use published by the Conservation Data Center and Nature Serve.

Table 4. Non-wetland migratory bird abundance, distribution and use of non-wetland habitats.

Species	Species Abundance	Use in Area	Distribution of each species within non-wetland habitats																						
			AM	AM:ap	AS	BL	BL:al	CB	CF	Fm02	LL	LL:ak	RO	RW	SC	SC:ab	SC:ep	SH	SH:ac	SH:ep	SO	SW	SW:as	UR	WW
Non-wetland migratory bird species of conservation concern for BCR 6																									
Alder Flycatcher	385	mb																							
American Kestrel	8	mb							X																X
American Three-toed Woodpecker	143	mb	X	X		X	X			X					X	X	X	X	X	X	X				
Baltimore Oriole	130	mb	X				X			X				X		X	X		X	X					
Bank Swallow	248	mb						X																	
Barn Swallow	12	mb												X										X	
Bay-breasted Warbler	6	mb	X							X					X			X			X				
Black-billed Magpie	71	rb			X				X					X											X
Blackpoll Warbler	38	mb	X			X									X			X			X				
Black-throated Green Warbler	619	mb	X	X		X	X			X					X	X	X	X			X				
Bohemian Waxwing	2	rb	X	X						X					X	X	X	X	X	X	X	X	X		
Boreal Chickadee	82	rb	X	X		X	X			X					X	X	X	X	X	X	X				
Brown Creeper	6	mb	X			X									X			X			X				
Canada Warbler	293	mb	X	X											X	X	X		X	X	X	X			
Cape May Warbler	6	mb	X							X					X			X	X	X	X	X			
Clay-colored Sparrow	595	mb			X				X																X
Common Nighthawk	69	mb							X					X										X	X
Common Yellowthroat	350	mb																							
Connecticut Warbler	72	mb	X			X					X					X	X	X				X			
Eastern Phoebe	36	mb							X					X											X
Le Conte's Sparrow	35	mb							X																X
Least Flycatcher	2248	mb	X	X		X	X			X				X	X	X	X	X	X	X	X				
Mourning Warbler	189	mb		X			X			X	X	X			X	X	X	X	X	X	X	X	X		
Nelson's Sparrow	13	mb																							
Northern Flicker	142	mb	X	X	X	X	X			X	X	X			X	X	X	X	X	X	X	X	X		
Northern Shrike	2	mb			X				X					X											X
Olive-sided Flycatcher	48	mb								X															

Species	Species Abundance	Use in Area	Distribution of each species within non-wetland habitats																						
			AM	AM:ap	AS	BL	BL:al	CB	CF	Fm02	LL	LL:ak	RO	RW	SC	SC:ab	SC:ep	SH	SH:ac	SH:ep	SO	SW	SW:as	UR	WW
Pileated Woodpecker	43	rb	X	X		X				X					X	X	X	X	X	X	X				
Sharp-tailed Grouse	N/A-leks located	rb	X	X	X		X		X	X	X				X	X	X	X	X	X	X	X	X		X
Western Tanager	842	mb	X			X					X				X							X			
Western Wood-Pewee	238	mb	X			X				X	X				X			X			X	X			
White-throated Sparrow	2804	mb			X				X					X											X
White-winged Crossbill	134	rb	X			X					X				X			X			X	X			
Yellow-bellied Sapsucker	480	mb	X	X								X			X	X	X	X	X	X	X	X	X		
Greater Yellowlegs	5	mb																						X	
Killdeer	149	mb							X					X										X	
Upland Sandpiper	1	mb							X					X										X	X
Other non-wetland migratory birds present within Local Assessment Area																									
American Pipit	34	mb	X						X				X												
American Redstart	1022	mb	X	X		X	X		X	X	X				X	X	X	X	X	X	X	X	X		X
American Robin	1811	mb	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Black and White Warbler	363	mb	X	X		X	X		X	X	X	X			X	X	X	X	X	X	X	X	X		
Black-capped Chickadee	967	rb	X		X	X			X	X	X			X	X			X			X	X		X	
Blue-headed Vireo	195	mb	X			X			X	X	X				X			X			X	X			
Calliope hummingbird	1	mb																X							
Cassin's vireo	5	mb																			X				
Cedar Waxwing	702	mb	X		X	X			X	X	X			X				X			X	X			
Chipping Sparrow	1222	mb	X	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Cliff Swallow	43	mb						b					X					X							
Common Grackle	9	rb	X	X	X	X	X		X	X	X	X			X	X	X	X	X	X	X	X	X		X
Dark-eyed Junco	863	rb	X	X	X	X	X				X	X			X	X	X	X	X	X	X	X	X		
Dusky Flycatcher	11	mb	X	X		X	X				X										X	X			
Eastern Kingbird	44	mb	X	X	X																X				
Evening Grosbeak	69	rb	X	X		X				X					X	X	X	X	X	X	X	X	X		
Fox sparrow	109	mb	X	X	X	X	X		X	X	X	X		X				X	X	X		X	X		X
Golden-crowned Kinglet	231	mb	X			X			X	X	X				X			X			X	X			
Grey Catbird	11	mb	X																						X
Grey Crowned Rosy Finch	1	mb						X					X	X										X	
Hairy Woodpecker	326	mb	X			X			X	X	X				X						X	X			

Species	Species Abundance	Use in Area	Distribution of each species within non-wetland habitats																						
			AM	AM:ap	AS	BL	BL:al	CB	CF	Fm02	LL	LL:ak	RO	RW	SC	SC:ab	SC:ep	SH	SH:ac	SH:ep	SO	SW	SW:as	UR	WW
Hammond's Flycatcher	62	mb	X	X						X					X	X	X	X	X	X	X	X	X		
Hermit Thrush	896	mb	X		X	X		X	X	X	X				X			X			X	X		X	X
House Sparrow	19	rb							X					X										X	
House Wren	164	mb	X	X	X				X		X	X		X				X	X	X		X	X	X	X
Lincon's Sparrow	1281	mb	X	X	X	X	X		X	X	X	X		X		X	X	X	X	X	X	X	X		X
Magnolia Warbler	237	mb	X	X	X	X	X			X	X	X			X	X	X	X	X	X	X	X			
Northern Rough-winged Swallow	23	mb						X	X															X	X
Oragne-crowned Warbler	666	mb	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Ovenbird	1556	mb	X	X		X	X		X	X	X	X			X	X		X	X	X	X	X	X	X	X
Pacific Wren	34	mb																							
Pacific Slope Flycatcher	77	mb	X		X					X	X				X			X			X	X		X	
Pine Siskin	1540	mb	X		X			X	X	X	X			X	X			X			X	X			X
Puple Finch	304	mb	X		X	X		X	X	X	X			X	X			X			X	X			X
Red Crossbill	29	mb	X												X						X	X			
Red-breasted Nuthatch	645	rb	X		X	X	X				X				X				X		X	X			
Red-eyed Vireo	1732	mb		X	X		X	X	X	X		X		X		X			X		X		X		X
Rose-breasted Grosbeak	849	mb	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X
Ruby-crowned Kinglet	389	mb	X			X			X	X	X				X			X			X	X			
Ruby-throated Hummingbird	1	mb	X	X																					
Savanna Sparrow	163	mb	X	X	X	X	X		X	X				X							X	X	X	X	
Says Phoebe	8	mb	X	X																					
Song Sparrow	285	mb	X	X	X			X	X	X					X	X	X	X	X	X	X	X	X		X
Swainson's Thush	1764	mb	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X
Tennesee Warbler	1079	mb	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	
Townsend's Soliatire	13	mb	X	X						X	X	X	X					X	X	X		X	X		X
Varied Thrush	86	mb	X	X		X	X		X	X					X	X	X	X	X	X	X	X	X		
Vesper Sparrow	93	mb		X	X				X					X									X		X
Violet-green Swallow	38	mb	X	X	X			X	X						X	X	X	X	X	X		X	X		
Warbling Vireo	1116	mb	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X			X
White-breasted Nuthatch	14	rb		X						X									X	X			X		
White-crowned Sparrow	44	mb	X	X	X				X		X	X										X	X		
Yellow-rumbed Warbler	3269	mb	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	

Species	Species Abundance	Use in Area	Distribution of each species within non-wetland habitats																						
			AM	AM:ap	AS	BL	BL:al	CB	CF	Fm02	LL	LL:ak	RO	RW	SC	SC:ab	SC:ep	SH	SH:ac	SH:ep	SO	SW	SW:as	UR	WW
mb=migrant, breeds in Project areas; rb=year round resident breeds in Project areas; X=habitats used for breeding and/or migration																									

7.2.4 Mitigation for Changes in Aquatic and Riparian-Related Food Resources

This section has been developed in accordance with **Condition 10.3.3** of the Decision Statement: *[The Plan shall 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.*

Changes in aquatic and riparian-food related resource and other habitat features associated with a change from a fluvial to a reservoir system as a result of the Project were determined as part of the assessment of the potential effects of the Project on fish and fish habitat (EIS Volume 2, Appendix P Part 3 Future Conditions in the Peace River). Measures proposed to mitigate these effects are described in the Fisheries and Aquatic Habitat Management Plan, which has been developed in accordance with Decision Statement Condition 8 and Environmental Assessment Condition 4.

Measures to mitigate changes in aquatic and riparian-related food resources for non-wetland migratory birds include reservoir shoreline and littoral zone[3] enhancements and reservoir shoreline riparian planting. These measures are expected to support the production of aquatic and riparian-related insects that are a food source for non-wetland migratory birds.

Reservoir shoreline enhancements are proposed at five sites to enhance physical habitat in the reservoir (Figure 7). The sites include contouring of two north bank borrow sites at Highway 29 and three additional sites on the south bank that will increase littoral, backwater, and shoal habitat. The goal of the shoreline and littoral zone (i.e., shallow water) enhancement is to create a diversity of shoreline habitats and increase the area of productive shallow water habitat. The shallow water habitats will convert predominant sandy shorelines to constructed littoral habitats expected to be dominated by mud bottoms that supports increased primary production through enhanced macrophyte growth and benthic invertebrate density (e.g., insects). This habitat is expected to support increased secondary production and higher densities of juvenile fish, thereby also providing a food source for non-wetland migratory birds.

A 15 m wide riparian area will be planted along the reservoir shoreline adjacent to BC Hydro-owned farmland to provide riparian habitat and bank stabilization. Riparian planting is proposed for an estimated 16 ha[4] of land, identified as currently non-forested, with a slope less than 25% suitable for riparian development, and within a 15 m zone surrounding the 5 year beach line.[5] The planting is proposed to include a mix of balsam poplar (60%), willow (30%) and red-osier dogwood (10%) live staked at densities of 4,000 stems/ha. The riparian habitat will provide additional habitat for non-wetland migratory birds.

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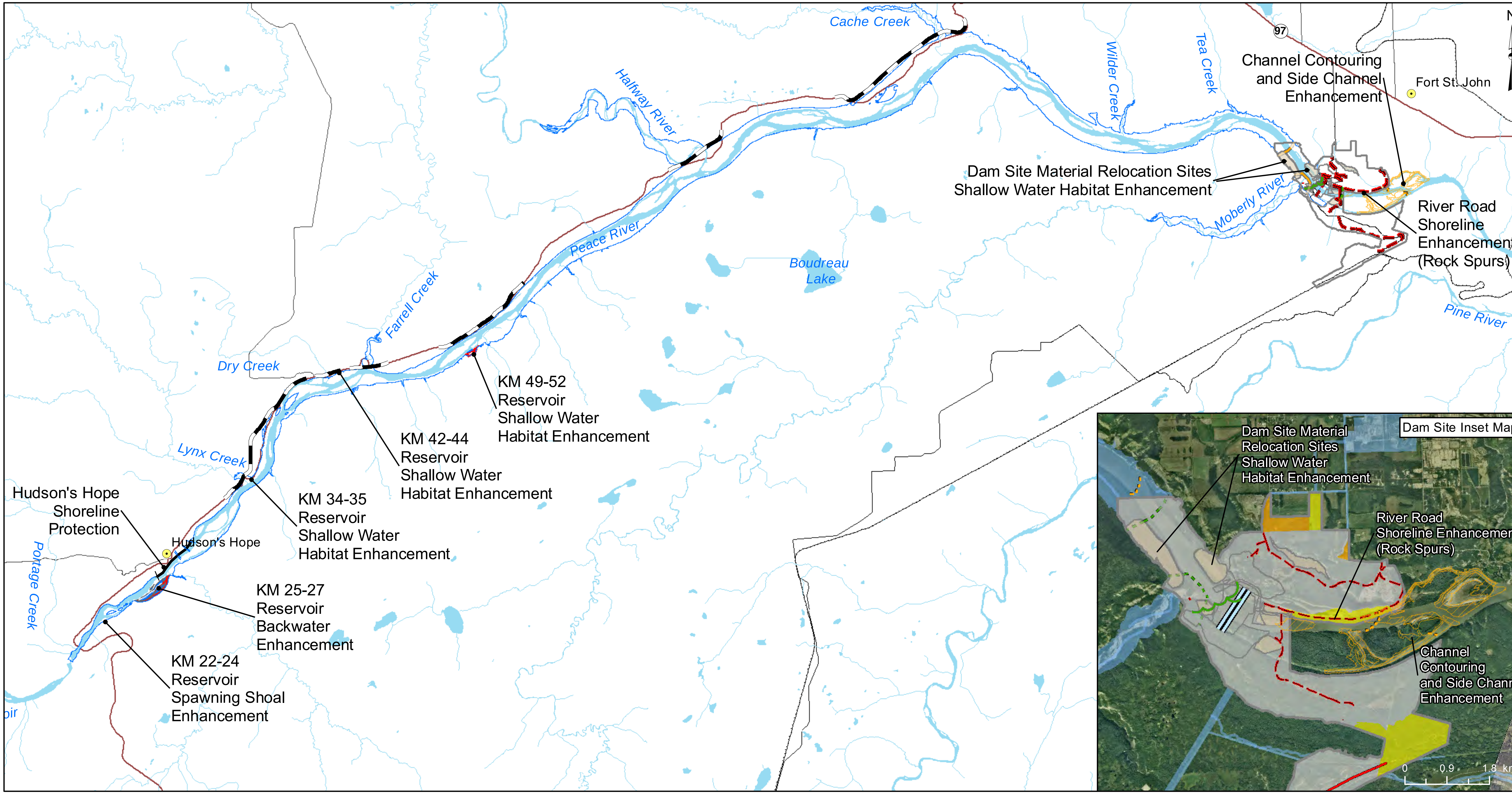
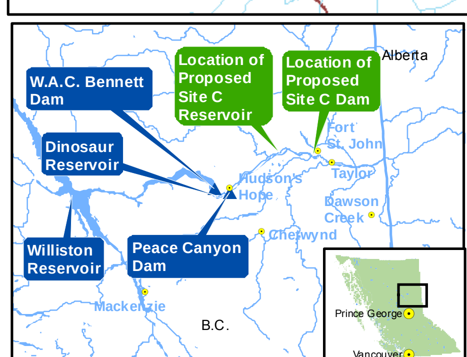
[3] The littoral zone is the shallow areas along the reservoir shoreline between maximum normal reservoir level (MNRL) of 461.8 m and 6 m below MNRL, which support higher aquatic production considered based on light penetration to bottom sediments supporting algal growth and growth of rooted aquatic plants (EIS, Vol. 2, App P, Part 3).

[4] Comprised of an estimated 4 ha of Crown and 12 ha of BC Hydro owned land.

[5] Five-Year Beach Line is the predicted extent of shoreline retreat at the maximum normal reservoir level five years after impoundment of the proposed reservoir (EIS, Vol. 2, Appendix B, Part 2)





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011 and TRIM.
5. Proposed reservoir area (461.8m maximum normal elevation) from Digital Elevation Models (DEM) generated from LiDAR data acquired July/August, 2006.

Legend

- Proposed Reservoir (FSL 461.8 m)
- Channel Contouring and Side Channel Enhancement
- Hudson's Hope Shoreline Protection
- Highway 29 Realignment
- Road
- Highway
- Railway
- Permanent Debris Boom
- Temporary Debris Boom
- Temporary Public Safety Boom
- Temporary Debris Boom Extension
- Dam Site Roads
- Project Access Road
- Dam Site Area
- Other Project Activity Zone
- Construction Area
- Construction Area — Restricted Activity Zone (Limited Activities)
- Potential Construction Area — Subject to further design
- Relocated Surplus Excavated Materials

0 10 km
1:200,000

SITE C CLEAN ENERGY PROJECT

Figure 7. Fish Habitat Enhancement

Date	September 16, 2014	DWG NO	1016-C14-B7650-5	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

Path: X:\ArcGIS\Projects\Permitting\Federal_Permits\NavProtAct\FishHabitatEnhancement_1016_C14_B7650_5.mxd

7.2.5 Compensation for Loss of Non-Wetland Migratory Bird Habitat

This section has been developed in accordance with **Condition10.3.4** of the Decision Statement: *[The Plan shall include]: compensation measures to address the unavoidable loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler.*

BC Hydro will implement compensation measures to address the unavoidable loss of non-wetland migratory bird habitat through its overall compensation plan for the effects of the Project on vegetation and ecological communities and wildlife habitat. In accordance with Decision Statement Condition 10.4.2, BC Hydro will submit a draft copy of its overall compensation plan to the Agency and Environment Canada 90 days prior to the implementation of any component of the compensation plan. Outlined below is BC Hydro's approach for the implementation of the overall compensation plan.

<u>Overall Compensation Approach</u>

BC Hydro's overall compensation approach to offset the effects of the Project on vegetation and ecological communities and wildlife habitat is focused on the retention of some of the lands that are surplus to Project development needs, and the acquisition of additional lands, or land rights, that will be suitable for vegetation and wildlife habitat mitigation. This type of mitigation is sometimes called "compensation" or "offsetting", and will be used to address a suite of compensation requirements, including:

- Wetland mitigation and compensation (see Section 7.3 of this Plan)
- Non-wetland migratory bird habitat compensation (see Section 7.2 of this Plan). Please note that:
  - Retention of lands will be identified to target those that support habitat for Canada Warbler, the Cape May Warbler and the Bay-breasted Warbler;
  - Additional species that may benefit from non-wetland migratory bird habitat mitigation include: American Kestrel, Bank Swallow, Black-billed Magpie, lay-colored Sparrow, Common Nighthawk, Eastern Phoebe, Le Conte's Sparrow, Northern Harrier, Northern Shrike, Sharp-tailed Grouse, Short-eared Owl, American Three-toed Woodpecker, Baltimore Oriole, Barred Owl, Blackpoll Warbler, Blackpoll Warbler, Black-throated Green Warbler, Bohemian Waxwing, Boreal Chickadee, Boreal Owl, Broad-winged Hawk, Brown Creeper, Common Yellowthroat, Connecticut Warbler, Mourning Warbler, Northern Flicker, Northern Goshawk, Olive-sided Flycatcher, Pileated Woodpecker, Rusty Blackbird, Western Tanager, Western Wood-Pewee, White-throated Sparrow, White-winged Crossbill, Yellow-bellied Sapsucker, Killdeer.
- Ungulate winter range (see Section 8.11 of this Plan)
- Riparian habitat (as described in the Fisheries and Aquatic Habitat Management Plan and summarized in Section 7.2.4 of this Plan)

Selection of Land for Compensation

In determining whether BC Hydro owned land would be retained for habitat mitigation in the above areas, BC Hydro will consider vegetation and wildlife suitability, official community plans and zoning, agricultural interests, and Aboriginal interests, including potential effects of habitat mitigation on current use of lands and resources for traditional purposes by Aboriginal peoples (see Decision Statement conditions 10.3.5 and 11.4.5).

Land selection priorities for habitat mitigation will be guided by their suitability to:

- Provide (retain, acquire or enhance) wetland mitigation and compensation;
- Protect non-wetland migratory bird habitat on BC Hydro owned land;
- Maintain suitable ungulate winter range on BC Hydro owned land;
- Support rare plants, or provide funds to projects that support lands with rare plants;
- Secure land or rights along suitable reservoir shoreline areas for riparian planting; or
- Provide suitable areas for the installation of habitat mitigation features (eagle nest platforms, bat roosts, fisher dens / rest sites)

For land retained or acquired by BC Hydro for habitat mitigation, BC Hydro will also identify the primary habitat management objectives, measures for the maintenance, creation or enhancement of habitat features, compatible land use and agricultural practices, and other property-specific management considerations (e.g. residential use). For example, BC Hydro has already identified BC Hydro owned land that would contribute to:

- breeding habitat for Northern Harrier and Short-eared Owl - management of cultivated fields in the valley, adjacent to the reservoir and at wetland mitigation sites;
- the retention and protection of unique wetland habitat to protect rare plant occurrences and provide habitat for wetland and non-wetland migratory birds, amphibians, and ungulates;
- the management of steep, south-facing breaks and gently sloping cultivated fields on lands west of Wilder Creek, to provide ungulate winter range and habitat for Northern Harrier, Short-eared Owl, and other non-wetland migratory birds, including species at risk; and,
- the establishment of a 15 m riparian vegetation zone along the reservoir shoreline along BC Hydro-owned farmland above the 5-year beach line, which will create, enhance and support riparian habitat (see Fisheries and Aquatic Habitat Management Plan).

Consultation and Reporting on Land Selection

BC Hydro will provide reports of candidate habitat mitigation lands for review by Environment Canada, the Ministry of Forests, Lands and Natural Resources, BC Ministry of Environment, Ministry of Agriculture, Reservoir Area Aboriginal groups, and Immediate Downstream Aboriginal groups. BC Hydro will review comments from these groups prior to final site selection. In finalizing site selection, BC Hydro will provide to CEA Agency an analysis that demonstrates how it has considered the input, views or information received from Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups, in accordance with Decision Statement conditions 10.6, 10.8, 11.4.5, and 11.7.

7.2.6 Analysis of Effects of Compensation for Loss of Non-Wetland Migratory Bird Habitat

This section has been developed in accordance with **Condition10.3.5** of the Decision Statement: *[The Plan shall include]: an analysis of the effects of any compensation measures identified in condition 10.3.4 on the current use of lands and resources for traditional purposes by Aboriginal peoples.*

Note that BC Hydro will submit a draft copy of its overall compensation plan, including the required analysis, to the Agency and Environment Canada 90 days prior to the implementation of any component of the compensation plan (See Condition 10.4.2).

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.

As described in Section 7.2.5, at this time, BC Hydro is in the process of identifying lands that may be suitable for mitigation and compensation. When Crown lands are identified as suitable for use for mitigation and compensation programs, BC Hydro will analyse the effects of securing these lands for mitigation purposes (e.g. establishing protective covenants on the land) on the current use of lands and resources for traditional purposes by Aboriginal peoples in the following way:

- Review baseline data BC Hydro has collected on traditional use (please see section 7.3.3 below) and through ground truthing to determine if the lands are currently used by Aboriginal peoples
- Consult with Aboriginal peoples currently using the Crown lands to determine if BC Hydro's planned use of the lands is compatible with the current use
- Consult with Aboriginal peoples currently using the Crown lands to determine how best to secure the land for mitigation purposes (e.g. protective covenants)
- Based on the consultation BC Hydro will analyze the effects of using the lands for compensation.

7.2.7 Evaluation of Effectiveness of Mitigation and Compensation Measures

This section has been developed in accordance with **Condition10.3.6** of the federal Decision Statement: *[The Plan shall include]: an approach to monitor and evaluate the effectiveness of the mitigation or compensation measures to be implemented and to verify the accuracy of the predictions made during the environmental assessment on non-wetland migratory bird habitat, including migratory bird use of that habitat.*

BC Hydro will use the following approach to monitor the effectiveness of mitigation or compensation measures implemented for non-wetland migratory bird habitat:

- Determine the effectiveness of the mitigation or compensation measure by evaluating the use of managed land by non-wetland migratory birds expected to use the property based on habitats present (see Table 4).

- Collect data during the breeding, migrating and winter seasons for 10 years after management of the lands using relevant provincial protocols.
- Analyze and report on data. Data collected during the 10 year period will be analyzed 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. A final survey report will provide the amount of each habitat being managed, species diversity, abundance and use of the lands by non-migratory birds.

7.2.8 Draft and Final Copies of Plan Submitted to the Agency and Environment Canada

This section has been developed in accordance with **Conditions 10.4, 10.5 and 10.6** of the federal Decision Statement:

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

<u>Conditions 10.4.1 and 10.5.1</u>

Please refer to Section 2.2 Consultation for information on the submission of draft and final Vegetation and Wildlife Mitigation and Monitoring Plan, including the measures described in Section 7.2, as well as consultation undertaken for the Plan.

<u>Conditions 10.4.2 and 10.5.2</u>

In accordance with Decision Statement Condition 10.4.2 and 10.5.2, BC Hydro will submit the draft and final compensation plans 90 and 30 days prior to implementing any components of the compensation plan, respectively.

<u>Condition 10.6</u>

In accordance with Decision Statement Condition 10.6, BC Hydro will provide to the Agency an analysis that demonstrates how it has appropriately considered the input, views or information received from Environment Canada.

7.2.9 Implementation of Plan and Analysis of Plan Implementation

This section has been developed in accordance with **Conditions 10.7 and 10.8** of the federal Decision Statement:

- *Condition 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.*
- *Condition 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.*

BC Hydro will implement compensation measures described in Section 7.2.5 above for the loss of non-wetland migratory bird habitat, including habitat associated with the Canada Warbler, the Cape May Warbler and the Bay-Breasted Warbler no later than five years from the initiation of construction.

Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 7.2.

7.3 Decision Statement Condition 11: Wetland Mitigation and Monitoring

7.3.1 Objective: Wetland Mitigation and Monitoring

This section has been developed in accordance with **Conditions 11.1 and 11.2** of the Decision Statement:

- *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.*

- *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.*

The objective of the Wetland Mitigation and Monitoring section is to describe the measures that will be implemented to mitigate for the effects of the 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. This section has been developed in accordance with Condition 11 of the Decision Statement, provided below.

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 7.3) and consultation undertaken for development of the Plan.

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.

7.3.2 Wetland Mitigation Hierarchy / No net loss of wetland functions

The sections below have been developed in accordance with **Condition 11.3** of the Decision Statement: *The Proponent shall, in developing the plan, describe how the mitigation hierarchy and the objective of no net loss of wetland functions were considered.*

7.3.2.1 Background

The Decision Statement provides the following definition for mitigation measures:

> "… as defined in the Canadian Environmental Assessment Act, 2012, measures for the elimination, reduction or control of the adverse environmental effects of a designated project, and includes restitution for any damage to the environment caused by those effects through replacement, restoration, compensation or any other means."

BC Hydro, in its EIS, concluded that loss of wetland habitat, that cannot be fully mitigated, would result in habitat alteration and fragmentation on certain species that would contribute to a significant adverse effect on wildlife resources (EIS Volume 2, Section 14.5.3). The Panel recommended that the "[federal] policy is based on a no-net-loss of wetland functions and should guide the development of the Proponent's Wetland Compensation Plan." However, the Joint Review Panel also concluded that some ecosystems, including marl fen wetlands, cannot be recreated and would be lost as a result of the Project, and that these effects would be permanent and irreversible (JRP report, p. 63). The Panel further concluded that the wetland compensation plan proposed by BC Hydro would offset "some of the functions lost", and therefore concluded "that the Project would have a significant adverse effect on wetlands, in particular valley bottom wetlands".

As stated in the Decision Statement for the Project, in accordance with CEAA 2012, the Governor in Council decided that the significant adverse environmental effects that the Designated Project is likely to cause are justified in the circumstances.

BC Hydro's approach to wetland mitigation and compensation reflects these conclusions, in that wetland compensation efforts will be guided by the federal no-net-loss policy and the provincial and federal conditions in support of the objective of full replacement of wetlands in terms of area and function, while acknowledging that not all functions will be able to be replaced. BC Hydro's application of a mitigation hierarchy, and several examples for each step of the hierarchy, is described below.

7.3.2.2 Wetland Mitigation Hierarchy

The wetland mitigation hierarchy used in this Plan consists of the following:

1) Avoid Impacts
2) Reduce Unavoidable Impacts
3) Restore and Compensate for Unavoidable Impacts

This hierarchy is consistent with the *Federal Policy on Wetland Conservation (*Environment Canada 2014) and the Province of British Columbia's *Provincial Policy for Mitigating Impacts on Environmental Values* (Ministry of Environment 2014). BC Hydro employed this mitigation hierarchy throughout the development phase of the Project (see EIS Section 4.2, Table 4.1 for a list of design considerations employed to avoid and mitigation the effects of the Project) and during the environmental assessment phase of Project, where mitigation measures to avoid, reduce and compensate for the adverse effects of the Project were developed to offset the effects of the Project on vegetation and ecological communities and wildlife resources.

The following sections describe how the mitigation hierarchy has been applied to the development of the Vegetation and Wildlife Mitigation and Monitoring Plan, the CEMP, and the Vegetation Clearing and Debris Management Plan – the guiding documents for the implementation of mitigation and monitoring measures for Project effects on vegetation and ecological communities and wildlife resources.

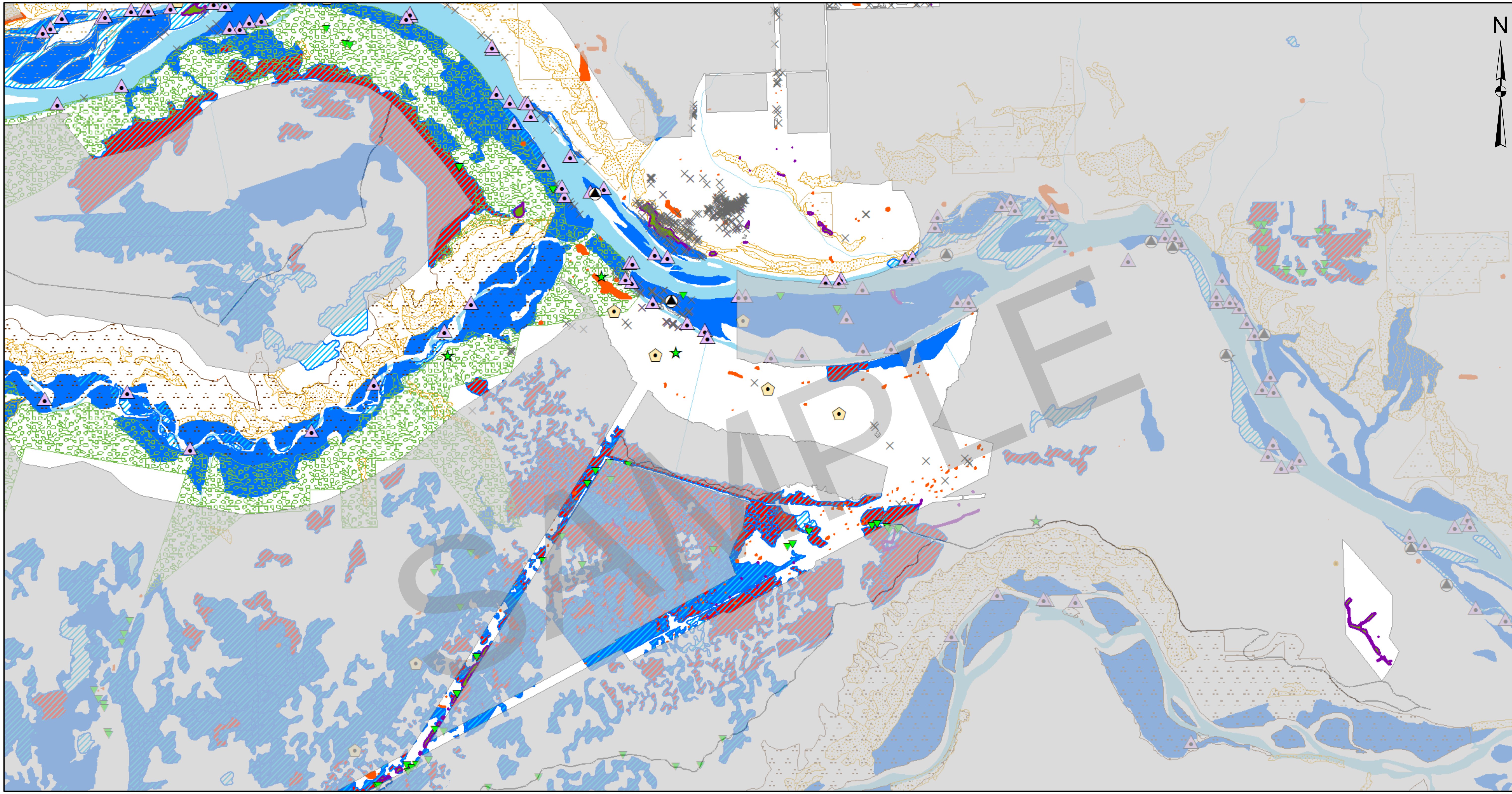
1) <u>Avoid Impacts</u>

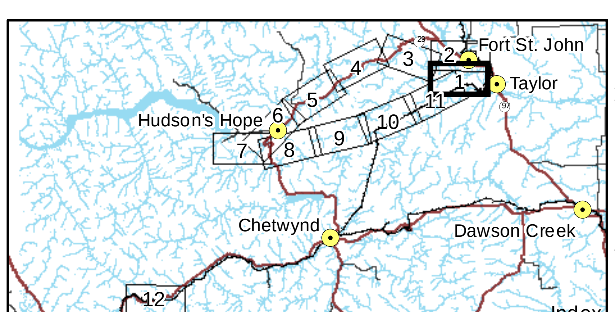
The conditions in the Environmental Assessment Certificate and the Decision Statement include several requirements to avoid impact, as shown below. The requirements of these conditions are addressed throughout this Plan, the CEMP and the Vegetation Clearing and Debris Management Plan. For example, some of the conditions that are intended to avoid, or reduce, effects on vegetation and wildlife include:

- Environmental Assessment Certificate 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. This condition is addressed in Section 8.1 of this Plan.
- Environmental Assessment Certificate Condition 17 and Decision Statement Condition 9: Avoidance of impacts to breeding wildlife will be achieved by scheduling clearing-outside the breeding season defined by CWS for Bird Conservation Region 6 and MFLNRO for the Peace Region. These conditions are addressed in Sections 7.1.1.1 and 7.1.1.2 of this Plan, in Section 4.17 of the CEMP (Wildlife Management), and in Section 3.5 of the Vegetation Clearing and Debris Management Plan.

- Environmental Assessment Certificate Condition 18: A human-wildlife conflict management plan will be used to avoid negative interactions with all wildlife. This condition is addressed in Section 4.17 of the CEMP.
- Environmental Assessment Certificate 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. This condition is addressed in Section 8.1.3.3 of this Plan.

In addition to the sample avoidance measures described above, BC Hydro has created, and will maintain during construction, an Environmental Features Map, which identifies known environmental, heritage and cultural features and environmentally sensitive areas. A sample Environmental Features Map is shown in Figure 8. BC Hydro and its Contractors will use this map during final design and during the planning and implementation of construction activities to identify potential interactions with Important Wildlife Areas and other environmental sensitive features, to guide actions that will avoid or reduce effects on known environmental features, following procedures outlined in the CEMP (Section 4.17).





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. There are no specific locations for Trumpeter Swan observations from 2013 due to type of survey.
5. All streams are assumed to be fish bearing or influence fish bearing habitat downstream.
6. All wetlands are assumed to contain amphibians.
7. Buffered sharp-tailed grouse leks from the Ecosystem Information Section, Ministry of the Environment.
8. Ungulate Winter Range (& Proposed), OGMAs, Wildlife Habitat Areas download from BC Geographic Warehouse.

- Amphibian Observations
- Bat Hibernaculae
- Fisher Den
- Snake Hibernaculae
- Beaver Lodge/Bank Den
- Bald Eagle Nest
- Trumpeter Swan Observations
- Possible Fox Den
- Raptor Nests
- Le Conte's Sparrow
- Nelson's Sparrow
- Yellow Rail
- Sharp-Tailed Grouse Lek
- Sharp-Tailed Grouse Lek (Buffered)
- Archaeological Site
- Noxious Weeds
- Noxious Weed Areas
- Ungulate Winter Range
- Ungulate Winter Range - Proposed
- Wildlife Habitat Areas
- Old Growth Management Area
- Grassland
- Rare Plants
- Wetlands
- Red Listed Ecosystem
- Blue Listed Ecosystem
- Seepage Site

1:50,000 0 2,500 m

BC hydro

SITE C CLEAN ENERGY PROJECT

Figure 8. Sample Environmental Features Map

Date	May 25, 2015	DWG NO	1016-C14-B7470	R 7

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Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

Path: X:\ArcGISProjects\Environment\Environmental_Features_Overview_1016_C14_B7470.mxd

2) Reduce Unavoidable Impacts

The conditions in the Environmental Assessment Certificate and the Decision Statement include several requirements for minimizing, or reducing, Project effects. In most cases, the conditions that seek to avoid, described above, will also serve to reduce effects as well.

Similar to avoidance, actions that reduce the extent, nature or duration of permanent and temporary Project effects on vegetation and wildlife will reduce Project effects. Examples that demonstrate the reduction of impacts in the design of the Project include the use of already disturbed areas, reducing the distance of haul routes, coordinating the use of access roads or construction areas for multiple purposes, and limiting the disturbed areas to those planned for construction activities.

An additional example of reducing unavoidable impacts is demonstrated by Environmental Assessment Certificate Condition 8. This condition requires that that temporarily disturbed areas are treated in a manner to achieve revegetation with native species as soon as practicable following construction, but no more than one year after the completion of construction activities at the particular site. This condition is addressed in Section 4.12 of the CEMP.

3) Restore and Compensate for Unavoidable Impacts

The third level of the mitigation hierarchy applied to the Project consists of implementing restoration and compensation measures for unavoidable impacts. These measures are described below.

Restore for Unavoidable Impacts:

The Environmental Assessment Certificate and Decision Statement conditions include several requirements for reclamation of disturbed areas that would achieve the restoration or creation of desired ecological communities. These requirements are addressed throughout this Plan, the CEMP and the Vegetation Clearing and Debris Management Plan. Examples include:

- Environmental Assessment Certificate Condition 8: Development of a Soil Management, Site Restoration and Revegetation Plan to effectively manage disturbed soils, and to reclaim and revegetate disturbed construction areas to a safe and environmentally acceptable condition. This condition is addressed in Section 4.12 of the CEMP, which, in addition to meeting the above requirements, stipulates that disturbed sites will be reclaimed in a manner that facilitates the re-establishment of natural ecological process on site.
- Environmental Assessment Certificate Condition 26. Identify within the Project footprint, including areas being reclaimed, potential sites for relocation of medicinal and food plants; Identify opportunities to restore ecological communities that support species of high traditional use value for affected Aboriginal Groups; Identify opportunities and provide financial support for propagation of indigenous plant species for use in reclamation programs. This condition is addressed in the Aboriginal Plant Use Mitigation Plan.

Site-specific reclamation plans will be developed to support the specific habitat mitigation measures for wetland mitigation and compensation, non-wetland migratory birds, ungulate winter range, rare plants, and riparian habitat, as described in the Fisheries and Aquatic Habitat

Management Plan. Appendix E provides an example of a restoration plan developed for the proposed wetland in Area A of the Dam Site Area.

Offsetting through Land

Condition 11.4.4 of the Decision Statement requires that compensation measures 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 the Environmental Assessment Certificate requires that the Wetland Mitigation and Compensation Plan "replace like for like where wetlands will be lost, in terms of functions and compensation in terms of area".

These compensation measures (or offsets) will be achieved through the retention or acquisition of land (or land rights) for habitat mitigation (see Section 7.2.5), that will be permanently maintained and managed in order to secure, replace, restore, or enhance wetlands. The first priority for selection lands for offsetting will be those located in close proximity to the Project footprint, followed by lands in the Peace Region, and finally expansion to other areas of the province if needed to meet objectives. Lands selected will be of similar value to those which will be affected by the Project. Habitat mitigation lands will be managed:

- by BC Hydro to support habitat mitigation offset priorities for wetland mitigation and compensation, non-wetland migratory birds, and ungulate winter range,
- by third parties with projects that will secure land or enhance habitat for rare plants; and
- by third parties to deliver riparian planting objectives set out in the Fisheries and Aquatic Habitat Management Plan, to support the establishment of riparian vegetation along the new reservoir shoreline.

7.3.3 Baseline Data for Wetlands and Riparian Habitat

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

BC Hydro has met the requirements of Condition 11.4.1 through (a) the collection of baseline data on wetlands and associated riparian habitat in the area affected by the Project during the environmental assessment process; (b) the development of a wetland function assessment using this baseline data; and (c) the collection of baseline information with respect to the current use of wetlands for traditional purposes.

Each of these aspects of the condition requirements is described below.

7.3.3.1 Baseline Data Collection

Baseline data collected for the assessment of Project effects on vegetation and ecological communities is provided in EIS Volume 2, Appendix R, Part 1, Vegetation and Ecological Communities. Ten wetland types were identified during baseline data collection on wetland habitats and associated riparian habitat in the area affected by the Project. They are:

1) Black Spruce- Labrador tea – Sphagnum (Black spruce/Lingonberry/Peat-mosses) (BT)
2) Shallow open water (OW)
3) Sedge wetland (SE)
4) Tamarack sedge (TS)
5) Willow-horsetail-sedge riparian wetland (WH)
6) Willow-Sedge Wetland (WS)
7) Narrow-leaved cotton-grass shore sedge (Wf13)
8) Scrub birch-water sedge (Wf02)
9) Marl Fen
10) Tufa Seep

A summary of each of these habitat types is provided in Appendix F.

7.3.3.2 Wetland Function Assessment

Data collected during the baseline studies for the EIS were used to complete the biogeochemical, hydrological and ecological functioning assessment of the wetlands and associated riparian habitat. This assessment is provided in Appendix G, “Assessment of Wetland Function and Impacts to Migratory Birds and Species at Risk for the Site C Clean Energy Project”, dated June 2, 2015. This document describes the function of wetlands lost or degraded by the Project in relation to migratory birds and species at risk (rare plants, amphibians and bats).

7.3.3.3 Current Use of Wetlands for Traditional Purposes

A major focus of work during the environmental assessment phase of the Project was gathering traditional land use information and, where possible, traditional knowledge. Starting in December 2009, BC Hydro negotiated Traditional Land Use Study (TLUS) agreements with those Aboriginal groups located immediately downstream of the Project or who may exercise rights within the area that is now defined as the Project activity zone. During the Environmental Assessment Stage of the Project, BC Hydro entered into agreements with a total of ten Aboriginal groups to carry out Traditional Land Use Studies (TLUS):

- Treaty 8 Tribal Association, representing Doig River, Halfway River, Prophet River, and West Moberly First Nations
- Duncan’s First Nation
- Saulteau First Nations

- Blueberry River First Nations
- Horse Lake First Nation
- Dene Tha' First Nation; and,
- McLeod Lake Indian Band

BC Hydro also reached agreements with the Kelly Lake Métis Settlement Society, Métis Nation British Columbia, Fort Nelson First Nation, Athabasca Chipewyan First Nation, Mikisew Cree First Nation, and the Deninu K'ue First Nation to provide funding to allow for existing traditional land use information that is applicable to the Project to be assembled and shared with BC Hydro.

Following submission of those reports, BC Hydro engaged Traditions Consulting Services to review the completed TLUS reports and related publicly available materials, and to consider where additional information would be beneficial. Traditions Consulting also completed summary reports for those Aboriginal groups that did not complete a TLUS for this Project but may, in some instances, have supplied information in other formats. The TLUS reports and the summary reports completed by Traditions Consulting are included in Volume 5 Appendix A Asserted or Established Aboriginal Rights and Treaty Rights, Aboriginal Interests, and Information Requirements Supporting Documentation.

Where First Nations submitted TLUS reports, these were used as the primary source of information for the baseline information presented in the EIS.

<u>Data Management, Mapping and Modelling for EIS Baseline</u>

In developing the EIS, a spatial analysis was undertaken to identify the overlap between the Project activity zone and areas that are currently used by Aboriginal groups for traditional purposes. Resource use was also depicted by Aboriginal groups in tabular form (see EIS, Volume 19, Tables 19.5 to 19.10).

Integration of the TLUS data posed a number of challenges. To begin with, the study areas defined in the Project-specific TLUS reports submitted to BC Hydro, and other reports reviewed, do not align precisely with the LAA or RAA. Interpretation of various TLUS and other maps was necessary in an attempt to discern the location of activities in relation to the LAA or RAA. Similarly, the spatial information supplied by Aboriginal groups was frequently buffered, or redacted, for purposes of confidentiality or sensitivity, making it difficult to identify specific locations in relation to the LAA for this VC. It is BC Hydro's understanding that the results of the TLUS are representative of the appropriate land uses in the respective TLUS areas.

<u>Application of EIS Baseline Data to Wetland Areas</u>

Given the prevalence of wetland habitat throughout the areas reviewed during the TLUS, and the scale at which information was made available, the TLUS data does not provide site-specific information with respect to use of lands and resources in wetland areas. Based on the species that are known to occur in wetland habitat, and the identification of use of those species by Aboriginal groups in the TLUS data, the following table was prepared to indicate any potential overlap, in a very general way, of those species with potential use by Aboriginal groups.

Table 5 summarizes wetland-associated wildlife and plant species that are used by Aboriginal people in the Local and Regional Assessment Areas for the Current Use of Lands and Resources Valued Component. Sources: EIS, Volume 3, Section 19, JRP IR #84, and Aboriginal Group Amendment Report (May 2013).

Future Data Collection

BC Hydro continues to consult with Aboriginal groups regarding wetland function assessment and the use of wetlands for current use. Additional information collected during the 2015-2016 ground-truthing program about current use of wetlands for traditional purposes will be used to assess the effects of wetland mitigation on current use practices.

Table 5. Wetland-associated wildlife and plant species that are used by Aboriginal people

Species	Saulteau First Nations	Treaty 8 Tribal Association	Blueberry River First Nations	McLeod Lake Indian Band	Métis Nation BC	Kelly Lake Métis Settlement Society	Dene Tha' First Nation	Duncan's First Nation	Horse Lake First Nation
Moose	X	X	X	X	X	X	X	X	X
Beaver	X	X	X				X		
Mink	X								
Muskrat	X								
Bald Eagle	X								
Birds (unspecified)								X	X
Black and White Duck	X								
Black Duck	X								
Duck (unspecified)	X	X	X	X	X		X		
Geese	X		X	X	X		X		
Grebe			X						
Mallard	X								
Pointed Tail Duck	X								
Berries (includes blackberries, blueberries, huckleberries, Saskatoons, soapberries, cranberries)	X	X	X	X			X		
Bulrushes	X								
Medicinal plants		X		X					
Labrador Tea	X		X	X					
Plant (herbs)									
Muskeg Peat				X					
Plant gathering	X		X					X	X
Wild onions	X								

7.3.4 Mitigation Measures to Maintain Baseline Wetland Functions

This section has been developed in accordance with **Condition 11.4.2** of the Decision Statement: *[The Plan shall include]: mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost.*

Mitigation measures to maintain baseline wetland functions for those wetlands that will not be permanently lost are included within the standard mitigation measures described in the CEMP. For example, sections 4.4, 4.13, 4.17 and 4.18 require that EPPs address, where appropriate:

- installation of culverts under access roads to maintain hydrological balance, and installation of sediment barriers;
- implementation of stormwater management designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities will occur;
- implementation of site-specific measures to reduce changes to the existing hydrologic balance of wetland function during construction of the Jackfish Lake Road (if built), Project access roads, and the transmission line;
- that approved work practices are followed and that the provincial guidebook *Develop with Care* is considered for all activities that involve potentially harmful or toxic substances, such as oil, fuel, antifreeze, and concrete; and
- implementation of restricted activity and work avoidance zones within which no construction activities will be allowed. Except within the Dam Site Area, work avoidance zones will be established around known tufa seeps, wetlands and rare plant occurrences that are adjacent to construction areas.

7.3.5 Evaluating Changes in Baseline Conditions

This section has been developed in accordance with **Condition 11.4.3** of the federal Decision Statement: *[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.*

In order to monitor and evaluate changes to baseline conditions for wetland habitat and function as described in condition 11.4.1, BC Hydro will collect additional data on wetlands affected by the Project throughout construction and during the first 30 years of operation. Using provincial sampling protocols, wetlands will be surveyed every five years during this time period and information collected on:

- vegetation cover,
- hydrological conditions,
- migratory bird abundance, density, diversity and use, and
- species at risk abundance.

In addition, further information on the current use of wetlands for traditional purposes may be collected during on-going consultation with Aboriginal groups. All collected data will be compared against previously collected baseline data, and analyzed for potential changes in wetland habitat and function and current use of wetlands for traditional purposes. This analysis will be used to assess the efficacy of wetland mitigation and compensation measures developed in accordance with Section 7.3.6 below. Where necessary, the analysis will also make recommendations for the improvement of mitigation measures and further monitoring of wetland habitat and function.

7.3.6 Compensation Measures for Loss of Wetland Areas and Functions

This section has been developed in accordance with **Condition 11.4.4** of the Decision Statement: *[The Plan shall include]: compensation measures to address the unavoidable loss of wetland areas and functions supporting migratory birds, species at risk, and the current use of lands and resources by Aboriginal people in support of the objective of full replacement of wetlands in terms of area and function*

BC Hydro will address the unavoidable loss of wetland areas and functions supporting migratory birds, species and risk, and the current use of lands and resources by Aboriginal groups through the implementation of the mitigation and compensation measures listed below. These measures will be implemented in support of the objective of full replacement of wetlands in terms of area and function. Note that these measures have been prepared in the context of the Decision Statement and the Environmental Assessment Certificate for the Project which recognize that it will not be possible to fully mitigate the effects of the Projects on wetlands.

The measures that will be implemented are:

1) Reclaiming construction areas to achieve wetland function

2) Improving function of existing wetlands,
3) Creating new wetland area(s), and
4) Protecting existing wetlands – e.g., through the retention or acquisition of land rights by BC Hydro

These measures will be implemented on sites selected through the process and considerations outlined below. Additional information on site selection is provided in the text box that follows, "Detailed Workplan for Selection of Wetland Mitigation and Compensation Sites".

Site Selection Guidance

Identification of sites for the implementation of the mitigation and compensation measures will be guided by the assessment of wetland functions lost as a result of the Project, in particular those wetland functions that support migratory birds, species at risk (wildlife and plants), and, where identified through ground-truthing work with Aboriginal groups, current use of lands and resources for traditional purposes by Aboriginal people. The identification of sites will also be guided by:

- the mitigation hierarchy described in the federal policy on wetland conservation and in Section 7.3.2 above,
- Environmental Assessment Certificate Condition 12 (see Section 8.4 in this Plan), which requires that BC Hydro replace like for like where wetlands will be lost, improve the function of existing wetland habitats, and create new wetland habitat (e.g., wetland replacement activities will be guided by a target of a 1:1 ratio, in terms of both function and area, as characterised by the results of the Wetland Function Assessment).

Site Selection Surveys

Site specific field surveys will be completed within areas identified as candidates for wetland reclamation, creation, improvement, and protection, guided by the ability of such sites to achieve replacement of lost wetland function and area (as described above).

Site Selection Plans

Once sites for wetland reclamation, creation, improvement, and protection have been selected, site-specific plans, including specifications, engineering design and any other relevant information will be developed.

Site Selection Timeline

The selection of sites for wetland reclamation, improvement, creation and protection will be completed within five years of the commencement of Project operations. Management and monitoring plans for these sites will be completed within this time frame as well.

As described in Section 7.3.5, information will be gathered over the course of construction and operation of the Project to monitor and evaluate changes to baseline conditions for wetland habitat and function, and current use of wetlands for traditional purposes by Aboriginal groups. Any information collected during this time will be taken into account in the development of the mitigation and compensation measures.

Detailed Workplan for Selection of Wetland Mitigation and Compensation Sites

Ducks Unlimited Canada (DUC)[6] has been engaged due to their technical expertise in wetland creation and enhancement, and for their regional knowledge of wetland development and enhancement opportunities. As candidate replacement wetland sites are identified, detailed site-specific plans will be developed to specify improvements or management measures that would maintain or improve the function of existing wetlands, create new wetland habitats, or revitalize existing wetland projects.

A hierarchy will be used, based on proximity to wetland areas affected by the Project, to identify or map replacement wetland site opportunities, as follows and as further described below:

Priority 1	within the Project Activity Zone
Priority 2	the Peace River valley within 1km of the Project Activity Zone
Priority 3	the Peace Lowland Ecosection
Priority 4	the remainder of British Columbia

Identification of Replacement Wetland Sites

The wetland function assessment will be used to guide identification of potential replacement wetland sites, by their ability to support replacement of wetland function and wetland area lost due to the Project.

BC Hydro will develop a list of candidate replacement wetland sites within the following priority areas for consideration, until the replacement wetland area has been achieved, on a one-to-one basis with the area lost.

The candidate replacement wetlands will be selected based on their ability to replace wetland functions lost due to the Project, in particular those that support migratory birds, species at risk, and if identified current use of lands and resources for traditional purposes (Federal condition 11.4.4). The potential effects of any proposed replacement wetland sites on the current use of lands and resources for traditional purposes by Aboriginal peoples (Federal condition 11.4.5) will be taken into account.

BC Hydro will provide reports of candidate replacement wetland sites for review by Environment Canada, FLNRO, MOE, and Aboriginal Groups, and will review comments from these agencies and Aboriginal groups prior to making final replacement wetland site selections. In finalising site selection, BC Hydro shall provide to CEA Agency an analysis that demonstrates how it has considered the input, views or information received from Environment Canada, Reservoir Area Aboriginal groups and Immediate Downstream Aboriginal groups (Federal condition 11.4.5, 11.7).

Any permits that may be required to allow construction and operation of wetlands will be identified.

Priority 1 – Project Activity Zone

The highest priority for replacement wetland sites is within areas not permanently affected by the Project, within the Project Activity Zone. To date, three potential Priority 1 sites for post- Project replacement wetland have been identified: i) Wilder Creek, ii) island near Watson Slough, and iii) an area known as

[6] Ducks Unlimited Canada (DUC) has been engaged due to their 75 year history of success in wetland conservation in Canada. Since 1938, DUC has secured over 6 million acres of habitat and completed nearly nine thousand projects across Canada. Over 380,000 acres of habitat are secured and under DUC management in British Columbia. Ducks Unlimited's research arm, the Institute for Wetland and Waterfowl Research, has led or participated in over 300 research projects in the past 20 years. This record makes DUC a leader in wetland protection and restoration in Canada.

Dam Site Area A, located within the dam site construction area immediately downstream of the Site C dam, along the south bank of the Peace River.

The initial feasibility of the Wilder Creek and Watson Slough island sites will be evaluated, using existing information and field investigations to verify contours and soils, collect additional survey information, and plans would be developed if these are deemed feasible for wetland mitigation. If, during the examination of existing information, other sites are identified, they would also receive an initial examination for feasibility.

Dam Site Area A is in an area that will be used for Project construction, as a gravel material source and general construction area. BC Hydro will establish requirements for the Contractor to reclaim this site with wetland features. Detailed design will be developed with the Contractor and BC Hydro, with opportunities to apply further wetland design prior to reclamation activities. Technical wetland specifications will be provided to the Contractor for them to take into account as they plan and undertake construction activities.

Priority 2 – Peace River valley

BC Hydro has undertaken extensive habitat mapping in the local assessment area, which is a large area that includes the Project Activity Zone plus a 1 km buffer and downstream to the BC / Alberta border. This area is the second highest priority for identification of replacement wetland sites.

The 1 km zone will be evaluated for additional wetland mitigation sites. Any available geo-referenced information (e.g. waterfowl survey data) will be used in the evaluation. An annotated list of potential replacement wetland sites will be developed, including maps and photos (as feasible). Field evaluations will be conducted on candidate replacement wetland sites.

Priority 3 – Peace lowland ecosection

The Project lies within the Peace Lowland ecosection (British Columbia Ministry of Forests. 1988; Demarchi, D.A. 1988) of British Columbia. The ecosection comprises the third area for identification of mitigation opportunities and, with a larger area, is expected to yield wetland mitigation opportunities.

- Since DUC has been active in British Columbia, the respective offices have maintained files of potential projects investigated through active reconnaissance and ongoing referrals. The Peace region files will be reviewed to produce an annotated list and map of potential mitigation sites that may have relevance to the Project. Interest by current landowners will be confirmed for the top 2 or 3 candidate sites. Upon confirmation of continued interest by landowners, site plans will be developed.
- DUC has constructed and continues to manage about 70 projects in the Peace Lowland ecosection. These projects will be reviewed to identify potential opportunities for reconstruction (where existing agreements are close to or have expired and/or where infrastructure needs replacement) or where existing projects have the opportunity for further enhancement, securement, or expansion. An annotated list, map(s) and photos will be provided to BC Hydro along with cost estimates.
- A decision support system (DSS) for the Peace Lowland ecosection has the potential to proactively identify additional marsh mitigation opportunities. Based upon habitat information, historical waterfowl capability maps, and waterfowl population data, a DSS will model and map the most likely areas of waterfowl habitat (typically marshes). These areas provide a higher level of success for identifying mitigation opportunities compared to systematically travelling roads and interviewing landowners for opportunities. DUC has completed a DSS for its priority program delivery landscapes in the interior of British Columbia and is completing a DSS for the lower mainland and Vancouver Island. DUC will provide a final map showing the highest probability of high value waterfowl habitat polygons along

with a report on what these areas specifically represent and how they could fit into the Project's wetland mitigation plan.

Priority 4

The fourth area within which mitigation opportunities will be identified includes the remainder of British Columbia, outside of the Peace Lowland ecosection.

DUC operates and manages over 360,000 acres in British Columbia, outside of the Peace region. As projects reach maturity (typically 30 years), they require replacement of infrastructure components, such as water controls, to maintain their function and habitat value. Several of these projects may be suitable for inclusion in the Project's mitigation plan. These projects will be reviewed to identify potential opportunities for reconstruction (where existing agreements are close to or have expired and/or where infrastructure needs replacement) or where existing projects have the opportunity for further enhancement, securement, or expansion. An annotated list, maps and photos (as feasible) will be provided to BC Hydro along with cost estimates.

Candidate Wetland Replacement Sites

Priority 1: Site C Project Activity Zone (areas not permanently disturbed).

1. The feasibility of potential wetland sites at Wilder Creek and the island that will be newly created in the Site C Reservoir at Watson Slough will be evaluated, using information from BC Hydro, conduct field investigations to verify contours and soils, collect additional survey information, and supply shovel-ready plans and cost estimates, provided the projects are feasible.
2. The options for reclamation strategies on the south bank terrace material extraction area, immediately downstream of the dam site, will be determined, considering different site development scenarios and wetland specifications. Options will include:
    a. A preliminary design outlining how the site is to be contoured at the end of construction.
    b. A process and schedule for advancing from preliminary to detailed design during the construction phase.
    c. Potential wetland area available after reclamation considering the development scenarios and wetland specifications for the site.

Priority 2: Within 1 km of the Project Activity Zone

1. DUC will supply an annotated list, along with maps and photos (as feasible), of potential sites within 1 km of the Project Activity Zone. Field evaluations would only be conducted following consultation with and approval from BC Hydro staff.

Priority 3: Peace Lowland ecosection.

1. The DUC Peace region files of potential project will be reviewed to produce an annotated list, map(s) and photos (as feasible) of candidate mitigation sites that may have relevance to the Project. Continued interest by landowners will be confirmed for the top 2 or 3 candidate sites. Upon confirmation of continued interest and agreement by BC Hydro, DUC will develop shovel-ready plans and cost estimates.
2. An annotated list, map(s) and photos (as feasible) of existing DUC projects nearing or reaching maturity will be provided, along with a list of renewal works needed, schedule for completing the works, and associated cost estimates.
3. DUC will provide a DSS map showing the highest probability of good waterfowl habitat polygons in the Peace Lowland ecosection, along with a report on what these areas specifically represent as potential mitigation sites.

Priority 4: British Columbia, outside of the Peace region.

1. DUC will provide BC Hydro with an annotated list, maps and photos (as feasible) of mitigation sites with the greatest potential from DUC potential project files.
2. DUC will provide BC Hydro with an annotated list of projects nearing or reaching maturity that may be suitable for inclusion in the Project's mitigation plan.

7.3.7 Analysis of Compensation Measures for Loss of Wetland Areas and Functions

This section has been developed in accordance with **Condition 11.4.5** of the federal Decision Statement: *[The Plan shall include]: 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.*

At this time BC Hydro is in the process of identifying lands that may be suitable for wetland mitigation and compensation. When crown lands are confirmed suitable for use for mitigation and compensation BC Hydro will analyse the effects of using these lands for mitigation on the current use of lands and resources for traditional purposes by Aboriginal peoples in the following way:

- Review baseline data BC Hydro has collected on traditional use (please see section 7.3.3 above) to determine if the lands are currently used by Aboriginal peoples or are near lands currently used
- Consult with Aboriginal peoples currently using the lands to determine if BC Hydro's planned use of the lands is compatible with the current use
- Based on the Consultation and potential mechanisms available to protect crown land BC Hydro will analyze the effects of using the lands for compensation.
- Recommend to BC potential mechanisms to protect crown land to ensure the objectives of mitigation or compensation can be achieved

7.3.8 Draft and Final Copies of Plan to Agency, Environment Canada and Aboriginal Groups

*This section has been developed in accordance with **Conditions 11.5, 11.6 and 11.7** of the federal Decision Statement:*

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.

Conditions 11.5.1 and 11.6.1

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 7.3) and consultation undertaken for development of the Plan.

Conditions 11.5.2 and 11.6.2

In accordance with Decision Statement Condition 11.5.2 and 11.6.2, BC Hydro will submit the draft and final compensation plans 90 and 30 days prior to implementing any components of the compensation plan, respectively.

Condition 11.7

In accordance with Decision Statement Condition 11.7, BC Hydro will 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.

7.3.9 Schedule

This section has been developed in accordance with **Condition 11.8** of the Decision Statement: *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.*

The mitigation and compensation measures identified in Section 7.3 will be implemented in accordance with Condition 11.8 of the Decision Statement.

7.3.10 Implementation of the Plan and Analysis of Implementation of Plan

This section has been developed in accordance with **Condition 11.9** of the federal Decision Statement: *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.*

BC Hydro will implement measures described in Section 7.3 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 7.3

7.4 Decision Statement Condition 16: Species at Risk, At-risk and Sensitive Ecological Communities and Rare Plants

7.4.1 Objective: Species at Risk, At-risk and Sensitive Ecological Communities and Rare Plants

This section has been developed in accordance with **Condition 16.1** and **Condition 16.2** of the

- *Condition 16.1 Decision Statement: 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.*

- *Condition 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.*

The objective of the Species at risk, at-risk and sensitive ecological communities and rare plants section is to describe the measures that will be implemented to address and monitor potential effects of the Project on Species at risk, at-risk and sensitive ecological communities and rare plants. This section has been developed in accordance with Condition 16 of the Decision Statement, provided below.

As required by Condition 16.2, consultation on the measures described in this section were undertaken during consultation for the Vegetation and Wildlife Mitigation and Monitoring Plan as a whole, as described in Section 2.2 of this Plan.

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.

7.4.2 Verification of Modeled Results for Surveyed Species at Risk

This section has been developed in accordance with **Condition16.3.1** of the Decision Statement: *[The plan shall include]: 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.*

Objective

The purpose of this section is to describe how field work will be undertaken to verify the modeled results for surveyed species and risk, and determine the habitat that would be permanently lost, habitat that would be fragments and habitat that would remain intact for those species, including the Short-eared Owl, the Western Toad and Myotis Bat species.

Verification of modeled results for surveyed species at risk will build on initial modelling conducted during the environmental assessment of the Project. The models used for the environment assessment indicated, through ratings, the degree to which each habitat is suitable for a given species based on the results of field surveys conducted between 2005 and 2012. In response to comments made during the Joint Review Panel hearings regarding correlation with species observations within habitats identified as being low or of no suitability, the accuracy of each model was assessed.

As shown in Table 6, field observations have demonstrated that the model accuracy ranges from a low of 1.2 % for Sharp-tailed Grouse in winter to a high of 87.8% for Sharp-tailed Grouse in the growing season. Models with an accuracy of greater than 80% (i.e., more than 80% of field observations correlate with habitats assigned a suitability rating of High or Moderate) are considered accurate and will not be subject to field verification surveys. Additional field surveys to verify the modeled results will be completed for species with an accuracy of less than 80% (i.e., fewer than 80% of field observations correlate with habitats assigned a suitability rating of High or Moderate).

Verification of modeled results for species at risk presented in the EIS will be completed through field surveys. A detailed work plan for these surveys is provided in the text box below, "Workplan for Verification of Modeled Results for Surveyed Species at Risk". Updated/verified models will be used to determine with specificity, and by ecosystem, the habitat permanently lost or fragmented, and habitat that would remain intact for those species identified by the Joint Review Panel (see below) as being significantly affected by the Project (but were not identified by BC Hydro as being significantly affected by the Project). The output will be used to inform final Project design and to develop additional mitigation measures in consultation with Environment Canada and Ministry of Forests Lands and Natural Resources.

Table 6. Summary of species model accuracy.

Species	# obs. in highly suitable habitat	# obs. in moderately suitable habitat	# obs. in low suitable habitat	# obs. in non-suitable habitat	# obs. in non-rated habitat	Total field obs.	Total field obs. in non-suitable (L & N) habitat	Model Accuracy (obs. H+M/total obs.)
Nelson's sparrow	11	6	1	4	0	22	5	77.3%
Yellow Rail	4	12	17	13	0	46	30	34.8%
Le Conte's Sparrow	73	3	13	13	0	102	26	74.5%
Broad-winged Hawk	18	1	23	4	1	47	27	40.4%
Short-eared owl	0	14	0	9	0	23	9	60.9%
Sharp-tailed grouse (LI W)	0	1	77	4	0	82	81	1.2%
Sharp-tailed grouse (LI G)	71	1	6	4	0	82	10	87.8%
eastern ret bat	0	0	0	0	0	0	0	NA
little brown Myotis/northern Myotis (RB)	45	49	5	27	0	126	32	74.6%

Species	# obs. in highly suitable habitat	# obs. in moderately suitable habitat	# obs. in low suitable habitat	# obs. in non-suitable habitat	# obs. in non-rated habitat	Total field obs.	Total field obs. in non-suitable (L & N) habitat	Model Accuracy (obs. H+M/total obs.)
little brown Myotis/northern Myotis (FD)	1	79	23	23	0	126	46	63.5%
old world swallowtail	4	33	1	3	2	43	4	86.0%
great spangled fritillary		14	29	8	0	51	37	27.5%
common wood-nymph	16	28	61	20	0	125	81	35.2%
Uhler's arctic	71	160	15	34	7	287	49	80.5%
tawny crescent	60	147	21	25	3	256	46	80.9%
Artic blue	6	38	3	15	1	63	18	69.8%
Aphrodite fritillary	2	26	8	9	1	46	17	60.9%
western toad	41090	3404	1	141374	0	185869	141375	23.9%
Canada warbler	120	77	150	17	36	400	167	49.3%
Cape May warbler	1	8	10	3	1	23	13	39.1%
Bay-breasted warbler	0	3	3	2	0	8	5	37.5%

Spatial Area

Area 2: The Local Assessment Area

Scope

Additional field work will be undertaken and targeted at verifying modeled results for the following species, as identified by the Joint Review Panel:

- Nelson's sparrow, Yellow Rail, Le Conte's Sparrow, Broad-winged Hawk, Short-eared owl, Sharp-tailed grouse,
- eastern red bat, little brown Myotis, northern Myotis,
- old world swallowtail (pikei subspecies), great spangled fritillary (pseudocarpenteri subspecies), common wood-nymph (nephele subspecies), Uhler's arctic, tawny crescent, Arctic blue (lacustris subspecies), Aphrodite fritillary (manitoba subspecies),
- western toad.

Schedule

Field work will be completed between June and September 2015

Workplan for Verification of Modeled Results for Surveyed Species at Risk

Project Understanding and Objective

BC Hydro has retained Bianchini Biological Services to verify modeled results for surveyed species at risk. The requested field program is to be conducted in the summer of 2015 in order to verify habitat ratings versus TEM ratings for selected wildlife species of concern as part of conditions set out in BC Hydro's Environmental Certificate for the Site C Clean Energy Project.

Study Area

The study area is defined as the Peace River main stem from the Peace Canyon dam to the Alberta border and the proposed transmission route located south of the Moberly River between Hudson's Hope and the proposed Site C dam site. A one kilometre (km) buffer extents around the study area and is referred to the Local Assessment Area (LAA).

In addition to assessing various sites within the LLA, select sites outside of the LAA will also be assessed where required.

Objectives of Proposed Field Surveys

The objective of the field program is to conduct ground truthing of observations of species at risk and to verify suitability ratings assigned to habitats in species specific suitability models. Specific objectives of the proposed field surveys are to:

1) Conduct field work to verify habitat model results presented in the EIS and additional materials provided during the Joint Review Panel process, for targeted species at risk;
2) Additional field work will be undertaken targeted at verifying modeled results for: Nelson's sparrow, Yellow Rail, Le Conte's Sparrow, Broad-winged Hawk, Short-eared owl, Sharp-tailed grouse, eastern red bat, little brown Myotis, northern Myotis, old world swallowtail (*pikei* subspecies), great spangled fritillary (*pseudocarpenteri* subspecies), common wood-nymph (*nephele* subspecies), Uhler's arctic, tawny crescent, Arctic blue (*lacustris* subspecies), Aphrodite fritillary (*manitoba* subspecies) and western toad.

Sampling Design and Effort

- Pre-Field Review: analyze existing model output using baseline data.
- Identify the species requiring model verification.
- For each species overlay field observations on output maps to determine the number and proportion of species observation in suitable (high and moderate) and non-suitable (low and nil) habitat, as identified by existing models.
- Determine if the occurrence matches the season and/or use modeled (e.g. breeding season observation vs. non-breeding season observation), only observations matching season or use modeled will be considered for field verification.
- Determine distance between observation and nearest suitable habitat (high or moderate); field observations near suitable habitat may not require site visits.
- Determine if suitable habitat is present in the map polygon.
- Perform field Work to determine, if possible, why the species was observed at the location.
- Target polygons to verify species suitability models.
- Visit polygons containing non-suitable and suitable habitat to determine if the observation was located in suitable habitat within the polygon.
- Using verification data, identify if model adjustments are appropriate, and scientifically feasible.
- Adjust models, re-calculate habitat lost or fragments due to the Project.
- Incorporate results into habitat or species-specific mitigation and monitoring where relevant.

Field Work Schedule

The proposed field surveys will be conducted between June 1 and September 31, 2015.

Qualifications

Work will be undertaken by a Registered Professional Biologist with experience in habitat suitability modeling and TEM mapping.

7.4.3 Rare Plant Surveys

This section has been developed in accordance with **Condition 16.3.2** of the federal Decision Statement: *[The plan shall include]: surveys to determine whether the rare plant species potentially facing extirpation in the Project Activity Zone are found elsewhere in the region.*

The purpose of the rare plant surveys is determine whether the rare plant species (persistent-sepal yellowcress (*Rorippa calycina*) and Peace daisy (*Erigeron pacalis*)) potentially facing extirpation in the Project Activity Zone are found elsewhere in the region. Both these species are known in BC only from the Vegetation and Ecological Communities LAA. Neither is considered a species at risk federally.

As described in EIS Volume 2, Appendix R, Part 1 Vegetation and Ecological communities, three seasons of detailed site-specific rare plant fieldwork (in 2008, 2011 and 2012) were undertaken for the environmental assessment of the Project. Persistent-sepal yellowcress was found at three locations along the Peace River within the LAA (Hilton, et al. 2013). All three occurrences will be affected by the Project: two of the occurrences are located within the area of the Site C reservoir, and the third was located immediately downstream of the dam site. Persistent-sepal yellowcress is a globally vulnerable species that is only known in BC from the three occurrences in the LAA (Hilton, et al. 2013).

Peace daisy was found at only one site within the LAA, located just outside of the reservoir footprint (Hilton, et al. 2013). Because of the site's close proximity to the reservoir, the assessment determined that the occurrence could be directly affected by the Project. Peace daisy is a newly-described species, with the only known location being in the LAA (Björk 2013).

Additional surveys were conducted in 2014 to locate potential additional occurrences of the two species. Work included a pre-field review to identify areas of potential habitat, pedestrian field surveys in the LAA and RAA, analysis of the collected data, and complete documentation of the methods and results.

No persistent-sepal yellowcress was found at any of the three sites where it was reported in 2008. Although the suitable habitat at each site was surveyed intensively, the only yellowcress species found was *Rorippa palustris* (marsh yellowcress). Marsh yellowcress differs from persistent-sepal yellowcress in that it is typically an annual with a taproot, has glabrous or sparsely pubescent pods, and has deciduous sepals.

Peace daisy individuals were found at the one known occurrence near Wilder Creek. The plants were at the fruiting stage so petal colour could not be confirmed, but other characters were consistent with the description of Peace daisy contained in Björk (2013).

7.4.4 Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Plants

This section has been developed in accordance with **Condition 16.3.3** of the Decision Statement: *[The plan shall include]: measures to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants.*

The purpose of this section is to describe the measures that will be implemented to mitigate the environmental effects of the Project on species at risk and at-risk and sensitive ecological communities and rare plants. These measures will be implemented through:

(A) the CEMP,
(B) wetland mitigation and compensation measures (as described in Section 7.3),
(C) a rare plant translocation program,
(D) a rare plant compensation fund, and
(E) species specific mitigation measures (i.e., for amphibians and bats)

These measures are described below.

A. CEMP

As described in Section 6.2, the CEMP provides the environmental specifications for the EPPs that must be prepared by a contractor's Qualified Professional prior to undertaking construction activities at a particular site. Each EPP will provide details on how potential adverse effects will be avoided, mitigated, or compensated for at a particular construction site. Examples of specifications from Section 4.17 of the CEMP (Wildlife Management) that pertain to species at risk and at-risk and sensitive ecological communities and rare plants are provided below.

<u>Wildlife Protection Measures</u>

- Least-risk timing windows:
  - Where feasible, vegetation clearing will take place during the Peace Region terrestrial wildlife least-risk windows and the General Nesting Period for Region 6 (see Section 7.1.1.1 of this Plan)
  - If clearing is to take place outside of the least-risk windows or inside the General Nesting Period, the contractor shall inform BC Hydro and retain a Qualified Environmental Professional to develop a nest and lek search protocol. The protocol will be developed in consultation with the Canadian Wildlife Service (Environment Canada), and the BC Ministry of Forests, Lands and Natural Resource Operations. The protocol will outline survey procedures that will be used to determine the presence of active nests and buffers required around active nest sites. Trees would be removed once nests are confirmed unoccupied
- Amphibian breeding and migration areas:
  - Limit vegetation clearing and avoid road construction in identified amphibian breeding and migration areas, where feasible

- If construction is required adjacent to any identified amphibian breeding and migration areas, implement appropriate barriers and set-back buffers around the sites in accordance with management of Important Wildlife Areas protection measures described below
- Implement amphibian salvage and relocation procedures as required

<u>General Wildlife Habitat Protection Measures</u>

- Control permanent habitat loss by carefully flagging and restricting clearing to those areas required for construction and the safe and reliable operation of the Project
- Outside the reservoir area, control riparian vegetation clearing including clearing around wetlands, and retain wildlife trees when possible, and safe to do so
- Where live or dead large trees must be removed within the transmission line fall zone, leave tall stumps where feasible and safe to do so
- Focus lighting on work sites and away from surrounding areas to minimize light pollution and disturbance to wildlife
- Take measures to mitigate against harming migratory birds, nests and eggs as described in *Incidental Take of Migratory Birds in Canada* (Environment Canada 2014b).

<u>Protection of Important Wildlife Areas</u>

The Environmental Features Map shows Important Wildlife Areas. Contractors will use this data when planning construction activities to identify potential interactions with Important Wildlife Areas and guide avoidance and mitigation planning associated with these areas. Contractors will provide updated data to BC Hydro. BC Hydro will provide the Environmental Features Map to applicable regulatory agencies prior to the start of construction and as it is updated.

- In temporary construction areas, plan construction methods that take into account the location of known rare plant occurrences. Where complete avoidance is not feasible, employ measures to reduce adverse effects such as timing construction activities to winter months, placing ramps or matts over occurrences to reduce soil compaction, use of rubber-tired equipment, implementing designated travel routes to and from work sites
- Except within the dam site area, on designated access roads and during clearing, construction activities shall be prohibited within 15 m of the Ordinary High Water Mark of streams or wetland, unless the activity was described in the EIS and is accepted by BC Hydro
- Avoid construction activity within Important Wildlife Areas, including designated set-back buffers, where feasible
- Designation of set-back buffers:
  - If construction activities must be undertaken within a setback buffer, develop and implement an appropriate mitigation and monitoring program in consultation with BC Hydro, Ministry of Forests Lands and Natural Resources and Canadian Wildlife Service

- o If a bird builds or occupies a nest in an active construction zone a 5m buffer will be established around the nest to protect the nest and allow construction activities to proceed

B. Wetland Mitigation and Compensation Measures

Please refer to Section 7.3 of this Plan for a description of the wetland mitigation and compensation measures that will be implemented to mitigate environmental effects on species at risk and at-risk and sensitive ecological communities and rare plants.

C. Rare Plant Translocation Program

Using baseline data on rare plant occurrence within the Project footprint and available information on the habitat requirements of each plant, BC Hydro identified twelve rare plant taxa as candidates for the translocation program (see below). The selected species have the majority of the known occurrences in the reservoir or in material source areas where avoidance is not feasible.

A five step approach, as outlined in Maslovat (2009) will be undertaken to select species, design, complete and monitor the translocation program. BC Hydro will work with rare plant recovery teams where they have been established in developing the program.

<u>Step 1. Justify the decision to perform the translocation.</u>

Justification criteria will include the following actions:

- A review of rarity status of the 12 candidate rare plant taxa (see below) will be conducted. Any questions regarding the taxonomic or conservation status of candidate species will be directed to CDC program biologists. If sufficient evidence is produced indicating that the taxon does not merit rare status and is not in need of protection, the taxon will be dropped from consideration.
- All of known occurrences of each proposed taxon that maybe impacted by the Project will be clearly identified. For occurrences outside the reservoir footprint, other feasible mitigation options will be reviewed. Only those occurrences subject to imminent and unavoidable extirpation will be considered suitable for translocation.
- An overview of the scientific literature available for each proposed taxon or a closely related species will be conducted. A brief report will be produced outlining each taxon's autecology, genetics, and previous translocation attempts, including methods and results.
- Potential types and locations of recipient sites on Crown and BC Hydro owned lands will be reviewed, including a short discussion of possible risks both to the proposed taxon and the recipient ecosystem. Maps will be included showing both the known distribution of each taxon within Vegetation RAA and the location of the proposed translocation. Only species for which suitable habitat outside the Project footprint on crown or BC Hydro owned lands will be considered suitable for translocation. Private lands will not be considered unless they have an appropriate covenant in place, as the land management cannot be guaranteed in these areas.

- Establish project goals and objectives.

Step 1 will conclude by identifying which of the species from the candidate list are recommended for translocation and establishing the goals and objectives of the program.

Step 2. Rare Plant Translocation Plans

At a minimum the following factors will be considered:

- habitat requirements of the species selected for translocation using data collected in Step 1, bullet 3
- date by which plants must be removed from the Project footprint; this will be determined by the Project construction schedule
- land status, including the potential for the translocation site to remain undisturbed
- additional field and office work required to determine candidate translocation sites on crown and BC Hydro owned lands
- number of plants to be translocated
- mechanics of the translocation including how and which parts of the plants will be collected, transported and replanted
- timing of translocation
- identification of immediate (2-3 months) post translocation care
- develop the ten year monitoring program

Step 2 will conclude with the development of a translocation and follow-up monitoring plan for each species selected in Step 1. Translocation will be monitored for up to 10 years.

Step 3. Rare Plant Translocations

This will include securing the translocation sites, conducting site preparation work, logistical planning, training of field personnel, moving plants, documenting and photographing completed translocation.

Step 3 will conclude once all targeted rare plants have been moved.

Step 4. Post translocation plant care and site management

This will include short-term (2-3 weeks) intensive post-translocation care of plants to maximize survival and longer term, less intensive, site management (invasive species management, access control), and other post-translocation care as identified during field observation.

The field component of Step 4 will conclude at the end of the growing season or as determined by observed plant growth. Step 4 will conclude with the submission of the translocation report. The report will summarize the activities of Steps 1-4.

Rare Plants to be considered for translocation

Twelve rare plants have been shortlisted as candidates for the experimental translocation program. These species were selected because: 1) majority of the known occurrences of these taxa are located in the reservoir or in material source areas where avoidance is not feasible and 2) all species are considered globally rare.

- ***Chrysosplenium iowense* (Iowa golden-saxifrage)**: Iowa golden-saxifrage is ranked G3?/S1 and very few populations have been documented in BC (BCCDC 2013; Natureserve 2013). Two occurrences were documented during baseline surveys: one within the reservoir and one along the transmission line corridor. The occurrence within the reservoir footprint is small (less than 50 plants in an area of 10 m2). No information other than approximate location is recorded for the occurrence in the transmission line corridor.
- ***Erigeron pacalis* (Peace daisy):** Peace daisy, a newly described species with a status of G1/S1, is known from only a single site along the Peace River in BC (Björk 2013; BCCDC 2013). The occurrence is small (less than 50 plants in an area of 10 m2), and is located approximately 18 m outside of the reservoir footprint.
- ***Oxytropis campestris* var. *davisii* (Davis' locoweed):** Davis' locoweed has a ranking of G5T3/S3, and is locally abundant in Northeast BC and adjacent areas of Alberta and Northwest Territories (Welch 1991; BCCDC 2013; Natureserve 2013). Eight of the twelve occurrences documented during baseline surveys are within the reservoir footprint. Seven of the populations contain less than 50 plants in estimated areas of 10 to 500 m2).
- ***Rorippa calycina* (persistent-sepal yellowcress):** Persistent-sepal yellowcress is ranked G3/S1S2 (BCCDC 2013). The three occurrences observed in the Project area are the first known sightings for BC. Two of the occurrences are within the reservoir footprint. All three occurrences are small (less than 50 plants in an area of 10 m2). Note: this species was not documented during 2014 surveys and as such will not be included in the translocation program.
- ***Arnica chamissonis* ssp. *incana* (meadow arnica):** This subspecies of meadow arnica currently carries a rounded global rank of T4 (Natureserve 2013). The four occurrences documented during baseline surveys represent the only records of this taxon in the BC Peace region (BCCDC 2013). All four sites are located within the Direct Effects polygon, and two are within the reservoir footprint. It should be noted that the authoritative Flora of North America does not recognize any subspecies for meadow arnica, and botanists working on the Site C Project have questioned the validity of the taxon (LGL 2006; Wolf 2006; KWR 2011).
- ***Carex heleonastes* (Hudson Bay sedge):** The single occurrence of Hudson Bay sedge discovered in the Project area is the first report of the species for the BC Peace (BCCDC 2013). The site, containing 50–250 plants in an estimated area of 100 m2, is located within the reservoir footprint.
- ***Carex sychnocephala* (many-headed sedge):** The single occurrence of many-headed sedge in the Project area is the only known record of the taxon for the BC Peace region (BCCDC 2013). The population is located within the reservoir footprint, and consists of 1,000–2,500 plants in an estimated area of 100 m2.

- ***Carex torreyi* (Torrey's sedge):** The distribution of Torrey's sedge in BC is restricted to the Peace River region (BCCDC 2013; Klinkenberg 2013). Of the five known occurrences, one containing one plant is situated within the 85th Avenue industrial lands.
- ***Epilobium halleanum* (Halls' willowherb):** The single occurrence of Hall's willowherb documented in the Project area during baseline surveys is the first report of the species for the BC Peace (BCCDC 2013). The site, containing 50-250 plants in an estimated area of 10 m2, is located within the reservoir footprint.
- ***Epilobium saximontanum* (Rocky Mountain willowherb):** The two occurrences of Rocky Mountain willowherb documented during baseline surveys represent the only known populations of the species for the BC Peace (BCCDC 2013). One occurrence is within the reservoir footprint.
- ***Juncus arcticus* ssp. *alaskanus* (arctic rush):** The four occurrences of arctic rush subspecies *alaskanus* documented during baseline surveys are the only records of the taxon in the BC Peace region (BCCDC 2013). The occurrences contain fewer than 50 plants in areas of less than 100 m2. Two are within the reservoir footprint. It should be noted that a number of taxonomic problems have yet to be resolved for arctic rush (Brooks and Clements 2000; Douglas et al. 2001; Natureserve 2013).
- ***Trichophorum pumilum* (dwarf clubrush):** The single occurrence of dwarf clubrush documented during baseline surveys is the first report of the species for the BC Peace (BCCDC 2013). The population is large consisting of 2,500–10,000 plants in an estimated area of 100,000 m2. It is located within the reservoir footprint.

D. Rare Plant Compensation Fund

<u>Objectives</u>

- Provide financial or in-kind assistance to the managing organization of suitable habitat enhancement projects in the RAA to support the protection of rare and sensitive habitats or rare plant occurrences.

<u>Spatial Area</u>

Area 3: The Regional Assessment Area

<u>Scope</u>

- Designated funds will be established in the amount of $200,000 to support existing or proposed mitigation projects for rare and sensitive habitats or rare plants within the Vegetation and Ecological Communities RAA (defined in Volume 2, Section 13 of the EIS).

<u>Schedule</u>

- Identification of potential projects will begin in Construction Year 2.
- Funds will be dispersed by end of Construction Year 3. If suitable projects are not identified by the end of Year 3 BC Hydro will seek other partner projects annually until designated funds are dispensed.

Mitigation and Management Measures

Approach

- The CDC, MFLNRO and interested Aboriginal Groups will be asked for assistance in identifying existing habitat enhancement projects in the RAA.
- BC Hydro will compile a list of existing habitat enhancement projects in the RAA that BC Hydro may be able to provide assistance to too achieve protection of rare ecosystems or rare plant occurrences.
- Using data collected during the additional RAA rare plant inventory surveys identify other opportunities/mechanisms that could be used to protect rare ecosystems or rare plant occurrences.
- The CDC, MFLNRO and Aboriginal Groups will be consulted to identify potential projects.

E. Species Specific Mitigation Measures (Amphibians and Bats)

The amphibian and snake avoidance and reduction of road mortality program will identify the location where mitigation measures (crossing structures or exclusion structures) are required along roads constructed for the Project. The bat roost installation project will target foliage roosting bat species and is intended to mitigate the loss of bat roosting opportunities due to vegetation removal through the installation of artificial bat roosts along the reservoir. These programs are described below.

E-1: Amphibian and Snake Avoidance and Reduction of Road Mortality Program

Objectives

- Install structures, signage or other mitigation measures at known amphibian migration locations (e.g. adjacent to wetlands or other known migrations), to reduce injury and mortality to amphibians and snakes on Project access roads constructed adjacent to wetland and other areas where amphibians and snakes are known to migrate across roads including locations with structures designed for wildlife passage. Western toad will be the focus of management of amphibian road mortality.

Spatial area

Area 1: The Project Activity Zone

Scope

- Multi-year or permanent Project access roads newly constructed specifically for the Project adjacent to wetlands and areas where amphibians and snakes are known to migrate across roads.
- Monitor amphibian use of migration crossing structures installed along Project roads.

Schedule

- Mitigation structures would be constructed during the access road construction.

- Monitoring efficacy of structures would occur between May and August, annually for the duration the access roads are used during Project Construction Years 1 - 8.

Mitigation Measures

Managers of current amphibian road crossing projects will be contacted to learn about current and effective techniques for BC situations (including testing projects in Pacific Rim National Park, Okanagan, Summit Lake, and Mica Dam).

Design of mitigation structures will be based on designs presented in Nyman and Barbaro (2009), Dodd et al. (2004) and designs provided by Leonard Sielecki of MOTI. Additional surveys will be conducted at Portage Mountain to identify specific mitigation structures and placement.

Identify amphibian migration locations along Project access roads:

- Surveys in 2013 and 2104 were conducted to identify and recommend amphibian mitigation measures along specific portions of existing Petroleum Development Roads and the potential Project Access Road (Albrecht et al. 2014). Exclusion fencing and amphibian underpass locations have been provided for incorporation into road design.
- Surveys at Portage Mountain Quarry in 2013 documented western toads along the current access road.

Implementation of Specific Measures:

- Structures will be installed at locations identified as needing mitigation during road construction
- Inspection and maintenance of structures will occur during Project Construction Years 1 – 8

Monitoring and Follow up Program

Monitoring will include:

- Use of amphibian crossing structures installed along existing Project Access and Portage Mountain access roads by amphibians
- Determination of success of exclusion structures at keeping amphibians off access roads during migrations to and from breeding sites
- Recommendation of alterations to mitigation informed by collected field datato improve success or address newly discovered movement corridors

Data will be collected through the completion of road surveys and monitoring of crossing structures.

Road surveys will be used to assess the quantity, distribution and timing of amphibian mortality along Project and Portage Mountain access roads, identify migration hotspots where additional mitigation is required, and provide information on use and modifications required to existing crossing structures. Road based surveys will be conducted by driving along the roads at low speeds, <30km/h. Surveys would be conducted in May to document adults moving to breeding sites and again in July-August to document toadlets moving away from breeding sites.

BC Hydro may monitor use of crossing structures via remote motion-sensitive cameras. Remote cameras have been used successfully for assessing effectiveness of other wildlife crossings in BC (BC Ministry of Environment 2011). Cameras would be set with functions to take set number of photographs at defined intervals every time a motion event is detected, and to take photographs at timed intervals to document small slow moving individuals, such as amphibians.

Potential Amphibian Salvage and Transport

Based on monitoring, or reports collected in wildlife sighting logs (maintained in accordance with CEMP section 4.17) identified mass migration events may require immediate salvage action to prevent road mortality of large numbers of toadlets. Actions during such events typically involve the manual collection and transport of migrating toadlets across the road. A *Wildlife Act* salvage permit will be required. A mass migration mitigation procedure will be developed and implemented if a mass migration is documented, including methods, salvage and information for a *Wildlife Act* permit.

Interim hygiene protocols for amphibian field staff and researchers (MOE 2008) will be followed by field staff handling amphibians.

Schedule

- Monitoring will occur annually during construction

Qualifications

- Environmental professional with experience in working with amphibians and snakes.

E-2: Bat Roost Installation and Monitoring Program

Note: a workplan for this program is attached in Appendix H.

Objectives

- Install up to 120 bat roost and maternity boxes to provide roosting structures for tree roosting bats (*Myotis* bats and big brown bat) around the reservoir.
- Install bat roost structures on new bridges constructed on in the Peace River Valley along re-aligned sections of Highway 29.
- Monitor boxes to determine use by bats.

Spatial area

Area 2: The Local Assessment Area

Scope

- Install and monitor bat roost structures around the reservoir and in new bridges constructed along re-aligned sections of Highway 29.

Schedule

- Box installation will begin in the summer-fall of Construction Year 1 and will continue throughout Project construction until the target of up to 120 boxes is achieved.
- Monitoring will being the year after the first roost boxes are installed and continue annually through the first 10 years of operations.

Mitigation Measures

- The bat box installation workplan is provided below (see 10.13.1).

Monitoring and Follow-up Program

- Monitor boxes to:
  - document use by bats
  - determine species using boxes
- Methodology will follow that outlined in Inventory Methods for Bats (Resources Inventory Committee. 1998a).

Qualifications

- Environmental professional with experience working with bats.

7.4.5 Conservation Measures for Rare Plants

This section has been developed in accordance with **Condition 16.3.4** of the federal Decision Statement: *[The plan shall include]: conservation measures to ensure the viability of rare plants, such as seed recovery and plant relocation.*

Please refer to Section 7.4.4 for a description of the Rare Plant Transplantation Program.

7.4.6 Avoid or Minimize Use of Herbicides and Pesticides

This section has been developed in accordance with **Condition 16.3.5** of the federal Decision Statement: *[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*

The herbicides used by BC Hydro are approved by Health Canada's Pest Management Regulatory Agency (PMRA). All registered herbicides have undergone stringent evaluation and testing by the PMRA to ensure they pose no unacceptable risks to people and the environment when used according to the label. Herbicides are applied by Certified Pesticide Applicators, who are licensed by the Province after writing a provincial exam. They are specially trained and qualified to apply herbicides safely, following stringent legislative requirements.

BC Hydro applies low amounts of herbicides to selectively target undesirable vegetation on ROWs (mostly tall-growing trees and noxious weeds). Selective use of herbicides allows desirable low-growing vegetation to flourish, such as grasses, forbs, legumes, and low-growing native shrubs.

Most targeted applications on rights-of-way are completed with hand-held sprayers. Herbicides may also be injected into tree stems and brushed onto the cut surfaces of stumps to prevent regrowth.

Applications are planned carefully, using federally and provincially registered herbicides formulated for specific application methods. Pesticide-free Zones (PFZ) protect environmentally-sensitive areas, such as bodies of water, watersheds, wells, water intakes, and other sensitive areas. A PFZ is a zone (usually 10m) around an area of land that must not be treated with pesticides, and must be protected from pesticides moving onto it. Herbicide applicators do not apply herbicides within PFZs.

Appendix I contains the Pest Management Plan for Management of Vegetation at BC Hydro Facilities and the Integrated Vegetation Management Plan for Transmission Rights-of-way.

7.4.7 Effectiveness of Mitigation Measures

This section has been developed in accordance with **Condition 16.3.6** of the federal Decision Statement: *[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.*

As described in Section 7.4.4, the several mitigation measures will be implemented to mitigate for the Project's effects on species at risk, at-risk and sensitive ecological communities and rare plants. Mitigation will take place through:

- specifications prescribed in the CEMP,
- wetland mitigation and compensation activities (as described in Section 7.3),
- a rare plant translocation program,
- a rare plant compensation fund, and
- species specific mitigation activities (i.e., for amphibians and bats).

In order to monitor the effectiveness of these mitigation measures, and to verify the accuracy of predictions made during the environmental assessment on species at risk, at risk and sensitive ecological communities and rare plants, BC Hydro will implement the following surveys and monitoring and follow-up programs:

(A) Supplemental Rare Plant Surveys
(B) Supplemental Regional Rare Plant Surveys
(C) Rare Plant Monitoring and Follow-up Program
(D) Downstream rare Plant Occurrence and Riparian Vegetation Monitoring
(E) Downstream Garter Snake and Western Toad Distribution and Habitat Use Monitoring

These surveys and programs are described below.

A. Supplemental Rare Plant Surveys

Please note that a work plan for the rare plant surveys completed in 2014 is provided in the text box that follows this section.

<u>Objectives</u>

- Complete rare plant inventories in Project areas not already surveyed along access roads and the transmission line.

- Use rare plant location information as inputs to final design of access roads and transmission lines.
- Identify measures to mitigate the loss of rare plants
- Verify the accuracy of the predictions made during the environmental assessment with regard to rare plants

Spatial Area

Area 1: The Project Activity Zone

Scope

Surveys will target vascular plants, mosses and lichens. Rare plants that will be targeted are[7]:

- Taxa listed on Schedule 1 of SARA as amended (Government of Canada 2008)
- Taxa assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (COSEWIC 2012)
- Taxa on the BCMOE provincial red or blue lists (B.C. Conservation Data Centre 2011)

Schedule

- Surveys will be completed within targeted areas prior to the initiation of ground disturbing activities
- Surveys will be conducted between June and September. Each area will be surveyed once.

Mitigation and Management Measures

- Additional Baseline Data Collection and/or Analysis
  - Rare plant occurrences within the footprints of Project access roads and the transmission lines.

Qualifications

- Rare plant biologist with experience in the Peace Region.

[7] This is the definition used for rare plants in the EIS: Volume 2, Section 13.2.2 (BC Hydro 2013)

Work Plan for Rare Plant Survey Conducted in 2014

Introduction

The Environmental Impact Statement (EIS) proposed mitigation measures to reduce habitat alteration and fragmentation for rare plants (Table 13.15 Mitigation Measures to Reduce Habitat Alteration and Fragmentation (p 13-27):

> "All known (rare plant) occurrences will be provided as inputs during the final design phase for consideration. If there is limited or no existing data to help facilitate avoidance measures, then supplemental surveys will be conducted. These surveys will target rare plants as defined in Section 13.2.2 and plants of interest to Aboriginal groups where these are made known to BC Hydro—including capsular plants, mosses, and lichens."

Work will include a pre-field review, pedestrian field surveys, analysis of the collected data, and documentation of the methods and results.

Study Area

Study areas will be based on areas requiring supplemental rare plant surveys. These areas will be identified as follows:

- The existing rare plant baseline inventory and areas surveyed during baseline surveys will be used to identify access roads and transmission lines that have limited or no rare plant data and require additional surveys.
- Terrestrial Ecosystem Mapping, known habitat requirements of rare plants previously documented in the Project area or that have the potential to occur in the footprint will be used to develop a list of rare plants that will be targeted for surveys.

Based on the spatial boundaries for clearing activities in Year 1, the following areas were identified for supplemental surveys in 2014:

- drill sites along the Transmission Line;
- Test Pits / Borehole and access within Area A; and
- Drillhole / Boreholes within the Rolling Work Plan #10.

Additional areas requiring survey will be identified based on Project design. As feasible areas will be surveyed the year prior to their disturbance.

Pre-field Review

Work will begin with a pre-field review, designed to identify sites not previously surveyed. Aerial imagery, ecosystem mapping data, and other information sources will be reviewed to delineate potential survey sites. The following sources will be consulted:

- BC Conservation Date Centre (BCCDC), Environment Canada, COSEWIC and Parks Canada records of known rare plant occurrences within the vicinity of the RAA (BCCDC 2013);
- element occurrence data collected by BC Hydro during the rare plant surveys conducted during the preparation of the EIS;
- species distribution maps on the Electronic Atlas of the Flora of British Columbia website (Klinkenberg 2014);
- published floras (e.g. Hitchcock, et al. 1955; Flora of North American Editorial Committee 1993+; Douglas, et al. 1998+);
- online databases (BCCDC 2014; NatureServe 2014); and

- ecosystem mapping data collected during the preparation of the EIS.

Field Program

There are no provincial standards for rare plant surveys, however the province indicates that a BC Plant Inventory protocol may be available by 2015. That survey protocol will be reviewed when released. The survey methodology will otherwise follow methods used consistently for the Project to date:

- *Rare plant inventory methods* (Penny and Klinkenberg 2012),
- Survey Protocols for Survey and Manage Strategy 2: Vascular Plants (Whiteaker et al. 1998)
- Alberta Native Plant Council Guidelines for Rare Plant Surveys in Alberta (ANPC 2000; ANPC 2012).

Field surveys will focus on all under-sampled sites. Due to limitations on gaining permission access to private lands to conduct surveys, only sites on BC Hydro-owned land or Crown land will be surveyed.

Surveys will be conducted on foot by qualified botanists with specific rare plant experience in the region. Pedestrian transects will be walked at the survey sites using a targeted meander survey protocol (ANPC 2012). The goal will be to maximize the possibility of locating occurrences of rare plants. A BCCDC Field Survey Form will be completed when a confirmed or suspected rare plant is detected. Non-vascular plant occurrences and any occurrences of invasive species will also be recorded

Voucher specimen collection

If a sample can be collected without compromising the population, voucher specimens will be collected for later confirmation of field identifications (Klinkenberg and Penny 2006; RIC 1999a). Collected materials will be pressed as soon as possible to ensure a high quality voucher specimen. Plants will be collected when in flower or seed whenever possible. Specimens will be deposited at the University of British Columbia herbarium. Voucher photos will also be taken to record occurrences, and when it would not be appropriate to remove a specimen due to small numbers of individual plants present.

Reporting

As requested in comments on the draft plan, survey results the Ministry of Forests Lands and Natural Resources and to the Conservation Data Center. Submissions to the CDC will conform to digital data submission standards.

B. Supplemental Regional Rare Plant Surveys

Objectives

The objective of this component of the rare plant mitigation program is to conduct inventory level in the RAA for the following 18 species (Table 7) of rare plants, that may be directly affected by the Project and that have been identified by the CDC as requiring additional inventory to support provincial management:

Table 7 Rare Plants Targeted for Inventory in the RAA

Species	Identification Period	Month
autumn willow (*Salix serissima*),	Summer	June, July, August
Colorado rush (*Juncus confuses*),	Mid-summer	July, early August
Drummond's thistle (*Cirsium drummondii*),	Mid to late summer	July, August
dry-land sedge (*Carex xerantica*),	Early summer	June, July

Gardner's sagebrush (Atriplex gardneri var. gardneri),	Mid-summer	July, early August
Hall's willowherb (*Epilobium halleanum*),	Mid-summer	July, early August
Iowa golden-saxifrage (*Chrysosplenium iowense*),	Early summer	June, July
little bluestem (Schizachyrium scoparium),	Mid-summer	July, early August
marsh muhly (Muhlenbergia glomerata).[8]	n/a	n/a
northern bog bedstraw (*Galium labradoricum*),	Early summer	Late June to mid-July
plains reedgrass (Calamagrostis montanensis),	Mid-summer	July, early August
purple-stemmed aster (Symphyotrichum puniceum var. puniceum),	Mid to late summer	July, August, September
riverbank anemone (Anemone virginiana var. cylindroidea),	Summer	June, July, August
Rocky Mountain willowherb (*Epilobium saximontanum*),	Mid-summer	July, early August
Siberian polypody (*Polypodium sibiricum*),	Summer	June, July, August
slender penstemon (*Penstemon gracilis*),	Early summer	June, July
spike-oat (Helictotrichon hookeri),	Mid-summer	July, early August
Torrey's sedge (*Carex torreyi*),	Early summer	June, early July

Spatial Area

Area 3: The Regional Assessment Area

Scope

- Surveys will target BC Hydro fee simple and crown lands as the data collected can be used to inform future land management in the region.

Schedule

- Surveys would begin in the first year of construction and continue over two years
- Surveys would be conducted between June and September

Mitigation and Management Measures

- Additional Baseline Data Collection and/or Analysis
  - Document additional occurrences in the Regional Assessment Area
  - Document population size within each occurrence
- Methods
  - Terrestrial Ecosystem Mapping and the known habitat requirements of each of the 18 target species will be used to identify survey areas.
  - Survey methodology will follow:
    - *Rare plant inventory methods* (Penny and Klinkenberg 2012),
    - Survey Protocols for Survey and Manage Strategy 2: Vascular Plants (Whiteaker et al. 1998)
    - Alberta Native Plant Council Guidelines For Rare Plant Surveys in Alberta (ANPC 2000; ANPC 2012).

[8] The Marsh muhly was downlisted to S3S4 (yellow) in 2013, as such this species will be removed from the target survey species list.

- o The CDC will be asked for input and advice on areas targeted for surveys and methods that will be used.

Qualifications

- Rare plant botanist with experience in the Peace Region.

C. Rare Plant Monitoring and Follow-up Program

Translocated plants will be monitored annually for up to ten years following their move to document if the translocation was successful. Monitoring of translocated plants may be suspended sooner than 10 years if field observations confirms they have not survived. Success will be determined based on the evidence of survival of the plants in the new location. The monitoring program will identify measurement criteria including vegetation growth, persistence of rare plants and establishment / spread (if any) of invasive plant species, and associated monitoring to document the effectiveness of habitat enhancement.

A rare plant botanist or ecologist with experience in rare plant translocations will undertake the monitoring for this program.

D. Downstream Rare Plant Occurrence and Riparian Vegetation Monitoring

- ObjectivesDocument the response of downstream vegetation and known rare plant occurrences between the dam and the Pine River to changes in the surface water regime during construction and operations, by undertaking long term monitoring of the response of riparian vegetation and known rare plant occurrences to changes in the surface water regime during construction and operations
- Document the establishment of new rare plants between the dam and the Pine River confluence

Scope

Surveys will target rare vascular plants, mosses and lichens. Rare plants that will be targeted are[9] :

- Taxa listed on Schedule 1 of SARA as amended (Government of Canada 2008)
- Taxa assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by COSEWIC (COSEWIC 2012)
- Taxa on the BCMOE provincial red or blue lists (B.C. Conservation Data Centre 2011)

Spatial Area

Area 4: The area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

[9] This is the definition used for rare plants in the EIS: Volume 2, Section 13.2.2 (BC Hydro 2013)

<u>Schedule</u>

- Surveys begin the year before river diversion and continue every 2 years for the first ten years then every 5 years for the next 15 years of Project operations.
- Surveys will be conducted between June and September

<u>Mitigation and Management Measures</u>

Approach:

- Locate sample transects.
  - o Terrestrial Ecosystem Mapping, distribution of crown and BC Hydro owned lands and know occurrences of rare plants will be used to locate long-term, fixed, sample transects.
  - o Transects will be established within a representative selection of riparian vegetation communities occurring between the dam tail race and the Pine River.
- Complete descriptions of the pre-diversion vegetation community along sample transects
  - o The first survey will be completed the year of river diversion.
  - o *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998) will be used to describe the vegetation communities. These standards will be used to re-inventory vegetation along each transect every 5 years for 25 years.
  - o Vegetation along each transect will be photographed.
- Rare plant surveys will be conducted in conjunction with riparian vegetation monitoring between the tailrace and Pine River to document the establishment of new rare plant populations in response to changes in downstream flow patterns.
- Methods developed to complete rare plant surveys in the RAA and pre-ground disturbing activities will be used to complete the rare plant survey component of this program.

Methods:

There are no provincial standards for rare plant surveys. Survey methodology will follow:

- *Rare plant inventory methods* (Penny and Klinkenberg 2012),
- Survey Protocols for Survey and Manage Strategy 2: Vascular Plants (Whiteaker et al. 1998)
- Alberta Native Plant Council Guidelines for Rare Plant Surveys in Alberta (ANPC 2000; ANPC 2012).

<u>Monitoring and Follow-up Program</u>

- Monitoring will document changes in the composition of riparian vegetation and the occurrence of rare plants, (establishment of new occurrences and responses of existing rare plant occurrences) to changes in the surface water regime during Project operations.

Qualifications

- Botanist or ecologist with experience rare plants of the Peace Region and in ecosystem classification

E. Downstream Garter Snake and Western Toad Distribution and Habitat Use Monitoring

Objectives

- Survey the distribution of western toad and garter snake populations downstream of the Site C dam to the Pine River.

Spatial area

Area 4: The area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

Scope

- Survey garter snakes and breeding western toad in wetlands downstream of the dam to the Pine River during construction to build a pre-operational baseline.
- Survey garter snakes and breeding western toad in wetlands downstream of the dam to the Pine River during the first ten years of operations to document changes in wetland use in response to changes in downstream flows.

Schedule

- Surveys will begin 1 year prior to river diversion and continue annually through the first 10 years of operations.
- Surveys will be completed May-September for snakes and in May for toads. Sites will be surveyed a minimum of three times each year.

Monitoring Measures

Monitoring Downstream Garter Snake Habitat Use

- Monitoring snake use of downstream wetlands will be carried out before and after Project construction to assess the effects of Project operation on garter snake habitat use. Wetlands will be identified between the Site C dam site and the Pine River, and a subsample will be chosen for cover board installation. Each chosen wetland will be sampled with the use of semi-permanent artificial cover objects or cover boards (Grant et al. 1992; Joppa et al. 2008; Eekhout 2010). This method has been successful at sampling garter snakes in the province (Engelstoft and Ovaska 2000; P. Gregory, pers. comm. 2014).
- Sheets of asphalt roofing materials will be laid out at regular intervals along a transect around the border of the wetland. Surveyors will visit the cover boards between May and September when daytime temperatures exceed 20oC and check underneath them for snakes. The intervals between checks will be at least 2 weeks. Linear mixed model statistics for repeated measures will be used to compare the numbers of snakes detected before and after the Project is operational. A detailed sampling plan will be developed that describes the

methodology for choosing sample wetlands, laying out transects, and scheduling cover board checks.

Monitoring of garter snake and western toad distribution

The portion of the Peace River that will experience the greatest hydrological fluctuations during Project operations lies between the dam site and the Pine River.

- A subset of wetlands and riverine backchannels in this section of the river will be chosen for sampling.
- A subset of downstream wetlands and riverine backchannels that are not anticipated to be impacted by Project operations will also be included to act as a control.
- Each chosen wetland will be sampled for garter snake with the use of semi-permanent artificial cover objects or cover boards (Grant et al. 1992; Joppa et al. 2008; Eekhout 2010). Cover boards will be laid out at regular intervals along a permanent transect around the border of the wetland. Surveys will be conducted between May and September when daytime temperatures exceed 20ºC. Cover boards will be lifted snakes present counted and classified (juvenile or adult). Intervals between checks will be at least 2 weeks.
- Egg mass surveys to document breeding western toad distribution will be completed according to Inventory Methods for Pond-breeding Amphibians and Painted Turtle (Resources Inventory Committee 1998).
- Time constraint surveys (per Inventory Methods for Pond-breeding Amphibians and Painted Turtle, Resources Inventory Committee 1998) will be used to survey the perimeter of wetlands for juvenile and adult western toad. This program will begin one year prior to river diversion and continue annually through the first 10 years of Project operations.

<u>Qualifications</u>

- Environmental Professional with experience in conducting snake and amphibian surveys

7.4.8 Tracking Updates to Status of Listed Species

This section has been developed in accordance with **Condition 16.3.7** of the federal Decision Statement: *[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.*

<u>Objectives</u>

- Maintain current knowledge and track updates of the Projects effects on the status of listed species by tracking updates for species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the *Species at Risk Act*, in the vicinity of the Project during Construction and Operations.

- Should the status of a listed species changes for the worse due to Project activities or during the life of the Project,
    - work with EC, MFLNRO 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,
    - complete analysis to identify if additional measures may be undertaken that would be expected to materially reduce the ongoing effects of the Project on the species.
    - Implement additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species

<u>Spatial Area</u>

Area 2: The Local Assessment Area

<u>Scope</u>

- Track the status of species, including rare plants, identified during the environmental assessment of the Project (including in the EIS, Joint Review Panel Report and Federal and Provincial conditions associated with Project approvals) by monitoring Schedule 1 of the federal *Species at Risk Act,* species on the BC red or blue list, and species assessed by the Committee on the Status of Endangered Wildlife in Canada.
- Where the listing of a particular species changes for the worse, determine the impact that the Project may be having on that species and whether there are any technically and economically feasible changes to management or monitoring plans;
- Report to, and seek input from EC, MFLNRO and MOE, and determine whether changes to management or monitoring plans should be implemented.

<u>Schedule</u>

- Construction: the status of listed species known to occur in the Project area will be reviewed annually during Project construction
- Operations: A schedule for periodic review of the listed species status during Project operations will be established at and reviewed during the Operations phase

<u>Mitigation and Management Measures</u>

Approach

- BC Hydro will regularly review species at risk schedules.
- Should the status of a listed species changes for the worse due to Project activities or during the life of the Project, BC Hydro will:
    - work with EC, MFLNRO 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.

- o complete analysis to identify if additional measures may be undertaken that would be expected to materially reduce the ongoing effects of the Project on the species.
- o Implement additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species. The level of BC Hydro's participation in any recovery planning will be determined by the degree of known impact of the ongoing effects of the Project on species at risk, considering:
  - the listing status of the species and other associated species
  - the likelihood and extent of impacts incurred by other stakeholders
  - species of concern in existing BC Hydro, federal, or provincial processes
  - public interest
  - Aboriginal interest

Qualifications

- Environmental practitioner with experience in addressing the species at risk for which additional mitigation measures are required.

7.4.9 Draft and Final Plan Submission

This section has been developed in accordance with **Conditions 16.4 and 16.5** of the federal Decision Statement:

> *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 7.4) and consultation undertaken for development of the Plan.

7.4.10 Implementation of the Plan and Analysis of Implementation of Plan

This section has been developed in accordance with **Condition 16.6** of the federal Decision Statement: *The Proponent shall implement the plan and provide to the Agency analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and for the first 10 years of operation, with the exception of condition 16.3.7 for which reporting will continue for the life of the Designated Project, as appropriate.*

BC Hydro will implement the mitigation and compensation measures described in Section 7.4 for Project effects on Species at Risk, At-risk and Sensitive Ecological Communities and Rare Plants.

Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 7.4.

8.0 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 requirements of each of these conditions are described in the following:

Section 8.1: Vegetation and Invasive Plant Management (Condition 9)

Section 8.2: Rare Plant Surveys (Condition 10)

Section 8.3: Rare and Sensitive Habitats and Rare Plants (Condition 11)

Section 8.4: Wetland Mitigation and Compensation (Condition 12)

Section 8.5: Vegetation and Ecological Communities Monitoring and Follow-Up Program (Condition 13)

Section 8.6: Wildlife Management (Condition 15)

Section 8.7: Compensation for Loss of Wetland Habitat (Condition 16)

Section 8.8: Avoid and Reduce Injury and Mortality to Amphibians and Snakes (Condition 19)

Section 8.9: Monitoring Wildlife Mitigation Measures (Condition 21)

Section 8.10:Tracking Changes in the Status of Listed Species (Condition 23)

Section 8.11:Ungulate Winter Range (Condition 24)

As described in Section 2.1 of this plan, 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, the Vegetation Clearing and Debris Management Plan and/or the Aboriginal Plant Use Mitigation Plan. They are, therefore, not duplicated in the Vegetation and Wildlife Mitigation and Monitoring Plan.

8.1 Condition 9: Vegetation and Invasive Plant Management

8.1.1 Objective of Vegetation and Invasive Plant Management

This section has been developed in accordance with the following requirements of Environmental Assessment Certificate 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 purpose of the Vegetation and Invasive Plant Management section is to describe the mitigation measures that will be implemented to ensure that the Project is carried out in a manner that protects ecosystems, plant communities and vegetation from being infested by invasive plants. This plan has been developed in accordance with the requirements of Environmental Assessment Certificate Condition 9, as described 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.

Vegetation and Invasive Plant Management measures will be implemented through the CEMP as described in Section 8.1.2 and the activities described in Section 8.1.3 of this Plan. The CEMP and the mitigation and compensation measures developed in the Vegetation and Wildlife Mitigation and Monitoring Plan (including those described in Section 8) have been developed by Qualified Environmental Professionals. Please see Section 2.3 of this Plan and Section 6.0 of the CEMP for details.

8.1.2 CEMP

Table 8 lists the requirements of Condition 9 that will be addressed through the implementation of standard mitigation measures identified in the CEMP.

Table 8. EAC Condition 9 Requirements Implemented through the CEMP.

Condition 9 Requirement	Relevant CEMP Specification
[The Vegetation and Invasive Plant Management Plan must include at least the following] • Surveys of existing invasive species populations prior to construction.	**From Section 5.1 Vegetation and Wildlife Surveys:** BC Hydro will conduct the following surveys: • Rare plant surveys (including vascular plants, mosses, and lichens) along the transmission line and temporary access roads • Invasive plant inventories at work sites BC Hydro will provide the results of these surveys to contractors, including updates, as appropriate. ***Note:** Surveys of existing invasive species have been conducted within the PAZ annually since 2009.
[The Vegetation and Invasive Plant Management Plan must include at least the following]:	**From Section 4.15 Vegetation and Invasive Plant Management** Construction activities may affect the dispersal of

Condition 9 Requirement	Relevant CEMP Specification
• Invasive plant control measures to manage established invasive species populations and to prevent invasive species establishment.	invasive plant species which can out-compete native vegetation, and cause damage to natural environments and agricultural production. BC Hydro will undertake invasive plant control on work sites, in accordance with BC Hydro's applicable Pest Management Plan, prior to construction, and coordinate control activities, and schedules with Contractors. EPPs must address, at a minimum, the following requirements if applicable: • Surveys of existing invasive species populations and mapping provided by BC Hydro • Limit the stripping of vegetation and soils to the areas required for Project activities • Ensure that weed material is not brought onto Project work sites from non-Project work sites, and that weed material from Project work sites is not transported to non-Project work sites • Manage vehicle movement in a manner that reduces seed dispersal both within and beyond construction sites • Locate vehicle wash areas at least 30 m from the Ordinary High Water Mark of any water body • Treat used wash water to prevent seed dispersal and release of contaminants • Keep machinery on designated routes to reduce damage to surrounding vegetation • Measures to control invasive plants, manage established invasive species populations and prevent invasive species establishment **Note:** Invasive plant control measures will be conducted in accordance with BC Hydro's Pest Management Plans (Appendix I).
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.	**See Section 4.15 Vegetation and Invasive Plant Management above** **From Section 4.5 Fisheries and Aquatic Habitat Management** EPPs will address, at a minimum, the following requirements if applicable: • Description of the areas and types of aquatic

Condition 9 Requirement	Relevant CEMP Specification
	and riparian habitat with the potential to be adversely affected from construction activities, and mitigation measures and best management practices proposed to reduce, avoid, or offset potential adverse effects • Unless otherwise authorized in a permit or approval, construction activities will be conducted in accordance with: o *A Users' Guide to Working In and Around Water* (B.C. Ministry of Environment, 2009) • Except at the Dam Site Area during clearing, prohibit construction within 15 m of the Ordinary High Water Mark, unless the activity was described in the EIS • Avoid construction and installation of transmission structures and associated infrastructure (i.e. anchors, guy wires) below the high water mark of any watercourse • Use existing roads, trails, or cut lines, wherever possible • Retain a 15 m machine-free riparian buffer from the Ordinary High Water Mark of watercourses and waterbodies during clearing • Locate lay-down and material storage areas at least 15 m from the the Ordinary High Water Mark • Clearly flag or otherwise delineate riparian areas throughout all phases of construction • Prevent debris and deleterious substances from entering watercourses Note: this condition will also be addressed through the application of the mitigation hierarchy described in section 7.3.2 described in this Plan.
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.	**From Section 4.18 Restricted Activity and Work Avoidance Zones** Within the Dam Site Area, restricted activity zones will be established to reduce or avoid potential construction effects in those areas. Only specified construction activities will be conducted within the restricted activity zones. Environmentally sensitive areas may also be identified as work avoidance zones. No construction activities will be allowed in work avoidance zones. Examples

Condition 9 Requirement	Relevant CEMP Specification
	are: • except within the Dam Site Area, work avoidance zones will be established around known tufa seeps, wetlands and rare plant occurrences that are adjacent to construction areas; These sites must be addressed, as applicable, in EPPs. Appropriate buffers and barriers will be established around these sites in consultation with BC Hydro.

8.1.3 Additional Mitigation Measures

The remaining requirements of Condition 9 will be addressed through the mitigation measures described below.

8.1.3.1 Rare and Sensitive Community Identification Program

This section has been developed in accordance with the following requirement of Condition 9: *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 requirements described above will be addressed through the Rare and Sensitive Plant Community Identification Program, described below. A survey plan is also provided in the text box below for additional detail.

<u>Objectives</u>

The objective of this program is to improve the identification of rare and sensitive communities within the baseline habitat mapping. The improved habitat mapping will be used to identify areas which provide habitat for species at risk, identify areas on BC Hydro lands that could be retained and managed to preserve habitat—rare and sensitive ecological communities. The improved mapping will also be used to monitor effects of the project on species at risk and at-risk ecological communities. Specifically, the program will:

- Expand modeling, including completion of field work, to improve identification of rare and sensitive plant communities and aid in the delineation of habitats that may require extra care.
- Identify measures to address/mitigate environmental effects on at-risk and sensitive ecological communities.
- Verify the accuracy of the predictions made during the environmental assessment on at-risk and sensitive ecological communities.

Spatial Area

Area 2: The Local Assessment Area

Scope

- Field surveys will be conducted in map polygons identified in the EIS as having the potential to support rare and sensitive ecosystems including wetlands as these are the only sites where such ecosystems would occur.
- Confirm the occurrence of rare and sensitive ecosystems through field work and use data to update identification of rare and sensitive plant communities on baseline (TEM) mapping.

Schedule

- 2014 and 2015.
- Surveys would be conducted between June and September as appropriate for the ecosystems targeted by the field work.

Mitigation and Management Measures

- Additional Baseline Data Collection and/or Analysis
    - Confirm through field work the presence of rare and sensitive plant (ecological) communities
    - Update identification of rare and sensitive plant communities on baseline (TEM) mapping.
- Implementation of Specific Measures
    - Areas requiring extra care during Project construction will be identified
- Recommendations for avoiding affecting identified areas will be provided

Required Qualifications

- R.P. Bio. with knowledge of plant communities in the study area, TEM mapping, conducting ecological classification plots.

Survey Plan for Rare and Sensitive Plant Community Identification

Introduction

BC Hydro conducted additional surveys in 2014 for rare and sensitive communities. This survey plan describes the methods, timing, and administrative aspects of the 2014 survey. Similar methods will be applied to future surveys.

The objectives of the surveys will be to:

- Field truth to confirm rare and sensitive ecological communities within work areas;
- Assess opportunities to improve the predictive capability of the mapping of rare and sensitive ecological communities within the local assessment area (LAA).

Study Area

Year one Project work areas include the dam site area, the lower Moberly River, Portage, Del Rio and West Pine quarries, and along Jackfish Road. Terrestrial Ecosystem Mapping (TEM) at 1:20,000 has been completed for the study area.

As construction continues, additional areas where such surveys have not already been completed will be added to the program.

Study Background

Rare and Sensitive Ecological Communities

An ecological community can be defined as a natural plant community and its associated environmental site characteristics including soil, landform, nutrient, and moisture regimes. At-risk ecological communities are defined and ranked by the CDC and placed on the provincial red- or blue-list according to the degree of threat, trend in area of occupancy, number of protected and managed occurrences, intrinsic vulnerability, specificity of habitat requirements, and other considerations. Forest or wetland plant communities listed by the CDC are usually associated with one or more forest or wetland site series. The association indicates that the site series has the potential to support the community in question but the community will not necessarily be present at each occurrence of the site series.

Sensitive ecological communities are those that may not be Red or Blue listed but are ecologically particularly fragile (Resource Information Standards Committee 2006).

Sensitive communities defined for the Project for assessment purposes include old-growth forest and Old-Growth Management Areas (OGMAs), tufa seeps, grasslands, wetlands, and communities ranked 1 or 2 for Goal 2 of the Conservation Framework that are not Red- or Blue-listed. Goal 2 emphasizes the prevention of species and ecosystems from becoming at risk in order to protect species and communities that are neither secure nor at risk (BC Ministry of Environment 2009).

Two Red-listed and 10 Blue-listed communities are defined for the BWBSmw, and SBSwk2 subzone variants. Twelve potentially occur in the BWBSmw subzone and four in the SBSwk2 (BC Conservation Data Centre 2011).

Hilton *et al*. (2013) provides a summary of additional detail of the communities.

> *The potential for the rare and sensitive ecological communities (RaSEC) to occur within and adjacent to the Project area was assessed following methods outlined in the BC Resource Inventory Standards Committee's (RISC)* ***Standard for Mapping Ecosystems at Risk in British Columbia: An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems*** *(2006). Information on the site series that potentially support the currently-defined RaSEC was gathered from the BC CDC (2014) and NatureServe (2014). This indicates the potential for a community to occur in a specific site series, but does not confirm that the RaSEC is present. The actual occurrence of RaSEC can only be determined during site visits.*

Pre-field Review

Polygons with red/blue communities within construction activity areas will be selected. Approximately 188 polygons that have the potential to contain a RaSEC were selected for surveying in 2014. A field plan will be prepared to efficiently sample the areas considering access and private properties.

Field Program

Surveys will sample representative/accessible sites with potential to contain a RaSEC in year 1 activity zones.

In 2014, ten days of field work was planned in August for two crews, based on the sample of about 100 polygons. Future surveys will use a similar level of effort.

Field crews will complete Site Visit Forms FS1333 (LMH25 ed2 2010). This will simultaneously confirm whether RaSEC is present and test the mapping.

Data Analysis and Reporting

Field data will be entered into the provincial standard VENUS database. The accuracy of the mapping will be assessed using the field data and previous plot data. A summary report will be prepared to present the results of the field program and report the accuracy of the mapping.

Red or Blue listed ecological communities potentially occurring in Project area.

Ecological Community Common Name	Scientific Name	BC Status	BEC Unit	TEM Ecosystem Unit
Arctic rush - Nuttall's alkaligrass - Seablite	Juncus arcticus - Puccinellia nuttalliana - Suaeda calceoliformis	Red	BWBSmw	00/SE
Mat muhly - Arctic rush - Nevada bluegrass	Muhlenbergia richardsonis - Juncus arcticus - Poa secunda ssp. juncifolia	Red	BWBSmw	00/SE
Scrub birch / Water sedge	Betula nana / Carex aquatlilis	Blue	BWBSmw SBSwk2	00/SE Wf02
Tamarack / Water sedge / Golden fuzzy fen moss	Larix laricina / Carex aquatilis / Tomentypnum nitens	Blue	BWBSmw SBSwk2	10/TS Wb06
Tamarack / Buckbean / Shore sedge	Larix laricina / Menyanthes trifoliata – Carex limosa	Blue	BWBSmw	10/TS
White spruce / Oak fern – Wild sarsaparilla	Picea glauca / Gymnocarpium dryopteris – Aralia nudicaulis	Blue	BWBSmw	05/SO
White spruce - Black spruce / Labrador tea / Glow moss	Picea glauca – Picea mariana / Rhododendron groenlandicum / Aulacomnium palustre	Blue	BWBSmw	08/BT
Black spruce / Common horsetail / Peat-mosses	Picea mariana / Equisetum arvense / Sphagnum spp.	Blue	BWBSmw	08/BT
Black spruce / Lingonberry / Peat-mosses	Picea mariana / Vaccinium vitis-idaea / Sphagnum spp.	Blue	BWBSmw	08/BT
Balsam poplar – White spruce / Mountain alder – red-osier dogwood	Populus balsamifera – Picea glauca / Alnus incana – Cornus stolonifera	Blue	BWBSmw	Fm02
Common cattail marsh	Typha latifolia Marsh	Blue	BWBSmw	00/SE

White spruce / Red swamp currant / Horsetails	Picea glauca / Ribes triste / Equisetum spp.	Blue	BWBSmw	07/SH
Lodgepole pine / Black huckleberry / Reindeer lichens	Pinus contorta / Vaccinium membranaceum / Cladina spp.	Blue	SBSwk2	02/LH
Narrow-leaved cotton-grass – Shore sedge	Eriophorum angustifolium – Carex limosa	Blue	SBSwk2	Wf13

8.1.3.2 Inventory of Areas Not Already Surveyed

This section has been developed 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.*

The requirements of this condition will be met through the implementation of the measures described in Section 7.4.3, Rare Plant Surveys.

8.1.3.3 Spatial Database of Known Rare Plant Occurrences

This section has been developed 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.*

BC Hydro has developed an Environmental Features Map which is produced from GIS spatial data. This map identifies known environmental, heritage and cultural features and environmental sensitive areas, and will include data on known rare plant occurrences in the vicinity of Project components. Both the spatial data used to create the map and the map itself will be updated as additional information is collected.

8.1.3.4 Rare Plant Translocation Program

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

The requirements of this condition will be met through the implementation of the measures described in Section 7.4.4, Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Plants.

8.1.4 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirements of Condition 9:

- *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.1) and consultation undertaken for development of the Plan.

8.1.5 Implementation and Adherence to Final Plan

This section has been developed in accordance with the following requirements of Condition 9: *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.*

BC Hydro will implement measures described in Section 8.1 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.1.

8.2 Environmental Assessment Certificate Condition 10: Rare Plant Surveys

8.2.1 Objective of Rare Plant Surveys

The purpose of this section is to describe how BC Hydro will fund or undertake directly with the use of a Rare Plant Botanist targeted surveys in the RAA for rare plant species, and a study focused on clarifying the taxonomy of Ochroleucus bladderwort. This section has been developed in accordance with the requirements of Environmental Assessment Certificate 10, provided 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.

8.2.2 Targeted Surveys for Rare Plant Species in the RAA

This section has been developed in accordance with the following requirements of 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.*

The requirements of the targeted surveys in the RAA for the identification of rare plant species as described in the condition will be meet through the implementation of surveys described in Section 7.4.4 Mitigation Measures.

Section 7.4 describes the supplemental rare plant surveys, supplemental regional rare plant surveys, and rare plant monitoring and follow-up program that will be implemented to monitor the effectiveness of mitigation measures and verify the accuracy of predictions made during the environmental assessment on species at risk, at risk and sensitive ecological communities and rare plants.

8.2.3 Taxonomy of Ochroleucus bladderwort

This section has been developed in accordance with the following requirements of Condition 10: *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 requirements to clarify the taxonomy of Ochroleucus bladderwort will be met through the implementation of the program described below.

Objective

Undertake, with the use of a rare plant botanist a study focused on clarifying the taxonomy of the following six species, through field, herbaria and genetic work in consultation with MFLNRO and the CDC:

- Ochroleucus bladderwort (*Utricularia ochroleuca*),
- Cicuta sp. nov[10].,
- Elymus sp. nov.
- Erigeron pacalis ined., [11],
- Erigeron sp. nov. (aff cespitosus),
- Platanthera aplectra ined

Spatial Area

Additional field work will be completed in Area 3: The Regional Assessment Area

Scope

- Taxonomic clarification

Schedule

- Work will be completed between Construction Year 2 and Year 6

Mitigation and Management Measures

- Additional Data Collection and/or Analysis
  - Additional research to clarify the taxonomy of 6 rare plants that will be affected by the Project.
  - BC Hydro will work with the CDC to determine the process, funding structure and scope required to advance the taxonomic classification of Cicuta sp. nov., Elymus sp. nov., Erigeron pacalis ined., Erigeron sp. nov. (aff cespitosus), Platanthera aplectra ined and Ochroleucus bladderwort, through up to five (5) years of additional work.
  - At the suggestion of the CDC, BC Hydro will contact the UBC Herbarium and specialist Curtis Bjork to seek further advice.

Qualifications

- Rare plant botanist with proven experience in taxonomic classification work.

[10] Site visits to the occurrence in 2014 by C. Björk failed to relocate plant. Without further material to study the classification of this species cannot be advanced. No work will be conducted (Pers. Comm. J. Penny, November 18, 2014)

[11] Taxonomic classification has been complete (Bjork 2013). (Pers. Comm. J. Penny, November 18, 2014)

8.2.4 Submission of Survey and Study Findings

This section has been developed in accordance with the following requirements of Condition 10: *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.*

As required, findings and analysis of results from the surveys and study will be provided to FLNRO and MOE (BC Conservation Data Centre). Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including those requirements described in Section 8.2.

8.3 Environmental Assessment Certificate Condition 11: Rare and Sensitive Habitats and Rare Plants

The purpose of this section is to describe how BC Hydro will compensate for the loss of rare and sensitive habitats and protect occurrences of rare plants to mitigate for the effects of the Project on rare and sensitive habitats and rare plants. This section has been developed in accordance with the requirements of Environmental Assessment Certificate 11, provided below.

EAC Condition 11

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

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

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

The requirements of this condition will be met through implementation of the measures described in Section 7.4.4, Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Plants. In particular, refer to Subsection B, Wetland Mitigation and Compensation Measures and Subsection D, the Rare Plant Compensation Fund.

As described in Section 2.3 of this Plan, BC Hydro is engaging with FLNR, MOE and Aboriginal Groups with regard to the development of the compensation program.

8.4 Environment Assessment Certificate Condition 12: Wetland Mitigation and Compensation

8.4.1 Objective of Wetland Mitigation and Compensation

This section has been developed in accordance with the following requirements of 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 purpose of this section is to describe the mitigation and compensation measures that will be implemented in order to mitigate the effects of the Project on wetland habitat. This section has been developed in accordance with the requirements of Environmental Assessment Condition 12, provided below.

The requirements of this condition will be met through the implementation of specifications in the CEMP as described in Section 8.4.2, and through the mitigation measures described in Section 8.4.3. Both the CEMP specifications and the measures in this plan have been developed by Qualified Environmental Professionals, as indicated in Section 2.3 of this Plan and Section 6.0 of the CEMP.

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;

- o Maintain or improve hydrology where avoidance is not feasible;
- o Replace like for like where wetlands will be lost, in terms of functions and compensation in terms of area;
- o Improve the function of existing wetland habitats; and
- o 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.

8.4.2 CEMP

Table 9 lists the requirements of Condition 12 that will be addressed through the implementation of standard mitigation measures identified in the CEMP.

Table 9. EAC Condition 12 Requirements that will be met through implementation of the CEMP

Condition 12 Requirement	Relevant CEMP Specification
If roads cannot avoid wetlands, culverts will be installed under access roads to maintain hydrological balance, and sedimentation barriers will be installed;	**From Section 4.4, Erosion Prevention and Sediment Control Management** Where required, install appropriately sized culverts to reduce road failure through erosion and to manage hydrological balance and wetland function
Stormwater management will be designed to control runoff and direct it away from work areas where excavation, spoil placement, and staging activities occur.	**From Section 4.4, Erosion Prevention and Sediment Control Management:** Include measures to control runoff and manage stormwater (for example rainfall or snow melt) and direct it away from construction 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	**From Section 4.4, Erosion Prevention and Sediment Control Management:** Prior to construction of the Jackfish Lake Road, or Project access roads, and of the transmission line,

Condition 12 Requirement	Relevant CEMP Specification
Project access roads and transmission line.	develop, with the assistance of a hydrologist, site-specific measures to reduce changes to the existing hydraulic balance and wetland function during construction.
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).	**From Section 4.13 Spill Prevention and Response** Activities that involve potentially harmful or toxic substances such as oil, fuel, antifreeze, and concrete will follow approved practices and consider *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2014). Equipment will be maintained according to manufacturers' specifications to reduce the likelihood of spills. EPPs will adhere to requirements of the *Spill Reporting Regulation, BC Transportation of Dangerous Goods Act, Environmental Emergency Regulations* and the *Canada Transportation of Dangerous Goods Act*. Each Plan shall also meet current BC Ministry of Environment Guidelines for Industry Emergency Response Plans or equivalent. *Note: See CEMP Section 4.13 for additional specifications on Spill Prevention, Spill Response Equipment, and Spill Response Procedures.

8.4.3 Wetland Mitigation and Monitoring Measures (Guide to Section 7.3)

The following requirements of Environmental Assessment Condition 12 are addressed in Section 7.3 and Appendix G of this Plan. Specifically,

- For information on BC Hydro's wetland compensation approach, see Section 7.2.5 Compensation for Loss of Non-Wetland Migratory Bird Habitat
- For information on location, size and type of wetlands affected by the Project, see Section 7.3.3 Baseline Data for Wetlands and Riparian Habitat
- For the a defined mitigation hierarchy that prioritizes mitigation to be undertaken, as well as an assessment of wetland function lost as a result of the Project that is important to migratory birds and species at risk, see Section 7.3.2 Wetland Mitigation Hierarchy / No net loss of wetland function, and Appendix G, Assessment of Wetland Function and Impacts to Migratory Birds and Species at Risk for the Site C Clean Energy Project.

- For information on monitoring of construction and operation activities that could cause changes in wetland functions, see Section 7.3.5 Evaluating Changes in Baseline Conditions.

8.4.4 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirements of Condition 12:

- *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.4) and consultation undertaken for development of the Plan.

8.4.5 Implementation of Final Plan

This section has been developed in accordance with the following requirements of Condition 12: *The EAC Holder must develop, implement and adhere to the final Wetland Mitigation and Compensation Plan, and any amendments, to the satisfaction of EAO.*

BC Hydro will implement measures described in Section 8.4 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.4.

8.5 Environmental Assessment Certificate Condition 14: Vegetation and Ecological Communities Monitoring and Follow-up Program

8.5.1 Objective: Vegetation and Ecological Communities Monitoring and Follow-up Program

This section has been developed in accordance with the following requirements of Environmental Assessment Certificate 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 purpose of this section is to describe the Vegetation and Ecological Communities Monitoring and Follow-Up Program, namely, the rare plant translocation program. This program has been developed by a Qualified Environmental Professional, as described in Section 2.3 of the Vegetation and Wildlife Mitigation and Monitoring Plan. This section has been developed in accordance with the requirements of Environmental Assessment Condition 14, provided 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.

The EAC Holder must provide this draft Vegetation and Ecological Communities Monitoring and Follow-up Program to Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John and Aboriginal Groups for review within 90 days after the commencement of construction.

The EAC Holder must file the final Vegetation and Ecological Communities Monitoring and Follow-up Program with EAO, Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John, and Aboriginal Groups, within 150 days after commencement of construction.

The EAC Holder must develop, implement and adhere to the final Vegetation and Ecological Communities Monitoring and Follow-up Program, and any amendments, to the satisfaction of EAO.

8.5.2 Rare Plant Translocation Program

This section has been developed in accordance with the following requirements of Environmental Assessment Certificate Condition 14:

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 requirements of this condition will be meet through the implementation of specifications described in Section 7.4.4 Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Plants.

8.5.3 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirements of Environmental Assessment Certificate Condition 14:

- *The EAC Holder must provide this draft Vegetation and Ecological Communities Monitoring and Follow-up Program to Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John and Aboriginal Groups for review within 90 days after the commencement of construction.*

- *The EAC Holder must file the final Vegetation and Ecological Communities Monitoring and Follow-up Program with EAO, Environment Canada, FLNR, MOE, Peace River Regional District, City of Fort St. John, and Aboriginal Groups, within 150 days after commencement of construction.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.5) and consultation undertaken for development of the Plan.

8.5.4 Implementation of Plan and Reporting Requirements

This section has been developed in accordance with the following requirements of Environmental Assessment Certificate Condition 14:

- *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.*
- *The EAC Holder must develop, implement and adhere to the final Vegetation and Ecological Communities Monitoring and Follow-up Program, and any amendments, to the satisfaction of EAO.*

BC Hydro will implement measures described in Section 8.5 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.5

8.6 Environmental Assessment Certificate Condition 15: Wildlife Management

8.6.1 Objective: Wildlife Management

This section has been prepared in accordance with the following requirements of Environmental Assessment Certificate Condition 15: *The EAC Holder must develop a Wildlife Management Plan. The Wildlife Management Plan must be developed by a QEP.*

The purpose of this section is to describe BC Hydro's Wildlife Management Plan. This section has been developed in accordance with the requirements of Environmental Assessment Certificate Condition 15, provided below.

The requirements of this condition will be met through the implementation of specifications in the CEMP and through mitigation measures described in Section 7.3 of this Plan (Wetland Mitigation and Monitoring). The CEMP and the measures in this plan have been developed by Qualified Environmental Professionals, as indicated in Section 2.3 of this Plan and Section 6.0 of the CEMP.

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.

8.6.2 CEMP

Table 10 lists the requirements of Condition 15 that will be addressed through the implementation of standard mitigation measures identified in the CEMP.

Table 10. EAC Condition 15 Requirements Implemented through the CEMP.

Condition 15 Requirement	Relevant CEMP Specification
The Wildlife Management Plan must include at least the following:	
• Measures to avoid, if feasible, constructing in sensitive wildlife habitats. If avoiding sensitive wildlife habitats is not feasible, condition 16 applies.	**From Section 4.18 Restricted Activity and Work Avoidance Zones** Within the Dam Site Area), restricted activity zones will be established to reduce or avoid potential construction effects in those areas. Only specified construction activities will be conducted within the restricted activity zones. … Environmentally sensitive areas may also be identified as work avoidance zones. No construction activities will be allowed in work avoidance zones. Examples are: • except within the Dam Site Area, work avoidance zones will be established around known tufa seeps, wetlands and rare plant occurrences that are adjacent to construction areas … These sites must be addressed, as applicable, in EPPs. Appropriate buffers and barriers will be established around these sites in consultation with BC Hydro.
• 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.	Please see above response.
• Protocol for the application of construction methods, equipment, material and timing of activities to mitigate adverse effects to wildlife and wildlife habitat.	See entirety of Section 4.17 Wildlife Management (not provided here due to length)
• 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	From Section 4.17 Wildlife Management Under General Wildlife Habitat Protection Measures: • Focus lighting on work sites and away from surrounding areas to minimize light pollution

Condition 15 Requirement	Relevant CEMP Specification
EAC Holder must ensure additional mitigation measures are implemented to reduce light pollution, including light shielding.	and disturbance to wildlife
• 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 4.7 Wildlife Management Plan • Under Human-Wildlife Conflict Management Plan: Project workers shall be prohibited from … o Hunting while on construction sites, Project built roads or worker housing sites o Cleaning game at construction sites, Project built roads or worker housing sites Section 3.0 Orientation, Training and Tailboard Meetings Management (not provided here due to length)
The EAC Holder must ensure that all workers are familiar with the Wildlife Management Plan.	Section 3.0 Orientation, Training and Tailboard Meetings Management (not provided here due to length)

8.6.3 Wildlife Management Measures

This section has been prepared in accordance with the following requirements of Environmental Assessment Certificate Condition 15: [*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.*

This requirement is addressed through implementation measures described in Section 7.4.2 Verification of Modelled Results for Surveyed Species at Risk.

8.6.4 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirements of Condition 15:

- *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.6) and consultation undertaken for development of the Plan.

8.6.5 Implementation of Final Plan

This section has been developed in accordance with the following requirements of Condition 15: *The EAC Holder must develop, implement and adhere to the final Wildlife Management Plan, and any amendments, to the satisfaction of EAO.*

BC Hydro will implement measures described in Section 8.6 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.6

8.7 Environmental Assessment Certificate Condition 16: Compensation for Loss of Wetland Habitat

8.7.1 Objective: Compensation for Loss of Wetland Habitat

This section has been prepared in accordance with the following requirement of Environmental Assessment 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.*

This purpose of this section is to describe the compensation measures that will be implemented for the effects of the Project on wetland habitat. This section has been developed in accordance with the requirements of Condition 16, provided 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.

8.7.2 Fish-Free Areas in Wetlands

This section has been developed in accordance with the following requirement of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation (measure): 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.*

In addition to the mitigation measures described in Section 7.3 Wetland Mitigation and Monitoring, compensation options for wetlands will include fish-free areas to manage the effects of fish predation on invertebrate and amphibian eggs and larvae and young birds.

8.7.3 Mitigation for Loss of Snake Hibernacula

This section has been developed in accordance with the following requirement of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation (measure): Mitigation for the loss of snake hibernacula, artificial dens must be included during habitat compensation.*

The mitigation program for the loss of snake hibernacula is described below. A Garter Snake Mitigation and Monitoring Work Plan is also provided in Appendix J.

<u>Objective</u>

Construction of up to 30 snake dens will be completed to replace potentially lost-hibernacula due to Project construction. Constructed dens will be distributed along the new reservoir shoreline in appropriate locations.

<u>Spatial area</u>

Area 2: The Local Assessment Area and Area 3: The Regional Assessment Area.

<u>Schedule</u>

- Den construction will begin in Construction Year 1
- Dens will be monitored every 3 years for up to 15 years into operations.
- Monitoring will begin 3 years after the first alternate den is constructed

<u>Mitigation Measures</u>

- The Garter Snake Mitigation workplan is provided below.

<u>Monitoring</u>

- Monitor constructed dens to document use by snakes. Dens will be monitored every 3-5 years for up to 15 years after their construction.
- Methodology for monitoring snakes will follow that outlined in Eekhout (2010), Grant et al. (1992) and Joppa et al. (2008)

<u>Qualifications</u>

- Snake biologist or R.P.Bio. with extensive experience with snakes

8.7.4 Lands for Breeding Habitat for Northern Harrier and Short-eared Owl

This section has been developed in accordance with the following requirement of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation (measure): Management of EAC Holder-owned lands adjacent to the Peace River suitable as breeding habitat for Northern Harrier and Short-eared Owl.*

The requirements of this part of condition 16 will be met through implementation of the Compensation for Loss of Non-Wetland Migratory Bird Habitat described in Section 7.2.5 above.

8.7.5 Nest Boxes for Cavity-Nesting Waterfowl

This section has been developed in accordance with the following requirements of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation (measure): 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.*

The requirements of these parts of condition 16 will be met through the measures described in Section 7.3.6 Compensation Measures for the Loss Wetland Areas and Function.

8.7.6 Bat Hibernating and Roosting Habitat

This section has been developed in accordance with the following requirement of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation measures:*

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

The requirements of this part of condition 16 will be met through implementation of the bat mitigation plan described in Section 7.4.4 above, Mitigation Measures for Species at Risk, Sensitive Ecological Communities, and Rare Species, Subsection E-2, Bat Roost Installation and Monitoring.

8.7.7 Fisher Dens and Rest Site Installation and Monitoring

This section has been developed in accordance with the following requirement of Condition 16: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include the following compensation (measure): 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 requirements of this part of condition 16 will be met through implementation of the fisher mitigation plan described below.

<u>Objective</u>

The Fisher Dens and Rest Site Installation program will see the 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. As per condition 16 fisher habitat measures will be targeted at the population south of the Peace River, and will be focused specifically on the plateau along the south side of the Peace River between the transmission line and the erosion impact line between Hudson's Hope and the Moberly River. After installation mitigation sites will be monitored to determine if they are being used by fisher.

Spatial area

Area 2: The Local Assessment Area and in Area 3: The Regional Assessment Area

Scope

- Creation of natural or artificial piles of coarse woody debris suitable for fisher. The focus will be on younger plateau forest where coarse woody debris is limited.
- Create arboreal resting sites in deciduous stands.
- Provide artificial den boxes within forested stands that have limited den trees.

Schedule

- Installation of mitigation will begin in Year 1 of Construction
- Monitoring will being in Year 2 of Construction and continue annually through the first 10 years of operations.
    - Artificial dens will be monitored between April and June
    - Coarse Woody Debris piles will be monitored between November and March

Mitigation Measures

- Develop a plan with specific location, number and design of structures, and a timeline for their construction/installation, that includes the following measures:
    - Create natural or artificial piles of coarse woody debris suitable for fisher. The focus will be on younger plateau forest where coarse woody debris is limited.
        - Coarse woody debris piles will be logs and stumps and root wads obtained from Project clearing activities, in various states of decay from healthy to advanced, and shall have a minimum diameter of 200mm and a minimum length of 10m, and shall be representative of the species mix of the target areas.
    - Create arboreal resting sites in deciduous stands.
    - Provide artificial den boxes within forested stands that have limited den trees.
    - The nature and number of habitat features to be installed shall be determined in consultation with MOE, and by considering the estimated losses due to the Project of fisher habitat features (e.g. cavity bearing trees) to develop targets for the number of installations.
- Install planned fisher habitat features:
    - Retention and placement of woody debris to clearing contractors.
    - Create coarse woody debris piles outside the 5 year beach line
    - Install artificial den structures and arboreal rest sites in forests on the South Bank
- Develop a monitoring program to document use of den sites (coarse woody debris piles, artificial den sites and artificial rest sites)

Monitoring and Follow-up Program

- Monitor fisher use of coarse woody debris piles, artificial den structures and arboreal rest sites will be implemented from installation through to the first ten years of Project operation.

Qualifications

- Qualified Environmental Professional with expertise in working with fisher populations.

8.7.8 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirement of Condition 16:

- *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.7) and consultation undertaken for development of the Plan.

8.7.9 Implementation of Plan

This section has been developed in accordance with the following requirement of Condition 16: *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.*

BC Hydro will implement measures described in Section 8.7 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.7.

8.8 Environmental Assessment Certificate Condition 19: Avoid and Reduce Injury and Mortality to Amphibians and Snakes

This section has been prepared in accordance with the requirements of Environmental Assessment Certificate Condition 19:

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.

Provided below are the mitigation measures that will be implemented to avoid and reduce injury and mortality to amphibians and snakes as required by the requirements of the condition.

In accordance with the condition, these measures have been developed by a Qualified Environmental Professional, as described in Section 2.3 of Plan. Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.8) and consultation undertaken for development of the Plan.

Objective

Mitigation measures (installation of structures, signage or other mitigation measures) will be implemented at known amphibian migration locations (e.g. adjacent to wetlands or other known migrations) to reduce injury and mortality to amphibians and snakes. These measures may be implemented on Project access roads constructed adjacent to wetlands and within other areas where amphibians and snakes are known to migrate across roads, including locations with structures designed for wildlife passage. Western toad will be the focus of management of amphibian road mortality.

This section has been developed in accordance with the requirements of Condition 19, provided below. The measures described in this section have been developed by Qualified Environmental Professionals, as indicated in Section 2.3 of this Plan.

Further, as described in Section 2.2 of this Plan, BC Hydro has met the requirements for submission of draft and final plans in accordance with this condition. Please see Section 9.0 for information on how BC Hydro will report on the implementation and adherence to the Plan

Spatial area

Area 1: The Project Activity Zone

Scope

- Multi-year or permanent Project access roads newly constructed specifically for the Project adjacent to wetlands and areas where amphibians and snakes are known to migrate across roads.
- Monitor amphibian use of migration crossing structures installed along Project roads.

Schedule

- Mitigation structures would be constructed during the access road construction.
- Monitoring efficacy of structures would occur between May and August, annually for the duration the access roads are used during Project Construction Years 1 - 8.

Mitigation Measures

Managers of current amphibian road crossing projects will be contacted to learn about current and effective techniques for BC situations (including testing projects in Pacific Rim National Park, Okanagan, Summit Lake, and Mica Dam).

Design of mitigation structures will be based on designs presented in Nyman and Barbaro (2009), Dodd et al. (2004) and designs provided by Leonard Sielecki of MOTI. Additional surveys will be conducted at Portage Mountain to identify specific mitigation structures and placement.

Identify amphibian migration locations along Project access roads:

- Surveys in 2013 and 2104 were conducted to identify and recommend amphibian mitigation measures along specific portions of existing Petroleum Development Roads and the potential Project Access Road (Albrecht et al. 2014). Exclusion fencing and amphibian underpass locations have been provided for incorporation into road design.
- Surveys at Portage Mountain Quarry in 2013 documented western toads along the current access road.

Implementation of Specific Measures:

- Structures will be installed at locations identified as needing mitigation during road construction
- Inspection and maintenance of structures will occur during Project Construction Years 1 – 8

Monitoring and Follow up Program

Monitoring will include:

- Use of amphibian crossing structures installed along existing Project Access and Portage Mountain access roads by amphibians
- Determination of success of exclusion structures at keeping amphibians off access roads during migrations to and from breeding sites
- Recommendation of alterations to mitigation informed by collected field data to improve success or address newly discovered movement corridors

Data will be collected through the completion of road surveys and monitoring of crossing structures.

Road surveys will be used to assess the quantity, distribution and timing of amphibian mortality along Project and Portage Mountain access roads, identify migration hotspots where additional mitigation is required, and provide information on use and modifications required to existing crossing structures. Road based surveys will be conducted by driving along the roads at low speeds, <30km/h. Surveys would be conducted in May to document adults moving to breeding sites and again in July-August to document toadlets moving away from breeding sites.

BC Hydro may monitor use of crossing structures via remote motion-sensitive cameras. Remote cameras have been used successfully for assessing effectiveness of other wildlife crossings in BC (BC Ministry of Environment 2011). Cameras would be set with functions to take set number of photographs at defined intervals every time a motion event is detected, and to take photographs at timed intervals to document small slow moving individuals, such as amphibians.

Potential Amphibian Salvage and Transport

Based on monitoring, or reports collected in wildlife sighting logs (maintained in accordance with CEMP section 4.17) identified mass migration events may require immediate salvage action to prevent road mortality of large numbers of toadlets. Actions during such events typically involve the manual collection and transport of migrating toadlets across the road. A *Wildlife Act* salvage permit will be required. A mass migration mitigation procedure will be developed and implemented if a mass migration is documented, including methods, salvage and information for a *Wildlife Act* permit.

Interim hygiene protocols for amphibian field staff and researchers (MOE 2008) will be followed by field staff handling amphibians.

Schedule

- Monitoring will occur annually during construction

Qualifications

- Environmental professional with experience in working with amphibians and snakes.

8.9 Environmental Assessment Certificate Condition 21: Monitoring of Wildlife Mitigation Measures

8.9.1 Objective: Monitoring of Wildlife Mitigation Measures

This section has been prepared in accordance with the following requirements of Environmental Assessment Certificate 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.*

This purpose of this section is to describe the monitoring measures that will be implemented to determine the efficacy of wildlife mitigation measures detailed in this Plan. This section has been developed in accordance with the requirements of Condition 21, provided below.

The measures described in this section have been developed by Qualified Environmental Professionals, as indicated in Section 2.3 of this Plan.

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.

8.9.2 Bald Eagle Nesting Population Monitoring Program

This section has been developed in accordance with the following requirement of Condition 21: *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.*

Objective

Based on active nest sites recorded in baseline studies, BC Hydro will target the installation of up to 38 alternate Bald Eagle nest platforms. This would provide two nest platforms for the maximum number of active nests (19) documented in the reservoir area during baseline surveys. Following installation platforms will be monitored for use by Bald Eagle or other bird species as will construction of Bald Eagle nests in trees. The number of chicks in nests located on nest platforms that survive to fledging (leaving the nest) will be documented.

Spatial area

Area 2: The Local Assessment Area.

Scope

- Installation of alternate nest platforms
- Monitoring use of platforms, nest productivity and construction of nest in trees

Schedule

- Platform installation will begin in the late summer-early fall of Year 1 of Construction and will continue through early Project operations in accordance with nest removal.
- Monitoring of the Bald Eagle population and use of alternate nest platforms will begin the nesting season following the installation of the first platform and continue annually through the first 10 years of operations.

Mitigation and Management Measures

- See attached Bald Eagle nest mitigation plan (Appendix K).
- Install up to 38 alternate nest platforms along the reservoir shoreline and at wetland mitigation sites.
- Maintain eagle nest platforms in safe condition, and remove poles and platforms at the end of life of the pole structure (estimated to be 30 years).

Monitoring and Follow up Program

- Monitor alternate nest platforms to document:
    - use of alternate nest platforms by Bald Eagles
    - the number of chicks each nest on alternate platforms raises to fledging (leaving the nest)
- Document construction of Bald Eagle nests in trees that remain around the reservoir, downstream of the Project on the Peace mainstem or its major tributaries (within 10km of the Peace mainstem) after reservoir inundation
- Monitoring methodology will follow *Inventory Methods for Raptors* (Resources Inventory Committee. 2001)
- Monitoring will occur annually during construction and the first 10 years of operations.

Qualifications

- Environmental professional with experience in raptor mitigation and surveys.

8.9.3 Waterfowl and Shorebird Population Monitoring

This section has been developed in accordance with the following requirement of Condition 21: *The Vegetation and Wildlife Mitigation and Monitoring Plan must include at least the following:*

Monitor waterfowl and shorebird populations and their use of natural wetlands, created wetlands, and artificial wetland features.

The requirements of this part of condition 21 will be met through implementation of the waterfowl and shorebird monitoring program as described in Section 7.1, Migratory Bird Mitigation and Monitoring, Subsection 7.1.1.2 Monitoring and Follow-Up Measures to be Implemented during Construction, Reservoir Filling and Operations, Waterfowl and Shorebird Follow-up Monitoring.

8.9.4 Monitoring Amphibian Use of Migration Crossing Structures

This section has been developed in accordance with the following requirement of Condition 21: *Monitor amphibian use of migration crossing structures installed along Project roads.*

The requirements of this part of condition 21 will be met through implementation of the Amphibian and Snake – Avoidance and Reduction of Road Mortality program as described in Section 8.8 above.

8.9.5 Songbird and Ground-nesting Raptor Surveys

This section has been developed in accordance with the following requirement of Condition 21: *Survey songbird and ground-nesting raptor populations during construction and operations.*The requirements of this part of condition 21 will be met through implementation of the songbird monitoring program described in section 7.1 above and implementation of the Ground Nesting Raptor Monitoring program described below.

8.9.5.1 Ground Nesting Raptor Monitoring

Objectives

- Survey ground-nesting raptor populations during construction and operations.
  - Determine the number of Northern Harrier and Short-eared Owl nesting in areas cleared during reservoir preparation
  - Determine the effects of seasonal head pond flooding on nesting Northern Harrier and Short-eared Owl
  - Determine the number of Northern Harrier and Short-eared Owl nesting in old field habitats created on BC Hydro owned lands

Spatial Area

Area 2: The Local Assessment Area

Scope

- Northern Harrier and Short-eared Owl

Schedule

- Annual monitoring will commence in the first year of construction and continue through the first ten years of operations

Monitoring Approach:

- Presence and abundance encounter transects following Inventory Methods for Raptors (Resources Inventory Committee 2001), will be conducted to document the occurrence of Northern Harriers or Short-eared Owl nests. If Northern Harrier or Short-eared Owl are detected, surveyors will record the direction type, time, species, sex, age class, activity, number heard/seen, and estimate distance and direction to the initial detection location.
- Stand watches will be conducted for one to two hours in areas where Northern Harrier or Short-eared Owl are recorded. If a pair is suspected, attempts will be made to locate any nest that might be in the area.
- Annually, providing sufficient observations are documented, survey data will be used to calculate the density of ground-nesting raptors. Densities will be used to estimate potential effects of construction head pond flooding on nesting individuals.
- After seasonal flooding events above the dam areas will be re-surveyed in an attempt to determine how nesting individuals respond.
- Monitoring will occur annually during construction and the first 10 years of operations

Qualifications

- Environmental professional with experience in conducting raptor surveys and familiarity with birds of the Peace Region

8.9.6 Western Toad and Garter Snake Population Surveys

This section has been developed in accordance with the following requirement of Condition 21:
The Vegetation and Wildlife Mitigation and Monitoring Plan must include at least the following: Survey the distribution of western toad and garter snake populations downstream of the Site C dam to the Pine River.

The requirement of this part of condition 21 will be met through implementation of the downstream garter snake and western toad monitoring program as described below.

Objectives

- Survey the distribution of western toad and garter snake populations downstream of the Site C dam to the Pine River.

Scope

- Survey garter snakes and breeding western toad in wetlands downstream of the dam to the Pine River during construction to build a pre-operational baseline.
- Survey garter snakes and breeding western toad in wetlands downstream of the dam to the Pine River during the first ten years of operations to document changes in wetland use in response to changes in downstream flows.

Spatial area

Area 4: The area downstream of the dam to the confluence of the Pine River that will be subject to changes in the surface water regime.

Schedule

- Surveys will begin 1 year prior to river diversion and continue annually through the first 10 years of operations.
- Surveys will be completed May-September for snakes and in May for toads. Sites will be surveyed a minimum of three times each year.

Monitoring Measures

Monitoring Downstream Garter Snake Habitat Use

- Monitoring snake use of downstream wetlands will be carried out before and after Project construction to assess the effects of Project operation on garter snake habitat use. Wetlands will be identified between the Site C dam site and the Pine River, and a subsample will be chosen for cover board installation. Each chosen wetland will be sampled with the use of semi-permanent artificial cover objects or cover boards (Grant et al. 1992; Joppa et al. 2008; Eekhout 2010). This method has been successful at sampling garter snakes in the province (Engelstoft and Ovaska 2000; P. Gregory, pers. comm. 2014).
- Sheets of asphalt roofing materials will be laid out at regular intervals along a transect around the border of the wetland. Surveyors will visit the cover boards between May and September when daytime temperatures exceed 20oC and check underneath them for snakes. The intervals between checks will be at least 2 weeks. Linear mixed model statistics for repeated measures will be used to compare the numbers of snakes detected before and after the Project is operational. A detailed sampling plan will be developed that describes the methodology for choosing sample wetlands, laying out transects, and scheduling cover board checks.

Monitoring of garter snake and western toad distribution

The portion of the Peace River that will experience the greatest hydrological fluctuations during Project operations lies between the dam site and the Pine River.

- A subset of wetlands and riverine backchannels in this section of the river will be chosen for sampling.
- A subset of downstream wetlands and riverine backchannels that are not anticipated to be impacted by Project operations will also be included to act as a control.
- Each chosen wetland will be sampled for garter snake with the use of semi-permanent artificial cover objects or cover boards (Grant et al. 1992; Joppa et al. 2008; Eekhout 2010). Cover boards will be laid out at regular intervals along a permanent transect around the border of the wetland. Surveys will be conducted between May and September when daytime temperatures exceed 20ºC. Cover boards will be lifted snakes present counted and classified (juvenile or adult). Intervals between checks will be at least 2 weeks.
- Egg mass surveys to document breeding western toad distribution will be completed according to Inventory Methods for Pond-breeding Amphibians and Painted Turtle (Resources Inventory Committee 1998).

- Time constraint surveys (per Inventory Methods for Pond-breeding Amphibians and Painted Turtle, Resources Inventory Committee 1998) will be used to survey the perimeter of wetlands for juvenile and adult western toad. This program will begin one year prior to river diversion and continue annually through the first 10 years of Project operations.

Qualifications

- Qualified Environmental Professional with experience in conducting snake and amphibian surveys

8.9.7 Submission of Draft and Final Plans

This section has been developed in accordance with the following requirement of Condition 21:

- *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.*

Please refer to Section 2.2 Consultation for information on submission of the draft and final Vegetation and Wildlife Mitigation Plan (which includes the measures described in Section 8.9 and consultation undertaken for development of the Plan.

8.9.8 Implementation of Plan and Reporting Requirements

This section has been developed in accordance with the following requirement of Condition 21: *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.*

BC Hydro will implement measures described in Section 8.9 of the Vegetation and Wildlife Mitigation and Monitoring Plan. Please refer to Section 9.0 of this Plan for a description of reporting requirements that will be met for the implementation of the Vegetation and Wildlife Mitigation and Monitoring Plan, including for those measures described in Section 8.9.

8.10 Environmental Assessment Certificate Condition 23: Track Changes in the Status of Listed Species

This section has been developed in accordance with the following requirements of 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.*

8.10.1 Tracking Updates for Species at Risk

The requirement of this part of condition 23 will be met through reviewing changes to the species at risk acts as described below.

Objective

BC Hydro will maintain current knowledge and track updates of the Projects effects on the status of listed species by tracking updates for species identified by the Government of British Columbia, Committee on the Status of Endangered Wildlife in Canada, and the *Species at Risk Act*, in the vicinity of the Project during Construction and Operations.

Spatial Area

Area 2: The Local Assessment Area

Scope

- Track the status of species, including rare plants, identified during the environmental assessment of the Project (including in the EIS, Joint Review Panel Report and Federal and Provincial conditions associated with Project approvals) by monitoring Schedule 1 of the federal *Species at Risk Act,* species on the BC red or blue list, and species assessed by the Committee on the Status of Endangered Wildlife in Canada.
- Where the listing of a particular species changes for the worse, determine the impact that the Project may be having on that species and whether there are any technically and economically feasible changes to management or monitoring plans;
- Report to, and seek input from EC, MFLNRO and MOE, and determine whether changes to management or monitoring plans should be implemented.

Schedule

- Construction: the status of listed species known to occur in the Project area will be reviewed annually during Project construction
- Operations: A schedule for periodic review of the listed species status during Project operations will be established at and reviewed during the Operations phase

8.10.2 Assessment of Management and Monitoring Plans Based on Species at Risk

The requirements of this part of condition 23 will be met as described below.

Should the status of a listed species changes for the worse due to Project activities or during the life of the Project, BC Hydro will:

- work with EC, MFLNRO 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.
- complete analysis to identify if additional measures may be undertaken that would be expected to materially reduce the ongoing effects of the Project on the species.
- Implement additional measures, in accordance with species recovery plans, to mitigate effects of the Designated Project on the affected species. The level of BC Hydro's participation in any recovery planning will be determined by the degree of known impact of the ongoing effects of the Project on species at risk, considering:
    - the listing status of the species and other associated species
    - the likelihood and extent of impacts incurred by other stakeholders
    - species of concern in existing BC Hydro, federal, or provincial processes
    - public interest
    - Aboriginal interest

Qualifications

- Environmental practitioner with experience in addressing the species at risk for which additional mitigation measures are required.

8.11 Environmental Assessment Certificate Condition 24: Ungulate Winter Range

This section has been developed in accordance with the following requirements of Condition 23:

The EAC Holder must identify suitable lands for ungulate winter range by the end of the first year of construction, on BC Hydro-owned lands, or Crown lands, in the vicinity of the Project in consultation with FLNR. If FLNR determines that identified winter range is required, the EAC Holder must identify and maintain suitable BC Hydro- owned lands for ungulate winter range to the satisfaction of FLNR and for the length of time determined by FLNR.

<u>Objective</u>

The purpose of this section is to describe BC Hydro's approach to identifying suitable lands for ungulate winter range.

<u>Context</u>

BC Hydro owns land along the north bank of the Peace River that has been identified by the province as containing ungulate winter range. After reservoir filling, it is anticipated that BC Hydro-owned lands will contain about 515 ha of ungulate winter range at commencement of operations (Figure 9, Figure 10 and Figure 11). The portions of these lands not required for Project development will be managed so that their value to ungulates as winter range is maintained (e.g. remain undisturbed and support vegetation suitable for ungulate forage) and that they remain accessible to ungulates through management of adjacent cultivated lands, fencing and access for hunting.

Some portion of these lands may lie within the erosion impact line or the stability impact line, however, and would otherwise not be likely needed for Project development. Areas within the erosion and stability impact lines are likely to remain suitable as ungulate winter range, based on their south facing aspect and steep slope profiles.

Provincial staff has indicated potential interest in provincial management of these lands. BC Hydro would be willing to discuss the long term management of these lands by the Province to support wildlife objectives, as there would be benefits to managing all lands with identified ungulate winter range as cohesive units.

<u>Spatial area</u>

Area 2: The Local Assessment Area

<u>Schedule</u>

- 2014: identification of suitable ungulate winter range on current BC Hydro-owned land.
- Land will be confirmed as habitat mitigation land during construction, after all lands required for Project development have been identified.

<u>Mitigation Measures</u>

- Retain identified lands and manage in a manner suitable for ungulate winter range.

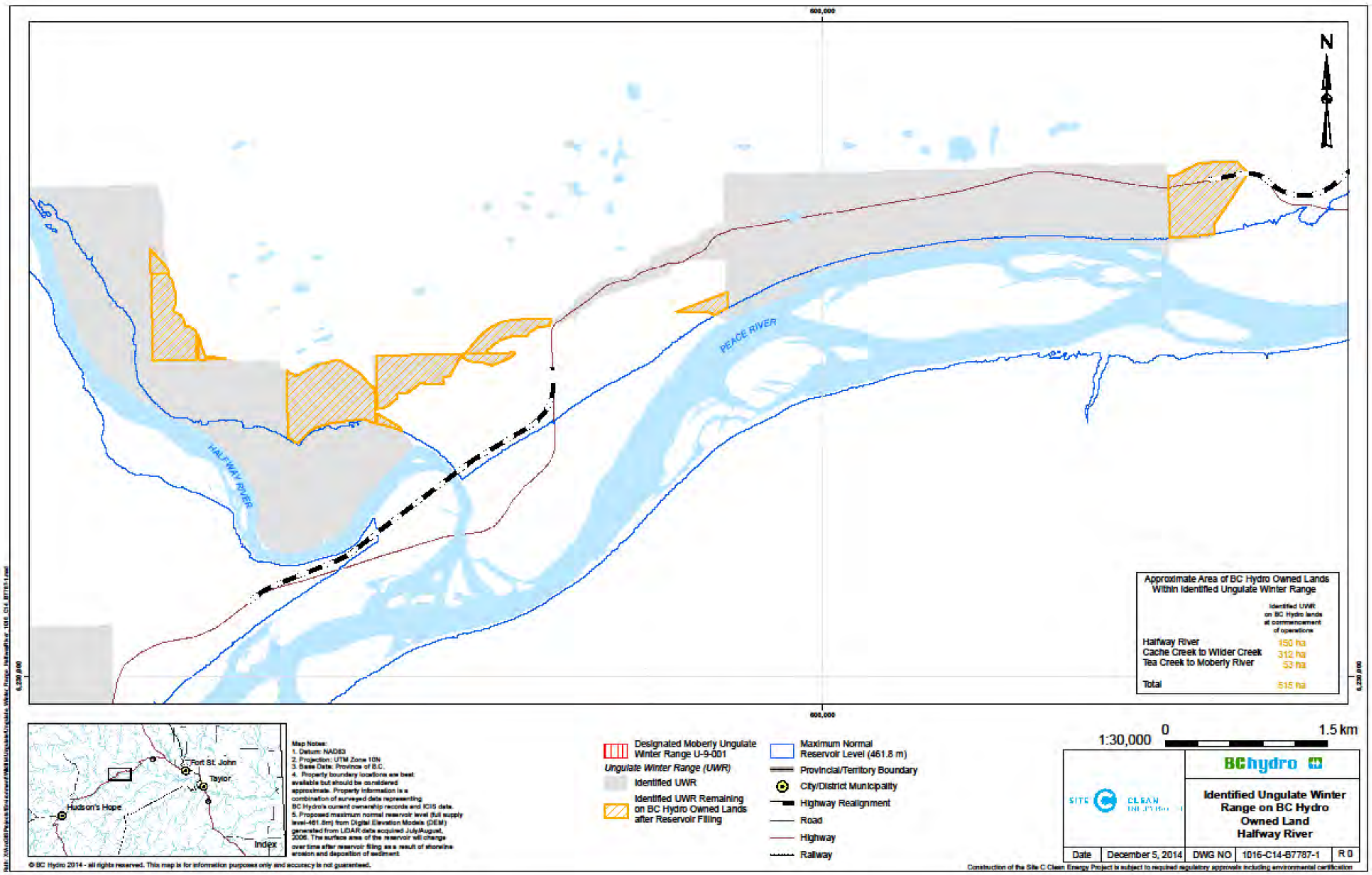


Figure 9. Suitable Ungulate Winter Range on BC Hydro owned land: Halfway River

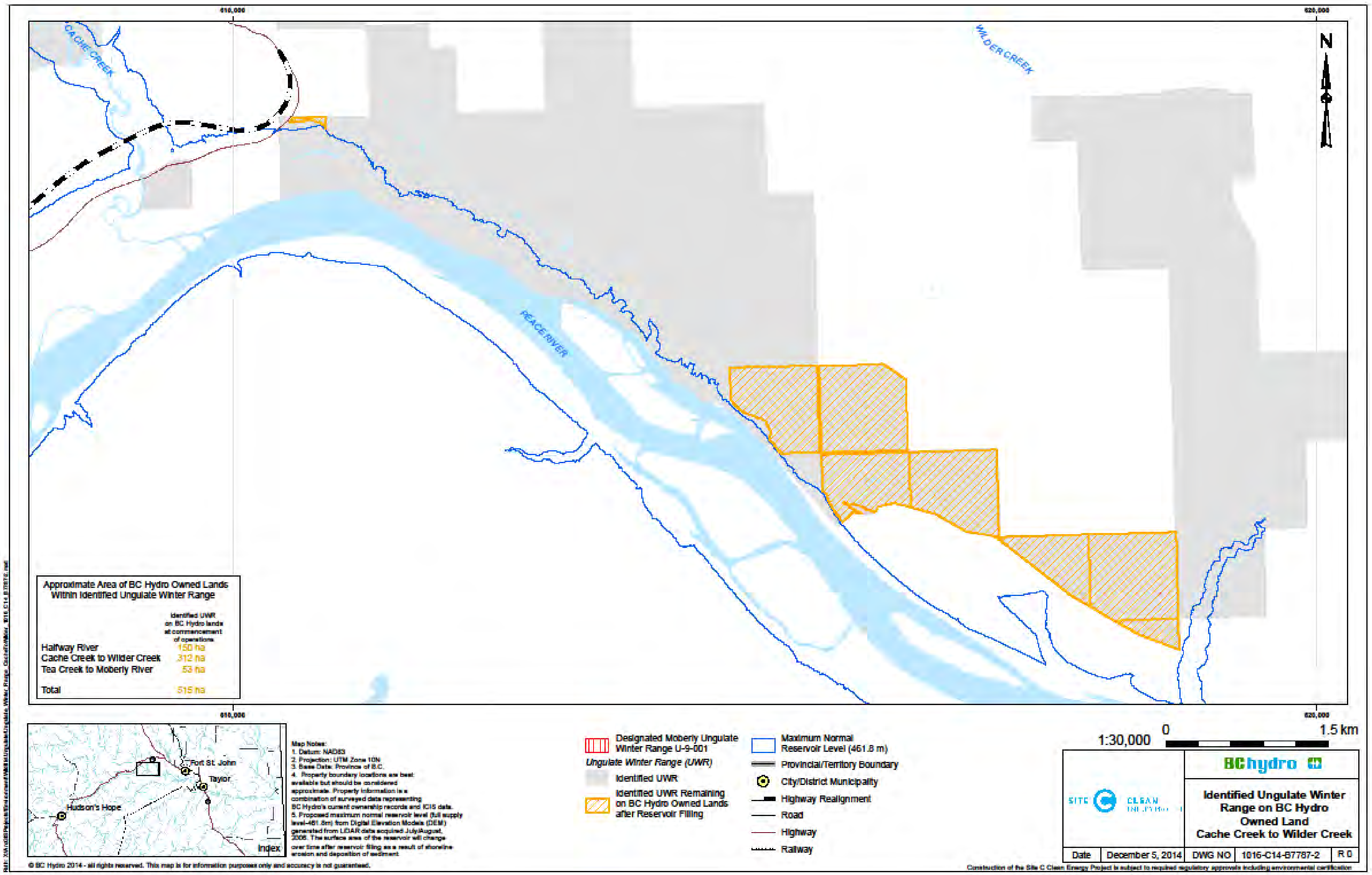


Figure 10. Suitable Ungulate Winter Range on BC Hydro owned land: Cache Creek to Wilder Creek

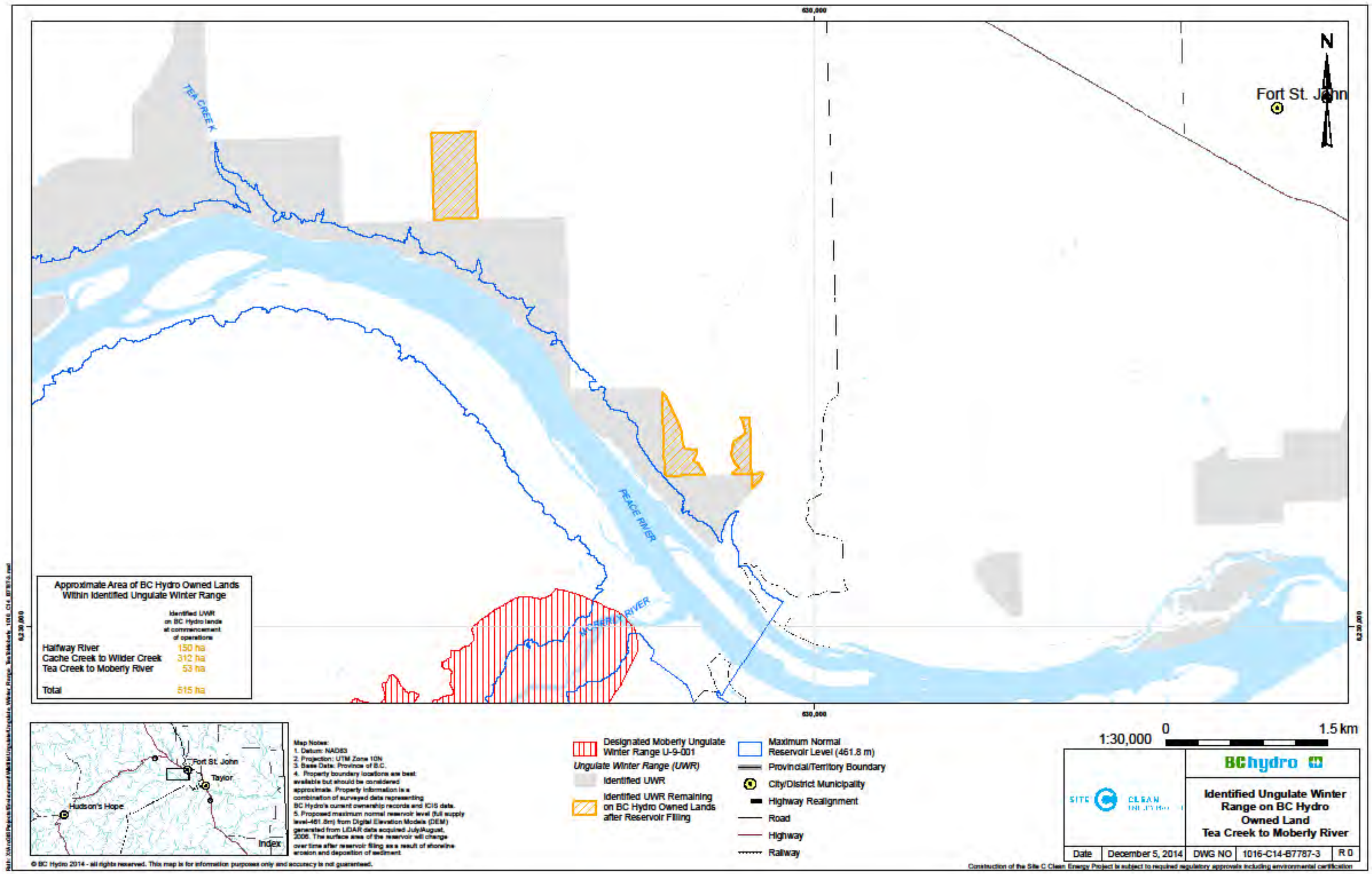


Figure 11. Suitable Ungulate Winter Range on BC Hydro owned land: Tea Creek to Moberly River

9.0 Reporting Requirements

The Environmental Assessment Certificate and Decision Statement conditions require certain reports to be submitted to various groups at various times during construction and operation of the Project. These reporting requirements are shown in the table below.

Decision Statement Condition 18 Record Keeping requires that:

"The Proponent shall record the following information in respect of any monitoring data collected, sampling conducted, or analyses performed in accordance with this Decision Statement:

- the place, date and time of sampling;
- the analyses that were performed and the dates they were performed;
- the analytical techniques, methods, or procedures used in the analyses;
- the names of the persons who collected and analyzed each sample; and
- the results of the analyses"

The Proponent shall retain any monitoring data collected, sampling conducted, or analyses performed in accordance with this Decision Statement for a minimum of twenty-five years and will make any such records available to the Agency on request."

Annual reports, prepared in accordance with Condition 18, will be issued for programs as listed in the table below and will be sent to the Canadian Environmental Assessment Agency.

In addition, various groups requested that some reports be sent to them directly. These requests were made during the review period of the draft Vegetation and Wildlife Mitigation and Monitoring Plan. These additional reporting requests are also provided in Table 11 below.

Table 11. Environmental Assessment Certificate and Decision Statement Reporting Requirements.

Condition	Reporting requirements	Reports	Additional Report Distribution List
Federal Conditions 16: Species at risk, at-risk and sensitive ecological communities Federal Condition 18: Record Keeping	The Proponent shall implement the plan and provide to the Agency analysis and summary of the implementation of the plan, as well as any amendments made to the plan in response to the results, on an annual basis during construction and for the first 10 years of operation, with the exception of condition 16.3.7 for which reporting will continue for the	Rare plant translocation monitoring report (Section 7.4.5)	Conservation Data Center Ministry of Environment Ministry of Forests Lands and Natural Resources and Reservoir Area First Nations
		Verification of species models (Section 7.4.2)	Ministry of Forests Lands and Natural Resources
		Rare plant surveys:	Ministry of Forests Lands

Condition	Reporting requirements	Reports	Additional Report Distribution List
	life of the Designated Project, as appropriate.	potentially extirpated species (Section 7.4.3)	and Natural Resources Conservation Data Center
Federal Condition 10.8: Non-wetland migratory bird habitat Federal Condition 11.9: Wetlands used by migratory birds and for current use of lands and resources for traditional purposes Federal Condition 18: Record Keeping	Annual reports on the Non-Wetland Migratory Bird Habitat Mitigation and Monitoring Plan will include a summary and analysis of plan implementation, and will be submitted to the Agency on an annual basis during construction, and at the end of year 1, 2, 3, 5, 10, 15, 20 and 30 of operation.	Compensation for loss of non-wetland migratory bird habitat (Section 7.2.5)	Environment Canada Ministry of Forests Lands and Natural Resources Ministry of Environment Ministry of Agriculture Reservoir Area Aboriginal groups
		Analysis of effects of compensation for loss of non-wetland migratory bird habitat (Section 7.2.6)	
		Evaluation of effectiveness of mitigation and compensation measures (Section 7.4.7)	
		Wetland compensation plan (Section 7.3.6)	
Federal Condition 18: Record Keeping	The annual reports will contain the following: • the place, date and time of sampling; • the analyses that were performed and the dates they were performed; • the analytical techniques, methods, or procedures used in the analyses; • the names of the persons who collected	Bird Nesting Monitoring Program (Section 7.1.3)	
		Risk assessment of bird collisions (Section 7.1.8)	
		Tracking Updates to Status of Listed Species (Section 7.4.8)	
		Compensation for loss of non-wetland	Environment Canada

Condition	**Reporting requirements**	**Reports**	**Additional Report Distribution List**
	and analyzed each sample; and • the results of the analyses	migratory bird habitat (Section 7.2.5)	Ministry of Forests Lands and Natural Resources Ministry of Environment Ministry of Agriculture, Reservoir Area Aboriginal groups
		Rare and sensitive plant community identification (Section 7.4.1)	Conservation Data Center.
		Supplemental Rare Plant Surveys (Section 7.4.7)	Ministry of Forests Lands and Natural Resources Conservation Data Center
		Supplemental Regional Rare Plant Surveys (Section 7.4.7)	Ministry of Forests Lands and Natural Resources Conservation Data Center
		Rare Plant Compensation Fund (Section 7.4.7)	Ministry of Environment Ministry of Forests Lands and Natural Resources Aboriginal Groups
		Downstream Rare Plant Occurrence and Riparian Vegetation Monitoring (Section 7.4.7)	A program report, summarizing all the monitoring data will prepared at the end of the 25 year monitoring program.
Federal Condition 18: Record Keeping Provincial Condition 14: Vegetation and	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	Amphibian and Snake – Avoidance and Reduction of Road Mortality (Section 8.8)	Ministry of Environment Conservation Data Center
		Conservation Measures for Rare Plants (Section 7.4.5)	Ministry of Forests and Natural Resources and the Ministry of

Condition	Reporting requirements	Reports	Additional Report Distribution List
Ecological Communities Monitoring and Follow-up Program	commencement of construction.		Environment (the Conservation Data Center)
Federal Condition 18: Record Keeping Provincial Condition 21: Vegetation and Wildlife Mitigation and Monitoring Plan	Require annual reporting during the construction phase and during the first 10 years of operations to EAO, beginning 180 days following commencement of construction.	Waterfowl and Shorebird Follow-up Program (Section 7.1)	Ministry of Environment Conservation Data Center
		Amphibian use of migration crossing structures installed on Project roads (Section 7.4.4)	
		Breeding bird follow-up monitoring program (Section 7.1.3)	
		Downstream Garter Snake and Western Toad Distribution and Habitat Use Monitoring (Section 7.4.7)	Ministry of Forests Lands and Natural Resources Ministry of Environment Conservation Data Center Canadian Wildlife Service
Provincial Condition 10: Targeted surveys in the RAA and A study focused on clarifying the taxonomy of Ochroleucus bladderwort (Utricularia ochroleuca)	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	Taxonomic clarification (Section 7.4.5)	
		Garter snake den monitoring (Section 7.4.7)	Monitoring data will be submitted, in the appropriate form to the provincial Wildlife Species Inventory database, annually in accordance with the monitoring schedule within the annual vegetation and wildlife program monitoring report.

Condition	**Reporting requirements**	**Reports**	**Additional Report Distribution List**
Provincial Condition 21: Vegetation and Wildlife Mitigation and Monitoring Plan	Require annual reporting during the construction phase and during the first 10 years of operations to EAO, beginning 180 days following commencement of construction.	Bald Eagle monitoring (Section 8.12)	
		Ground Nesting Raptor Monitoring (Section 8.12)	survey results for the Short-eared Owl will be sent to the Conservation Data Center
		Downstream garter snake and western toad monitoring program (Section 8.12)	survey results for the western toad will be sent to the Conservation Data Center.

10.0 References

Alberta Native Plant Council. 2000. Alberta Native Plant Council Guidelines for Plant Surveys in Alberta. Edmonton, AB. Available at: http://www.anpc.ab.ca/assets/rareplant.pdf.

Alberta Native Plant Council. 2012. ANPC Guidelines for Rare Vascular Plant Surveys in Alberta - 2012 Update. Prepared for Alberta Native Plant Council, Edmonton, AB.

Albrecht, C., C. Churchland and K. Routledge. 2014. Peace River Site C Hydro Project. Jackfish Amphibian Mitigation Assessment. Consultant's Report to BC Hydro.

British Columbia Ministry of Forests. 1988. Biogeoclimatic zones of British Columbia 1988. British Columbia Ministry of Forests, Victoria. Map.

Bat Conservation and Management. 2010. *Building a Better Bat House*. Bat Conservation and Management.

BC Centre for Disease Control. 2011. *Rabies*. Available at: http://www.bccdc.ca/dis-cond/a-z/_r/Rabies/overview/Rabies.htm.

BC Conservation Data Centre: 2011 http://a100.gov.bc.ca/pub/eswp/search.do?method=process&searchType=COMBINED&bcList=Red&bcList=Blue

BC Conservation Data Centre. 2013. *Species Summary:* Myotis yumanensis. BC Ministry of Environment. Available at: http://a100.gov.bc.ca/pub/eswp/speciesSummary.do?id=14966.

BC Conservation Data Centre. 2014. BC Species and Ecosystems Explorer. Province of British Columbia. Available at: http://a100.gov.bc.ca/pub/eswp/.

BC Hydro, 2012. Pest Management Plan for Management of Vegetation at BC Hydro Facilities. Access via: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/safety/pest-management-plan-for-management-of-vegetation-105-0980-12-17.pdf

BC Hydro. 2013. *Environmental Impact Statement for Site C Clean Energy Project - Volume 2*. Available at: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_371_35290.html.

BC Ministry of Environment, 2004. Standards and Best Practices for Instream Works. Access via: 42TUhttp://www.env.gov.bc.ca/wld/documents/bmp/iswstdsbpsmarch2004.pdfU42T

BC Ministry of Environment. 2010. Terms and Conditions for Changes In and About a Stream Specified by Ministry of Environmental Habitat Officers, Peace Sub-Region. Access via: http://www.env.gov.bc.ca/wsd/regions/nor/wateract/terms_conditions_per.pdf

BC Ministry of Environment, 2009. A Users' Guide to Working in and Around Water: Understanding the Regulation under British Columbia's *Water Act.* Access via: 42TUhttp://www.env.gov.bc.ca/wsd/water_rights/cabinet/working_around_water.pdf

BC Ministry of Environment. 2009. Conservation Framework: Conservation Priorities for Species and Ecosystems. Victoria, BC. Available at:

http://www.env.gov.bc.ca/conservationframework/documents /CF_Primer.pdf.

BC Ministry of Environment. 2010. Terms and Conditions for Changes In and About a Stream Specified by Ministry of Environmental Habitat Officers, Peace Sub-Region. Access via: 42TUhttp://www.env.gov.bc.ca/wsd/regions/nor/wateract/terms_conditions_per.pdf

BC Ministry of Environment. 2011. *Herpetofauna and Roads Workshop: Is there light at the end of the tunnel?* Vancouver Island University, Nanaimo, BC Feb. 22-23, 2011.

Carter, T.C. and J.M. Menzel. 2007. Ch. 3. Behaviour and day-roosting ecology of North American foliage-roosting bats. In: M. Lacki, J. P. Hayes, and A. Kurta (eds.), *Bats in Forests: Conservation and Management*. Johns Hopkins University Press, Baltimore, MD. Pp. 61–82.

Cresswell, W., J. Hay, R. Whitworth, M. Head, L. Penniston and Cresswell Associates. 2008. Moving lizards and snakes from the path of new roads and improvements: how to get it right. In: Scottish Transport Applications and Research Conference, 24 April 2008. Glasgow. Pp. 1–14. Available at: ww.stsg.org/star/2008//Warren_Cresswell.pdf.

Demarchi, 1988. Ecoregions of British Columbia. British Columbia Ministry of Environment and Parks, Wildlife Branch, Victoria. Map.

Dodd, C.K., W.J. Barichivich and L.L. Smith. 2004. Effectiveness of a barrier wall and culverts in reducing wildlife mortality on a heavily traveled highway in Florida. *Biological Conservation* 118(5):619–631

Ecosystems Branch, Ministry of Environment. 2008. Interim Hygiene Protocols for Amphibian field staff and researchers. Available at: http://www.env.gov.bc.ca/wld/documents/wldhealth/BC%20Protocol%20-%20Amphibian%20field%20researchers%202008.pdf

Eekhout, X. 2010. Ch. 20. Sampling amphibians and reptiles. In: J. Eymann, J. Degreef, C. Hauser, J. C. Monje, Y. Samyn, and D. VandenSpiegel (eds.), *Volume 8 - Manual on Field Recording Techniques and Protocols for All Taxa Biodiversity Inventories (ATBIs)*. European Communities. Pp. 530–557. Available at: http://www.abctaxa.be/volumes.

Engelstoft, C. and K.E. Ovaska. 2000. Artificial cover-objects as a method for sampling snakes (Contia tenuis and Thamnophis spp.) in British Columbia. Northwestern Naturalist 81(1):35.

Fisheries and Oceans Canada 1993. Land Development Guidelines for the Protection of Aquatic Habitat. Access via: 42TUhttp://www.dfo-mpo.gc.ca/Library/165353.pdfU42T

Fisheries and Oceans Canada, 1995. Freshwater Intake End-of-Pipe Fish Screen Guidelines. Access via: 42TUhttp://www.dfo-mpo.gc.ca/library/223669.pdfU42T

Fisheries and Oceans Canada, 2013. Measures to Avoid Causing Harm to Fish and Fish Habitat. Access via: 42TUhttp://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.htmlU42T

Fure, A. 2006. Bats and lighting. *London Naturalist* 85:1–20.

Grant, B.W., A.D. Tucker, J.E. Lovich, A.M. Mills, P.M. Dixon and J.W. Gibbons. 1992. The use of coverboards in estimating patterns of reptile and amphibian biodiversity. In: D. R. McCullough and R. H. Barrett (eds.), *Wildlife 2001: Populations*. Elsevier Applied Science, London. Pp. 379–403.

Government of Canada. 1991. The Federal Policy on Wetland Conservation. Environment Canada. Ottawa, Ontario. 14p.

Gregory, P.T. and K.W. Stewart. 1975. Long-distance dispersal and feeding strategy of the red-sided garter snake (Thamnophis sirtalis parietalis) in the Interlake of Manitoba. Canadian Journal of Zoology 53(3):238–245.

Hilton, S., L. Simpson, L. Andrusiak, and C. Albrecht. 2013. Part 4 Migratory Birds. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC.

Johnston, D., G. Tatarian and E. Pierson. 2004. *California Bat Mitigation Techniques, Solutions, and Effectiveness*. Project Number 2394-01. California Department of Transportation (Caltrans) Office of Biological Studies and Technical Assistance, Sacramento, CA. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=19685.

Jones, K.B. 1987. Ch. 14. Amphibians and reptiles. In: A. Cooperrider, R. J. Boyd, S. L. McCulloch, and H. R. Stuart (eds.), Inventory and Monitoring of Wildlife Habitat. U.S. Dept. Inter. Bur. Land Manage. Service Center., Denver, CO. Pp. 858. Available at: http://archive.org/details/inventorymonitor00coop. Accessed September 2013.

Joppa, L.N., C.K. Williams, S.A. Temple and G.S. Casper. 2008. Environmental factors affecting sampling success of artificial cover objects. *Herpetological Conservation and Biology* 5(1):143–148.

Judy, D.J., D.W. Sparks, J.O. Whitaker and S.J. Oyler-McCance. 2010. Bat guano is useful for more than diet studies. *Indiana Academy of Sciences* 119(1):1–36.

Keely, B. and M. Tuttle. 1999. *Bats in American Bridges: How to Create Bat Roosts in Highway Structures*. Bat Conservation International, Austin, TX. Available at: www.batcon.org/pdfs/bridges/BatsBridges2.pdf.

Kellner, M. and S. Rasheed. 2002. *Campbell River Bat Project Inventory and Habitat Enhancement*. BC Hydro Bridge-Coastal Fish and Wildlife Restoration Program, Burnaby, BC.

Kiser, M. and S. Kiser. 2004. A decade of bat house discovery. *The Bat House Researcher* 12(1):1–7.

Kunz, T.H. and D.S. Reynolds. 2003. Bat colonies in buildings. In: T. J. O'Shea and M. A. Bogan (eds.), *Monitoring Trends in Bat Populations of the US and territories: problems and prospects. Information and Technology Report 2003-0003*. US Geological Survey, Biological Sciences Division, Washington, DC. Pp. 91–101. Available at: www.fort.usgs.gov/products/publications/21329/21329.pdf.

Larsen, K.W. 1987. Movements and behavior of migratory garter snakes, Thamnophis sirtalis. Canadian Journal of Zoology 65(9):2241–2247.

Manier, M.K. and S.J. Arnold. 2005. Population genetic analysis identifies source–sink dynamics for two sympatric garter snake species (Thamnophis elegans and Thamnophis sirtalis). Molecular Ecology 14(13):3965–3976.

Maslovat, C. 2009. Guidelines for Translocation of Plant Species at Risk in British Columbia. BC Ministry of Environment, Victoria, BC

Matsuda, B.M., D.M. Green and P.T. Gregory. 2006. Amphibians & Reptiles of British Columbia Illustrated Edition. Royal British Columbia Museum, Victoria, BC.

Mitchell-Jones, A.J. 2004. *Bat Mitigation Guidelines*. English Nature, Peterborough, UK.

Ministry of Environment and Ministry of Forest Land and Natural Resource Operations. 2012. Decontamination SOPs for working around bats and bat habitats. Available at: http://www.env.gov.bc.ca/wld/documents/wldhealth/WNS%20Decontamination%20Protocol%20Bat%20Researchers%202012.pdf

Ministry of Forests, Lands and Natural Resource Operations et al, 2012. Fish-stream Crossing Guidebook: Revised Edition. Access via: 42TUhttp://www.for.gov.bc.ca/HFP/Fish/Fish-Stream%20Crossing%20Print.pdfU42T

Ministry of Forest and Range, Ministry of Environment. 2010. Field Manual for Describing Terrestrial Ecosystems 2nd Edition. Land Management Handbook 25.

NatureServe. 2014. *NatureServe Explorer: An online encyclopedia of life: Version 7.1*. Available at: http://www.natureserve.org/explorer. Accessed: August 27, 2013.

Nagorsen, D.W. 2009. *Campbell River Bat Project: Bat House Mitigations*. Report to BC Hydro Bridge Coastal Fish and Wildlife Restoration Program, Burnaby, BC. Available at: http://www.bchydro.com/bcrp/reports/wildlife/wildlife_2006.html.

Nyman, D.P.E. and H. Barbaro. 2009. Mass highway guidance handbook: design of bridges and culverts for wildlife passages. In: *International conference on ecology and transportation*. Pp. 283–298.

Penny, J and R. Klinkenberg. 2012. *Rare plant inventory methods*. Available at: http://ibis.geog.ubc.ca/biodiversity/eflora/ProtocolsforRarePlantSurveys.html

Resources Inventory Committee. 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Province of BC, Victoria, BC.

Resources Inventory Committee. 1998b. Inventory Methods for Snakes. Version 2.0. Standards for Components of British Columbia's Biodiversity No. 38. BC Ministry of Environment, Lands and Parks, Resource Inventory Branch, Victoria, BC. Available at: http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/.

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

Resources Inventory Committee. 1998. Inventory Methods for Nighthawks and Poorwills. Version 2.0. Standards for Components of British Columbia's Biodiversity No. 9. BC Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria, BC. Available at: http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/.

Resources Inventory Committee. 1998. Inventory Methods for Riverine Birds (Dippers and Harlequins). Version 2.0. Standards for Components of British Columbia's Biodiversity No. 12. BC Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria, BC. Available at: http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/.

Resources Inventory Committee. 1999. Inventory Methods for Waterfowl and Allied Species. Version 2.0. Standards for Components of British Columbia's Biodiversity No. 18. BC Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria, BC. Available at: http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/.

Resources Inventory Committee. 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Province of BC, Victoria, BC.

Resources Inventory Committee. 2001. Inventory Methods for Raptors. Version 2.0. Standards for Components of British Columbia's Biodiversity No. 11. BC Ministry of Environment, Lands and Parks, Resources Inventory Branch, Victoria, BC. Available at: http://archive.ilmb.gov.bc.ca/risc/pubs/tebiodiv/.

Resource Information Standards Committee 2006. Standard for Mapping Ecosystems at Risk in British Columbia. An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems. Available at: http://www.env.gov.bc.ca/fia/documents/standards _for_mapping_ear_version1.pdf

Penny, J.L. and R. Klinkenberg. 2012. Protocols for Rare Vascular Plant Surveys. In: B. Klinkenberg (ed.), *2012. E-Flora BC: Electronic Atlas of the Flora of British Columbia [eflora.bc.ca]*. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. Available at: http://www.geog.ubc.ca/biodiversity/eflora/ProtocolsforRarePlantSurveys.html.

Sarell, M.J. 2006. Monitoring and Selected Wildlife and Habitat Mitigation Actions Employed for the Southern Crossing Pipeline in Region 8. Report prep. for Terasen Gas, Vancouver, BC.

Sarell, M.J. 2005. Snake Barrier Fencing. South Okanagan-Similkameen Stewardship Program Living in Nature Series, Penticton, BC. Available at: http://www.soscp.org/wp-content/uploads/2013/02/Snake-Barrier-Fencing.pdf.

Simpson, K., T.K. Simpson, L. Simpson, L. Andrusiak, S. Hilton, M. Kellner, R. Klafki, I. Mattson and A. Creagh. 2013. *Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Part 7 Mammals*. Report to BC Hydro, Vancouver, BC.

Takats, L. 2002. Red-sided garter snake Thamnophis sirtalis parietalis relocation and education project: final report. Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, AB. Available at: http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/documents/SAR30-RedSidedGarter snake.pdf.

Tuttle, M., M. Kiser and S. Kiser. 2004. *The Bat House Builder's Handbook*. Bat Conservation International, Austin, TX.

Tuttle, M. and D. Hensley. 1993. Bat houses: The secrets of success. *Bats* 11(1):3–14.

Vonhof, M. and J. Gwilliam. 2000. *A summary of bat research in the Pend d'Oreille Valley in southern British Columbia*. Report to Columbia Basin Fish and Wildlife Compensation Program.

Whiteaker, L., J. Henderson, R. Holmes, L. Hoover, R. Lesher, J. Lippert, E. Olson, L. Potash, J. Seevers, M. Stein and N. Wogen. 1998. Survey Protocols for Survey and Manage Strategy 2 Vascular Plants: V 2.0. Prepared For US Bureau of Land Management, Oregon. Available at:

http://www.blm.gov/or/plans/surveyandmanage/SP/VascularPlants/cover.htm. Accessed November 2011.

Zappalorti, R.T. and H.K. Reinert. 1994. Artificial refugia as a habitat-improvement strategy for snake conservation. In: J. B. Murphy, K. Adler, and J. T. Collins (eds.), Captive Management and Conservation of Amphibians and Reptiles. Contributions to Herpetology. Society for the Study of Amphibians and Reptiles, Ithaca, NY.

Zinck, J.M., D.A. Duffield and P.C. Ormsbee. 2004. Primers for identification and polymorphism assessment of Vespertilionid bats in the Pacific Northwest. *Molecular Ecology Notes* 4(2):239–242.

Appendix A. Summary of Baseline Information and Potential Effects for Vegetation and Ecological Communities

Summary of Baseline Information and Potential Effects for Vegetation and Ecological Communities.

Based on the effects assessment methodology described in the EIS and in the relevant technical appendices, an assessment was undertaken for Vegetation and Ecological Communities.

The potential effects of the Project on vegetation and ecological communities (terrestrial ecosystems, rare and sensitive ecological communities, and rare plants) are assessed based on one general effect category – habitat alteration and fragmentation – which covers the temporary and permanent loss and fragmentation of vegetation and ecological communities, including wetlands.

Assessment Area

The Local Assessment Area for vegetation and ecological communities includes the Project activity zone buffered by an additional 1,000 m, and downstream from the Site C dam to the Alberta border buffered by 1,000 m on both the south and north banks of the Peace River.

The Regional Assessment Area comprises five Wildlife Management Units, including most of the Peace Lowlands eco-section and all Project components.

Baseline Conditions

Baseline conditions for each of the key indicators were compiled from available literature, field studies, and information from traditional land use studies.

Summary of Potential Effects and Mitigation Measures

This assessment evaluates how categories of effects on the VC (habitat alteration and fragmentation) would be affected by activities during construction and operation of the Project.

Table A. Potential Effects and Mitigation Measures on Vegetation and Ecological Communities

Potential Effect	Key Mitigation Measures
Habitat alteration and fragmentation	• Place transmission towers and temporary roads away from wetlands and known rare plant occurrences where technical requirements and ground conditions permit • Establish Environmental Protection Zones to protect known rare plant occurrences located adjacent to construction areas • Plan and implement construction activities in a manner that seeks to maintain the hydrology of adjacent wetlands, particularly where known rare plant occurrences are present • Implement measures to maintain existing hydrological patterns if roads cannot avoid wetlands • Install culverts under access roads to maintain hydrological balance • Install sedimentation barriers where sediment control is

Potential Effect	Key Mitigation Measures
	needed • Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed • Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark. Merchantable trees and vegetation that could interfere with navigation will be removed using clearing practices to maintain a 15 m machine-free zone. • BC Hydro will fund a compensation program that will include: o A survey of habitat enhancement projects in the Regional Assessment Area to identify projects that might provide compensation for rare and sensitive habitats and protect occurrences of rare plants (e.g., wetlands). If suitable habitat enhancement projects can be found, BC Hydro will provide assistance (financial or in-kind) to the appropriate managing organization. o Identification of areas that are under threat from development or in need of habitat enhancement. Where opportunities exist, BC Hydro will consider direct purchase – if offered for sale – and/or management of these lands to enhance or retain rare plant values. BC Hydro will also consider contributing to other protection options where direct purchase is not feasible. • Implement the following Environmental Management Plans: o Air Quality Management o Erosion Prevention and Sediment Control o Fisheries and Aquatic Habitat Management o Fuel Handling and Storage Management o Soil Management Site Restoration and Revegetation o Vegetation and Invasive Plant Management

Key Findings: Vegetation and Ecological Communities

The creation of the reservoir and other Project activities would alter and fragment some unique terrestrial ecosystems that include marl fen, tufa seeps, and old and mature riparian and floodplain forests. In addition, occurrences of rare plants would be lost, including two red-listed rare plant species, Drummond's thistle and little bluestem.

As a result of potential alteration and fragmentation of unique terrestrial ecosystems and loss of occurrences of two plant species at risk, a determination of significance has been made.

The anticipated residual effects to Vegetation and Ecological Communities from other future projects and activities combined are considered significant, even without the Project. This is because the potential residual effects of other projects and activities that include road construction, forestry and land clearing activities, cannot be fully mitigated and the future loss of rare plants and rare and sensitive ecosystems due to these other projects have the potential to further elevate provincial or federal listings. The cumulative effect with the Project is also considered significant.

Appendix B. Summary of Baseline Information and Effects for Wildlife Resources.

Summary of Baseline Information and Effects for Wildlife Resources.

Wildlife Resources

The Wildlife Resources assessment considers the potential effects to habitat alteration and fragmentation, disturbance and displacement, and mortality for the following wildlife groups: butterflies and dragonflies, amphibians and reptiles, migratory birds, non-migratory gamebirds, raptors, bats, furbearers, ungulates, and large carnivores.

Assessment area

The Local Assessment Area (LAA) encompasses the Project activity zone, buffered by an additional 1,000 m. The LAA also extends downstream from the Site C dam to the Alberta border and includes a 1,000 m buffer on both the south and north banks of the Peace River. The Regional Assessment Area (RAA) includes five Wildlife Management Units and includes most of the Peace Lowlands eco-section and incorporates all Project components.

Baseline conditions for each of the key indicators were compiled based on available literature, field studies, and information from traditional land use studies.

Table B. Summary of Potential Effects and Mitigation Measures on Wildlife Resources

Potential Effect	Key Mitigation Measures
Habitat Alteration and Fragmentation	Wetlands • Establish appropriate barriers and Environmental Protection Zones to avoid direct disturbance to wetland sites • Create new wetland habitat areas for migratory birds and a range of other species • Create areas that are “fish-free”, where appropriate, to reduce the effects of fish predation on invertebrates, amphibian eggs and larvae, and young birds • Maintain existing hydraulic patterns if roads cannot avoid wetlands; ditches, culverts, and other structures will be placed to maintain the natural drainage patterns and allow the movement of flows Habitats • Retain vegetation on steep, unstable slopes that would be highly susceptible to landslides if the vegetation was removed • Retain non-merchantable trees and vegetation in riparian areas within a 15 m buffer zone from the high water mark. Merchantable trees and vegetation that could interfere with navigation will be removed using clearing practices to maintain a 15 m

	machine-free zone
	• Locate artificial dens on warm aspect slopes in open areas away from major roads
	• Incorporate nest boxes for cavity-nesting waterfowl into wetland mitigation plans and within riparian vegetation zones
	• Provide a portion of BC Hydro-owned land for breeding habitat for Northern Harrier and Short-eared Owl. Wetland compensation will also be made available to address some habitat losses for these two species
	• Incorporate bat roosting habitat features into new bridge designs as approved by MOTI
	• Install bat boxes on free-standing poles or on facility walls where their presence will not interfere with facility operations and maintenance
	• Create and disperse natural or artificial piles of coarse woody debris to maintain fisher foraging areas and cold-weather rest sites
	• Create arboreal resting sites for fisher
	• Provide artificial fisher den boxes within forested stands that have limited Tier 3 trees
	
	Ungulates
	
	• Manage BC Hydro-owned lands at the Halfway River and Wilder Creek to provide ungulate winter range on the north bank of the Peace River
	• Consider the use of supplemental ungulate feeding programs during severe winters
	
	Environmental Management Plans
	
	• Implement the following Environmental Management Plans:
	  o Erosion Prevention and Sediment Control Plan
	  o Fisheries and Aquatic habitat Management Plan
	  o Fuel Handling and Storage Management Plan
	  o Soil Management Site Restoration and Re-vegetation
	  o Surface Water Quality Management Plan
	  o Vegetation and Invasive Plant Management Plan

Disturbance and Displacement	Construction: • Reduce, light pollution at work sites

	• Restrict access on roads used by work crews during construction • Incorporate the location of rare species along the transmission line right-of-way or adjacent to generation facilities into BC Hydro’s GIS-based mapping system • Provide all known grouse lek locations during the final construction design phase • Use appropriate flagging if work is required immediately adjacent to any leks, and instruct personnel to avoid these sites • Develop a detailed Human-Bear Conflict Management Plan for the Project • Implement the following Environmental Management Plans: o Soil Management Site Restoration and Revegetation Plan o Wildlife Management Plan Bald Eagles • Update the baseline data on Bald Eagle nest sites from 2011 prior to commencement of construction • Erect Bald Eagle nesting platforms along the reservoir shoreline. If an active nest is lost due to the Project, new nesting structures will be provided • Retain Bald Eagle nests outside the dam construction area that are confirmed active the year that clearing is started within the reservoir through the entire construction phase until reservoir filling is initiated • Remove nests that could be lost during seasonal flooding associated with dam construction. For active nests retained through the construction period, a “no-clearing buffer” around each active nest will be implemented
Mortality	• Design a portion of the wetlands created to compensate for habitat loss to remain fish-free to eliminate predation to invertebrates (dragonfly larva), amphibians, and reptiles • Include amphibian passage structures in road design where roads are adjacent to wetlands or amphibian migrations • Clear forested habitat – potential roosting and cover

	sites for bats and fisher – before inundation begins. Clearing will take place during late fall and winter, before the birthing season, and when bats are not present or are in hibernacula, • Schedule construction activities following guidance from Peace Region Selected Terrestrial and Aquatic Wildlife Least Risk Windows • Develop a Human-Bear Conflict Management Plan • Implement the following Environmental Management Plans: o Erosion Prevention and Sediment Control Plan o Fuel Handling and Storage Management Plan o Vegetation and Invasive Plant Management Plan o Wildlife Management Plan

Key Findings: Wildlife Resources

The residual effects to wildlife resources would be local for all indicators except migratory birds, and would not jeopardize the persistence of those indicator groups in a regional context.

Habitat for certain migratory birds (Canada, Cape May and Bay-breasted Warblers, Yellow Rail and Nelson's Sparrow) would be affected by the creation of the reservoir. Because these select migratory birds are considered species at risk, a determination of significance has been made. All other species of wildlife are not expected to be significantly affected by the Project as mitigation will be effective or the populations are not at risk.

The anticipated residual effects to Wildlife Resources from other future projects and activities combined are considered significant, even without the Project. The footprints of other projects and activities within the regional assessment area would result in the loss and fragmentation of habitat for wildlife. The Project would potentially result in the alteration and fragmentation of habitat, disturbance or displacement, and mortality for certain key indicator species or species groups. The cumulative effect with the Project is also considered significant.

Appendix C. Belted Kingfisher Survey Data Collection and Analysis Work Plan.

Belted Kingfisher Survey Data Collection and Analysis Work Plan

Site C Clean Energy Project

May 19, 2015

Table of Contents

1.0 Purpose

The purpose of the project is to fulfill commitments made by BC Hydro during the Joint Review Panel hearings regarding collecting baseline data on the Belted Kingfisher population along the Peace River.

2.0 Study Area

The study area is defined as the Peace River main stem and accessible back channels from the Peace Canyon dam to the Alberta border.

Objectives of Proposed Field Surveys

The field study program will collect Belted Kingfisher population data along the main stem of the Peace River. Specific objectives of the field surveys are:

1) Complete Belted Kingfisher surveys using a standard methodology and timeframe to allow for comparisons with surveys to be conducted during operations;
2) Determine the abundance of Belted Kingfisher and distribution of nest sites on the Peace River main stem from the Peace Canyon Dam to the Alberta border during the breeding season (mid to late May to mid-July) the year prior to river diversion to allow for comparison during the first 10 years of operations.
3) Report findings as number of Belted Kingfisher/kilometre of the Peace River, distribution along the north bank and south bank and, if the data allow, number of Kingfisher/habitat type.

3.0 Proposed Field Survey Methodology

3.1 Wildlife

Surveys will be completed by adapting the Resource Inventory Committee Inventory Methods for Inventory Methods for Riverine Birds: Harlequin Duck, Belted Kingfisher and American Dipper. (Resources Inventory Committee 1998).

3.1.1 Sampling Design and Effort

Two surveys will be completed: one during mid to late May (to locate Kingfisher nesting habitat and identify nest locations), and one in June/early July (to conduct the population inventory). The entire study area from the Peace Canyon dam to the Alberta border will be inventoried during the May visit including back channels where suitable habitat occurs. Only areas with suitable Kingfisher nesting habitat will be re-surveyed in June/July.

The study area extends over 140 km in length with many islands and back channels occurring within. A complete survey of all shorelines (including islands and back channels) by foot or with a drift boat as recommended in the RISC standards is not possible for this project. In order to cover the study area in a practical manner a power boat will be used.

Areas along the Peace River main stem supporting suitable Belted Kingfisher habitat will be identified using:

- Existing Terrestrial Ecosystem Mapping (TEM). TEM data for the study area will be utilized to identify areas containing habitats with the characteristic associated with Belted Kingfisher nesting habitat.
- The Northern Rough-winged Swallow nesting habitat model. Northern Rough-winged Swallows often use former Belted Kingfisher nest sites and, as such, the Northern Rough-winged Swallow model developed to support the EIS by Keystone Wildlife Research (2011) will be used to aid in identifying preferred Belted Kingfisher nesting habitats.
- Baseline nest site data for swallows and kingfishers (Keystone 2010) along the Peace River.

The survey will be conducted with two observers searching for Belted Kingfishers from the boat. GPS Mapping Software will be used to record the survey route and to ensure that surveyors know at all times which river segment or habitat is being inventoried. The study area will be divided into 1 km segments. Segments will run along the river (not across). Data collected will be recorded on RISC standard data forms modified for this project.

The goal of the surveys is to document 100% of the Belted Kingfishers present. The boat will travel along the middle of the mainstem and one observer will record observations along the north bank while the second observer will record observations along the south bank. Islands and backchannels with suitable habitat will be surveyed using the same metholodogy.

It is anticipated the first survey may take up to three days to complete. At the end of the first survey, habitats for Belted Kingfisher will have been confirmed and mapped, this should reduce the effort for the second survey to two days as only areas with confirmed suitable habitat will be visited.

4.0 Field Work Schedule

The proposed field surveys will be conducted between the third week of May and July 15. The timing is important to allow the identification of kingfishers breeding along the Peace River. Surveys during this time correspond to the time when birds will be defending nesting territories and are therefore easier to detect.

5.0 Deliverables

The deliverables will induced:

- Survey summary reports. Provided to the project manager within seven days of each field session.

At the completion of the project the following will be provided:

- Original field data sheets
- Photographs taken during surveys
- EXCEL data summaries
- A hard copy and electronic copy of the survey report.

Deliverable	**Deliverable submission date**
Survey summary reports	Within 7 days after each survey

	completed
Draft program survey report	September 25th
Final program survey report	October 23rd
Submission of data sheets, photos and databases	September 25th
Submission of accrual estimates	22 day of each month (May-October)

6.0 References

Keystone Wildlife Research Ltd. (Keystone). 2010. Baseline nest site data for swallows and kingfishers (Excel spreadsheet).

Keystone Wildlife Research Ltd. (Keystone). 2011. Site C Clean Energy Project Environmental Impact Statement Volume 2: Assessment Methodology and Environmental Effects Assessment Baseline Vegetation and Wildlife Report (Sections 13 and 14).

Ministry of Environment, Lands and Parks (MELP). 1998. Inventory Methods for Riverine Birds: Harlequin Duck, Belted Kingfisher and American Dipper. Standards for Components of British Columbia's Biodiversity No. 12. Prepared by Ministry of Environment, Lands and Parks Resources Inventory Branch for the Terrestrial Ecosystems Task Force Resources Inventory Committee. March 1998. Version 2.0.

Appendix D. Expanded Legend for the Peace River Terrestrial Ecosystem Mapping Project.

Expanded Legend for the Peace River Terrestrial Ecosystem Mapping Project

Prepared by:
L. Andrusiak and L. Simpson
Keystone Wildlife Research Ltd.

Prepared for:

BC Hydro and Power Authority

Burnaby, BC

December 2012

A.1 Introduction

Terrestrial ecosystem mapping of the Peace River Corridor at 1:20,000 was requested by BC Hydro and Power Authority as base mapping for strategic planning. Terrestrial ecosystem mapping (TEM) can be used as the basis for a number of types of interpretive maps, including wildlife habitat, rare ecosystems, rare plants, and resources important to First Nations.

The purpose of the expanded legend is to describe and define the ecosystem units mapped for the Project, with notes on their use by wildlife. Each ecosystem is illustrated with a photo (where available), its physical characteristics are described and the dominant and associate plant species are listed for each potential structural stage of the ecosystem. Data for the expanded legend came from field-truthing done in the summers of 2005 and 2006, and from the regional field guides (DeLong et al. 1990; BC Ministry of Forests 2002).

A.2 **Study Area**

The study area is located in northeastern British Columbia. The mapped Peace River corridor area extends for approximately 2 km north and south along the river (62,000 ha in area; Figure 1). Geographically, the core river corridor refers to the entire river valley including the floodplain and the ascending slopes extending approximately 2 km on either side of the river.

Midway through the mapping project, a second area was added to the study area. This new area consisted of a transmission line corridor located on the south side of the river. This corridor extends east and north from the Peace Canyon dam to an area about 14 km southwest of Taylor. Both the river valley and transmission line corridor are located entirely within the BWBSmw1 subzone variant.

Ancillary sites (4634 ha) were added to the mapping project in 2012 and consisted of additional uplands south of the proposed dam site, generating station and spillway, Wuthrich quarry and 85th Avenue Industrial Lands near Fort St. John, small areas in the drainages of the Halfway River, Cache Creek and Farrell Creek, and West Pine quarry, located on the Pine River. The total project area totals 68,711 ha and includes portions of 31 TRIM map sheets.

The Peace River corridor, transmission line, and most of the ancillary sites are located within the Peace Lowlands (PEL) ecosection in the Peace River Basin Ecoregion (Demarchi 2011), and are found entirely within the Boreal White and Black Spruce moist, warm Peace subzone variant (BWBSmw1) within the Peace Forest District in the Northern Interior Forest Region). The climate is moderate and continental, with moderately warm summers and relatively cold winters (Farstad et al. 1965).

The West Pine quarry is located within the Central Canadian Rocky Mountains Ecoregion (Demarchi 2011) in the Prince George Forest District. It includes two subzone variants: the Sub-boreal Spruce Finlay-Peace wet, cool (SBSwk2) at low elevations and a small portion of Engelmann Spruce-Subalpine Fir Bullmoose moist, very cold (ESSFmv2) at higher elevations at the western edge of the study area. The SBSwk2 lies within the Hart Foothills (HAF) ecosection, while the ESSFmv2 lies within the Northern Hart Ranges (NHR) ecosection.

A.3 Ecosystem Units and Map Codes

Ecosystem units used in the mapping of the Peace River Corridor were developed from a number of sources. Most of the forested sites in the BWBSmw1 (01 to 08) were described in DeLong (1990), and the corresponding seral units ($01 to $07) in BC MoF (2002). Two-letter mapcodes for those units, and for several noncorrelated or '00' units ('AS', 'SE', 'TS', 'WH' and 'WW') were listed in the provincial mapcodes database (BC MSRM 2003). There were significant differences between the units as described in DeLong (1990) and MoF (2002) and the ecosystems found in the project area. Those differences have been described below.

Midway through the project, in 2006, several new wetland site series for the BWBSmw1 were released by BC MoF. Those new site series included the 09, 10 and 11 site series as well as the Scrub birch-Sedge Wf02 ecosystem, with the new '10' site series developed as the previously non-correlated 'TS' unit. The new site series were incorporated into the final mapping. One new seral association, the birch-dogwood or 'ep', was defined for the project. The ep seral association can occur in the 05 or 07 site series.

Regional ecologist Craig DeLong reviewed the preliminary classification of ecosystems for the study area. He approved the retention of the 'TS' code for the 10 site series, and suggested the use of the 'ep' seral association to describe birch-dominated sites in the 07 and 05 units (C. DeLong, pers. comm. 2006). Several different types of floodplain and wetland communities as described in MacKenzie and Moran (2004) were located in the study area during field truthing. However, the majority of these non-forested communities could not be adequately distinguished using air photos, therefore the non-forested floodplain communities have been grouped together as the Willow-Horsetail (WH) map unit, and the wetlands grouped as Shrub Wetlands (WS) and Sedge Wetlands (SE).

Some important differences were noted between the existing field guides and the vegetation present within the river valley. Most notable was the rarity of oak fern (*Gymnocarpium dryopteris*) and tall bluebells, which are listed as indicator species in the field guides. Moss development is an important criterion for distinguishing seral from non-seral sites. Moss layers were generally sparse within the Peace River valley itself, even on the non-seral sites. Additional information is provided in the project report.

Ecosystem units for the SBSwk2 and ESSFmv2 were mapped as described in DeLong (2004) and DeLong (1994), respectively. Two-letter mapcodes and seral codes and non-correlated site series were obtained from the provincial mapcode database (BC Ministry of Environment 2006).

A.4 BWBSmw1 - Forested Ecosystems

A.4.1 AM: SwAt - Step moss (01)

The AM unit is typically submesic to mesic forest on gentle slopes with deep, moderately fine to coarse - textured soil. Nutrient regimes range from poor to rich, and the unit can occur on fluvial, glaciofluvial, morainal or lacustrine parent materials (DeLong et al. 1990). Assumed modifiers: d, f, j.

Map Symbol with Mapped Site Modifiers:

- **AMa –** the ecosystem occurs on an active floodplain
- **AMat –** the ecosystem occurs on an active floodplain and on a terrace

- **AMay –** the ecosystem occurs on an active floodplain and is moister than average
- **AMg -** the ecosystem occurs on gullied terrain or in a gully
- **AMgh –** the ecosystem occurs on gullied terrain that is also hummocky
- **AMgk** - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)
- **AMgs –** the ecosystem occurs on gullied terrain on shallow soils
- **AMgw** - the ecosystem occurs on gullied terrain or in a gully, on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)
- **AMgy**– the ecosystem occurs on gullied terrain or in a gully and is moister than average
- **AMh –** the ecosystem occurs on hummocky terrain
- **AMhk**– the ecosystem occurs on hummocky terrain on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)
- **AMhr** – the ecosystem occurs on hummocky, ridged terrain
- **AMhw**– the ecosystem occurs on hummocky terrain on a warm aspect (aspect of135 - 285 o on a slope that is 25-100%)
- **AMhy**– the ecosystem occurs on hummocky terrain and is moister than average
- **AMk -** the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)
- **AMks**– the ecosystem occurs on a cool aspect (aspect of 285-135o on a slope that is 25-100%) on shallow soils
- **AMn –** the ecosystem occurs on a fan or cone
- **AMr –** the ecosystem occurs on ridged terrain
- **AMrs –** the ecosystem occurs on ridged terrain on shallow soils
- **AMs –** the ecosystem occurs on shallow soils
- **AMt** - the ecosystem occurs on a terrace

- **AMty–** the ecosystem occurs on a terrace and is moister than average
- **AMw -** the ecosystem occurs on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)
- **AMy –** the ecosystem is moister than average

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Paper birch Prickly rose Trembling aspen Twinflower White spruce	Prickly rose Step moss Trembling aspen Twinflower White spruce	Asters Prickly rose Step moss Trembling aspen Twinflower White spruce	Asters Bunchberry Creamy peavine Highbush cranberry Prickly rose Soopolallie Step moss Trembling aspen Twinflower White spruce	Asters Bunchberry Creamy peavine Highbush cranberry Prickly rose Soopolallie Step moss Trembling aspen Twinflower White spruce

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	American vetch Black gooseberry Creamy peavine Soopolallie	Highbush cranberry Red-osier dogwood Saskatoon Soopolallie Trembling aspen	Creamy peavine Highbush cranberry One-sided wintergreen Red-osier dogwood Red-stemmed feathermoss Saskatoon	Balsam poplar Common snowberry Dwarf red raspberry Paper birch Red-osier dogwood Tall bluebells Wild sarsaparilla	Balsam poplar Dwarf red raspberry Paper birch Red-osier dogwood Tall bluebells Trembling aspen
Plots	KS103	0107664, B1-06, C1-12, SK093, TKS017	0107663, 0107658, 0107671, BC001, C2-01, D1-08, DT022, DT026, E1-05, E1-07, JG033, JG352, JG575, JG636, K2-02, KS015, KS019, LA040, LA237, LS019, LS026, SK369, WB048, WB275, X2-10	A1-05, E2-06, JG006, JG116, K1-12a, K2-16, LA041, LS039, LS060, LS127, RP123, SK009, SK095, SK097, SK373, T1-01, WB227, WB262, WB274, WB300, WB323, WB336, WB346, X2-11	No project plots; vegetation list prepared from other sources

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	In the project area, the AM was found mainly on mid-slope and level, moderately well-drained to well-drained sites, with mesic to submesic moisture regimes and medium nutrient regimes. Parent materials were mainly fluvial and glaciolacustrine. The AM was very variable in terms of vegetation.				

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

A.4.2 AM ap: $At - Creamy peavine (seral association) (01)

Typic AM:ap occurs on gentle slopes (usually <20%) on fine to coarse soils, on glaciofluvial, fluvial, morainal or lacustrine surficial materials. It has a medium to rich nutrient regime and a submesic to mesic moisture regime (BC Ministry of Forests 2002). Assumed modifiers: d, f, j.

Map Symbol with Mapped Site Modifiers:

AMa:ap – the ecosystem occurs on an active floodplain

<table>
<tr><th>Structural Stage</th><th>3 - Shrub</th><th>4 - Pole-sapling</th><th>5 - Young Forest</th><th>6 - Mature Forest</th><th>7 - Old Forest</th></tr>
<tr><td colspan="6">
AMac:ap – the ecosystem occurs on an active floodplain on coarse textured soils
AMag:ap – the ecosystem occurs on an active floodplain in a gully
AMat:ap – the ecosystem occurs on an active floodplain on a terrace
AMc:ap – the ecosystem occurs on coarse textured soils on a terrace
AMct:ap – the ecosystem occurs on coarse textured soils on a terrace
AMg:ap - the ecosystem occurs on gullied terrain or in a gully
AMgh:ap - the ecosystem occurs on gullied and hummocky terrain
AMgn:ap - the ecosystem occurs on gullied terrain and on a fan or cone
AMgs:ap - the ecosystem occurs on gullied terrain on shallow soils
AMh:ap - the ecosystem occurs on hummocky terrain
AMhr:ap - the ecosystem occurs on hummocky, ridged terrain
AMn:ap – the ecosystem occurs on a fan or cone
AMq:ap - the ecosystem occurs on a very steep cool aspect (aspect of 285- 135o on a slope that is >100%)
AMr:ap - the ecosystem occurs on ridged terrain or on a ridge crest
AMrs:ap - the ecosystem occurs on ridged terrain with shallow soils
AMs:ap - the ecosystem occurs on shallow soils
AMt:ap - the ecosystem occurs on a terrace
</td></tr>
</table>

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Prickly rose Showy aster Trembling aspen	Creamy peavine Prickly rose Saskatoon Showy aster Trembling aspen	Trembling aspen Saskatoon Prickly rose Showy aster Bunchberry	Trembling aspen Prickly rose Wild sarsaparilla Showy aster Bluejoint reedgrass Bunchberry Creamy peavine Red raspberry Highbush cranberry Birch-leaved spirea	Trembling aspen Prickly rose Wild sarsaparilla Showy aster Bluejoint reedgrass Bunchberry Creamy peavine Red raspberry Highbush cranberry Birch-leaved spirea
Associated Plant Species	Balsam poplar Bedstraws Creamy peavine Red raspberry Saskatoon Soopolallie	Bedstraws Common snowberry Dwarf red raspberry Highbush cranberry Soopolallie	Soopolallie Willows Common snowberry Northern bedstraw	Saskatoon Balsam poplar White spruce Soopolallie	Saskatoon Balsam poplar White spruce Soopolallie

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	BC014a, BC373, BC385, BC468, Farrah3, LA039, LA202, LA295, LA317, SK424	0107642, al-2, BC038, BC465, BC466, DT031, G1-04, J1-04, JG098, KS005, KS037, LA011, LA032, LA292, LA302, LA308, LS051, SK1010, SK022, SK353, SK392, SK540, SK618, WB042, WB044, WB050, WB051, WB212, WB241, WB356	0107637, 0107640, 0107641, 0107647, 0107669, BC009, BC026, BC044, DT001, DT009, DT019, DT030, DT038, DT039, DT041, farrah1, JG127, KS036, KS039, LA020, LA034, LA245, LA256, LS018, LS020, LS070, LS118, SK001, SK051, SK053, SK076, SK087, TKS095, WB004, WB007, WB010, WB017, WB041, WB049, WB099, WB258, WB351, WB352	3-3000, BC377B, JG017, JG113, KS016, LS054, LS112, RP127, SK013, SK354, SK427, SK477, WB260, WB306, WB310, WB342, WB347	No project plots; it is unlikely that the seral unit exists in structural stage 7.

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	The AM:ap was the ecosystem most commonly mapped in the study area. It was found on mesic sites with medium nutrient regimes, mainly on glaciolacustrine or glaciofluvial surficial materials. Drainage was mainly moderately-well to well. The AM: ap provides cover for ungulates and bears and habitat for a variety of birds. In structural stages >4, it may provide bats with roost sites.				

A.4.3 AM y: ap $At - Creamy peavine (seral association) (01), moister than typic

Typic AM y:ap is typically found on gentle slopes with deep, fine-textured soils. This unit represents permanent trembling aspen stands with a mesic to subhygric moisture regime. Medium nutrient regime. Assumed modifiers: d, f, j.

Map Symbol with Mapped Site Modifiers:

AMay:ap - the ecosystem occurs on an active floodplain and is moister than average

AMgy:ap - the ecosystem occurs on gullied terrain and is moister than average

AMhy:ap - the ecosystem occurs on hummocky terrain and is moister than average **AMny:ap** - the ecosystem occurs on a fan or cone and is moister than average **AMsy:ap** - the ecosystem occurs on shallow soils and is moister than average **AMty:ap** - the ecosystem occurs on a terrace and is moister than average

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Balsam poplar Prickly rose Trembling aspen	Balsam poplar Prickly rose Red-osier dogwood Trembling aspen	Balsam poplar Prickly rose Red-osier dogwood Saskatoon Trembling aspen	Balsam poplar Red-osier dogwood Trembling aspen Bunchberry	Balsam poplar Red-osier dogwood Trembling aspen Bunchberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Fireweed Highbush cranberry Horsetails Northern gooseberry Red-osier dogwood White spruce Willows	Highbush cranberry Northern gooseberry Showy aster Northern bedstraw Wild strawberry	Bunchberry Common snowberry Creamy peavine Highbush cranberry Northern gooseberry Showy aster White spruce Wild sarsaparilla Wild strawberry Willow	Common snowberry Highbush cranberry Northern gooseberry Tall bluebells Red raspberry	Common snowberry Highbush cranberry Northern gooseberry Tall bluebells Red raspberry
Plots	BC353, WB329	BC372, LA037, LA254, Q2-02, SK351, SK524	0107652, D1-01, DT036, DT037, fawcet1, JG665, KS017, LA013, LA259, LS114, LS115, SK008, SK017, SK102, WB014, WB016	BC395, LS056, SK018, WB343, WB355	No project plots; it is unlikely that the seral unit exists in structural stage 7.

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Comments	Plots were allocated to AMy:ap if moisture-indicating plants, such as red-osier dogwood or *Ribes* spp. were present and their percent cover totalled over 5%. The seral 06 unit is not distinguished from the seral 01 unit according to the draft seral field guide (BC Ministry of Forests 2002), but it is possible that the AMy:ap is actually the seral 06. The AMy:ap was found mainly on level sites or on cool aspects, predominantly on moderately well-drained sites.				

A.4.4 AM k:ap $At - Creamy peavine (seral association) (01), cool aspect

Typic AMk :ap occurs on steep slopes (>25%) on north facing aspects (135-285 degrees) and sometimes in gullies; these deciduous forest generally occur on deep fine-textured lacustrine surficial materials and less frequently on coarse-textured glaciofluvial and colluvial surficial materials. This unit represents permanent trembling aspen stands with a mesic moisture regime.

Map Symbol with Mapped Site Modifiers:

AMgk:ap - the ecosystem occurs on gullied terrain on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

AMhk: ap - the ecosystem occurs on hummocky terrain on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **AMks:ap** – the ecosystem occurs on shallow soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **AMkv:ap** – the ecosystem occurs on very shallow soils on a cool aspect (aspect of 285-135o on a slope that is 25-100%)

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Trembling aspen Willow Showy aster	Trembling aspen Willow Spreading dogbane Highbush cranberry Showy aster	Trembling aspen Prickly rose Soopolallie Highbush cranberry Showy aster	Trembling aspen Prickly rose Soopolallie Showy aster	Trembling aspen Prickly rose Soopolallie Showy aster

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Saskatoon Red-osier dogwood Wild sarsaparilla	Prickly rose	Red-osier dogwood Wild sarsaparilla Creamy peavine	Highbush cranberry Northern bedstraw Creamy peavine	Highbush cranberry Northern bedstraw Creamy peavine
Plots	BC011	KS006, WB043	0107648, BC010, H1-06a, H1-09, K1-04, K2-06a, L1-02, LA009, LA010, SK048, WB252	SK047, SK612, WB046, WB213	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	In the project area, the AMk:ap was found on upper to lower slopes (mostly mid-slope), with submesic to mesic moisture regimes and medium nutrient regimes. Slopes averaged 29%.				

A.4.5 AM w:ap $At - Creamy peavine (seral association) (01), warm aspect

Typic AMw :ap occurs on steep slopes (>25%) on south-facing aspects (135-285 degrees); these deciduous forest generally occur on deep, medium-textured glaciofluvial and undifferentiated surficial materials; these sites occur on upper to lower meso slope positions and are generally well to moderately well-drained; this unit represents permanent trembling aspen stands with a mesic moisture regime.

Map Symbol with Mapped Site Modifiers:

AMgw: ap – the ecosystem occurs on warm aspect (aspect of 135 - 285 o on a slope that is 25-100%) sites on gullied terrain

AMhw:ap – the ecosystem occurs on hummocky terrain on a warm aspect (aspect of135 - 285 ^{o} on a slope that is 25-100%)

AMnw:ap- the ecosystem occurs on a fan or cone on a warm aspect (aspect of135 - 285 ^{o} on a slope that is 25-100%) **AMsw:ap**- the ecosystem occurs on shallow soils on a warm aspect (aspect of135 - 285 o on a slope that is 25-100%)

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Trembling aspen Saskatoon Prickly rose Common snowberry	Trembling aspen Saskatoon Prickly rose Common snowberry	Trembling aspen Saskatoon Prickly rose	Trembling aspen Grasses Saskatoon Prickly rose	Trembling aspen Grasses Saskatoon Prickly rose
Associated Plant Species	Snowberry Northern bedstraw Grasses Willow	Showy aster American vetch	Pin cherry Northern bedstraw Creamy peavine Showy aster	White spruce Showy aster Creamy peavine Northern bedstraw	White spruce Showy aster Creamy peavine Northern bedstraw
Plots	J1-02, LA015, SK023, WB003	0107636, 0107643, al-1, BC025, BC040, LA030, LS074, LS105	BC037, BC041, DT007, J1-07	LS125	No project plots; it is unlikely that the seral unit exists in structural stage 7.

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	The AMw:ap was found on slopes averaging 35% on sites that were generally submesic with medium nutrient regimes. Drainage ranged from rapid to moderately-well.				

A.4.6 LL: Pl - Lingonberry - Velvet-leaved blueberry (02)

Typically subxeric forest on gentle slopes with deep, medium to coarse - textured soil. The LL unit normally occurs on glaciofluvial or fluvial soils and has a poor to medium nutrient regime (DeLong et al. 1990). Assumed modifiers c, d, j.

Map Symbol with Mapped Site Modifiers:
LLk - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)
LLr- the ecosystem occurs on ridged terrain
LLs- the ecosystem occurs on shallow soils
LLt- the ecosystem occurs on a terrace
LLw - the ecosystem occurs on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Birch-leaved spirea Kinnikinnick Lodgepole pine Soopolallie Trembling aspen Twinflower	Birch-leaved spirea Kinnikinnick Lodgepole pine Northern bedstraw Prickly rose Soopolallie Twinflower White spruce	Birch-leaved spirea Lodgepole pine Prickly rose Soopolallie Twinflower Lingonberry White spruce	Creamy peavine Kinnikinnick Lodgepole pine Prickly rose Saskatoon Soopolallie White spruce	*Cladina* Kinnikinnick Lodgepole pine White spruce

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Red-stemmed feathermoss White spruce	Lingonberry Red-stemmed feathermoss Wild lily-of-the-valley	Bunchberry Creamy peavine Kinnikinnick Red-stemmed feathermoss Step moss Wild lily-of-the-valley	Common juniper Paper birch Red-stemmed feathermoss Trembling aspen	Common juniper Prickly rose Red-stemmed feathermoss Saskatoon Step moss Trembling aspen
Plots	No project plots; vegetation list prepared from other sources	0107657, LA243, BC358	0107631, LA008, BC360, JG570, SK565, WB232, WB409, WB410, WB001	SK006, SK014, SK365, SK564, BC362	No project plots; vegetation list prepared from other sources
Comments	The LL ecosystem was not common in the study area. When it was found, it occurred mainly on well-drained level to gentle slopes with a xeric to submesic moisture regime and a poor to medium nutrient regime. Velvet-leaved blueberry was rare in the study area.				

A.4.7 LL: ak: $At - Kinnikinnick (seral association) (02)

Typically subxeric to submesic forest on gentle slopes with deep, coarse - textured soil. This unit normally is found on fluvial or glaciofluvial parent materials with poor to medium nutrient regimes (BC Ministry of Forests 2002). Assumed modifiers c, d, j.

Map Symbol with Mapped Site Modifiers:

LLgw:ak - the ecosystem occurs on gullied terrain and on a warm aspect (aspect of135 - 285 ^{o} on a slope that is 25-100%)

LLh:ak - the ecosystem occurs on hummocky terrain

LLr:ak - the ecosystem occurs on a fan or cone

LLt:ak - the ecosystem occurs on a fan or cone

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Trembling aspen Saskatoon Kinnikinnick	Trembling aspen Kinnikinnick	Trembling aspen Prickly rose Soopolallie	Trembling aspen Kinnikinnick	Trembling aspen Kinnikinnick
Associated Plant Species	White spruce Wild strawberry	White spruce Saskatoon Rocky Mountain juniper Soopolallie Creamy peavine American vetch	Common juniper White spruce Kinnikinnick Willows Creamy peavine Twinflower	Common juniper White spruce Willows Creamy peavine Twinflower	Common juniper White spruce Willows Creamy peavine Twinflower
Plots	KS034, TKS116	LA019, LA035	LA004, LA006	No project plots; vegetation list prepared from other sources	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	The LL:ak unit was rare in the study area. It was found on level sites that were submesic to xeric, and well to moderately well-drained, with poor to medium nutrient regimes.				

A.4.8 SW: Sw - Wildrye - Peavine (03)

Typically submesic to mesic forest on gentle slopes with deep, medium to coarse - textured soils. The 03 unit normally occurs on sites with a poor to medium nutrient regime, and can occur on a variety of parent materials (DeLong et al. 1990). Assumed modifiers c, d, j.

Map Symbol with Mapped Site Modifiers:

SWg- the ecosystem occurs on gullied terrain or in a gully

SWgh - the ecosystem occurs on hummocky, gullied terrain

SWgk - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **SWgs** - the ecosystem occurs on gullied terrain on shallow soils **SWgw-** the ecosystem occurs on gullied terrain or in a gully, on a warm aspect (aspect of 135 - 285 ^{o} on a slope that is 25-100%) **SWk** - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **SWks** –the ecosystem occurs on shallow soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **SWn** - the ecosystem occurs on a fan or cone **SWq** - the ecosystem occurs on a very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%) **SWr** – the ecosystem occurs on ridged terrain or on a ridge crest **SWs** - the ecosystem occurs on shallow soils **SWt-** the ecosystem occurs on a terrace **SWw-** the ecosystem occurs on a warm aspect (aspect of135 - 285 ^{o} on a slope that is 25-100%)

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Common snowberry Grasses Paper birch	Lodgepole pine Step moss White spruce	Lodgepole pine Prickly rose Saskatoon Soopolallie Trembling aspen White spruce	Bunchberry Fuzzy-spiked wildrye Lodgepole pine Prickly rose Soopolallie Step moss Trembling aspen Twinflower White spruce	Prickly rose Soopolallie Step moss White spruce Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Showy aster Prickly rose	Showy aster Prickly rose	Bunchberry Creamy peavine Northern bedstraw Red-stemmed feathermoss Showy aster Step moss Wild lily-of-the-valley	Balsam poplar Creamy peavine Highbush cranberry Pink wintergreen Red-stemmed feathermoss Wild sarsaparilla	Balsam poplar Creamy peavine Highbush cranberry Northern gooseberry Saskatoon Trembling aspen
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	0107639, 0107645, B1-04, B2-03, BC049, DT013, DT016, DT023, DT024, H1-12a, JG009, JG012, JG037, JG046, JG057, JG150, JG558, LA187, LS063, LS116, SK004, WB236	BC018, H1-13, JG044, JG100, JG118, LA002, LS123, RP194, SK592, WB239, WB316, WB322	WB219

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	In the study area, this unit was usually found on level sites or on mid to upper slopes on cool aspects. This ecosystem was uncommon in the study area. Nutrient regimes were generally poor to medium, and moisture regimes were submesic to mesic.				

A.4.9 SW: as: $At - Soopolallie (seral association) (03)

Typically submesic forest on gentle slopes. This unit normally occurs on fluvial, glaciofluvial, morainal or lacustrine parent materials with coarse to fine-textured soils, on mid-to upper slopes or level sites (BC Ministry of Forests 2002). Assumed modifiers c, d, j.

Map Symbol with Mapped Site Modifiers:

SWf:as – the ecosystem occurs on fine-textured soils

SWfk:as – the ecosystem occurs on fine-textured soils and on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SWg:as - the ecosystem occurs on gullied terrain or in a gully

SWgh:as - the ecosystem occurs on gullied terrain and hummocky terrain

SWgk:as - the ecosystem occurs on gullied terrain on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SWgs:as - the ecosystem occurs on gullied terrain on shallow soils

SWgw:as – the ecosystem occurs on gullied terrain on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

SWh:as - the ecosystem occurs on hummocky terrain

SWhw:as - the ecosystem occurs on hummocky terrain on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

SWk:as - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SWks:as - the ecosystem occurs on shallow soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SWn:as - the ecosystem occurs on a fan or cone

SWq:as - the ecosystem occurs on a very steep cool aspect (aspect of 285- 135^{o} on a slope that is >100%)

SWr:as- the ecosystem occurs on a ridge crest or on ridged terrain

SWs:as –the ecosystem occurs on shallow soils

SWsw:as - the ecosystem occurs on shallow soils on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

SWt:as - the ecosystem occurs on a terrace

SWw:as- the ecosystem occurs on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

SWz:as – the ecosystem occurs on a very steep warm aspect (aspect of 135 - 285 ^{o} on a slope that is >100%)

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Fuzzy-spiked wildrye Prickly rose Soopolallie Trembling aspen	Prickly rose Saskatoon Soopolallie Trembling aspen	Prickly rose Soopolallie Trembling aspen	Fuzzy-spiked wildrye Prickly rose Soopolallie Trembling aspen	Fuzzy-spiked wildrye Prickly rose Soopolallie Trembling aspen
Associated Plant Species	Balsam poplar Fireweed Palmate coltsfoot Showy aster Wild strawberry Willow	Birch-leaved spirea Creamy peavine Northern bedstraw Showy aster White spruce	Creamy peavine Highbush cranberry Northern bedstraw Saskatoon Showy aster Wild strawberry	Creamy peavine Highbush cranberry Northern bedstraw Showy aster White spruce Wild sarsaparilla Wild strawberry	Creamy peavine Highbush cranberry Northern bedstraw Showy aster White spruce Wild sarsaparilla Wild strawberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	LA246, SK397, SK420, SK454, SK541	0107638, BC470, CD007, G1-08, JG508, JG611, LA038, LA233, SK091, SK092, SK363	DT014, H1-05, KS018, KS030, KS033, LA005, LA218, LS007, LS438, SK005, SK052, TKS056, TKS069, TKS093, WB353	BC351, BC376, K1-11, RP193, SK089, SK400, SK588, WB214	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	The SW:as unit was found in the study area on a variety of slope positions from crest to toe, and on level sites. It occurred on mesic to submesic sites with medium moisture regimes and moderately well-drained to well-drained.				

A.4.10 BL: Sb - Lingonberry - Coltsfoot (04)

The 04 ecosystem can be found on a very wide range of moisture conditions (submesic to hygric)(DeLong et al. 1990). Typically black spruce forest on gently sloping sites with deep, fine to coarse- textured soils. The 04 unit is found on morainal, lacustrine or (glacio) fluvial parent materials and has a very poor to poor nutrient regime (DeLong et al. 1990). Assumed modifiers d, f, j.

Map Symbol with Mapped Site Modifiers:

BLg- the ecosystem occurs on gullied terrain

BLh - the ecosystem occurs on hummocky terrain

BLt - the ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Black spruce Lodgepole pine Bunchberry Step moss Twinflower	Black spruce Bunchberry Lodgepole pine Twinflower	Black spruce Bunchberry Knight's plume Lodgepole pine Prickly rose Red-stemmed feathermoss Step moss White spruce	Black spruce Bunchberry Labrador tea Lodgepole pine Red-stemmed feathermoss Step moss	Black spruce Bunchberry Labrador tea Lodgepole pine Red-stemmed feathermoss Step moss
Associated Plant Species	Horsetails Labrador tea Willows	Horsetails Labrador tea Willows	Creamy peavine Dwarf blueberry Fireweed Horsetails Lingonberry Paper birch Twinflower	Horsetails Prickly rose Saskatoon	Highbush cranberry Saskatoon

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	BC047, BC049, BC355, DT104, JG013, JG104, LA237, WB236	3-3001, JG117, WB344	No project plots; vegetation list prepared from other sources
Comments	This ecosystem was uncommon in the Peace Valley but was mapped along the powerline corridor on the plateau. This site was usually found on level sites (up to 15% slope) with mesic to subhygric moisture regimes and poor to medium nutrient regimes, on lacustrine or glaciofluvial materials.				

A.4.11 BL: al $At - Labrador tea (seral association) (04)

Typically submesic to hygric forest on gently sloping sites or depressions with deep, fine to coarse- textured soils. The :al seral association normally occurs on morainal or fluvial parent materials with very poor to poor nutrient regimes (BC Ministry of Forests 2002).

Map Symbol with Mapped Site Modifiers:

BLg:al – the ecosystem occurs on gullied terrain or in a gully

BLh:al – the ecosystem occurs on hummocky terrain

BLk:al - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

BLw:al – the ecosystem occurs on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Bluejoint Bunchberry Highbush cranberry Soopolallie Trembling aspen	Bluejoint Bunchberry Creamy peavine Dwarf red raspberry Highbush cranberry Prickly rose Redstemmed feathermoss Soopolallie Step moss Trembling aspen Velvet-leaved blueberry	Bunchberry Highbush cranberry Prickly rose Trembling aspen	Dwarf red raspberry Prickly rose Soopolallie Trembling aspen Willows	Bluejoint Bunchberry Creamy peavine Dwarf red raspberry Highbush cranberry Prickly rose Redstemmed feathermoss Soopolallie Step moss Trembling aspen Velvet-leaved blueberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Labrador tea Paper birch Prickly rose	Black spruce Dwarf blueberry Fuzzy-spiked wildrye Kinnikinnick Labrador tea Lingonberry	Twinflower Tall bluebells Labrador tea One-sided wintergreen Bluejoint reedgrass Lodgepole pine Paper birch Dwarf red raspberry	Balsam poplar Highbush cranberry Labrador tea	Black spruce Dwarf blueberry Fuzzy-spiked wildrye Kinnikinnick Labrador tea Lingonberry
Plots	SK519	No project plots; vegetation list prepared from other sources	WB047, WB328	WB354	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	The BL:al unit was found on level, moderately well-drained sites with subhygric to hygric moisture regimes and poor to medium nutrient regimes. The BL:al was mapped very rarely within the project area, and mainly along the powerline on the plateau.				

A.4.12 SO: Sw - Currant - Oak fern (05)

Typically mesic to subhygric forest on gently sloping moisture-receiving sites with deep, medium to fine- textured soils. The SO unit is found on a variety of parent materials (DeLong et al. 1990) and typically has a rich nutrient regime. Assumed modifiers d, f, j.

Map Symbol with Mapped Site Modifiers:

SOg- the ecosystem occurs on gullied terrain or in a gully

SOgk - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SOgs - the ecosystem occurs on gullied terrain or on shallow soils

SOgw - the ecosystem occurs on gullied terrain or in a gully, on a warm aspect (aspect of135 - 285 o on a slope that is 25-100%)

SOh - the ecosystem occurs on hummocky terrain

SOk- the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SOn- the ecosystem occurs on a fan or cone

SOr – the ecosystem occurs on ridged terrain

SOt – the ecosystem occurs on a terrace

SOw - the ecosystem occurs on a warm aspect (aspect of 135 - 285 o on a slope that is 25-100%)

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Bunchberry Common snowberry Green alder Highbush cranberry Paper birch Prickly rose Red-osier dogwood Twinflower White spruce	Balsam poplar Black gooseberry Bunchberry Common mitrewort Common snowberry Creamy peavine Dwarf red raspberry Highbush cranberry Paper birch Prickly rose Red-osier dogwood Step moss Tall bluebells White spruce Wild sarsaparilla	Balsam poplar Black gooseberry Bunchberry Common mitrewort Common snowberry Creamy peavine Highbush cranberry Paper birch Prickly rose Red-osier dogwood Step moss Twinflower White spruce Wild sarsaparilla	Balsam poplar Bunchberry Common snowberry Highbush cranberry Paper birch Prickly rose Red-osier dogwood Red-stemmed feathermoss Step moss Twinflower White spruce Wild sarsaparilla	Balsam poplar Black gooseberry Bunchberry Common snowberry Highbush cranberry Paper birch Prickly rose Red-osier dogwood Red-stemmed feathermoss Step moss Twinflower White spruce Wild sarsaparilla

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Associated Plant Species	Red raspberry Rough-fruited fairybells Wild strawberry Willows	Baneberry Blunt-fruited sweet-cicely Horsetails Rough-fruited fairybells Sweet coltsfoot Violets Wild strawberry	Asters Bedstraws Black twinberry Blunt-fruited sweet-cicely Choke cherry Dwarf red raspberry Horsetails Oak fern Red raspberry Saskatoon Tall bluebells Wild lily-of-the-valley Willows	Asters Baneberry Bedstraws Black twinberry Choke cherry Creamy peavine Dwarf red raspberry Horsetails Oak fern One-sided wintergreen Red raspberry Saskatoon Soopolallie Tall bluebells Wild strawberry	Asters Bedstraws Choke cherry Common mitrewort Creamy peavine Creamy peavine Devil’s club Dwarf red raspberry Horsetails Oak fern Red raspberry Saskatoon Sitka alder Soopolallie Wild strawberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	SK639	JG154	C1-14a, DT020, F1-07, K1-01, LA028, N1-07, SK044, SK045, WB271	0107654, A1-06, BC006, BC380-1, D2-09, JG047, JG130, JG548, K1-14, L2-05, LS001, RP142, RP195, SK090, SK099, WB257, WB261, WB320, X1-03	0107656, LS036, LS113, WB220, WB333
Comments	Paper birch was commonly found within this unit, but devil's club and oak fern were rare. This unit was uncommon in the project area, and was generally found on gentle slopes or on cool aspects on well to moderately-well-drained sites.				

A.4.13 SC :ab: $At - Black twinberry (seral association) (05)

The draft seral guide (BC Ministry of Forests 2002) calls this unit the $At-Oak fern, but the 2003 provincial mapcodes list refers to it as the $At-Black twinberry. Typically, the seral 05 unit is found on gentle slopes with mesic to subhygric moisture regimes and medium to rich nutrient regimes, on fluvial or morainal parent materials (BC Ministry of Forests 2002).

Map Symbol with Mapped Site Modifiers:

SCg:ab - the ecosystem occurs on gullied terrain or in a gully

SCgk:ab - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SCgw: ab – the ecosystem occurs on gullied terrain or in a gully, on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

SCh:ab – the ecosystem occurs on hummocky terrain

SCk:ab - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SCs:ab – the ecosystem occurs on shallow soils

SCt:ab – the ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Common horsetail Canada goldenrod	Balsam poplar Trembling aspen Red-osier dogwood Prickly rose Bunchberry	Balsam poplar Red-osier dogwood Prickly rose Bunchberry	Balsam poplar Prickly rose Common snowberry Bunchberry	Balsam poplar Prickly rose Common snowberry Bunchberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Balsam poplar Trembling aspen Willows Narrow-leaved hawkweed	Balsam poplar Trembling aspen Willows	Willows Mountain alder Highbush-cranberry Black gooseberry Common snowberry Wild sarsaparilla Wild lily-of-the-valley Showy aster	White spruce Trembling aspen Paper birch Soopolallie Highbush-cranberry Red-osier dogwood Saskatoon Black gooseberry Red raspberry Choke cherry Common horsetails Creamy peavine Northern bedstraw Wild lily-of-the-valley One-sided wintergreen Pink wintergreen Baneberry	Trembling aspen Paper birch Willows Soopolallie Wild sarsaparilla Black gooseberry Highbush cranberry Creamy peavine Showy aster Red raspberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	KS027, LS069, SK046, SK073	LS065, SK603	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	Typic SC:ab does not occur in the project area. This seral ecosystem occurs closer to the Rocky Mountains. Plots allocated to this ecosystem did not “fit” into seral ecosystem /01 or /07. In the study area, the SC:ab was found primarily on moderately well-drained cool aspects with mesic to subhygric moisture regimes and medium to rich nutrient regimes. In the shrub stage, several weedy species have invaded.				

A.4.14 SC :ep: $Paper birch- red-osier dogwood (seral association) (05)

Typically moist to wet sites with coarse, unstable soils on cool aspect slopes (noncorrelated unit).

Map Symbol with Mapped Site Modifiers:

SCan:ep - the ecosystem occurs on an active floodplain and on a fan or cone

SCck:ep - the ecosystem occurs on coarse-textured soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SCg:ep - the ecosystem occurs on gullied terrain

SCgk:ep - the ecosystem occurs on gullied terrain on a cool aspect (aspect of 285-135^o on a slope that is 25-100%) **SCk:ep -** the ecosystem occurs on a cool aspect (aspect of 285-135^o on a slope that is 25-100%) **SCt:ep -** the ecosystem occurs on a terrace **SCw:ep -** the ecosystem occurs on a warm aspect (aspect of 135-285^o on a slope that is 25-100%)

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Alder Bluejoint reedgrass Paper birch	Paper birch Wild sarsaparilla	Alder Highbush cranberry Paper birch Prickly rose Red-osier dogwood	Bunchberry Dwarf red raspberry Highbush cranberry Paper birch Prickly rose Wild sarsaparilla	Bunchberry Dwarf red raspberry Highbush cranberry Paper birch Prickly rose Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Black gooseberry Fuzzy-spiked wildrye Red-osier dogwood Trembling aspen	One-sided wintergreen Prickly rose Trembling aspen White spruce	Black gooseberry Bunchberry White spruce	Balsam poplar Birch-leaved spirea Black gooseberry White spruce	Balsam poplar Birch-leaved spirea Black gooseberry White spruce
Plots	RP164, WB312	LA026, LS062	C1-09, M2-11, KS-25, L1-12a, LA230, WB209, WB334	M2-13a, WB259, WB319	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	This seral ecosystem was defined for the project and is based upon a similar unit defined by Lea and Lacelle (1989). The SC:ep was found mainly on rich, cool aspect, mid to lower slopes that were well-drained to moderately well-drained. Moisture regimes were mainly mesic to subhygric.				

A.4.15 SC:Sw - Currant - Bluebells (06)

Typically mesic to subhygric forest on gently sloping, moisture-receiving sites with deep, fine- textured soils

The $06 has been merged with the $01 based on advice from the regional ecologist (C. DeLong, pers. comm. 2006).

Map Symbol with Mapped Site Modifiers:

SCg - the ecosystem occurs on gullied terrain

SCh - the ecosystem occurs on hummocky terrain

SCk - the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

SCn - the ecosystem occurs on a fan or cone

SCt - the ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	Balsam poplar White spruce Willow	Balsam poplar Step moss White spruce Willow	Balsam poplar Black twinberry Prickly rose Red-osier dogwood Step moss Twinflower White spruce Willow	Balsam poplar Common snowberry Highbush cranberry Prickly rose Red-osier dogwood Red-stemmed feathermoss Step moss Twinflower White spruce Wild sarsaparilla	Balsam poplar White spruce Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Soopolallie Wild strawberry	Red-osier dogwood Trembling aspen	Black gooseberry Dwarf red raspberry One-sided wintergreen Trembling aspen	Dwarf red raspberry Paper birch Sweet-scented bedstraw Trembling aspen Wild strawberry	Prickly rose Wild lily-of-the-valley
Plots	JG619, SK012	JG609	B1-15, DT104, JG011, JG022, KS020, SK447, SK475, WB011	0107650, A2-15, LA033, M2-08, N1-10, SK015, SK094, SK096, SK098, WB270, WB317	SK007
Comments	The SC unit was usually found on gentle slopes with a medium nutrient regime and a mesic to subhygric moisture regime. Tall bluebells was rare in the study area.				

A.4.16 SH: Sw - Currant - Horsetail (07)

Typically subhygric to hygric forest on gentle slopes with deep, coarse to fine- textured soils. The SH normally has a medium to very rich nutrient regime and occurs on lacustrine or fluvial parent materials.

Map Symbol with Mapped Site Modifiers:

SHa– the ecosystem occurs on an active floodplain

SHat – the ecosystem occurs on an active floodplain on a terrace **SHg** – the ecosystem occurs on gullied terrain or in a gully **SHk** – the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) **SHp** – the ecosystem occurs on a peaty material **SHat** – the ecosystem occurs on an active floodplain on a terrace **SHt** – the ecosystem occurs on a terrace

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Balsam poplar Highbush cranberry Bunchberry Horsetails Red-osier dogwood Step moss Trembling aspen White spruce	Bunchberry Highbush cranberry Horsetails Prickly rose Red-osier dogwood White spruce	Balsam poplar Bunchberry Common snowberry Horsetails Prickly rose Red-osier dogwood White spruce	Balsam poplar Highbush cranberry Horsetails Prickly rose Red-osier dogwood White spruce	Balsam poplar Highbush cranberry Bunchberry Common snowberry Horsetails Prickly rose Red-osier dogwood White spruce Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Fireweed Peavines Prickly rose Red raspberry Twinflower Willows	Balsam poplar Black twinberry Black gooseberry Dwarf red raspberry Grasses Trembling aspen Twinflower Wild sarsaparilla	Black twinberry Dwarf red raspberry Highbush cranberry Peavines Twinflower	Asters Bedstraws Black twinberry Common snowberry Paper birch Prickly rose Red raspberry Red raspberry Twinflower Wild sarsaparilla	Bedstraws Black twinberry Common snowberry Mountain alder Paper birch Red raspberry Red swamp currant

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	LS002	BC002	CD201, KS012	0107633, 0107661, 0107670, E2-01, H2-17, KS010, KS028, LA042, LA183, LA234, LS108, LS119, N2-04, RP121, SK042, TKS010, WB228, WB336, X1-08	H2-08, LS030, RP147, SK591a, WB207, WB221, WB222
Comments	In the study area, the SH was typically found on level sites with subhygric to hygric moisture regimes and medium to rich nutrient regimes, on imperfectly to moderately well-drained soils. The SH was found mainly on fluvial parent materials, and was mapped on the lower slopes of the Peace River valley and on the islands in the river. The 07 is a rich forested site that produces large-diameter white spruce and balsam poplar if undisturbed. Fishers, marten, bats and cavity-nesting birds find shelter in cavities of large trees. The lush herb and shrub layer of the 07 make it an attractive foraging habitat for ungulates and bears.				

A.4.17 SH ac: $Ac - Cow parsnip (seral association) (07)

The SH:ac typically occurs on rich, lower slopes with medium to coarse-textured soils on fluvial, morainal or lacustrine parent materials with rich nutrient regimes and subhygric to hygric moisture regimes(BC Ministry of Forests 2002).

Map Symbol with Mapped Site Modifiers:

SHf:ac – the ecosystem occurs on fine textured soils

SHg:ac – the ecosystem occurs on gullied terrain or in a gully

SHgk:ac - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135o on a slope that is 25-100%)

SHh:ac – the ecosystem occurs on hummocky terrain

SHk:ac – the ecosystem occurs on a cool aspect (aspect of 285-135o on a slope that is 25-100%)

SHn:ac – the ecosystem occurs on a fan or cone

SHs:ac – the ecosystem occurs on shallow soil

SHt:ac – the ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Balsam poplar Grasses Horsetails Red raspberry Red-osier dogwood Willows	Balsam poplar Common horsetail Common snowberry Highbush cranberry	Balsam poplar Grasses Highbush cranberry Horsetails Prickly rose Red-osier dogwood Wild sarsaparilla	Alder Balsam poplar Common snowberry Horsetails Prickly rose Red raspberry Red-osier dogwood Wild sarsaparilla	Balsam poplar Prickly rose Highbush cranberry Dwarf red raspberry

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Alder Bedstraws Bluejoint reedgrass Canada goldenrod Common snowberry Prickly rose Star-flowered false Solomon's-seal Yarrow	Asters Bunchberry Paper birch Red raspberry Trembling aspen White spruce	Alder Bedstraws Coltsfoot Creamy peavine Dwarf red raspberry Paper birch Red raspberry Saskatoon White spruce Willows	Bedstraws Bluejoint reedgrass Dwarf red raspberry Grass spp. Highbush cranberry Star-flowered false Solomon’s-seal White spruce Wild lily-of-the-valley Willows	Bedstraws Bluejoint reedgrass Dwarf red raspberry Grass spp. Star-flowered false Solomon’s-seal White spruce Wild lily-of-the-valley

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	CD085, DT108, JG667, KS002, LA014, LA036, LS034, LS117, SK030, SK077, SK082, SK426, SK538, TKS009, WB013	SK085, SK470	B1-09, DT003, DT011, DT017, DT116, KS004, KS009, KS026, LA021, LA197, LA232, LS033, LS124, SK440, SK537, SK539, SK553, TKS004, WB211, WB215	0107646, 0107662, BC369, DT033, JG632, KS001, KS041, LA023, LA332, LA342, LS057, LS065, RP128, RP140, RP144, RP177, SK049, SK081, SK088, WB015, WB223, WB301	LS010

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	A typic SH :ac forest has an open tree canopy with a well-developed shrub and herb layers. Generally prickly rose, red-osier dogwood and horsetails or bluejoint are the dominant species. Bluejoint replaces common horsetail on drier sites. The moss and lichen cover is absent or poorly developed. Several herbs (coltsfoot, showy aster, wild strawberry, pink wintergreen, northern bedstraw) commonly occur with a cover less than 1%. In the study area, SH:ac sites were mainly found on level fluvial sites with subhygric to hygric moisture regimes, medium to rich nutrient regimes, and were imperfectly to moderately well-drained. The $07 is a rich forested site that produces large-diameter balsam poplar if undisturbed. Fishers, marten, bats, and cavity-nesting birds find shelter in cavities of large trees. The lush herb and shrub layer of the $07 make it an attractive foraging habitat for ungulates and bears. Plots originally classified as $07 that were on active floodplains were reassigned to the new 09 (Fm02) ecosystem, defined in 2006.				

A.4.18 SH ep: $Ep - (seral association) (07)

Typic SH:ep mainly occurs on level or toe sites with medium to coarse-textured soils.

Map Symbol with Mapped Site Modifiers:

SHa:ep – the ecosystem occurs on an active floodplain

SHt:ep – the ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Horsetails Paper birch Prickly rose Red raspberry	Horsetails Paper birch Prickly rose Red raspberry Saskatoon	Horsetails Paper birch Prickly rose Red raspberry Saskatoon	Paper birch Prickly rose Red raspberry Red-osier dogwood	Paper birch Prickly rose Red raspberry Red-osier dogwood
Associated Plant Species	Balsam poplar Trembling aspen Black gooseberry Red-osier dogwood Bluejoint reedgrass	Balsam poplar Highbush cranberry Pink wintergreen Sweet-scented bedstraw White spruce Wild lily-of-the-valley Wild sarsaparilla	Balsam poplar Highbush cranberry Pink wintergreen Sweet-scented bedstraw White spruce Wild lily-of-the-valley Wild sarsaparilla	Balsam poplar Sweet-scented bedstraw White spruce	Balsam poplar Highbush cranberry Pink wintergreen Sweet-scented bedstraw White spruce Wild lily-of-the-valley Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	LA185, LS016, LS044	LS041, WB208	No project plots; it is unlikely that the seral unit exists in structural stage 7.
Comments	The :ep seral association was defined in this project to represent seral 07 units where the balsam poplar had been replaced by paper birch as the dominant seral tree species. As in the more typical :ac unit, the :ep unit was found mainly on fluvial surficial materials on level, subhygric to hygric rich sites.				

A.4.19 BT: Sb - Labrador tea - Sphagnum (08)

Typically a forested organic wetland with deep, peaty soil. The BT unit normally has a poor to very poor nutrient regime and occurs on organic or fluvial parent materials (DeLong et al. 1990), often on cold sites underlain by permafrost. Assumed modifiers d, j, p.

Map Symbol with Mapped Site Modifiers:

BTg – the ecosystem occurs on gullied terrain or in a gully

BTh – the ecosystem occurs on hummocky terrain

BTs – the ecosystem occurs on shallow soils

BTt: The ecosystem occurs on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Black spruce Labrador tea Lingonberry Sphagnum mosses Tamarack Willows	Black spruce Black twinberry Labrador tea Red-stemmed feathermoss Step moss Tamarack	Black spruce Labrador tea Red-stemmed feathermoss Step moss Tamarack	Black spruce Tamarack Bunchberry Common mitrewort Horsetails Knight’s plume Labrador tea Sedges Step moss Willows	Black spruce Horsetails Knight’s plume Knight’s plume Labrador tea Step moss

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Black twinberry Bunchberry Cloudberry Common mitrewort Grey reindeer lichen Horsetails Paper birch Twinflower	Common mitrewort Dwarf red raspberry Horsetails Prickly rose Sedges Tall bluebells Willows	Bunchberry Common mitrewort False Solomon's-seal Horsetails Lingonberry Prickly rose	Black twinberry Dwarf red raspberry Large-leaved avens Prickly rose Soopolallie Tall bluebells Twinflower White spruce	Black twinberry Bunchberry Highbush cranberry Prickly rose Willows
Plots	BC387, JG014, LA242, LS121, SK359, SK459, SK467, WB238	JG046a, JG063, JG099, JG115, JG140, JG153, WB341	BC046, BC354-1, G1-10, JG013, JG040, JG129, LS126, SK451, WB036, WB308, WB309, WB327, WB337, WB404	A-SK338, BC379, JG055, JG108, WB305, WB318, WB411	No project plots; vegetation list prepared from other sources

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	This site was rarely mapped in the Peace River Valley but was common along the powerline route on the plateau. It was generally found on poorly drained, level to depressional sites (0-12% slope) on organic surficial materials, with subhygric to subhydric moisture regimes and poor to medium nutrient regimes.				

A.4.20 Fm02: Cottonwood-Spruce-Red-osier dogwood (09)

Typically a medium bench floodplain found on sandy or gravelly fluvial materials adjacent to streams and rivers. Typically an open canopy of P. balsamifera with a sparse to well-developed understorey, subject to short flood durations followed by continual subirrigation (MacKenzie and Moran 2004).This unit is a new for the BWBSmw1, and was defined by the MoF in 2006. No assumed modifiers are listed in BECdb (BC Ministry of Environment 2006) for this unit.

Map Symbol with Mapped Site Modifiers:

Fm02a - the ecosystem occurs on an active floodplain **Fm02ab** –the ecosystem occurs on a gravel bar on an active floodplain **Fmo2ac** - the ecosystem occurs on an active floodplain on coarse-textured soils **Fmo2af** - the ecosystem occurs on an active floodplain on fine-textured soils **Fm02ag** – the ecosystem occurs on an active floodplain on a terrace **Fm02ap** – the ecosystem occurs on an active floodplain on a terrace **Fm02at** – the ecosystem occurs on an active floodplain on a terrace

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Dominant Plant Species	American vetch Balsam poplar Bluejoint reedgrass Canada goldenrod Highbush cranberry Horsetails Prickly rose Red raspberry Red-osier dogwood Star-flowered false Solomon's-seal Sweet-scented bedstraw Yarrow	Balsam poplar Grasses Horsetails Mountain alder	Balsam poplar Horsetails Prickly rose Red-osier dogwood Grasses	Balsam poplar Bedstraws Common snowberry Horsetails Prickly rose Red raspberry Red-osier dogwood Star-flowered false Solomon's seal Wild sarsaparilla	Balsam poplar Horsetails Prickly rose Wild sarsaparilla

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Common snowberry Creamy peavine Northern gooseberry Wild sarsaparilla	Canada goldenrod Prickly rose Red-osier dogwood Sweet-scented bedstraw	Alder Canada goldenrod Red raspberry White spruce	Canada goldenrod Highbush cranberry White spruce Wild lily-of-the-valley	Alder Common snowberry Red-osier dogwood Sweet-scented bedstraw White spruce
Plots	BC005, Cloudy1, Cloudy2, Cloudy3, LA318, LA319, LA328, LS428, LS431, norma1, SK079, SK083, WB256, WB400, WB408, WB412	CD066, SK057	KS022, LA316, LS427, liza1, SK080, SK560, WB205	0107649, 0107668, farrah2, KS024, LA027, LS110, RP132, WB201, WB278, WB280, willy1	WB206

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Comments	The 09 unit was found on fluvial surficial materials with submesic to hygric moisture regimes and medium to rich nutrient regimes. Plots in this unit were mostly moderately well-drained to well-drained, and located adjacent to the Peace River or its tributaries. The 09 unit can produce large-diameter balsam poplar in its older structural stages. Large old balsam poplars provide valuable habitat for cavity-users such as bats, marten, fisher and a number of bird species.				

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

A.4.21 TS: Tamarack-Sedge (10)

Typically a bog on deep, peaty soils on gentle slopes and depressions, slightly richer than the 08 BT. Subhydric to hydric moisture regime. Defined in MacKenzie and Moran (2004).

Map Symbol with Mapped Site Modifiers:

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
TSh – the ecosystem occurs on hummocky terrain					

Structural Stage	2 - Herb	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Sedges	Tamarack Sedges Labrador tea Scrub birch	Tamarack Scrub birch Labrador tea Willows Bluejoint reedgrass Sedges	Tamarack Scrub birch Willows Sedges	Tamarack Sedges	Tamarack Sedges

Structural Stage	2 - Herb	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Tamarack Willows Arrow-leaved coltsfoot Red swamp currant Golden fuzzy fen moss	Black spruce Willows Arrow-leaved coltsfoot Bluejoint reedgrass Marsh cinquefoil Golden fuzzy fen moss	Peat mosses Arrow-leaved coltsfoot	Red-osier dogwood Black spruce Labrador tea	Black spruce Labrador tea White spruce	Black spruce Willows
Plots	No project plots; vegetation list prepared from other sources	0107666, BC356, BC363, BC420, JG075, RP164a, RP183, SK003, SK357, SK358, SK366, SK370, SK531, SK572, WB231, WB233, WB235, WB403	BC370, BC386	A-SK336, LA236, RP184	A-SK303, A-SK304, RP156, WB311	No project plots: plot data from other sources

Structural Stage	2 - Herb	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
	The 10 ecosystem (Wb06) was formerly known as the noncorrelated TS Lt-Sedge unit, and permission was obtained from the Regional Ecologist to continue to map this unit using the ‘TS’ code rather than ‘Wb06’ (C.DeLong, pers. comm. 2006). In the project area, this ecosystem was generally found on level to depressional sites with a subhygric to hydric moisture regime and a poor to medium nutrient regime.					

A.4.22 AS: SwAt - Soopolallie (00)

This unit is noncorrelated but has been described in the provincial mapcodes list as xeric to submesic aspen forest on warm aspect, significant slopes with deep, medium-textured soils. This ecosystem may be a reflection of a history of frequent fires on dry, warm slopes.

Map Symbol with Mapped Site Modifiers:

ASc – the ecosystem occurs on coarse-textured soils

ASck - the ecosystem occurs on coarse-textured soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

ASg - the ecosystem occurs on gullied terrain or in a gully

ASgh – the ecosystem occurs on gullied and hummocky terrain

ASgk – the ecosystem occurs on gullied terrain on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

ASgq – the ecosystem occurs on gullied terrain on very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%)

ASgs – the ecosystem occurs on gullied terrain on shallow soils

ASgz - the ecosystem occurs on gullied terrain or in a gully, on a very steep warm aspect (aspect of 135 - 285 ^{o} on a slope that is >100%)

ASh – the ecosystem occurs on hummocky terrain

ASj – the ecosystem occurs on gentle slopes (<25%)

ASk – the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

ASks - the ecosystem occurs on shallow soils on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

ASn - the ecosystem occurs on a fan or cone

ASr – the ecosystem occurs on ridged terrain or on a ridge crest

ASs – the ecosystem occurs on shallow soils

ASt – the ecosystem occurs on a terrace

ASz - the ecosystem occurs on a very steep warm aspect (aspect of135 - 285 ^{o} on a slope that is >100%)

Structural Stage	2 - Herb	3 - Shrub
Dominant Plant Species	Fuzzy-spiked wildrye Prickly rose	Saskatoon Trembling aspen Choke cherry Prickly rose Common snowberry Spreading dogbane
Associated Plant Species	Common snowberry Showy aster saskatoon	Showy aster Soopolallie
Plots	No project plots; plants extrapolated from other structural stages.	BC021, KS032, LA007,
Comments	The AS unit was mostly found on subxeric sites on moderately well-drained to well-drained sites. Although the provincial mapcodes list has this noncorrelated unit occurring in structural stages up to 7, the aspen in this unit are stunted due to lack of moisture. The Regional Ecologist approved mapping the AS unit up to structural stage 3 (C. DeLong, pers. comm. 2006). Aspen stands originally mapped as AS units in structural stages >3 were reclassified as AMw:ap or SWw:as ecosystems.	

A.5 **BWBSmw1- Nonforested Ecosystems**

A.5.1 WH: Willow-Horsetail-Sedge riparian wetland (00)

This noncorrelated unit is described in the provincial mapcodes list as a riparian wetland on coarse to fine-textured fluvial soils. Subhygric to hygric moisture regime.

Map Symbol with Mapped Site Modifiers:

WHa - the ecosystem occurs on an active floodplain

WHac - the ecosystem occurs on an active floodplain on coarse-textured soils

WHaf - the ecosystem occurs on an active floodplain on fine-textured soils

Structural Stage	2 - Herb	3 - Shrub	4 - Pole-sapling
Dominant Plant Species	Bluejoint reedgrass Horsetails Sedges Willows Common spike-rush	Alders Bluejoint reedgrass Grasses Horsetails Red-osier dogwood Sedges Common spike-rush Willows	Alders Horsetails Red raspberry Red-osier dogwood Pacific Willow Common spike-rush
Associated Plant Species	Large-leaved avens Alders	Balsam poplar Bedstraws Canada goldenrod Red raspberry Stinging nettle	Grasses Stinging nettle

Plots	LA167, KS040, RP126, RP141, SK407, WB272, WB273	0107660, A-SK332, BC003, JG002, JG688, KS011, KS021, LA181, LA334, LS107, LS111, LS420, LS422, LS429, LS437, SK029, SK064, SK536, TKS002, TKS008, WB200, WB210, WB217, WB277, WB279, WB281, WB401, WB402, WB405, WB406, WB407, WB415	KS003
Comments	This unit includes the Fl01 Alder-Horsetail Floodplain, Red-osier dogwood floodplain, At-Red-osier dogwood floodplain, Fl03 Willow-Red-osier dogwood –Horsetail floodplain, and Fl05 Willow-Bluejoint Floodplain units from MacKenzie and Moran (2004). Merging the non-forested floodplain units was appropriate for this scale of mapping. This is a diverse unit that is heavily influenced by flood regimes. Soils range from coarse gravel to fine silt, and vegetation varies from a near total cover of horsetails and sedges to dense willow thickets. The WH unit was mapped on level floodplains adjacent to the Peace River and its tributaries, and occasionally along some of the larger creeks. Moisture regimes were generally subhygric to hygric, and nutrient regimes ranged from poor to rich.		

A.5.2 SE: Sedge Wetland (00)

Typically a sedge wetland (marsh or fen) with a deep to thin peat layer. Description from MacKenzie and Moran (2004); includes Wm01 and Wf01. Medium to rich nutrient regime; hydric moisture regime. Assumed modifiers: d, j, p.

Map Symbol with Mapped Site Modifiers:

SEh - the ecosystem occurs on hummocky terrain

Structural Stage	2 - Herb	3 - Shrub
Dominant Plant Species	Beaked sedge Water sedge Marsh cinquefoil Bluejoint reedgrass	Scrub birch Sedges Grasses Peat mosses Willows Bluejoint reedgrass
Associated Plant Species	Willows Small bedstraw Foxtail barley Swamp horsetail Arrow-leaved coltsfoot Marsh skullcap Richardson's water moss Scrub birch	Bluegrass Marsh cinquefoil

Structural Stage	2 - Herb	3 - Shrub
Plots	LA 240, CD202, JG134, LA244b, LA247, LA249, LA250, LA313, LS008, LS058, RP117, RP118, RP125, RP139, RP153, RP182, WB224, WB226, WB229, WB240, 0107665, 0107667, 0107672, WB3013, 3-3002, BC050, BC367, BC412, BC413, BC414, BC416, BC440, BC444, BC461, JG003, SK350, SK352, SK360, SK361b, SK362, SK368, SK374, SK377, SK379, SK380, SK385, SK387, SK390, SK391, SK393, SK394, SK395, SK396, SK402, SK403, SK404, SK410, SK411, SK416, SK419, SK422, SK432, SK436, SK437, SK456, SK520	BC397, KS029, SK408, SK409, SK442
Comments	The SE wetland unit was mapped on level to depressional sites on organic surficial materials with subhygric to hydric moisture regimes. Nutrient regimes were generally medium to rich, and sites were poorly to very poorly drained. Sedge fens provide spring foraging habitat for bears and ungulates, and foraging sites for bats if open water is also present.	

A.5.3 WS: Willow Sedge Wetland (00)

Typically a swamp (noncorrelated unit); includes Ws03 and Ws06 in MacKenzie and Moran (2004).

Map Symbol with Mapped Site Modifiers:

WSh - the ecosystem occurs on hummocky terrain

Structural Stage	2 - Herb	3 - Shrub

Structural Stage	2 - Herb	3 - Shrub
Dominant Plant Species	Sedges Bluejoint wheatgrass Willows	Bluejoint wheatgrass Sedges Willows spp.
Associated Plant Species	Asters	Arrow-leaved coltsfoot Horsetails Marsh cinquefoil Red-osier dogwood Scrub birch Sedges White spruce
Plots	KS023, SK084, SK399, SK460, SK479	A-SK301, A-SK316, A-SK318, LA031, BC441, CD118, JG005, LA012, LA198, LS109, SK071, SK455, SK482, SK526, SK529, SK530

Structural Stage	2 - Herb	3 - Shrub
Comments	Within the project area, the WS unit was found on level to depressional sites with subhygric to subhydric moisture regimes and medium to rich nutrient regimes. Swamps provide spring forage for bears, deer and elk, nesting habitat for waterfowl and wetland birds, and moose foraging habitat.	

A.5.4 WW: Fuzzy-spiked wildrye – Wolf-willow (00)

Typically sparsely vegetated sites on warm aspects on deep, medium-textured soils (noncorrelated unit). Assumed modifiers: d, m, w. There are no tree or moss layers.

Map Symbol with Mapped Site Modifiers:

WWg - the ecosystem occurs on gullied terrain or in a gully

WWgh - the ecosystem occurs on gullied or hummocky terrain.

WWgk - the ecosystem occurs on gullied terrain on a cool aspect slope (aspect of 285-135^{o} on a slope that is 25-100%)

WWgq - the ecosystem occurs on gullied terrain or in a gully on a very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%)

WWgs - the ecosystem occurs on gullied terrain or in a gully

WWgz - the ecosystem occurs on gullied terrain or in a gully, on a very steep warm aspect (aspect of 135 - 285 ^{o} on a slope that is >100%)

WWh - the ecosystem occurs on hummocky terrain

WWj – the ecosystem occurs on a gentle slope (<25%)

WWjs – the ecosystem occurs on gentle slopes (<25%) on shallow soils

WWq –the ecosystem occurs on a very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%)

WWr - the ecosystem occurs on a ridge crest or on ridged terrain

WWs - the ecosystem occurs on shallow soils

WWsz- the ecosystem occurs on shallow soils on a very steep warm aspect (aspect of 135 - 285 ^{o} on a slope that is >100%)

WWt - the ecosystem occurs on a terrace

WWz - the ecosystem occurs on a very steep warm aspect (aspect of 135 - 285 o on a slope that is >100%)

Structural Stage	2 - Herb	3 - Shrub
Dominant Plant Species	Altai fescue Fuzzy-spiked wildrye Prairie sagewort Spreading needlegrass Stiff needlegrass Thickspike wheatgrass Blunt sedge False melic Columbia needlegrass	Altai fescue American vetch Columbia needlegrass Spreading needlegrass Common snowberry Stiff needlegrass Thickspike wheatgrass Fuzzy-spiked wildrye Prairie sagewort False melic Blunt sedge Prickly rose Saskatoon Wolf-willow (silverberry)
Associated Plant	Chokecherry Nodding onion	Asters Grasses

Species	Poaceae Prickly pear Saskatoon Snowberry Wheatgrass Yarrow	Trembling aspen Yarrow Spreading dogbane
Plots	0107634, 0107635, 0107644, LA029, LA034, RP108, RP110, RP111, RP114, RP115, RP133, RP151, RP159, RP160, RP174, RP175, RP178, RP179, RP196, RP199, SK543, WB242	JG539, RP135, SK050, SK101, SK544, TKS132, WB005, LA022
Comments	This unit is listed in the provincial mapcodes list as 'Fuzzy-spiked Wildrye-Coyote willow', however, coyote or sandbar willow *Salix exigua* is a species found in moist floodplain habitats, not steep dry warm aspects. We have used a revised version of the ecosystem unit name that includes wolf-willow (*Elaeagnus commutatus*) rather than coyote willow. Wolf-willow is also known as silverberry. This unit was mapped extensively on steep, south aspects on the north bank of the river, often complexed with AS and CB units. It was distinguished from the AS unit by its lack of tree species. The WW unit was found on mid to upper slopes, on xeric to subxeric sites with poor nutrient regimes, usually on colluvial surficial materials. Prickly pear cactus is often present in this unit at the east end of the study area (Clayhurst).	

A.6 SBSwk2 – Forested Ecosystems

A.6.1 SO: Sxw – Oak fern (01)

Typically a spruce forest on gentle slopes with deep, medium-textured soils.

Assumed modifiers: d, j, m.

Map Symbol with Mapped Site Modifiers:

SOg – the ecosystem occurs on gullied terrain or in a gully

SOgs – the ecosystem occurs on gullied terrain on shallow soils

SOs – the ecosystem occurs on shallow soils

SOr – the ecosystem occurs on ridged terrain

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Bunchberry Sitka mountain-ash Trembling aspen Douglas maple Paper birch Balsam poplar Trembling aspen Fireweed Birch-leaved spirea False Solomon's-seal Queen's cup	Hybrid white spruce Subalpine fir Trembling aspen Bunchberry Douglas maple False Solomon's-seal Black gooseberry Highbush cranberry Prickly rose Creamy peavine Black huckleberry Three-leaved foamflower Oak fern	Hybrid white spruce Subalpine fir False Solomon's-seal Black gooseberry Highbush cranberry Black huckleberry Three-leaved foamflower	Hybrid white spruce Subalpine fir Red-stemmed feathermoss Knight's plume Step moss Black huckleberry	Hybrid white spruce Subalpine fir Black huckleberry Thimbleberry Oak fern Bunchberry Five-leaved bramble Three-leaved foamflower Red-stemmed feathermoss Knight's plume Step moss

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Hybrid white spruce Subalpine fir Heart-leaved arnica Oak fern	Heart-leaved arnica Saskatoon Rattlesnake plantain Red-stemmed feathermoss Knight's plume Step moss	Devil's club Oak fern Trembling aspen Birch-leaved spirea Clasping twistedstalk Red-stemmed feathermoss Knight's plume Step moss	False Solomon's-seal Highbush cranberry Devil's club Clasping twistedstalk Black gooseberry	Douglas maple Sitka alder Highbush cranberry Palmate coltsfoot False Solomon's-seal Devil's club Black gooseberry One-sided wintergreen Clasping twistedstalk Stiff clubmoss
Plots	LAV1238, LAV1236	LAV1237, LAV240, LAV1240, LAV1239	LAV1235, LAG1223	LAG1224	No project plots; vegetation list prepared from other sources

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**
Comments	This ecosystem provides cover for ungulates, berry feeding habitat for bears, and migratory bird nesting habitat.				

A.6.2 LH: Pl – Huckleberry – Cladina (02)

Typically pine forest on gentle slopes to level sites; deep coarse-textured soils

Assumed modifiers: c, d, j.

Map Symbol with Mapped Site Modifiers:

LHrs – the ecosystem occurs on ridged terrain on shallow soils

LHsw – the ecosystem occurs on shallow soils on a warm aspect (aspect of 135-285 ^{o} on a slope that is 25 – 100%)

LHs – the ecosystem occurs on shallow soils

Structural Stage	**3 - Shrub**	**4 - Pole-sapling**	**5 - Young Forest**	**6 - Mature Forest**	**7 - Old Forest**

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Sitka alder Trembling aspen Black huckleberry Bunchberry	Lodgepole pine Subalpine fir Hybrid white spruce Trembling aspen Black huckleberry Bunchberry	Lodgepole pine Subalpine fir Hybrid white spruce Black huckleberry Bunchberry	Lodgepole pine Subalpine fir Hybrid white spruce Black huckleberry Bunchberry	Lodgepole pine Subalpine fir Hybrid white spruce Black huckleberry Bunchberry One-sided wintergreen Crane's-bill mosses
Associated Plant Species	Lodgepole pine Subalpine fir Hybrid white spruce	Red-stemmed feathermoss Green wintergreen	Red-stemmed feathermoss Green wintergreen	Red-stemmed feathermoss Green wintergreen	Sitka alder Cladina lichens Freckle pelt lichen Green wintergreen Leafy liverworts
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem provides cover for ungulates, berry feeding habitat for bears, and migratory bird nesting habitat.				

A.6.3 SC: Sxw – Huckleberry – Highbush cranberry (03)

Typically spruce forests on warm aspect slopes; deep, coarse-textured soil.

Assumed modifiers: c, d, w.

Map Symbol with Mapped Site Modifiers:

SCgs – the ecosystem occurs on gullied terrain on shallow soils

SCr – the ecosystem occurs on ridged terrain

SCrs – the ecosystem occurs on ridged terrain on shallow soils

SCs – the ecosystem occurs on shallow soils

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest

Structural Stage	**3 – Shrub**	**4 – Pole-sapling**	**5 – Young Forest**	**6 – Mature Forest**	**7 – Old Forest**
Dominant Plant Species	Black huckleberry Birch-leaved spirea Sitka alder Trembling aspen	Lodgepole pine Hybrid white spruce Subalpine fir Black huckleberry Birch-leaved spirea Trembling aspen	Lodgepole pine Hybrid white spruce Subalpine fir Black huckleberry Birch-leaved spirea Red-stemmed feathermoss Knight's plume	Lodgepole pine Hybrid white spruce Subalpine fir Black huckleberry Birch-leaved spirea Red-stemmed feathermoss Knight's plume	Lodgepole pine Hybrid white spruce Subalpine fir Black huckleberry Birch-leaved spirea Western mountain-ash Bunchberry Five-leaved bramble Twinflower Red-stemmed feathermoss Knight's plume

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Associated Plant Species	Lodgepole pine Hybrid white spruce Subalpine fir Red-stemmed feathermoss Knight's plume	Red-stemmed feathermoss Knight's plume False Solomon's-seal	Trembling aspen One-sided wintergreen Stiff clubmoss Heart-leaved arnica False Solomon's-seal	Trembling aspen One-sided wintergreen Stiff clubmoss Heart-leaved arnica False Solomon's-seal	One-sided wintergreen Heart-leaved arnica False Solomon's-seal Highbush cranberry Sitka alder Black gooseberry Stiff clubmoss
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem provides cover and food habitat for ungulates and bears, migratory bird nesting habitat and bat roosting habitat.				

A.6.4 BF: SbPl – Feathermoss (04)

Typically black spruce forest on gentle slopes, or aspects, with deep, coarse- textured soils; poor nutrient regime.

Assumed modifiers: c, d, j.

Map Symbol with Mapped Site Modifiers:

BFg – the ecosystem occurs on gullied terrain **or in a gully**

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Dominant Plant Species	Fireweed Bunchberry Sitka alder Trailing raspberry Prickly rose Western mountain-ash Trembling aspen	Hybrid white spruce Lodgepole pine Black spruce Fireweed Bunchberry Sitka alder Trailing raspberry Prickly rose Western mountain-ash Trembling aspen	Hybrid white spruce Lodgepole pine Black spruce Bunchberry Trailing raspberry Prickly rose Knight's plume Red-stemmed feathermoss	Hybrid white spruce Lodgepole pine Black spruce Bunchberry Trailing raspberry Prickly rose Knight's plume Red-stemmed feathermoss	Hybrid white spruce Lodgepole pine Black spruce Prickly rose Black huckleberry Labrador tea Bunchberry Twinflower Dwarf scouring-rush Common miterwort Oak fern Trailing raspberry Palmate coltsfoot Five-leaved bramble Knight's plume Red-stemmed feathermoss

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Associated Plant Species	Hybrid white spruce Lodgepole pine Black spruce Knight's plume Red-stemmed feathermoss	Knight's plume Red-stemmed feathermoss	Fireweed Sitka alder Western mountain-ash Trembling aspen	Fireweed Stiff clubmoss Freckle pelt lichen Sitka alder Western mountain-ash Trembling aspen	One-sided wintergreen Black gooseberry Highbush cranberry Fireweed Freckle pelt lichen Stiff clubmoss Sitka alder Western mountain-ash
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem provides cover for ungulates and bears, migratory bird nesting habitat and bat roosting habitat.				

A.6.5 SD: Sxw – Devil's club (05)

Typically spruce forest on moisture- receiving sites; gentle slope; deep, medium - textured soil.

Assumed modifiers: d, j, m.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Dominant Plant Species	Five-leaved bramble Three-leaved foamflower Queen's cup Thimbleberry Mountain sweet-cicely	Hybrid white spruce Subalpine fir Five-leaved bramble Three-leaved foamflower Queen's cup Thimbleberry Mountain sweet-cicely	Hybrid white spruce Subalpine fir Five-leaved bramble Three-leaved foamflower Queen's cup Knight's plume Red-stemmed feathermoss Leafy mosses	Hybrid white spruce Subalpine fir Five-leaved bramble Three-leaved foamflower Queen's cup Knight's plume Red-stemmed feathermoss Leafy mosses	Hybrid white spruce Subalpine fir Oak fern Five-leaved bramble Three-leaved foamflower Queen's cup Bunchberry False Solomon's-seal Trailing raspberry Knight's plume Red-stemmed feathermoss Leafy mosses

Structural Stage	**3 – Shrub**	**4 – Pole-sapling**	**5 – Young Forest**	**6 – Mature Forest**	**7 – Old Forest**
Associated Plant Species	Hybrid white spruce Subalpine fir Knight's plume Red-stemmed feathermoss Leafy mosses	Knight's plume Red-stemmed feathermoss Leafy mosses	Devil's club Stiff clubmoss Mountain sweet-cicely	Devil's club Stiff clubmoss Mountain sweet-cicely	Devil's club Stiff clubmoss Clasping twistedstalk Mountain sweet-cicely Thimbleberry Black gooseberry
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem provides cover for ungulates and bears, migratory bird nesting habitat and bat roosting habitat, as well as living habitat for western toads.				

A.6.6 SH: Sxw – Horsetail (06)

Typically moist spruce forests on level sites or depressions; coarse-textured soils.

Assumed modifiers: c, j.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest

Structural Stage	**3 – Shrub**	**4 – Pole-sapling**	**5 – Young Forest**	**6 – Mature Forest**	**7 – Old Forest**
Dominant Plant Species	Trembling aspen Black twinberry Step moss Leafy mosses Knight's plume Red-stemmed feathermoss Prickly rose Common horsetail Meadow horsetail Bunchberry Trailing raspberry Twinflower Common miterwort Oak fern Red-osier dogwood Black gooseberry	Hybrid white spruce Subalpine fir Black twinberry Prickly rose Common horsetail Meadow horsetail Bunchberry Trailing raspberry Twinflower Common miterwort Oak fern Red-osier dogwood Step moss Leafy mosses Knight's plume Red-stemmed feathermoss	Hybrid white spruce Subalpine fir Trembling aspen Prickly rose Red-osier dogwood Common horsetail Meadow horsetail Bunchberry Trailing raspberry Twinflower Common miterwort Oak fern Step moss Leafy mosses Knight's plume Red-stemmed feathermoss	Hybrid white spruce Subalpine fir Prickly rose Common horsetail Meadow horsetail Bunchberry Trailing raspberry Twinflower Common miterwort Oak fern Step moss Leafy mosses Knight's plume Red-stemmed feathermoss	Hybrid white spruce Subalpine fir Black twinberry Highbush cranberry Red-osier dogwood Prickly rose Common horsetail Meadow horsetail Bunchberry Trailing raspberry Twinflower Common miterwort Oak fern Five-leaved bramble Step moss Leafy mosses Knight's plume Red-stemmed feathermoss

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Associated Plant Species	Hybrid white spruce Subalpine fir	Tall bluebells Sweet-scented bedstraw Clasping twistedstalk False Solomon's-seal Cow-parsnip Black gooseberry	Black twinberry Tall bluebells Sweet-scented bedstraw Clasping twistedstalk False Solomon's-seal Cow-parsnip Black gooseberry	Trembling aspen Black twinberry Tall bluebells Sweet-scented bedstraw Clasping twistedstalk False Solomon's-seal Cow-parsnip Black gooseberry	Tall bluebells Sweet-scented bedstraw Clasping twistedstalk False Solomon's-seal Cow-parsnip Black gooseberry
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem may provide high-suitability food habitat for ungulates and bears, and living habitat for amphibians when close to waterbodies.				

A.6.7 Fm02: ActSw – Red-osier dogwood (Fm02)

Riparian community that occurs on sandy or gravelly fluvial materials adjacent to streams and rivers (MacKenzie and Moran 2004).

Assumed modifiers: none.

Map Symbol with Mapped Site Modifiers:

Fm02a – the ecosystem occurs on an active floodplain

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Dominant Plant Species	Red-osier dogwood Trembling aspen Balsam poplar Horsetails	Red-osier dogwood Balsam poplar Trembling aspen Horsetails	Red-osier dogwood Balsam poplar Trembling aspen Horsetails	Red-osier dogwood Balsam poplar Horsetails	Red-osier dogwood Balsam poplar Horsetails
Associated Plant Species	Prickly rose Balsam poplar Twinberry	Prickly rose Twinberry	Prickly rose Hybrid white spruce Twinberry	Prickly rose Hybrid white spruce Trembling aspen Twinberry	Prickly rose Hybrid white spruce Twinberry

Structural Stage	3 – Shrub	4 – Pole-sapling	5 – Young Forest	6 – Mature Forest	7 – Old Forest
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This ecosystem can provide high suitability food habitat for deer and moose, and early-season food habitat for bears. It is used as denning habitat by fishers and other furbearers and provides food for beaver when adjacent to suitable streams. Bats roost in live and dead balsam poplars and cavity-nesting birds are common.				

A.7 SBSwk2 – Nonforested Ecosystems

A.7.1 Wf02: Scrub birch – Water sedge (Wf02)

Typically a shrubby peatland with a fluctuating water table.

Assumed modifiers: none.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	2-Herb	3 - Shrub
Dominant Plant Species	Water sedge Sphagnum mosses	Scrub birch Water sedge Sphagnum mosses
Associated Plant Species	Scrub birch Bluejoint reedgrass Sitka sedge White bog orchid	Bog willow Barclay's willow Bluejoint reedgrass Sitka sedge White bog orchid

Structural Stage	**2-Herb**	**3 - Shrub**
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This sedge wetland provides early-season feeding habitat for bears, moose and deer, feeding habitat for bats and insectivorous birds, and breeding habitat for dragonflies and amphibians if open water is present.	

A.7.2 Wf13: Narrow-leaved cotton-grass – Shore sedge (Wf13)

Typically occurs in depressions or on seepage slopes where standing water is present for most of the growing season.

Assumed modifiers: none.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	**2-Herb**	**3 - Shrub**

A.7.2 Wf13: Narrow-leaved cotton-grass – Shore sedge (Wf13)

Typically occurs in depressions or on seepage slopes where standing water is present for most of the growing season.

Assumed modifiers: none.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	**2-Herb**	**3 - Shrub**
Dominant Plant Species	Shore sedge Water sedge Narrow-leaved cotton-grass white mtn. marsh-marigold Glow moss Peat mosses	Bog willow Barclay's willow Shore sedge Water sedge Narrow-leaved cotton-grass Glow moss Peat mosses

A.7.2 Wf13: Narrow-leaved cotton-grass – Shore sedge (Wf13)

Typically occurs in depressions or on seepage slopes where standing water is present for most of the growing season.

Assumed modifiers: none.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	2-Herb	3 - Shrub
Associated Plant Species	Bog willow Barclay's willow Poor sedge Sitka sedge Mountain hairgrass	white mtn. marsh-marigold Poor sedge Sitka sedge Mountain hairgrass
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This sedge wetland provides early-season feeding habitat for bears, moose and deer, feeding habitat for bats and insectivorous birds, and breeding habitat for dragonflies and amphibians if open water is present.	

A.7.3 AF: Alder – Fern avalanche track (00)

Dense shrub- or herb-dominated ecosystem in moderate to steep slopes where periodic snow and rock slides have prevented coniferous forest establishment.

Assumed modifiers: d.

Map Symbol with Mapped Site Modifiers:

AFs – the ecosystem occurs on shallow soils

Structural Stage	2-Herb	3 - Shrub
Dominant Plant Species	Lady fern Cow parsnip Sedges	Sitka alder Lady fern
Associated Plant Species	Sitka alder Stinging-nettle Sitka valerian Indian hellebore	Willows Indian hellebore Sitka valerian

Structural Stage	**2-Herb**	**3 - Shrub**
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	Avalanche tracks may provide foraging habitat for bears and ungulates.	

A.8 ESSFmv2 – Forested Ecosystems

A.8.1 FR: Bl – Rhododendron – Feathermoss (01)

Typically a subalpine fir forest on gentle slopes with medium-textured soils.

Assumed modifiers: d, j, m.

Map Symbol with Mapped Site Modifiers:

FRs – the ecosystem occurs on shallow soils

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	White-flowered rhododendron Black huckleberry Bunchberry Black gooseberry	Engelmann spruce Subalpine fir White-flowered rhododendron Black huckleberry Bunchberry Knight's plume Red-stemmed feathermoss Step moss	Engelmann spruce Subalpine fir White-flowered rhododendron Black huckleberry Bunchberry Knight's plume Red-stemmed feathermoss Step moss	Engelmann spruce Subalpine fir White-flowered rhododendron Black huckleberry Bunchberry Knight's plume Red-stemmed feathermoss Step moss	Engelmann spruce Subalpine fir White-flowered rhododendron Black huckleberry Bunchberry Five-leaved bramble Twinflower Knight's plume Red-stemmed feathermoss Step moss
Associated Plant Species	Engelmann spruce Subalpine fir Knight's plume Red-stemmed feathermoss Step moss	Black gooseberry One-sided wintergreen	Black gooseberry Stiff clubmoss One-sided wintergreen Heart-leaved arnica	Black gooseberry Stiff clubmoss One-sided wintergreen Heart-leaved arnica	Black gooseberry Stiff clubmoss One-sided wintergreen Heart-leaved arnica

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This mesic forest provides growing-season cover for ungulates and bears.				

A.8.2 FL: Bl – Lingonberry (02)

Typically subalpine fir forest on deep, coarse-textured soils; gentle slopes.

Assumed modifiers: c, d, j.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Dominant Plant Species	Black huckleberry White-flowered rhododendron Mountain alder Sitka alder Bunchberry	Lodgepole pine Engelmann spruce Black huckleberry White-flowered rhododendron Red-stemmed feathermoss Knight's plume Mountain alder Sitka alder Bunchberry	Lodgepole pine Engelmann spruce Black huckleberry White-flowered rhododendron Bunchberry Red-stemmed feathermoss Knight's plume	Lodgepole pine Engelmann spruce Black huckleberry White-flowered rhododendron Lingonberry Bunchberry Red-stemmed feathermoss Knight's plume	Lodgepole pine Engelmann spruce Black huckleberry White-flowered rhododendron Bunchberry Twinflower Lingonberry Red-stemmed feathermoss Knight's plume Dicranum mosses Step moss

Structural Stage	3 - Shrub	4 - Pole-sapling	5 - Young Forest	6 - Mature Forest	7 - Old Forest
Associated Plant Species	Lodgepole pine Engelmann spruce Red-stemmed feathermoss Knight's plume	One-sided wintergreen Lingonberry	Mountain alder Sitka alder One-sided wintergreen Lingonberry	Mountain alder Sitka alder One-sided wintergreen Cladonia lichens Peltigera lichens	Mountain alder Sitka alder One-sided wintergreen Cladonia lichens Peltigera lichens
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	This dry forest unit provides growing-season cover for ungulates and bears and nesting habitat for a variety of birds.				

A.9 ESSFmv2 – NonForested Ecosystems

A.9.1 AF: Alder – Fern avalanche track (00)

Dense shrub- or herb-dominated ecosystem in moderate to steep slopes where periodic snow and rock slides have prevented coniferous forest establishment.

Assumed modifiers: d.

Map Symbol with Mapped Site Modifiers:

None

Structural Stage	2-Herb	3 - Shrub
Dominant Plant Species	Lady fern Sitka valerian Cow parsnip Sedges	Sitka alder Lady fern Sitka valerian
Associated Plant Species	Sitka alder Stinging-nettle Indian hellebore	Willows Indian hellebore

Structural Stage	2-Herb	3 - Shrub
Plots	No project plots; vegetation list prepared from other sources	No project plots; vegetation list prepared from other sources
Comments	Avalanche tracks can provide high-quality growing season food habitat for bears	

A.10 Nonvegetated/Sparsely Vegetated/Anthropogenic Units

A.10.1 CB: Cutbank (00)

A nonvegetated or sparsely vegetated part of a road corridor or river course situated upslope of the road or river, which is created by excavation and/or erosion of the hillside.

Map Symbol with Mapped Site Modifiers:

CBg - the ecosystem occurs on gullied terrain or in a gully

CBgk - the ecosystem occurs on gullied terrain or in a gully, on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

CBgq - the ecosystem occurs on gullied terrain or in a gully, on a very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%)

CBgw - the ecosystem occurs on gullied terrain or in a gully, on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)

CBgz - the ecosystem occurs on gullied terrain or in a gully, on a very steep warm aspect (aspect of 135 - 285^{o} on a slope that is >100%)

CBh – the ecosystem occurs on hummocky terrain

CBk – the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%)

CBks – the ecosystem occurs on a cool aspect (aspect of 285-135^{o} on a slope that is 25-100%) and on shallow soils

CBs - the ecosystem occurs on shallow soils

CBsw - the ecosystem occurs on shallow soils on a warm aspect (aspect of135 - 285^{o} on a slope that is 25-100%)

CBw - the ecosystem occurs on a warm aspect (aspect of 135 - 285^{o} on a slope that is 25-100%)

CBq - the ecosystem occurs on a very steep cool aspect (aspect of 285-135^{o} on a slope that is >100%)

CBz - the ecosystem occurs on a very steep warm aspect (aspect of 135 - 285^{o} on a slope that is >100%)

Structural Stage	1 - Nonvegetated/sparse
Dominant Plant Species	none
Associated Plant Species	Wolf-willow (silverberry) Yarrow Sweet clover

Structural Stage	1 - Nonvegetated/sparse
	Perennial sow-thistle Long-leaved mugwort Spreading dogbane Paper birch Pasture sage
Plots	WB243, RP137
Comments	This unit was mapped extensively on steep slopes north and south of the river. Due to its steepness, instability and lack of vegetation it has little value for most wildlife species. However, some species such as Bank Swallows and Belted Kingfishers may use it for nesting, and bats may roost in crevices. If adjacent to flowing water, cutbanks may be used for bank dens by beavers.

A.10.2 CF: Cultivated Field (00)

A flat or gently rolling, nonforested open area subject to human agricultural practices. This unit was mapped extensively both north and south of the river.

Map Symbol with Mapped Site Modifiers: CFj

CFn - the ecosystem occurs on a fan or con

CFs - the ecosystem occurs on shallow soils

CFt - the ecosystem occurs on a terrace

Comments: Cultivated fields may be valuable as foraging habitat for ungulates, especially deer and elk. Within the study area, the CF unit was mapped on sites that had undergone human intervention for agricultural practices, including crops and cattle grazing. Those practices included draining, seeding, plowing and clearing. It did not include sites where periodic brushing was used to maintain early seral stages for non-agricultural purposes (e.g. transmission line ROWs).

A.10.3 ES: Exposed Soil (00)

Map Symbol with Mapped Site Modifiers:

ESg -the ecosystem occurs on gullied terrain or in a gully

ESgk -the ecosystem occurs on gullied terrain or in a gully and on a steep cool aspect (aspect of 285-135^o on a slope that is 25-100%)

ESk -the ecosystem occurs on a steep cool aspect (aspect of 285-135^o on a slope that is 25-100%)

ESn - the ecosystem occurs on a fan or cone

ESt - the ecosystem occurs on a terrace

ESw - the ecosystem occurs on a warm aspect

Structural Stage	**1 - Nonvegetated/sparse**
Dominant Plant Species	none
Associated Plant Species	Balsam poplar Willow Sweet clover
Plots	No project plots; vegetation list prepared from other sources
Comments	Exposed soil has little wildlife value.

A.10.4 GB: Gravel Bar (00)

An elongated landform generated by waves and currents and usually running parallel to the shore. It is composed of unconsolidated small rounded cobbles, pebbles, stones and sand.

Map Symbol with Mapped Site Modifiers: none

Structural Stage	**1 - Nonvegetated/sparse**
Dominant Plant Species	none
Associated Plant Species	Balsam poplar

	Willow Alfalfa Grasses Meadow arnica Asters Sweet clover
Plots	RP124
Comments	Gravel bars may be used as loafing sites for waterfowl and foraging areas for shorebirds, and may assist terrestrial wildlife species in crossing the river

A.10.5 LA: Lake (00)

A naturally occurring static body of water, greater than 2 m deep in some portion. The boundary for the lake is the natural high water mark.

Map Symbol with Mapped Site Modifiers: none

Comments: Lakes may provide foraging and nesting habitat for waterfowl, and foraging habitat for moose, bats and furbearers such as mink and beaver. Lakes were rarely mapped in the project area. Smaller bodies of water (PD and OW) were more common.

A.10.6 GP: Gravel Pit (00)

An area used for the extraction of sand and gravel.

Map Symbol with Mapped Site Modifiers: none

Comments: Little value for most wildlife. Bank Swallows may nest in steep walls of gravel pits.

A.10.7 MI: Mine (00)

An unvegetated area used for the extraction of mineral ore and other materials.

Map Symbol with Mapped Site Modifiers: none

Comments: Mine sites have little wildlife value. Cliff-nesting birds may occasionally nest on steep-sided pit walls of inactive pit mines.

A.10.8 OW: Shallow open water (00)

A wetland composed of permanent shallow open water and lacking extensive emergent plant cover. The water is less than 2 m deep.

Map Symbol with Mapped Site Modifiers: none

Comments: Open water wetlands may provide foraging and nesting habitat for waterfowl, amphibian breeding habitat, and foraging habitat for moose, bats and furbearers such as mink and beaver.

A.10.9 PD: Pond (00)

A small body of water greater than 2 m deep, but not large enough to be classified as a lake

Map Symbol with Mapped Site Modifiers: none

Comments: Ponds may provide foraging and nesting habitat for waterfowl, amphibian breeding habitat and foraging habitat for moose, bats and furbearers such as mink and beaver.

A.10.10 RE: Reservoir (00)

An artificial basin created by the impoundment of water behind a human-made structure such as a dam, berm, dyke or wall.

Map Symbol with Mapped Site Modifiers: none

Comments: Reservoirs provide habitat for waterfowl, amphibians and aquatic mammals such as otters and beaver. Bats and other aerial insectivores forage over the water.

A.10.11 RI: River (00)

A watercourse formed when water flows between continuous, definable banks.

Map Symbol with Mapped Site Modifiers: none

Comments: the Peace, Pine, Halfway and Moberly rivers provide security and foraging habitat for waterfowl and beaver, and foraging habitat for mink, bats, and fish-eating birds such as kingfishers. Amphibians use river backchannels for living and breeding.

A.10.12 RN: Railway surface (00)

A roadbed with fixed rails for possibly single or multiple rail lines.

Map Symbol with Mapped Site Modifiers: none

Comments: little value for wildlife

A.10.13 RO: Bedrock (00)

A gentle to steep bedrock escarpment or outcropping, with little soil development and sparse vegetative cover.

Map Symbol with Mapped Site Modifiers: none

Comments: Small mammals and bats may find den and roost sites in the crevices of rocky outcrops.

A.10.14 RY: Reclaimed Mine (00)

A mined area that has plant communities composed of a mixture of agronomic or native grasses, forbs, and shrubs.

Map Symbol with Mapped Site Modifiers: none

Comments: This unit was used to map a reclaimed garbage dump.

A.10.15 RZ: Road Surface (00)

An area cleared and compacted for the purpose of transporting goods and services by vehicles.

Map Symbol with Mapped Site Modifiers: none

Comments: Roads have little wildlife value, and are a source of mortality to most wildlife. Ungulates may travel on plowed roads when the snow is deep elsewhere.

A.10.16 RW: Rural (00)

Any area in which residences and other human developments are scattered and intermingled with forest, range, farmland and native vegetation and cultivated crops.

Map Symbol with Mapped Site Modifiers: none

Comments: Few wildlife species will use habitat in close proximity to human activities. Ungulates such as deer and elk may occasionally forage on crops, haystacks and ornamental plants. Buildings may provide roost sites for bats. Passerine birds may forage in gardens and feed at bird feeders, especially during the winter months, and may nest in or on buildings or ornamental plants.

A.10.17 UR: Urban/Suburban (00)

An area in which residences and other human developments form an almost continuous covering of the landscape. These areas include cities and towns, subdivisions, commercial and industrial parks, and similar developments.

Map Symbol with Mapped Site Modifiers: none

Comments: Urban/suburban areas have little value for most wildlife. However, buildings may provide roost sites for bats. Passerine birds may forage in gardens and feed at bird feeders, especially during the winter months.

A.11 Citations

A.11.1 References

BC Ministry of Environment. 2006. Provincial Site Series & Map Code List (database). Available at: http://www.env.gov.bc.ca/ecology/tem/list.html.

BC Ministry of Forests. 2002. Draft Field Guide Insert for Site Identification of Seral *Populus* Units of the Northeast Portion of the Prince George Forest Region.

DeLong, C. 2004. A Field Guide to the Site Identification and Interpretation for the North Central Portion of the Northern Interior Forest Region. Land Management Handbook 54. BC Ministry of Forests.

DeLong, C., A. MacKinnonn and L. Jang. 1990. A Field Guide for Identification and Interpretation of Ecosystems of the Northeast Portion of the Prince George Forest Region. Land Management Handbook 22. BC Ministry of Forests.

DeLong, C., D. Tanner and M.J. Jull. 1994. A Field Guide for Site Identification and Interpretation for the Northern Rockies Portion of the Prince George Forest Region. Land Management Handbook 29. BC Ministry of Forests.

Demarchi, D.A. 2011. The British Columbia Ecoregion Classification 3rd Edition. Ecosystem Information Section, BC Ministry of Environment, Victoria, BC. Available at: http://www.env.gov.bc.ca/ecology/ecoregions/index.html.

Farstad, L., T.M. Lord, A.J. Green and H.J. Hortie. 1965. Soil Survey of the Peace River Area in British Columbia. Report No. 8. British Columbia Soil Survey. University of BC, BC Dept. of Agriculture and Research Branch, Canada Dept. of Agriculture.

Lea, E.C. and L.E.H. Lacelle. 1989. Biophysical Habitat Units of the Lower Halfway Study Area: Expanded Legend. BC Ministry of Environment, Lands and Parks, Victoria, BC.

MacKenzie, W. and J.R. Moran. 2004. Wetlands of British Columbia: A Guide to Identification. Land Management Handbook 52. Research Branch, BC Ministry of Forests, Victoria, BC. Available at: http://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh52.htm.

A.11.2 Personal Communications

DeLong, C. Regional Ecologist. Ministry of Forests and Range, Northern Interior Region, Prince George. Email December 2006. *Carex torreyi* (Torrey's sedge)

Appendix E. Dam Site Area A: Constructed Wetland Guidelines

Site C Clean Energy Project

Site C Replacement Wetland Site: Reclamation Area – Dam Site Area A Constructed Wetland Guidelines

Doc 06-142

(Draft 2)

Prepared for BC Hydro Site C Project by

Ducks Unlimited Canada

December 2014

Site C Clean Energy Project

Site C Replacement Wetland Site: Reclamation Area – Dam Site Area A Constructed Wetland Guidelines

Prepared for BC Hydro
By
Ducks Unlimited Canada
November, 2014

Lead Authors:	**Darryl Kroeker** **Paul Usher**
Task Lead Review by:	______________________
Accepted by:	______________________

INTRODUCTION

One of the objectives of wetland creation is to mimic as closely as possible the form, function, and values of natural wetlands. In a natural wetland, these properties develop and evolve over centuries. In a constructed wetland, the basic building blocks or processes are incorporated into the site to support the completion and complexity of these processes over time to replicate, as close as we can, those found in a natural wetland.

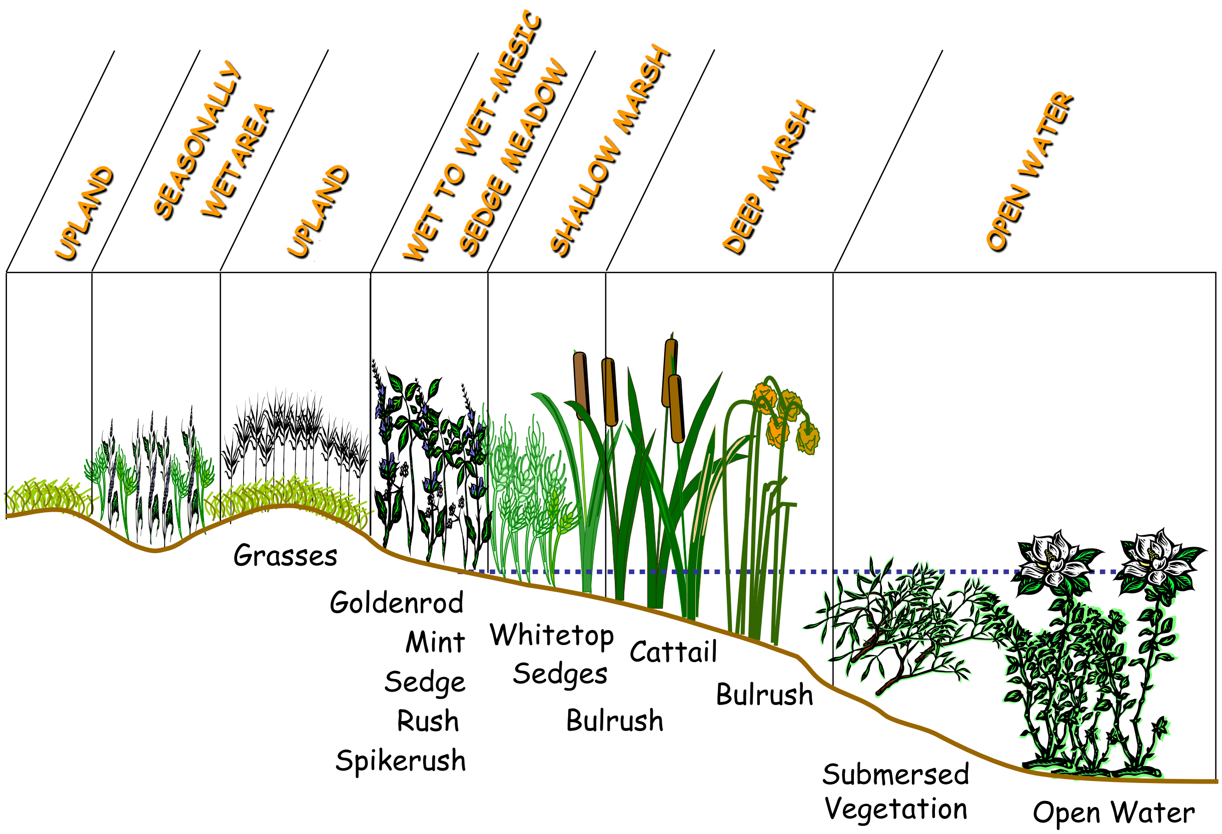


Figure 1. A typical wetland shoreline profile, transitioning from upland (grasses) through a riparian zone (wet meadow), shallow and deep marsh, to open water.

The fundamental shoreline features of marsh wetlands are illustrated in **Figure 1**. A relatively level and flat upland area gives way to the riparian zone, often referred to as a green zone because of the lush vegetation, which progresses via a low sloping shoreline to progressively deeper marsh habitats with open water in the deepest zones. This report will review the components that contribute these features, applying them to the Area A Borrow Site located next to the Site C dam, referencing the information Ducks Unlimited Canada received on the characteristics of the borrow site. Given the complexities and uncertainties of the construction stages and timelines, it is impossible to develop a detailed process and schedule to go from a borrow area to a wetland. Rather, this report will outline the features that need to be included in the final product, with some suggestions on how to achieve them. This report is intended as a guide to contractors tasked with remediating the Area A borrow area into a functioning created wetland. This report is the second component of deliverables identified in **Priority 1** of the Replacement Wetland Site Program, as set out in the revised Site C Clean Energy Project Vegetation and Wildlife Management and Monitoring Plan (draft October 17, 2014).

Depending upon the final development approach for the borrow area, the area of created wetland that may result from Area A is estimated to be between 280 ha to 1,300 ha, depending upon available resources. The anticipated wetland functions that Area A would support include habitat for migratory birds (nesting, brood-rearing, feeding and migration), rare plants, bats (foraging and roosting), amphibians (feeding, breeding and hibernation). It is also expected that this areas will be available for use by Aboriginal Groups for traditional purposes.

WATER DEPTH

The majority (50% or more) of the created wetland should be 2.5m or less in depth. This relatively shallow depth facilitates light penetration to the bottom, promoting the growth of submerged vegetation essential to processing nutrients as well as providing structure, food and cover for algae, bacteria, invertebrates, and amphibians. The relatively shallow depth also precludes overwintering of any fish that may accidentally enter the wetland. Fish compete with waterbirds and amphibians for the nutrient rich invertebrate food supply. Fish also predate upon amphibians at all life stages. Given the objective is to provide wetland habitat and not fish habitat, fish are an unwelcome component in this ecosystem.

Some areas of the created wetland can be deeper than 2.5m but generally less than 50% of the total area. These deeper areas become refuges during periods of prolonged drought and low water.

HYDROLOGY

A reliable water supply is required to fill or top up the wetland every spring. Water sources could include surface runoff, groundwater and/or a supply from the adjacent Peace River or Site C Reservoir. Soil test information supplied by BC Hydro indicates the presence of ground water above a bedrock layer at Area

A, suggesting that ground water is a viable potential source. Several ravines come off the bench south of and above Area A suggesting periodic surface water flow. When the final footprint size and location of the created wetland are known, calculations could be made to determine whether the watershed is of sufficient size to be the sole water supply. The third option would be to divert a sufficient amount of water from the Peace River or the Site C reservoir to fill and manage water levels. In considering a diversion from the reservoir, it is absolutely critical that any fish, regardless of size, be excluded from the created wetland.

Annual water level fluctuations within the created wetland of 0.30-0.50m are desirable to promote and maintain vegetation in the riparian and shallow marsh zone. Periodic inundation of the riparian zone is important to maintain plant diversity and to prevent the invasion of upland grasses, forbs and shrubs while promoting growing conditions suitable for water tolerant shrubs (e.g. willows and dogwood), sedges, cattails, and bulrushes. However, timing of water level fluctuations is critical to the created wetland's success, mimicking natural seasonal water level changes. Flooding or surcharges can occur only in spring, followed by generally stable or gradually receding water levels during the course of summer. Fall would typically see some recharge of basin water levels resulting from the onset of fall rains combined with reduced evapotranspiration. Minor fluctuations (e.g. +/- 0.10m) during the summer are acceptable. Significant increases of water levels run the risk of flooding nests of ground-nesting birds, birds using floating nests, and those birds that nest in vegetation close to the water's surface. Prolonged flooding outside of spring also runs the risk of killing plants unable to tolerate high water levels, leaving areas open to weed invasion.

It is important to the created wetland's success that water used to fill the basin is allowed to stay there and become "stagnant". This allows the development of a complex ecology in the water column and around submerged and emergent (cattails, sedges, bulrushes) vegetation. Flushing the wetland with a continuous flow of water through the system is likely to result in a more riverine type of ecosystem, depending upon the rate and volume of flow. Continuous or regular flushing results in a less productive ecosystem, effectively diluting its productivity.

SHORELINE CONFIGURATION

The shoreline of the created wetland is to be highly irregular when completed, i.e. with bays or inlets and peninsulas or points. This is important for 2 main reasons. The first reason is that it maximizes the amount of shoreline in relation to the area of open water. This interface between the riparian zone and the shallow marsh zone is the most productive part of the wetland. The second reason for an irregular shoreline is that it creates an abundance of isolated bays that are important to pairing and breeding waterfowl (ducks and geese). These birds prefer to establish breeding territories that are visually isolated from others of the same species. Therefore, a wetland with an irregular shoreline accommodates a greater number of breeding waterfowl than a wetland with a straight shoreline.

SHORELINE PROFILE

The finished shoreline of the created wetland will have slopes varying from 7:1 to as flat as 20:1 (i.e. 1m change in elevation over 7m to 20m of horizontal run respectively). This is essential to create a wide zone of wetland vegetation alongside a wide riparian zone. These slopes should extend above and below the water line. To emphasize again, these shallow flooded areas are the most productive are the most productive and active zone of the wetland, and the associated riparian zone benefits from the abundant water supply to produce lush vegetation for riparian wildlife.

SUBSTRATE

The constructed wetland must; 1) hold water and 2) grow vegetation.

1. To achieve the first objective, the bottom of the wetland must be impervious to water loss. A layer of clay placed overtop of more pervious substrate could be used to achieve this. Given that the borrow Area A is being excavated for gravel, a liner such as clay, would be required to prevent continuous water loss. The exception to this scenario would be if the created wetland was excavated to intercept the water table for its water supply. Similar to an oxbow along a river, the water level in the created wetland would fluctuate as the level of the water table changes. This variability could affect the success of establishing and maintaining riparian and shallow marsh vegetation.
2. While clay is useful to seal the wetland basin, it provides a poor substrate for vegetation growth. A layer of approximately 0.10m of topsoil is to be placed overtop of any stripped areas, sloped shorelines above and below the water line, and across the bottom of the created wetland to the maximum extent possible. Topsoil stripped prior to construction can be used and/or soils collected from areas scheduled to be inundated by the Site C reservoir.

CONSTRUCTED ISLANDS

Constructed islands are an option that provides relatively secure habitat for ground-nesting birds. Irregular shaped islands can be constructed with 4:1 shoreline slopes with topsoil to be placed on the tops and slopes to below the water line. The longevity of islands can be enhanced by locating them towards the western and southern parts of the Area A constructed wetland, providing them with some protection from wind erosion. Islands can be a challenge to access for weed control so it is important to vegetate them well and early to eliminate the potential of noxious weed establishment. This is easiest to accomplish while conditions are still dry. Vegetation establishment must extend to below the water line to provide erosion protection to the slopes.

REVEGETATION

The Peace River Forage Association has conducted several trials to evaluate the effectiveness of using different species of grasses and forbs to revegetate disturbed areas. Native grasses such as slender wheatgrass and domestic plants such as meadow brome, creeping red fescue, and alfalfa showed generally good germination and growth when seeded on spoil piles and pipeline right-of-ways. These plants and others, depending upon specific objectives and seed availability, would be appropriate to seed on upland areas surrounding the created wetland.

The riparian zone (the area near the water's edge) can be planted with willows and dogwood, plants or cuttings, creating habitat for riparian songbirds and moose while protecting shorelines from erosion due to wind. Plugs of sedges, cattails and bulrush can be collected by hand or using an excavator from nearby wetlands and planted in the shallow marsh zone to begin the establishment of a well-vegetated shoreline. Sedges would be planted in the shallowest areas while cattails and bulrushes would be planted in water depths of about 0.30m. It is extremely important that no invasive species are introduced along with material from donor sites.

As already mentioned, any islands should be seeded with a mix of upland grasses and legumes as soon as possible after construction to prevent weed establishment. Shrubs (willows and dogwood) can be included along the shoreline but trees should be avoided. Trees should not be planted in proximity of the clay liner due to the risk of perforation by the roots. Mature trees also become convenient perches for hawks and owls hunting for meals in the wetland. Seeding and planting is most easily done while construction conditions are dry as access to islands becomes difficult once the created wetland is flooded.

Spring is generally considered the most successful time of year for planting shrubs and for seeding grasses and forbs. Grasses and forbs could also be seeded in August, if moisture conditions are adequate, or overtop of light snow cover in early winter. Seeding rates of 20lbs/ac (20kg/ha) are generally used for good growing conditions (spring). Seeding rates are often doubled when conditions are less ideal (late summer and winter).

If the topsoil used to dress the slopes and shorelines of the created wetland came from a wetland area that was suitable as it was scheduled to be flooded under the Site C reservoir, the soil would likely contain an abundance of seed from those native plants. Upon exposure to air and shallow flooding, it is quite possible that revegetation would occur naturally from this seed source.

AREA A BORROW AREA

The characteristics of Area A provided to Ducks Unlimited Canada by BC Hydro include a borrow area that is estimated to cover 280 ha with a depth of 6 to 17 m and a projected volume of 20 million cubic meters. The footprint of Area A is constrained by transmission lines, roads, the Peace River, and a substation. Based upon limited information regarding the actual construction of the Site C dam, there appear to be 3 general concepts to achieving a created wetland at the conclusion of construction.

1. The first concept assumes that the footprint of Area A is limited to the footprint on the existing plans and that the constructed wetland will blend into the surrounding landscape (i.e. the constructed wetland is not simply a 2m deep pond at the bottom of a deep hole). To achieve a created wetland of approximately 280 ha in size with an average depth of 1.5m, up to 16 million cubic meters of material, including fill, clay liner, and topsoil, would have to be sourced to fill the bottom of the pit and bring it to within a few meters of ground. This volume could be reduced with the strategic placement of benches or terraces along the shoreline. All materials are to be placed and shaped as outlined in this guideline report.
2. The second concept assumes the footprint of the created wetland can expand to an area as large as necessary. Assuming the necessary materials are available immediately surrounding Area A, these materials could be excavated and used to fill the pit to the appropriate depth. At an average wetland depth of 1.5m, the resulting created wetland would be approximately 1,300 ha in size. All materials are to be placed and shaped as outlined in this guideline report.
3. The third concept is a compromise between the previous two. The footprint of the created wetland would be as large as surrounding infrastructure requirements limit it, with the difference in materials required to fill the pit coming from elsewhere. The resulting footprint, obviously, would be somewhere between 280 and 1,300 ha.

SUMMARY

This report identifies key components to be included in the conversion of the Site C Area A borrow pit to a created wetland:

1) At least 50% of the created wetland to be 2.5m or less in depth.
2) An adequate water supply could come from surface runoff, groundwater or the Site C reservoir.
3) Hydrology of the created wetland mimics a natural wetland regime: minor flooding in spring to fill the wetland, stable or somewhat declining water levels over summer, some recharge of water levels in fall. The created wetland is allowed to stagnate over summer as opposed to continuous flushing.
4) The shoreline is irregular with many bays and peninsulas incorporated into the design.
5) The shoreline slope is shallow; 7:1 to 20:1 when completed.
6) A clay liner is likely required to prevent water loss through seepage. Topsoil is placed across all disturbed areas and into the created wetland to promote vegetation growth.
7) Constructed islands are an option that can provide secure habitat for ground-nesting birds but require care during construction and planting.
8) All disturbed areas are planted. Upland areas are seeded with a mix of native grasses and legumes. Riparian areas are planted with shrubs and sedges. Plants such as cattails and bulrushes are planted in the shallow marsh zone.
9) The created wetland resulting from Area A can be anywhere in size from approximately 280 ha to 1,300 ha, depending upon available resources.

Appendix F. Baseline Data on Wetland Habitats and Associated Riparian Habitat in the Area Affected by the Project.

Baseline Data on Wetland Habitats and Associated Riparian Habitat in the Area Affected by the Project, as derived from EIS Volume 2, Appendix R, Part 1, Vegetation and Ecological Communities

Ten wetland types were identified in baseline data as occurring within the area affected by the Project. They are:

1) Black Spruce- Labrador tea – Sphagnum (Black spruce/Lingonberry/Peat-mosses) (BT)
2) Shallow open water (OW)
3) Sedge wetland (SE)
4) Tamarack sedge (TS)
5) Willow-horsetail-sedge riparian wetland (WH)
6) Willow-Sedge Wetland (WS)
7) Narrow-leaved cotton-grass shore sedge (Wf13)
8) Scrub birch-water sedge (Wf02)
9) Marl Fen
10) Tufa Seep

1) Black Spruce- Labrador tea – Sphagnum (Black spruce/Lingonberry/Peat-mosses) (BT)

BT wetlands are forested ecosystem generally occurring in cold air drainages. Soils are cold and organic layers thick. They are fed by groundwater that is very low in dissolved minerals and nutrients resulting in a poor nutrient regime within the wetland. The water table is high and limits rooting zone depths (MacKenzie and Moran 2004). Bogs are acidic with a pH below 4.5.

DeLong et al. (2011) describes the community as the Wb03:

> The Wb03 represents the climax condition of long-term peatland succession in boreal climates. Climatic conditions in the BWBSmk are favourable to true bog formation and therefore the Wb03 is widespread in suitable terrain. The Wb03 is less common in other subzones. Many Wb03 sites are underlain with permafrost and have a domed surface shape. Deep blankets of acidic *Sphagnum* peat are typical and there is little or no surface water present. Soil types are fibrisols or organic cryosols. Stunted black spruce, usually less than 10 metres tall, forms a sparse to open canopy over an open herb layer and continuous *Sphagnum* blanket (except variations described below). Labrador tea, cloudberry and lingonberry are the most abundant understorey species. Sites are hummocky, but because of luxuriant *Sphagnum* growth, hollows are generally no wetter than hummocks and support few minerotrophic indicators.

There are two variations of the Wb03:

> Wb03.1 Black spruce – lingonberry – peat-moss (Reindeer lichen variation): ‘Over mature’ bogs can experience drying of surface peat and subsequent death of *Sphagnum* followed by an increase in ground lichens (*Cladonia* and *Cladina*) on some sites.
>
> Wb03.2 Black spruce – lingonberry – peat-moss (Feathermoss variation): ‘Terrestrialized’ bogs occur due to lowered water table and subsequent increase in tree cover, which shades out *Sphagnum*, and feather mosses become dominant. This variation is floristically similar to the Sb – Lingonberry – Step moss site series but occurs on deep peat soils.”

Vegetation cover documented within BT wetlands in the LAA is summarized in Table 5 below. Bold indicates species used for traditional purposes by Aboriginal people. Source: EIS, Volume 2, Appendix R, Part 1 and Volume 3, Section 19.

Table 1. Vegetation cover within BT wetlands.

	Vegetation Cover				
	Shrub	**Pole-sapling**	**Young Forest**	**Mature Forest**	**Old Forest**
Dominant Plant Species	Black spruce **Labrador tea** **Lingonberry** Sphagnum mosses Tamarack Willows	Black spruce Black twinberry **Labrador tea** Red-stemmed feathermoss Step moss Tamarack	Black spruce **Labrador tea** Red-stemmed feathermoss Step moss Tamarack	Black spruce Tamarack Bunchberry Common mitrewort Horsetails Knight’s plume **Labrador tea** Sedges Step moss Willows	Black spruce Horsetails Knight’s plume Knight’s plume **Labrador tea** Step moss
Associated Plant Species	Black twinberry Bunchberry **Cloudberry** Common mitrewort Grey reindeer	Common mitrewort **Dwarf red raspberry** Horsetails Prickly rose Sedges	Bunchberry Common mitrewort False Solomon’s-seal Horsetails Lingonberry	Black twinberry **Dwarf red raspberry** Large-leaved avens Prickly rose Soopolallie	Black twinberry Bunchberry **Highbush cranberry** **Prickly rose** Willows

	Vegetation Cover				
	Shrub	Pole-sapling	Young Forest	Mature Forest	Old Forest
	lichen Horsetails Paper birch Twinflower	Tall bluebells Willows	**Prickly rose**	Tall bluebells Twinflower White spruce	

Migratory bird abundance, density, diversity and use of BT wetlands is summarized in Table 6 below. Species in bold are species at risk (federally and/or provincially). Species in italix are harvested by Aboriginal groups. Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 2. Migratory bird abundance, density, diversity and use of BT wetlands

Species	Abundance in baseline data	Use of BT wetlands	Species Density in BT wetlands
Alder Flycatcher	385	Migrating/Breeding	3
Bay-breasted Warbler	6	Migrating/Breeding	2
Blackpoll Warbler	38	Migrating/Breeding	2
Black-capped Chickadee	967	Breeding resident	5
Black-throated Green Warbler	619	Migrating/Breeding	4
Black Tern	29	Migrating/Breeding	1
Blue-headed Vireo	195	Migrating/Breeding	3
Blue Jay	61	Migrating/Breeding	2
Boreal Chickadee	82	Breeding resident	1
Brown-headed Cowbird	705	Migrating/Breeding	4
Bufflehead	240	Migrating/Breeding	2
Canada Goose	10641	Migrating/Breeding	6
Dark-eyed Junco	863	Breeding resident	17
Downy Woodpecker	153	Breeding resident	1
Eastern Kingbird	44	Migrating/Breeding	1
Fox sparrow	109	Migrating/Breeding	2
Golden-crowned Kinglet	231	Migrating/Breeding	2
Hairy Woodpecker	326	Migrating/Breeding	1
Hermit Thrush	896	Migrating/Breeding	8
House Wren	164	Migrating/Breeding	1
Le Conte's Sparrow	35	Migrating/Breeding	1
Least Flycatcher	2248	Migrating/Breeding	3
Lesser Yellowlegs	49	Migrating/Breeding	1
Lincoln's Sparrow	1281	Migrating/Breeding	39
Magnolia Warbler	237	Migrating/Breeding	1

Species	Abundance in baseline data	Use of BT wetlands	Species Density in BT wetlands
Mallard	5093	Migrating/Breeding	1
Northern Flicker	142	Migrating/Breeding	4
Northern Shoveler	100	Migrating/Breeding	1
Olive-sided Flycatcher	48	Migrating/Breeding	3
Orange-crowned Warbler	666	Migrating/Breeding	7
Ovenbird	1556	Migrating/Breeding	6
Pileated Woodpecker	43	Breeding resident	1
Pine Siskin	1540	Migrating/Breeding	5
Purple Finch	304	Migrating/Breeding	3
Red-breasted Nuthatch	645	Breeding resident	9
Red-eyed Vireo	1732	Migrating/Breeding	7
Red-necked Grebe	21	Breeding resident	1
Rose-breasted Grosbeak	849	Migrating/Breeding	4
Ruby-crowned Kinglet	389	Migrating/Breeding	30
Ruffed Grouse	416	Breeding resident	3
Savannah Sparrow	163	Migrating/Breeding	1
Solitary Sandpiper	27	Migrating/Breeding	4
Sora	9	Migrating/Breeding	6
Swanson's Thrush	1764	Migrating/Breeding	15
Swamp Sparrow	87	Migrating/Breeding	7
Tennessee Warbler	1079	Migrating/Breeding	12
Tree Swallow	144	Migrating/Breeding	4
Trumpeter Swan	252	Migrating/Breeding	3
Varied Thrush	86	Migrating/Breeding	2
Warbling Vireo	1116	Migrating/Breeding	7
White-breasted Nuthatch	14	Breeding resident	1
Western Tanager	842	Migrating/Breeding	3
White-throated Sparrow	2804	Migrating/Breeding	12
White-winged Crossbill	134	Breeding resident	1
Yellow-bellied flycatcher	43	Migrating/Breeding	5
Yellow-bellied Sapsucker	480	Migrating/Breeding	17
Yellow Warbler	2631	Migrating/Breeding	50

2) Shallow open water (OW)

Shallow open water areas are permanently flooded by still or slow moving water less than 2m deep. Shallow open water areas are found in depressions and may be components of larger wetland complexes. Shallow open water areas have no vegetation cover.

Migratory bird abundance, density, diversity and use of OW wetlands is summarized in Table 7 below. Species in bold are species at risk (federally and/or provincially). Species in italics are harvested by Aboriginal groups. Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 3. Migratory bird abundance, density, diversity and use of shallow open water

Species	Abundance in baseline data	Use of OW wetlands	Species Density in OW wetlands
American Robin	1811	Migrating/Breeding	2
American Widgeon	1023	Migrating/Breeding	1
Black Tern	29	Migrating/Breeding	1
Blue-winged Teal	114	Migrating/Breeding	3
Brown-headed Cowbird	705	Migrating/Breeding	4
Bufflehead	240	Migrating/Breeding	1
Common Grackle	9	Breeding resident	1
Eastern Kingbird	44	Migrating/Breeding	1
Greater Yellowlegs	5	Migrating/Breeding	1
Green-winged Teal	820	Migrating/Breeding	9
Hairy Woodpecker	326	Migrating/Breeding	1
Hooded Merganser	26	Breeding resident	1
Lesser Scaup	177	Migrating/Breeding	1
Lesser Yellowlegs	49	Migrating/Breeding	4
Lincoln's Sparrow	1281	Migrating/Breeding	2
Mallard	5093	Migrating/Breeding	2
Northern Flicker	142	Migrating/Breeding	1
Northern Pintail	232	Migrating/Breeding	1
Ring-necked Duck	523	Migrating/Breeding	2
Rose-breasted Grosbeak	849	Migrating/Breeding	1
Solitary Sandpiper	27	Migrating/Breeding	4
Sora	9	Migrating/Breeding	3
Spotted Sandpiper	809	Migrating/Breeding	1
Swanson's Thrush	1764	Migrating/Breeding	1
Swamp Sparrow	87	Migrating/Breeding	2
Tennessee Warbler	1079	Migrating/Breeding	1
Tree Swallow	144	Migrating/Breeding	1

Species	Abundance in	Use of OW wetlands	Species Density
Trumpeter Swan	252	Migrating/Breeding	1
White-throated Sparrow	2804	Migrating/Breeding	1
Western Wood-Pewee	238	Migrating/Breeding	1
Yellow-bellied Sapsucker	480	Migrating/Breeding	2

3) Sedge wetland (SE)

Sedge wetlands represent fen and marsh wetlands.

MacKenzie and Moran (2004) describe sedge-wetland fens as nutrient medium peatland ecosystems. They are considered an intermediate stage between marshes and bog ecosystems. Fens are fed by a combination of ground and surface water. The water table in sedge fens is at or above the soil surface early in the growing season followed by lowering water levels as the growing season progresses. Groundwater keeps the soils permanently saturated throughout the growing season. Mineral content of soils is high due to the groundwater flows. pH ranges between acid to neutral (5.5-7.0).

Sedge-wetland marshes are flooded in the early season to depths up to 3m (MacKenzie and Moran 2004). Flood waters recede during the growing season. Water in marshes comes from ground or surface water. Soils are mineral based and nutrient rich. Marshes supporting sedges are alkaline, that is they have high pH (pH >7). Due to rapid decomposition of organics in marshes peat does not form.

Vegetation cover documented within SE wetlands in the LAA is summarized in Table 8 below. Source: EIS, Volume 2, Appendix R, Part 1 EIS Volume 3, Section 19.

Table 4. Vegetation cover documented within SE wetlands

	Vegetation Cover	
	Herb	**Shrub**
Dominant Plant Species	Beaked sedge Water sedge Marsh cinquefoil Bluejoint reedgrass	Scrub birch Sedges Grasses Peat mosses Willows Bluejoint reedgrass
Associated Plant Species	Willows Small bedstraw Foxtail barley	Bluegrass Marsh cinquefoil
	Swamp horsetail Arrow-leaved coltsfoot Marsh skullcap	

	Vegetation Cover	
	Herb	**Shrub**
	Richardson's water moss Scrub birch	

Migratory bird abundance, density, diversity and use of SE wetlands is summarized in Table 9below. Species in bold are species at risk (federally and/or provincially). Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 5. Migratory bird abundance, density, diversity and use of SE wetlands

Species	Abundance in baseline data	Use of SE wetlands	Species density in SE wetlands
Alder Flycatcher	385	Migrating/Breeding	22
American Coot	286	Migrating/Breeding	9
American Redstart	1022	Migrating/Breeding	11
American Robin	1811	Migrating/Breeding	39
American Widgeon	1023	Migrating/Breeding	18
Baltimore Oriole	130	Migrating/Breeding	1
Bay-breasted Warbler	6	Migrating/Breeding	10
Black-capped Chickadee	967	Breeding resident	13
Black-throated Green Warbler	619	Migrating/Breeding	1
Black Tern	29	Migrating/Breeding	7
Blue-headed Vireo	195	Migrating/Breeding	2
Blue Jay	61	Migrating/Breeding	5
Blue-winged Teal	114	Migrating/Breeding	17
Bohemian Waxwing	2	Breeding resident	1
Bonaparte's Gull	1462	Migrant	9
Boreal Chickadee	82	Breeding resident	5
Brown-headed Cowbird	705	Migrating/Breeding	13
Bufflehead	240	Migrating/Breeding	12
Canada Goose	10641	Migrating/Breeding	30
Canvasback	16	Migrating/Breeding	2
Cedar Waxwing	702	Migrating/Breeding	11
Chipping Sparrow	1222	Migrating/Breeding	33
Cinnamon Teal	1	Seasonal resident, nonbreeder	1
Clay-colored Sparrow	595	Migrating/Breeding	20
Common Goldeneye	413	Migrating/Breeding	10
Common Nighthawk	69	Migrating/Breeding	2
Common Snipe	14	Migrating/Breeding	37
Common Tern	1	Migrating/Breeding	1

Species	Abundance in baseline data	Use of SE wetlands	Species density in SE wetlands
Common Yellowthroat	350	Migrating/Breeding	55
Dark-eyed Junco	863	Breeding resident	25
Double-crested cormorant	1	Transient	1
Downy Woodpecker	153	Breeding resident	3
Eastern Kingbird	44	Migrating/Breeding	3
Fox sparrow	109	Migrating/Breeding	2
Gadwall	21	Migrating/Breeding	4
Golden-crowned Kinglet	231	Migrating/Breeding	2
Greater Scaup	8	Transient	1
Greater Yellowlegs	5	Migrating/Breeding	1
Green-winged Teal	820	Migrating/Breeding	13
Hairy Woodpecker	326	Migrating/Breeding	1
Herring Gull	186	Migrant	1
Hermit Thrush	896	Migrating/Breeding	22
Hooded Merganser	26	Breeding resident	1
House Wren	164	Migrating/Breeding	1
Lapland Longspur	20	Nonbreeding resident	1
Le Conte's Sparrow	35	Migrating/Breeding	15
Least Flycatcher	2248	Migrating/Breeding	17
Least Sandpiper	7	Migrant	1
Lesser Scaup	177	Migrating/Breeding	12
Lesser Yellowlegs	49	Migrating/Breeding	12
Lincoln's Sparrow	1281	Migrating/Breeding	101
Long-billed Dowitcher	3	Transient	1
Mallard	5093	Migrating/Breeding	20
Marbled Godwit	1	Migrating/Breeding	1
Marsh Wren	25	Transient	9
Mourning Warbler	189	Migrating/Breeding	1
Nelson's Sparrow	13	Migrating/Breeding	9
Northern Flicker	142	Migrating/Breeding	6
Northern Rough-winged Swallow	23	Migrating/Breeding	1
Northern Shoveler	100	Migrating/Breeding	6
Olive-sided Flycatcher	48	Migrating/Breeding	5
Orange-crowned Warbler	666	Migrating/Breeding	20
Ovenbird	1556	Migrating/Breeding	15
Philadelphia Vireo	21	Breeding resident	1
Pied-billed Grebe	2	Migrating/Breeding	7
Pine Siskin	1540	Migrating/Breeding	5
Purple Finch	304	Migrating/Breeding	2

Species	Abundance in baseline data	Use of SE wetlands	Species density in SE wetlands
Red-breasted Nuthatch	645	Breeding resident	21
Red-eyed Vireo	1732	Migrating/Breeding	10
Red-necked Grebe	21	Breeding resident	12
Ring-necked Duck	523	Migrating/Breeding	14
Rose-breasted Grosbeak	849	Migrating/Breeding	15
Ruby-crowned Kinglet	389	Migrating/Breeding	16
Ruddy Duck	5	Breeding resident	1
Ruffed Grouse		Breeding resident	10
Sabine's Gull	5	Transient	1
Sandhill Crane	37	Migrating/Breeding	1
Sharp-tailed Grouse	1	Breeding resident	1
Savannah Sparrow	163	Migrating/Breeding	11
Solitary Sandpiper	27	Migrating/Breeding	7
Song Sparrow	285	Migrating/Breeding	11
Sora	9	Migrating/Breeding	25
Spotted Sandpiper	809	Migrating/Breeding	2
Swanson's Thrush	1764	Migrating/Breeding	37
Swamp Sparrow	87	Migrating/Breeding	35
Tennessee Warbler	1079	Migrating/Breeding	33
Tree Swallow	144	Migrating/Breeding	24
Trumpeter Swan	252	Migrating/Breeding	7
Violet-green Swallow	38	Migrating/Breeding	2
Warbling Vireo	1116	Migrating/Breeding	10
White-crowned Sparrow	44	Migrating/Breeding	2
Western Tanager	842	Migrating/Breeding	12
Wilson's Phalarope	5	Migrating/Breeding	3
Wilson's Warbler	168	Breeding resident	2
White-throated Sparrow	2804	Migrating/Breeding	52
Western Wood-Pewee	238	Migrating/Breeding	3
White-winged Crossbill	134	Breeding resident	5
Yellow Rail	25	Migrating/Breeding	15
Yellow-bellied Sapsucker	480	Migrating/Breeding	32
Yellow Warbler	2631	Migrating/Breeding	40

4) Tamarack sedge (TS)

Tamarack sedge bogs are nutrient poor *Sphagnum* dominated peatland wetlands. The water table stays high and flows through the wetland throughout the growing season. The groundwater feeding Tamarack sedge bogs is very low in dissolved minerals and nutrients. Soils are organic, composed of sedge and peat. pH is low (<4.5).

Vegetation cover documented within TS wetlands in the LAA is summarized in Table 10 below. Bold indicates species used for traditional purposes by Aboriginal people. Source: EIS, Volume 2, Appendix R, Part 1 EIS Volume 3, Section 19.

Table 6. Vegetation cover documented within TS wetlands

	Vegetation Cover					
	Herb	**Shrub**	**Pole-sapling**	**Young Forest**	**Mature Forest**	**Old Forest**
Dominant Plant Species	Sedges	Tamarack Sedges **Labrador tea** Scrub birch	Tamarack Scrub birch **Labrador tea** Willows Bluejoint reedgrass Sedges	Tamarack Scrub birch Willows Sedges	Tamarack Sedges	Tamarack Sedges
Associated Plant Species	Tamarack Willows Arrow-leaved coltsfoot Red swamp currant Golden fuzzy fen moss	Black spruce Willows Arrow-leaved coltsfoot Bluejoint reedgrass Marsh cinquefoil Golden fuzzy fen moss	Peat mosses Arrow-leaved coltsfoot	Red-osier dogwood Black spruce **Labrador tea**	Black spruce **Labrador tea** White spruce	Black spruce Willows

Migratory bird abundance, density, diversity and use of TS wetlands is summarized in Table 11 below. Species in bold are species at risk (federally and/or provincially). Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 7. Migratory bird abundance, density, diversity and use of TS wetlands.

Species	Abundance in baseline data	Use of TS wetlands	Species density in TS wetlands
Alder Flycatcher	385	Migrating/Breeding	16
American Coot	286	Migrating/Breeding	2
American Redstart	1022	Migrating/Breeding	15
American Robin	1811	Migrating/Breeding	47
American Widgeon	1023	Migrating/Breeding	6
Bank Swallow	248	Migrating/Breeding	2
Barrow's Goldeneye	17	Migrating/Breeding	1
Barn Swallow	12	Migrating/Breeding	2
Bay-breasted Warbler	6	Migrating/Breeding	10
Black-billed Magpie	71	Breeding resident	1
Blackpoll Warbler	38	Migrating/Breeding	1
Black-capped Chickadee	967	Breeding resident	15
Black-throated Green Warbler	619	Migrating/Breeding	4
Black Tern	29	Migrating/Breeding	6
Blue-headed Vireo	195	Migrating/Breeding	1
Blue Jay	61	Migrating/Breeding	2
Blue-winged Teal	114	Migrating/Breeding	3
Bonaparte's Gull	1462	Migrant	1
Boreal Chickadee	82	Breeding resident	3
Brown-headed Cowbird	705	Migrating/Breeding	7
Bufflehead	240	Migrating/Breeding	12
Canada Goose	10641	Migrating/Breeding	17
Canvasback	16	Migrating/Breeding	2
Cedar Waxwing	702	Migrating/Breeding	15
Chipping Sparrow	1222	Migrating/Breeding	48
Clay-colored Sparrow	595	Migrating/Breeding	15
Cliff Swallow	43	Migrating/Breeding	2
Common Grackle	9	Breeding resident	2
Common Goldeneye	413	Migrating/Breeding	10
Common Redpoll	2	Nonbreeding resident	2
Common Snipe	14	Migrating/Breeding	52
Connecticut Warbler	72	Migrating/Breeding	1
Common Yellowthroat	350	Migrating/Breeding	69
Dark-eyed Junco	863	Breeding resident	28
Downy Woodpecker	153	Breeding resident	2

Species	Abundance in baseline data	Use of TS wetlands	Species density in TS wetlands
Eastern Kingbird	44	Migrating/Breeding	8
Evening Grosbeak	69	Breeding resident	1
Fox sparrow	109	Migrating/Breeding	3
Golden-crowned Kinglet	231	Migrating/Breeding	12
Greater Scaup	8	Transient	1
Greater Yellowlegs	5	Migrating/Breeding	4
Green-winged Teal	820	Migrating/Breeding	6
Hairy Woodpecker	326	Migrating/Breeding	4
Hermit Thrush	896	Migrating/Breeding	28
Horned Grebe	23	Migrating/Breeding	2
Hooded Merganser	26	Breeding resident	4
House Wren	164	Migrating/Breeding	2
Killdeer	149	Migrating/Breeding	3
Le Conte's Sparrow	35	Migrating/Breeding	18
Least Flycatcher	2248	Migrating/Breeding	12
Lesser Scaup	177	Migrating/Breeding	9
Lesser Yellowlegs	49	Migrating/Breeding	8
Lincoln's Sparrow	1281	Migrating/Breeding	118
Long-billed Dowitcher	3	Transient	1
Long-tailed Duck	10	Migrating/Breeding	1
Mallard	5093	Migrating/Breeding	16
Marsh Wren	25	Transient	12
Nelson's Sparrow	13	Migrating/Breeding	2
Northern Flicker	142	Migrating/Breeding	18
Northern Pintail	232	Migrating/Breeding	2
Northern Shoveler	100	Migrating/Breeding	3
Olive-sided Flycatcher	48	Migrating/Breeding	8
Orange-crowned Warbler	666	Migrating/Breeding	21
Ovenbird	1556	Migrating/Breeding	16
Palm Warbler	1	Transient	1
Pectoral Sandpiper	8	Transient	1
Philadelphia Vireo	21	Breeding resident	1
Pied-billed Grebe	2	Migrating/Breeding	3
Pine Siskin	1540	Migrating/Breeding	13
Purple Finch	304	Migrating/Breeding	3
Red-breasted Nuthatch	645	Breeding resident	24
Red-eyed Vireo	1732	Migrating/Breeding	8
Red-necked Grebe	21	Breeding resident	12

Species	Abundance in baseline data	Use of TS wetlands	Species density in TS wetlands
Ring-necked Duck	523	Migrating/Breeding	10
Rose-breasted Grosbeak	849	Migrating/Breeding	22
Ruby-crowned Kinglet	389	Migrating/Breeding	44
Ruffed Grouse	416	Breeding resident	3
Sandhill Crane	37	Migrating/Breeding	1
Says Phoebe	8	Migrating/Breeding	2
Savannah Sparrow	163	Migrating/Breeding	16
Solitary Sandpiper	27	Migrating/Breeding	18
Song Sparrow	285	Migrating/Breeding	8
Sora	9	Migrating/Breeding	8
Spotted Sandpiper	809	Migrating/Breeding	7
Surf Scoter	40	Migrating/Breeding	2
Swanson's Thrush	1764	Migrating/Breeding	42
Swamp Sparrow	87	Migrating/Breeding	19
Tennessee Warbler	1079	Migrating/Breeding	53
Tree Swallow	144	Migrating/Breeding	31
Trumpeter Swan	252	Migrating/Breeding	4
Varied Thrush	86	Migrating/Breeding	7
Violet-green Swallow	38	Migrating/Breeding	1
Virginia Rail	2	Migrating/Breeding	2
Warbling Vireo	1116	Migrating/Breeding	12
White-crowned Sparrow	44	Migrating/Breeding	2
Western Tanager	842	Migrating/Breeding	8
Wilson's Warbler	168	Breeding resident	2
White-throated Sparrow	2804	Migrating/Breeding	34
Western Wood-Pewee	238	Migrating/Breeding	5
White-winged Crossbill	134	Breeding resident	3
White-winged Scoter	2	Migrating/Breeding	1
Yellow-bellied flycatcher	43	Migrating/Breeding	3
Yellow Rail	25	Migrating/Breeding	6
Yellow-bellied Sapsucker	480	Migrating/Breeding	32
Yellow Warbler	2631	Migrating/Breeding	83

5) Willow-horsetail-sedge riparian wetland (WH)

Willow-horsetail-sedge riparian wetland are floodplain wetlands that are subject to either short annual spring flooding or prolonged spring flooding and occasional summer flooding. Soils in these areas nutrient medium to rich.

Vegetation cover documented within WH wetlands in the LAA is summarized in Table 12 below. Bold indicates species used for traditional purposes by Aboriginal people. Source: EIS, Volume 2, Appendix R, Part 1 EIS Volume 3, Section 19.

Table 8. Vegetation cover documented within WH wetlands.

	Vegetation Cover		
	Herb	**Shrub**	**Pole-sapling**
Dominant Plant Species	Bluejoint reedgrass Horsetails Sedges Willows Common spike-rush	Alders Bluejoint reedgrass Grasses Horsetails Red-osier dogwood Sedges Common spike-rush Willows	Alders Horsetails **Red raspberry** Red-osier dogwood Pacific Willow Common spike-rush
Associated Plant Species	Large-leaved avens Alders	Balsam poplar Bedstraws Canada goldenrod **Red raspberry** **Stinging nettle**	Grasses **Stinging nettle**

Migratory bird abundance, density, diversity and use of WH wetlands is summarized in Table 13 below. Species in bold are species at risk (federally and/or provincially). Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 9. Migratory bird abundance, density, diversity and use of WH wetlands.

Species	Abundance in baseline data	Use of WH wetlands	Species density in WH wetlands
Alder Flycatcher	385	Migrating/Breeding	2
American Kestrel	8	Migrating/Breeding	1
American Pipit	34	Migrating/Breeding	1
American Redstart	1022	Migrating/Breeding	2
American Robin	1811	Migrating/Breeding	12
American Widgeon	1023	Migrating/Breeding	5
Bay-breasted Warbler	6	Migrating/Breeding	1
Black-billed Magpie	71	Breeding resident	6

Species	Abundance in baseline data	Use of WH wetlands	Species density in WH wetlands
Black-capped Chickadee	967	Breeding resident	4
Boreal Chickadee	82	Breeding resident	1
Bufflehead	240	Migrating/Breeding	2
Canada Goose	10641	Migrating/Breeding	22
Canada Warbler	293	Migrating/Breeding	1
Cedar Waxwing	702	Migrating/Breeding	3
Chipping Sparrow	1222	Migrating/Breeding	6
Clay-colored Sparrow	595	Migrating/Breeding	3
Common Goldeneye	413	Migrating/Breeding	3
Common Merganser	956	Breeding resident	3
Common Yellowthroat	350	Migrating/Breeding	3
Dark-eyed Junco	863	Breeding resident	7
Downy Woodpecker	153	Breeding resident	1
Eastern Kingbird	44	Migrating/Breeding	1
Eastern Phoebe	36	Migrating/Breeding	2
Fox sparrow	109	Migrating/Breeding	1
Green-winged Teal	820	Migrating/Breeding	8
Hairy Woodpecker	326	Migrating/Breeding	4
Hermit Thrush	896	Migrating/Breeding	4
Hooded Merganser	26	Breeding resident	1
Killdeer	149	Migrating/Breeding	4
Least Flycatcher	2248	Migrating/Breeding	10
Lincoln’s Sparrow	1281	Migrating/Breeding	6
Mallard	5093	Migrating/Breeding	16
Northern Flicker	142	Migrating/Breeding	2
Northern Rough-winged Swallow	23	Migrating/Breeding	2
Northern Shoveler	100	Migrating/Breeding	1
Orange-crowned Warbler	666	Migrating/Breeding	1
Pileated Woodpecker	43	Breeding resident	2
Pine Siskin	1540	Migrating/Breeding	4
Purple Finch	304	Migrating/Breeding	1
Red-breasted Nuthatch	645	Breeding resident	1
Red-eyed Vireo	1732	Migrating/Breeding	4
Ring-billed gull	2603	Breeding resident	1
Rose-breasted Grosbeak	849	Migrating/Breeding	2
Ruby-crowned Kinglet	389	Migrating/Breeding	1
Ruffed Grouse	416	Breeding resident	3
Solitary Sandpiper	27	Migrating/Breeding	1
Song Sparrow	285	Migrating/Breeding	8
Sora	9	Migrating/Breeding	1
Spotted Sandpiper	809	Migrating/Breeding	7
Swanson’s Thrush	1764	Migrating/Breeding	1
Tennessee Warbler	1079	Migrating/Breeding	5
Townsend's Solitaire	13	Migrating/Breeding	1

Species	Abundance in baseline data	Use of WH wetlands	Species density in WH wetlands
Warbling Vireo	1116	Migrating/Breeding	5
Western Tanager	842	Migrating/Breeding	2
White-throated Sparrow	2804	Migrating/Breeding	7
Western Wood-Pewee	238	Migrating/Breeding	1
White-winged Crossbill	134	Breeding resident	1
Yellow-bellied Sapsucker	480	Migrating/Breeding	5
Yellow Warbler	2631	Migrating/Breeding	10

6) Willow-Sedge Wetland (WS)

Willow sedge wetlands swamp wetlands. They are nutrient rich (pH >7) with significant ground-water inflow. Groundwater is abundant and flows at or near the surface and keeps soils moist throughout the growing season. In some locations early season flooding occurs. Soils in willow-sedge wetlands in the LAA are peat and show signs of gleying. Mounds within WS wetlands allow vegetation to grow in subhydric conditions.

Vegetation cover documented within WS wetlands in the LAA is summarized in Table 14 below. None of the plant species documented in WS wetlands were identified by Aboriginal groups as being used (EIS Volume 3, Section 19). Source: EIS, Volume 2, Appendix R, Part 1.

Table 10. Vegetation cover documented within WS wetlands.

	Vegetation Cover	
	Herb	**Shrub**
Dominant Plant Species	Sedges Bluejoint wheatgrass Willows	Bluejoint wheatgrass Sedges Willows spp.
Associated Plant Species	Asters	Arrow-leaved coltsfoot Horsetails Marsh cinquefoil Red-osier dogwood Scrub birch Sedges White spruce

Migratory bird abundance, density, diversity and use of WS wetlands is summarized in Table 15 below. Species in bold are species at risk (federally and/or provincially). Source: EIS, Volume 2, Appendix R, Part 4 and 5.

Table 11. Migratory bird abundance, density, diversity and use of WS wetlands.

Species	Abundance in baseline data	Use of WS wetlands	Species density in WS wetlands
Alder Flycatcher	385	Migrating/Breeding	3
American Coot	286	Migrating/Breeding	4
American Redstart	1022	Migrating/Breeding	5
American Robin	1811	Migrating/Breeding	9
American Widgeon	1023	Migrating/Breeding	1
Barrow's Goldeneye	17	Migrating/Breeding	1
Bay-breasted Warbler	6	Migrating/Breeding	4
Black-billed Magpie	71	Breeding resident	1
Black-capped Chickadee	967	Breeding resident	3
Black-throated Green Warbler	619	Migrating/Breeding	3
Blue Jay	61	Migrating/Breeding	1
Blue-winged Teal	114	Migrating/Breeding	1
Brown-headed Cowbird	705	Migrating/Breeding	2
Bufflehead	240	Migrating/Breeding	5
Canada Goose	10641	Migrating/Breeding	3
Cedar Waxwing	702	Migrating/Breeding	2
Chipping Sparrow	1222	Migrating/Breeding	3
Clay-colored Sparrow	595	Migrating/Breeding	3
Common Goldeneye	413	Migrating/Breeding	1
Common Snipe	14	Migrating/Breeding	8
Connecticut Warbler	72	Migrating/Breeding	1
Common Yellowthroat	350	Migrating/Breeding	6
Dark-eyed Junco	863	Breeding resident	6
Eastern Kingbird	44	Migrating/Breeding	1
Golden-crowned Kinglet	231	Migrating/Breeding	2
Green-winged Teal	820	Migrating/Breeding	2
Hairy Woodpecker	326	Migrating/Breeding	1
Hermit Thrush	896	Migrating/Breeding	1
Hooded Merganser	26	Breeding resident	1
House Wren	164	Migrating/Breeding	1
Least Flycatcher	2248	Migrating/Breeding	7
Lesser Scaup	177	Migrating/Breeding	1
Lincoln’s Sparrow	1281	Migrating/Breeding	8
Magnolia Warbler	237	Migrating/Breeding	5
Mallard	5093	Migrating/Breeding	2
Marsh Wren	25	Transient	1

Species	Abundance in baseline data	Use of WS wetlands	Species density in WS wetlands
Northern Flicker	142	Migrating/Breeding	1
Northern Shoveler	100	Migrating/Breeding	1
Olive-sided Flycatcher	48	Migrating/Breeding	2
Philadelphia Vireo	21	Breeding resident	1
Pine Siskin	1540	Migrating/Breeding	1
Red-breasted Nuthatch	645	Breeding resident	3
Red-eyed Vireo	1732	Migrating/Breeding	6
Red-necked Grebe	21	Breeding resident	1
Ring-necked Duck	523	Migrating/Breeding	6
Rose-breasted Grosbeak	849	Migrating/Breeding	4
Ruby-crowned Kinglet	389	Migrating/Breeding	3
Ruffed Grouse	416	Breeding resident	4
Solitary Sandpiper	27	Migrating/Breeding	2
Song Sparrow	285	Migrating/Breeding	1
Sora	9	Migrating/Breeding	5
Spotted Sandpiper	809	Migrating/Breeding	1
Swanson’s Thrush	1764	Migrating/Breeding	6
Swamp Sparrow	87	Migrating/Breeding	5
Tennessee Warbler	1079	Migrating/Breeding	4
Tree Swallow	144	Migrating/Breeding	3
Trumpeter Swan	252	Migrating/Breeding	1
Varied Thrush	86	Migrating/Breeding	1
Warbling Vireo	1116	Migrating/Breeding	10
Western Tanager	842	Migrating/Breeding	2
Winter Wren	2	Breeding resident	1
White-throated Sparrow	2804	Migrating/Breeding	12
Western Wood-Pewee	238	Migrating/Breeding	4
Yellow-bellied Sapsucker	480	Migrating/Breeding	5
Yellow Warbler	2631	Migrating/Breeding	3

7) Narrow-leaved cotton-grass shore sedge

Narrow-leaved cotton-grass shore sedge fens are a high elevation wetland. They occur in depressions with standing water present throughout the growing season. Soils are peat based with poor to medium nutrient regimes.

Vegetation cover documented within BT wetlands in the LAA is summarized in Table 16 below. None of the plant species identified in BT wetlands identified by Aboriginal groups as being used (EIS Volume 3, Section 19).Source: EIS, Volume 2, Appendix R, Part 1.

Table 12. Vegetation cover documented within BT wetlands.

	Vegetation Cover	
	Herb	**Shrub**
Dominant Plant Species	Shore sedge Water sedge Narrow-leaved cotton-grass white mtn. marsh-marigold Glow moss Peat mosses	Bog willow Barclay's willow Shore sedge Water sedge Narrow-leaved cotton-grass Glow moss Peat mosses
Associated Plant Species	Bog willow Barclay's willow Poor sedge Sitka sedge Mountain hairgrass	white mtn. marsh-marigold Poor sedge Sitka sedge Mountain hairgrass

Migratory bird abundance, density, diversity and use of narrow-leaved cotton-grass shore sedge wetlands were not collected during baseline data collection.

8) Scrub birch-water sedge (Wf02)

Scrub birch-water sedge fens are nutrient medium peatland ecosystems. Fens are an intermediate stage between marshes and bog ecosystems. Hummocks are often present. These units experience fluctuating water tables over the growing season. The water table recedes enough to allow surface soils to become aerated during the growing season.

Vegetation cover documented within Wf02 wetlands in the LAA is summarized in Table17 below. None of the plant species documented Wf02 wetlands were identified by Aboriginal groups as being used (EIS Volume 3, Section 19).Source: EIS, Volume 2, Appendix R, Part 1.

Table 13. Vegetation cover documented within Wf02 wetlands.

	Vegetation Cover	
	Herb	**Shrub**
Dominant Plant Species	Water sedge Sphagnum mosses	Scrub birch Water sedge Sphagnum mosses
Associated Plant Species	Scrub birch Bluejoint reedgrass Sitka sedge	Bog willow Barclay's willow Bluejoint reedgrass

	White bog orchid	Sitka sedge White bog orchid

Migratory bird abundance, density, diversity and use of narrow-leaved cotton-grass shore sedge wetlands were not collected during baseline data collection.

9) Marl Fen

Marl fens are a special class of calcareous fens, also called rich fens with a high pH. Calcium carbonate or other calcareous minerals accumulate to create the marl. The climate must be dry and boreal to allow the marl to accumulate, in wet climates the marl is continually washed away and unable to accumulate. Marl Fens in the LAA are a component of larger wetland complexes.

Vegetation cover documented within BT wetlands in the LAA is summarized in Table 18 below. Bold indicates species used for traditional purposes by Aboriginal people. Source: Simson et al. (2014) and EIS Volume 3, Section 19.

Table 14. Vegetation cover documented within BT wetlands.

	Vegetation Cover		
	Mosses and lichens	**Herbs**	**Shrubs**
Associated Plant Species	*Amblystegium serpens* *Aulacomnium palustre* *Brachythecium sp.*	Hair Bentgrass American Water-plantain Little Meadow-foxtail Round-leaved Orchis Rattlesnake Fern	Green Alder Bog-rosemary
	Bryoerythrophyllum recurvirostre var. recurvirostre	Bluejoint Reedgrass Slimstem Reedgrass Slimstem Reedgrass	Paper Birch
	Bryum caespiticium *Bryum pseudotriquetrum*	Wild Calla Spring Water-starwort Water Sedge	Low Birch Red-osier Dogwood
	Bryum sp. *Calliergon trifarium* *Calypogeia sphagnicola* *Campylium sp.* *Campylium stellatum* *Cephalozia lunulifolia* *Ceratodon purpureus*	Awned Sedge Black Sedge Golden Sedge Bebb's Sedge Brownish Sedge Hairlike Sedge Cordroot Sedge Low Northern Sedge	Black Spruce **Labrador-Tea** Tamarack Bunchberry Five-leaved Bramble Sage Willow Bog Willow
	Conardia compacta	Cusick's Sedge	

	Vegetation Cover		
	Mosses and lichens	**Herbs**	**Shrubs**
	Dicranum fuscescens var. fuscescens *Dicranum polysetum* *Dicranum undulatum*	Lesser-panicled Sedge Soft-leaved Sedge Yellow Bog Sedge Inland Sedge Slender Sedge Bristle-stalked Sedge Shore Sedge Pale Sedge Poor Sedge	
		Few-seeded Fen Sedge Small-winged Sedge Blunt Sedge Thick-headed Sedge	

Migratory bird abundance, density, diversity and use of Marl Fen wetlands is summarized in Table 19 below. Species in bold are species at risk (federally and/or provincially). Source: EIS, Volume 2, Appendix R, Part 4 and 5 and Simpson et al. (2014).

Table 15. Migratory bird abundance, density, diversity and use of Marl Fen wetlands.

Species	Abundance in baseline data	Use of Marl Fen wetlands	Species density in Marl Fen wetland
American Redstart	1022	Migrating/Breeding	7
American Robin	1811	Migrating/Breeding	65
Black-billed Magpie	71	Breeding resident	5
Black-capped Chickadee	967	Breeding resident	13
Brown-headed Cowbird	705	Migrating/Breeding	13
Blue-headed Vireo	195	Migrating/Breeding	9
Blackpoll Warbler	38	Migrating/Breeding	4
Canada Goose	10641	Migrating/Breeding	31
Clay-colored Sparrow	595	Migrating/Breeding	18
Chipping Sparrow	1222	Migrating/Breeding	71
Common Yellowthroat	350	Migrating/Breeding	14
Dark-eyed Junco	863	Breeding resident	34
Downy Woodpecker	153	Breeding resident	2
Golden-crowned Kinglet	231	Migrating/Breeding	9
Greater Yellowlegs	5	Migrating/Breeding	4
Hermit Thrush	896	Migrating/Breeding	34
Lesser Yellowlegs	49	Migrating/Breeding	15

Species	Abundance in baseline data	Use of Marl Fen wetlands	Species density in Marl Fen wetland
Mallard	5093	Migrating/Breeding	9
Mountain Chickadee	0	Migrating/Breeding	2
Northern Flicker	142	Migrating/Breeding	8
Northern Waterthrush	285	Breeding resident	8
Pine Siskin	1540	Migrating/Breeding	45
Pacific-slope Flycatcher	77	Migrating/Breeding	1
Purple Finch	304	Migrating/Breeding	3
Ruby-crowned Kinglet	389	Migrating/Breeding	46
Ruffed Grouse	416	Breeding resident	6
Sandhill Crane	37	Migrating/Breeding	11
Savannah Sparrow	163	Migrating/Breeding	79
Sora	9	Migrating/Breeding	8
Song Sparrow	285	Migrating/Breeding	1
Swainson's Thrush	1764	Migrating/Breeding	79
Tennessee Warbler	1079	Migrating/Breeding	61
Tree Swallow	144	Migrating/Breeding	8
Upland Sandpiper	15	Migrating/Breeding	17
White-crowned Sparrow	44	Migrating/Breeding	29
Wilson's Snipe	14	Migrating/Breeding	93
Wilson's Warbler	168	Breeding resident	8
White-throated Sparrow	2804	Migrating/Breeding	14
Yellow-bellied Sapsucker	480	Migrating/Breeding	11
Yellow Warbler	2631	Migrating/Breeding	15
Yellow-rumped Warbler	3269	Migrating/Breeding	49

10) Tufa Seep

Tufa seeps are formed as mosses hyper-accumulate calcium carbonate and other calcareous minerals on alkaline groundwater seeps. These sites are nutrient rich and have a high pH. The stems and leaves of the mosses become coated as carbonate-laden water seeps over the mosses, encasing them in stone. In order to form tufa the seepage emerges to the surface in well-lit sites, allowing the growth of the mosses that make the precipitate spongy rather than solid. In the LAA Tufa may be dripping wet and actively accumulating, or may be the dry remnants of former seeps.

Vegetation cover documented within tufa seep wetlands in the LAA is summarized in the Table below. None of the mosses were identified by Aboriginal groups as being used (EIS Volume 3, Section 19). Source: EIS, Volume 2, Appendix R, Part 1.

Table 16. Vegetation cover documented within tufa seep wetlands.

Vegetation Cover	Structural Stage
	Herb
Dominant Plant Species	*Amblyodon dealbatus*[1] *Lempholemma polyanthes*[1] *Leptogium tenuissimum*[1] mourning phlegm birdnest vinyl
1 No common name	

Tufa seeps do not provide breeding or migrating habitat for migratory birds. As such migratory bird abundance density, diversity and use are not applicable to this wetland type.

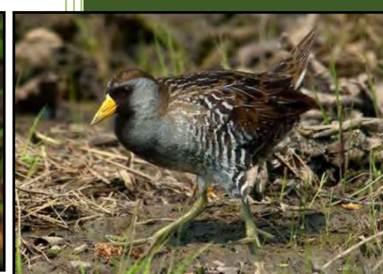
Appendix G. Assessment of Wetland Function for the Site C Clean Energy Project.

Assessment of Wetland Function for the Site C Clean Energy Project

–prepared for BC Hydro –

June 2, 2015






NATIVE PLANT SOLUTIONS

BC hydro

Prepared by:

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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 issues 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 a scientifically based system (Figure 1) that was used to characterize the ecological functioning of wetlands for migratory birds and species at risk (in accordance with federal condition 11 above), then describes baseline ecological functioning of wetlands in the area that may be affected by the Project.

The process identifies function at the landscape level (Hanson et al. 2008), and uses existing GIS and baseline survey data from the Project, in conjunction with the scientific literature, to identify the relative importance of wetlands to migratory birds, rare plant, amphibian and bat species at risk (see Table 8 and 'Record Keeping' section).

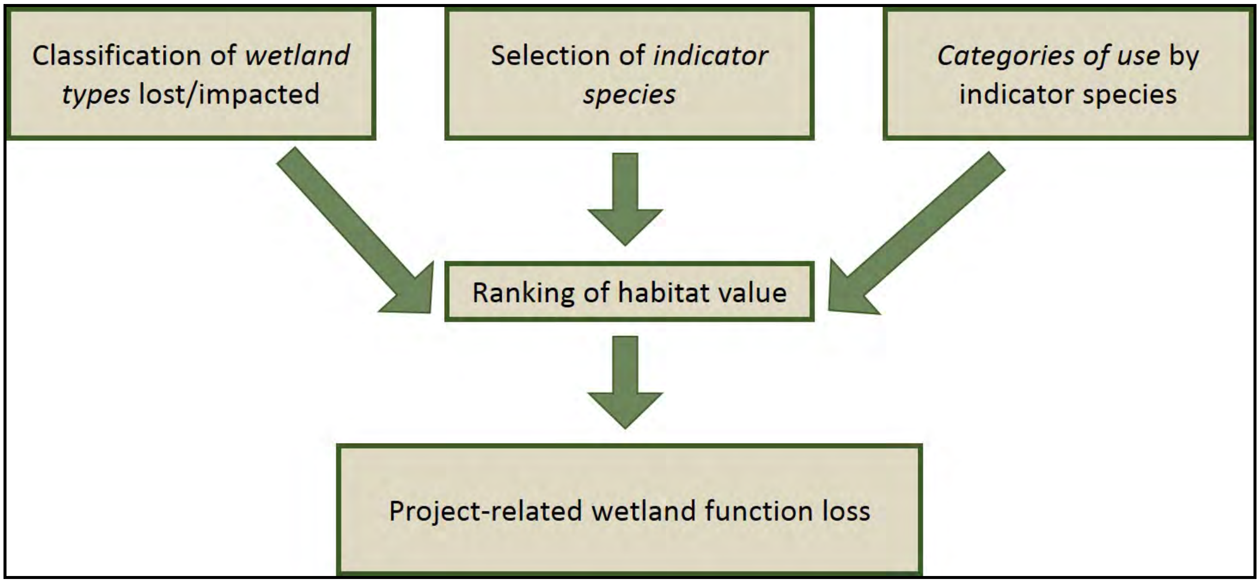


Figure 1. Wetland function assessment process for the Project.

In order to quantify project-related wetland function lost, this process considers:

1. *Wetland types* in the area;
2. Selection of wetland *indicator species*, including migratory birds and rare plant, amphibian and bat species at risk; and
3. Categorizing the *use* of wetland type by each indicator species.

Together, these three factors are used to assign a habitat value to wetlands and their function, as part of a ranking process. This ranking process helps assess wetland function that will be lost due to the Project and will inform planning and estimation of the mitigation measures required to replace functional loss.

This document provides a summary of the process described above, and describes the actual ranking process, for review. BC Hydro anticipates engaging in further discussions with agencies and interested Aboriginal Groups regarding this process.

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. Two excel spreadsheets for flora and fauna (bchydro_siteC_faunaspp_wetlandranking_9Dec2014.xlsx and bchydro_siteC_floraspp_wetlandranking_9Dec2014.xlsx) 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.

All calculations in the ranking process are provided in the spreadsheets, as well as described below.

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 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.

Step 1. Classification of wetland types.

Classification of wetland types in the LAA followed the structure of mapping and terrestrial ecosystem classification presented in the EIS (Hilton et al. 2013a). 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. At this point, 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 the areas have been verified in the field.

The Provincial classification system was used to identify wetlands, 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).

Where possible, habitat associations and categories of use for the indicator species described above 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). 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.

Both total area in the LAA, and total area to be affected by construction and operations in the Project Activity Zone (PAZ) was considered, as part of the ranking process to estimate project-related function loss (Table 1). TEM mapping developed for the Site C project was used to confirm the area and distribution of the wetland types across the LAA.

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 and Step 3. Categorizing of use by indicator species.

In order to determine project-related wetland function loss, indicator species were selected from the list of species documented in the Project baseline. The selection of wetland indicator species for migratory birds, amphibians, bats and rare plants, categories of wetland use, and indicators of wetland function 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, as part of Step 1 and Step 2 of this process. Baseline wildlife and vegetation survey data from the LAA was used to verify and confirm the literature review. Appendix A in this document lists the literature reviewed for each of the indicator species considered as part of this process.

Wetland Function Assessment for Migratory Birds

To examine the loss of wetland function to migratory birds a detailed review of the baseline conditions and the available literature was used to identify the important functions wetland habitats provide migratory bird species. 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. Then one to three indicator species were selected to represent each assemblage. Twelve 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. With the exception of wood ducks (*Aix sponsa*), which are surface feeders, all are diving ducks from the genera *Bucephala, Mergus*, and *Lophodytes*.

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 occupy primarily coniferous-dominated habitat types

When selecting indicator species to represent each of these 12 assemblages, the goal was to choose species that 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 in terms of habitat selection. Species with generalized habitat preferences were not selected because there was the potential that they would diminish the overall importance of wetland habitats in terms of their categories of use as many of these species do not cue in on specific habitat types. Only the species recorded during baseline inventories conducted within the LAA were chosen as representative species.

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 overlaps with the Peace River area were selected (Environment Canada 2013). Only species listed as "priority species" in wetland habitats were used as indicators. Wetland habitat classes included bogs, fens, marshes, swamps, and shallow open water (largely non-vegetated surface, but <2m deep; Environment Canada 2013). The final selection of species excluded species that were found 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), occurred in the region at the periphery of their range, had habitat preferences that mirrored other species on the list, or had more general habitat preferences in relation 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 Biologist – boreal waterfowl ecology), Darryl Kroeker (Head of Conservation Programs, BC Peace), and Julienne Morissette PhD (Conservation Biologist – National Boreal Program). In total, 22 species were selected to represent the 12 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).

Because few songbird species met the above criteria and because several of those that did were extremely rare on the landscape, it was suggested that additional species be added to the Deciduous Songbirds and Coniferous Songbirds species assemblages in order 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.

Wetland habitat use for migratory bird species was divided into four categories: Nesting, Feeding, Brood-rearing, and Migration. Brood-rearing was only considered a category of use if a species assemblage was known to transfer their young to a new location or habitat type after hatching and do not rear their young at the original nest site (e.g. waterfowl). In all other instances nesting and brood-rearing habitat were considered identical and not divided into separate categories of use. The literature used to determine habitat preferences for each of the representative species is outlined in Appendix A.

Table 2. Rationale for species inclusion[1]. Yellow highlight indicates species selected as an indicator.

Species Category	*Included*	*Rationale*[1]
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 found in bog habitats. In the western part of its range habitat preferences shift towards upland deciduous types
Le Conte's Sparrow	Y	Blue-listed wetland species 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
Shorebirds		
Greater Yellowlegs	N	Similar habitat preferences as lesser yellowlegs & solitary sandpiper and found in low numbers within the study area
Killdeer	N	Considered a habitat generalist found in most open or disturbed habitat types
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

[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.

Table 2. (continued)

Shorebirds continued	***Included***	***Rationale***[1]
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
Pacific Loon	N	Found in low numbers in the study area and considered a transient

Table 2. (continued)

Waterbirds continued	***Included***	***Rationale***[1]
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 due to population declines noted in the boreal region is a species of conservation interest (Stuart Slattery, pers. comm., Ducks Unlimited Canada)
Blue-winged Teal	N	Numbers lower than other dabbling duck species within the area and similar habitat preferences
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
Mallard	N	Very common species within the study area but tends to have the most generalized nesting preferences of all dabbling ducks
Northern Pintail	N	Numbers suggest it's a relatively common dabbling duck species in the area but 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 has similar habitat preferences
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

Table 2. (continued)

Diving Ducks continued	***Included***	***Rationale***[1]
Ring-necked duck	Y	Most common diving duck species within the area and nests over water, which is typical of other diving duck species
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 in the area
Common Goldeneye	Y	Common cavity nesting species in the area
Geese and Swans		
Cackling Goose	N	Blue-listed; 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] '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

Wetland Function Assessment for Amphibians

Amphibians are particularly vulnerable to wetland disturbance as they rely on available water to complete their breeding cycle. Five amphibian species were detected with 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). The western toad was selected to represent this assemblage of species because it is the only species observed that is a listed species provincially and nationally. The western toad is provincially blue-listed (B.C. Ministry of Environment 2014) and is 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). Habitat use for western toads was divided into: Feeding, Breeding, and Hibernation. A detailed review of the baseline conditions on in the LAA and the available literature was conducted in order to identify which existing wetland habitats within the project area may facilitate these three categories of use for the western toad. These sources are summarized in Appendix A.

Wetland Function Assessment for Bats

Eight bat species were either 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 eastern red bat is a Red-listed species and the northern myotis is a Blue-listed species. 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 slightly 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. Bat species do not use wetland habitats in the LAA for hibernation, but most species have been documented feeding at wetland habitats. During the seasons where bats remain active, many species will also use trees and shrubs as maternity dens and roosting sites during the daytime and there is the potential that forested wetlands could be functionally important as roosting sites for some of these bat species. A detailed review of the baseline conditions in the LAA and the available literature was conducted in order to identify which species could potentially be using each wetland habitat type for feeding or roosting purposes. A list of these sources is summarized in Appendix A.

Wetland Function Assessment for Flora

Unlike migratory birds, which may have many different categories of use (e.g., breeding, feeding, etc.) across wetland types, rare plants are either present or absent. Rare plants are particularly vulnerable as many are habitat specialists and tend to adapt to their unique wetland environments over long periods of time (Haeussler, 1998).

Research focused on rare plant species documented in the LAA that have strong associations to wetland habitat types mapped in the LAA. An initial list of wetland associated rare plant species was compiled from baseline data (Hilton et al., 2013a), confirmed with the BC Hydro rare plant botanist, 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). Wetland zonation for plants includes Obligate Wetland (OBL) species and Facultative Wetland (FACW) species (Table 3). OBL species are plants that almost always occur in wetlands whereas FACW are plants that usually occur in wetlands but can also be found in non-wetland habitats (USDA, 2014). Rare plant species were selected, based on the provincial list (i.e, Red: S1 and/or S2 and Blue: S2 and/or S3; Government of BC, N.D), including any indigenous species or subspecies considered to be threatened or vulnerable in BC. Since the release of the EIS, the CDC list of rare plants has been updated, and currently 14 of the original 18 wetland associated rare plants documented in the LAA remain red or blue listed (Table 4). The other four rare plants are now considered secure by the CDC in BC and are ranked as yellow listed (Table 4). An additional five rare plant species (i.e., *Epilobium saximontanum*, *Utricularia ochroleuca*, *Herzogiella turfacea*) are currently being investigated for their inclusion as indicators of wetland function, and are noted in Tables 3 and 4; however, they have not been incorporated into the ranking process at this time.

For each of the 14 rare 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 in order to explore LAA rare plant associations with wetland habitat, and rank their importance to wetland function: 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 5). This included both raw data from baseline inventories conducted within the LAA, as well as descriptions in the EIS (Hilton et al., 2013a; Simpson & Andrusiak, 2009). In total, 12 of the 14 species have been directly linked to a wetland habitat type located in the LAA. The remaining 2 of the 14 species were either not linked to wetland habitat types found in Site C (i.e., Meadow Willow), or the habitat type was not noted at the time of survey and the species was not found again in future surveys (i.e., Slender Mannagrass).

- **Secondary habitat associations:** As the primary habitat associations from the baseline data may not have completely described the extent of the rare species wetland habitat associations, 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), in order to fully evaluate the importance of wetland function to these species. This method considered the associated species found in conjunction with rare plants during the baseline vegetation surveys in the LAA (Table 6), 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). 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 (i.e., genus only given) in baseline observations, or not described in MacKenzie and Moran (2004). This information was then used as part of 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 the rare plant observations in the field. This produced a secondary habitat association value, or an estimate of the likelihood of a rare plant to 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).

Table 3. 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**[A]
Meadow arnica	*Arnica chamissonis ssp. incana*	FACW
Hudson Bay sedge	*Carax heleonastes*	OBL (Alaska)
Many-headed sedge	*Carex sychnocephala*	FACW
Tender sedge	*Carex tenera*	FACW
Fox sedge	*Carex vulpinoidea*	OBL
Iowa golden-saxifrage	*Chrysosplenium iowense*	OBL (Midwest)
European water-hemlock	*Cicuta virosa*	OBL (Alaska)
Hall's willowherb	*Epilobium halleanum*	FACW
Northern bog bedstraw	*Gallium labradoricum*	OBL (Midwest)
Slender mannagrass	*Glyceria pulchella*	OBL (Alaska)
White Adder's-mouth Orchid	*Malaxis brachypoda*	FACW(Alaska)[A]
Marsh muhly	*Muhlenbergia glomerata*	FACW
Small-flowered lousewort	*Pedicularis parviflora ssp. parviflora*	FACW (Alaska)
Meadow willow	*Salix petiolaris*	OBL
Autumn willow	*Salix serissima*	OBL
Slender wedgegrass	*Sphenopholis intermedia*	FAC
Purple-stemmed aster	*Symphyotrichum puniceum*	OBL (Midwest)
Dwarf clubrush	*Trichophorum pumilum*	FACW
Rocky mountain willowherb	*Epilobium saximontanum*	FACW
Ochroleucous bladderwort	*Utricularia ochroleuca*	OBL
No common name	*Herzogiella turfacea*	N/A

[A] Wetland indicator status taken from Anderson, 2006. OBL - Obligate Wetland, FACW - Facultative Wetland, FAC – Facultative wetland and non-wetland habitats. Grey shading denotes rare plant species that are being investigated for their inclusion as indicator species of wetland function.

Table 4. Rare plant species considered threatened or vulnerable by the BC CDC (2014).

Common Name	**Scientific Name**	**Provincial Rank (i.e., Red or Blue)(2008)**	**Status Change (2014)**
Meadow arnica	*Arnica chamissonis* ssp. *incana*	Blue	Yellow
Hudson Bay sedge	*Carax heleonastes*	Blue	
Many-headed sedge	*Carex sychnocephala*	Blue	
Tender sedge	*Carex tenera*	Blue	
Fox sedge	*Carex vulpinoidea*	Blue	
Iowa golden-saxifrage	*Chrysosplenium iowense*	Red	
European water-hemlock	*Cicuta virosa*	Blue	Yellow
Hall's willowherb	*Epilobium halleanum*	Blue	
Northern bog bedstraw	*Gallium labradoricum*	Blue	
Slender mannagrass	*Glyceria pulchella*	Blue	
White Adder's-mouth Orchid	*Malaxis brachypoda*	Blue	
Marsh muhly	*Muhlenbergia glomerata*	Blue	Yellow
Small-flowered lousewort	*Pedicularis parviflora* ssp. *parviflora*	Blue	
Meadow willow	*Salix petiolaris*	Blue	
Autumn willow	*Salix serissima*	Blue	
Slender wedgegrass	*Sphenopholis intermedia*	Blue	
Purple-stemmed aster	*Symphyotrichum puniceum*	Blue	
Dwarf clubrush	*Trichophorum pumilum*	Blue	Yellow
Rocky mountain willowherb	*Epilobium saximontanum*	Red	
Ochroleucous bladderwort	*Utricularia ochroleuca*	Blue	
No common name given	*Herzogiella turfacea*	Red	

[A] Grey shading denotes rare plant species that are being investigated for their inclusion as indicator species of wetland function.

Table 5. Primary rare plant occurrences in habitat types identified in the EIS.

Rare Plant Species Detected	Primary Habitat Associations[A]
Meadow arnica, Many-headed sedge, Tender sedge, European water-hemlock, Purple-stemmed aster,	SE
Hudson Bay sedge, Hall's willowherb, Northern bog bedstraw, Autumn willow, Purple-stemmed aster,	TS
Tender sedge, Fox sedge, Slender wedgegrass,	WH
Purple-stemmed aster	WS
White Adder's-mouth orchid, Small-flowered lousewort,	BT
Dwarf clubrush, Marsh muhly	Marl Fen
Iowa golden-saxifrage,	Tufa Seep

[A] Rare plant occurrences in habitat types taken from Hilton et al, 2013a; Bjork, Simpson, & Andrusiak, 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 6. Secondary rare plant occurrences in habitat types identified in the EIS.

Rare Plant Species	**Associated Species**[A]
Meadow arnica	Scrub birch, Bluejoint reedgrass, Water sedge,
Hudson Bay sedge	Tamarack, Labrador tea, Black spruce, Golden fuzzy fen moss
Many-headed sedge	
Tender sedge	Speckled alder, Water sedge, Hook-mosses, Common spike-rush, Small bedstraw, Sandbar willow, Small-flowered bulrush
Fox sedge	Water sedge, Small-flowered bulrush
Iowa golden-saxifrage	
European water-hemlock	Speckled alder, Bluejoint reedgrass, Water sedge, marsh cinquefoil, Red-oiser dogwood, Common horsetail, Hemlock water-parsnip, Broadleaf cattail
Hall's willowherb	Tamarack, Labrador tea, Black spruce, Prickly rose, Drummond's willow, Golden fuzzy fen moss
Northern bog bedstraw	Scrub birch, Star-moss, Water sedge, Soft-leaved sedge, Marsh cinquefoil, Common horsetail, Tamarack, Labrador tea, Bog cranberry, Bilberry willow
Slender mannagrass	
White Adder's-mouth Orchid	Glow moss, Black spruce, Balsam poplar, Bilberry willow, Golden fuzzy fen moss
Marsh muhly	Great bulrush
Small-flowered lousewort	Crowberry, Tamarack, Labrador tea, Black spruce, Lingonberry
Meadow willow	Drummond's willow, Pacific willow
Autumn willow	Scrub birch, water sedge, Tamarack, Bilberry willow, Peat moss
Slender wedgegrass	Bluejoint reedgrass, Water sedge, Awned sedge, Nightshade, Tufted hairgrass, Common horsetail, Broadleaf cattail, Stinging nettle
Purple-stemmed aster	Speckled alder, Lady fern, scrub birch, Tufted hairgrass, Watersedge, Awned sedge, Slender sedge, beaked sedge, Marsh cinquefoil, Red-osier dogwood, Blue wildrye, Swamp horsetail, Buckbean, Balsam poplar, Prickly rose, Drummond's willow, Bog willow, Hemlock water-parsnip, Stinging nettle,
Dwarf clubrush	Great bulrush

[A] Rare plant associations with indicator species of a habitat type in the LAA taken from Hilton et al, 2013a; rare vascular plant 2005, 2006, 2008, 2011, 2012 ; MacKenzie & Moran, 2004). Associated species with rare plants were not considered if they were generalists, invasive, if the level of genus was indicated only for associated species during baseline surveys, or if the habitat type was not described in MacKenzie and Moran (2004) as an indicator of wetland habitat type.

Ranking of wetland habitat value

A ranking process has been developed by Native Plant Solutions that considers the three factors described above (i.e., indicator species, category of use, and wetland type) to place a habitat value to wetland function. Although the ranking process is similar for each species group considered (i.e., migratory birds, amphibians, bats and plants), there are slight differences between methods for fauna and flora. A step by step process of the ranking of wetland habitat value for each 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 B and Appendix C), 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

Refer to Excel file 'bchydro_siteC_faunaspp_wetlandranking 9Dec2014.xlsx'' as a companion document to the step-by-step ranking protocol below. Screenshots from this spreadsheet are given in Appendix B, to aid the reader in following the examples provided. The Excel file also contains comments to demonstrate each step.

a) *Summarize the number of categories of use each wetland type provides to indicator species:* Based on the indicator species selected, their use of the wetland habitats (see 'Species Habitat Use' tab in Excel file and screenshot 1 & 2 in Appendix B) and the categories of use for each (e.g., nesting, brood-rearing, feeding, etc.; see 'Functional Loss per Habitat' tab in Excel file and screenshot 2 in Appendix B) has been compiled for each assemblage. Habitat value is first ranked, based on the categories use of each wetland type.

   For example: 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 functional use by each indicator species/assemblage to a value of 1:* Some species may use multiple wetland habitat types for one category of use, where as other species may be restricted to one habitat type. To consider the importance of species which are specialists, versus generalists, the importance of each habitat to an indicator species (or assemblage) is standardized to 1. This is considered for each category of use for each assemblage (i.e., nesting, brood-rearing, feeding and migration for migratory birds; feeding, breeding and hibernation for amphibians; feeding and roosting for bats).

   For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 3 in Appendix B)**:** Dabbling ducks may use five different wetland habitat types for nesting; therefore, each wetland habitat gets a 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 a value of 1 (1/1).

c) *Total functional use summarized across each wetland type, to calculate total wetland value:* Based on all indicator species (and assemblage) that use a particular wetland type (e.g., for nesting, brood-rearing, etc.), these values are summed to get a total habitat value.

   For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 4 in Appendix B)**:** The total habitat value for nesting of migratory birds in wetland type WS is 1.1, this is a sum of total use by dabbling ducks, forest-nesting shorebirds, deciduous songbirds and coniferous songbirds.

d) *Multiply the habitat value by the actual baseline wetland area in the LAA, to get a baseline habitat value:* Although some wetland types considered as part of this process may have valuable wetland functions for the indicator species, the wetland type may have limited coverage in the LAA. Conversely, some wetland types considered to have low function for the indicator species may be very common in the LAA. By calculating a baseline habitat value, this step provides a representation of the baseline habitat value each wetland type provides in the LAA.

   For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 5 in Appendix B)**:** SE has a habitat value for nesting migratory birds of 4.533, and the total area of SE in the LAA is 1169ha. This leads to a habitat baseline value for SE for nesting migratory birds of approximately 5299 for the LAA.

e) *Multiply the habitat value by the affected wetland area (i.e., construction and operations) to get an affected habitat value:* 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 (i.e., by construction or operations) 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. By calculating an affected habitat value, this step provides a representation of the affected habitat value that will be lost with each wetland type, regardless of its baseline coverage in the LAA.

   For example (see 'Migratory Birds Nesting' tab in Excel file and screenshot 6 in Appendix B)**:** WH has a habitat value for nesting migratory birds of 1.1, and a total area of 393ha of this wetland type will be affected by the project. This leads to a habitat affected value of WH for nesting migratory birds of 432.3.

f) *Sum across all functions to get a summary habitat value:* Although wetland habitat value for each assemblage of indicator species can be compared, based on their importance for each category of use (i.e., nesting, brood-rearing, etc.), a summary habitat value can be calculated to indicate the overall importance of wetland function of each type, for the indicator species. In this case, habitat values are summed across each category of use, to provide a total summary habitat value.

For example (see 'Migratory Birds - Summary' tab in Excel file and screenshot 7 in Appendix B)**:** For migratory birds, the summary baseline habitat value for TS is 1617, which sums all baseline habitat values in all categories of use including nesting, brood-rearing, feeding and migration.

In the case of the above ranking process for fauna species, a number of assumptions are made to obtain an overall wetland habitat value:

- 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 prefer using WS, WH, SE, Wf02 or Wf13.
- The ranking process assumes that indicator species assemblages are equally valuable, in terms of what is to be mitigated for loss. For example, dabbling ducks are equally as valuable as cavity nesters.
- The ranking process assigns equal importance to the various categories of use for each indicator species. For example, nesting, brood-rearing, feeding and migration are all equally important to migratory birds.

Flora ranking protocol for wetland habitat value: Rare Plant Species

Refer to Excel file 'bchydro_siteC_floraspp_wetlandranking9Dec2014.xlsx' as a companion document to the step-by-step ranking protocol below. Screenshots from this spreadsheet are given in Appendix C, 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:* As noted above, rare plants were not considered by wetland habitat type based on their category of use, but by potential presence or absence in a wetland type. Their associations 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 their 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 vale for WH).

   For example (for primary habitat associations; see 'Species associated habitats' tab and 'Primary habitat use' tab in Excel file and screenshot 8 in Appendix C**):** 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 9-11 in Appendix C): Tender sedge was observed six times in the LAA. Seven plant species that were observed with tender sedge were selected as associated species, to help better indicate what their wetland habitat preference could be 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 wetland type (according to MacKenzie and Moran, 2004).

- For example (screenshot 9, Appendix C), Sandbar willow occurred with tender sedge in only 1 out of 6 observations in the field (1/6 = 17%) and has a 30% chance of being associated with Fl03, a WH wetland habitat (MacKenzie and Moran, 2004). Therefore the likelihood that tender sedge would occur adjacent to sandbar willow in a WH wetland habitat is 0.17*0.30 = 0.05. These values are averaged across all associated species with tender sedge to provide a secondary habitat use value for Fl03 (e.g., for Tender sedge, two of the seven associated species were indicators of Fl03, and these values were averaged to provide a secondary habitat value for Fl03 of 0.03 [0.14 + 0.05/7=0.03]; see 'Species Associated Habitats' tab in Excel file).
- (screenshot 10 & 11, Appendix C) 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+0.03+0.00]/3, to provide a value for WH for Tender sedge =-0.02). 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 use by each rare species to a value of 1:* Similar to the process for fauna, some species may use multiple wetland habitat types, whereas other species may be restricted to one habitat type. To consider the importance of species that are specialists, versus generalists, the importance of each habitat to a rare plant species is standardized to 1. This was undertaken for both primary habitat ranking and secondary habitat ranking.

- **For example** (for primary habitat associations; see 'Primary habitat use' tab and 'Primary habitat rank' tab in Excel file and screenshots 12 & 13 in Appendix C)**:** based on primary habitat data collected in the LAA, purple-stemmed aster was found in WS, SE and TS (screenshot 12); therefore each habitat gets a value of 0.33 (1/3; screenshot 13).
- **For example** (for secondary habitat associations; see 'Secondary habitat use' tab and 'Secondary habitat rank' tab in Excel file and screenshots 14 & 15 in Appendix C)**:** Based on secondary habitat data, purple-stemmed aster was associated with all wetland types (except open water), with a total secondary habitat association value of 0.30 (screenshot 14). Therefore, to standardize to 1, WH for example gets a score of 0.05/0.30 = 0.18 (see screenshots 14 & 15).

c) *Total use summarized across each wetland type, to calculate total wetland value:* Similar to the process for fauna, based on all rare species that use a particular wetland type, these values are summed to get a total habitat value. This was undertaken for both primary habitat ranking and secondary habitat ranking.

For example (see 'Primary habitat rank' tab in Excel file and screenshot 16 in Appendix C)**:** the total primary habitat value for TS is 4.83, which summarizes its use by Hudson Bay Sedge, Hall's Willowherb, Northern Bog Bedstraw, Small-flowered Lousewort, Autumn Willow and Purple-stemmed Aster.

d) *Scale to sum to 1:* For rare plants only, habitat values for wetland habitats across species are summed to one, in order to place equal weighting between the primary and secondary habitat association data (i.e., although more data was available from the literature on associated species, for the calculation of secondary habitat values, this data is not considered to be more valuable than primary habitat association data).

For example (see 'Primary habitat rank' tab in Excel file and screenshot 17 in Appendix C)**:** the total primary habitat value for TS, after being scaled to 1, is 0.40 (i.e., 4.83/12).

e) *Multiply the habitat value by the baseline wetland area in the LAA, to get baseline habitat value:* Similar to the process for fauna, although some wetland types considered as part of this process may have valuable wetland functions for the rare plant species, the wetland type may be rare in the LAA. Conversely, some wetland types considered may have low function for the rare plant species, but may be very common in the LAA. By calculating a baseline habitat value, this step provides a representation of the baseline habitat value each wetland type provides in the LAA. This was undertaken for both primary habitat ranking and secondary habitat ranking.

For example (see 'Primary habitat rank' tab in Excel file and screenshot 18 in Appendix C)**:** SE has a primary habitat value for rare plants of 0.1528 (when scaled to 1), and the total area of SE in the LAA is 1169ha. This leads to a primary habitat baseline value for SE for rare plants of approximately 178.6 for the LAA.

f) *Multiply the habitat value by the impacted area (i.e., construction and operations) to get the affected habitat value:* Similar to the process for fauna, 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 (i.e., by construction or operations) 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. By calculating an affected habitat value, this step provides a representation of the affected habitat value that will be lost with each wetland type, regardless of its baseline coverage in the LAA. This was undertaken for both primary habitat ranking and secondary habitat ranking.

For example (see 'Primary habitat rank' tab in Excel file and screenshot 19 in Appendix C)**:** WH has a primary habitat value for rare plants of 0.2083 (when scaled to 1), and a total area of

393ha of area to be affected by the project. This leads to a habitat affected value of WH for rare plants of approximately 81.8.

g) *Value relative to a reference habitat:* For rare plants only, habitat values were calculated relative to a reference habitat that had values for both the primary and secondary habitat association values. Particularly in the primary habitat association data, some wetland habitats that were less common on the landscape were not well surveyed/understood, in terms of their value to rare plants. By calculating habitat values relative to a reference habitat, this gives a common denominator by which to compare across all habitats. For the wetland function ranking process for rare plants, the reference habitat (i.e., had wetland value for both primary and secondary habitat association values) that was selected is TS. These values relative to a reference habitat, for primary and secondary habitat values, are then used to calculate the summary value.

   For example (see 'Primary habitat rank' tab and 'Secondary habitat rank' tab in Excel file and screenshots 20 & 21 in Appendix C)**:** For WH, its primary habitat value relative to TS is 0.5172 (0.2083/0.4028; screenshot 20). For its secondary habitat value, its value relative to TS is 0.5647 (0.1182/0.2093; screenshot 21).

h) *Average across primary and secondary habitat association values to get a summary habitat value:* Although wetland habitat value for rare plants can be explored, based on the ranking by primary habitat associations (i.e., based on field observations) or secondary habitat associations (i.e., based on associated species, and as indicators of wetland types), a summary habitat value can be calculated to indicate the overall importance of wetland function of each type, for the rare plant species. In this case (unlike methods described above, for fauna), habitat values (relative to the reference habitat, TS; see description in step g)) are averaged across primary and secondary habitat association values (as primary and secondary habitat association values provide a representation of the same function – presence), and scaled to 1, to provide a total summary habitat value.

   For example (see 'Summary habitat rank' tab in Excel file and screenshots 22 & 23 in Appendix C)**:** For rare plants, the summary baseline habitat value for SE is 116.93. This summary value is obtained from the average of the primary habitat value and secondary habitat value ([0.38 +.35]/2 = 0.36; screenshot 22), scaling to 1 (0.36/3.63 = 0.1, placing equal weight to primary and secondary habitat values; screenshot 23), and multiplied by the baseline SE area (1169).

In the case of the above ranking process for flora species, a number of assumptions are made to obtain an overall habitat value:

- The ranking process assumes that, for primary habitat ranking, habitats where rare plant species are found are equally preferred. For example, for tender sedge, the process assumes it equally prefers WH and SE.

- The ranking process assumes that rare plant species are equally valuable, in terms of what is to be mitigated for wetland loss. For example, tender sedge is equally as valuable as Hall's willowherb.
- The ranking process assumes, for primary habitat ranking, that equal sampling effort was conducted across all wetland habitat types, during baseline rare plant species surveys.

Summary

Overall, this process assessed 48 indicator species, and their categories of use (e.g., nesting, brood-rearing, feeding and migration for migratory birds) in wetland habitats in order to evaluate the functional importance of wetland habitat in the LAA to migratory birds and at risk rare plants, amphibians and bats (Figure 2). An estimated 941 ha of wetland area will be lost or affected in the project area zone. As the ranking process outlines above, functional importance for wetland habitat to be affected for these 48 species can be identified using a scientifically based process for estimating and evaluating wetland function.

Table 7 summarizes the results of the wetland function assessment process. Note that baseline and affected wetland habitat value 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. Willow-horsetail-sedge riparian wetland (WH) and Labrador tea-sphagnum (BT) wetland ecosystem types were found to have high baseline habitat value for all species groups (i.e., migratory birds, amphibians, bats and rare plants), as well as a larger portion of the total habitat value to be affected by the project. Sedge wetland (SE) was identified as contributing the highest baseline and affected habitat value for migratory birds, but of lesser importance to amphibians, bats and rare plants. On the other hand, the tamarack-sedge ecosystem (TS) contributed higher baseline and affected habitat value for amphibians, bats and rare plants, but was of lesser importance to migratory birds. Across all groups, open water (OW), willow sedge wetland (WS), scrub birch-water sedge (Wf02) and narrow-leaved cotton-grass – shore sedge (Wf13) ecosystem types provided lower baseline habitat value for wetland function, and had lower portions of total habitat value to be affected by the project. By identifying total wetland function that may be affected (i.e., 941 ha), summed across all wetland habitat types, appropriate wetland area and function can be accounted for in the design of the mitigation measures.

The results from this process can then be used to guide field-level wetland and species monitoring programs and be taken into account in the implementation of mitigation measures.

Table 7. Summary baseline and affected habitat values for wetland function for migratory birds, amphibians, bats and rare plants.

	Wetland habitat type								
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Total
	Migratory birds								
Baseline	1200.00	937.75	2606.58	12196.57	1616.90	51.67	35.40	2358.65	21003.52
Affected	288.00	170.50	1015.25	2055.37	132.25	0.00	3.93	173.65	3838.95
	Amphibians								
Baseline	9.38	278.73	774.77	313.13	376.61	2.68	2.41	549.38	2307.07
Affected	1.17	103.83	288.61	42.12	50.66	0.36	0.32	73.90	560.98
	Bats								
Baseline	56.25	635.25	1765.75	876.75	2460.50	7.50	6.75	3589.25	9398.00
Affected	13.50	115.50	687.75	147.75	201.25	0.00	0.75	264.25	1430.75
	Rare plants								
Baseline	0.00	31.44	150.37	116.93	387.34	1.01	0.46	427.90	1115.45
Affected	0.00	5.72	58.57	19.71	31.68	0.00	0.05	31.50	147.23

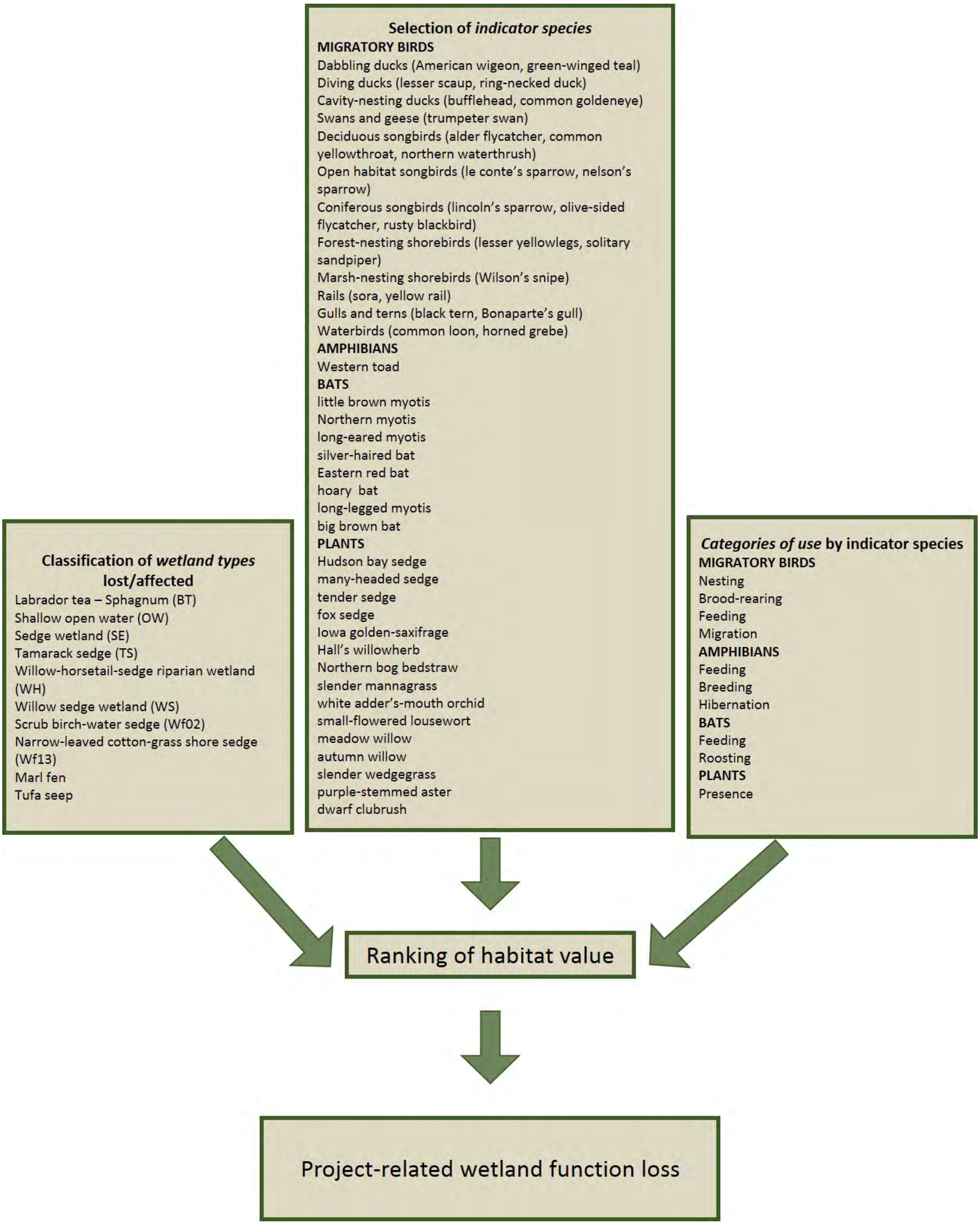


Figure 2. Components of the wetland function assessment process for the BC Hydro Site C Clean Energy Project.

Record keeping

Table 8. 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 to December, 2014
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)

References

Anderson, G. 2006. Colorado State University: *Malaxis brachypoda* (A.Gray) Fernald (white adder's-mouth orchid): A Technical Conservation Assessment. [Online] Available: http://www.cnhp.colostate.edu/download/documents/Spp_assessments/malaxisbrachypoda.pdf [2014 November 27]

BC Conservation Data Centre. 2014. BC Species and Ecosystems Explorer [Online] Available: http://a100.gov.bc.ca/pub/eswp/search.do?method=change [2014 November 27]

Bjork, C., Simpson, L., & Andrusiak, L. (2009, July). Peace River Site C Hydro Project Stage 2 Baseline Vegetation and Wildlife Report. In *BC Hydro Site C Project*. [Online] Available: http://www.bchydro.com/content/dam/hydro/medialib/internet/documents/planning_regulatory/site_c/2010q3/site_c_project_stage.pdf [2014 November 23]

British Columbia Ministry of Environment. 2014. BC Species and Ecosystems Explorer: Species and Ecosystems Search. [Online] Available: http://www.env.gov.bc.ca/atrisk/toolintro.html [2014 November 18]

Committee on the Status of Endangered Wildlife in Canada [COSEWIC]. 2014. Wildlife Species Search. Government of Canada. [Online] Available: http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm. [2014 November 18]

Cornell University. 2011. All About Birds. Cornell Lab of Ornithology. Ithaca, NY. [Online] Available: http://www.allaboutbirds.org [2014 November 6]

Dunn, J.L., and Alderfer, J. (eds.). 2006. National Geographic Field Guide to the Birds of North America, 5th ed. National Geographic Society, Washington, D.C. 504 pp.

Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy

Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 6: Boreal Taiga Plains. Canadian Wildlife Service, Environment Canada. Edmonton, AB. 295 pp.

Government of BC. N.D. BC List Status. [Online] Available: http://www.env.gov.bc.ca/atrisk/help/list.htm [2014 November 27]

Haeussler, S. 1998. Government of BC. Rare Plant Communities of the Southeastern Skeena Region. [Online] Available: http://a100.gov.bc.ca/appsdata/acat/documents/r35357/Rareplantcommunityandspeciesreports_1360285280572_6ba6903174026a4b344fad09f9830a2f413aefa13b3b69080f8423aed07053f4.pdf [2014 November 23]

Hanson, A., L. Swanson, D. Ewing, G. Grabas, S. Meyer, L. Ross, M. Watmough, and J. Kirby. 2008. Wetland Ecological Function Assessment: An Overview of Approaches. Canadian Wildlife Service Technical Report Series N. 497. Atlantic Region. 59 pp.

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

Hilton, S., Simpson, L., Andrusiak, L., and Albrecht, C. 2013b. Part 4 Migratory Birds. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 266 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013c. Part 3 Amphibians and Reptiles. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Lichvar, R.W. 2013. The National Wetland Plant List: 2013 wetland ratings. Phytoneuron 2013-49: 1-241.

MacKenzie, W. H., & Moran, J.R. 2004. Wetlands of British Columbia: A Guide to Identification

National Wetland Working Group. 1997. Canadian Wetland Classification System: 2nd ed. University of Waterloo, Waterloo, ON.

Simpson, K., Simpson, T.K., Simpson, L., Andrusiak, L., Hilton, S., Kellner, M., Klafki, K., Mattson, I., and Creagh, A. 2013. Part 7 Mammals. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 347 pp.

United States Department of Agriculture (USDA). 2014. Natural Resources Conservation Service. Plants Database. [Online] Available: http://plants.usda.gov/java/ [2014 Novmeber 21]

Appendix A: Sources used to identify individual species' habitat preferences

Migratory Birds

Alder Flycatcher

Bent, A.C. 1942. Life histories of North American flycatchers, larks, swallows, and their allies. United States National Museum, Washington, D.C. Bulletin 179. 555 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

The Boreal Avian Modelling Project. (n.d.). The Boreal Avian Modelling Project Online Database. Results by species. [Online] Available: http://www.borealbirds.ca/avian_db/ [2014 November 20]

American Wigeon

Clark, R.G., and Shutler, D. 1999. Avian habitat selection: pattern from process in nest-site use by ducks? Ecology 80: 272-287.

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Hirst, S.M., and Easthope, C.A. 1981. Use of agricultural lands by waterfowl in southwestern British Columbia. Journal of Wildlife Management 45: 453-462.

Kantrud, H.A., and Stewart, R.E. 1975. Use of natural basin wetlands by breeding waterfowl in North Dakota. Journal of Wildlife Management 41: 243-253.

Kindopp, R. 2006. Patterns of habitat use of breeding ducks and grebes in the western boreal forest. Master of Science Thesis, University of Lethbridge, Lethbridge, AB. 97 pp.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Nummi, P., and Poysa, H. 1995. Breeding success of ducks in relation to different habitat factors. Ibis 137: 145-150.

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Toft, C.A., Trauger, D.L., and Murdy. H.W. 1982. Tests for species interactions: breeding phenology and habitat use in subarctic ducks. American Naturalist 120: 586-613.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Black Tern

Bergman, R.D., Swain, P., and Weller, M.W. 1970. Comparative study of nesting Forster's and black terns. Wilson Bulletin 82: 435-444.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Munson, B., Ealey, D., Beaver, R., and Fyfe, R. 1980. Inventory of selected raptor, colonial, and sensitive bird species in the Athabasca oil sands area of Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.3.2. 66 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Bonaparte's Gull

Bent, A.C. 1921. Life histories of North American gulls and terns. United States National Museum, Washington, D.C. Bulletin 113. 337 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Bufflehead

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Gauthier, G. 1988. Factors affecting nest box use by buffleheads and other cavity-nesting birds. Wildlife Society Bulletin 16: 132-141.

Gauthier, G., and Smith, J.N.M. 1987. Territorial behaviour, nest-site availability, and breeding density in buffleheads. Journal of Animal Ecology 56: 171-184.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Knutsen, G.A., and King, J.C. 2004. Bufflehead breeding activity in south-central North Dakota. Prairie Naturalist 36: 187-190.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Martin, K., Aitken, K.E.H., and Wiebe, K.L. 2004. Nest sites and nest webs for cavity-nesting communities in interior British Columbia, Canada: nest characteristics and niche partitioning. Condor 106: 5-19.

Monda, M.J., and Ratti, J.T. 1988. Niche overlap and habitat use by sympatric duck broods in eastern Washington. Journal of Wildlife Management 52: 95-103.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Peterson, B., and Gauthier, G. 1985. Nest site use by cavity-nesting birds of the Cariboo Parkland, British Columbia. Wilson Bulletin 97: 319-331.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Common Goldeneye

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Nummi, P., and Poysa, H. 1995. Breeding success of ducks in relation to different habitat factors. Ibis 137: 145-150.

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Senechal, H., Gauthier, G., and Savard, J.-P.L. 2008. Nesting ecology of common goldeneyes and hooded mergansers in a boreal river system. Wilson Journal of Ornithology 120: 732-742.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Common Loon

Found, C., Webb, S.M., and Boyce, M.S. 2008. Selection of lake habitat by waterbirds in the boreal transition zone of northeastern Alberta. Canadian Journal of Zoology 86: 277-285.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Munson, B., Ealey, D., Beaver, R., and Fyfe, R. 1980. Inventory of selected raptor, colonial, and sensitive bird species in the Athabasca oil sands area of Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.3.2. 66 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Common Yellowthroat

DeGraaf, R.M., Hestbeck, J.B., and Yamasaki, M. 1998. Associations between breeding bird abundance and stand structure in the White Mountains, New Hampshire and Maine, USA. Forest Ecology and Management 103: 217-233.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Hagan, J.M., and Meehan, A.L. 2002. The effectiveness of stand-level and landscape-level variables for explaining bird occurrence in an industrial forest. Forest Science 48: 231-242.

Hobson, K.A., and Schieck, J. 1999. Changes in bird communities in boreal mixedwood forest: harvest and wildfire effects over 30 years. Ecological Applications 9: 849-863.

Kendeigh, S.C. 1945. Nesting behavior of wood warblers. Wilson Bulletin 57: 145-164.

Kirk, D.A., Diamond, A.W., Hobson, K.A., and Smith, A.R. 1996. Breeding bird communities of the western and northern Canadian boreal forest: relationship to forest type. Canadian Journal of Zoology 74: 1749-1770.

Lambert, J.D. 2000. A breeding bird survey of the West Mountain Wildlife Management Area and the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. Unpublished report. Vermont Institute of Natural Science, Woodstock, VT.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Robbins, C.S., Dawson, D.K., and Dowell, B.A. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic states. Wildlife Monographs 103: 1-34.

Schmiegelow, F.K.A., Machtans, C.S., and Hannon, S.J. 1997. Are boreal birds resilient to forest fragmentation? An experimental study of short-term community responses. Ecology 78: 1914-1932.

The Boreal Avian Modelling Project. (n.d.). The Boreal Avian Modelling Project Online Database. Results by species. [Online] Available: http://www.borealbirds.ca/avian_db/ [2014 November 20]

Titterington, R.W., Crawford, H.S., and Burgason, B.N. 1979. Songbird responses to commercial clear-cutting in Maine spruce-fir forests. Journal of Wildlife Management 43: 602-609.

Green-winged Teal

Decarie, R., Morneau, F., Lambert, D., Carriere, S., and Savard, J.-P.L. 1995. Habitat use by brood-rearing waterfowl in Subarctic Quebec. Arctic 48: 383-390.

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Kantrud, H.A., and Stewart, R.E. 1975. Use of natural basin wetlands by breeding waterfowl in North Dakota. Journal of Wildlife Management 41: 243-253.

Kindopp, R. 2006. Patterns of habitat use of breeding ducks and grebes in the western boreal forest. Master of Science Thesis, University of Lethbridge, Lethbridge, AB. 97 pp.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Murkin, H.R., Murkin, E.J., and Ball, J.P. 1997. Avian habitat selection and prairie wetland dynamics: a 10-year experiment. Ecological Applications 7: 1144-1159.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Nummi, P., and Hahtola, A. 2008. The beaver as an ecosystem engineer facilitates teal breeding. Ecography 31: 519-524.

Nummi, P., and Poysa, H. 1995. Breeding success of ducks in relation to different habitat factors. Ibis 137: 145-150.

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Paquette, G.A., and Ankney, C.D. 1996. Wetland selection by American green-winged teal breeding in British Columbia. Condor 98: 27-33.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Renouf, R.N. 1972. Waterfowl utilization of beaver ponds in New Brunswick. Journal of Wildlife Management 36: 740-744.

Toft, C.A., Trauger, D.L., and Murdy, H.W. 1982. Tests for species interactions: breeding phenology and habitat use in subarctic ducks. American Naturalist 120: 586-613.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Horned Grebe

COSEWIC. 2009. COSEWIC assessment and status report on the Horned Grebe *Podiceps auritus*, Western population and Magdalen Islands population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 42 pp. [Online] Available: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_horned_grebe_0809_e.pdf. [2014 November 24]

Faaborg, J. 1976. Habitat selection and territorial behavior of the small grebes of North Dakota. Wilson Bulletin 88: 390-399.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Kindopp, R. 2006. Patterns of habitat use of breeding ducks and grebes in the western boreal forest. Master of Science Thesis, University of Lethbridge, Lethbridge, AB. 97 pp.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Nudds, T.D. 1982. Ecological separation of grebes and coots: interference competition or microhabitat selection? Wilson Bulletin 94: 505-514.

Onas, E.E. 2003. The role of competition and local habitat conditions for determining occupancy patterns in grebes. Waterbirds 26: 209-216.

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Le Conte's Sparrow

Bent, A.C. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies – Part 2: Towhees, Juncos, Sparrows. United States National Museum, Washington, D.C. Bulletin 237. 646 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

The Boreal Avian Modelling Project. (n.d.). The Boreal Avian Modelling Project Online Database. Results by species. [Online] Available: http://www.borealbirds.ca/avian_db/ [2014 November 20]

Lesser Scaup

Anteau, M.J., and Afton, A.D. 2009. Wetland use and feeding by lesser scaup during spring migration across the upper Midwest, USA. Wetlands 29: 704-712.

Clark, R.G., and Shutler, D. 1999. Avian habitat selection: pattern from process in nest-site use by ducks? Ecology 80: 272-287.

Corcoran, R.M., Lovvorn, J.R., Bertram, M.R., and Vivion, M.T. 2007. Lesser scaup nest success and duckling survival on the Yukon Flats, Alaska. Journal of Wildlife Management 71: 127-134.

Decarie, R., Morneau, F., Lambert, D., Carriere, S., and Savard, J.-P.L. 1995. Habitat use by brood-rearing waterfowl in Subarctic Quebec. Arctic 48: 383-390.

Dirschl, H.J. 1969. Foods of lesser scaup and blue-winged teal in the Saskatchewan River Delta. Journal of Wildlife Management 33: 77-87.

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Fast, P.L.F., Clark, R.G., Brook, R.W., and Hines, J.E. 2004. Patterns of wetland use by brood-rearing lesser scaup in northern boreal forest of Canada. Waterbirds 27: 177-182.

Fournier, M.A., and Hines, J.E. 2001. Breeding ecology of sympatric greater and lesser scaup (*Aythya marila* and *Aythya affinis*) in the subarctic Northwest Territories. Arctic 54: 44-456.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Kantrud, H.A., and Stewart, R.E. 1975. Use of natural basin wetlands by breeding waterfowl in North Dakota. Journal of Wildlife Management 41: 243-253.

Kindopp, R. 2006. Patterns of habitat use of breeding ducks and grebes in the western boreal forest. Master of Science Thesis, University of Lethbridge, Lethbridge, AB. 97 pp.

Koons, D.N., and Rotella, J.J. 2003. Comparative nesting success of sympatric lesser scaup and ring-necked ducks. Journal of Field Ornithology 74: 222-229.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Monda, M.J., and Ratti, J.T. 1988. Niche overlap and habitat use by sympatric duck broods in eastern Washington. Journal of Wildlife Management 52: 95-103.

Murkin, H.R., Murkin, E.J., and Ball, J.P. 1997. Avian habitat selection and prairie wetland dynamics: a 10-year experiment. Ecological Applications 7: 1144-1159.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Siegfried, W.R. 1976. Segregation in feeding behaviour of four diving ducks in southern Manitoba. Canadian Journal of Zoology 54: 730-736.

Toft, C.A., Trauger, D.L., and Murdy, H.W. 1982. Tests for species interactions: breeding phenology and habitat use in subarctic ducks. American Naturalist 120: 586-613.

Walker, J., Lindberg, M.S., MacCluskie, M.C., Petrula, M.J., and Sedinger, J.S. 2005. Nest survival of scaup and other ducks in the boreal forest of Alaska. Journal of Wildlife Management 69: 582-591.

Walsh, K.A., Halliwell, D.R., Hines, J.E., Fournier, M.A., Czarnecki, A., and Dahl, M.F. 2006. Effects of water quality on habitat use by lesser scaup (*Aythya affinis*) broods in the boreal Northwest Territories, Canada. Hydrobiologia 567: 101-111.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Lesser Yellowlegs

Colwell, M.A., and Oring, L.W. 1988. Habitat use by breeding and migrating shorebirds in southcentral Saskatchewan. Wilson Bulletin 100: 554-566.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Johnsgaurd, P.A. 2009. Rails, cranes, and shorebirds. p. 142-182. In: Birds of the Rocky Mountains. Paper 12.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Manuwal, D.A. 1978. Avian diversity and habitat selection in the Noatak Valley, Brooks Range, Alaska. Murrelet 59: 42-58.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Nelson's Sparrow

Bent, A.C. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies – Part 2: Towhees, Juncos, Sparrows. United States National Museum, Washington, D.C. Bulletin 237. 646 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

The Boreal Avian Modelling Project. (n.d.). The Boreal Avian Modelling Project Online Database. Results by species. [Online] Available: http://www.borealbirds.ca/avian_db/ [2014 November 20]

Olive-sided Flycatcher

Andres, B.A., Sorensen, A.J., and Browne, B.T. 2001. Inventory and monitoring of Neotropical migratory landbirds on Fort Richardson, Alaska. Nongame Migratory Bird Management. U.S. Fish and Wildlife Service, Anchorage, AK.

Bock, C.E., and Lynch, J.F. 1970. Breeding bird populations of burned and unburned conifer forest in the Sierra Nevada. Condor 72: 182-189.

COSEWIC. 2007. COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 25 pp. [Online] Available: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_olivesided_flycatcher_0808_e.pdf [2014 November 20]

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Golder Associates. 2011. Shell Jackpine Mine Expansion & Pierre River Mine Project: Federally Listed Species at Risk. Prepared for Shell Canada Limited. Report No. 10-1346-0001/6500. 45 pp.

Hutto, R.L. 1995. Composition of bird communities following stand-replacement fires in northern Rocky Mountain (U.S.A.) conifer forests. Conservation Biology 9: 1041-1058.

Kirk, D.A., Diamond, A.W., Hobson, K.A., and Smith, A.R. 1996. Breeding bird communities of the western and northern Canadian boreal forest: relationship to forest type. Canadian Journal of Zoology 74: 1749-1770.

Lambert, J.D. 2000. A breeding bird survey of the West Mountain Wildlife Management Area and the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. Unpublished report. Vermont Institute of Natural Science, Woodstock, VT.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Manuwal, D.A. 1978. Avian diversity and habitat selection in the Noatak Valley, Brooks Range, Alaska. Murrelet 59: 42-58.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Raphael, M.G., Morrison, M.L., and Yoder-Williams, M.P. 1987. Breeding bird populations during twenty-five years of postfire succession in the Sierra Nevada. Condor 89: 614-626.

Schmiegelow, F.K.A., Machtans, C.S., and Hannon, S.J. 1997. Are boreal birds resilient to forest fragmentation? An experimental study of short-term community responses. Ecology 78: 1914-1932.

The Boreal Avian Modelling Project. (n.d.). The Boreal Avian Modelling Project Online Database. Results by species. [Online] Available: http://www.borealbirds.ca/avian_db/ [2014 November 20]

Wright, J.M. 1997. Preliminary study of olive-sided flycatchers, July 1994-April 1997. Alaska Department of Fish and Game. Final research report. Endangered species conservation fund federal aid studies SE-3-3, 4 and 5. Juneau, AK.

Ring-necked Duck

Donaghey, R.H. 1974. Waterfowl use of boreal forest waterbodies near Utikuma Lake, northern Alberta. Ducks Unlimited Canada, Edmonton, AB. 194 pp.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Hennan, E. 1972. Status of waterfowl on the Peace-Athabasca Delta. Ducks Unlimited Canada, Winnipeg, MB. 105 pp.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

Hohman, W.L. 1985. Feeding ecology of ring-necked ducks in northwestern Minnesota. Journal of Wildlife Management 49: 546-557.

Hohman, W.L. 1986. Incubation rhythms of ring-necked ducks. Condor 88: 290-296.

Kantrud, H.A., and Stewart, R.E. 1975. Use of natural basin wetlands by breeding waterfowl in North Dakota. Journal of Wildlife Management 41: 243-253.

Kindopp, R. 2006. Patterns of habitat use of breeding ducks and grebes in the western boreal forest. Master of Science Thesis, University of Lethbridge, Lethbridge, AB. 97 pp.

Koons, D.N., and Rotella, J.J. 2003. Comparative nesting success of sympatric lesser scaup and ring-necked ducks. Journal of Field Ornithology 74: 222-229.

Lambert, J.D. 2000. A breeding bird survey of the West Mountain Wildlife Management Area and the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. Unpublished report. Vermont Institute of Natural Science, Woodstock, VT.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. 2010. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321-332.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Maxson, S.J., and Pace, R.M., III. 1992. Diurnal time-activity budgets and habitat use of ring-necked duck ducklings in northcentral Minnesota. Wilson Bulletin 104: 472-484.

Maxson, S.J., and Riggs, M.R. 1996. Use and nest success of overwater nesting ducks in westcentral Minnesota. Journal of Wildlife Management 60: 108-119.

Monda, M.J., and Ratti, J.T. 1988. Niche overlap and habitat use by sympatric duck broods in eastern Washington. Journal of Wildlife Management 52: 95-103.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Rempel, R.S., Abraham, K.F., Gadawski, T.R., Gabor, S., and Ross, R.K. 1997. A simple wetland habitat classification for boreal forest waterfowl. Journal of Wildlife Management 61: 746-757.

Renouf, R.N. 1972. Waterfowl utilization of beaver ponds in New Brunswick. Journal of Wildlife Management 36: 740-744.

Toft, C.A., Trauger, D.L., and Murdy, H.W. 1982. Tests for species interactions: breeding phenology and habitat use in subarctic ducks. American Naturalist 120: 586-613.

Wiacek, R., Nietfeld, M., and Lazaruk, H. 2002. A review and assessment of existing information for key wildlife and fish species in the Regional Sustainable Development Strategy Study Area, Vol. 1: Wildlife. Prepared for the Cumulative Environmental Management Association, Fish and Wildlife Working Group by Westworth Associates Environmental Ltd., Edmonton, AB. 281 pp.

Rusty Blackbird

COSEWIC. 2006. COSEWIC assessment and status report on the Rusty Blackbird *Euphagus carolinus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 28 pp. [Online]

Available:
http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_rusty_blackbird_0806_e.pdf [2014 November 24]

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Golder Associates. 2011. Shell Jackpine Mine Expansion & Pierre River Mine Project: Federally Listed Species at Risk. Prepared for Shell Canada Limited. Report No. 10-1346-0001/6500. 45 pp.

Hobson, K.A., and Schieck, J. 1999. Changes in bird communities in boreal mixedwood forest: harvest and wildfire effects over 30 years. Ecological Applications 9: 849-863.

Lambert, J.D. 2000. A breeding bird survey of the West Mountain Wildlife Management Area and the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. Unpublished report. Vermont Institute of Natural Science, Woodstock, VT.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Solitary Sandpiper

Colwell, M.A., and Oring, L.W. 1988. Habitat use by breeding and migrating shorebirds in southcentral Saskatchewan. Wilson Bulletin 100: 554-566.

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates. 2011. Shell Jackpine Mine Expansion & Pierre River Mine Project: Federally Listed Species at Risk. Prepared for Shell Canada Limited. Report No. 10-1346-0001/6500. 45 pp.

Hobson, K.A., and Schieck, J. 1999. Changes in bird communities in boreal mixedwood forest: harvest and wildfire effects over 30 years. Ecological Applications 9: 849-863.

Johnsgaurd, P.A. 2009. Rails, cranes, and shorebirds. p. 142-182. In: Birds of the Rocky Mountains. Paper 12.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

Manuwal, D.A. 1978. Avian diversity and habitat selection in the Noatak Valley, Brooks Range, Alaska. Murrelet 59: 42-58.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Westworth, D.A., and Telfer, E.S. 1993. Summer and winter bird populations associated with five age-classes of aspen forest in Alberta. Canadian Journal of Forest Research 23: 1830-1836.

Sora

Baschuk, M.S., Koper, N., Wrubleski, D.A., and Goldsborough, G. 2012. Effects of water depth, cover and food resources on habitat use of marsh birds and waterfowl in boreal wetlands of Manitoba, Canada. Waterbirds 35: 44-55.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Johnsgaurd, P.A. 2009. Rails, cranes, and shorebirds. p. 142-182 In: Birds of the Rocky Mountains. Paper 12.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Trumpeter Swan

Hansen, H.A., Shepherd, P.E.K., King, J.G., and Troyer, W.A. 1971. The trumpeter swan in Alaska. Wildlife Monographs 26: 3-83.

Hennan, E., and Munson, B. 1979. Species distribution and habitat relationships of waterfowl in northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 22.1.2. AOSERP Report 81. 115 pp.

James, M.L. 2000. Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 26, Edmonton, AB.

La Montagne, J.M., Jackson, L.J., and Barclay, R.M.R. 2003. Characteristics of ponds used by trumpeter swans in a spring migration stopover area. Canadian Journal of Zoology-Revue Canadienne De Zoologie 81: 1791-1798.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

McKelvey, R.W., Dennington, M.C., and Mossop, D. 1983. The status and distribution of trumpeter swans (*Cygnus buccinator*) in the Yukon. Arctic 36: 76-81.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Schmidt, J.H., Lindberg, M.S., Johnson, D.S., and Schmutz, J.A. 2009. Environmental and human influences on trumpeter swan occupancy in Alaska. Condor 111: 266-275.

Shandruk, L. 1987. A review of habitat requirements and management priorities for the Canadian breeding population of trumpeter swans. p. 179-187. In: G.L. Holroyd, W.B. McGillivray, P.H.R. Stepney, D.M. Ealey, G.C. Trottier, and K.W. Eberhart (eds.). Proceedings of the Workshop on Endangered Species in the Prairie Provinces. Provincial Museum of Alberta Natural History Occasional Paper No. 9. Edmonton, AB.

Wilson's Snipe

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Lambert, J.D. 2000. A breeding bird survey of the West Mountain Wildlife Management Area and the Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge. Unpublished report. Vermont Institute of Natural Science, Woodstock, VT.

Lumbis, K., Martin, J., and Rhude, L. 1999. Fish and wildlife considerations for wetland creation. Appendix E. In: N. Chymko (ed.). 2000. Guidelines for wetland establishment on reclaimed oil sands leases. Prepared by the Oil Sands Wetlands Working Group, Alberta Environment, Environmental Service, Edmonton, AB. Report No. ESD/LM/00-1.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Westworth, D.A., and Telfer, E.S. 1993. Summer and winter bird populations associated with five age-classes of aspen forest in Alberta. Canadian Journal of Forest Research 23: 1830-1836.

Yellow Rail

COSEWIC. 2001. COSEWIC assessment and status report on the yellow rail *Coturnicops noveboracensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 62 pp. [Online] Available: http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_yellow_rail_1101_e.pdf. [2014 November 24]

Francis, J., and Lumbis, K. 1979. Habitat relationships and management of terrestrial birds in northeastern Alberta. Prepared for the Alberta Oil Sands Environmental Research Program by the Canadian Wildlife Service, Edmonton, AB. 365 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Golder Associates. 2011. Shell Jackpine Mine Expansion & Pierre River Mine Project: Federally Listed Species at Risk. Prepared for Shell Canada Limited. Report No. 10-1346-0001/6500. 45 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Poole, A. (ed.). 2013. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. [Online] Available: http://bna.birds.cornell.edu/bna/ [2014 November 20]

Amphibians

Western Toad

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Wind, E.I., and Dupuis, L.A. 2002. COSEWIC status report on the western toad *Bufo boreas* in Canada, in COSEWIC assessment and status report on the western toad *Bufo boreas* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

Bats

Big Brown Bat

Betts, B. 1996. Roosting behavior of silver-haired and big brown bats in Northeast Oregon. p. 55-61. In: R.M.R. Barclay, and R.M. Brigham (eds.). Bats and Forests Symposium. Ministry of Forests, Victoria, BC. Working Paper 23.

Black, H.L. 1974. A north temperate bat community structure and prey populations. Journal of Mammalogy 55: 138-157.

Brigham, R.M. 1991. Flexibility in foraging and roosting behaviour by the big brown bat (*Eptesicus fuscus*). Canadian Journal of Zoology 69: 117-121

Christian, J.J. 1956. The natural history of a summer aggregation of the big brown bat*, Eptesicus fuscus fuscus*. The American Midland Naturalist 55: 66-95.

Davis, W.H., Barbour, R.W., Hassell, M.D. 1968. Colonial behavior of *Eptesicus fuscus*. Journal of Mammalogy 49: 44-50.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Furlonger, C.L., Dewar, H.J., and Fenton, M.B. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology 65: 284-288.

Geggie, J.F., and Fenton, M.B. 1985. A comparison of foraging by *Eptesicus fuscus* (Chiroptera: Vespertilionidae) in urban and rural environments. Canadian Journal of Zoology 63: 263-267.

Goehring, H. 1972. Twenty-Year Study of *Eptesicus fuscus* in Minnesota. Journal of Mammalogy 53: 201-207.

Hamilton, I.M., and Barclay, R.M.R. 1994. Patterns of daily torpor and day-roost selection by male and female big brown bats (*Eptesicus fuscus*). Canadian Journal of Zoology 72: 744-749

Hamilton, I.M., and Barclay, R.M.R. 1998. Diets of juvenile, yearling, and adult big brown bats (*Eptesicus fuscus*) in southeastern Alberta. Journal of Mammalogy 79: 764-771.

Kalcounis, M. 1994. Selection of tree roost sites by big brown (*Eptesicus fuscus)*, little brown (*Myotis lucifugus)* and hoary (*Lasiurus cinereus)* bats in Cypress Hills, Saskatchewan. Bat Research News 35: 103.

Knowles, B. 1992. Bat hibernacula on Lake Superior's north shore, Minnesota. Canadian Field Naturalist 106: 252-254.

Kurta, A. 1982. Flight patterns of *Eptesicus fuscus* and *Myotis lucifugus* over a stream. Journal of Mammalogy 63: 335-337.

Kurta, A., and Baker, R.H. 1990. *Eptesicus fuscus*. American Society of Mammalogists, Mammalian Species 356: 1-10

Kurta, A., Hubbard, T., and Stewart, M.E. 1989. Bat species diversity in central Michigan. Jack-Pine Warbler 67: 80-87.

Mills, R.S., Barrett, G.W., and Farrell, M.P. 1975. Population dynamics of the big brown bat (*Eptesicus fuscus*) in southwestern Ohio. Journal of Mammalogy 56: 591-604.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Perkins, J.M. 1996. Bat distribution within a managed forest. p. 164-174. In: R.M.R. Barclay and R.M. Brigham (eds.). Bats and Forests Symposium. Ministry of Forests, Victoria, BC, Working Paper 23.

Phillips, G.S. 1966. Ecology of the big brown bat (Chiroptera: Vespertilionidae) in northeastern Kansas. American Midland Naturalist 75: 168-198.

Vonhof, M. 1995. Roosting ecology and roost-site preferences of reproductive *Eptesicus fuscus* and *Lasionycteris noctivagans* in the Pend D'Oreille Valley in southern British Columbia. p. 62-80. In: R.M.R. Barclay and R.M. Brigham (eds.). Bats and Forests Symposium. Ministry of Forests, Victoria, BC, Working Paper 23.

Vonhof, M.J., and Barclay, R.M.R. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74: 1797-1805.

Whitaker, J.O., Jr. 1995. Food of the big brown bat *Eptesicus fuscus* from maternity colonies in Indiana and Illinois. American Midland Naturalist, 134: 346-360.

Whitaker, J.O., Jr., and Gummer, S.L. 1992. Hibernation of the big brown bat, *Eptesicus fuscus*, in buildings. Journal of Mammalogy 73: 312-316

Whitaker, J.O., Maser, C., and Keller, L.E. 1977. Food habits of bats of Western Oregon. Northwest Science. 51: 46-55.

Eastern Red Bat

Constantine, D.G. 1958. Ecological observations on lasiurine bats in Georgia. Journal of Mammalogy 39: 64-70.

Constantine, D.G. 1959. Ecological observations on lasiurine bats in the North Bay area of California. Journal of Mammalogy 40: 13-15.

Constantine, D.G. 1966. Ecological observations on lasiurine bats in Iowa. Journal of Mammalogy 47: 34-41.

Crampton, L.H., and Barclay, R.M.R. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12: 1347-1358.

Downes, W.L., Jr. 1964. Unusual roosting behavior in red bats. Journal of Mammalogy 45: 143-144.

Furlonger, C.L., Dewar, H.J., and Fenton, M.B. 1987. Habitat use by insectivorous bats. Canadian Journal of Zoology 65: 284-288.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Hickey, B., Acharya, L., and Pennington, S. 1996. Resource partitioning by two species of vespertilionis bats (*Laiurus cinereus* and *Lasiurus borealis*) feeding around street light. Journal of Mammology 77: 325-334.

Kunz, T.H. 1973. Resource utilization: temporal and spatial components of bat activity in central Iowa. Journal of Mammalogy 54: 14-32.

McClure, H.E. 1942. Summer activities of bats (genus *Lasiurus*) in Iowa. Journal of Mammalogy 23: 430-434.

Mumford, R.E. 1973. Natural history of the red bat (*Lasiurus borealis*) in Indiana. Period. Biol. 75: 155-158.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Little Brown Myotis

Adams, R.A. 1990. Biogeography of bats in Colorado - ecological implications of species tolerances. Bat Research News 31: 17-21.

Anthony, E., and Kunz, T. 1977. Feeding strategies of the little brown bat, *Myotis lucifugus*, In southern New Hampshire. Ecology 58: 775-786.

Buchler, E.R. 1976. Prey selection by *myotis lucifugus* (Chiroptera: Vespertilionidae). American Naturalist 110: 619-628.

Crampton, L.H., and Barclay, R.M.R. 1995. Relationships between bats and stand age and structure in aspen mixedwood forests in Alberta. In: J.B. Stelfox (ed.). Relationships between Stand Age, Stand Structure and Biodiversity in Aspen Mixedwood Forests in Alberta. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB. Canada-Alberta Partnership Agreement in Forestry Report 302. 308 pp.

Crampton, L.H., and Barclay, R.M.R. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12: 1347-1358.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Fenton, B. 1978. Bats. Nature Canada 7: 32-38.

Fenton, M.B. 1969. Summer activity of *Myotis lucifugus* (Chiroptera: Vespertilionidae) at hibernacula in Ontario and Quebec. Canadian Journal of Zoology 47: 597-602.

Fenton, M.B., and Barclay, R.M.R. 1980. *Myotis lucifugus*. Mammalian Species 142: 1-8.

Fenton, M.B., and Bell, G.P. 1979. Echolocation and feeding behaviour in four species of *Myotis* (Chiroptera). Canadian Journal of Zoology 57: 1271-1277.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Herd, R.M., and Fenton, M.B. 1983. An electrophoretic, morphological, and ecological investigation of a putative hybrid zone between *Myotis lucifugus* and *Myotis yumanensis* (Chiroptera: Vespertilionidae). Canadian Journal of Zoology 61: 2029-2050.

Jones, J.K., Armstrong, D.M., Hoffmann, R.S., and Jones, C. 1982. Mammals of the Northern Great Plains. University of Nebraska Press, Lincoln, NE. 379 pp.

Kunz, T.H., and Reichard, J.D. 2010. Status review of the little brown myotis (*Myotis lucifugus*) and determination that immediate listing under the Endangered Species Act is scientifically and legally warranted. Report in collaboration with: Friends of Backwater Canyon, Wildlife Advocacy Project, Bat Conservation International, Center for Biological Diversity, and Meyer Glitzenstein & Crystal. Boston University, Boston, MA. 30 pp.

Nagorsen, D.W., and Brigham, R.M. 1993. Bats of British Columbia; Volume 1 Mammals of British Columbia. Royal British Columbia Museum Handbook. University of British Columbia Press, Vancouver, BC. 164 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Randall, L.A., Barclay, R.M.R., Reid, M.L., and Jung, T.S. 2011. Recent infestation of forest stands by spruce beetles does not predict habitat use by little brown bats (*Myotis lucifugus*) in southwestern Yukon, Canada. Forest Ecology and Management 261: 1950-1956.

Schwartz, C.W., and Schwartz, E.R. 1981. The wild mammals of Missouri. University of Missouri Press, Columbia, MO. 392 pp.

Soper, J.D. 1964. The Mammals of Alberta. Hamly Press Ltd., Edmonton, AB. 402 pp.

Thomas, D.W., and West, S.D. 1991. Forest age associations of bats in the southern Washington Cascade and Oregon Coast Ranges. U.S. Forest Service. General Technical Reports PNW 295-303.

Tuttle, M. 1991. How North America's Bats Survive the winter. Bats 9: 7-12.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. Vol. 2: Bats. National Museum of Natural Sciences, Ottawa, ON. 212 pp.

Wilson, D., and Ruff, S. 1999. The Smithsonian book of North American mammals. Smithsonian Institution Press in association with the American Society of Mammalogists, Washington, DC. 750 pp.

Hoary Bat

Barclay, R.M.R. 1985 -1986. Foraging strategies of silver haired (*Lasionycteris noctivagans*) and hoary (*Lasiurus cinereus*) bats. Myotis 23-24: 161-166.

Barclay, R.M.R. 1985. Long- versus short-range foraging strategies of hoary (*Lasiurus cinereus*) and silver-haired (*Lasionycteris noctivagans*) bats and the consequences for prey selection. Canadian Journal of Zoology 63: 2507-2515.

Constantine, D.G. 1966. Ecological observations on lasiurine bats in Iowa. Journal of Mammalogy, 47: 34-41.

Crampton, L.H., and Barclay, R.M.R. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12: 1347-1358.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Furlonger, C.L., Dewar, H.J., and Fenton, M.B. 1987. Habitat use by insectivorous bats. Canadian Journal of Zoology 65: 284-288.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Hickey, C.B. 1990. Use of torpor by free-living *Lasiurus cinereus*. Bat Research News, 30: 67.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Perkins, J. M., and Cross, S.P. 1988. Differential use of some coniferous forest habitats by hoary and silver-haired bats in Oregon. Murrelet 69: 21-24.

Shump, K.A., Jr., and Shump, A.U. 1982. *Lasiurus cinereus*. American Society of Mammalogists, Mammalian Species, 185: 1-5.

Whitaker, J.O., Maser, C., and Keller, L.E. 1977. Food habits of bats of western Oregon. Northwest Science 51: 46-55.

Long-eared Myotis

Albright, R. 1959. Bat banding at Oregon Caves. Murrelet 40: 26-27.

Allen, H. 1864. Monograph of the bats of North America. Smithsonian Miscellaneous Collection 7: 1-85.

Andersen, K.W., and Jones, J.K., Jr. 1971. Mammals of Northwestern South Dakota. University of Kansas Publication, Museum of Natural History 19: 361-393.

Chruszcz, B., and Barclay, M. 2002. Thermoregulatory ecology of a solitary bat, *Myotis evotis*, roosting in rock crevices. Functional Ecology 16: 18-26.

Chruszcz, B., and Barclay, M. 2003. Prolonged foraging bouts of a solitary gleaning/hawking bat, *Myotis evotis*. Canadian Journal of Zoology 81: 823-826.

Cowan, I. M., and Guiguet, C.J. 1960. The mammals of British Columbia. Handbook British Columbia Provincial Museum 11:1-413.

Faure, P.A., and Barclay, R.M.R. 1994. Substrate-gleaning versus aerial-hawking: plasticity in the foraging and echolocation behaviour of the long-eared bat, *Myotis evotis*. Journal Comparative Physiology 174: 651-660.

Jones, C. 1965. Ecological distribution and activity periods of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. Tulane Stud. Zool. 12: 93-100.

Jones, J.K., Jr., Lampe, R.P., Spenrath, C.A., and Kunz, T.H. 1973. Notes on the distribution and natural history of bats in Southeastern Montana. Occasional Papers of the Museum of Texas Tech University 15: 1-12.

Manning, R.W. 1993. Systematics and evolutionary relationships of the long-eared myotis, *Myotis evotis* (Chiroptera: Vespertilionidae). Texas Tech University Special Publications No. 37: 1-58.

Manning, R.W., and Jones, J.K., Jr. 1989. *Myotis evotis*. American Society of Mammalogists, Mammalian Species 329: 1-5.

Maser, C., Mate, B.R., Franklin, J.F., and Dryness, C.T. 1981. Natural history of the Oregon coast mammals. Pacific Northwest Forest Range Experiment Station, U. S. Department of Agriculture, Forest Service, General Technical Report, PNW-133: 1-496.

Nagorsen, D.W., and Brigham, R.M. 1993. Bats of British Columbia; Volume 1 Mammals of British Columbia. Royal British Columbia Museum Handbook. University of British Columbia Press, Vancouver, BC. 164 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Rancourt, S.J., Rule, M.I., and O'Connell, M.A. 2005. Maternity roost site selection of long-eared myotis, *Myotis evotis*. Journal of Mammalogy 86: 77-84.

Rust, H.J. 1946. Mammals of northern Idaho. Journal of Mammalogy 27: 308-327.

Vonhof, M.J., and Barclay, R.M.R. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74: 1797-1805.

Vonhof, M.J., and Barclay, R.M.R. 1997. Use of tree stumps as roosts by the western long-eared bat. Journal of Wildlife Management 61: 674-684.

Waldien, D., Hayes, J., and Arnett, E. 2000. Day-roosts of female long-eared myotis in Western Oregon. Journal of Wildlife Management 63/4: 785-796.

Long-legged Myotis

Bell, G.P. 1980. Habitat use and response to patches of prey by desert insectivorous bats. Canadian Journal of Zoology 58: 1876-1883.

Black, H.L. 1974. A north temperate bat community: structure and prey populations. Journal of Mammalogy 55: 138-157.

Dalquest, W.W., and Ramage, M.C. 1946. Notes on the long-legged bat (*Myotis volans*) at Old Fort Tejon and vicinity, California. Journal of Mammalogy 27: 60-63.

Fenton, M.B., and Bell, G.P. 1979. Echolocation and feeding behaviour in four species of *Myotis* (Chiroptera). Canadian Journal of Zoology 57: 1271-1277.

Fenton, M.B., van Zyll de Jong, C.G., Bell, G.P., Campbell, D.B., and Laplante, M. 1980. Distribution, parturition dates, and feeding of bats in south-central British Columbia. Canadian Field-Naturalist 94: 416-420.

Jones, J.K., Jr., Lampe, R.P., Spernath, C.A., and Kunz, T.H. 1973. Notes on the distribution and natural history of bats in southern Montana. Occassional Papers of the Museum of Texas Tech University 15: 1-12.

Martin, R.A., and Hawks, B.G. 1972. Hibernating bats of the Black Hills of South Dakota: distribution and habitat selection. New Jersey Academy of Science Bulletin 17: 24-30.

Nagorsen, D.W., and Brigham, R.M. 1993. Bats of British Columbia; Volume 1 Mammals of British Columbia. Royal British Columbia Museum Handbook. University of British Columbia Press, Vancouver, BC. 164 pp.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ormsbee, P.C. 1996. Characteristics, use, and distribution of day roosts selected by female *Myotis volans* (long-legged myotis) in forested habitat of the central Oregon Cascades. p. 124-131. In: R.M.R. Barclay and R.M. Brigham (eds.). Bats and Forests Symposium. British Columbia Ministry of Forests, Victoria, BC, Working Paper 23.

Parker, D.I., Cook, J.A., and Lewis, S.W. 1996. Effects of timber harvest on bat activity in southeastern Alaska's temperate rainforests. p. 277-292. In R.M.R. Barclay and R.M. Brigham (eds.). Bats and Forests Symposium. British Columbia Ministry of Forests, Victoria, BC, Working Paper 23.

Quay, W.B. 1948. Notes on some bats from Nebraska and Wyoming. Journal of Mammalogy 29: 181-182.

Schowalter, D.B. 1980. Swarming, reproduction and early hibernation of *Myotis lucifugus* and *M. Volans* in Alberta, Canada. Journal of Mammalogy 61: 350-354.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. Vol. 2: Bats. National Museum of Natural Sciences, Ottawa, ON. 212 pp.

Vonhof, M.J., and Barclay, R.M.R. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74: 1797-1805.

Warner, R.M., and Czaplewski, N.J. 1984. *Myotis volans*. American Society of Mammalogists, Mammalian Species 224: 1-4.

Whitaker, J. O., Maser, C., and Cross, S.P. 1981. Food habits of eastern Oregon bats, based on stomach and scat analysis. Northwest Science 55: 281-292.

Whitaker, J. O., Maser, C., and Keller, L.E. 1977. Food habits of bats of western Oregon. Northwest Science 51: 46-55.

Northern Myotis

Alberta Sustainable Resource Development and Alberta Conservation Association. 2009. Status of the northern myotis (*Myotis septentrionalis*) in Alberta: update 2009. Alberta Sustainable Resource Development. Wildlife Status Report No. 3 (Update 2009). Edmonton, AB. 34 pp.

Brandon, R.A. 1961. Observations of young keen bats. Journal of Mammalogy 42: 400-1

Caceres, M.C., and Barclay, R.M.R. 2000. *Myotis septentrionalis*. Mammalian Species, No. 634.

Caceres, M.C., and Pybus, M.J. 1997. Status of the northern long-eared bat (*Myotis septentrionalis*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, AB. 19 pp.

Caire, W., LaVal, R.K., LaVal, M.L., and Clawson, R. 1979. Notes on the ecology of *Myotis keenii* (Chiroptera, Vespertilionidae) in Eastern Missouri. American Midland Naturalist 102: 404-407.

Clark, B.K., Bowles, J.B., and Clark, B.S. 1987. Summer status of the endangered Indiana bat in Iowa. American Midland Naturalist 118: 32-39.

Cope, J.B., and Humphrey, S.R. 1972. Reproduction of the bats *Myotis keenii* and *Pipistrellus subflavus* in Indiana. Bat Research News 13: 9-10.

Crampton, L.H., and Barclay, R.M.R. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12: 1347-1358.

Foster, R.W., and Kurta, A. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy 80: 659-672.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Griffin, D.R. 1940. Migrations of New England bats. Bulletin of the Museum of Comparative Zoology 86: 217-246.

Griffin, D.R. 1940. Notes on the life histories of New England cave bats. Journal of Mammalogy 21: 181-187.

Hitchcock, H.B. 1949. Hibernation of bats in southeastern Ontario and adjacent Quebec. Canadian Field Naturalist 63: 47-59.

Jones, J.K., Armstrong, D.M., Hoffmann, R.S., and Jones, C. 1982. Mammals of the Northern Great Plains. University of Nebraska Press, Lincoln, NE. 379 pp.

Jones, J.K., Jr., Fleharty, E.D., and Dunnigan, P.B. 1967. The distributional status of bats in Kansas. University of Kansas, Museum of Natural History Miscellaneous Publication 46: 1-33.

Kunz, T.H. 1971. Reproduction of some vespertilionid bats of central Iowa. American Midland Naturalist 86: 477-486.

Kunz, T.H. 1973. Resource utilization: temporal and spatial components of bat activity in central Iowa. Journal of Mammalogy 54: 14-32.

Kurta, A. 1982. A review of Michigan bats: seasonal and geographic distribution. Michigan Academy of Science, Arts, and Letters 14: 295-312.

LaVal, R.K., Clawson, R.L., LaVal, M.L., and Caire, W. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. Journal of Mammalogy 58: 592-599.

Layne, J.N. 1958. Notes on animals of southern Illinois. American Midland Naturalist 60: 219-254

McNab, B.K. 1982. Evolutionary alternatives in the physiological ecology of bats. p. 151-200. In: T. H. Kunz (ed.). Ecology of Bats. Plenum Press, New York, NY.

Menzel, M.A., Odom, R., Owen, S., Ford, W.M., Chapman, B.R., Miller, K.V., Edwards, J., and Wood, P. 1999. Investigation of foraging habitat use by bats with a focus on northern long-eared myotis (*Myotis septentrionalis*): a comparison of methods. In: M.K. Clark (ed.). Abstracts from the 1999 Colloquium on the conservation of mammals in the Southeastern United States.

Mills, R.S. 1971. A concentration of *Myotis keenii* at caves in Ohio. Journal of Mammalogy 52: 625.

Mumford, R.E., and Cope, J.B. 1964. Distribution and status of the Chiroptera of Indiana. American Midland Naturalist 72: 473-489.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ollendorff, J. 2002. *Myotis septentrionalis* (Northern Long Eared Bat). University of Michigan Museum of Zoology Animal Diversity Web. [Online] Available: http://animaldiversity.ummz.umich.edu/accounts/Myotis_septentrionalis/ [2014 November 21].

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Pearson, E.W. 1962. Bats hibernating in silica mines in southern Illinois. Journal of Mammalogy 43: 27-33.

Sasse, D.B., and Pekins, P.J. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. p. 91-101. In: R.M.R. Barclay and R.M. Brigham (eds.). Bats and forests symposium. B.C. Ministry of Forests, Research Branch, Victoria, BC. Working Paper 23/1996.

Stones, R.C. 1981. Survey of winter bat populations in search of the Indiana bat in the western Upper Peninsula of Michigan. Report submitted to Michigan Department of Natural Resources. 20 pp.

van Zyll de Jong, C.G. 1979. Distribution and systematic relationships of long-eared myotis in western Canada. Canadian Journal Zoology 57: 987-994.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. Vol. 2: Bats. National Museum of Natural Sciences, Ottawa, ON. 212 pp.

Vonhof, M.J., and Barclay, R.M.R. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74: 1797-1805.

Vonhof, M.J., and Wilkinson, L.C. 2000. A summary of roosting requirements of northern long-eared myotis in northeastern British Columbia. p. 459-460. In: L.M. Darling (ed.). Proceedings of the Conference on Biology and Management of Species and Habitats at Risk, vol. 1. British Columbia Ministry of Environment, Lands and Parks, Victoria, BC, and University College of the Cariboo, Kamloops, BC.

Silver-haired Bat

Barclay, R.M.R. 1986. Long-versus short-range foraging strategies of hoary (*Lasiurus cinereus)* and silver-haired (*Lasionycteris noctivagans)* bats and the consequences for prey selection. Canadian Journal of Zoology 63: 2507-2515.

Barclay, R.M.R., Faure, P.A., and Farr, D.R. 1988. Roosting behavior and roost selection by migrating silver-haired bats (*Lasionycteris noctivagans*). Journal of Mammalogy 69: 821-825.

Betts, B.J. 1996. Roosting behaviour of silver-haired bats (*Lasionycteris noctivagans*) and big brown bats (*Eptesicus fuscus*) in northeast Oregon. p. 55-61. In: R.M.R. Barclay and M.R. Brigham (ed.) Bats and Forest Symposium. British Columbia Ministry of Forests, Victoria, BC.

Campbell, L.A., Hallett, J.G., and O'Connell, M.A. 1996. Conservation of bats in managed forests: use of roosts by *Lasionycteris noctivagans*. Journal of Mammology 77: 976-984.

Crampton, L.H., and Barclay, R.M.R. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12: 1347-1358.

Cross, S.P. (ed.). 1976. A survey of bat populations and their habitat preferences in Southern Oregon. Unpublished report.

Ealey, D.M., Hannon, S., and Hilchie, G.J. 1979. An interim report on the insectivorous animals in the AOSERP study area. Prepared for Alberta Oil Sands Environmental Research Program, Edmonton, AB. AOSERP Project LS 28.1.12. AOSERP Report 70. 294 pp.

Golder Associates Ltd. 2007. Section 5: Wildlife and Wildlife Habitat. Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project. Prepared for Shell Canada Limited, Calgary, AB. pp. 5-1 – 5-185. [Online] Available: http://s04.static-shell.com/content/dam/shell-new/local/country/can/downloads/pdf/aboutshell/aosp/esr-terrestrial.pdf [2014 November 24]

Kunz, T.H. 1982. *Lasionycteris noctivagans*. American Society of Mammalogists, Mammalian Species, 172: 1- 5.

Mattson, T.A., Buskirk, S.W., and Stanton, N.L. 1996. Roost sites of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills, South Dakota. Great Basin Naturalist 56: 247-253.

NatureServe. 2014. NatureServe Explorer: An Online Encyclopedia of Life. [Online] Available: http://www.natureserve.org/explorer/ [2014 November 20]

Ontario Ministry of Natural Resources. 2000. Wildlife habitat matrices and habitat descriptions for rare vascular plants. Appendix G. In: Significant wildlife habitat technical guide. Fish and Wildlife Branch, Peterborough, ON. 151 pp.

Perkins, J.M., and Cross, S.P. 1988. Differential use of some coniferous forest habitats by hoary and silver- haired bats in Oregon. Murrelet 69: 21-24.

Vonhof, M.J. 1996. Roost-site preference of big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*) in the Pend d'Oreille Valley in southern British Columbia. p. 62-80. In: R.M.R. Barclay and M.R. Brigham (eds.). Bats and Forest Symposium. British Columbia Ministry of Forests, Victoria, BC.

Vonhof, M.J., and Barclay, R.M.R. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74: 1797-1805.

Whitaker, J.O., Maser, C., and Keller, L.E. 1977. Food habits of bats of western Oregon. Northwest Science 51: 46-55.

Meadow arnica - *Arnica chamisso ssp. incana*

Reference:

Flora of North America Association. 2006. Flora of North America. 21:368-372. [Online] Available:. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250066109 [2014 November 27]

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

Project. Report to BC Hydro, Vancouver, BC. 340 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Arnica%20chamissonis&noTransfer=0 [2014 November 27]

Symbios Research & Restoration. 2003. Growing and Using Native Plants in the Northern Interior of B.C. Prepared for British Columbia Ministry of Environment.[Online] Available: http://www.env.gov.bc.ca/wld/documents/fia_docs/native_seed_manual/28arnica_chamissonis.pdf [2014 November 27]

Hudson Bay Sedge - *Carex heleonastes*

Reference:

Graff, P.W. 1922. Unreported Plants from Glacier National Park. Bulletin of the Torrey Botanical Club 49(6): 175-181.

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 355 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Carex%20heleonastes&redblue=Both&lifeform=6 [2014 November 27]

Shackleford, R. 2004. Conservation Assessment for Hudson Bay Sedge (*Carex heleonastes* L.f.). USDA Forest Service, Eastern Region. Milwaukee, WI. 36 pp. [Online] Available: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_054358.pdf [2014 November 27]

Trass, H., Vellak, K., and Ingerpuu, N. 1999. Floristical and ecological properties for identifying of primeval forests in Estonia. Annales Botanici Fennici 36: 67-80.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

University of Saskwatchewan. n.d. Hudson Bay Sedge. Virtual Herbarium of Plants at Risk in Saskwatchewan: A Natural "Heritage. [Online] Available: http://www.usask.ca/biology/rareplants_sk/root/htm/en/plants-description/carex-heleonastes/y-carex-heleonastes.php [2014 November 27]

Vittoz, P., Gobat, J.-M., and Wyss, T. 2006. Ecological conditions for *Saxifraga hirculus* in Central Europe: a better understanding for a good protection. Biological Conservation 131: 594-608.

Many-headed Sedge - *Carex sychnocephala*

Reference:

Ball, P.W., Reznicek, A.A., Murray, D.F. 2008. Cyperaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242357573 [2014 November 27]

British Columbia Conservation Data Centre. 2014. Species Summary: *Carex sychnocephala*. British Columbia Ministry of Environment. [Online] Available: Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 358 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Carex%20sychnocephala&noTransfer=0 [2014 November 27]

Larson, G.E., and Johnson, J.R. 1999. Plants of the Black Hills and Bear Lodge Mountains. South Dakota State University, Brookings, SD. 608 pp.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Washington State Natural Heritage Program. 2014. Carex sychnocephala field guide. Adapted from: P. Camp and J.G. Gamon. 2011. Field Guide to the Rare Plants of Washington. University of Washington Press, Seattle, WA. 404 pp.

Wisconsin Department of Natural Resources. 2014. Many-headed Sedge. [Online] Available: http://dnr.wi.gov/topic/EndangeredResources/Plants.asp?mode=detail&SpecCode=PMCYP03DE0 [2014 November 27]

Tender Sedge - (*Carex tenera*)

Reference:

Ball, P.W., Reznicek, A.A., Murray, D.F. 2008. Cyperaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242357578 [2014 November 27]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 361 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Carex%20tenera [2014 November 27]

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Fox Sedge - (*Carex vulpinoidea*)

Reference:

Ball, P.W., Reznicek, A.A., Murray, D.F. 2008. Cyperaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242357627 [2014 November 27]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 367 pp.

Kettenring, K.M., and Galatowitsch, S.M. 2007. Temperature requirements for dormancy break and seed germination vary greatly among 14 wetland Carex species. Aquatic Botany 87(3): 209-220

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Carex%20vulpinoidea [2014 November 27]

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Iowa Golden-saxifrage - *Chrysosplenium iowense*

Reference:

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 372 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Chrysosplenium%20iowense&redblue=Both&lifeform=7 [2014 November 27]

Levsen, N.D. and Mort, M.E. 2008. Determining patterns of genetic diversity and post-glacial recolonization of western Canada in the Iowa golden saxifrage, *Chrysosplenium iowense* (Saxifragaceae), using inter-simple sequence repeats. Biological Journal of the Linnean Society 95(4): 815-823.

Packer, J.G. 1962. The taxonomy of some North American species of Chrysosplenium L., section Alternifolia Franchet. Canadian Journal of Botany. 41: 85-103.

Patchell, M. 2013. Vegetation and Rare Plant Survey of Lois Hole Centennial Provincial Park Summer 2013. Taxon Metrics Biological Consulting. Prepared for: Big Lake Environmental Support Society. 55 pp.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Wells, W.F. and Elvander, P.E. 2008. Saxifragaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250065922 [2014 November 27]

European Water-hemlock - (*Cicuta virosa*)

Reference:

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 375 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Cicuta%20virosa&noTransfer=0 [2014 November 27]

Mulligan, G.A. and Munro, D.B. 1981. The biology of Canadian weeds: 48. Cicuta maculata L. C. douglasii (DC.) Coult. & Rose and C. virosa L. Canadian Journal of Plant Science 51: 93-105.

Shin, C.J., Nam, J.M., and Kim, G.J. 2013. Comparison of environmental characteristics at Cicuta virosa habitats, an endangered species in South Korea. Journal of Ecotoxicology and Environmental Safety 36(1): 19-29.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Hall's Willowherb - *Epilobium halleanum*

Reference:

Adamus, P.R. 2013. Biota Tables. Wetland Ecosystem Services Protocol for Southern Alberta (WESPAB). Prepared for Alberta Environment and Sustainable Resource Development, Government of Alberta, Edmonton, AB. [Online] Available: BiotaTables_WESPAB_31July2013.xls [2014 November 26]

British Columbia Conservation Data Centre. 2014. Species Summary: *Epilobium halleanum*. British Columbia Ministry of Environment. [Online] Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Cenovus FCCL Ltd. 2013. Rare plant potential. Apendix 12D. In: Foster Creek Thermal Phase J Expansion Volume 5 Terrestrial Resources. Washington, DC.

Colorado Wetland Information Centre. n.d. Colorado Wetland Plant Field Guide List. Colorado State University. [Online] Available: http://www.cnhp.colostate.edu/cwic/ident/plantList.asp [2014 November 28]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 385 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Epilobium%20halleanum&redblue=Both&lifeform=7 [2014 November 27]

Lesica, P. 2012. Manual of Montana Vascular Plants. Botanical Reasearch Institute of Texas Press. Fort Worth, TX. 779 pp.

Rochefort, R.M. 2010. Vascular plant inventory of Mount Rainier National Park. Natural Resource Technical Report NPS/NCCN/NRTR—2010/347. National Park Service, Fort Collins, CO. 50 pp.

Total E&P Canada. 2013. Table H-3-1 Community Diversity Indicators. Appendix H Vegetation Supporting Information. In: Joslyn North Mine Project Modifications ESRD Application. Calgary, AB.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Northern Bog Bedstraw - *Galium labradoricum*

Reference:

Adamus, P.R. 2013. Biota Tables. Wetland Ecosystem Services Protocol for Southern Alberta (WESPAB). Prepared for Alberta Environment and Sustainable Resource Development, Government of Alberta, Edmonton, AB. [Online] Available: BiotaTables_WESPAB_31July2013.xls [2014 November 26]

Bowles, M.L. 1991. Some aspects of the status and ecology of seven rare wetland plant species of the Chicago region of Northeastern Illinois. Erigenia 11: 52-66.

British Columbia Conservation Data Centre. 2014. Species Summary: *Galium labradoricum*. British Columbia Ministry of Environment. [Online] Available: Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Douglas, G.W., Meidinger, D.V., Penny, J.L. 2002. Rare Native Vascular Plants of British Columbia 2nd. ed. BC Ministry for Sustainable Resource Management and BC Ministry of Forests, Lands, and Natural Resource Operations, Victoria, BC. 359pp.

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 389 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Galium%20labradoricum&redblue=Both&lifeform=7 [2014 November 27]

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

Slender Mannagrass - (*Glyceria pulchella*)

Reference:

British Columbia Conservation Data Centre. 2014. Species Summary: *Glyceria pulchella*. British Columbia Ministry of Environment. [Online] Available: Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Douglas, G.W., Straley, G.B., and Meidinger, D.V. 1998. Rare Native Vascular Plants of British Columbia. B.C. Ministry of Environment, Lands and Parks. Victoria, BC. 423 pp.

Evergreen. 2014. *Glyceria pulchella.* The Native Plant Database. [Online] Available: http://nativeplants.evergreen.ca/search/advanced.php [2014 November 27]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 391 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Glyceria%20pulchella&NoTransfer=1 [2014 November 27]

Stewart, H., and Hebda, R.J. 2000. Grasses of the Columbia Basin of British Columbia. Prepared for BC Ministry of Forests and Royal British Columbia Museum, Victoria, BC. Working Paper 45. 228 pp.

University of Alberta Museums. n.d. Canadensys explorer. [Online] Available: http://data.canadensys.net/explorer [2014 November 27]

White Adder's-mouth Orchid - *Malaxis monophylla var. brachypoda*

Reference:

Douglas, G.W., Meidinger, D.V., and Pojar, J. (eds.). 2001. Illustrated Flora of British Columbia, Volume 7: Monocotyledons (Orchidaceae through Zosteraceae). B.C. Ministry of Sustainable Resource Management, and B.C. Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC. 379 pp

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and

Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 404 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Malaxis%20brachypoda&redblue=Both&lifeform=7 [2014 November 27]

Schultz, J. 2003. Conservation Assessment for White Adder's Mouth Orchid (*Malaxis B Brachypoda*) (A. *Gray*) Fernald. USDA Forest Service, Eastern Region, Escanaba, MI. [Online] Available: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_054124.pdf. [2014 November 27]

Marsh Muhly- (*Muhlenbergia glomerata*)

Reference:

British Columbia Conservation Data Centre. 2014. Species Summary: *Muhlenbergia glomerata*. British Columbia Ministry of Environment. [Online] Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 406 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Muhlenbergia%20glomerata [2014 November 27]

Larson, G.E., and Johnson, J.R. 1999. Plants of the Black Hills and Bear Lodge Mountains. South Dakota State University, Brookings, SD. 608 pp.

Small-Flowered Lousewort - (*Pedicularia parviflora*)

Reference:

Adamus, P.R. 2013. Biota Tables. Wetland Ecosystem Services Protocol for Southern Alberta (WESPAB). Prepared for Alberta Environment and Sustainable Resource Development, Government of Alberta, Edmonton, AB. [Online] Available: BiotaTables_WESPAB_31July2013.xls [2014 November 26]

Bartemucci, P. 2004. Plant Species and Communities. Table 1. Rare and Endemic Plant Species. Appendix 4.3. In: R.F. Holt. Environmental Conditions Report for the Haida Gwaii/Queen Charlotte Islands Land Use Plan. Veridian Ecological Consulting Ltd. Nelson, BC.

British Columbia Conservation Data Centre. 2014. Species Summary: *Pedicularia parviflora*. British Columbia Ministry of Environment. [Online] Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 27]

Cenovus FCCL Ltd. 2013. Rare plant potential. Apendix 12D. In: Foster Creek Thermal Phase J Expansion Volume 5 Terrestrial Resources. Washington, DC.

Douglas, G.W., Meidinger, D.V., Penny, J.L. 2002. Rare Native Vascular Plants of British Columbia 2nd. ed. BC Ministry of Sustainable Resource Management and BC Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC. 359 pp.

Douglas, G.W., D. Meidinger, and J. Pojar, eds. 2000. Illustrated Flora of British Columbia, Vol. 5, Dicotyledons (Salicaceae through Zygophyllaceae) and Pteridophytes. B.C. Minist. Environ., Lands and Parks, and B.C. Minist. For., Victoria. 389pp.

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 412 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Pedicularis%20parviflora&redblue=Both&lifeform=7 [2014 November 27]

Meadow Willow (*Salix petiolaris*)

Reference:

Argus, G.W. 1974. An experimental study of hybridization and pollination in *Salix* (willow). Canadian Journal of Botany 52: 1613-1619.

Argus, G.W., Eckenwalder, J.E., Kiger, R.W. 2008. Salicaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242417202 [2014 November 26]

Bird, R.D. 1961. Ecology of the Aspen Parkland of Western Canada in relation to land use. Research Branch, Canada Department of Agriculture, Ottawa, ON. 184 pp.

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and

Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 425 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Johnson, D., Kershaw, L.J., MacKinnon, A., and Pojar, J. 2009. Plants of the Western Forest: Alberta, Saskatchewan & Manitoba Boreal and Aspen Parkland. Lone Pine Publishing, Edmonton, AB. 392 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Salix%20petiolaris&redblue=Both&lifeform=4 [2014 November 26]

Larson, G.E., and Johnson, J.R. 1999. Plants of the Black Hills and Bear Lodge Mountains. South Dakota State University, Brookings, SD. 608 pp.

Mirck, J., and Schroeder, W. 2013. Composition, Stand Structure, and Biomass Estimates of “Willow Rings” on the Canadian Prairies. BioEnergy Research. 6(3): 864-876.

Timoney, K.P., Argus, G.W. 2006. Willows, water regime, and recent cover change in the Peace–Athabasca Delta. Ecoscience 13: 308–317.

Autumn Willow (*Salix serissima*)

Reference:

Argus, G.W., Eckenwalder, J.E., Kiger, R.W. 2008. Salicaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242445867 [2014 November 26]

British Columbia Conservation Data Centre. 2014. Species Summary: *Salix serissima*. British Columbia Ministry of Environment. [Online] Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 26]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 427 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Salix%20serissima [2014 November 26]

Slender Wedgegrass - (*Sphenopholis intermedia*)

Reference:

Adamus, P.R. 2013. Biota Tables. Wetland Ecosystem Services Protocol for Southern Alberta (WESPAB). Prepared for Alberta Environment and Sustainable Resource Development, Government of Alberta, Edmonton, AB. [Online] Available: BiotaTables_WESPAB_31July2013.xls [2014 November 26]

British Columbia Conservation Data Centre. 2014. Species Summary: *Sphenopholis intermedia*. British Columbia Ministry of Environment. [Online] Available: http://a100.gov.bc.ca/pub/eswp/ [2014 November 26]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 439 pp.

Hilton, S., Andrusiak, L., Simpson, L., and Sarell, M. 2013. Part 1 Vegetation and Ecological Communities. Environmental Impact Statement: Volume 2 Appendix R Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 85 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Sphenopholis%20intermedia&noTransfer=0 [2014 November 26]

Lichvar, R.W., Butterwick, M., Melvin, N.C., and Kirchner, W.N. 2014. The National Wetland Plant List: 2014 Update of Wetland Ratings. Phytoneuron 2014-41: 1-42.

NatureServe. 2014. *Sphenopholis intermedia.* NatureServe Explorer: An online encyclopedia of life. Version 7.1. NatureServe, Arlington, VA. [Online] Available: http://explorer.natureserve.org/servlet/NatureServe?searchName=Sphenopholis+intermedia. [2014 November 26]

Purple-stemmed Aster - *Symphyotrichum puniceum* var. *puniceum*

Reference:

Consortium of Pacific Northwest Herbaria. 2011. Specimen data for *Symphyotrichum puniceum*. University of Washington Herbarium, The Burke Museum of Natural History and Culture. Seattle, WA. [Online] Available: http://www.pnwherbaria.org/data/search.php [2014 November 26]

Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 442 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Symphyotrichum%20puniceum%20var.%20puniceum [2014 November 26]

Smreciu, A., Gould, K., and Wood, S. 2013. *Symphyotrichum puniceum.* Appendix 4. In: Boreal Plant Species for Reclamation of Athabasca Oil Sands Disturbances. Oil Sands Research and Information Network, University of Alberta, School of Energy and the Environment, Edmonton, AB. Report No. TR-44. 23 pp.

USDA, NRCS. 2014. Symphyotrichum puniceum. The PLANTS Database. National Plant Data Team, Greensboro, NC. [Online] http://plants.usda.gov/core/profile?symbol=SYPUP [2014 November 26]

Dwarf Clubrush - *Trichophorum pumilum*

Reference:

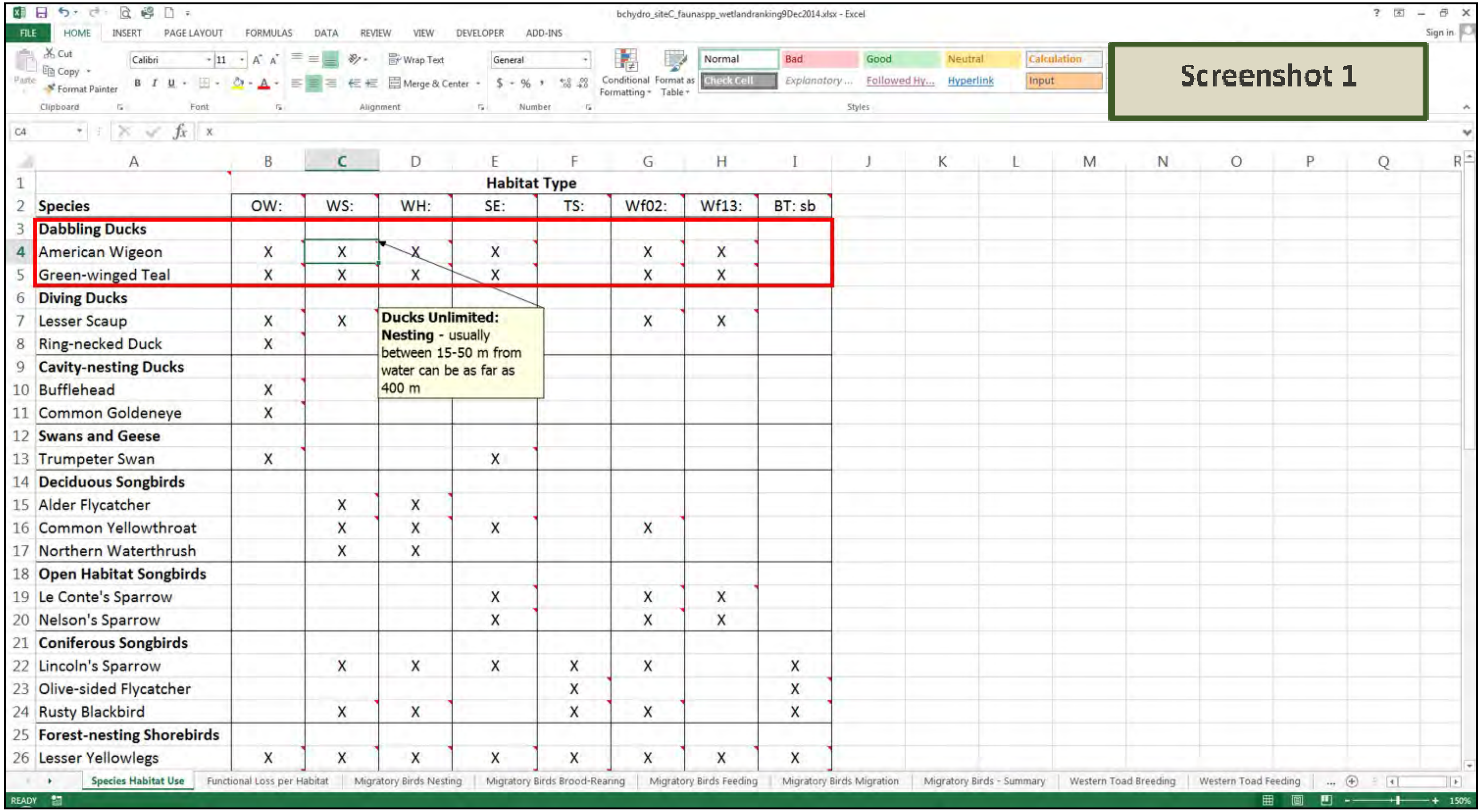
Ball, P.W., Reznicek, A.A., and Murray, D.F. 2008. Cyperaceae. In: Flora of North America. Missouri Botanical Garden, St. Louis, MO and Harvard University Herbaria, Cambridge, MA. [Online] Available: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242101207 [2014 November 26]

Cooper, D.J. 1996. Water and soil chemistry, floristics, and phytosociology of the extreme rich High Creek fen, in South Park, Colorado, U.S.A. Canadian Journal of Botany. 74: 1801-1811.

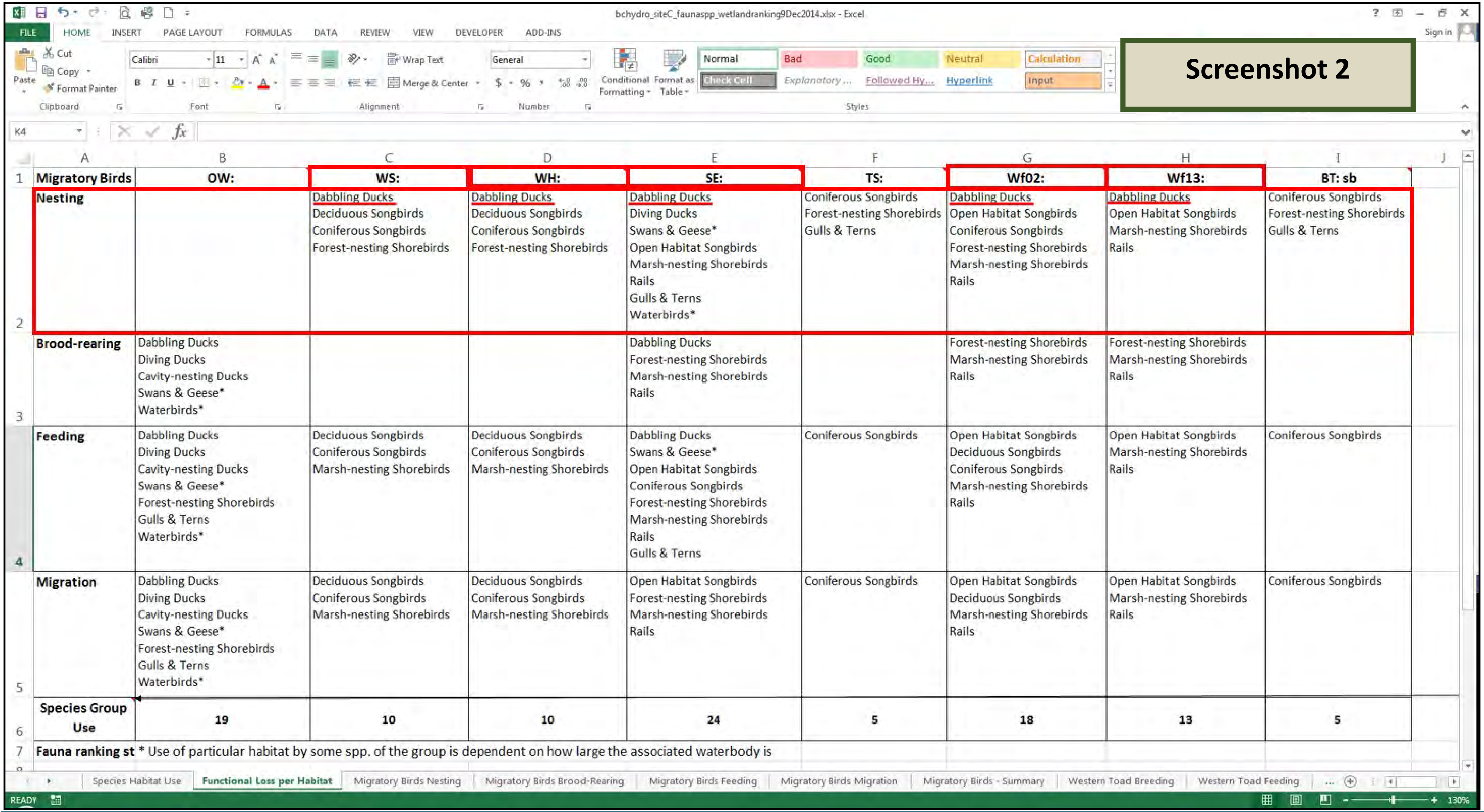
Hilton, S., L. Andrusiak, R. Krichbaum, L. Simpson, and C. Bjork. 2013. Part 1 Vegetation and Ecological Communities. Terrestrial Vegetation and Wildlife Report. Site C Clean Energy Project. Report to BC Hydro, Vancouver, BC. 445 pp.

Klinkenberg, B. (ed.). 2014. E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver, BC. [Online] Available: http://linnet.geog.ubc.ca/Atlas/Atlas.aspx?sciname=Symphyotrichum%20puniceum%20var.%20puniceum [2014 November 26]

Appendix B: Screenshots for fauna ranking examples

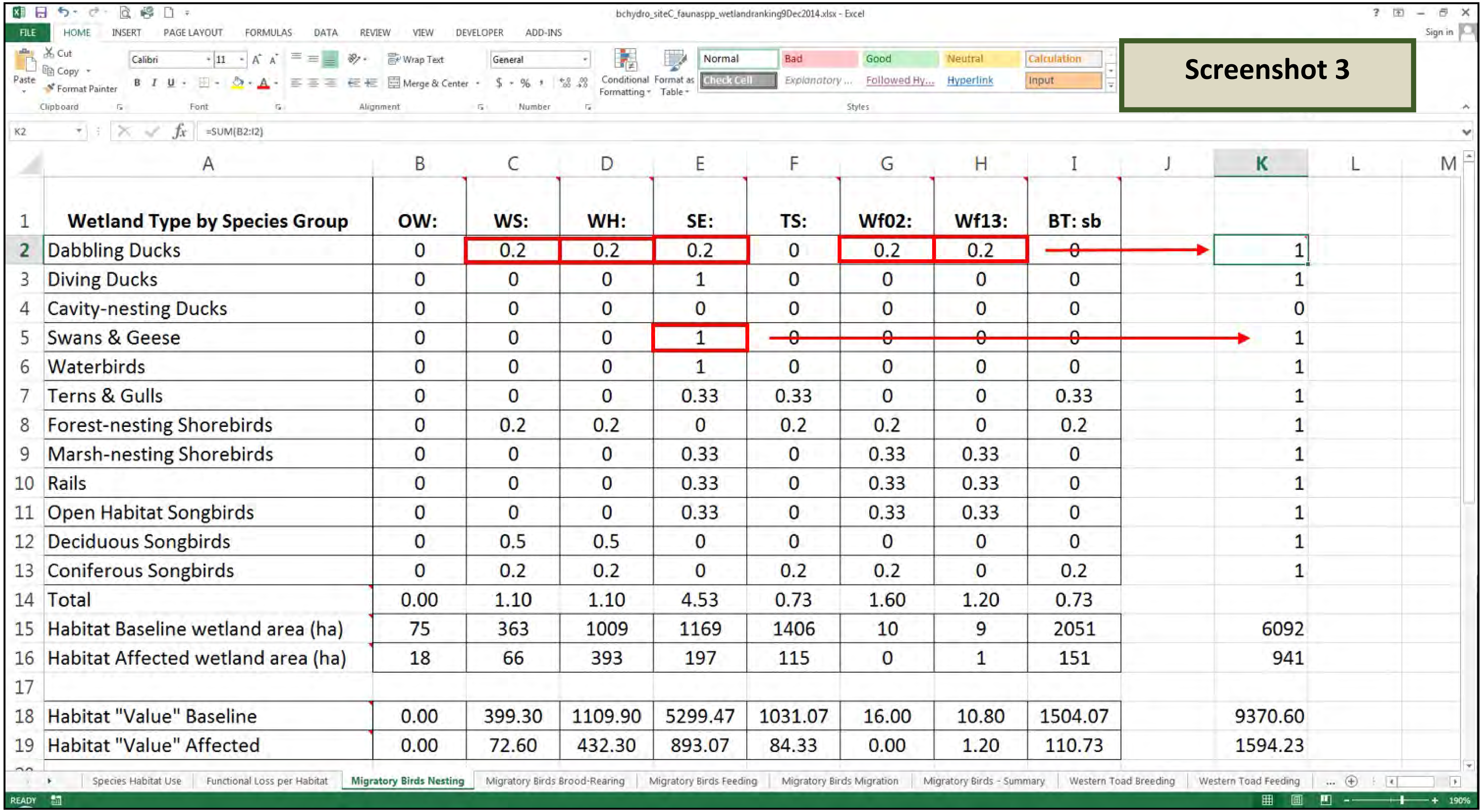


	Habitat Type							
Species	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Dabbling Ducks								
American Wigeon	X	X	X	X		X	X	
Green-winged Teal	X	X	X	X		X	X	
Diving Ducks								
Lesser Scaup	X	X				X	X	
Ring-necked Duck	X							
Cavity-nesting Ducks								
Bufflehead	X							
Common Goldeneye	X							
Swans 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

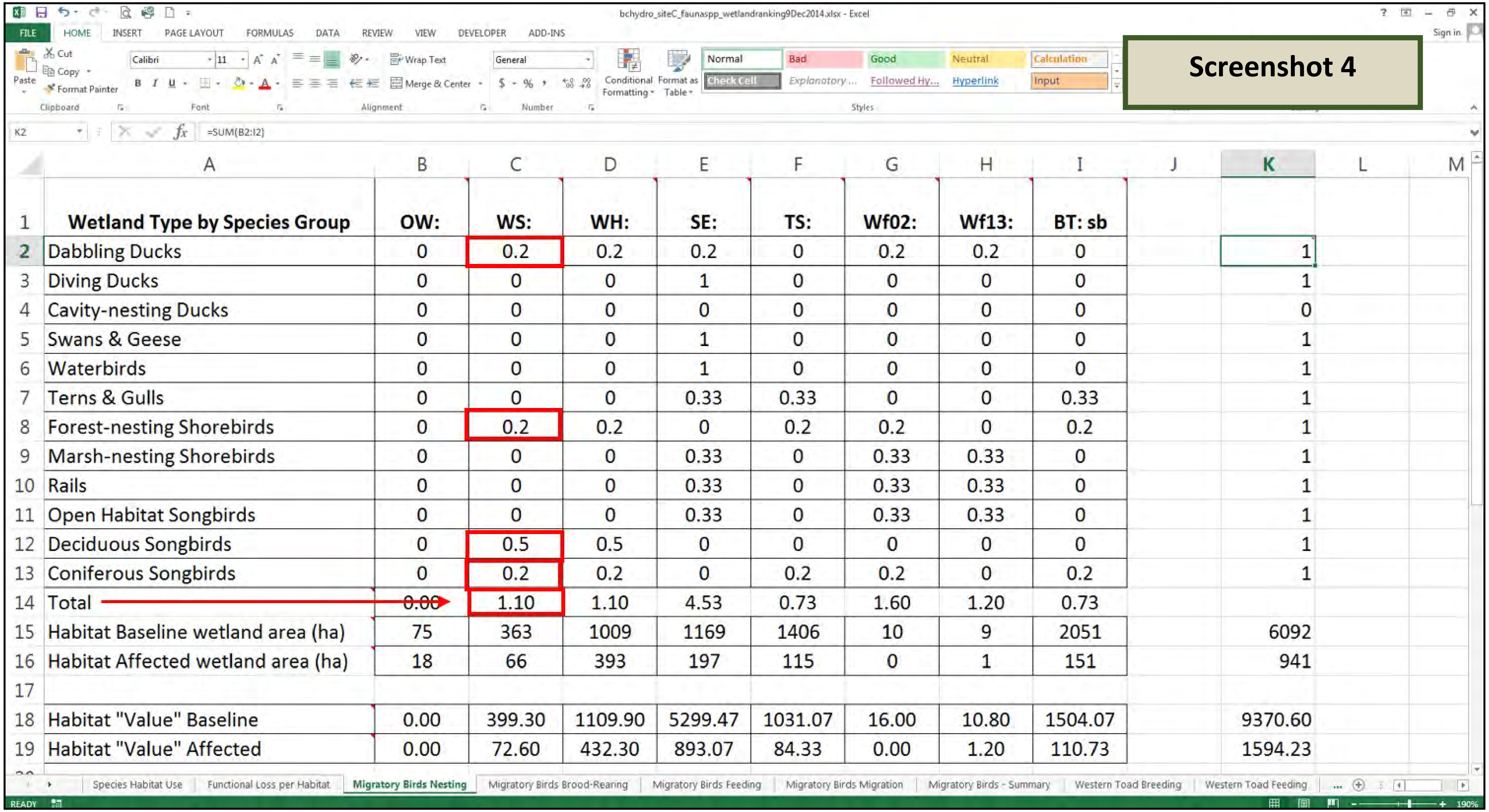


Migratory Birds	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb
Nesting		Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds	Dabbling Ducks Deciduous Songbirds Coniferous Songbirds Forest-nesting Shorebirds	Dabbling Ducks Diving Ducks Swans & Geese* Open Habitat Songbirds Marsh-nesting Shorebirds Rails Gulls & Terns Waterbirds*	Coniferous Songbirds Forest-nesting Shorebirds Gulls & Terns	Dabbling Ducks Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Dabbling Ducks Open Habitat Songbirds Marsh-nesting Shorebirds Rails	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*	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds	Dabbling Ducks Swans & Geese* Open Habitat Songbirds Coniferous Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails Gulls & Terns	Coniferous Songbirds	Open Habitat Songbirds Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds Rails	Open Habitat Songbirds Marsh-nesting Shorebirds Rails	Coniferous Songbirds
Migration	Dabbling Ducks Diving Ducks Cavity-nesting Ducks Swans & Geese* Forest-nesting Shorebirds Gulls & Terns Waterbirds*	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds	Deciduous Songbirds Coniferous Songbirds Marsh-nesting Shorebirds	Open Habitat Songbirds Forest-nesting Shorebirds Marsh-nesting Shorebirds Rails	Coniferous Songbirds	Open Habitat Songbirds Deciduous Songbirds Marsh-nesting Shorebirds Rails	Open Habitat Songbirds Marsh-nesting Shorebirds Rails	Coniferous Songbirds
Species Group Use	**19**	**10**	**10**	**24**	**5**	**18**	**13**	**5**

Fauna ranking st * Use of particular habitat by some spp. of the group is dependent on how large the associated waterbody is



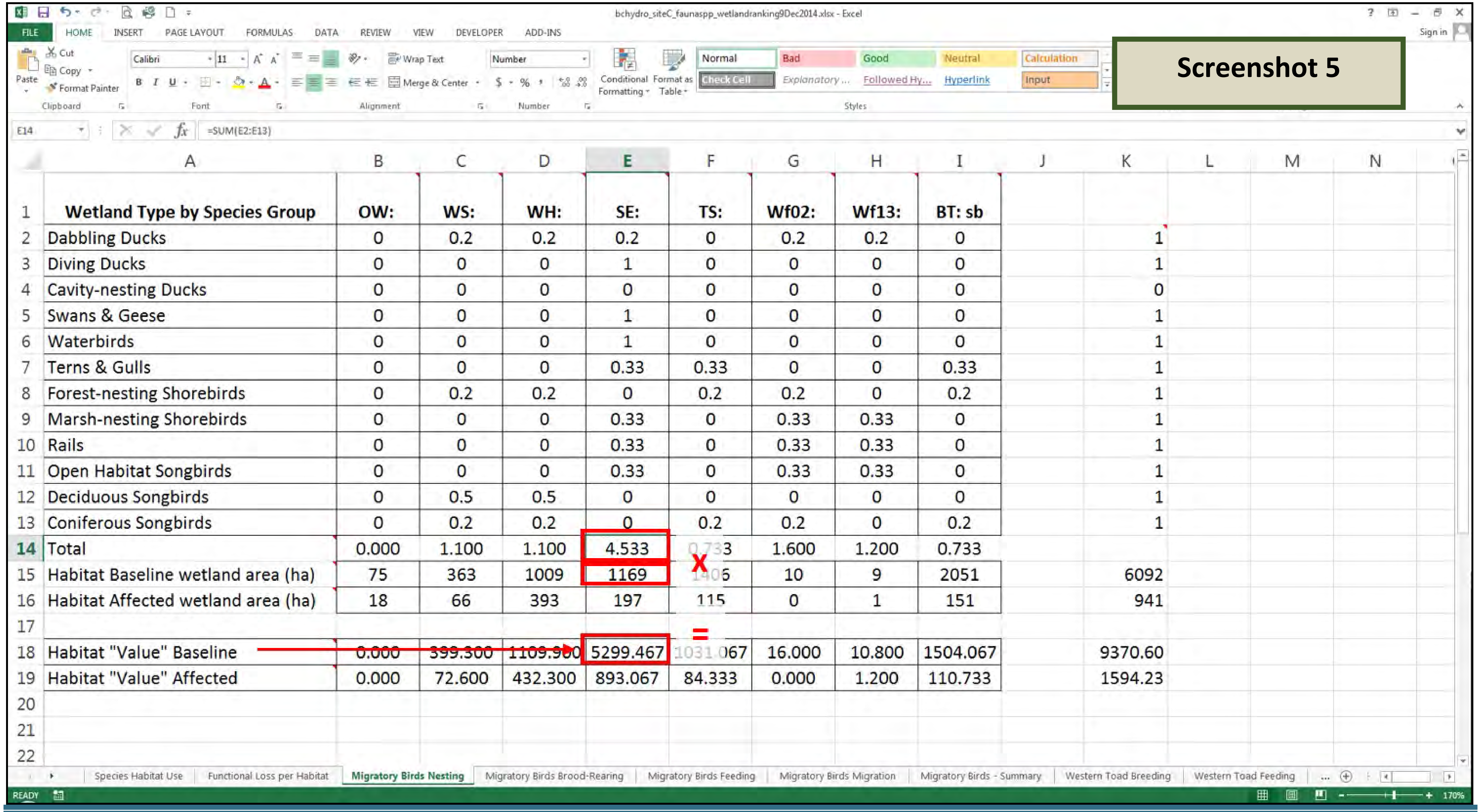
	A	B	C	D	E	F	G	H	I	J	K
1	**Wetland Type by Species Group**	**OW:**	**WS:**	**WH:**	**SE:**	**TS:**	**Wf02:**	**Wf13:**	**BT: sb**		
2	Dabbling Ducks	0	0.2	0.2	0.2	0	0.2	0.2	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	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	0.2	0.2	0	0.2	0.2	0	0.2		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	0.5	0.5	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.2	0.2	0	0.2	0.2	0	0.2		1
14	Total	0.00	1.10	1.10	4.53	0.73	1.60	1.20	0.73		
15	Habitat Baseline wetland area (ha)	75	363	1009	1169	1406	10	9	2051		6092
16	Habitat Affected wetland area (ha)	18	66	393	197	115	0	1	151		941
17											
18	Habitat "Value" Baseline	0.00	399.30	1109.90	5299.47	1031.07	16.00	10.80	1504.07		9370.60
19	Habitat "Value" Affected	0.00	72.60	432.30	893.07	84.33	0.00	1.20	110.73		1594.23



Screenshot 4

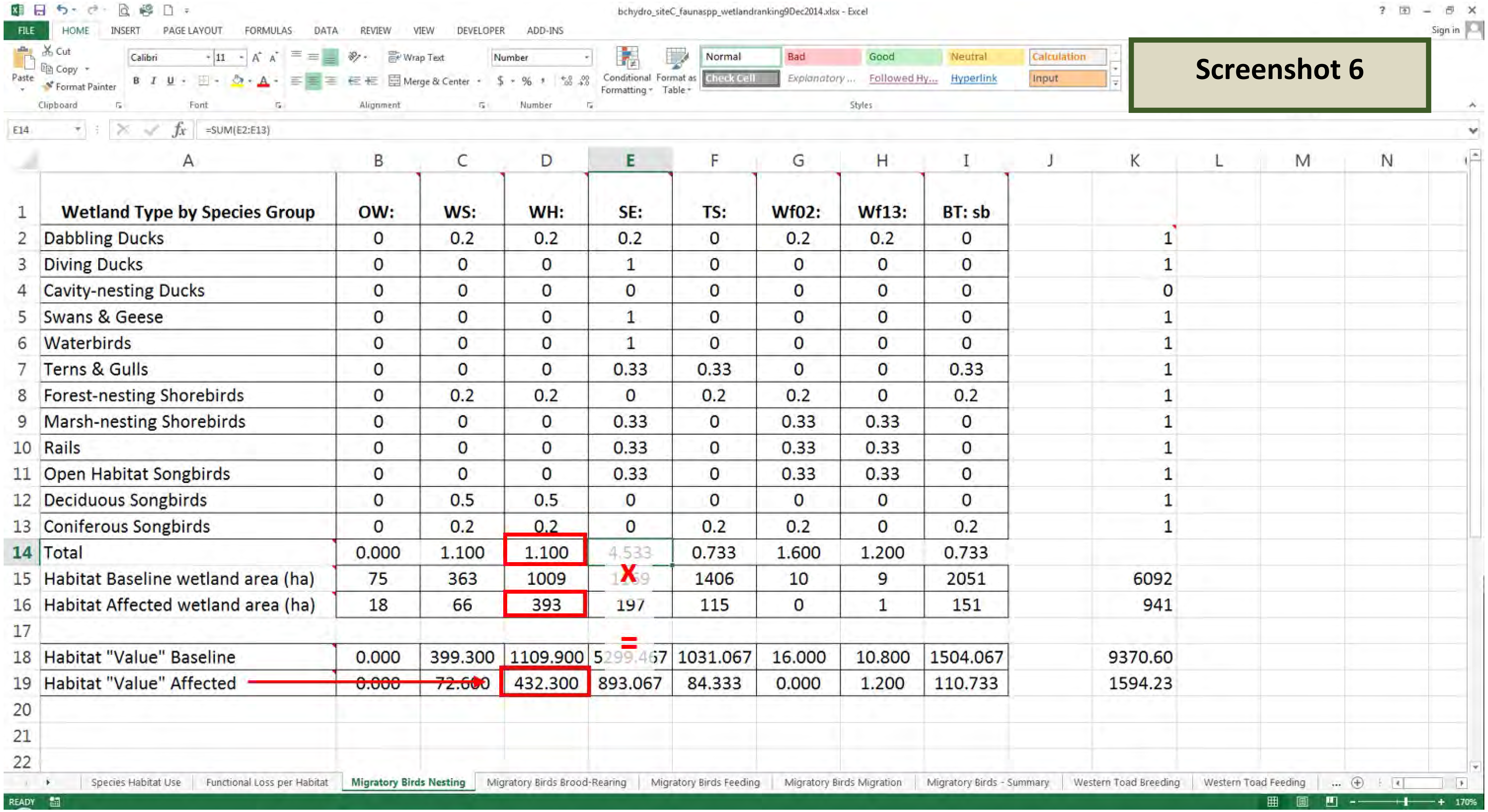
K2 =SUM(B2:I2)

	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	K
2	Dabbling Ducks	0	0.2	0.2	0.2	0	0.2	0.2	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	0.2	0.2	0	0.2	0.2	0	0.2	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	0.5	0.5	0	0	0	0	0	1
13	Coniferous Songbirds	0	0.2	0.2	0	0.2	0.2	0	0.2	1
14	Total	0.00	1.10	1.10	4.53	0.73	1.60	1.20	0.73	
15	Habitat Baseline wetland area (ha)	75	363	1009	1169	1406	10	9	2051	6092
16	Habitat Affected wetland area (ha)	18	66	393	197	115	0	1	151	941
17										
18	Habitat "Value" Baseline	0.00	399.30	1109.90	5299.47	1031.07	16.00	10.80	1504.07	9370.60
19	Habitat "Value" Affected	0.00	72.60	432.30	893.07	84.33	0.00	1.20	110.73	1594.23



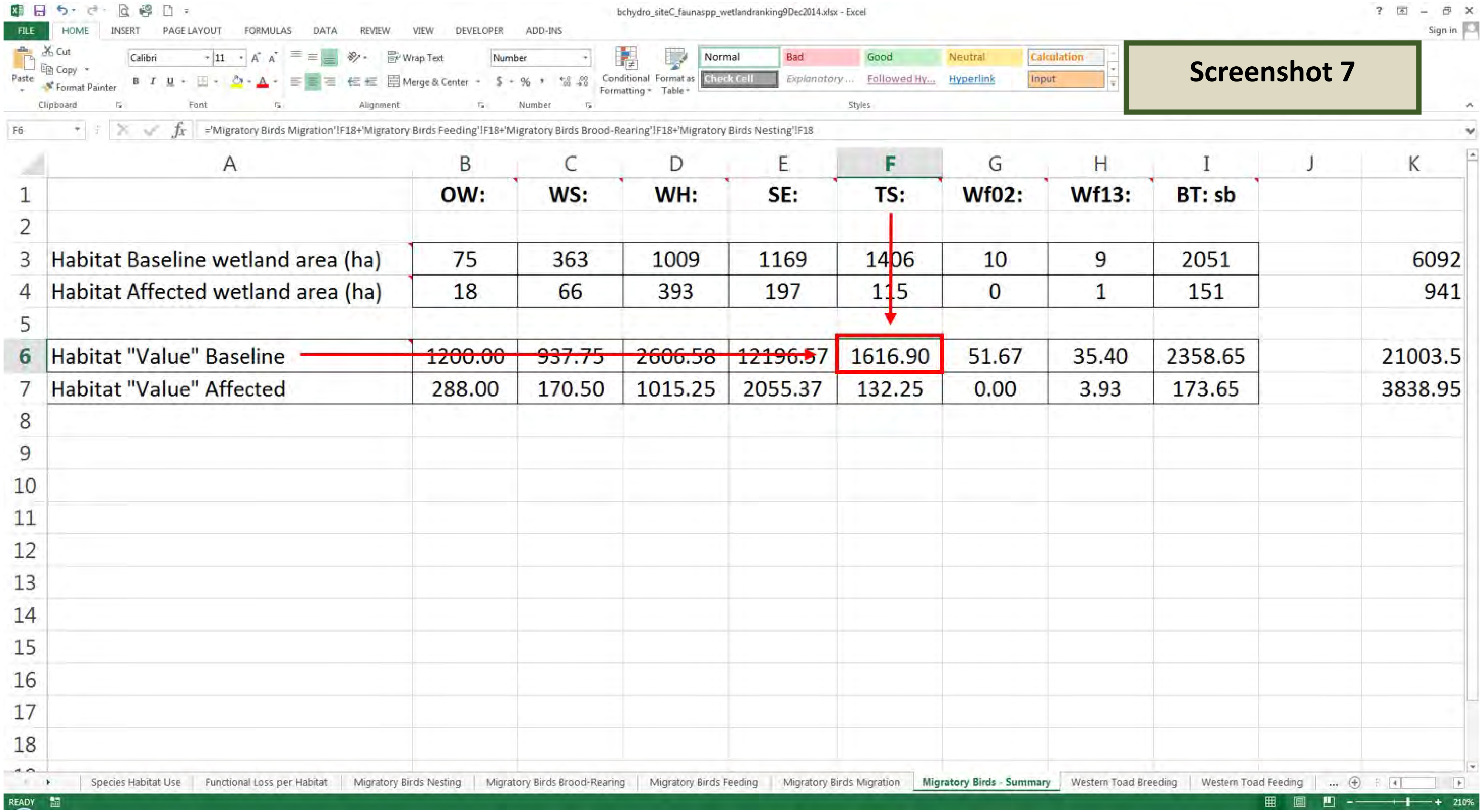
	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	J	K
2	Dabbling Ducks	0	0.2	0.2	0.2	0	0.2	0.2	0		1
3	Diving Ducks	0	0	0	1	0	0	0	0		1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0		0
5	Swans & Geese	0	0	0	1	0	0	0	0		1
6	Waterbirds	0	0	0	1	0	0	0	0		1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33		1
8	Forest-nesting Shorebirds	0	0.2	0.2	0	0.2	0.2	0	0.2		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	0.5	0.5	0	0	0	0	0		1
13	Coniferous Songbirds	0	0.2	0.2	0	0.2	0.2	0	0.2		1
14	Total	0.000	1.100	1.100	4.533	0.733	1.600	1.200	0.733		
15	Habitat Baseline wetland area (ha)	75	363	1009	1169	1406	10	9	2051		6092
16	Habitat Affected wetland area (ha)	18	66	393	197	115	0	1	151		941
17											
18	Habitat "Value" Baseline	0.000	399.300	1109.900	5299.467	1031.067	16.000	10.800	1504.067		9370.60
19	Habitat "Value" Affected	0.000	72.600	432.300	893.067	84.333	0.000	1.200	110.733		1594.23

Screenshot 6



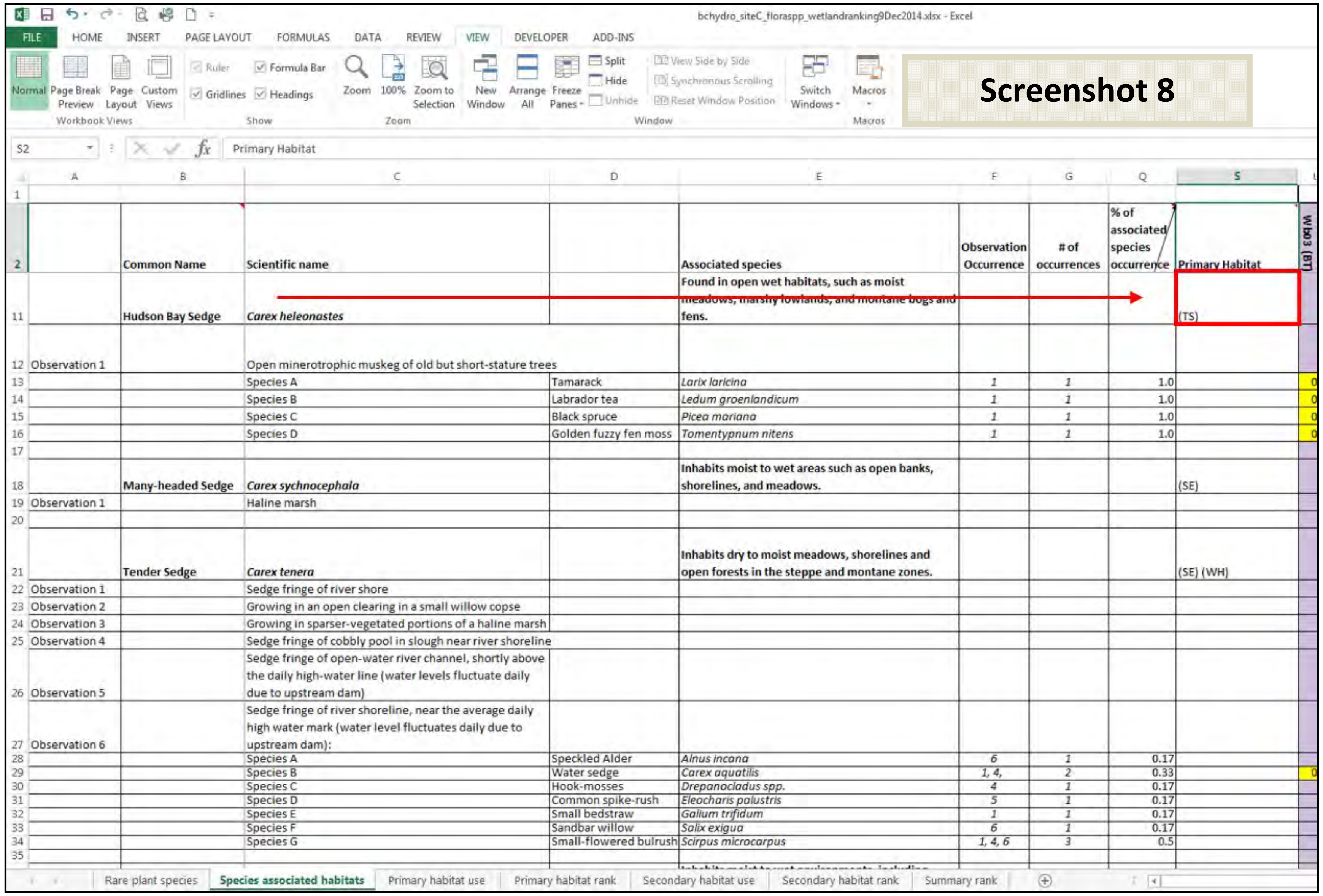
	Wetland Type by Species Group	OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb	K
2	Dabbling Ducks	0	0.2	0.2	0.2	0	0.2	0.2	0	1
3	Diving Ducks	0	0	0	1	0	0	0	0	1
4	Cavity-nesting Ducks	0	0	0	0	0	0	0	0	0
5	Swans & Geese	0	0	0	1	0	0	0	0	1
6	Waterbirds	0	0	0	1	0	0	0	0	1
7	Terns & Gulls	0	0	0	0.33	0.33	0	0	0.33	1
8	Forest-nesting Shorebirds	0	0.2	0.2	0	0.2	0.2	0	0.2	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	0.5	0.5	0	0	0	0	0	1
13	Coniferous Songbirds	0	0.2	0.2	0	0.2	0.2	0	0.2	1
14	Total	0.000	1.100	1.100	4.533	0.733	1.600	1.200	0.733	
15	Habitat Baseline wetland area (ha)	75	363	1009	1169	1406	10	9	2051	6092
16	Habitat Affected wetland area (ha)	18	66	393	197	115	0	1	151	941
17										
18	Habitat "Value" Baseline	0.000	399.300	1109.900	5299.467	1031.067	16.000	10.800	1504.067	9370.60
19	Habitat "Value" Affected	0.000	72.600	432.300	893.067	84.333	0.000	1.200	110.733	1594.23

Screenshot 7

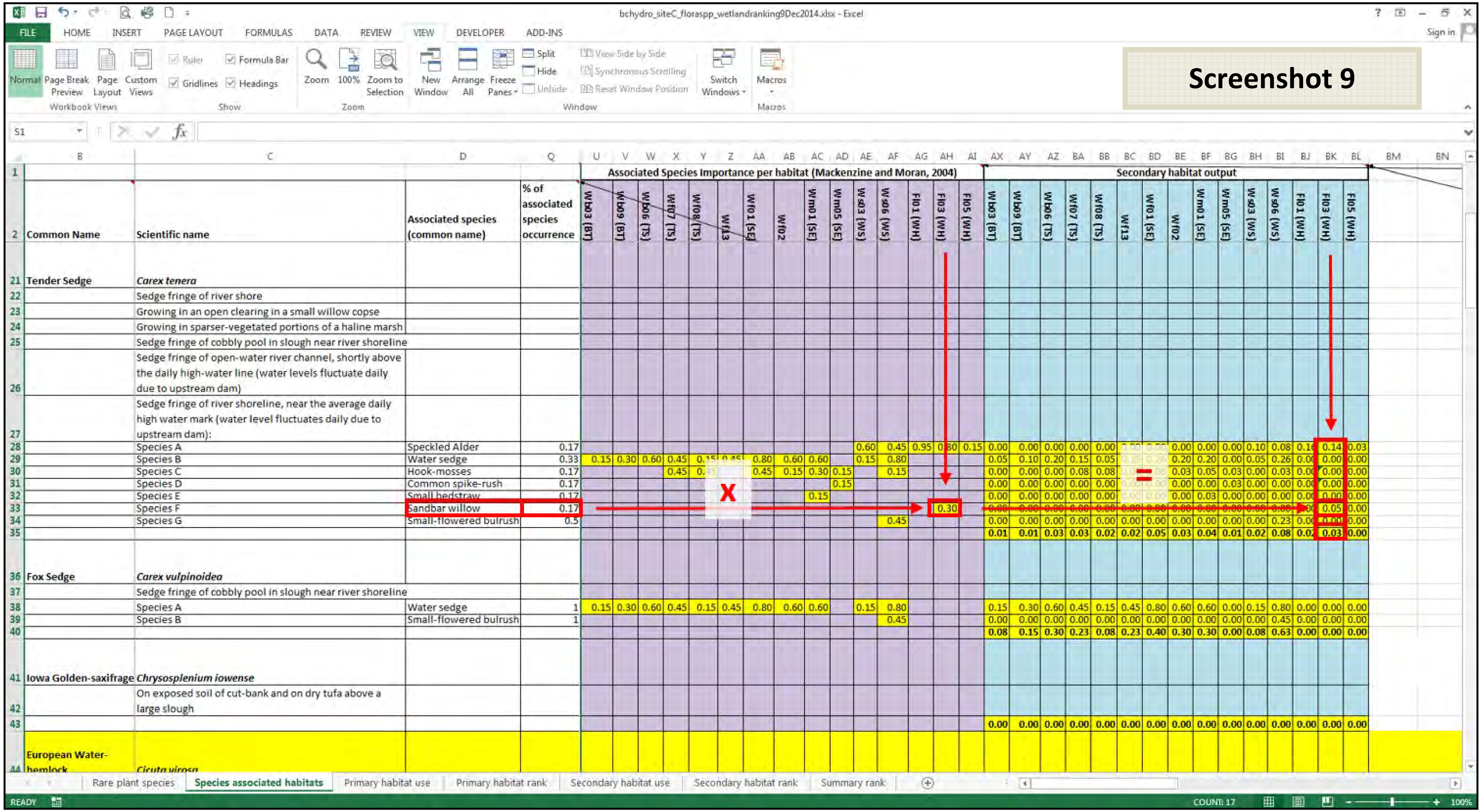


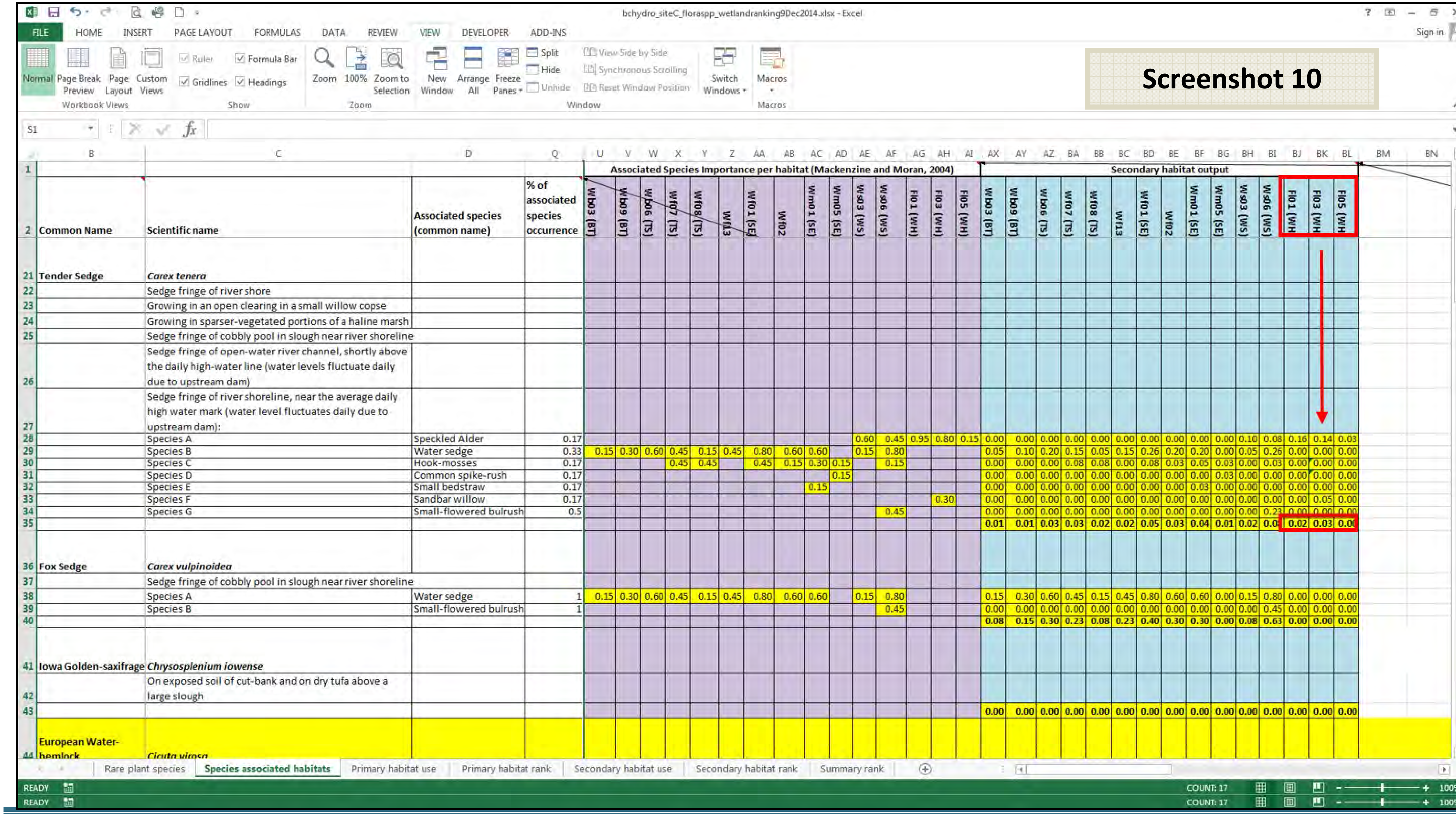
	A	B	C	D	E	F	G	H	I	J	K
1		OW:	WS:	WH:	SE:	TS:	Wf02:	Wf13:	BT: sb		
2											
3	Habitat Baseline wetland area (ha)	75	363	1009	1169	1406	10	9	2051		6092
4	Habitat Affected wetland area (ha)	18	66	393	197	115	0	1	151		941
5											
6	Habitat "Value" Baseline	1200.00	937.75	2606.58	12196.57	1616.90	51.67	35.40	2358.65		21003.5
7	Habitat "Value" Affected	288.00	170.50	1015.25	2055.37	132.25	0.00	3.93	173.65		3838.95

Appendix C: Screenshots for flora ranking examples



	A	B	C	D	E	F	G	Q	S
2		Common Name	Scientific name		Associated species	Observation Occurrence	# of occurrences	% of associated species occurrence	Primary Habitat
11		Hudson Bay Sedge	*Carex heleonastes*		Found in open wet habitats, such as moist meadows, marshy lowlands, and montane bogs and fens.				(TS)
12	Observation 1		Open minerotrophic muskeg of old but short-stature trees						
13			Species A	Tamarack	*Larix laricina*	1	1	1.0	
14			Species B	Labrador tea	*Ledum groenlandicum*	1	1	1.0	
15			Species C	Black spruce	*Picea mariana*	1	1	1.0	
16			Species D	Golden fuzzy fen moss	*Tomentypnum nitens*	1	1	1.0	
17									
18		Many-headed Sedge	*Carex sychnocephala*		Inhabits moist to wet areas such as open banks, shorelines, and meadows.				(SE)
19	Observation 1		Haline marsh						
20									
21		Tender Sedge	*Carex tenera*		Inhabits dry to moist meadows, shorelines and open forests in the steppe and montane zones.				(SE) (WH)
22	Observation 1		Sedge fringe of river shore						
23	Observation 2		Growing in an open clearing in a small willow copse						
24	Observation 3		Growing in sparser-vegetated portions of a haline marsh						
25	Observation 4		Sedge fringe of cobbly pool in slough near river shoreline						
26	Observation 5		Sedge fringe of open-water river channel, shortly above the daily high-water line (water levels fluctuate daily due to upstream dam)						
27	Observation 6		Sedge fringe of river shoreline, near the average daily high water mark (water level fluctuates daily due to upstream dam):						
28			Species A	Speckled Alder	*Alnus incana*	6	1	0.17	
29			Species B	Water sedge	*Carex aquatilis*	1, 4,	2	0.33	
30			Species C	Hook-mosses	*Drepanocladus spp.*	4	1	0.17	
31			Species D	Common spike-rush	*Eleocharis palustris*	5	1	0.17	
32			Species E	Small bedstraw	*Galium trifidum*	1	1	0.17	
33			Species F	Sandbar willow	*Salix exigua*	6	1	0.17	
34			Species G	Small-flowered bulrush	*Scirpus microcarpus*	1, 4, 6	3	0.5	


Screenshot 9
bchydro_siteC_floraspp_wetlandranking9Dec2014.xlsx - Excel
Associated Species Importance per habitat (Mackenzine and Moran, 2004)
Secondary habitat output
Common Name
Scientific name
Associated species (common name)
% of associated species occurrence
Tender Sedge
Carex tenera
Fox Sedge
Carex vulpinoidea
Iowa Golden-saxifrage
Chrysosplenium iowense
European Water-hemlock
Cicuta virosa
X
=
Rare plant species
Species associated habitats
Primary habitat use
Primary habitat rank
Secondary habitat use
Secondary habitat rank
Summary rank

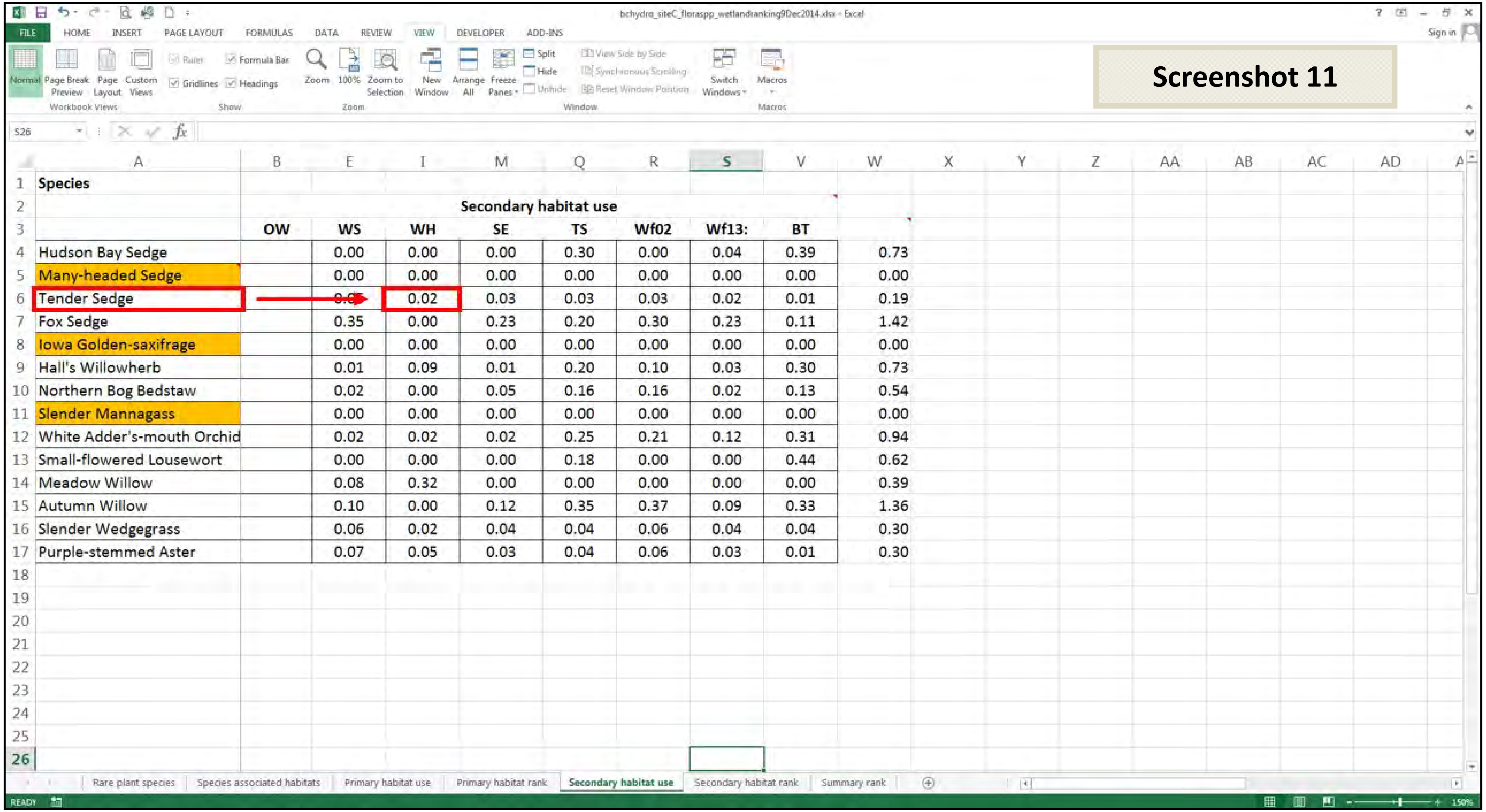


Screenshot 10

bchydro_siteC_floraspp_wetlandranking9Dec2014.xlsx - Excel

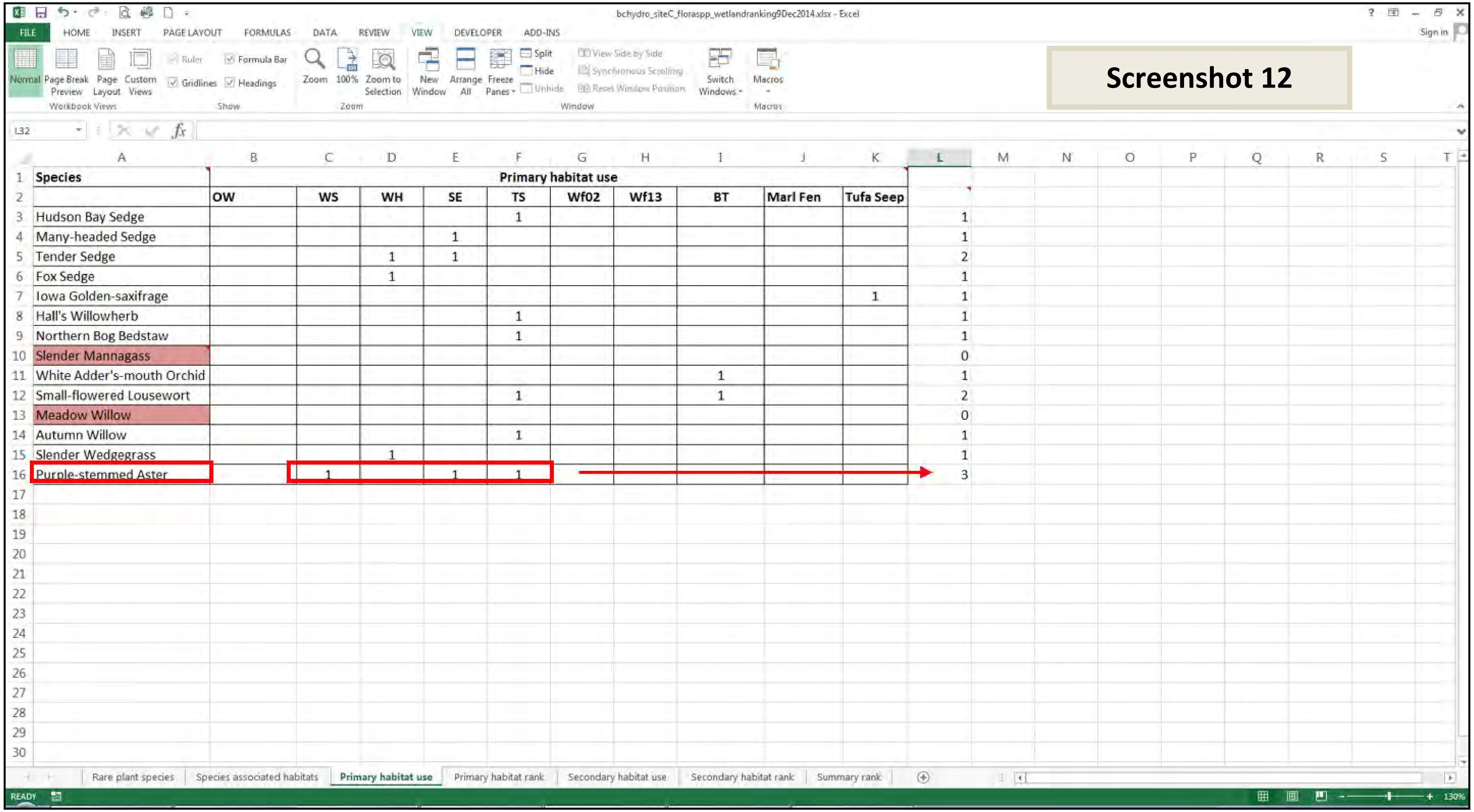
Row	Common Name	Scientific name	Associated species (common name)	% of associated species occurrence	Wb03 (BT)	Wb09 (BT)	Wb06 (TS)	Wf07 (TS)	Wf08 (TS)	Wf13	Wf01 (SE)	Wf02	Wm01 (SE)	Wm05 (SE)	Ws03 (WS)	Ws06 (WS)	Fl01 (WH)	Fl03 (WH)	Fl05 (WH)	Wb03 (BT)	Wb09 (BT)	Wb06 (TS)	Wf07 (TS)	Wf08 (TS)	Wf13	Wf01 (SE)	Wf02	Wm01 (SE)	Wm05 (SE)	Ws03 (WS)	Ws06 (WS)	Fl01 (WH)	Fl03 (WH)	Fl05 (WH)
1					Associated Species Importance per habitat (Mackenzine and Moran, 2004)															Secondary habitat output														
21	Tender Sedge	*Carex tenera*																																
22		Sedge fringe of river shore																																
23		Growing in an open clearing in a small willow copse																																
24		Growing in sparser-vegetated portions of a haline marsh																																
25		Sedge fringe of cobbly pool in slough near river shoreline																																
26		Sedge fringe of open-water river channel, shortly above the daily high-water line (water levels fluctuate daily due to upstream dam)																																
27		Sedge fringe of river shoreline, near the average daily high water mark (water level fluctuates daily due to upstream dam):																																
28		Species A	Speckled Alder	0.17											0.60	0.45	0.95	0.80	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.08	0.16	0.14	0.03
29		Species B	Water sedge	0.33	0.15	0.30	0.60	0.45	0.15	0.45	0.80	0.60	0.60		0.15	0.80				0.05	0.10	0.20	0.15	0.05	0.15	0.26	0.20	0.20	0.00	0.05	0.26	0.00	0.00	0.00
30		Species C	Hook-mosses	0.17				0.45	0.45		0.45	0.15	0.30	0.15		0.15				0.00	0.00	0.00	0.08	0.08	0.00	0.08	0.03	0.05	0.03	0.00	0.03	0.00	0.00	0.00
31		Species D	Common spike-rush	0.17										0.15						0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
32		Species E	Small bedstraw	0.17									0.15							0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
33		Species F	Sandbar willow	0.17														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	0.00	0.05	0.00
34		Species G	Small-flowered bulrush	0.5												0.45				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00
35																				0.01	0.01	0.03	0.03	0.02	0.02	0.05	0.03	0.04	0.01	0.02	0.0	0.02	0.03	0.00
36	Fox Sedge	*Carex vulpinoidea*																																
37		Sedge fringe of cobbly pool in slough near river shoreline																																
38		Species A	Water sedge	1	0.15	0.30	0.60	0.45	0.15	0.45	0.80	0.60	0.60		0.15	0.80				0.15	0.30	0.60	0.45	0.15	0.45	0.80	0.60	0.60	0.00	0.15	0.80	0.00	0.00	0.00
39		Species B	Small-flowered bulrush	1												0.45				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00
40																				0.08	0.15	0.30	0.23	0.08	0.23	0.40	0.30	0.30	0.00	0.08	0.63	0.00	0.00	0.00
41	Iowa Golden-saxifrage	*Chrysosplenium iowense*																																
42		On exposed soil of cut-bank and on dry tufa above a large slough																																
43																				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
44	European Water-hemlock	*Cicuta virosa*																																

Screenshot 11



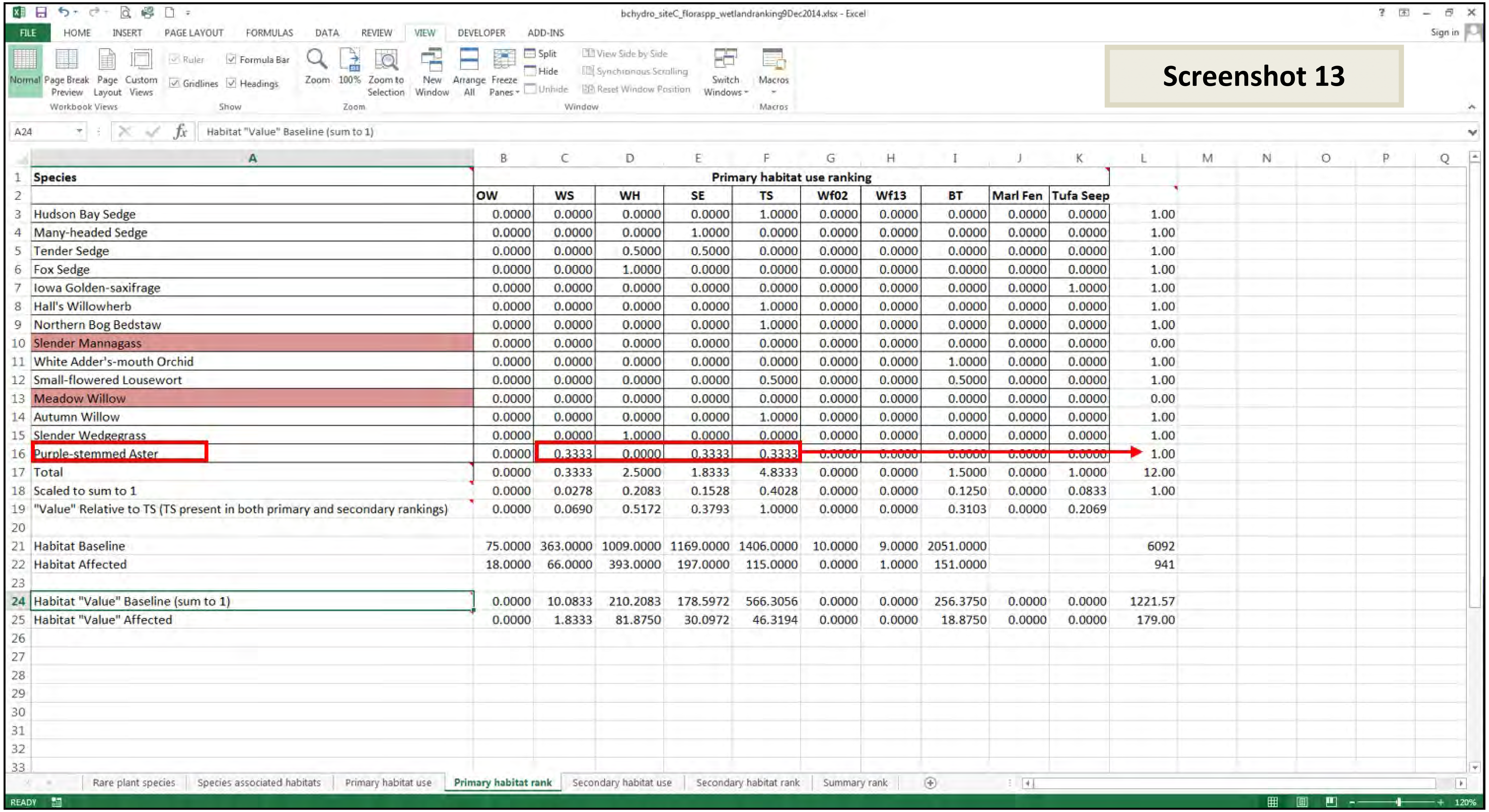
Species	OW	WS	WH	SE	TS	Wf02	Wf13:	BT	
	Secondary habitat use								
Hudson Bay Sedge		0.00	0.00	0.00	0.30	0.00	0.04	0.39	0.73
Many-headed Sedge		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tender Sedge		[illegible]	0.02	0.03	0.03	0.03	0.02	0.01	0.19
Fox Sedge		0.35	0.00	0.23	0.20	0.30	0.23	0.11	1.42
Iowa 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
Northern Bog Bedstaw		0.02	0.00	0.05	0.16	0.16	0.02	0.13	0.54
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
Autumn Willow		0.10	0.00	0.12	0.35	0.37	0.09	0.33	1.36
Slender Wedgegrass		0.06	0.02	0.04	0.04	0.06	0.04	0.04	0.30
Purple-stemmed Aster		0.07	0.05	0.03	0.04	0.06	0.03	0.01	0.30

Screenshot 12

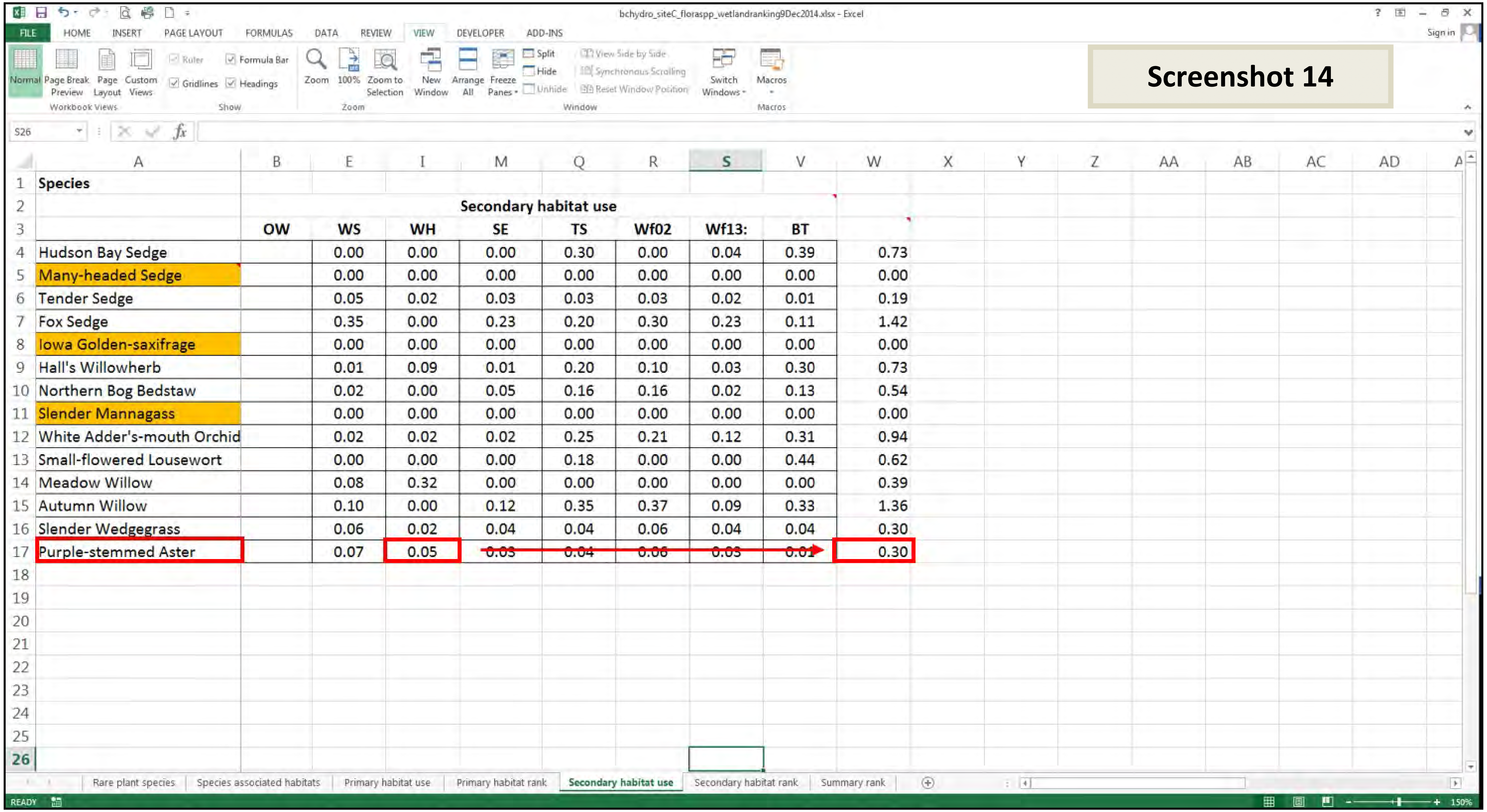


Species	Primary habitat use										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge					1						1
Many-headed Sedge				1							1
Tender Sedge			1	1							2
Fox Sedge			1								1
Iowa Golden-saxifrage										1	1
Hall's Willowherb					1						1
Northern Bog Bedstaw					1						1
Slender Mannagass											0
White Adder's-mouth Orchid								1			1
Small-flowered Lousewort					1			1			2
Meadow Willow											0
Autumn Willow					1						1
Slender Wedgegrass			1								1
Purple-stemmed Aster		1		1	1						3

Screenshot 13



	A	B	C	D	E	F	G	H	I	J	K	L
1	**Species**					**Primary habitat use ranking**						
2		**OW**	**WS**	**WH**	**SE**	**TS**	**Wf02**	**Wf13**	**BT**	**Marl Fen**	**Tufa Seep**	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
4	Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
5	Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
6	Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
8	Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
9	Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
11	White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
13	Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
14	Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
15	Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
16	Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
17	Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
18	Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
19	"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
20												
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941
23												
24	Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
25	Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00



Species	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
Many-headed Sedge		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tender Sedge		0.05	0.02	0.03	0.03	0.03	0.02	0.01	0.19
Fox Sedge		0.35	0.00	0.23	0.20	0.30	0.23	0.11	1.42
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
Northern Bog Bedstaw		0.02	0.00	0.05	0.16	0.16	0.02	0.13	0.54
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
Autumn Willow		0.10	0.00	0.12	0.35	0.37	0.09	0.33	1.36
Slender Wedgegrass		0.06	0.02	0.04	0.04	0.06	0.04	0.04	0.30
Purple-stemmed Aster		0.07	0.05	0.03	0.04	0.06	0.03	0.01	0.30

Screenshot 15

bchydro_siteC_floraspp_wetlandranking9Dec2014.xlsx - Excel

A18 — Scaled to sum to 1

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Species**					**Secondary habitat use ranking**						
2		**OW**	**WS**	**WH**	**SE**	**TS**	**Wf02**	**Wf13**	**BT**	**Marl Fen**	**Tufa Seep**	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	0.4069	0.0000	0.0516	0.5415	0.0000	0.0000	1.0000
4	Many-headed Sedge	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	Tender Sedge	0.0000	0.2756	0.0925	0.1648	0.1358	0.1659	0.1102	0.0551	0.0000	0.0000	1.0000
6	Fox Sedge	0.0000	0.2463	0.0000	0.1642	0.1408	0.2111	0.1584	0.0792	0.0000	0.0000	1.0000
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	Hall's Willowherb	0.0000	0.0171	0.1181	0.0114	0.2705	0.1371	0.0343	0.4114	0.0000	0.0000	1.0000
9	Northern Bog Bedstaw	0.0000	0.0439	0.0000	0.0847	0.2987	0.2864	0.0416	0.2448	0.0000	0.0000	1.0000
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11	White Adder's-mouth Orchid	0.0000	0.0159	0.0212	0.0212	0.2619	0.2230	0.1274	0.3292	0.0000	0.0000	1.0000
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.2965	0.0000	0.0000	0.7035	0.0000	0.0000	1.0000
13	Meadow Willow	0.0000	0.1915	0.8085	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
14	Autumn Willow	0.0000	0.0699	0.0000	0.0908	0.2577	0.2724	0.0663	0.2429	0.0000	0.0000	1.0000
15	Slender Wedgegrass	0.0000	0.1927	0.0808	0.1472	0.1167	0.1841	0.1472	0.1312	0.0000	0.0000	1.0000
16	Purple-stemmed Aster	0.0000	0.2359	0.1790	~~0.1144~~	~~0.1173~~	~~0.2108~~	~~0.1085~~	~~0.0341~~	~~0.0000~~	~~0.0000~~	1.0000
17	Total	0.0000	1.2890	1.3003	0.7988	2.3027	1.6909	0.8454	2.7730			11.0000
18	Scaled to sum to 1	0.0000	0.1172	0.1182	0.0726	0.2093	0.1537	0.0769	0.2521			1.0000
19	"Value" Relative to TS (TS present in both primary and secondary rankings	0.0000	0.5597	0.5647	0.3469	1.0000	0.7343	0.3671	1.2042			
20												
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092.0000
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941.0000
23												
24	Habitat "Value" Baseline (sum to 1)	0.0000	42.5355	119.2714	84.8864	294.3314	1.5372	0.6917	517.0426			1060.2961
25	Habitat "Value" Affected	0.0000	7.7337	46.4555	14.3051	24.0740	0.0000	0.0769	38.0660			130.7113

Rare plant species | Species associated habitats | Primary habitat use | Primary habitat rank | Secondary habitat use | **Secondary habitat rank** | Summary rank

Screenshot 16

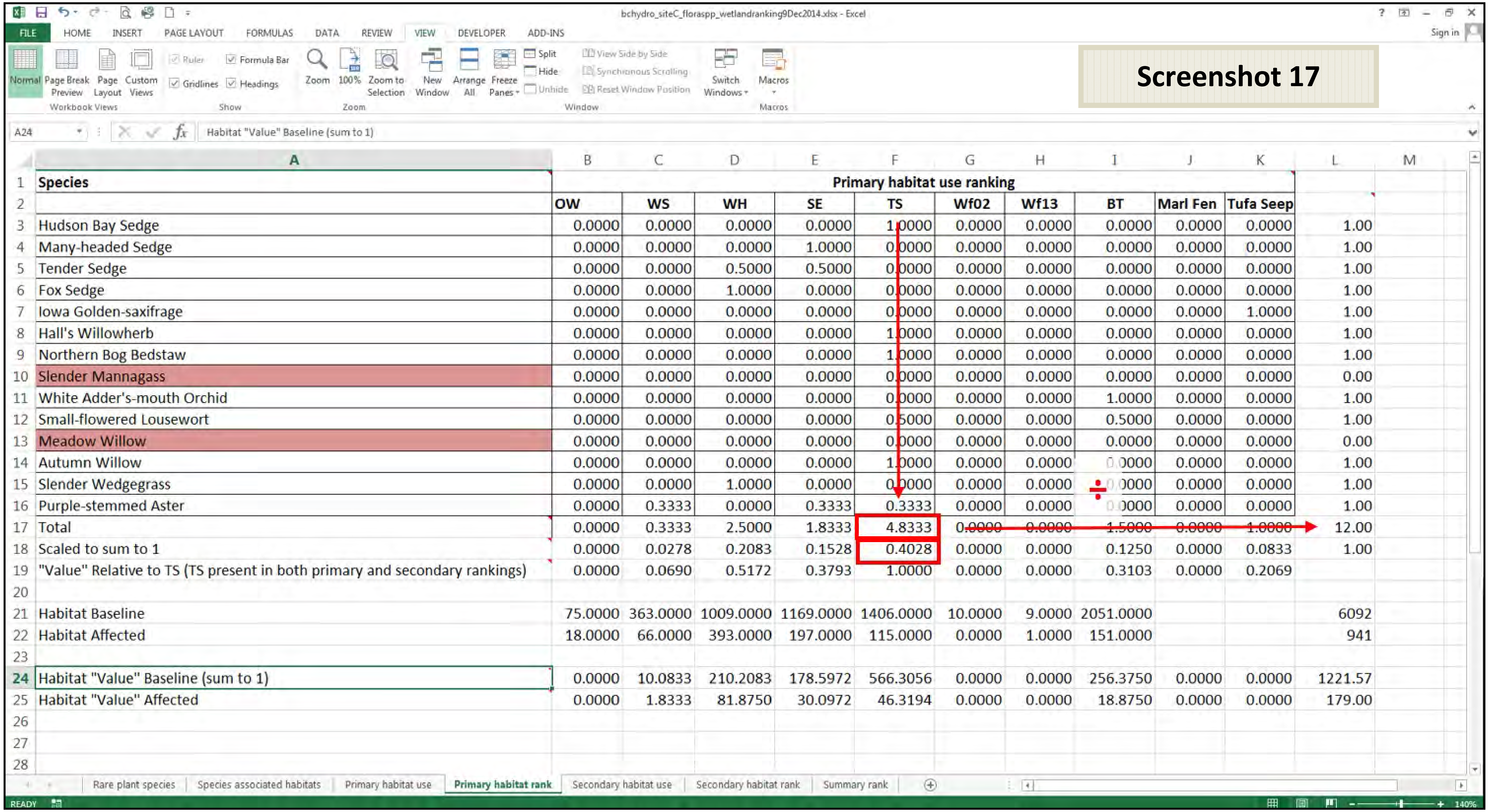
bchydro_siteC_floraspp_wetlandranking9Dec2014.xlsx - Excel

A24 | Habitat "Value" Baseline (sum to 1)

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Species**	**Primary habitat use ranking**										
2		**OW**	**WS**	**WH**	**SE**	**TS**	**Wf02**	**Wf13**	**BT**	**Marl Fen**	**Tufa Seep**	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
4	Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
5	Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
6	Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
8	Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
9	Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
11	White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
13	Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
14	Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
15	Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
16	Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
17	Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
18	Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
19	"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
20												
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941
23												
24	Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
25	Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00

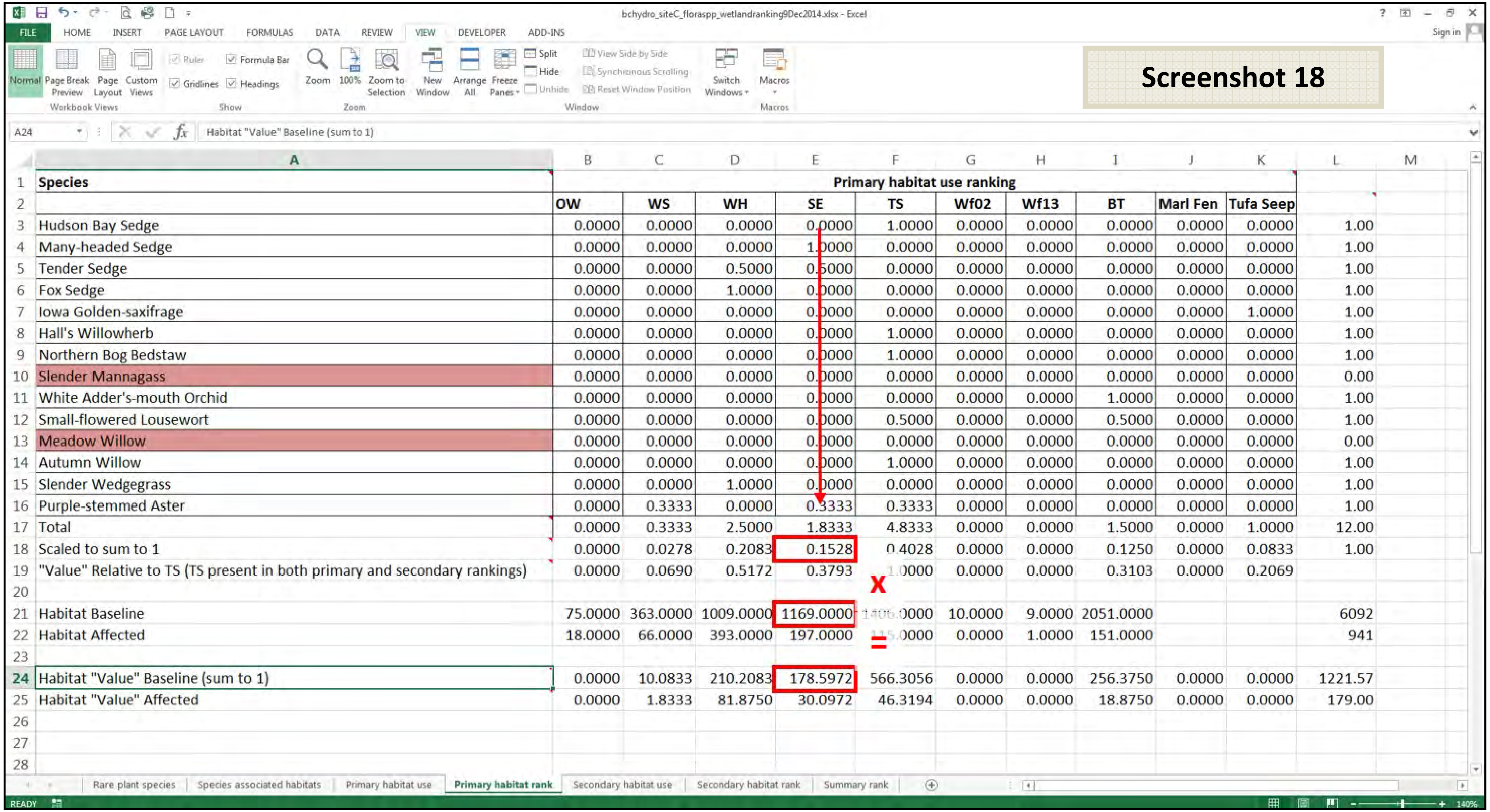
Rare plant species | Species associated habitats | Primary habitat use | **Primary habitat rank** | Secondary habitat use | Secondary habitat rank | Summary rank

Screenshot 17

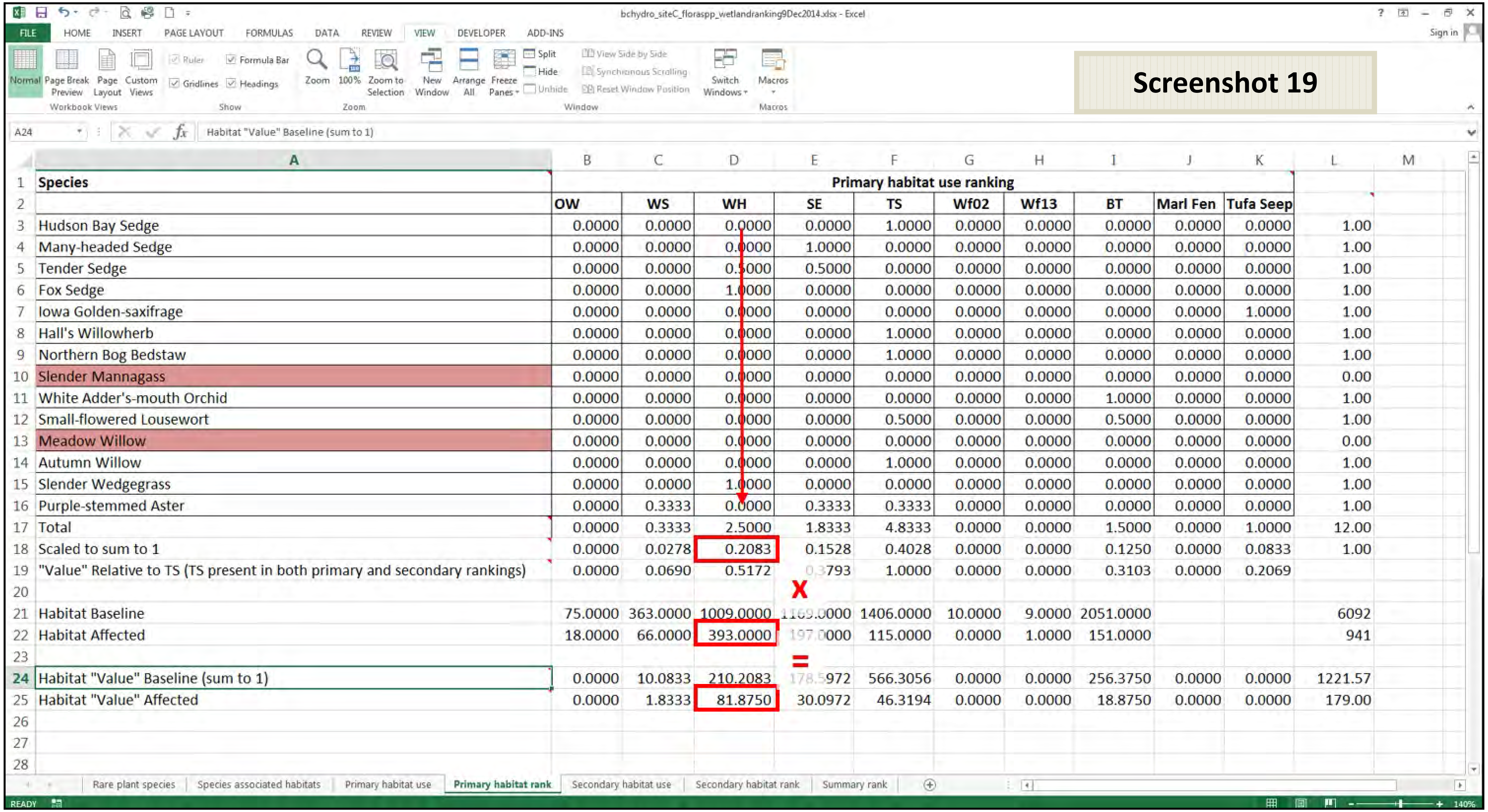


	A	B	C	D	E	F	G	H	I	J	K	L
1	Species	Primary habitat use ranking										
2		OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
4	Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
5	Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
6	Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
8	Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
9	Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
11	White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
13	Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
14	Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
15	Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
16	Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
17	Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
18	Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
19	"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
20												
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941
23												
24	Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
25	Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00

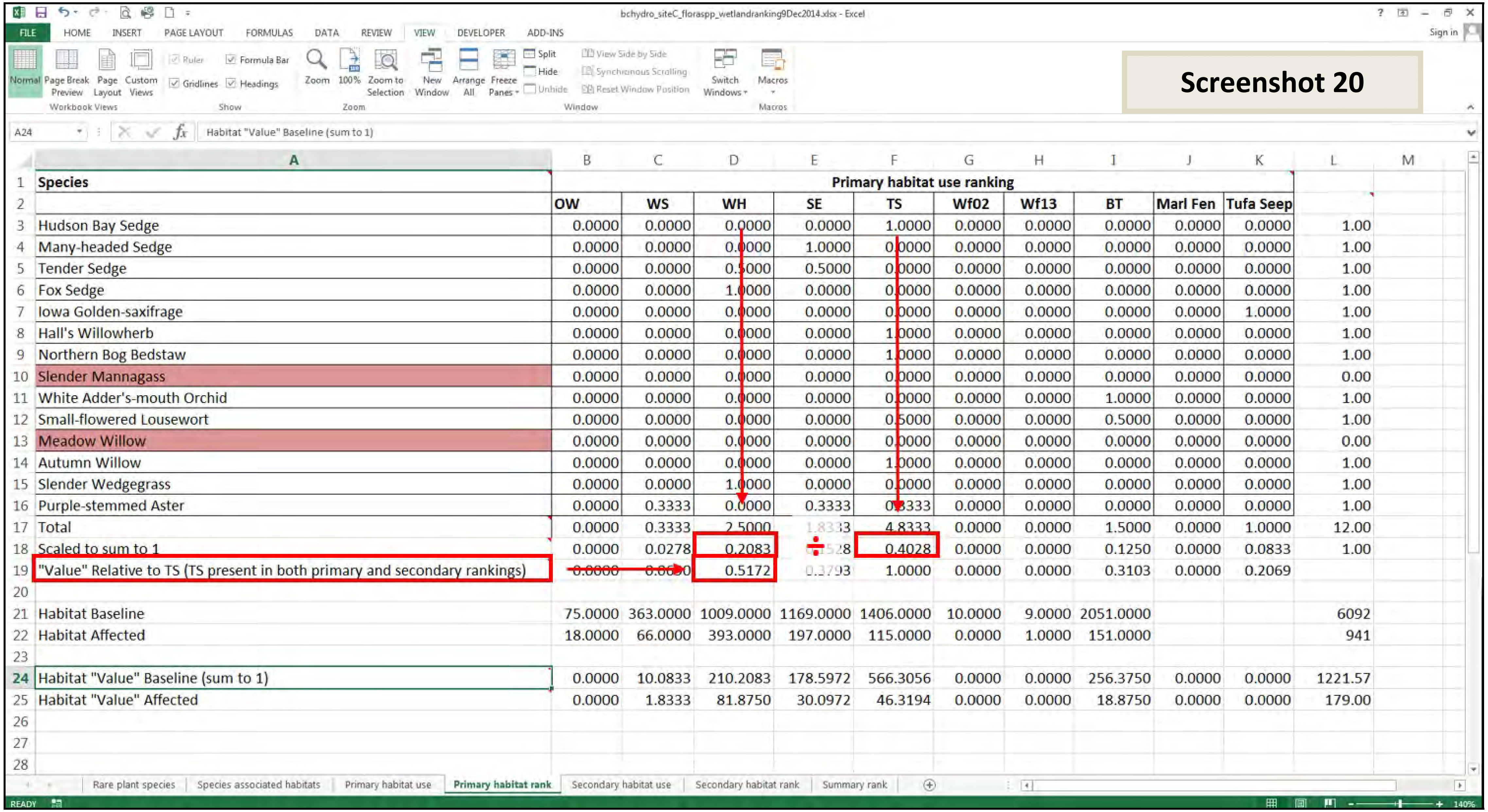
Screenshot 18



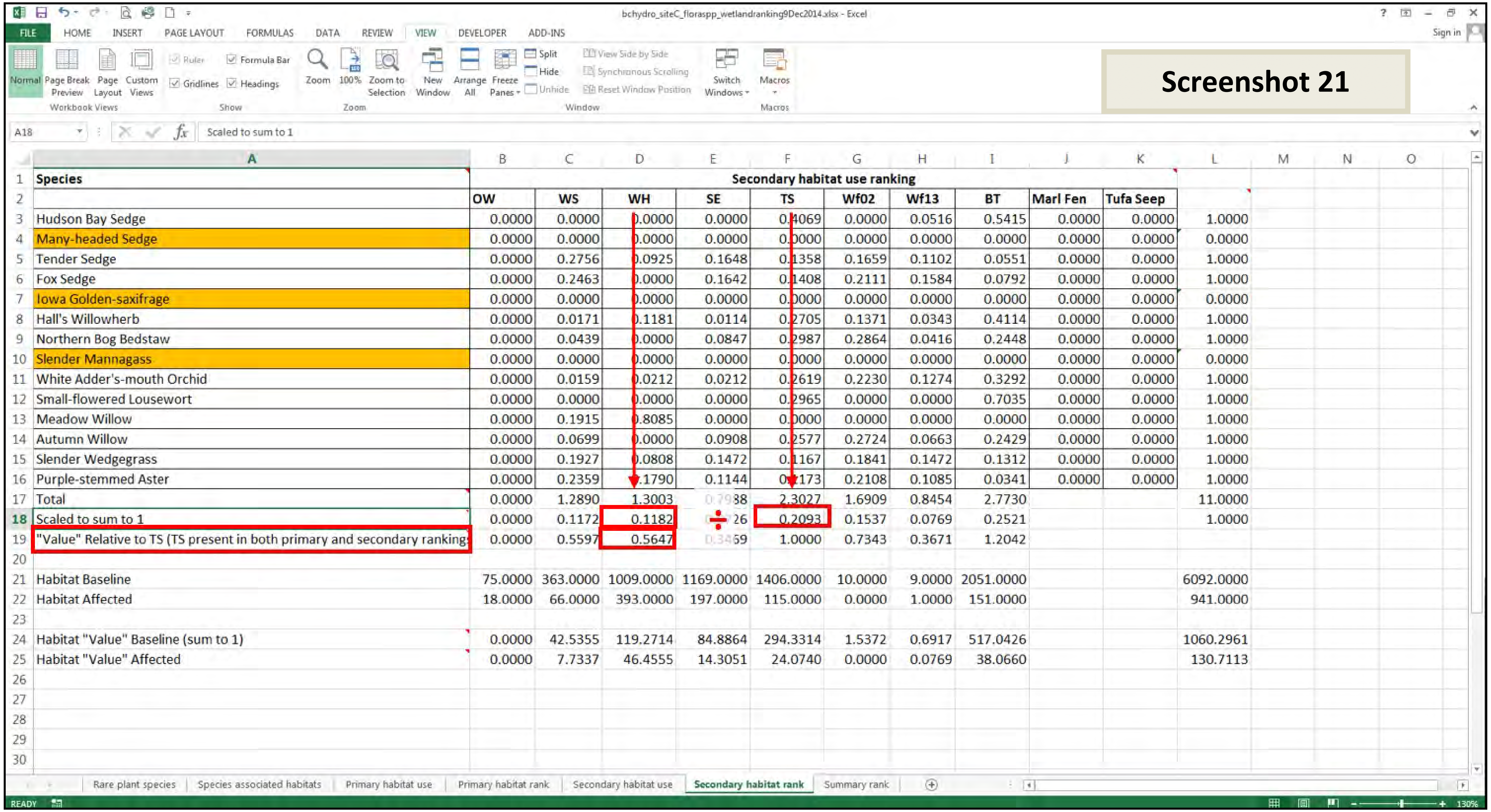
	A	B	C	D	E	F	G	H	I	J	K	L
1	**Species**	**Primary habitat use ranking**										
2		**OW**	**WS**	**WH**	**SE**	**TS**	**Wf02**	**Wf13**	**BT**	**Marl Fen**	**Tufa Seep**	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
4	Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
5	Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
6	Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
8	Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
9	Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
11	White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
13	Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
14	Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
15	Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
16	Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
17	Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
18	Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
19	"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
20						X						
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	= 115.0000	0.0000	1.0000	151.0000			941
23												
24	Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
25	Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00
26												
27												
28												



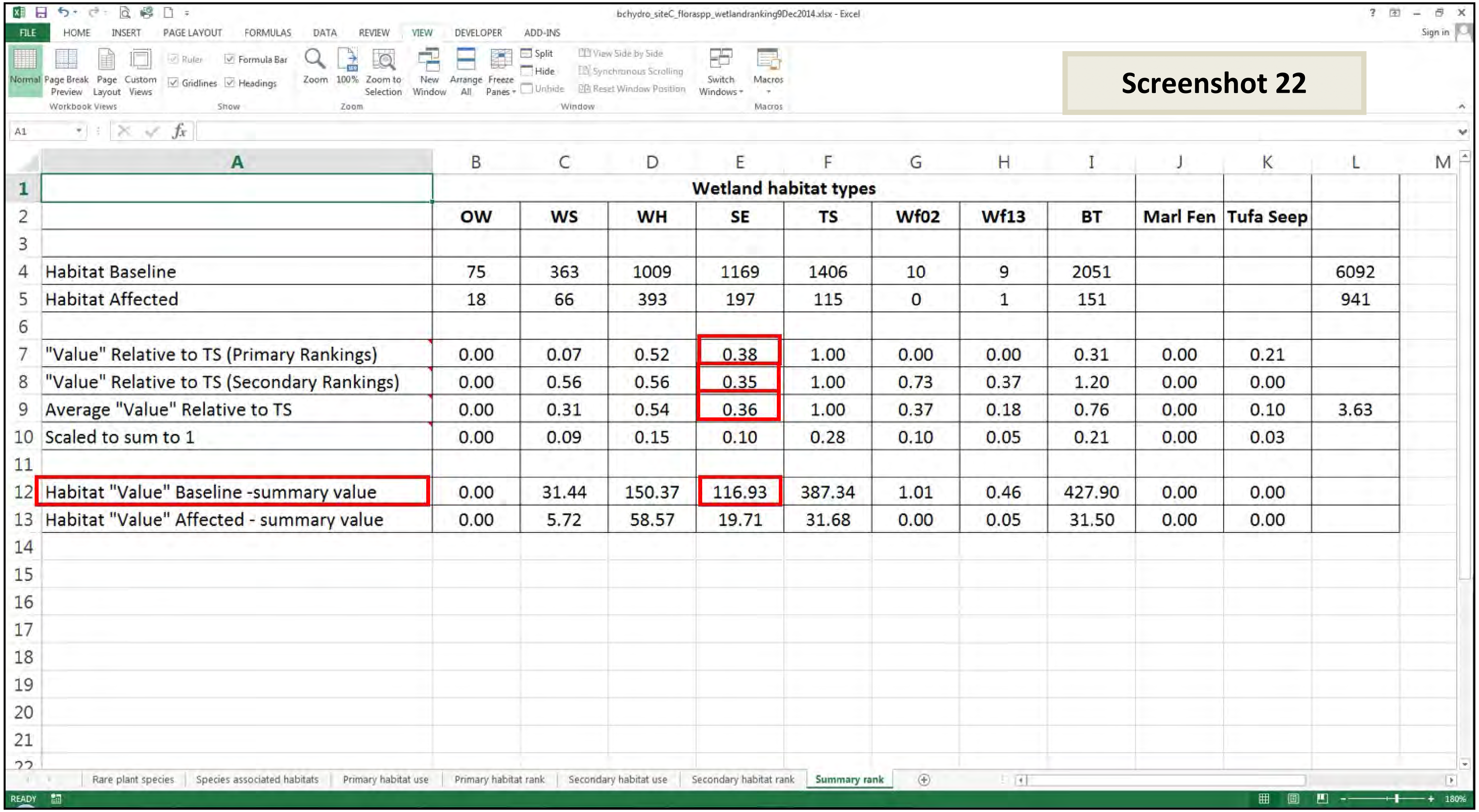
	A	B	C	D	E	F	G	H	I	J	K	L
1	Species	Primary habitat use ranking										
2		OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
3	Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
4	Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
5	Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
6	Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
7	Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
8	Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
9	Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
10	Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
11	White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
12	Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
13	Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
14	Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
15	Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
16	Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
17	Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
18	Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
19	"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
20					X							
21	Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
22	Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941
23					=							
24	Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
25	Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00



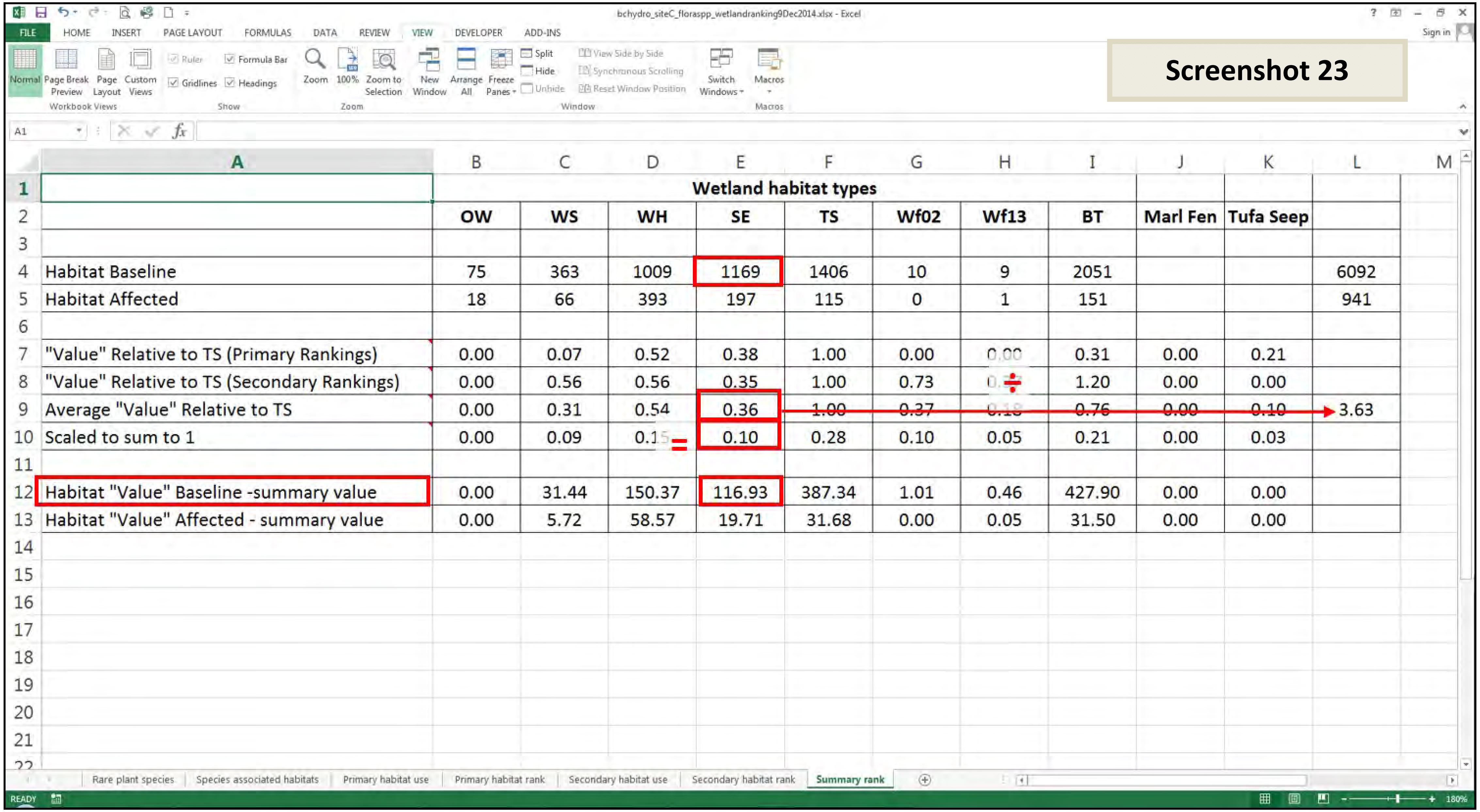
Species	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
	Primary habitat use ranking										
Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Many-headed Sedge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Tender Sedge	0.0000	0.0000	0.5000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Fox Sedge	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.00
Hall's Willowherb	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Northern Bog Bedstaw	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
White Adder's-mouth Orchid	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.00
Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	1.00
Meadow Willow	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Autumn Willow	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Slender Wedgegrass	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Purple-stemmed Aster	0.0000	0.3333	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	1.00
Total	0.0000	0.3333	2.5000	1.8333	4.8333	0.0000	0.0000	1.5000	0.0000	1.0000	12.00
Scaled to sum to 1	0.0000	0.0278	0.2083	0.1528	0.4028	0.0000	0.0000	0.1250	0.0000	0.0833	1.00
"Value" Relative to TS (TS present in both primary and secondary rankings)	0.0000	0.0690	0.5172	0.3793	1.0000	0.0000	0.0000	0.3103	0.0000	0.2069	
Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092
Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941
Habitat "Value" Baseline (sum to 1)	0.0000	10.0833	210.2083	178.5972	566.3056	0.0000	0.0000	256.3750	0.0000	0.0000	1221.57
Habitat "Value" Affected	0.0000	1.8333	81.8750	30.0972	46.3194	0.0000	0.0000	18.8750	0.0000	0.0000	179.00



Species	Secondary habitat use ranking										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Hudson Bay Sedge	0.0000	0.0000	0.0000	0.0000	0.4069	0.0000	0.0516	0.5415	0.0000	0.0000	1.0000
Many-headed Sedge	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tender Sedge	0.0000	0.2756	0.0925	0.1648	0.1358	0.1659	0.1102	0.0551	0.0000	0.0000	1.0000
Fox Sedge	0.0000	0.2463	0.0000	0.1642	0.1408	0.2111	0.1584	0.0792	0.0000	0.0000	1.0000
Iowa Golden-saxifrage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hall's Willowherb	0.0000	0.0171	0.1181	0.0114	0.2705	0.1371	0.0343	0.4114	0.0000	0.0000	1.0000
Northern Bog Bedstaw	0.0000	0.0439	0.0000	0.0847	0.2987	0.2864	0.0416	0.2448	0.0000	0.0000	1.0000
Slender Mannagass	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
White Adder's-mouth Orchid	0.0000	0.0159	0.0212	0.0212	0.2619	0.2230	0.1274	0.3292	0.0000	0.0000	1.0000
Small-flowered Lousewort	0.0000	0.0000	0.0000	0.0000	0.2965	0.0000	0.0000	0.7035	0.0000	0.0000	1.0000
Meadow Willow	0.0000	0.1915	0.8085	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
Autumn Willow	0.0000	0.0699	0.0000	0.0908	0.2577	0.2724	0.0663	0.2429	0.0000	0.0000	1.0000
Slender Wedgegrass	0.0000	0.1927	0.0808	0.1472	0.1167	0.1841	0.1472	0.1312	0.0000	0.0000	1.0000
Purple-stemmed Aster	0.0000	0.2359	0.1790	0.1144	0.[illegible]173	0.2108	0.1085	0.0341	0.0000	0.0000	1.0000
Total	0.0000	1.2890	1.3003	0.7988	2.3027	1.6909	0.8454	2.7730			11.0000
Scaled to sum to 1	0.0000	0.1172	0.1182	0.[illegible]726	0.2093	0.1537	0.0769	0.2521			1.0000
"Value" Relative to TS (TS present in both primary and secondary ranking	0.0000	0.5597	0.5647	0.3469	1.0000	0.7343	0.3671	1.2042			
Habitat Baseline	75.0000	363.0000	1009.0000	1169.0000	1406.0000	10.0000	9.0000	2051.0000			6092.0000
Habitat Affected	18.0000	66.0000	393.0000	197.0000	115.0000	0.0000	1.0000	151.0000			941.0000
Habitat "Value" Baseline (sum to 1)	0.0000	42.5355	119.2714	84.8864	294.3314	1.5372	0.6917	517.0426			1060.2961
Habitat "Value" Affected	0.0000	7.7337	46.4555	14.3051	24.0740	0.0000	0.0769	38.0660			130.7113



	Wetland habitat types										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Habitat Baseline	75	363	1009	1169	1406	10	9	2051			6092
Habitat Affected	18	66	393	197	115	0	1	151			941
"Value" Relative to TS (Primary Rankings)	0.00	0.07	0.52	0.38	1.00	0.00	0.00	0.31	0.00	0.21	
"Value" Relative to TS (Secondary Rankings)	0.00	0.56	0.56	0.35	1.00	0.73	0.37	1.20	0.00	0.00	
Average "Value" Relative to TS	0.00	0.31	0.54	0.36	1.00	0.37	0.18	0.76	0.00	0.10	3.63
Scaled to sum to 1	0.00	0.09	0.15	0.10	0.28	0.10	0.05	0.21	0.00	0.03	
Habitat "Value" Baseline -summary value	0.00	31.44	150.37	116.93	387.34	1.01	0.46	427.90	0.00	0.00	
Habitat "Value" Affected - summary value	0.00	5.72	58.57	19.71	31.68	0.00	0.05	31.50	0.00	0.00	



	B	C	D	E	F	G	H	I	J	K	L
	Wetland habitat types										
	OW	WS	WH	SE	TS	Wf02	Wf13	BT	Marl Fen	Tufa Seep	
Habitat Baseline	75	363	1009	1169	1406	10	9	2051			6092
Habitat Affected	18	66	393	197	115	0	1	151			941
"Value" Relative to TS (Primary Rankings)	0.00	0.07	0.52	0.38	1.00	0.00	0.00	0.31	0.00	0.21	
"Value" Relative to TS (Secondary Rankings)	0.00	0.56	0.56	0.35	1.00	0.73	[illegible]	1.20	0.00	0.00	
Average "Value" Relative to TS	0.00	0.31	0.54	0.36	1.00	0.37	0.18	0.76	0.00	0.10	3.63
Scaled to sum to 1	0.00	0.09	0.15	0.10	0.28	0.10	0.05	0.21	0.00	0.03	
Habitat "Value" Baseline -summary value	0.00	31.44	150.37	116.93	387.34	1.01	0.46	427.90	0.00	0.00	
Habitat "Value" Affected - summary value	0.00	5.72	58.57	19.71	31.68	0.00	0.05	31.50	0.00	0.00	

Appendix H. Bat Roost Installation Workplan.

Bat Roost Installation Workplan

Bats were included in the assessment as a species group in the Site C EIS (BC Hydro 2013). The EIS identified the loss of bat roosting sites and foraging habitat resulting from tree removal and flooding as the main effect of the Project on bats with ~11% of the reproductive habitat in the local assessment area projected to be lost. Other impacts include the loss of roosts in bridges, loss of potential hibernacula at Portage Mountain, and disturbance or mortality during construction. This workplan describes:

- Recommendations and specifications for the creation of bat roosts
- Reduction of mortality during construction
- Protocols for dealing with bats within Project facilities.

Bat Roost Creation

Mitchell-Jones (2004) and Johnston et al. (2004) ranked maternity sites of high conservation concern and recommended they be given high priority in any mitigation plan. The creation of artificial roosts by installing bat houses is the focus of this plan. Two different types of roosts will be created: bat houses and tree roosts. These are described below.

Background

The Bat House Research Project, initiated in the early 1990s by Bat Conservation International (BCI), demonstrated that several bat house designs will attract and support a number of species of bats including maternity colonies of females (Kiser and Kiser 2004; Tuttle et al. 2004). Bat houses have been successfully employed at several BC Hydro generating stations for mitigation. They were installed at the Strathcona and Ladore generating stations in April 2007 as part of a BCRP Project to mitigate for habitat loss from historical dams and as alternative habitat to attract bats roosting inside the generating stations. An inventory in late summer 2008 estimated ~1600 bats to be roosting in the bat houses (Nagorsen 2009). Several bat houses were installed in early 2010 at the Clowhom generating station to mitigate for the demolition of buildings associated with an old fishing lodge that supported a Yuma myotis (*Myotis yumanensis*) maternity colony. No systematic inventories or monitoring were done as follow up, but BC Hydro staff observed bats occupying the houses by July 2010. Similarly, bat houses were installed at the Falls River generating station in late 2009 to mitigate for the demolition of a staff bunkhouse that supported a population of Yuma myotis.

Of the eight bat species that occur in the Site C project area (Simpson et al. 2013), four have been confirmed to use bat houses (Table 1) as summer day roosts. Occupation of bat houses has not been documented for the long-legged myotis, but it is a potential user of bat houses as small colonies have been found in buildings (BC Conservation Data Centre 2013). Bat houses will not provide roosting habitat for three of the bat species that occur in the Site C project area. The eastern red bat and hoary bat are obligate tree bats that roost in foliage (Carter and Menzel 2007). The silver-haired bat is rarely found in buildings and generally roosts in cavities or under bark in trees (Vonhof and Gwilliam 2000).

Table 1. Bat house use by eight bat species that occur in the Site C project area.

Scientific name	Common name	Known to use bat houses?
Eptesicus fuscus	Big Brown Bat	Yes
Lasionycteris noctivagans	Silver-haired Bat	No
Lasiurus borealis	Eastern Red Bat	No
Lasiurus cinereus	Hoary Bat	No
Myotis evotis	Long-eared Myotis	Yes
Myotis lucifugus	Little Brown Myotis	Yes
Myotis septentrionalis	Northern Myotis	Yes
Myotis volans	Long-legged Myotis	Maybe

Bat House Designs

Multi-chambered Maternity House Design

This design consists of a rectangular wooden box with vertical chambers, an open bottom, and a landing board. The 4-chamber nursery house recommended by BCI (http://www.batcon.org/pdfs/bathouses/FourChamberNurseryHousePlans.pdf) has proven effective in most regions of North America (Kiser and Kiser 2004; Tuttle et al. 2004). Large numbers of *Myotis* sp. bats occupied 4-chamber maternity houses at the Strathcona and Ladore generating stations on Vancouver Island. The standard design is ~84 cm (33") high, 45 cm (17.5") wide with chambers ~51 cm (20") high with 19 mm (3/4") spacing between chambers. This size of box would be well suited for mounting on the poles of Bald Eagle (*Haliaeetus leucocephalus*) nest platforms or on smaller wooden poles used solely for bat houses.

The standard maternity house can be doubled in width (Figure 1) or height to increase the roosting area and provide a greater range of temperature regimes. Because of weight, the larger design would be best mounted on the side of buildings or concrete retaining walls associated with the dam, or on poles designed to support their weight.

Figure 1. BCI double-wide maternity house. Scale is 1 metre ruler.

Evaluation

- the design has proven effective in British Columbia.
- double-sized boxes of the BCI design can support hundreds of bats, the standard size box can support smaller colonies including species that roosts in small colonies.
- it can be installed on poles, sides of buildings, or concrete structures associated with the generating station and spillways.
- paired maternity boxes mounted back-to-back on a pole provide a range of temperature regimes.
- boxes can be easily moved if the location is unsuccessful.

Recommended Placement

- dam site
- within 400 m of the expected reservoir shoreline outside the erosion impact line (exact locations to be determined).

Rocket Box Design

The BCI rocket box (see Tuttle et. al. 2004 for plans) is a narrow rectangular box ~122 cm (48") high and 27 cm (10.5") wide with two 4-sided chambers (Figure 2) mounted on a dedicated pole. The chambers are built around an inner pole sleeve that contains the supporting pole. Surveys by BCI revealed the rocket boxes were 6% more effective than maternity boxes attracting bats but 8% less likely to support maternity colonies (Tuttle et al. 2004). Therefore, the design may be particularly effective for supporting male bats. A project in coastal Washington demonstrated that long-eared myotis occupied rocket boxes. Nagorsen (2009) observed that a rocket box installed on a flag pole attached to a building at the Strathcona generating station had large guano accumulations under it indicating bat use.

Figure 2. BCI rocket box; scale is 1 metre ruler.

Evaluation

- the design has proven effective in British Columbia.
- rocket boxes may attract male bats or species such as the northern myotis or long-eared myotis that roost in small colonies.
- the design provides a range of temperatures.
- rocket boxes are mounted on metal or wooden poles.
- they can be moved and reinstalled on another pole if the location is unsuccessful.

Recommended Placement

- dam site and
- within 400 m of the reservoir shoreline outside the erosion impact line (exact locations to be determined).

Texas Bat-Abode Design

The Texas Bat-Abode (Figure 3) is designed for bats day-roosting in bridges or culverts (Keely and Tuttle 1999). Internal wooden panels similar to those in the BCI maternity house create chambers sandwiched between two wooden side panels that are cut to fit inside bridge beams. The beams support the side panels and the bridge deck provides a roof covering. With a number of chambers, the Texas Bat-Abode potentially can support large numbers of bats. Although designed for bridges, it may be possible to fit the Texas Bat-Abode house into concrete overhangs at the dam site.

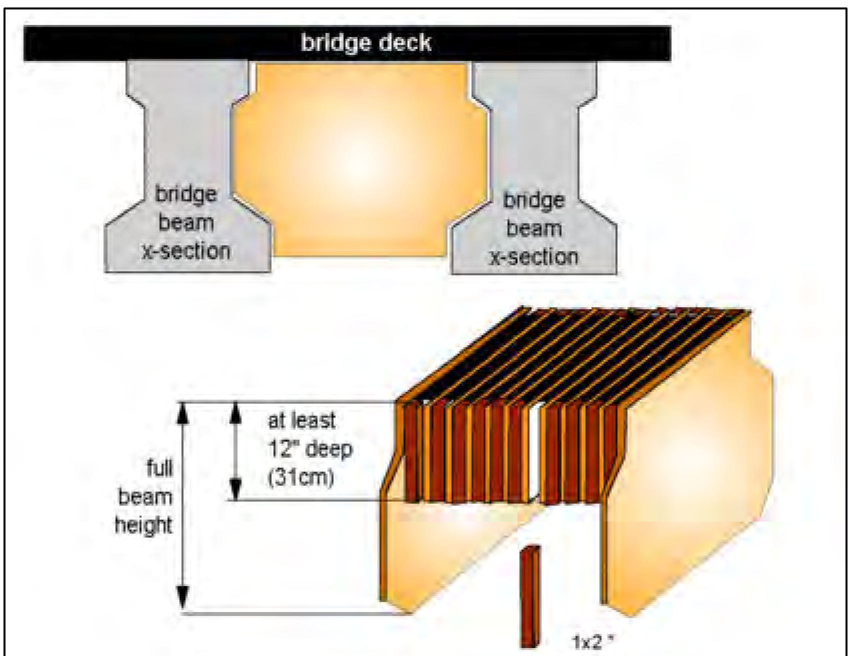


Figure 3. Texas Bat-Abode (courtesy Bat Conservation International).

Evaluation

- developed for bridges in the warmer climates of the southern United States, it is unknown how effective this design would be in the cooler temperature regimes of the

Project area especially for bridges or other structures constructed of concrete decks and beams.

- as the bat house is fitted to a structure it cannot be easily moved and re-installed if the location is unsuccessful.

Recommended Placement

- Bridges with maternity roost potential and possibly concrete overhangs at the dam site.

Oregon Wedge Design

The Oregon Wedge (Keeley and Tuttle 1999) consists of a single plywood panel 46 x 61 cm attached by three wood strips to the vertical concrete in structure of a bridge (Figure 4). This creates a simple one-chamber bat house with a wooden front and a back of concrete.

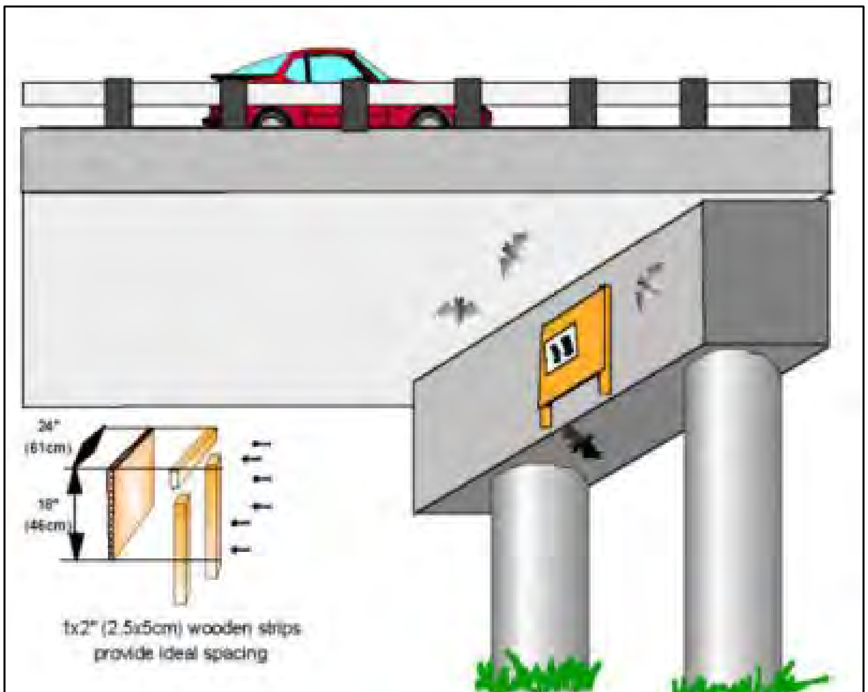


Figure 4. Oregon Wedge (courtesy Bat Conservation International).

Evaluation

- unknown if this design with a concrete back is effective in northern regions
- inexpensive, easy to install, and readily moved if unsuccessful.

Recommended Placement

- bridges with day-roost potential.

Bat Condo Design

Bat condos or community bat roosts are large stand-alone bat houses designed to hold tens of thousands of bats. Typical design is a small wooden house-like structure mounted on poles.

The house structure contains hundreds of removable baffles that provide roosting chambers. In British Columbia, a large bat condo has been installed in the Creston Valley. Design plans are available from BCI and Bat Conservation and Management Inc.[1]

Evaluation

- in the Project area, a bat condo is likely to attract the little brown myotis, a species that forms large maternity colonies in buildings. The big brown bat and *Myotis* species that roost in smaller colonies may not be attracted to large bat condos.
- bat condos are typically used to mitigate for the demolition of buildings with large maternity colonies.
- within the Project area, the only known bat roost in a building is at Lynx Creek and there are no known colonies of 100s or 1000s of bats in buildings that require mitigation.

Recommended Placement

- If BC Hydro is unable to relocate the Lynx Creek building used by bats, a bat condo may be appropriate to replace the roost, depending on the size of that colony.

Bat House General Guidelines on Construction

Essential design requirements for bat houses were summarized in Tuttle and Hensley (1993), Tuttle et. al. (2004), Bat Conservation and Management (2010) and on the web sites of BCI (http://www.batcon.org/index.php/get-involved/install-a-bat-house/subcategory/39.html) and Bat Conservation and Management Inc.

(http://www.batmanagement.com/Batcentral/batcentral.html)

Key Construction Guidelines for Bat Houses are:

- Construct exteriors from 4-ply ½” plywood.
- Avoid pressure treated wood.
- Use screws (stainless or galvanized) and not nails.
- Seal and caulk all seams and joins.
- Cover the roof with roofing material, with asphalt side facing up.
- Paint the exterior black using a primer and several coats of water-based paint.
- Paint a distinct unique number on the front of each house to label for monitoring.
- Roughen wood on the interior to provide a gripping surface for bats.
- Cut horizontal grooves on the landing pad area portion of the bat house.
- Use narrow ventilation slots to prevent overheating.
- Space chambers 19 mm (3/4”) apart.

Proposed Bat House Locations and Installations

Given that the purpose of the bat houses is to mitigate for the loss of natural tree roosts in the Project area, they should be installed throughout the project area from the dam site to the

[1] http://www.batcon.org/index.php/resources/getting-involved/install-a-bat-house
http://www.batmanagement.com/Ordering/condos/batcondo.html

Hudson's Hope area (Table 2). The timing of installation is not critical but early spring is optimal. Monitoring results will be used to determine the success of the bat boxes based on observed use of the boxes. Should monitoring results identify bat boxes not being used by bats, then these boxes may be re-deployed to another more suitable location within the monitoring period, as informed by the monitoring program results.

Table 2. Proposed Number and Distribution of Bat Houses.

Location	Timeline for installation	Type	Number	Installations
Site C dam Site (locations to be determined in consultation with EIT)	At the end of construction at installation location	double sized BCI maternity houses	4	concrete walls
		standard sized BCI maternity houses	4	concrete walls
		BCI rocket boxes	4	poles
		Texas Bat-Abode	1	concrete wall if feasible
Reservoir at eagle platform sites	In conjunction with installation of alternate nest platforms for Bald Eagle	standard sized BCI maternity houses	32	On Bald Eagle nest platform poles or free-standing poles pairs mounted back-to-back 1 pair at each site
		BCI rocket boxes	32	stand-alone poles 2 at each maternity house site
Additional locations along reservoir- outside erosion impact line	1-2 years prior to reservoir clearing, as feasible	standard sized BCI maternity houses	24	pairs mounted back-to-back 1 pair at each site
		BCI rocket boxes	24	Stand-alone poles 2 at each maternity house site

Multiple bat houses of several designs will be installed at each site. Tuttle et al. (2004) found that three or more bat houses were nearly twice as successful as sites with a single bat house. Installing bat houses of several designs and sizes increases roosting opportunities and improves success. Clustering several bat houses at a site is also more efficient for monitoring, particularly for exit counts. Detailed plans for pole or wall installations are available from BCI: http://www.batcon.org/index.php/get-involved/install-a-bat-house/subcategory/39.html.

Key Guidelines for Bat House Placement are:

- Select a southeast or south aspect with 6-10 hr of sunlight in summer;
- Select locations <400 m from water above the erosion zone and ideally with some habitat diversity;
- Select locations that are accessible for monitoring and maintenance;
- Bat houses should be mounted 3.5-6 m above ground on poles, sides of buildings, or retaining walls;
- Do not mount bat houses on trees;
- Bat houses should be >6 m from nearest tree branches, wires, or perches for aerial predators;
- Avoid sites where bat houses are shaded;
- Avoid locations that may be prone to vandalism or human disturbance;
- Avoid sites where dawn-dusk lights shine directly on the bat boxes; and,
- Avoid locations along roads where bats may collide with vehicles when returning to the roost at dawn.

Dam Site

South-facing concrete walls, associated with the spillway, auxiliary spillway, and the generating station area at the dam site, are ideal locations for mounting bat houses. Concrete provides an ideal medium for maintaining stable temperature regimes because it absorbs and radiates heat.

<u>Considerations</u>

- The installation locations at the dam site will be selected to provide a range of temperature regimes with some houses mounted to obtain maximum sun exposure and others positioned for less solar heat.
- Bat houses will be installed at locations away from bright lights that could cause bats to avoid bat houses. According to Fure (2006), using low-pressure sodium lamps or fitting mercury lamps with UV filters will reduce the impact of lighting on bat activity.
- Placement of bat houses at the Site C dam site area will require close cooperation and consultation with the site manager to accommodate concerns and conflicts with BC Hydro crews. Live bats and the presence of bat guano are generally perceived negatively by staff. Experiences with bat house installations at the Strathcona and Ladore dams revealed that bat houses must be placed in locations well away from work areas or access areas. Several successful bat house installations at these facilities had to be moved to other locations because of concerns about large accumulations of bat guano. Predicting conflicts may be difficult and an adaptive approach will be required to respond to placement-related issues that arise after installation.
- Installations at the dam site will be inside a secure restricted area and protected from vandalism. Access for monitoring, particularly for exit counts or mist-netting at night, will require authorization and possibly specialized training from BC Hydro.

<u>Recommended Installations</u>

- Up to 2 double-sized and 4 standard-sized BCI bat houses mounted on concrete walls (Figure 5). Bat houses can be mounted directly to walls with concrete anchors. If the height of a wall is insufficient, mounting on metal poles or brackets attached to concrete walls will increase the height of a bat house above ground. The double-sized and standard-sized boxes can be interspersed to provide a mix of bat house sizes.

- If there is a suitable area at the dam site with concrete cross beams and overhang, install a Texas Bat-Abode type bat house. The number of chambers will depend on the dimensions of the available space.
- Up to 4 BCI rocket boxes. Rocket boxes can be mounted on free-standing metal or wooden poles (Figure 6), or on poles attached to walls (Figure 8). Rocket boxes could be located near maternity boxes or situated in other locations away from walls.

Reservoir shoreline-outside erosion impact line

Bat houses will be most effective if placed within 400 m of the reservoir above the 5-year erosion line. For installation and follow-up monitoring, it would be most efficient to install bat houses at locations near access roads and locations where other installations exist such as Bald Eagle nest platforms. In order to cover the full length of the reservoir area, it may be necessary to select some locations accessible only by boat. See *Key Guidelines For Bat House Placement* (above) for essential criteria for bat house locations and placement.

<u>Recommended Installations</u>

- At 16 locations with eagle nest platforms[2], install 2 standard BCI maternity houses mounted back-to-back on poles supporting the eagle nest platforms. Bat houses will be mounted to the pole using mounting boards with one house facing south and the other facing north to provide a range of temperature regimes. If mounting to the eagle nest platform poles proves ineffective, then the 2 maternity houses will be mounted back-to-back on a dedicated post using the double post setup recommended by BCI.
- At the 16 locations with eagle nest platforms selected for maternity houses, also install 2 rocket boxes each mounted on a separate metal or wooden pole.
- At 12 additional locations along reservoir with no eagle nest platforms, install 2 standard BCI maternity houses mounted back-to-back with the BCI double post set up. Also install 2 rocket boxes each mounted on an individual metal or wooden pole.

<u>Considerations</u>

- Installing maternity houses on poles with eagle nest platforms is a novel approach (Mark Kiser, pers. comm.).
- Bat houses will be placed at least 2 m below the nest platform to avoid disturbance by eagle activity or obstruction by overhanging nesting material but at heights 3.5-6 m above ground.
- Disturbance or predation from eagles or Ospreys (*Pandion haliaetus*) using the nest platforms is likely to be insignificant. If maternity bat houses mounted below nest platforms remain occupied for 4 years after installation, they will be relocated to separate pole mounts at the same site or moved to another location on the reservoir.

[2] As not all locations for Bald Eagle nest platforms are expected to be suitable for bat boxes and because mounting bat boxes on the same structure as the nest platform has not been tested, only a portion of nest platform sites will be used.

Permanent BC Hydro Buildings

Permanent buildings constructed in the project area by BC Hydro may have potential for bat house installation.

Recommended Installations

- For suitable buildings, install 1 or 2 standard maternity houses on the south wall.

Considerations

- Only unoccupied buildings with adequate wall height (minimum 3.5 m) should be considered for bat house installations.
- To avoid bat-human conflicts, bat houses will not be installed on buildings used for work areas or residence.

The operational life of a box is about 10 years. A sub-set of the bat boxes installed will provide short-term, alternate roost structures for bats, that is, they will not be replaced after 10 years. Short-term boxes will be installed along the reservoir and near areas that will be restored after Project activities are complete.

The remainder of the boxes will be maintained to provide long-term roost structures for bats. These boxes will be replaced as they approach their operational end of life, or sooner if they are damaged or adversely affected by weather. Long-term roost structures will be located at the dam site and other Project buildings. Roosts installed to provide short-term roosting opportunities are documented being used by large numbers of bats or bat species at risk may be re-classified as long-term and be maintained and replaced over the lifetime of the Project.

Figure 5. One double-wide, and 8 standard maternity houses mounted on south-facing retaining wall (Strathcona generating station).

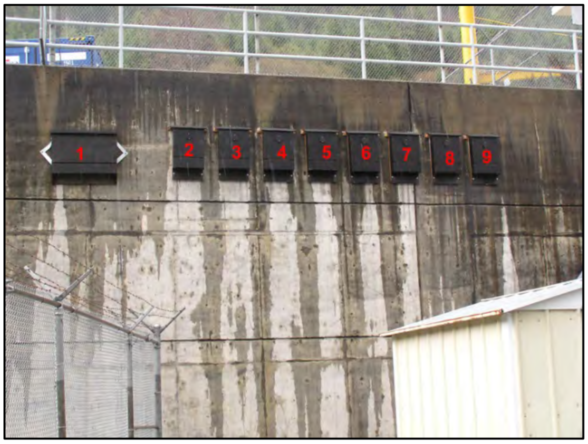


Figure 6. Rocket box mounted on metal pole at Clowhom dam (BC Hydro).

Figure 7. Double pole mount maternity houses. Colony Farm, photo by Kiyoshi Takahashi.

Figure 8. Rocket box mounted on flag pole at Strathcona generating station.

Protocols for Bats Occupying BC Hydro Facilities

In the Project area, bats could occupy temporary construction buildings and permanent buildings and structures. The structure with the potential for greatest conflicts is the generating station at the dam site. With warm stable temperatures and many ventilation openings, hydro generating stations provide ideal conditions for pregnant and nursing female bats during the summer maternity period. The loss of natural tree roosts from reservoir creation probably increases the attractiveness of these human-made structures for roosting bats. Bats in generating stations create human-bat interactions and Hydro staff generally will not tolerate guano deposits in an active workplace. The Ladore and Strathcona generating stations in the Campbell River watershed, for example, have had a long history of bat occupation in summer with associated conflicts. Excluding bats from these stations has proven difficult (Kellner and Rasheed 2002).

Risk from Bats in Buildings

The only disease risk from bats is a bite from a rabid bat or handling a dead bat that has died from rabies. The incidence of bat rabies in British Columbia is low (estimated at 0.5% of wild bats; BC Centre for Disease Control. 2011).

Although some find the odour unpleasant, there is no health risk from bat guano. Bats do not carry hantavirus. Histoplasmosis, a fungal disease associated with bird and bat droppings, is unknown in the province.

Recommendations

BC Hydro will offer a training session for BC Hydro staff who will work at the dam site or reservoir to explain the purpose of the bat houses and educate workers about the health risks and benefits of bats around the dam facility and reservoir.

General Guidelines and Protocols for Bats in Buildings:

- Bats are protected from killing, capture or harassment by the British Columbia Wildlife Act.
- Do not touch or handle dead bats unless wearing disposable gloves.
- Unless bats are day-roosting in living quarters or work areas, there is no reason to remove bats from facilities.
- When removing live bats from a building wear leather gloves.
- Any worker bitten by a bat should seek medical advice.
- Wear a respirator when sweeping up guano to avoid lung irritation from dust particles.
- Solitary bats in buildings will usually leave if a door or window is left open or the bat can be captured and released outside. See the Bat Conservation International web site http://www.batcon.org/index.php/bats-a-people/bats-in-buildings.html for instructions and a video on how to remove a bat.
- Bats found roosting outside on walls or sides of buildings should be left undisturbed.
- Bats can be prevented from entering buildings with exclusion methods. See the Bat Conservation International web site for detailed instructions.
- If large or persistent colonies become established in a building, consult a qualified bat expert.

Monitoring Bat Houses

Long-term monitoring, 10 years for short-term boxes and up to 20 years for long-term boxes, will be undertaken to evaluate bat use and success of the mitigation, and to evaluate the effectiveness of different bat house designs and placement in a northern region. Boxes will be monitored annually.

Hygiene protocol for minimizing White Nose Syndrome transmission will be followed (MOE/FLNRO 2012) during all monitoring activities.

Every 3 years, the monitoring results should be analyzed to assess the success of project and if the objectives are being met (see Evaluating Monitoring Results below). An adaptive management approach should be taken and adjustments made in the number, design, and placement of bat houses during the first 10 years after installation if necessary.

Objectives

The objectives of monitoring are to:

- determine if bat houses are occupied by bats;
- estimate numbers of bats occupying bat houses;
- determine the bat species occupying bat houses;
- record temperature profiles within bat houses;
- evaluate the effectiveness of different bat house designs and siting; and,
- assess condition of bat houses and conduct maintenance needed to maintain functionality.

Determining Bat Occupancy

Bats would be expected to occupy bat houses from April to early September. During baseline surveys (Simpson et al. 2013), pregnant females were caught from 13-23 July and post-lactating females were detected 17 July-25 August suggesting that young would be expected to appear in the populations as early as July. Minimal monitoring at a site would include a sample before and after the young are born.

Monitoring will be done monthly from 15 April to 30 September. If monitoring bat houses on eagle nest poles is observed to disturb nesting eagles, then the monitoring schedule will have to be adapted.

The simplest level of monitoring (i.e., presence-absence) is to examine each bat house for evidence of active or recent bat usage. Evidence for bat use is the presence of bat guano under the bat house. Guano may be observed on the ground under bat houses. Collecting frames with plastic sheeting, window screening, or gauze fabric can be placed under bat houses for systematic collecting of bat guano (Judy et al. 2010). Looking up into the bottom of bat houses usually reveals bats in the roost chambers.

Presence-absence monitoring can be done during the day. It is simple, quick, and will be done for every bat house that is installed in the Project area. Procedures and suggested schedules are provided below.

Emergence Counts

Because bats may be tightly packed in the roost chambers with some hidden, reliable counts of bats inside bat houses is not possible. The most effective and least disturbing method to assess numbers is emergence counts at sunset (Kunz and Reynolds 2003). Observers placed at several strategic locations near one or more bat houses count bats as they emerge from the roost to forage. At least 3 counts will be made at a bat house over the year in order to document changes in colony size resulting from weather effects, roost switching, and recruitment of young in summer.

Exit counts are labour intensive and only one site or cluster of bat houses can be monitored in a night by a field crew, therefore a subset of installations with evidence of bat occupation will be selected for exit counts each season. The sample will be designed to compare counts at the dam and selected reservoir habitats and among different bat house types and placements.

Species Identification

Determining the species occupying the bat houses is needed to evaluate the effectiveness of the bat houses and their use by listed species such as the northern myotis. Of the five bat species at Site C that could use the bat houses, only the big brown bat is visually identifiable. Identification of the 4 *Myotis* species cannot be confirmed from observations or photographs of bats in the roosting chambers. There are several options for identification.

- The eight bat species found in the Project area can be discriminated from DNA extracted from their guano (Judy et al. 2010; Zinck et al. 2004). Samples of guano collected under bat houses will be collected for future DNA analysis.
- Mist-netting will be done at selected bat house installations to capture bats for identification in the hand. Captures will also yield data on gender and reproductive condition; wing punches taken for future DNA sequencing will be used to confirm the identification of problematic species. The frequency and scheduling of mist-netting will be laid out in a detailed sampling plan prepared after bat house installation.
- Active recording of echolocation calls of bats at emergence may provide data for acoustic identification. The most effective detectors for active monitoring are the Anabat SD2 (Titley Scientific) or the Echo Meter EM3+ (Wildlife Acoustics). Acoustic recordings could be made during exit count surveys.

Considerations

- DNA sequencing of guano samples or wing punches can be done by Wildlife Genetics International, Nelson, BC.
- Mist-netting will take place in close proximity to bat houses to ensure captures are of bats occupying the installations. There is some risk of disturbance with mist-netting but it is the only method that will yield information on the gender and reproductive condition of bats using bat houses.
- Many acoustic files may not be identifiable to species level for the *Myotis* bats. Their steep calls emitted at emergence are particularly problematic for species-level identification. Nonetheless, the four *Myotis* species found in the Project area all emit some distinctive echolocation calls that are identifiable.

Temperature Profiles

Tuttle and Hensley (1993) and Kiser and Kiser (2004) concluded that that the single most important criterion for successful bat houses is temperature. Reproductive females require temperatures of 27-38° C; males select cooler regimes. Temperature profiles recorded from bat houses and their correlations with occupancy rates and roost size will assist in evaluating the effectiveness of bat house placement and different bat house designs. Two options for temperature loggers are the Tidbit v2 logger[3] and the iButton DS1922L[4]. The Tidbit logger is waterproof; the iButton can be placed in a waterproof holder (DS9107). Either logger requires an additional device for downloading data. Loggers can be programmed to record at set intervals (30 min intervals adequate for bat house monitoring) and can record continuously throughout the spring and summer with data downloaded after bats vacate the bat houses.

[3] Onset http://www.onsetcomp.com/products/data-loggers/utbi-001
[4] Maxim Integrated http://www.maximintegrated.com/datasheet/index.mvp/id/4088

Nagorsen (2009) successfully recorded temperature profiles in the bat houses installed at the Strathcona and Ladore generating stations with Onset Tidbit loggers attached to a removable wooden plug on each bat house (Figure 9 and Figure 10).

A logger will be installed outside of bat boxes at each location to record ambient temperature at a subset of bat houses. Sampling should be designed to compare reservoir vs. dam sites, rocket boxes vs. maternity boxes and paired (back-to-back) maternity houses.

Maintenance of Bat Houses

Bat houses will be checked each fall for evidence of damage from vandalism, predators, woodpeckers, or extreme weather and the presence of wasp nests. Long-term maintenance may involve some vegetation clearing around bat house sites. The life span of bat houses and associated wooden support poles is approximately 10 years.

Figure 9. Standard BCI maternity house with attached circular plug with data logger.

Figure 10. Onset Tidbit temperature logger attached to inside of circular plug. Note weather seal.

Evaluating Monitoring Results

The purpose of the bat houses is to provide short-term and long-term artificial day roosts for five bat species in the Project area that potentially occupy bat houses. Short-term structures will provide roost sites until new vegetation is established in disturbed areas. Long-term structures will provide roost sites through the life of the Project at the dam site and at select buildings. Long-term structures may also be established at locations documented having high levels of use or use by species at risk. The highest priority (Mitchell-Jones 2004; Johnston et al. 2004) is to create maternity roosts for breeding females of the five species. This includes large maternity roosts for species such as the little brown myotis or big brown bat and smaller nursery colonies of the long-legged myotis, long-eared myotis, and northern myotis. Although a lower conservation priority, successful mitigation will also target the creation of day roosting habitat for solitary or small groups of male bats.

Considerations for Evaluating Bat Houses are:

- If installed in late winter or early spring, bat houses should be occupied during their first year of installation; move any bat houses not occupied after year 2 to new locations.
- Check unsuccessful bat houses for damage or construction flaws and assess their temperature profiles if temperature loggers were installed.
- Evaluation needs to be in the context of the entire system of bat houses in the project area rather than an individual bat house.

- Bats may move daily among adjacent bat houses in response to different temperature regimes.
- Bats may move seasonally among adjacent bat houses. At Strathcona generating station, bats occupied a double-wide maternity house during pregnancy but dispersed among seven adjacent smaller bat houses after the young were born.
- Large maternity colonies may show some fidelity over a number of years to a set of bat houses; smaller colonies or solitary bats can be expected to frequently switch their roost locations.

Creation of Bat Tree Roosts

Restoration plantings of native tree and shrub species will, over time, address the habitat needs of three bat species -- silver-haired bat, eastern red bat and hoary bat – that are obligate tree bats roosting in cavities or foliage.

Simpson et al. (2013) recommended planting balsam poplar and aspen in reclaimed areas as a general mitigation measure. Vonhof and Gwilliam (2000) and Simpson et al. (2011) noted the importance of trembling aspen and balsam poplar as roost trees for silver-haired bats.

Radio-telemetry studies in the Project area revealed *Myotis* species also use these tree species (Simpson et al. 2011). No data are available on tree roosts selected by the eastern red bat and hoary bat in the Site C project area. Both species use deciduous and coniferous trees (Carter and Menzel 2007) and would be expected to roost in trembling aspen and balsam poplar.

The CEMP requires revegetation using appropriate native species, and the Fish and Aquatic Habitat Management Plan outlines the riparian vegetation planting that will be implemented to advance the establishment of riparian vegetation around the new reservoir shoreline.

Avoidance and Reduction of Mortality and Disturbance during Construction

Tree Removal

Bats may be killed or disturbed during clearing and tree cutting for the reservoir. Pregnant or nursing females and pups would be most affected by this activity. Identifying individual tree roosts throughout the reservoir area is not possible. The most effective and practical mitigation is to limit tree cutting to winter months (October-March) where the Project schedule permits. The most critical period to avoid tree cutting is during the maternity period (June-August).

Demolition of Existing Buildings

A bat colony has been confirmed using one of the outbuildings at Lynx Creek. BC Hydro owns the building and is considering re-locating it prior to reservoir filling.

Other buildings on private land requiring demolition will require assessment prior to removal. Demolition of buildings that cannot be re-located will be done in autumn or winter (October-March) when bats are in hibernation and are unlikely to be occupying buildings. If evidence of bat use is indicated by guano accumulations, then installation of bat houses near the site will be considered. If a bat colony is discovered inside a building during demolition, activity should cease until the building and colony can be assessed and a mitigation plan developed by a qualified bat expert.

Demolition of Bridges

Simpson et al. (2013) reported three existing bridges that will be inundated are used as night roosts. It is currently unknown if the bridges will be removed or left in place. Bridges would be expected to be occupied by bats from May-September. Demolition of existing bridges should, as feasible, be restricted to autumn or winter (October-April). If a bat colony is discovered roosting under a bridge during demolition or renovation, activity should cease until the bridge and colony can be assessed by a qualified bat expert.

If the decision is made to retain bridges no special action is required as reservoir filling is scheduled to commence in October, when bats would not be present. If the reservoir filling schedule changes and shifts to times when bats could be present exclusion measures may be required as described in Johnston et al. (2004).

Appendix I. BC Hydro Pest Management Plans.

Pest Management Plan

For Management of Vegetation at BC Hydro Facilities

PMP # 105-0975-07/12

First published March 2000; revised and republished August 2006, March 2009.

BC Hydro
Field Services Vegetation
Quality Control
8475 - 128 Street
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Acknowledgements / Signing Authority:

This document was produced and reviewed by the
BC Hydro lines of business: Field Operations, Generation, and Distribution

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Chapter 1 — Introduction to Facilities Pest Management Plan

1.1, About BC Hydro

BC Hydro distributes electricity produced by several hydroelectric and other plants to the majority of BC's population. It is responsible for the safe and efficient movement of electricity from the time it leaves substations until it reaches customers through distribution lines.

Hydroelectric plants consist of a dam, a reservoir, a powerhouse, and a switchyard. At each hydroelectric plant, water from a reservoir flows into the powerhouse via a tunnel or penstock. The flowing water turns turbines (rotating blades), which in turn drive generators. The generators convert the turbine's mechanical energy into electrical energy. Transformers located within switching stations convert the generators' low-voltage electricity into a higher voltage (greater than 60,000 volts), which is then transmitted over long distances via transmission lines. Transmission lines terminate at substations, which contain transformers that reduce the voltage of the electricity. The electricity is then distributed to BC Hydro customers via approximately 55,000 km of distribution lines (at less than 60,000 volts).

Administrative buildings and storage sites supporting BC Hydro’s electrical distribution are located throughout the province and are also covered under this PMP.

For the purposes of this Pest Management Plan (PMP), a **facility** is a well-defined site, owned or leased by BC Hydro, which typically has limited public access.

1.2, About This PMP

This Pest Management Plan allows BC Hydro to use pesticides within its operating area. A PMP is a plan that describes:

- a program for managing pest populations or reducing damage caused by pests, based on integrated pest management
- the methods of handling, preparing, mixing, applying and otherwise using pesticides within the program

Legal Authority

BC’s *Integrated Pest Management Act* and *Regulation* requires organizations to conduct pest management programs under a single, comprehensive Pest

Management Plan (PMP). PMPs are required for pesticide use on public and some types of private land.

This PMP has been prepared to comply specifically with Section 58 of the Ministry of Environment's *Integrated Pest Management Regulation.*

The PMP ensures legal accountability with the provisions of the Act and Regulation, as well as all other applicable federal, provincial, and regional laws and regulations.

Purpose of PMP

The primary purpose in developing this PMP is to provide a single document describing BC Hydro's IPM planning processes to ensure effective vegetation management while protecting environmental values and human health.

The PMP is required to:

- guide the responsible use of pesticides
- incorporate the principles of integrated pest management (IPM)
- allow public awareness of, and input into, the BC Hydro facilities vegetation management program
- ensure that the effective use of an IPM program takes into account environmentally sensitive areas and land uses
- ensure continuing investigations into alternative methods of vegetation management, while preventing damage to the environment

PMP Term

PMPs remain valid for five years. This PMP is an updated replacement of one that was first approved in 2000 and extended to 2006. This version will be valid from 2007 to 2012.

Person Responsible, Section 58(1)(b)(c)

Within BC Hydro, the person responsible for managing pests under this PMP is: Rene Roddick, Vegetation/Pest Biologist: 604-543-1533.

Definitions

The following words and phrases are key to this PMP. A more complete Glossary is included at the end of this PMP in Appendix 1.

Pest — any undesirable organism that should be controlled to ensure the safety and integrity of operating systems. For BC Hydro facilities, this means **Weeds**, defined under this PMP as any undesirable plant, including grass, brush, trees, noxious weeds, or other vegetation.

Integrated pest management (IPM) — a decision-making process that uses a combination of techniques to suppress pests and that must include, but is not limited to, the following elements:

- planning and managing ecosystems to prevent organisms from becoming pests
- identifying potential pest problems
- monitoring populations of pests and beneficial organisms, pest damage, and environmental conditions
- using injury thresholds in making treatment decisions
- reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, mechanical, behavioral, and chemical controls
- evaluating the effectiveness of treatments

Integrated vegetation management — the IPM process specifically for the control of weeds at BC Hydro facilities. The primary objectives are to ensure worker and public safety and system reliability.

1.3, About Vegetation Management

Weeds within and immediately surrounding BC Hydro facilities must be effectively controlled because weeds can cause harm in various ways. Weeds can:

- lead to power outages by interfering with electrical components
- become a fire hazard or serve as a fuel source for fires
- compromise the structural integrity of dams and penstocks
- spread seeds and debris into the facility from outside, damaging or contaminating the crushed rock base at electrical facilities, and leading to increased risk of electrical hazard and worker injury

- restrict access to electrical components for maintenance, safety inspections, and emergency response
- interfere with surveillance and inspection abilities
- cover or hide fences, increasing the risk of unauthorized entry and theft
- serve as shelter for structural insect pests, especially rodents
- lead to corrosion of steel equipment and structural deficiencies
- lead to proliferation of noxious weeds (introduced weeds that must be controlled under the BC *Weed Act*)
- degrade the appearance of the site

Worker Safety Issues

Vegetation management at substations is critical for safety reasons. If an electrical fault or lightning strike occurs, current flows through the structure and into the ground. Weeds can conduct electricity, putting workers at risk of electrocution through “step and touch” potential. These current flows can also be transferred outside the facility, thereby putting the public at risk.

For the above reasons, buried underneath each of these sites is a grid of bare wires. This provides a common grounding system for electrical and metallic structures. The purpose of the grounding system is to:

- protect staff and the public from electrocution in case of a system fault, equipment failure, or lightning strike by limiting electrical potentials to safe levels
- support the proper operation of the electrical system by providing a low impedance path for fault currents

Any weeds growing over or into this grid can seriously compromise the safety functions of the grid and pose an electrical hazard to workers. Therefore, a surface of clean, crushed rock (similar to gravel) is laid over the grid to prevent weeds from establishing.

Many facilities have high voltage equipment located outdoors. Areas around electrical equipment must be kept clear of all vegetation, including nearby trees that might drop debris onto the equipment.

In addition, weeds within facilities can increase the risk of tripping and slipping.

Worker safety around electrical sites is covered under the *Occupation Health and Safety Regulation* of the Worker's Compensation Board of BC.

Pest Management Objectives

Pest management objectives at BC Hydro facilities are based on system design and prevention measures that are aimed at stopping the initial growth and spread of weeds. Therefore, BC Hydro will:

- manage vegetation in and around facilities in a professional manner
- maintain a reliable supply of electricity
- ensure safe working conditions and public safety
- protect environmental resources
- reduce long-term program costs
- maintain site security

1.4, Geographic Boundaries, Section 58(1)(a)

The BC Hydro service area encompasses most of British Columbia except the City of New Westminster, and those areas of the Kootenays and Boundary between Creston and Rock Creek, the Similkameen Valley, and the Okanagan Valley from the Canada/U.S. Border north to and including the City of Kelowna. Also excluded from this PMP are sites within the Bridge River Generating Facility.

Types of Facilities

The types of facilities covered by this PMP include:

- substations
- capacitor stations
- microwave sites
- repeater stations
- data collection sites
- helipads
- office buildings and storage yards
- pole yards
- switchyards
- dams
- reservoirs
- dikes
- spillways and diversion channels
- penstocks
- hydroelectric generating stations
- thermal generating stations
- diesel generating stations
- gas turbine stations
- cable termination sites
- access roads to facilities
- potential facilities

Substations — facilities that receive high voltage electricity from transmission lines and reduce the voltage to an appropriate level for delivery via distribution lines to residential, commercial, and industrial customers. They consist of a system of transformers, circuit breakers, and other high voltage equipment installed outdoors. BC Hydro has more than 330 substations throughout the province.

Capacitor stations — sites with equipment that controls system voltage.

Microwave sites — telecommunications facilities that house a microwave repeater station. They receive and redirect microwave signals to distant points.

Repeater stations — also known as amprodomes, and similar to microwave sites, except they receive, amplify, and redirect radio signals.

Data collection sites — instrumentation facilities that collect information on weather and reservoir levels. These facilities also monitor performance of dams and transmit geological information to a central control centre, using a computer application called ADAS (Automatic Data Acquisition System).

Helipads — helicopter landing pads for access to facilities in remote areas.

Office buildings and storage yards — corporate, regional, and district administrative office sites, and visitor sites. Most of these office sites are associated with storage yards, which are facilities for storage of electrical system components and other equipment. These are usually fenced with numerous out buildings. BC Hydro has over 90 office sites.

Pole yards — compounds that store wooden distribution poles. These sites are usually fenced and covered with clean, crushed rock.

Switchyards — facilities that receive low-voltage electricity from a hydroelectric powerhouse and increase the voltage to an appropriate level for long distance transmission over transmission lines to substations.

Dams / Reservoirs — dams are concrete or earthfill barriers across a river that are designed to control water flow and/or form a reservoir to store the water. Reservoirs have intakes that feed water into tunnels and penstocks

Dikes — banks constructed to control or confine water.

Spillways and diversion canals — Spillways are concrete or natural channels designed to pass excess water around the dam without going through the turbines. Diversion canals (or power canals) are open channels that carry water to penstocks or storage reservoirs.

Penstocks — large wooden or metal pipes that carry water from a reservoir to the turbines in the hydroelectric station. Penstocks may be adjacent to surge towers, which divert and hold excess flow from reservoirs.

Hydroelectric generating stations — facilities that generate electricity by harnessing water energy into electric energy. BC Hydro has over 30 stations.

Thermal generating stations — facilities that generate electricity by converting heat energy (through burning of fossil fuels) into electric energy. BC Hydro has one station.

Diesel generating stations — facilities that use diesel generators to produce electricity. BC Hydro has 12 stations.

Gas turbine generating stations — facilities that use natural gas or fuel oil in jet engines to produce electricity. BC Hydro has 2 stations.

Cable termination sites — locations where electrical cables enter the ground or water.

Access roads to facilities — vehicle rights-of-way that provide access to facilities for routine maintenance, daily operations, safety inspections, and emergency response.

Potential facilities – lands owned or leased by BC Hydro that may be used for or affected by future facilities, including lands in the vicinity of potential dams or reservoirs.

Chapter 2 — IPM Program for Vegetation Management

This chapter describes BC Hydro's integrated pest management program for control of weeds at facilities, as per Section 58 of the *Integrated Pest Management Regulation*, which describes information required for the PMP.

The steps for integrated vegetation management include:

- prevention (planning) — Section 58(2)(a)
- identification of pests — Section 58(2)(b)
- monitoring for pests — Section 58(2)(c)
- identification and use of injury threshold levels — Section 58(2)(d)
- treatment options and selection criteria — Section 58(2)(e)
- evaluation of treatment — Section 58(2)(f)

2.1, Prevention (Planning), Section 58(2)(a)

Vegetation management at BC Hydro facilities depends primarily on system design and preventive measures that are aimed at stopping the initial growth and spread of undesirable vegetation (weeds). These measures are considered for incorporation into facility designs prior to construction, and may be implemented during upgrades. Preventive measures may reduce the use of herbicides and other non-chemical control methods.

Preventive measures that BC Hydro may implement include the installation of crushed rock, asphalt, concrete, geotextiles, and other surfacing materials.

Crushed Rock

The most effective way to prevent weeds from establishing is by maintaining a 15cm layer of clean, crushed rock (similar to gravel) in and around areas that have zero tolerance for weeds. Crushed rock surfaces should also extend 2m outside the facility fence line to minimize the drift of seeds from outside, and to maintain public safety by reducing electrical exposure.

Crushed rock has many features that contribute to electrical and engineering safety. In particular, it has a high level of electrical resistivity, which means it does not conduct electricity, thereby reducing the risk of electrocution over the ground grid. Other functions and advantages of crushed rock are:

- It retards the evaporation of moisture from the underlying soil, thus lowering the resistivity of the soil and improving its ability to conduct the fault or lightning current into the ground and away from the surface.
- It allows rapid surface drainage.
- It is economical and readily available.
- It is non-flammable and helps to prevent fires in areas around oil-filled equipment.
- It provides a suitable surface for the movement of equipment and vehicles.
- It helps control dust.
- It provides a finished, aesthetically pleasing surface.
- It greatly impedes the establishment of weeds.

Over time, the resistivity and effectiveness of crushed rock surfaces is reduced due to construction activity, traffic, and organic matter build-up that encourages establishment of weeds. Therefore, for optimal safety and weed control, crushed rock surfaces are occasionally replenished.

Crushed Rock Over Geotextile

The effectiveness of crushed rock for excluding weeds can be enhanced with a geotextile layer close to fence lines, and in areas where herbicides cannot be used. Geotextile is a porous, polypropylene fabric that is laid underneath the crushed rock. It can also be staked to the soil in areas without crushed rock. Geotextile should not normally be used in driveable areas because it may become damaged, or around oil-filled equipment because it will cause the oil to spread during a spill.

Asphalt and Concrete

Asphalt and concrete can also be used near electrical equipment, but are not as favourable as crushed rock. They conduct electricity and are more expensive than crushed rock. They cannot be used around oil-filled equipment because they will cause the oil to spread in the event of a spill, and asphalt will burn at high temperatures.

The use of asphalt and concrete is generally limited to access roads and storage areas inside facilities.

Other Surfacing Materials

BC Hydro has tested other surfacing materials, such as limestone surfacing and crushed oyster shell surfacing, to see if they exclude weeds more effectively than crushed rock. Limestone has low resistivity, may impede drainage, is expensive, and is not readily available. Oyster shells are expensive and have limited application.

Restricting Organic Matter and Seeds

Organic matter and seeds should be kept from entering the facility and contaminating the crushed rock. This can be done by:

- removing trees (especially deciduous), grass, and shrubs growing close to the facility fence line to reduce debris deposition inside the facility
- maintaining a 2m crushed rock strip outside the fence line (over the ground grid) of substations to reduce the spread of invasive plants, such as blackberry, horsetail, broom, and groundsel

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2.2, Pest Identification,
Section 58(2)(ii)

Accurate identification of weeds present at a facility is necessary because control methods work differently on various species. For example, the herbicide treatment for grass will not control horsetail. Some vegetation types at a particular facility may be tolerable or even desirable (such as grass at a landscaped office area). In order to safely operate our facilities, BC Hydro staff and contractors are able to distinguish between desirable and undesirable species.

BC Hydro has Vegetation Management Specialists/Biologists located around the province with experience in weed management. These staff members provide information and support to other staff and to contractors on types of weeds, how they establish, their biology and growth rates, and other information.

BC Hydro staff and contractors will use field guides to help them identify weeds.

For each facility, the BC Hydro Vegetation Management Specialist/Biologist or delegate:

- identifies major vegetation species that have, or may have, an impact on the management of the site
- identifies vegetation species by common name and/or Latin name, to the taxonomic level required for proper control method selection

2.3, Monitoring Pest Populations, Section 58(2)(c)

Monitoring of facilities provides a record of information about weed occurrence, density, and site conditions. Information is recorded in Site Management Plans (SMPs — see below), including changes in weed species composition, distribution and density over time, as well as changes in surface materials and adjacent plant communities that could invade the site.

All sites are assessed before treatment to make decisions about the timing of treatments and whether they are necessary. Sites are monitored once per year, or sometimes more frequently depending on the specific environmental sensitivities and electrical concerns of the site.

Incidental Monitoring

BC Hydro maintains site integrity by routinely inspecting and monitoring facilities for potential or existing weed problems. This incidental monitoring is carried out by BC Hydro staff working on-site or visiting sites, such as electricians, security officers, Vegetation Management Specialists/Biologists, or facility managers.

Staff will notify the facility manager or regional BC Hydro Vegetation Management Specialist/Biologist of any weed problems that require immediate action.

Annual Monitoring

Regional BC Hydro Vegetation Management Specialists/Biologists or qualified designates annually monitor conditions at facilities to ensure that treatments are applied at the most effective times for weed control.

Monitoring is done visually and may be documented in writing. Weed percentages are estimated and compared to the threshold levels. Decisions are then made to prescribe treatment, methods, and timing.

Weed control contractors are provided with a map of the facility and asked to sketch in the areas where weeds are present, estimate the total percentage cover for the site, and note the major species present. This is done each time the site is treated, using a single map for each calendar year.

Site Management Plans

A Site Management Plan (SMP) is a document that contains detailed information on a particular site, such as its history, weed coverage, environmental concerns, etc. The SMP also describes how integrated vegetation management activities will be carried out on the site, and may include a detailed map of the facility.

SMPs have been developed for sites requiring integrated vegetation management, primarily substations. They have been prepared by BC Hydro Vegetation Management Specialists/Biologists in each region, or their qualified designates. SMPs may be developed for smaller and lower priority sites on an as needed basis. Lesser sites for which a SMP is not developed will have a prescription prepared prior to treatment.

The prescription will contain the following:

- site sensitivities (nearby water bodies, pesticide-free zones, residual-free zones)
- current conditions (surfacing materials, list of weed species within and outside the facility)
- preventive measures that can be taken
- recommended treatment methods, procedures, and timing

2.4, Injury Thresholds, Section 58(2)(d)

Treatment of weeds within BC Hydro facilities is required when the surface weed cover reaches a predetermined level, called the **injury threshold** (or action level). It is generally expressed as a percentage of the total weed area that can be tolerated while still maintaining the integrity, security, and safety of the site. Any percentage weed cover above the established injury threshold requires a vegetation management action.

Injury thresholds vary because weed control is more critical for certain areas within each facility. They can be specific and include all weed species (e.g., within a substation where there is low tolerance for weed growth), or they may be specific to one weed species (e.g., where a single, tall-growing tree or shrub species compromises site safety and security).

Injury thresholds that are deemed acceptable for weeds at BC Hydro facilities reflect the reasons for the control—safety, system security, structural integrity, economic impacts, and aesthetics.

Injury Thresholds for Electrical Facilities

Electrical facilities include substations, hydroelectric facilities, capacitor stations, and cable termination sites. Injury thresholds for each major type of site are listed on the following pages (threshold percentages are in bold).

Facilities can be divided into several areas with different injury thresholds, as follows.

Within Electrical Compounds

Due to serious electrical safety hazards, there is a very low tolerance for weeds within fenced electrical compounds.

BC Hydro does not allow weed populations to exceed **5%** of the cover of the electrical compound. When weeds reach this density, control is initiated.

In addition, the following areas are maintained weed free (**0%**):

- under or around electrical equipment
- under switch operators and equipment control cabinets because of the high risk of people standing at the equipment during an electrical fault
- around oil-filled transformers and equipment
- around high voltage equipment with ground level insulators

Just Inside or Outside Fence Lines

For safety reasons the ground grid often extends beyond the fence line for 2m. Therefore, requirements for weed control are the same as those inside electrical compounds. Weeds are controlled when densities exceed **5%** of the 2m area inside and outside the fence line.

Pole Yards and Storage Yards

In pole yards and storage yards, weeds are controlled because they can:

- increase fire hazards
- create slipping and tripping hazards
- degrade the appearance if the site
- interfere with equipment access, site security, and storage capabilities
- serve as food and habitat for ants and wood pests
- lead to corrosion of steel equipment

Storage of woodpoles is governed by the Canadian Standards Association (CSA). CAN/CSA 015, section 5.7, states that “poles shall be piled and supported in such a manner that all poles are at least one foot above the general ground level. No vegetation or decaying wood shall be permitted underneath stored poles.”

Therefore, control is initiated at >**0%** weed cover under pole bunks. Control is initiated at **10%** weed cover in the yard areas.

Hazard trees outside the fence line are removed because they may damage equipment and material (**0%**). (Hazard trees are defective trees that may fall into the site.)

Mowed grass, forbs, and shrubs are acceptable in some open areas.

Hydroelectric Facilities

Hydroelectric facilities include generating plants, earthfill or concrete dams, penstocks, spillways, and canals. Weeds at dam sites are a safety concern and must be removed because they can:

- damage the structural integrity of the dam by penetration of the dam core by roots, increasing the risk of water leaks and erosion
- damage the dam by windthrow (i.e., by tree roots pulling out of dam face)
- impede access to structures and instrumentation for safety inspections
- block sightlines during visual inspections for monitoring seepage and sinkholes
- block sightlines for survey pins in the ground, used as reference points to monitor surface movement of dams and other structures
- provide cover for burrowing rodents and other pests

It is important to control weeds before extensive roots become established, since root systems can provide channels for water to move through the dam.

Low-growing vegetation, such as grasses, forbs, and mat-forming shrubs, is desirable at dam sites and along waterway corridors as long as it does not exceed 0.5m in height. Such vegetation helps prevent the growth of weeds and spread of pests. It also improves aesthetics and controls erosion.

Earthfill Dams — All vegetation will be controlled within 6m from the toe of the dam, and on the upstream and downstream dam faces (**0%**). These areas must be kept clear to monitor for seepage, which is an indicator of dam failure. Deep-rooted trees and shrubs will be controlled once they reach 1m in height. Control measures will be implemented once **5%** of the upstream and downstream dam faces are covered in saplings. When control is implemented, all potentially tall-growing vegetation will be removed.

Concrete Dams — Plants can become established around the buttresses and in cracks, contributing to dam deterioration. All vegetation must be controlled within 6m from the toe of the dam to monitor seepage (**0%**). Deep-rooted trees and shrubs should be controlled before they reach 1m in height (**0%**). Control measures will be implemented once **5%** of the upstream and downstream dam faces are covered in saplings. When control is implemented, all potentially tall-growing vegetation will be removed. Mosses, liverworts, and algae that become established on the concrete may need to be controlled to ensure access for maintenance and inspection.

Penstocks — Penstocks can range from several metres to several kilometres in length. Drainage channels located alongside of penstocks prevent erosion of the concrete cradle foundations. Penstocks are generally inspected at least once a year.

Weeds must be controlled (**10%**) along the penstock right-of-way up to 5m on either side, and around the cradle or saddle support, to:

- maintain the integrity of the penstock structure
- maintain access for safety inspections and maintenance

- prevent trees and debris from impeding drainage in ditches and waterways, and damaging channels
- minimize fire hazards
- provide proper aeration for wooden penstocks to minimize decay
- reduce shade to prevent the growth of moss, algae, and fungi on penstocks

Vegetation management is very important on wooden penstocks because plants can contribute to their deterioration. Weeds, especially resinous species (e.g., broom) that create a fire hazard, and tall-growing trees and shrubs, must be removed. Grasses and other low-growing herbaceous species are acceptable.

Spillways, Dikes and Diversion Canals — Weed control is required around spillways, dikes, and diversion canals to:

- prevent debris accumulation in the canal, especially trees that can lead to downstream log jams
- ensure spillways can function to full capacity (if functioning improperly, water could spill over the top of the dam, resulting in dam failure)
- prevent roots from growing under the slabs of diversion channels and damaging the concrete lining
- maintain access for safety inspections and maintenance

Trees and shrubs alongside canals will be controlled when **10%** of the area is covered. Grasses and other low-growing herbaceous species are acceptable.

Designated Roadways

Weeds established within or alongside roadways around electrical facilities can rapidly spread. Even though electrical hazards are not as high, BC Hydro cannot leave weed populations unchecked. When weed levels reach **10%** of the area, control is initiated.

The exception is asphalt roadways, where no weeds are tolerated because the resistivity and surface integrity of the asphalt would be compromised (**0%**).

Mosses, liverworts, and algae may be acceptable and may not require control.

Undeveloped Areas (no buildings or equipment)

Weeds established in undeveloped areas inside the electrical facility (either crushed rock-covered or grass-seeded) can rapidly spread to adjacent electrical compounds. When weed levels reach **10%** of the area, control is initiated.

Mosses, liverworts, and algae may be acceptable and may not require control.

Other Weed Control

There is no tolerance for noxious weeds, which will be controlled at all sites as soon as they are noticed, to comply with the *Weed Control Act* **(0%)**. Noxious weeds are any plants that pose a threat to people, animals, or crops as specified under the Act.

Trees and other tall-growing or deep-rooted vegetation must be removed regardless of the hazard level for the location **(0%)**. This is because trees can interfere with required electrical clearances and site security, and pose a risk of fires or power outages.

In particular, damaged and dying trees (hazard trees) that could fall into the site must be removed (**0%**).

In areas where pedestrian or vehicular access is required and a slipping hazard exists, control of liverworts, lichens, and algae may be required.

Injury Thresholds for Communication Facilities

Communication facilities include data collection platforms, microwave stations, and repeater stations. Weeds at these facilities can interfere with reception of communication signals.

Any weeds interfering with the proper functioning of this equipment should be controlled as soon as possible (**0%**), including:

- trees and tall-growing vegetation, which can disrupt transmission of microwave and radio signals and become energized during lightning strikes
- trees, shrubs, and weeds around data collection platforms, because they can interfere with accurate measurement and transmission of data

Injury Thresholds for Transportation Facilities

Transportation facilities include access roads, parking lots, and helipads that are part of a BC Hydro owned or leased site. These sites must be kept clear of tall-growing vegetation for maintenance, access, emergency response, and safe helicopter landing.

Helipads

The BC Ministry of Transportation has stringent clearance requirements around helipad sites, where contact with trees or other vegetation could cause a fatal crash.

Helipads consist of a critical zone, secondary zone, and manoeuvering area. Vegetation management will vary depending on the topography, terrain, and direction of helicopter approach. Low-growing grass, forbs, and shrubs are acceptable around helipad sites, except within the critical zone.

The following types of weeds are controlled around helipad sites (**0%**):

- all vegetation within the critical helipad area (5m radius passenger and equipment exit zone)
- trees and tall-growing vegetation within the secondary helipad area (15m x 15m area)
- trees and tall-growing vegetation within the manoeuvering area (generally 44m x 44m, but may vary depending on the terrain), if space is required to ensure rotor clearance and manoeuvering room

Access Roads and Parking Lots

The following types of weeds are to be controlled around roads and parking lots (**10%**):

- trees and shrubs within 1m on either side of access roads and roadside ditches
- all vegetation in parking lots and within 1m of the edge of parking lots

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2.5, Method Selection, Section 58(2)(e)

IPM involves the use of different techniques (options) to control weeds within BC Hydro facilities. Methods may differ depending on the type of weeds to be controlled. Treatment options used for larger, established trees are different from those used for herbaceous weeds, grasses, and tree seedlings.

The IPM techniques proposed for the control of weeds in or adjacent to BC Hydro facilities include:

- chemical methods (herbicides)
- physical methods
- cultural/biological methods

General Selection Criteria

Selection of a particular option depends on:

- the weed species being targeted
- safety, security, economic impacts, and site accessibility
- treatment timing
- effectiveness
- land use within the facility

- environmental sensitivities in surrounding areas (fish, wildlife, surrounding land use)
- site characteristics, including land use, proximity to water sources, bodies of water, biogeoclimatic zones, and soil type
- the consequences of not treating

Herbicide Selection Criteria

Chemical control involves the use of herbicides to inhibit growth of weeds within or adjacent to BC Hydro facilities. Selection of the herbicide is determined by:

- soil residual activity
- mode of action
- selectivity
- environmental characteristics
- health and safety characteristics

Soil Residual Activity

A herbicide with residual properties tends to be retained in the soil for a certain period of time. Herbicide active ingredients are generally classified by their degree of soil residual activity—low, moderate, or high. The most common herbicides used by BC Hydro have low to moderate soil residual activity.

Mode of Action

An herbicide's mode of action refers to how it affects the plant. Uptake of herbicides is by plant roots, stems, and foliage. All herbicides used under this PMP are translocated with the exception of chlorsulfuron, which also works on contact, as well as translocation.

Selectivity

Herbicides that control all vegetation are termed non-selective, while those that are effective in controlling certain types of vegetation are termed selective.

Environmental Characteristics

The following properties are considered when making a herbicide selection:

- volatility
- adsorption to soil particles
- toxicity to non-target organisms
- selectivity
- residual activity

Health and Safety Characteristics

All herbicides used by BC Hydro have low to moderate toxicity. Applicators are well-trained and protected by personal safety equipment such as goggles, gloves, coveralls, and chemical-resistant boots based on the label recommendations. To minimize exposure, BC Hydro selects herbicides with the lowest level of toxicity and rates that proved acceptable levels of weed control.

Table 1: Properties of Approved Herbicides

The herbicide active ingredients proposed for use under this PMP, their soil residual activity, mode of action, selectivity, and application mode are shown in the table below.

Active Ingredient	Soil Residual Activity*	Mode of Action	Selectivity	Where and How Applied
2,4-D	Low	translocation	selective	foliage; post-emergent
aminopyralid	Low	translocation	selective	foliage; post-emergent
amitrole	High	translocation	non-selective	foliage; post-emergent
chlorsulfuron	Moderate	contact/ translocation	selective	foliage; post-emergent
chondrostereum	Low	fungal	selective	cut stumps; during growing season
clopyralid	Moderate	translocation	selective	foliage; post-emergent
dicamba	Low	translocation	selective	foliage; post-emergent
diuron	Moderate	translocation	non-selective	soil; pre-emergent
glyphosate	Low	translocation	non-selective	foliage; post-emergent
imazapyr	Moderate	translocation	non-selective	soil & foliage; pre-and post emergent
picloram	High	translocation	selective	foliage; post-emergent
simazine	Moderate	translocation	non-selective	soil; pre-emergent
triclopyr	Low	translocation	selective	foliage; post-emergent

* LOW generally refers to residual soil activity of up to 40 days, MODERATE for residual soil activity of up to one year and HIGH for residual soil activity of greater than one year.

Selection and Use of Residual vs. Non-Residual Herbicides

Residual — Residual herbicides are prescribed only for sites that pass soil and site sensitivity assessments. In the Lower Mainland and coastal areas of BC, assessment of weed densities and a recommendation to apply residual herbicides to the soil will generally be made in the fall.

Residual herbicides are only applied a maximum of once per year. The residual herbicides simazine, diuron, or imazapyr may be used alternatively each year in the spring so that the same active ingredient is not applied more than once every two years.

In the interior regions of BC, assessment of weed densities is also made in the fall. However, simazine and diuron are generally applied in the fall, rather than the spring. This is because the herbicides will be protected in the soil by the winter snow pack, and will begin working immediately in the spring to prevent rapid weed growth. Imazapyr is generally applied in the spring.

Non-Residual — If weed density by surface area is less than two times the injury threshold, a combination of hand-pulling and spot treatment with a low residual herbicide such as glyphosate or dicamba is generally used. If broadleaf weeds such as groundsel or fireweed are predominant at the facility, dicamba may be used instead of glyphosate. Weeds can also build up a resistance to glyphosate, so if a weed species seems to persist after glyphosate application, dicamba is generally substituted.

Low residual herbicides are not applied more than three times per year in the same facility.

2.6, Herbicide Types and Equipment, Section 58(3)(c)

BC Hydro only uses the herbicides listed and described below for weed control at facilities. These herbicides are all of low toxicity to mammals, and except for picloram, have either low or moderate soil residual activity.

Approved Herbicides

2,4-D

This herbicide is generally used in combination with other herbicides, particularly picloram (Tordon 101) to control a wide range of weeds, however, it can also be used on its own. It is applied as a foliar treatment to control rangeland vegetation and woody vegetation. 2,4-D depletes the plant's stored energy, causing plant death.

Aminopyralid

Aminopyralid controls a number of noxious and invasive weeds, such as Canada thistle, dandelion, and knapweeds. When tank-mixed with 2,4-D amine, the control spectrum broadens significantly to include such hard to control species as buttercup, curled dock, perennial sow thistle, and hawkweed.

Aminopyralid is absorbed through leaves and roots, and translocates throughout the plant. It interrupts cell division causing the plants to die.

Amitrole

Although it controls a wide variety of weeds and grasses, BC Hydro generally uses amitrole to spot-treat horsetail. It is not used as a soil-applied herbicide. Amitrole hinders or inhibits the production of chlorophyll, thereby killing the plant.

Chlorsulfuron

This herbicide is useful for the control of hard to manage annual and perennial broadleaf weeds. It is generally used by BC Hydro to spot treat horsetail. Chlorsufuron is not used as a soil-applied residual herbicide.

Chondrostereum purpureum

This biological herbicide is useful for control of alder trees. It is composed of fungus in a paste formulation which is applied to freshly cut stumps. This product has not yet been used operationally by BC Hydro as it was recently registered.

Clopyralid

This herbicide is useful for spot treatment control of broadleaf noxious weed species. It is preferred over picloram for the control of noxious weeds such as Canada thistle, perennial sow-thistle, and scentless chamomile. It is effective only on actively growing plants in areas where high-residual herbicides should not be used. For perennial weeds, clopyralid will control the initial top growth and inhibit regrowth during the season of application. Clopyralid is not used as a soil-applied residual herbicide, and will not be used in areas of high rainfall.

Dicamba

This herbicide is used for the spot treatment of actively-growing broadleaf weeds and brush species. Dicamba can be safely mixed with other herbicides to broaden the number of target species controlled. Because it is a selective herbicide, it is useful in areas where grasses will be retained.

Diuron

This herbicide is used to control many annual and perennial grasses and herbaceous weeds such as dandelion, goldenrod, thistles, and milkweed. It is used by BC Hydro as a soil-applied residual herbicide to prevent germination and growth of weed seedlings.

As diuron requires moisture (minimum 12mm) to move it into the root zone, application timing is important in the drier interior areas of BC. Because it requires moisture to activate, effects on weeds are slow and will not become apparent until the diuron has been absorbed into the plant and leaves.

Glyphosate

This herbicide is the most commonly used herbicide at BC Hydro facilities and is used to control a wide variety of weeds. It works best on annual and perennial weeds that have emerged above the soil and are actively growing. Glyphosate is useful in areas in close proximity to wells, water bodies, and other environmentally sensitive features due to its high soil adsorption properties.

Glyphosate can also be used to control resprouting from tree stumps (cut-surface method) or as a foliar spray application to control small patches of weeds. It may be used following manual and mechanical control methods to prevent re-sprouting of deciduous trees.

Imazapyr

This herbicide is used to control broadleaf weeds, annual and perennial grass species, and woody vegetation. It is particularly useful in controlling weeds that have not been effectively managed using a combination of physical controls and glyphosate application. BC Hydro uses imazapyr both as a soil-applied residual herbicide and to control established weeds by spot treatment.

Imazapyr works by preventing germination of weed seeds. It is readily absorbed through foliage and roots and moves rapidly throughout the plant where it breaks down tissue.

Picloram

Although picloram is effective in controlling a variety of broadleaf weeds, its use under this PMP (as formulated in the product Tordon 22K) will be restricted to the control of broadleaf noxious weed species, including diffuse and Russian knapweed, Dalmatian toadflax, and hound’s tongue. Picloram does not control established grasses and will not be used as a soil-applied residual herbicide. Picloram will not be used in areas of high rainfall such as the Fraser Valley and Vancouver Island.

Picloram may occasionally be used in combination with the active ingredient 2,4-D (Tordon 101) for the control of patches of rangeland weeds and woody vegetation.

Simazine

This herbicide is used as a soil-applied residual herbicide to prevent the germination of a wide range of annual and perennial grasses and broadleaf weed seedlings. It is particularly useful where combinations of physical controls and post emergent spot herbicide treatments have not been effective.

Simazine is absorbed mainly through roots and has very little foliar activity. It has little lateral movement in the soil but can be washed along with soil particles to adjacent areas.

Triclopyr

Although it is effective in controlling established perennial weed and brush species, triclopyr will generally be used to selectively control trees that are encroaching on the fences of electrical facilities or alongside access roads. As a basal bark treatment, it is particularly effective in controlling trees that commonly re-sprout following cutting. It is more effective than glyphosate for control of birch and aspen.

Triclopyr is absorbed by both leaves and roots and readily moves throughout the plant.

Application Equipment

Depending on the herbicide being applied, the following types of equipment may be used.

Backpack Sprayer

A backpack is a portable, manually operated, pressurized container with a nozzle for spraying herbicides. It operates under low pressure, thus minimizing the possibility of drift. It is particularly useful for spraying small areas or individual plants and trees. Backpack sprayers may be used for selective herbicide applications or for spraying individual trees or plants. Within this PMP, backpack sprayers may be used for applying all of the herbicides proposed for use by foliar or soil application.

Powerhose Spraygun

A hand-held spray gun and hose attached to a portable tank filled with herbicide will selectively control a variety of vegetation with directed spray. Its use, effectiveness, and disadvantages are similar to the backpack, except that a spraygun is not as mobile or as convenient to use. However, sprayguns are efficient for larger scale applications. They can be used for the application of all herbicide liquid mixtures.

Broadcast treatments applied from the ground can be done with powerhose sprayguns, although terrain conditions may require the use of backpacks.

Operating pressures may range from 200–350 kPa at the nozzle of a powerhose spraygun. The volume ranges between 300–2000L per hectare. The hand guns can be fitted with various size nozzles to modify the delivery rate required and to alter the production of fine particles (fog vs. large droplets) in the application pattern.

Boom Sprayer

Boom sprayers are widely available commercially for ATV and agricultural tractor equipment. They use a solution tank and spray apparatus similar to a powerhose sprayer, except that solution is delivered to nozzles mounted at designated intervals along the boom length.

Flat fan or hollow cone nozzles are typically used on ATV boom sprayers, and deliver volumes no less than 55 litres per hectare in order to minimize drift. Sprayer manufacturers and dealers should be consulted to assure that proper nozzles and systems are used. Typically, ATV boom sprayers used on BC Hydro sites would range from 2-4m in total spray width.

Wick/Wipe-on Applicator

This tool is used to selectively apply herbicide by wiping it directly onto plants. Wicks are made of rope or absorbent pads. The wick applicators are available in various materials and in many sizes, from hand-operated to vehicle mounted. Only small amounts of herbicide are applied, so the need for pumps, control devices, and spray tanks is eliminated.

Injection Tools

This tool is used to inject a small capsule containing glyphosate into the stem of a target tree or stump. It is a battery-powered drill or automatic loading lance.

The EZ-Ject® product uses a recycled 0.22 caliber shell casing containing gelled glyphosate. A lance with a multiple capsule magazine is used to drive the casings into the tree stem. The magazine holds up to 400 capsules.

Squirt Bottle

A squirt bottle refers to a hand-held, non-pressurized container, usually plastic. It may have a trigger pump sprayer. It is used to spray a solution of low-toxicity herbicides directly onto foliage or tree stumps.

2.7, Herbicide Application Methods, Section 58(2)(e)

BC Hydro uses the following herbicide techniques at facilities:

- cut surface
- capsule injection of stumps
- hack-and-squirt
- wipe-on
- basal bark applications
- foliar applications

Cut-Surface

This method (also called cut-and-treat) will be used in conjunction with manual tree cutting (slashing) in deciduous stands. The tree is cut low to the ground, then a herbicide is applied to the cut surface of the stump to limit resprouting. Herbicide products containing glyphosate, 2,4-D, picloram, or triclopyr may be applied to the stump with a squirt bottle or backpack sprayer. Cut-surface is a selective technique, in that only the unwanted trees are removed and other species are left.

Capsule Injection of Stumps

In this technique, a small capsule containing glyphosate is injected into the stem of a target tree or stump with an injection tool. The herbicide is slowly released into the sapwood. Capsule injection is best employed when cut-surface cannot be done immediately after slashing. This technique is also effective on resprouting stumps, provided the capsules are applied to live tissue.

One capsule of 1ml of glyphosate per 5cm of stem diameter is recommended for control. Trees greater than 20cm diameter are not effectively controlled by capsule injection. The cutting edge of the capsules must penetrate to the sapwood to ensure translocation of the herbicides throughout the tree.

Hack-and-Squirt

Hack-and-squirt is a type of injection technique that involves making one or more incisions into the tree trunk, down to the sapwood, and placing small amounts of the active ingredient glyphosate into the cuts with a squirt bottle. This technique may be used where tree removal is not mandatory for fire hazard or aesthetic purposes. The cuts should be spaced evenly around the trunk, with at least one cut for each 2.5cm of stem diameter at breast height. The glyphosate is normally applied as a carbopaste, generally with a squirt bottle, within minutes after making the incisions.

Wipe-on Techniques

In this technique, a wick soaked with the active ingredient glyphosate is wiped or dragged over the foliage of the target species. This application technique virtually eliminates drift. Wick application is ideal for vegetation management in areas where no spray drift can be tolerated, or when individually treating the stumps of deciduous trees immediately following manual cutting.

The wipe-on technique is best employed where cut stumps have resprouted to a height that raises the tree over the desirable vegetation so that it may be treated safely and effectively.

Basal Bark Applications

This procedure involves treating the bark of a tree from the root collar to a point above the ground with a hand-operated backpack sprayer, with products containing the active ingredient triclopyr. The herbicide penetrates the bark into the cambium layer of target stems and diffuses itself throughout the tree. It also travels to the roots and prevents resprouting.

Although most effective in the late summer, basal bark applications can be made throughout the year, except in wet weather. Although this technique is used primarily for controlling individual trees, it can also be applied to cut stumps to prevent resprouting and root suckering.

Foliar Applications

With this technique, a backpack, powerhose with spraygun, or boom sprayer is used to apply post-emergent herbicides. This method is generally used for individual trees or small clusters of trees where the vegetation is between 50cm and 1.5m high. It may also be used as a touch-up for cut-surface treatments and to treat areas where there are many resprouts on stumps after mowing or slashing. It is most effective when done in the late summer or early fall, prior to leaf fall, when the resprouts are less than 50cm high.

2.8, Physical Treatment Methods, Section 58(2)(e)

The physical IPM techniques to control hazard trees and weeds in or adjacent to BC Hydro facilities include:

- tree cutting
- girdling
- mowing
- weed-trimming
- hand-pulling

Physical Treatment Methods for Trees

Trees must be removed from around electrical facilities, helipads, access roads, parking lots, pole yards, and storage yards for the reasons described earlier. Trees are either slashed or girdled.

Tree Cutting (Slashing)

The required equipment for manual tree cutting includes chain saws, circular brush saws, and axes.

The benefits and limitations of tree cutting include:

- selective (only cuts desirable species)
- assures electrical safety requirements
- expensive and labour-intensive
- deciduous stumps must be removed, ground down, covered, or treated with a herbicide to prevent resprouting
- chain saws, hand tools, and falling trees pose safety hazards
- negative aesthetics unless costly clean-up is completed

Girdling

Girdling involves cutting a strip of bark from around the entire tree trunk with a specialized girdling tool, an axe, or other hand tool. The bark strip is removed along with other tissue down to the sapwood. The above-ground parts of the tree will continue to grow, but the roots starve and the tree slowly dies.

The benefits and limitations of girdling are:

- effective on any tree more than 4cm in diameter
- tools are inexpensive, durable, relatively safe, easy to use, and quiet
- flexible because individual stems and species can be removed or left on a tree-by-tree basis
- close inspection required to ensure adequate depth and width of girdle is maintained
- possible safety issue if girdled trees snap and fall over
- not all tree species are susceptible to girdling, such as maple species

Physical Treatment Methods for Weeds

Herbaceous plants, grasses, tree seedlings, mosses, liverworts, and woody weeds both inside and outside facilities are controlled through mowing, weed trimming, or hand-pulling.

Mowing

Grass cutting is recommended in undeveloped areas such as fields and low priority sites. Mowing helps control weeds before they go to seed, thus reducing spread into areas where there is low weed tolerance. Mowing promotes aesthetics and is economical, but requires repeated treatments. Commercial lawnmowers, garden tractors, or industrial tractors with rotary or flail cutters will be used. There are some safety risks due to flying debris.

Weed Trimming

Cutting weeds at ground surface is recommended along fence lines and at low priority sites. Commercial type weed trimmers are available. Weed trimming helps to remove seed heads and is convenient and economical. It is not useful on species that propagate from stem pieces, and it does not remove roots. Flying rocks and debris propelled by the spinning thread or blade may damage windows and equipment and can be a safety hazard to the operator and other staff.

Hand Pulling

Hand pulling is an important treatment option for areas within facilities where herbicides cannot or should not be used. Weeds will be hand-pulled as soon as they establish, at any time of the year, using gloves and weed wrenches.

Large or clumpy rhizomatous or woody vegetation is pulled from the site at the beginning of the season to reduce the amount of herbicide that needs to be sprayed. By dealing with weeds early, the potential for weeds to propagate inside the facility is reduced, and the problem can be eliminated before it becomes too large or costly.

Alternatively, when weeds have extensive root systems, an appropriate herbicide is used to spot-treat them, and the dead vegetation is removed by early fall.

The benefits and limitations of hand pulling are:

- in certain areas, weed density can be reduced to a manageable level, allowing use of other control methods to complete the work
- effective for larger, established weeds that can be easily uprooted, such as grass clumps, tree seedlings, and broom
- effective if there are only a few weeds on the site (e.g., 100 or less)
- roots can regenerate because many species snap off at ground line
- tends to degrade the crushed rock surface
- tends to expose soil and seeds
- risk of electrical safety hazard when roots are in contact with the ground grid, or where electrical equipment is close to the ground
- must dispose of debris
- labour-intensive and costly
- may expose labourers to unsafe equipment, especially in electrical facilities
- may lead to acute and chronic back problems

2.9, Cultural/ Biological Treatments, Section 58(2)(e)

Biological and cultural control methods use other plants or organisms to help control or displace weeds. BC Hydro often uses grass seeding and may use parasitic insects where appropriate.

Grass Seeding

Grass seeding refers to the manual planting of turf or agricultural grasses, or to the seeding of large areas of bare soil with grass-seeding machines. This method is used to reduce the establishment of broadleaf weeds with rapidly spreading airborne seeds. It can be used on any undeveloped site or disturbed area. Required equipment may include cyclone spreaders, belly grinders, seed drills, and hydro-seeding machines.

The benefits and limitations of grass seeding are:

- prevents erosion
- inhibits the growth of weeds
- promotes aesthetics
- may require irrigation to establish and maintain
- safety concerns using equipment around electrical wires and equipment
- hydro-seeding has better chances of success than manual grass seeding

Parasitic Insects

The release of parasitic insect species can help control noxious weeds and invasive plants by invading the plant and slowly killing it, or by reducing seed production and plant vigour. This method will only be used at large-area sites with a high density of noxious weeds or invasive plants, such as fields or areas with adjacent properties where there is a cooperative effort to control weeds. The size of the weed stand must be large enough to support the insect population, and the site itself must be suitable habitat for the insect species. This type of program is generally employed with the cooperation and guidance of an expert from Agriculture Canada.

This method is expensive and labour-intensive, is not usually effective in eliminating weed populations, but does help to reduce the spread of weeds and may reduce weed densities to a manageable level.

2.10, Post Treatment Evaluation, Section 58(2)(f)

All contract vegetation management work will be evaluated to:

- ensure compliance with this PMP and the contract
- ensure compliance with the *Integrated Pest Management Act* and *Regulation*
- determine the efficacy of the work done by the contractor

Results of vegetation management will be evaluated on a site to determine the success of the Site Management Plan (SMP) and techniques, and to ensure there was no negative environmental impact.

The timing and procedure for evaluating specific treatment programs will be part of the SMP, and will depend on the treatment used. In general, all sites will be evaluated within one year of the treatment. (This is in addition to an end-of-contract inspection, which focuses primarily on contractor performance.)

Treatment program evaluations will be based on visual estimates of the percentage of weed cover. Evaluations will be conducted by the regional Vegetation Management Specialist/Biologist or delegate.

Information Collected

To evaluate the results of a vegetation management program, all relevant information is collected, such as previous monitoring data and current site conditions. Both formal and informal assessments may be completed.

When evaluating the results of weed control at a facility, BC Hydro will collect the following information:

- the effectiveness of the treatment method/program in controlling the weeds
- the percentage of weeds still present and a percentage estimate of mortality
- the need for follow-up or touch-up treatments, if any
- the amount of herbicide used to determine if increases or decreases are necessary
- the cost-effectiveness of the treatment program and of any follow-up treatments
- any impact of the treatment method/program on adjacent landscaped grounds and surrounding areas
- whether the technique used was the most appropriate one for the job
- recommendations for enhanced preventive measures
- recommendations for future treatment methods/programs

Five-year Review

In addition to the above evaluations, all previously treated facilities will be subject to a review every five years by the regional BC Hydro Vegetation Management Specialist/Biologist or delegate. During these reviews, all monitoring and inspection/evaluation information collected for the facility over time will be reviewed. The results of the review will be incorporated into a revised SMP for the facility.

Water Sampling Audit

To ensure that the recommended treatment program is environmentally sound, some of the sites treated with residual herbicides will be selected for a water sampling program. This ensures that sites and surrounding land and water bodies are not being contaminated by residual herbicides. Sites will be selected according to the following criteria:

- proximity to water, water sources, the public, and schools
- the environmental sensitivity of the area
- whether herbicide use has increased over time (or whether herbicides are used at all at the site)
- the topography, soil type, and size of the site

Not all facilities have a location that is suitable for water sampling.

At facilities where residual herbicides were used, the water sampling location will be where the majority of surface run-off and discharge from underground drainage systems can be collected. The location of water sampling will be recorded on the SMP map. Water samples will be taken from each site prior to herbicide application to establish a baseline. After herbicide application, samples will be taken again within 24 to 30 hours after the start of the first significant rainfall.

Chapter 3 — Use and Handling of Herbicides

This chapter covers the responsible use and handling of herbicides at BC Hydro facilities, including:

- qualifications of personnel
- transportation — Section 58(3)(a)(i)
- storage — Section 58(3)(a)(ii)
- mixing, loading and application — Section 58(3)(a)(iii)
- disposal — Section 58(3)(a)(iv)
- spill response plan — Section 58(3)(a)(v)

3.1, Qualifications of Personnel

The use and handling of herbicides is governed by federal and provincial legislation. All persons working with herbicides will follow safe handling practices, including workplace requirements for Workplace Hazardous Materials Information System (WHMIS), labeling, and worker education.

The required practices for pesticide applicators are detailed in:

- Worker's Compensation Board of British Columbia (1998) *Occupational Health and Safety Regulation* – BC Regulation 296/97 as amended by BC Regulation 185/99 – Sections 6.70 to 6.109

- B.C Ministry of Environment (2005) *Handbook for Pesticide Applicators and Dispensers*

- Worker's Compensation Board of British Columbia (1990) *Standard Practices for Pesticide Applicators*

Any individual or company (i.e., a contractor) that provides a service to BC Hydro by applying commercial or industrial pesticides must have a valid BC Pest Control Service License. Each supervising applicator must have a valid BC Pesticide Applicator Certificate in the Industrial Vegetation and Noxious Weed Control category.

Under the *BC Integrated Pest Management Act* and *Regulation,* a certified pesticide applicator can supervise up to four uncertified assistants, provided the assistants are within continuous auditory or visual range at all times while applying pesticides. Individuals must carry proof of their applicator certification with them when applying pesticides.

3.2, Herbicide Transportation, Section 58(3)(a)(i)

The transportation of herbicides will comply with all current legislation governing their transport, as well as the following requirements under this PMP.

- The quantity of herbicides carried in a vehicle will be limited and no more than what is necessary for each project, except where transportation occurs between storage facilities.
- Herbicides will be carried in a secure lockable compartment.
- Herbicides will be transported in original labeled containers.
- Herbicides will be transported separately from food and drinking water, safety gear, and people.
- Spill containment and clean up equipment will be transported separately from pesticides, but in close proximity to them, on each vehicle during transport and use.
- Appropriate documents such as Pest Control Service Operations Records, Material Safety Data Sheets (MSDS), and the PMP document will be available during transport and use of pesticides.
- All documents and placards will be carried in, or placed on, transport vehicles if required under the *Transportation of Dangerous Goods Act* or the *BC Integrated Pest Management Act.*
- All pesticide containers will be inspected for defects prior to transporting and will be secured against spillage or unauthorized removal.

3.3, Herbicide Storage, Section 58(3)(a)(ii)

Pesticides may be stored by BC Hydro or its contractors at facilities owned or operated by BC Hydro or the contractor.

Pesticide storage will adhere to requirements of the *Integrated Pest Management Act* and *Regulation* and the Worker's Compensation Board document *Standard Practices for Pesticide Applicators.*

The storage area must:

- be ventilated to the outside
- be locked when left unattended
- be entered only by authorized persons

- have a placard affixed on the outside of each door with clearly visible block letters saying: "WARNING – CHEMICAL STORAGE – AUTHORIZED PERSONS ONLY"

The person responsible for the storage area must notify the appropriate fire department of the presence of the herbicide on the premises.

BC Hydro has no direct control of the pesticide storage practices of its contractors while not under contract to them. These companies are still governed by the provisions of the *BC Integrated Pest Management Act and Regulations* with respect to storage by a Pest Control Service License.

Some contractors may store pesticides for extended periods of time in vehicles when performing a number of pesticide treatments for BC Hydro. The vehicle is considered a mobile storage unit. Persons responsible for the pesticide storage must ensure that all pesticides are stored in a locked canopy or similar arrangement, separate from the driver and personal protective gear.

3.4, Mixing, Loading, and Applying Herbicides, Section 58(3)(a)(iii)

All mixing, loading, and application of herbicides are carried out by certified pesticide applicators who are certified in the appropriate category, or by individuals directly supervised by a certified pesticide applicator with the appropriate category of certification.

Mixing and application of herbicides must be consistent with product label rates.

To help ensure safe mixing of herbicides, the following will be kept on site, as recommended on the respective product labels:

- safety spill kits
- spill response plans
- first aid supplies
- eye wash station(s)
- protective clothing
- product labels
- Material Safety Data Sheets (MSDS)

There will be no mixing or loading of pesticides within 15m of sensitive environmental features.

3.5, Herbicide Disposal, Section 58(3)(a)(iv)

Disposal of empty containers is done according to the manufacturer's instructions on the product label, or provincial instructions and recommendations detailed in the BC Ministry of Environment's *Handbook for Pesticide Applicators and Dispensers* (2005).

At a minimum, empty pesticide containers must be either:

- returned to the pesticide distributor as part of their recycling program ***or***
- triple-rinsed or pressure-rinsed, then crushed, punctured, or damaged so they cannot be reused, and disposed of in a permitted sanitary landfill or other approved disposal site

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3.6, Spill Response Procedures, Section 58(3)(a)(v)

Spill treatment equipment will be ready and available at storage sites (including mobile storage sites) and mixing and loading sites. It will include:

- personal protective equipment as recommended on product labels
- absorbent material, such as sawdust, sand, activated charcoal, vermiculite, dry coarse clay, kitty litter, or commercial absorbent
- neutralizing material, such as lime, chlorine bleach, or washing soda
- long handled broom, shovel, and waste-receiving container with lid
- approved spill response kit

A copy of an approved spill response plan will be available at each work site. All personnel working on a project involving herbicides must be familiar with its contents. If contractors working under this PMP have their own spill response plan, it must meet or exceed the contents of the BC Hydro plan.

Contractors will follow these procedures if a spill occurs:

- Ensure all personnel are wearing appropriate protective clothing and safety gear.
- Move persons exposed to a herbicide away from the place of the spill and keep them warm.
- Administer first aid if required.
- Stop the source of the spill, if possible.
- Create a dam or ridge to stop the spilled material from spreading.
- Stop operations until the spill is contained and the source is repaired.

- Spread absorbent material over the spill, if applicable, to absorb any liquid.
- Collect the absorbent material into garbage bags or containers with the contents clearly marked.
- Remove contaminated soil or other material from the spill site and place in garbage bags or containers.
- Contact the environmental coordinator at the BC Hydro Materials Management Business unit for shipping instructions and disposal requirements.
- If the spilled herbicide is released (or may be released) into the environment, immediately report it to the Provincial Emergency Program at 1-800-663-3456. If that is impractical, the local police or nearest RCMP detachment can be called.
- Notify an approved representative of the PMP holder as soon as possible about the details of the spill.

Chapter 4 — Environmental Protection

All vegetation management activities proposed for use within this PMP (both chemical and non-chemical) will incorporate measures designed to protect the environment, as described in this chapter:

- responsible herbicide application
- strategies to protect community watersheds, and other domestic and agricultural water sources
- strategies to protect fish and wildlife, riparian areas, and wildlife habitat
- strategies to prevent pesticide contamination of food intended for human consumption
- pre-treatment inspection procedures for identifying treatment area boundaries
- procedures for monitoring weather conditions and strategies for modifying pesticide application methods for different weather conditions
- procedures for maintaining and calibrating pesticide application equipment

The size of the pesticide-free zone (PFZ) and no-treatment zone (NTZ) that will be adhered to in this PMP are based on the standards contained in the *Integrated Pest Management Act* and *Regulation.*

4.1, Responsible Herbicide Application

To protect the environment, BC Hydro ensures that the following conditions are adhered to for all application of herbicides under this PMP:

- Applicators must have current labels and Material Safety Data Sheets for the herbicide products they will be using.

- Applicators will inspect each site and plan application procedures before treatment begins.

- All herbicides are applied by or under the supervision of certified applicators using appropriate application and protective equipment.

- All herbicides are applied at the lowest possible application rate to ensure efficacy.

- Where possible, herbicides are applied when target species are at their most susceptible stage.
- Herbicide products and application methods are selected to maximize the degree of selectivity for the weed species, and minimize the degree of toxicity to non-target organisms, herbicide drift, bystander and worker exposure, and persistence in the environment.
- Herbicide use is restricted to periods that minimize human exposure and adverse impacts to the environment. Due consideration is given to the proximity of bystanders, workers, high foot-traffic areas, and other locally sensitive features. Where possible, herbicides are applied during periods of low public presence, in the early morning or evening, or on weekends if necessary, unless otherwise required by product labels.
- Applications are restricted to conditions where wind speeds do not exceed 8 km/h.
- Most applications of herbicide are not acceptable during rainfall.

4.2, Protecting Community Watersheds, Section 58(3)(b)(i)

BC Hydro protects community watersheds as follows:

- Locations of community watershed are verified by accessing the BC Hydro GIS Database, which is updated with government information every six months.
- Herbicides are not stored within a community watershed for more than 24 hours before use, and are removed within 7 days of use, unless they are stored in a permanent structure; No-treatment zones (NTZs) are maintained around all lakes and other water bodies consistent with those listed in Table 2.
- A 100m NTZ is maintained upslope from all licensed water intakes within the community watershed, except when failure to treat weeds could compromise public or worker safety. In these cases, NTZs are consistent with those listed in Table 2.
- Herbicide use is discontinued if herbicide residues or breakdown products are detected at a community watershed water intake. Further use is stopped until the BC Ministry of Health Services (Medical Health Officer) is satisfied that all required measures have been implemented to preserve water quality.

- Before using herbicides, community watershed maps are reviewed to determine if herbicide treatments are within a community watershed or are within 100m upslope of any water intake.

4.3, Protecting Water Sources, Section 58(3)(b)(i)

Table 2 lists the minimum no-treatment zones (NTZs) and pesticide-free zones (PFZs) that are followed to protect domestic and agricultural water sources, such as water intakes and wells.

In addition to these protection measures, BC Hydro will make efforts to identify and protect sources of groundwater before applying herbicides. All registered wells are displayed on the BC Hydro GIS Database, which is updated with government information every six months. In addition, contractors are required to survey the NTZ to determine if there are wells present.

Table 2: NTZs and PFZs for Water Sources

All Pesticides*	**Required Distance**
Domestic and agricultural wells and water	30 metre NTZ**
Any body of water or stream	10 metre PFZ
Glyphosate Applications	
A body of water or stream that is fish-bearing and not within an industrial site (as defined by *Integrated Pest Management Regulation*)	5 metre PFZ
A body of water or stream that is fish-bearing and within an industrial site (as defined by *Integrated Pest Management Regulation*)	2 metre PFZ***
A permanent body of water that is not fish-bearing at any time of the year	2 metre PFZ
Up to the high water mark of a temporary free-standing body of water that is not fish-bearing and does not drain directly into fish-bearing waters	0 metre PFZ
Dry streams that are not fish-bearing at any time of the year and do not drain directly into fish-bearing water, at any time of the year	0 metre PFZ

* Aminopyralid will be applied as per label restrictions.

** The 30m NTZ may be reduced if the contractor is reasonably satisfied that a smaller NTZ will ensure no herbicide enters the water supply, intake, or well.

*** PFZs may be reduced for noxious weed control according to the *Integrated Pest Management Act*, Sections 74 to 77.

4.4, Protecting Fish, Wildlife, Habitat,
Section 58(3)(b)(ii)

In addition to the PFZs specified in Table 2, BC Hydro exercises caution when working with herbicides adjacent to riparian areas and water bodies. A riparian area is land adjacent to the banks of streams, lakes, and wetlands, and often includes belts of trees and shrubs that are needed to protect or buffer the water body.

BC Hydro follows the protocol agreement signed with the federal Department of Fisheries and Oceans (DFO) and the BC Ministry of Environment that describes procedures for working within 15m of a stream, pond, lake, or wetland. This protocol agreement is called the *Approved Work Practices for Riparian Vegetation Management* (AWPRV).

A 15m NTZ is maintained around riparian features when cleaning or fueling application equipment and refilling herbicide-dispensing equipment.

Endangered wildlife species are protected under the federal *Species At Risk Act* (SARA). BC Hydro is committed to avoiding and/or reducing the impacts on provincially and federally listed species at risk. If avoiding some impact is not possible, BC Hydro works with regulatory agencies and other stakeholders on recovery planning processes. The level of participation in recovery planning is determined by the degree of known impact that BC Hydro activities have on species at risk, including:

- the listing status of the species and other associated species
- the likelihood and extent of impacts incurred by other stakeholders
- consideration given to species of concern in existing BC Hydro, federal, or provincial processes
- public interest
- identifying specific species at risk as significant aspects in our environmental management system

4.5, Preventing Contamination of Food,
Section 58(3)(b)(iii)

BC Hydro facilities are sometimes located near environmentally sensitive areas such as parks, schools, lawns, gardens, residences, berry-picking and bee-keeping areas, and areas containing agricultural crops and domestic animals. Within these areas, food intended for human consumption is sometimes grown or found.

BC Hydro attempts to identify areas where there is food intended for human consumption (including berries). Appropriate precautions are taken during weed control operations to avoid contaminating these areas, such as timing applications after the berry-growing season, providing increased buffer zones during herbicide applications, or using alternative, non-chemical methods of control.

4.6, Identifying Treatment Boundaries, Section 58(3)(b)(iv)

To protect environmentally sensitive areas, BC Hydro records on maps any sensitive areas such as water bodies. These maps are supplied to the contractor and discussed at the pre-job conference. The contractor is instructed to inspect the site before work begins to verify presence of environmentally sensitive areas and flag areas as required. This may include the use of flagging tape to mark off the no-treatment zones and pesticide-free zones.

During the pre-job conference, all crew members are instructed in flagging requirements and precautions. They also review the methodology and procedures for applications and handling of the herbicide.

Notification Signs

As per Section 64 of the *Integrated Pest Management Regulation*, notification signs will be posted on land being treated with herbicides. The contractor is responsible for posting notification signs according to regulatory requirements.

Signs will be clearly visible and legible from each approach to the treatment area used by the public. All approaches from highways must be posted. Signs may not be removed for at least 14 days after the herbicides have been applied. Records will be kept on how public notification was given and where notices were posted.

4.7, Weather Monitoring, Section 58(3)(b)(vi)

Prior to, and periodically during herbicide applications, weather conditions are measured and recorded, including wind speed and direction, precipitation, temperature, and sky conditions. These are recorded only for foliar herbicide applications using backpacks, powerhose and handguns, and boom sprayers. For wipe on/wick applications, stem, bark and stump applications, only precipitation and temperature is recorded.

Herbicide applications are shut down if:

- the maximum temperature stated on the herbicide label is exceeded
- the wind speed and/or direction cause the application of herbicide to drift and/or miss the weeds
- it begins to rain, increasing the chances of excessive runoff and leaching

4.8, Maintaining Herbicide Application, Equipment, Section 58(3)(b)(v)

All herbicide application equipment used on BC Hydro property will be kept safe, clean, and in good repair. Equipment will be compatible and appropriate for the herbicide being used.

At a minimum, all sprayers will be calibrated once per year prior to use and at regular intervals throughout the season of use.

Personnel will follow these instructions:

- Ensure that equipment used meets with the approval of BC Hydro and meets all applicable regulatory requirements.
- Calibrate application equipment at the beginning of the treatment contract to conform to with the application rates on the pesticide label.
- Repeat calibrations:
  - after 25 hours of use with abrasive formulations (such as wettable powders)
  - when another product is used
  - if application rates are questionable
- Keep a record for each piece of calibrated application equipment showing when it was calibrated and the supporting data.
- Ensure that tools and equipment are in good working order and are properly cared for and stored.
- Replace tools that are prone to failure and carry spares.
- Implement a regular maintenance schedule on each piece of equipment.

Chapter 5 — Notification and Consultation

BC Hydro is committed to providing proper notification and consultation with respect to herbicide use under this PMP.

5.1, Notifications

BC Hydro will, within 7 days of the PMP confirmation date, make available to the public at its local offices a copy of the confirmation and the PMP, along with relevant maps. The PMP will also be available on the BC Hydro website.

BC Hydro will immediately report to the Administrator (BC Ministry of Environment) any violation of the *Integrated Pest Management Act* and *Regulations,* the PMP, or the PMP Pesticide Use Notice.

Agency Notification

In the first year of the PMP term, BC Hydro will provide written notification to each Regional Administrator of the *Integrated Pest Management Act* before starting the season's vegetation management work. In subsequent years, written notice will be provided two weeks before starting the season's work.

Annual Notification of Intent to Treat

For each year of the PMP term, BC Hydro will forward to the BC Ministry of Environment a written Annual Notification of Intent to Treat (NIT) for the following year. This NIT will identify which facilities are scheduled for treatment for vegetation management.

5.2, First Nations Engagement

BC Hydro is committed to establishing and maintaining positive relationships with First Nations. BC Hydro engages with First Nations to avoid infringement on aboriginal rights, treaty rights, or cultural values during its vegetation management program. BC Hydro must also attempt to address First Nations concerns and accommodate their cultural interests.

PMP Engagement

BC Hydro's First Nations engagement plan/process for the Pest Management Plan is outlined below:

- Send a letter to all First Nations that have facilities on or adjacent to their reserve lands, inviting their input into the development of the draft PMP (enclose copy or web link).

- Follow up to ensure that the PMP has been reviewed, and comments, if any, are received.

- Maintain a summary of First Nations engagements, including the names and addresses of those First Nations that were invited to provide input, a description of any concerns or recommendations received (in particular if they related to potential for impacts outside of the facility on reserve lands), and BC Hydro's response.

Annual Notification

Once the PMP has been finalized and approved, annual notice of intent to treat (NIT) will be given for planned herbicide treatment in all areas identified during the engagement process as having potential for infringement on aboriginal rights, treaty rights, or cultural values, including areas on or adjacent to First Nations Federal Reserve lands.

BC Hydro will follow these procedures:

- Send a letter referencing the confirmed PMP, and that a facility site inspection has indicated that vegetation management is required. In the letter:
    - describe the methods to be used and why
    - request comments and any concerns
    - offer to meet upon request to review plans

- If treatment is required at facilities within Federal Reserve Lands, request permission to use herbicides, and stress the risks and liability associated with not treating the site to control problem weeds or hazard trees. If permission to treat is not received before the contractor needs access to the site, follow up with the Band Office to obtain permission.

- Follow up to ensure that the letter has been received and to record any concerns. Document all discussions.

- Carry out appropriate follow-up as required, such as sending out a final letter summarizing all previous correspondence and discussions.

Glossary

conifers — trees with cones.

crushed rock — a surfacing material similar to gravel that is used to cover facility areas that have zero tolerance for weeds. Crushed rock has a high level of electrical resistivity, which means it does not conduct electricity, thereby reducing the risk of electrocution over the ground grid.

deciduous — trees that lose their leaves during winter.

evaluation — a formal assessment carried out after weed control, to determine the effectiveness of the vegetation management program. It takes into account monitoring information, contract results, and SMP requirements. Evaluation results are used to revise SMPs.

facility — a well-defined site, owned or leased by BC Hydro, which typically has limited public access. Examples include substations, dams, and generating plants.

geotextile — a porous, polypropylene fabric that may be laid underneath a crushed rock surface, to prevent weeds from establishing.

ground grid —a grid of bare wires buried underneath substations that provides a common grounding system for electrical and metallic structures. It protects staff and the public from electrocution in case of a system fault, equipment failure, or lightning strike by limiting electrical potentials to safe levels, and it supports the proper operation of the electrical system by providing a low impedance path for fault currents.

habitat — a particular environment in which organisms live.

hazard tree — a tree that is defective, has an imminent potential to fail, and is likely to hit or damage a person or target (electrical equipment) when it falls.

herbicide — a pesticide used to control or manage weeds.

injury threshold — the point at which weed control becomes necessary, in order to minimize the risk of outages and optimize safety. It is generally expressed as a percentage of the total weed area that can be tolerated while still maintaining the integrity, security, and safety of the site. Any percentage weed cover above the established injury threshold requires a vegetation management action.

integrated pest management (IPM) — a decision-making process that uses a combination of techniques to suppress pests and that must include, but is not limited to, the following elements:

- planning and managing ecosystems to prevent organisms from becoming pests
- identifying potential pest problems
- monitoring populations of pests and beneficial organisms, pest damage, and environmental conditions
- using injury thresholds in making treatment decisions
- reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, mechanical, behavioral, and chemical controls
- evaluating the effectiveness of treatments

Integrated Pest Management Act — a provincial Act that regulates the use of pesticides, including the sale, purchase, use, handling, storage, disposal, and transportation of pesticides.

integrated vegetation management — the IPM process specifically for the control of weeds at BC Hydro facilities. The primary objectives are to ensure worker and public safety and system reliability.

monitoring — a visual assessment of facilities that provides a record of information about weed occurrence and density and site conditions. The percentage of the surface that is covered with identified weed species is estimated, and information recorded on Site Management Plans.

no treatment zone — a strip of land between the pesticide-free zone and the pesticide treatment area. Pesticides are not applied directly in the NTZ to prevent entry of pesticides or pesticide residues by drift, runoff, or leachate into the pesticide-free zone.

non-residual herbicide — a chemical that breaks down quickly in the soil and leaves little or no residue.

non-selective herbicide — a chemical that will effectively control a wide range of species.

noxious weeds — plants that are injurious to public health, crops, livestock, land, or other property, and which must be controlled under the BC *Weed Act*.

pest — any undesirable organism that should be controlled to ensure the safety and integrity of operating systems. For BC Hydro facilities, this means weeds.

pesticide — under the *Integrated Pest Management Act*, any substance or mixture of substances, other than a device, intended for killing, controlling, or managing insects, rodents, fungi, weeds, and other forms of plant or animal life that are considered pests.

pesticide-free zone — a strip of land adjacent to bodies of water. Herbicides may not be directly applied to, or allowed to reach the pesticide-free zone via drift, runoff, or leachate. Specific authorization is needed if the pesticide-free zone is to be less than 10m.

Pest Management Plan (PMP) — a legally-binding plan that describes a program for controlling pests or reducing pest damage using integrated pest management, and the methods of handling, preparing, mixing, applying, and otherwise using pesticides within the program. The PMP is the authorization required to use pesticides at BC Hydro-owned or leased property in BC.

pre-emergent herbicide — a chemical that controls weed seeds and sprouts before they leave the ground. These are generally residual herbicides.

post-emergent herbicide — a chemical that is used directly on growing foliage or plant stems. These can be either residual or non-residual herbicides.

residual herbicide — a chemical that tends to persist in the soil for a certain period of time.

re-sprouting — the growth of new stems on deciduous trees that have been injured or where manual or mechanical control methods have been applied.

riparian — the area of land adjacent to a water body that contains vegetation that is distinctly different from the vegetation of adjacent upland areas due to the presence of water.

riparian habitat — vegetation growing close to a water body that is generally critical for wildlife cover, fish food organisms, stream nutrients, and large organic debris, and for streambank stability.

selective herbicide —a chemical that is designed to effectively control specific species and not others.

Site Management Plan (SMP) — a document that contains detailed information on a *particular* site, such as its history, weed coverage, environmental concerns, etc. The SMP also describes how integrated vegetation management activities will be carried out on the site, and may include a detailed map of the facility.

species — a group of living organisms which are similar in structure and physiology and are capable of producing fertile offspring.

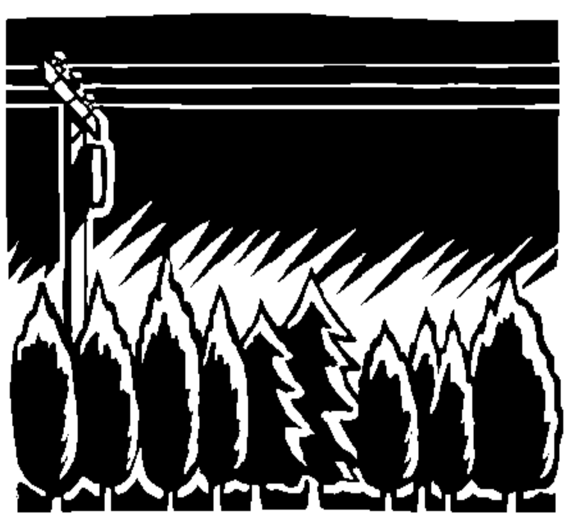
water body — any river, stream, creek, lake, pond, marsh, slough, ocean, sea, strait, inlet, bay, or ditch. Also, any temporary or seasonal water body that currently contains water, and any accumulation of water that may discharge into fish-bearing waters.

weeds —any undesirable plant, including grass, brush, trees, noxious weeds, or other vegetation.

Integrated Vegetation Management Plan

For Transmission Rights-of-way

105-977-2010/2015



BC hydro

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Acknowledgements / Signing Authority:

This document is the responsibility of BC Hydro's transmission vegetation management program**:**

Primary Contact: Tom Wells, Telephone: 604-699-7406

(Technical writer: Joyce Arthur, Duncan Kent & Associates Ltd., Vancouver)

Notice: Both federal and provincial legislation contain information required and pertinent to this BC Hydro *Integrated Vegetation Management Plan for Transmission Rights-of-way*. As well, many other individuals, organizations, companies, and vegetation experts have cooperated in providing information and sources for this IVMP document. This IVMP document is essentially a set of best practices and guidelines compiled from knowledgeable and experienced industry and government personnel. It is intended to provide the owner, operator, and contractors with advice regarding the specific topic. The recommendations set out in this IVMP are meant to allow flexibility and must be used in conjunction with competent IPM practices and judgment. It remains the responsibility of the user of the IVMP to judge its suitability for a particular application. If there is any inconsistency or conflict between any of the recommended practices contained in the IVMP and the applicable legislation requirements, the legislative requirements shall prevail. Every effort has been made to ensure the accuracy and reliability of the data and recommendations contained in the IVMP.

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Chapter 1, Introduction

About Transmission

BC Hydro manages 18,000 km of transmission rights-of-way (ROW) covering 75,000 ha of land throughout the province of BC. A transmission line carries high-voltage electricity (69kV to 500kV) over long distances from generating plants (mostly hydroelectric dams) and delivers it to substations, where the voltage is reduced for delivery to customers over distribution lines.

The transmission assets include:

- all transmission lines of 69kV and up
- all electrical structures, equipment, switching facilities, substation facilities, and telecommunications facilities used in connection with this transmission
- right-of-way permits, licenses, and agreements relating to any of these assets

About this Plan

This document is an **Integrated Vegetation Management Plan (IVMP)** for the management of vegetation on transmission line rights-of-way (ROWs) operated by British Columbia Hydro (BCH). It has been prepared in accordance with Section 58 of the Ministry of Environment's *Integrated Pest Management Regulation* (note subsection references in major headings).

The IVMP is a **Pest Management Plan** that describes:

- the program for controlling vegetation along transmission rights-of-way (ROWs), using the principles of integrated vegetation management
- the process for planning, selecting, using, and evaluating control methods within that program
- the methods for handling, preparing, mixing, applying, and otherwise using herbicides within that program

This IVMP is intended to be used by BC Hydro and its agents and contractors to carry out vegetation management work on all transmission ROWs.

Person Responsible, Section 58(1)(b)(c)

The person listed below is responsible for administering the IVMP provincially and is the principal contact for information relating to the plan.

Tom Wells, Transmission Vegetation Program Manager, 604-699-7406

Geographic Boundaries, Section 58(1)(a)

This IVMP includes all BC Hydro-managed transmission lines in BC (18,000 km covering 75,000 ha of land). For operational purposes, BC Hydro divides the province into four regions: Lower Mainland, Vancouver Island, Southern Interior, and Northern Interior. Each of these regions has differing characteristics and needs. The IVMP covers all Regional Districts in the province except Stikine and Central Coast.

Here is a link to a provincial map of the transmission system: http://transmission.bchydro.com/NR/rdonlyres/83A5FDF4-F326-4AEC-ABCE-A13D2D00542B/0/AffectedTreatmentArea.pdf

More specifically, the IVMP covers vegetation management and the treatment of noxious weeds, including the use of herbicides, adjacent to and or within the boundaries of legal rights-of-way (ROWs). The legal widths of transmission rights-of-way vary from 10 metres to about 300 metres. Individual transmission lines vary in length from 1 to 500 kilometres.

It also covers facilities associated with the ROWs, such as:

- helicopter landing pads
- the base of towers and other electrical structures
- lands occupied by equipment storage sheds
- access roads and adjacent lands leading to the ROW or other facilities that BC Hydro manages
- highway easements
- the base of woodpole structures

It also covers areas outside the ROW where:

- BC Hydro transmission structures and equipment are located
- BC Hydro is authorized to manage as per Section 20 of the *BC Hydro & Power Authority Act*
- BC Hydro is authorized to manage as per its right-of-way agreements
- areas adjacent to the ROW that are currently under active management

Finally, the IVMP covers the treatment of noxious weeds and invasive plants on all ROWs and areas listed above.

This plan does **not** cover herbicide use at BC Hydro generating sites or distribution circuits defined as less than 69kV. These areas of responsibility are covered by their own PMPs.

Why Control Trees?

BC Hydro must control trees to ensure the safe and reliable transmission of electricity. Control measures used include manual, mechanical, and herbicide use.

Trees that contact powerlines are a major cause of power failure, because BC has some of the tallest and fastest-growing trees in North America. Conifer species such as Douglas fir, spruce, and pine, and deciduous species such as alder, birch, aspen, and maple, can grow into powerlines or fall onto them and even start forest fires. In addition, thick vegetation can prevent line workers from getting to a downed line in an emergency or for routine maintenance.

BC Hydro's vegetation management program must:

- minimize public and worker safety hazards
- reduce the number of outages due to vegetation sources
- reduce the risk of fires caused by trees contacting the lines
- allow access and lines of sight for maintenance

As a utility in North America, BC Hydro is required to ensure that there are no outages on the transmission system caused by trees growing into the lines, under the North American Electrical Reliability Council (NERC) standard FAC003, *Vegetation Management*,.

Objective of Vegetation Management Program

The long-term objective of the vegetation management program is the conversion of the right-of-way (ROW) from dense stands of tall-growing deciduous species that are created by continuous mowing and slashing, into low-growing stable plant communities of more desirable plants, such as low-lying berry bushes and wildflowers.

There are four main ways of managing the ROW to achieve the goal of a stable low-growing plant community:

Selective control — Wherever possible, control methods target only tall-growing vegetation and encourage or introduce desirable low-growing species, particularly shrubs and indigenous plants that are naturally present on the site, since this helps to suppress tall-growing species.

Compatible use — BC Hydro encourages the use of ROWs for activities that will not conflict with transmission lines and that control or prevent the growth of tall trees, such as recreational or agricultural uses.

No clearing required (NCR) — Areas not cleared are where trees at their mature height will never come within the "limits of approach" (minimum allowable distance between vegetation and the conductor) at the maximum "conductor sag" (degree to which the line could sag towards the ground).

NCR sites are those that will never require vegetation maintenance because they pose no threat to transmission lines.

Altering existing vegetation — In rare cases where it is impractical to remove undesirable species from along the edges of the ROW, existing vegetation can be modified by pruning or trimming to maintain clearances from conductors, thus protecting transmission lines.

The vegetation management program strives to:

- use leading edge techniques and practices
- respect agreements with the public, landowners, and other stakeholders
- respect First Nations' aboriginal and treaty rights
- comply with all government regulations and corporate policies
- minimize impact to the environment and protect biodiversity

Benefits of Low-growing Plant Community

The advantages of successfully establishing a low-growing stable plant community include:

- Minimizes maintenance and thereby reduces disruption and damage to the natural environment.
- Enhances biodiversity by increasing the number of low-growing forage species and improving wildlife habitat.
- Improves the recreational opportunities on ROWs by eliminating dense thickets and slash.
- Improves aesthetics as ROWs are becoming important green spaces in urban areas, and recreational corridors in rural areas.
- Allows people and communities to use the ROW more effectively for berry-picking.
- Increases public safety by reducing the risk of tree contact to lines and thereby reducing the fire hazard.
- Increases operational reliability by maintaining ROW security.
- Permits access and maintains lines of sight for maintenance.
- Reduces the total area requiring future treatment, and reduces herbicide use over time.
- Reduces long-term vegetation maintenance costs.

Definitions

Integrated pest management (IPM) means a process for managing pest populations that includes the following elements:

(a) planning and managing ecosystems to prevent organisms from becoming pests

(b) identifying pest problems and potential pest problems

(c) monitoring populations of pests and beneficial organisms, damage caused by pests and environmental conditions

(d) using injury thresholds in making treatment decisions

(e) suppressing pest populations to acceptable levels using strategies based on considerations of:

- (i) biological, physical, cultural, mechanical, behavioural and chemical controls in appropriate combinations
- (ii) environmental and human health protection

(f) evaluating the effectiveness of pest management treatments

(Definition from the *Integrated Pest Management Act Regulation*)

Integrated vegetation management (IVM) involves selecting and combining vegetation treatments to target specific plant species that pose a risk to safety or reliability, while minimizing impacts to the environment and the public. Implementing IVM using a “Pest Management Plan” is a common practice on utility rights-of-way, railways, roadways, oil and gas pipelines, forestry plantations, and at electrical and industrial facilities in BC.

A **pest** is any undesirable organism that must be controlled to ensure the safety and integrity of operating systems. For BC Hydro transmission rights-of-way, this means primarily tall-growing trees that would grow past safe clearance limits or hazard trees that could fall onto the transmission lines from the edges of the right-of-way.

A **hazard tree** is a tree that is defective, has an imminent potential to fail, and is likely to hit or damage a person or target (BC Hydro line or electrical equipment) when it falls. A **danger** tree is a tree close to powerlines, which is tall enough, or will be tall enough within five years, that it could pose a danger to the lines if it fails.

A **noxious weed** is a plant that negatively interferes with management objectives for particular areas of land at particular times, for example, weeds that pose a threat to farm crops or animals. Noxious weeds in BC are designated as such under the *Weed Control Regulation*, including seeds of noxious weeds.

An **invasive species** is an alien plant species that has the potential to pose undesirable or detrimental impacts on humans, animals, or ecosystems.

Regulation and Safety of Herbicides

The herbicides used by BC Hydro are approved by Health Canada's Pest Management Regulatory Agency (PMRA). All registered herbicides have undergone stringent evaluation and testing by the PMRA to ensure they pose no unacceptable risks to people and the environment when used according to the label. Herbicides are applied by Certified Pesticide Applicators, who are licensed by the Province after writing a provincial exam. They are specially trained and qualified to apply herbicides safely, following stringent legislative requirements.

Reputable scientific studies have shown that the active ingredients of the most common herbicides used by BC Hydro are of low or extremely low toxicity to people, fish, and wildlife (mammals). For example, two of the most commonly used herbicides—triclopyr and glyphosate—break down quickly in the soil.

Selective Use of Herbicides

Using IVM, BC Hydro applies low amounts of herbicides to selectively target undesirable vegetation on ROWs (mostly tall-growing trees and noxious weeds). Selective use of herbicides allows desirable low-growing vegetation to flourish, such as grasses, forbs, legumes, and low-growing native shrubs.

Most targeted applications on rights-of-way are completed with hand-held sprayers. Herbicides may also be injected into tree stems and brushed onto the cut surfaces of stumps to prevent regrowth.

Compared to previous decades, today's herbicide applications are more selective and focused than ever before, and BC Hydro is continually researching and testing for new technologies and alternatives.

Legal Protections

All herbicide use must abide by applicable federal and provincial legislation and their regulations, including BC's *Integrated Pest Management Act* and *Regulation*, and the federal *Pest Control Products Act*. It is illegal to treat pests with products not governed by this legislation or to use a herbicide in a manner inconsistent with its product label. Applications are planned carefully, using federally and provincially registered herbicides formulated for specific application methods.

Pesticide-free Zones (PFZ) protect environmentally-sensitive areas, such as bodies of water, watersheds, wells, water intakes, and other sensitive areas. A PFZ is a zone (usually 10m) around an area of land that must not be treated with pesticides, and must be protected from pesticides moving onto it. Herbicide applicators do not apply herbicides within PFZs.

Site-specific Plans

This province-wide IVMP provides general guidance for the use of herbicides within an integrated vegetation management decision-making process. Before herbicides are applied at a specific location, a detailed site prescription is prepared for the site, including maps that identify all bodies of water and other environmental issues. BC Hydro’s standard operating procedures are provided to contractors before work begins. Specialized layout crews flag the work areas in the field to ensure that all pesticide-free zones have been properly identified and marked before any herbicide applications begin.

Chapter 2, Elements of Integrated Vegetation Management

This chapter describes BC Hydro's Integrated Vegetation Management Program, as per Section 58 of the provincial *Integrated Pest Management Act* (information required for Pest Management Plans). It covers:

- prevention program — Section 58(2)(a)
- identification of species — Section 58(2)(b)(ii)
- monitoring program — Section 58(2)(c)(i)(ii)(iii)
- injury thresholds — Section 58(2)(d)(i)(ii)
- mechanical and manual treatments — Section 58(2)(e)(i)(ii)(iii)
- reasons for herbicide use
- herbicides and equipment – Section 58(3)(c)
- herbicide application methods – Section 58(2)(e)(i)(ii)(iii)
- method selection – Section 58(2)(e)(iv)
- evaluation program — Section 58(2)(f)

Prevention, Section 58(2)(a)

Prevention means stopping target vegetation from becoming established, as opposed to treating existing vegetation. Target vegetation to be prevented includes any tree or shrub capable of falling onto or growing into the conductors, causing a power outage.

BC Hydro's vegetation management program is preventive in nature because the main goal is to establish a stable, low-growing plant community, which outcompetes tall-growing trees.

Preventive measures that BC Hydro uses on ROWs include:

- natural controls, primarily the establishment of a stable, low-growing plant community that out-competes taller growing species
- good site preparation in the design stage, such as seeding programs to reduce germination of target vegetation
- compatible uses, such as agricultural crops, golf courses, or industrial uses
- non-vegetation techniques to provide more clearance, such as physical re-contouring of the land, and raising conductor heights to avoid contact with vegetation

Identification of Species, Section 58(2)(b)(ii)

The primary target vegetation to be controlled on transmission ROWs are trees that have the potential to reach or exceed the limits of approach to the line (see page 12 for information on limits of approach). A physical and/or chemical treatment method will be used to control such trees, with herbicides used primarily on deciduous tree species and invasive weed species. Most other vegetation can remain to improve ROW biodiversity and to out-compete target vegetation.

Primary Target Vegetation

The following species represent the majority of target trees growing along the BC Hydro-managed transmission system; species will vary by region. In some areas of very low clearance, tall shrubs or bushes must be controlled. Any plant that could interfere with access to and maintenance of transmission towers and structures will also be controlled, such as thorny bushes and vines.

Table 1: Primary Target Species Along Transmission Lines

Common Name	Scientific Name
Conifers	
Douglas fir	*Pseudotsuga menziesii*
Western red cedar	*Thuja plicata*
Yellow cedar	*Chamaecyparis nootkatensis*
Pine	*Pinus spp.*
Spruce	*Picea spp.*
True fir	*Abies spp.*
Larch	*Larix spp.*
Deciduous	
Alder	*Alnus spp.*
Birch	*Betula spp.*
Aspen	*Populus tremuloides*
Poplar	*Populus spp.*
Maple	*Acer spp.*
Cherry	*Prunus spp.*
Willow	*Salix spp.*
Arbutus	*Arbutus menziesii*

BC Hydro also controls noxious or invasive plant species as part of the corporate commitment to the Provincial Invasive Plant Strategy, and to meet the requirements of regional weed control committees and the *Weed Control Act*.

Monitoring Program, Section 58(2)(c)(i),(ii),(iii)

BC Hydro has established a biophysical inventory project to collect, record, analyze, and monitor the current state of the ROW vegetation. Information identified and collected during the biophysical inventory includes:

- Administrative Management Units (see below for definition)
- streams and other bodies of water, and their characteristics
- vegetation communities — biogeoclimactic zone, species density, percent coverage, growth rates, species composition, presence of noxious weeds, presence of threatened or endangered plants
- conductor to ground clearances, including unusual terrain features
- amount of slash (vegetative debris) present that might pose a fire risk
- access information — bridges, culverts, fords, helipads, gates, roads
- heritage information — archaeological sites, First Nations traditional uses
- secondary use — agriculture, rangeland, recreation, berry picking, buildings and structures, underground features
- wildlife habitat

All data collected is entered into a GIS database that contains information related to vegetation management on ROWs, including treatment history, patrol and inventory information, site maps, prescriptions, environmental and consultation issues, landowner agreements, contracts, and so on.

Noxious weeds are primarily monitored by regional weed committees and are entered into a database administered by the Ministry of Agriculture.

Monitoring Method

The main monitoring method consists of aerial or ground patrols. Right-of-way patrols gather information within each Administrative Management Unit on a transmission line. An **Administrative Management Unit** is a defined area within a right-of-way that has relatively uniform characteristics and can be managed with the same long-term site objectives. This allows BC Hydro to follow the vegetation inventory, control method costs, and evaluate the efficacy of treatments on each specific AMU over the long term.

Once patrol information is collected, it is used to identify deficiencies and verify the need for treatment and the location and timing of treatments.

Frequency of Patrols

BC Hydro has designated patrol frequencies for every circuit in BC, and works with field personnel to schedule patrols. NERC designated-lines must be patrolled at least once a year as required by NERC standard FAC 003, *Vegetation Management*. The lines designated for annual patrols are those that join the BC Hydro system to other utilities, and the objective of the standard is to prevent cascading failures.

The frequency and timing of patrols depends on the type of management site. For example, for low-clearance, high-growth sites requiring intensive vegetation control, several patrols over a calendar year may be required to monitor the presence and development stage of target vegetation. In contrast, for high clearance or recently managed areas, one spring patrol a year should be sufficient. Any outages or knowledge of poor conditions may also require additional patrols to identify and mitigate risk. Over time, BC Hydro has refined its patrol cycles based on local knowledge of the area, so it is known which areas need more frequent patrols and their specific monitoring requirements.

In addition to regular patrols, special patrols will be conducted whenever there is a transmission circuit outage to identify the cause of the problem.

Patrol Information

The following aspects are considered when patrolling the lines to determine work timing and method:

- tree heights and proximity to limits of approach
- imminent threats, i.e., dead, dying, and leaning trees, and root rot pockets (on the ROW and along the edge)
- general condition of off-ROW danger tree strip
- width of the ROW edge (narrowing or encroachments
- the relative density of deciduous or coniferous target trees, expressed in percentage cover of the site
- compatible vegetation that should be retained
- terrain characteristics that help determine the appropriate work method, such as steep slopes
- terrain features such as topographical features, eroded or erosion-prone areas, bare-ground areas, and hazards such as large rocks and stumps
- fuel loading potential of the site
- special conditions, such as compatible land use issues, property encroachments, and other concerns
- the environmental conditions and features of the treatment area, such as riparian issues, wildlife issues, and other environmental concerns
- damage to structures and lines
- road access conditions, including gates, locks, road surface, culvert conditions, etc., and other factors that will dictate the types of equipment that can be brought onto the site

The following information is collected during patrols:

- areas where vegetation management must be conducted, to help develop the annual work plan
- methods to be used in each of these identified areas
- relative timing of the work during the treatment year

Injury Thresholds, Section 58(2)(d)(i),(ii)

An injury threshold (also called an action threshold or hazard level) is the point at which vegetation control becomes necessary, in order to minimize the risk of outages and optimize safety.

Tall-growing trees that have the potential to reach or exceed the limits of approach to the line will be controlled.

How Injury Thresholds are Chosen

Clearance Requirements

To determine when vegetation must be controlled at a particular site, the following factors related to the clearance requirements for the transmission line will be evaluated:

- limits of approach
- maximum conductor sag
- mature vegetation height
- unusual terrain features that may result in a low conductor to ground clearance
- maximum conductor swing

Lines can also be threatened by trees growing adjacent to the right-of-way. Therefore, another aspect in determining injury thresholds is identifying and rating hazard and danger trees along the edges of the right-of-way (the trees most likely to fall into the lines).

Limits of Approach

The limits of approach are the primary consideration for vegetation management work on the right-of-way. However, work must also be practical, efficient, cost-effective, safe, and have minimal impact on the environment.

The limits of approach refer to the distance a person, machine, or conductive material (such as a tree) can be in relation to the energized conductors based on the circuit rating, flashover distance (when an arc of electricity jumps from a conductor to a nearby tree), and other attributes, such as conductor sag (where the line sags closer to the ground due to increased heat.)

Table 2 shows the limits of approach for tree clearing on transmission lines.

Table 2: Limits of Approach

	Limits of Approach					
Nominal Voltage	**69kV**	**138kV**	**230kV**	**287kV**	**345kV**	**500kV**
Limits of approach for: 1) unqualified workers; 2) all uninsulated equipment	3.0m	4.5m	4.5m	6.0m	6.0m	6.0m

How Injury Thresholds are Applied

Vegetation Management Cycles

Vegetation management is conducted on a cyclical basis. Maintenance schedules are determined for each area to be treated under a contract, and optimized within the Administrative Management Units (AMUs) to ensure appropriate and timely treatment.

The length of the vegetation management cycle on transmission lines will vary depending mostly on growth rates. Generally, the cycle ranges from 4–12 years. Areas that have very high growth rates or low clearance may require a shorter two or three-year cycle.

A number of other factors help determine the length of the management cycle, in particular, fuel loading. Within 300m of forested and grassland areas, Section 10 of the provincial *Wildfire Regulation* requires BC Hydro to maintain ROWs in a manner that prevents any fire from spreading. Therefore, some areas may need to be managed before the target species grow too tall because they create too much biomass when cut.

Timing of Treatment

Once it has been determined that a particular site requires treatment, other concerns come into play to determine the specific timing of treatment, For example:

- Herbicides should be used when trees are actively growing (growth rates of specific trees must be identified).
- A forest may be closed due to fire hazard.
- There may be snow on the ground, preventing treatment.
- There may be closures around riparian areas due to fish windows, or concerns around bird nesting areas.

Other Threshold Criteria

BC Hydro will control any invasive weed or vegetation that could interfere with its other objectives for ROW vegetation management, primarily public or worker safety, prevention of fires, and access to the lines and structures for maintenance.

In urban areas, aesthetics is also a major objective and might preclude the presence of any vegetation except grass, shrubs, and low-growing ornamental species.

Weeds and trees also need to be controlled along access roads and helicopter landing pads adjacent to remote transmission lines, to ensure safe access and driving. Tree limbs must not hang down into the access road or landing pad, and all debris around roads and landing pads will be removed. Vegetation around the base of woodpole structures will be controlled to minimize the risk of fire.

Manual and Mechanical Treatments, Section 58(2)(e)(i),(ii),(iii)

This section describes the various manual and mechanical vegetation management techniques that BC Hydro uses on transmission ROWs. It covers the:

- description of the technique
- selection criteria for techniques
- benefits and limitations of the technique

BC Hydro will use the following manual and mechanical methods for this IVMP:

- slashing
- mowing
- girdling
- grooming
- pruning

Slashing

Slashing (also called brushing) is the removal by hand tools of individual stems that will eventually grow into transmission lines. Tall-growing tree species are cut down within a few inches of the ground line.

Slashing is the most commonly used manual vegetation management technique on transmission lines, and is sometimes combined with the herbicide cut-surface method. Tools used include chainsaws or circular brush saws.

Generally, slashing is carried out at the specific time of year when the target vegetation is more likely to die after being cut. Slashing is usually directed only to target species, preserving the maximum amount of low-growing species. In addition, a tall slash/girdle method may be used, which involves cutting taller trees at a higher height, then girdling the stem to prevent resprouting.

Selection Criteria for Slashing

Slashing is the preferred method in the following situations:

- in areas with a well-established low-growing plant community

- in combination with mowing
- in difficult terrain with limited machine access, e.g., around guy wires, steep slopes, and riparian areas
- when environmental concerns have a high priority

Although generally confined to ROWs, slashing may be extended beyond the ROW edge to improve long-term line security by removing hazard trees that could fall onto the line from the edge.

Slashing is **not** preferred in the following circumstances:

- for high densities of target trees
- areas where mowing is a suitable alternative
- areas with high aesthetic concerns
- areas with a high fire risk
- areas where trees are of a size that when cut will leave debris levels that violate BC Hydro's fuel management standard or the *Wildfire Act*

Benefits of Slashing

- Slashing allows the immediate removal of target vegetation, with complete retention of low-growing compatible species.

- Conifer trees cut below the lowest branch are permanently controlled.

- Slashing allows spot treatment with herbicides to prevent stumps from resprouting.

- Slashing protects areas close to fish-bearing streams and other environmentally sensitive areas, since it can be done without causing excessive erosion or damage to the streambed.

- Slashing is beneficial in areas where target vegetation is widely scattered.

Limitations of Slashing

- Slashing is labour-intensive and can be dangerous to workers in steep terrain.

- Slashing is more difficult in dense vegetation.

- It can increase the fire risk if there is a buildup of debris.

- In the absence of follow-up herbicide treatment, deciduous stumps can resprout repeatedly (into coppices) each time they are cut, resulting in increased stem densities, growth rates, clearing costs, and shortened treatment cycles in subsequent years.

- Aesthetics of slashing may be a public concern due to the buildup of debris.

Mowing

Mowing is the cutting of target vegetation with wheel or track-mounted heavy-duty rotary or flail cutters. A heavy-duty tractor or excavator is equipped with the cutting head and driven over the ROW to cut target vegetation. This method is primarily used for transmission lines in conifer-prone areas and to reduce high-density deciduous areas.

In some situations, machines such as a “Rolly chipper” or “feller buncher” may be used to cut down mature trees at the edge of the ROW in order to widen the existing ROW. If a logging operation is being conducted, BC Hydro follows all requirements as regulated by the BC Ministry of Forests.

Selection Criteria for Mowing

Mowing is the preferred method where the terrain allows, and in areas:

- with high densities of target trees
- with trees of a size that when cut will leave debris levels that violate BC Hydro’s fuel management standard or the *Wildfire Act*

In general, mowing should **not** be used:

- on target trees of large diameter (mowing larger stems is impractical)
- where low-growing compatible species are well-established and there are low stem densities of target vegetation
- in areas with a dense understory of low-growing compatible species and high stem densities of target vegetation (an excavator machine should be used)
- in areas with rocks that can cause excessive damage to cutting heads (unless an excavator with an articulating mower is used)
- in areas that are developed or have high public use because of the risk of flying debris
- in areas with stumps that create accessibility problems
- in boggy or wet areas where excessive rutting and soil compaction and damage could occur
- on slopes that create a worker hazard
- in riparian areas

Benefits of Mowing

- Mowing mulches the vegetation into smaller pieces that readily biodegrade, which reduces fuel loading fire hazards.
- Mowing is seasonally effective, inhibiting growth from spring through late summer. This is important in areas where herbicide follow-up treatment is not possible.
- In areas where fast-regenerating ground covers are plentiful, resprouting of unwanted vegetation is suppressed.
- In non-selective mowing (Hydro-axe or Kershaw), all vegetation is cut to ground, leaving a level ROW and facilitating future herbicide applications that use mechanical delivery systems.
- In mowing directed only towards target vegetation (hydraulic excavator, rotary disc, or flail), the ROW retains biodiversity and existing low ground cover.
- Target vegetation can be removed faster and more economically than other methods.
- Work progress and workmanship are clearly visible.
- Using machines is generally less hazardous to the operator than using hand-held equipment.

Limitations of Mowing

- Mowing is not generally suitable in certain riparian areas, and should not be used there unless a site-specific riparian prescription has been produced and approved.
- Mowing can promote heavier regrowth of deciduous vegetation.
- Mowing is often limited by terrain, such as large rocks, stumps, and bodies of water.
- In wet terrain, machines cannot operate effectively and could damage the environment.
- Mowing mulches the brush using a high-speed, mowing/flailing action, which can leave ROWs unsightly, hazardous, and subject to public complaints.

- Mowing may result in rutting, track marks, or degradation of the ROW surface.
- Mowing should not be used on slopes greater than 30% because most machines are unsafe to operate.

Girdling

Girdling (also called frilling) involves cutting one or more strips of bark from around the entire tree trunk with a special girdling tool or other hand tool. The bark strips are removed along with other tissue down to the sapwood. This procedure is usually limited to single-stemmed, deciduous trees on transmission lines, but can also be carried out on selected conifer trees when required.

After the bark has been severed, the tree is left to die. The above-ground parts continue to grow, but the roots starve and the tree slowly dies.

Only girdling and herbicide applications will kill deciduous species. They will resprout if mowed or slashed.

Selection Criteria for Girdling

- Girdling is most often used in riparian areas or other environmentally-sensitive sites.
- Girdling is generally not used on trees of small diameter, since they may break at the girdle, causing the tree to resprout.
- Girdling is not acceptable in areas where the target vegetation will reach limits of approach within two growing seasons, unless the tall slashing and girdling technique is used.
- Girdling should not be used for stem densities of over 15,000 stems per hectare because it is not practical, effective, or cost-effective. Also, the amount of standing dead stems may create a fire hazard.
- Girdling is not acceptable in situations where tree failure could lead to worker or public injury or property damage. In these cases, girdling may only be done via the tall slashing and girdling method.
- Conifers are never girdled unless they are part of a riparian prescription.
- Girdling is effective on alder, birch, and willow species. Girdling is not as effective on northern black cottonwood and small-diameter aspen poplar because of prolific resprouting.

- On maple species, girdling is not used on coppices of more than five stems, or where the root collar is over half a metre in size.

Benefits of Girdling

- Girdling promotes retention of vegetation cover and increased site stability due to root structure retention.
- Girdling has greater public acceptance than herbicide use.
- Girdling is not limited by difficult terrain.
- Girdling is flexible, because individual stems and species can be removed or left on a tree-by-tree basis.
- Girdling increases low-growing forage vegetation for wildlife and habitat for small mammals and birds. There is no danger to wildlife.
- Deciduous overstory is removed naturally over several years, giving coniferous and other low-growing understory time to adjust to new environmental conditions.

Limitations of Girdling

- Girdling cannot be used effectively over large areas or in dense brush, because it becomes too laborious and costly.
- Close inspection and careful work are required to ensure adequate depth and width of the girdles is maintained.
- Tools are not effective on large stems with thick bark.
- If stems have many live branches below breast height (1.3m above ground), additional work with hand tools will be required to remove the branches.
- The dead trees remain standing for 2–3 years, which may be objectionable in highly visible areas.
- The use of hand tools may be hazardous to workers.
- Blowdown of dead trees may pose a safety problem alongside well-travelled areas, or to workers re-entering the area.
- Workers must be experienced girdlers, since poor girdling results in resprouts or premature blowdown with resprouts.

Grooming

Grooming is the mechanical grubbing and grading of the transmission ROW using excavators or bulldozers to remove all existing vegetation. The exposed soils are then seeded with grass or other low-growing species to prevent the growth of unwanted tall-growing species. Grooming is generally confined to areas with a high density of target vegetation, and is used to convert the site to one requiring little or no maintenance. The advantage of grooming over mowing is that stumps are also removed.

Grooming uses a combination of the following techniques:

- mowing
- machine-raking or brush-blading
- ploughing or discing
- rough grading / harrowing
- seeding and fertilizing

Selection Criteria for Grooming

Grooming is an acceptable method in the following situations:

- to clear land for economically viable and sustainable grazing or agriculture
- to recontour ROWs to increase the clearance to the conductor
- to create a shift to low-growing vegetation species in areas with a high density of target vegetation
- in response to requests of municipal government agencies or private property owners
- to maintain road access

Benefits of Grooming

- Grooming clears the site completely of vegetation and stumps, leaving it properly prepared for reseeding with desirable vegetation (i.e., to create new and enhanced habitat) or conversion to compatible use.

- Grooming and reseeding benefits the property owner by providing a better use of the land base, such as for pastureland.

- BC Hydro benefits because of the reduced ongoing maintenance required under the transmission lines.

- Using heavy equipment is generally less hazardous to the operator than using hand-held equipment.

Limitations of Grooming

- Topography and soil conditions must be suitable for grazing or agricultural use, if the site is to be converted to this use.
- Bulldozing is only a temporary measure since it exposes bare soil, thereby opening the area for infiltration by unwanted species, including noxious or invasive weed species.
- Root-suckering species and resprouting species are not totally removed by bulldozing, thereby increasing multi-stemmed regeneration of unwanted species.
- Grooming leaves the area temporarily exposed to the elements, resulting in possible erosion.

Pruning

Pruning is the removal of branches or limbs in order to direct and control tree growth away from transmission lines. The term pruning generally implies the use of proper arboricultural practices. It is not trimming, which refers to the cutting back of vegetation to a uniform distance; and it is not topping, which refers to cutting tree limbs back to a stub, bud, or a lateral branch.

Pruning is the approved vegetation management method for areas where tree removal is not an acceptable option.

Selection Criteria for Pruning

In most instances, BC Hydro does not support pruning trees on transmission lines because of the clearances that must be maintained between the lines and the trees.

Trees should be removed at ground level. However, pruning may be the best management technique in the following circumstances:

- where it is cost-effective compared to tree removal
- where there is significant public opposition to tree removal, and there is no legal right-of-way agreement
- where the main stem is not on the ROW, but branches encroach on the ROW
- where trees are required for wildlife habitat or to protect riparian areas
- where written agreements exist that require pruning on private land
- as a temporary measure until a written long-term agreement is in place

In general, 69kV and 138kV circuits are the only areas where the ROW is narrow enough that edge trees would require pruning to maintain clearances.

Tree removal or engineering changes to the overhead conductors will be carried out if pruning operations cannot provide both adequate clearance and healthy, aesthetically acceptable trees.

Benefits of Pruning

- Trees are not removed and still provide aesthetic and other functions.
- Pruning influences the direction of branch growth so that trees can be directed away from conductors.
- Pruning can minimize adverse effects on tree health, and over time, reduce line clearing workload and risk from unhealthy trees.
- A pruned tree provides wildlife habitat and retains aesthetics, as opposed to a removed tree.

Limitations of Pruning

- Pruning is usually costlier than removal because trees may need to be pruned repeatedly.
- Pruning requires a skilled, experienced operator. Improper pruning techniques can seriously damage trees and result in unhealthy, unsightly, or hazardous trees that may require off-cycle remedial work.
- Pruned trees remain in proximity to transmission lines and have hazard potential, while removed trees do not.
- There is a risk of injury to workers from hand tools and from falling when pruning the tops of trees.

Reasons for Herbicide Use

The careful, limited use of herbicides is an essential part of IVM on BC Hydro transmission rights-of-way (ROWs), for safety reasons and to prevent power outages. Herbicide use accounts for only about 20% of BC Hydro's vegetation management. They are used only in certain circumstances in certain areas.

Safety and Reliability

Tall-growing trees must be removed from the ROW because safe, uninterrupted electrical service is a requirement for transmission rights-of-way. An IVM program that combines physical techniques with selective follow-up use of herbicides is often the most effective way to establish a stable, low-growing, biologically-diverse plant community—the primary objective for transmission rights-of-way. Once this site conversion is complete, it requires minimal maintenance, which reduces disruption to the natural environment over the long term, and helps reduce herbicide use over time.

For the utility industry in general, the effective control of vegetation using herbicides is absolutely necessary to ensure safety and operational reliability. Good IVM programs protect workers by preventing electrocutions, fires, and tripping hazards caused by vegetation. IVM ensures reliability of equipment and operations, including minimizing power outages on ROWs. IVM also provides visibility for inspection purposes and access for the maintenance of electrical operations.

Deciduous Tree Control

Herbicides are used primarily on tall-growing deciduous trees because they are fast-growing and quick to resprout, compared to conifers. (When conifers are cut below the lowest branch, they will die.) The quick resprouting of deciduous species creates more biomass and more debris for the next cycle. Use of herbicides will prevent this resprouting.

Environmental Benefits

The *Migratory Bird Convention Act* prohibits the disturbance or destruction of birds' nests. BC Hydro cannot feasibly conduct all vegetation management outside of bird nesting season, but a basal bark application will allow effective control of the tree without damaging nests.

Studies indicate that herbicide-managed sites can have a greater volume of wildlife forage compared to mowed sites. This is because the site objective of a low-growing stable plant community favours vegetation species used by browsing wildlife.

Some vegetative species at risk can be protected by using a stem-applied treatment. Instead of sites being taken over by rapid, high density regrowth from slashed deciduous species, treated stems die slowly, allowing sensitive plant species more time to grow and thrive.

Improved Aesthetics

Herbicide use reduces aesthetic concerns caused by slash build-up. This is often a concern for people living close to ROWs in urban and residential areas.

Cost Benefits

This judicious use of herbicides in combination with manual and mechanical methods significantly reduces the costs of BC Hydro's vegetation management program, which are borne by BC ratepayers. For example, a 2005 BC Hydro study showed that over a 10-year period, using only slashing to control vegetation would cost almost twice as much as combining slashing with herbicides (because slashing is labour-intensive and leads to dense regrowth). Accordingly, vegetation management cycles can be extended with herbicide use, resulting in significant savings in labour resources over time.

Limitations of Physical Methods

The use of non-chemical control methods alone has proven to be ineffective for the long-term management of undesirable vegetation on ROWs. This is especially true in BC, where transmission ROWs often run through remote geographic areas.

Fire Risk

Tree cutting or brush slashing operations using chainsaws may build up vegetative debris on rights-of-way over time, which increases the “fuel load,” or risk of fire.

BC Hydro is subject to the *Wildfire Act* and *Regulation*, which requires BC Hydro to maintain the ROW in a condition that would not start or cause a fire to spread. Therefore, BC Hydro must implement programs to reduce the fuel load created from vegetation management activities.

Frequent Disturbances

Reliance on mechanical methods requires more frequent intrusions onto the site, which increases the disturbance to wildlife and the environment due to repeated entries for mechanical treatment. This is because treatments like mowing or slashing lead to shortened maintenance cycles due to rapid resprouting and increased density of deciduous vegetation.

In contrast, herbicides provide more selective long-term control, reducing the need for frequent manual or mechanical treatments.

Increased Regrowth and Density

Without the complementary use of herbicides, continuous mechanical cutting results in increased stem (tree) density and decreased control and effectiveness over time. Trees such as alder, birch, aspen, and maple resprout quickly from cut stumps, resulting in even higher densities of tall-growing trees after repeated mowing or slashing. Follow-up use of herbicides prevents this resprouting and greatly extends the duration of vegetation control.

Continuous mowing on a right-of-way also increases the root mass from cut stumps and root stocks. This leaves roots to regrow vigorously each spring.

Environmental Harms

Some physical techniques such as mowing facilitate soil erosion, which negatively impacts fish-bearing water bodies.

There is more potential for mowing or slashing to destroy bird nests and habitat for burrowing animals, compared to herbicide applications.

Physical techniques often use heavy machinery that is more likely to damage non-target vegetation and the natural environment.

Mechanized equipment can cause rutting, track marks, or degradation of the ground surface.

Mechanical equipment has a higher inherent carbon footprint from fuel consumption and emissions.

Safety Hazards

The use of hand tools and mechanized equipment can be hazardous. The risk of accident and injury among workers is far greater when using mechanical means of controlling vegetation than when applying herbicides.

Some equipment may be impractical to use in remote or inaccessible areas, as well as dangerous in some terrain, such as on land with steep slopes or large rocks.

Increased slash and root mass from the sole use of mechanical methods creates physical hazards for wildlife, people, and equipment, and impedes service vehicle access.

Control of Invasive Plants and Noxious Weeds

Control of noxious weeds and their seeds is regulated by the *Weed Control Act* of British Columbia. Noxious weeds are invasive plants that can displace native vegetation and reduce wildlife habitat and forage.

Herbicides are the most economic and environmentally sound solution to control invasive plants and prevent their spread. Physical methods alone cannot control invasive plants. For example, mowing stimulates the production of species such as orange hawkweed, thereby increasing the weed population. Also, mechanical techniques can spread noxious weed seeds to other locations.

BC Hydro is not subject to the *Weed Control Act.* However, BC Hydro recognizes the environmental damage caused by noxious weeds and has implemented programs to control noxious weeds on its property, including substations, office sites, dams, power facilities, and rights-of-way. Vegetation management staff are trained to identify the species of noxious weeds on the Provincial list through internal education programs. Staff are also familiar with ways to reduce the spread of noxious weeds, such as inspecting vehicles. Finally, BC Hydro supports research into new control methods, such as the use of insects for biological control.

Herbicides and Equipment, Section 58(3)(c)

Types of herbicide application equipment that may be used include:

- backpack — hand-operated tank with pump worn on the back, with a hose attached to a spray wand, and a positive shut-off system
- mechanized foliar — boom, directed nozzle or wick sprayer mounted on an all-terrain vehicle
- powerhose — truck-mounted tank with hose and high-pressure nozzle and handgun
- wick — sponge or long-handled applicator stick containing herbicide
- squirt bottle — hand-held, non-pressurized container, may have a trigger pump sprayer
- injection tools — battery-powered drill or automatic lance used to inject capsules of herbicide into stems
- brush bar with herbicide — a brush saw or chainsaw with an attachment that deposits the herbicide on the spinning blade or chain, and automatically applies the herbicide onto the stump when cutting the stem

The following herbicides will be used, according to the methods and application equipment in Table 3. (Some of the herbicides are described in more detail below, and application methods are described further in the next section.)

- glyphosate (G)
- imazapyr (I)
- aminopyralid (A)
- metsulfuron-methyl (M)
- triclopyr (T)
- chondostereum purpureum (C)

Some herbicide products may have the identical active ingredient but a different trade name and a different PCP (pesticide control product) number by the federal Pest Management Regulatory Agency (PMRA). These herbicides are considered equivalent and can be used under this IVMP.

Table 3: Herbicide Method and Equipment

Equipment	Application Method			
	Cut Surface	**Basal**	**Foliar**	**Injection techniques**
Backpack	**C G T**	**T**	**A C G I M T**	
Mechanized boom			**A G M T**	
Powerhose			**A G M T**	
Wick			**G T**	
Squirt bottle	**C G T**			**C G T**
Injection tools				**G**
Brush saw with herbicide	**C G T**			

Glyphosate – Roundup, Vantage, or Equivalent

This herbicide is effective for controlling re-sprouts of most deciduous tree species. It is applied to the cut stump surface of the woody vegetation immediately after slashing, or injected/squirted into the cut frill of a tree as a liquid formulation. It can also be used in a broadcast application. Glyphosate is non-selective and has no or very little residual activity in the soil. It binds tightly to all types of soils independent of the levels of organic matter, silt, clay, and soil pH.

Imazapyr – Arsenal or Equivalent

This herbicide is used to control most broadleaf weeds and annual and perennial grasses. It is applied once the plants have had time to sprout. This herbicide is translocated throughout the plant and plant growth stops almost immediately after application. It is moderately residual and can usually provide season-long control on many perennial plants.

Aminopyralid – Milestone or Equivalent

This herbicide is a selective, post-emergent herbicide that controls a broad spectrum of broadleaf weeds, including Canada thistle, knapweeds, oxeye daisy, scentless chamomile and many others. This herbicide is mildly residual, and uses reduced application rates.

Aminopyralid / Metsulfuron methyl – ClearView or Equivalent

ClearView combines two active ingredients (aminopyralid and metsulfuron methyl) to produce a selective, post-emergent herbicide that controls a broad spectrum of broadleaf annual and perennial weeds, including Canada thistle, knapweeds, oxeye daisy, scentless chamomile, and many others. This herbicide can be applied for 12-24 months of good control, and uses reduced application rates.

Triclopyr – Garlon Ultra, Garlon RTU, or Equivalent

The active ingredient is effective for control of deciduous trees and brush. It provides an effective alternative to glyphosate for control of certain tree species, such as aspen poplar and trembling aspen. Triclopyr is a selective herbicide, has very little soil residual activity, and rapidly degrades in soil microorganisms and sunlight. It generally takes 10-46 days to break down in soil depending on soil type, moisture, and temperature. Although the herbicide does not bind to soil as tightly as glyphosate, once triclopyr moves into the soil, there is generally little movement. The herbicide tends to stay in the upper 30 cm of the surface soil layers following rainfall where it undergoes degradation.

Garlon Ultra can be applied foliar and basal bark applications, while *Garlon RTU* has a new formulation with lower active ingredient and generally used for basal bark and cut stump applications only.

Chondostereum Purpureum – Chontrol or Equivalent

This product is a fungus organism that slows or stops the re-growth or suckering of targeted plants. It is best applied during September/October and provides best results in areas with a high concentration of alder and on some other deciduous woody species.

Herbicide Application Methods, Section 58(2)(e)(i),(ii),(iii)

This section describes the various herbicide techniques that BC Hydro uses on transmission rights-of-way to control vegetation. It covers:

- description of the technique
- selection criteria for techniques
- benefits and limitations of the technique
- decision-making process for all treatment methods, including flowchart

BC Hydro will use the following herbicide methods for this IVMP:

- cut surface
- basal bark
- backpack foliar
- mechanized foliar
- injection techniques

Cut Surface

This method (also called cut-and-treat) is used in conjunction with slashing in deciduous stands. The tree is cut as low as possible to the ground, and herbicide is applied to the cut surface of the stump to limit resprouting.

Cut surface is a directed technique, which reduces the impact on non-target species. It also minimizes herbicide use and optimizes natural control.

The herbicide of choice is triclopyr. Glyphosate is preferred in environmentally-sensitive areas, and imazapyr on dense clumps of hard-to-control species such as bigleaf maple.

Selection Criteria for Cut Surface Treatment

- The cut surface treatment is used in areas where basal bark treatment is not optimal, such as where standing dead trees are an aesthetic concern (e.g., alongside roadways), or in low conductor-to-ground situations.
- Cut surface treatment is highly effective on most species that do not sucker from their roots.

Benefits of Cut Surface

- Cut surface treatment can be used in any terrain.
- No standing dead foliage remains, making this technique desirable in highly visible areas.
- There is minimal risk of herbicide exposure to workers or the public due to the directed nature of the treatment.
- Herbicide is limited to the stump surface, resulting in minimal impact on fish, wildlife, or the environment.
- It removes the canopy, but increases low-growing forage for wildlife.

Limitations of Cut Surface

- Improper application can result in unsuccessful treatment, and may require re-application of the herbicide.
- Treatment results in reduced forage and cover in the short term.
- It is a labour-intensive method and not cost-effective for dense stands.

Basal Bark

Basal bark treatment involves applying herbicide onto the bark of the target tree. The herbicide penetrates the bark into the cambium layer and diffuses throughout the tree and the roots, to prevent resprouting. It is applied with a low-volume backpack or hand-held sprayers with a positive shut-off system.

Selection Criteria for Basal Bark Treatment

- The method is best used on small deciduous trees under about 4m in height.
- At very high stem densities, basal treatment may not be practical, effective, or cost-effective. Also, the amount of standing dead stems may create a fire hazard.

Benefits of Basal Bark

- It is less labour-intensive than manual slashing and girdling.
- It is suitable for remote or difficult-to-access areas.
- It treats only targeted individual stems and so is appropriate for areas with low densities of target trees.
- It removes the canopy over a three-year period, allowing a low-growing plant community to establish.
- The potential for spray drift is reduced.
- There is minimal risk of herbicide exposure to workers or the public due to the targeted nature of the treatment.
- A small amount of product is applied per hectare.

Limitations of Basal Bark

- Dead foliage may be objectionable.
- In areas of low clearance, surviving treated stems may continue to grow.

Backpack Foliar

Backpack foliar treatment sprays herbicides onto the foliage of individual trees or small clusters of trees, using a manually-operated, low-volume, pressurized backpack with a positive shut-off system.

Selection Criteria for Foliar Treatment

- The terrain must have good foot access to reduce the risk of tripping and falling by applicators.

- If target vegetation is below 1.5m in height, it allows for better coverage, and will reduce the potential for operators to overreach.
- It is often used to treat resprouts one to two years after the area has been mowed or slashed.
- It is the main treatment used for noxious and invasive weed control.

Benefits of Backpack Foliar

- Backpack foliar is the most efficient method for managing the resprouts of high-density target vegetation.
- It targets specific vegetation, with adjustable application rates and dosages.

Limitations of Backpack Foliar

- Buffer zones may be required to protect pesticide-free zones (see page 44), depending on wind direction and topography.
- The recommended treatment height is 1.5m.
- Caution must be exercised to avoid treating areas where desirable species may be affected.
- There may be a short-term decrease in vegetation forage species.

Mechanized Foliar

This treatment method uses a fixed nozzle or boom-directed nozzle or wick sprayer mounted on a vehicle such as a skidder or an ATV, to spray herbicides onto the foliage of target trees. This method often uses a Radiarc nozzle.

Selection Criteria for Mechanized Foliar Treatment

- This method is optimally used on areas that have been previously mowed or hand-slashed to reduce resprouts.
- It is often used to treat resprouts one to two years after the area has been mowed or slashed.
- It is recommended for use when there is a high density of target cover at a uniform height. This will reduce the potential for spray runoff to the ground.
- It is an excellent treatment for noxious and invasive weed control.

Benefits of Mechanized Foliar

- Mechanized foliar is an efficient method for managing the resprouts of high-density target vegetation.
- It targets specific vegetation, with adjustable application rates and dosages.
- The Radiarc nozzle reduces the amount of herbicide used because well-defined droplets are produced, producing good coverage of the foliage with limited runoff.

Limitations of Mechanized Foliar

- It is not as selective as backpack foliar application.
- There is more potential for drift than a backpack foliar application.
- Buffer zones may be required to protect pesticide-free zones (see page 44), depending on wind direction and topography.
- Caution must be exercised to avoid treating areas where desirable species may be affected.
- There may be a short-term decrease in vegetation forage species.
- Mechanized foliar is often limited by terrain, such as steep slopes, large rocks, stumps, and bodies of water.
- In wet terrain, machines cannot operate effectively.
- Mechanized foliar may result in rutting, track marks, or degradation of the ROW surface.
- It should not be used on slopes greater than 30% because most machines are unsafe to operate.

Injection Techniques

There are two injection techniques used – mechanical injection and hack-and-squirt. In mechanical injection, a small capsule containing glyphosate is injected into the stem of the target tree or stump by means of a battery-powered drill or automatic loading lance. The herbicide is slowly released into the sapwood. Hack-and-squirt uses a small axe, machete, or hatchet to cut through the thick bark and into the sapwood. Glyphosate is then squirted into the cut with a bottle.

Selection Criteria for Injection Techniques

- An injection technique should be used when the cut surface method cannot be done.
- It should not be used when there is a risk to line security because the trees do not die immediately..
- It is effective on resprouting stumps, provided the capsules are applied to live tissue.
- It can be used in areas of limited access.
- It may also be a good choice around riparian areas.
- Larger-diameter trees are not effectively controlled by injection.
- It is not effective on bigleaf maple or aspen poplar.
- Blowdown of dead trees may pose a safety problem alongside well-travelled areas, or to workers re-entering the area.

Benefits of Injection Techniques

- Injection techniques are highly selective and injury to surrounding species is uncommon.
- It is effective on certain species, such as red alder, and for larger trees that cannot be managed with basal applications.
- It is not limited by terrain.
- It is easily learned and safe for the applicator.
- Herbicide use is minimal and self-contained. The potential for worker and public exposure is virtually eliminated.
- It virtually eliminates the possibility of environmental contamination because it is so directed (although shell casings may be left onsite).
- It removes the canopy, but increases low-growing forage for wildlife.
- It can be done at any time during the year.

Limitations of Injection Techniques

- In highly visible areas, dead foliage of standing trees may be objectionable.
- Capsules are not bio-degradable.
- There is more risk of line security being compromised because trees continue to grow after treatment, and trees may be occasionally missed for treatment.
- The method is labour-intensive.
- Capsules are not readily available.

Method Selection, Section 58(2)(e)(iv)

A decision-making process for choosing treatment methods ensures that the most suitable, effective, and cost-effective method or combination of methods is selected for an area to be treated, taking into account various assessment criteria.

Using these criteria, personnel will evaluate, select, and combine the methods that best suit the vegetation management site, whether manual and mechanical, herbicides, or both.

The overall objective for a site and the prescription will guide the choices (see page 6, *Site Objectives*). The best methods are those that will meet the ROW's long-term site objective. Treatments will be optimally timed for maximum efficacy, with consideration given to seasonal growing conditions, weather, and windows for fish, species at risk, and migratory birds.

Assessment Criteria

The techniques chosen will be justified and evaluated against the following assessment criteria:

Environmental, Social, and Economic Considerations

- safety and environmental considerations
- public and First Nations considerations
- availability of tools and contractors
- scope of the work
- aesthetics

Effectiveness and Timing

- consequences of not treating or delaying treatment
- benefits vs. limitations of each method

- efficacy
- short vs. long term impacts
- urgency
- limits of approach, line security rating, and conductor sag
- timing
- cost
- potential fuel loading on ground (i.e., fire risk)

Suitability for Site

- site objective
- density of target stems
- stem height and DBH
- species (conifer/deciduous)
- terrain (slope, aspect, access)
- compatible and other land use
- condition of the target area and target vegetation

There are additional assessment criteria for herbicides. The most suitable herbicide for the job will be selected. For the application technique and equipment, the combination will be chosen that will least affect desirable vegetation in the treatment area, and which will minimize the amount of herbicide used.

External Communications

When treating areas of Crown land with herbicide, BC Hydro will seek input from parties who may be significantly impacted. On private land and Indian Reserves, BC Hydro will obtain permission from the owner or manager of the land before treating with herbicides.

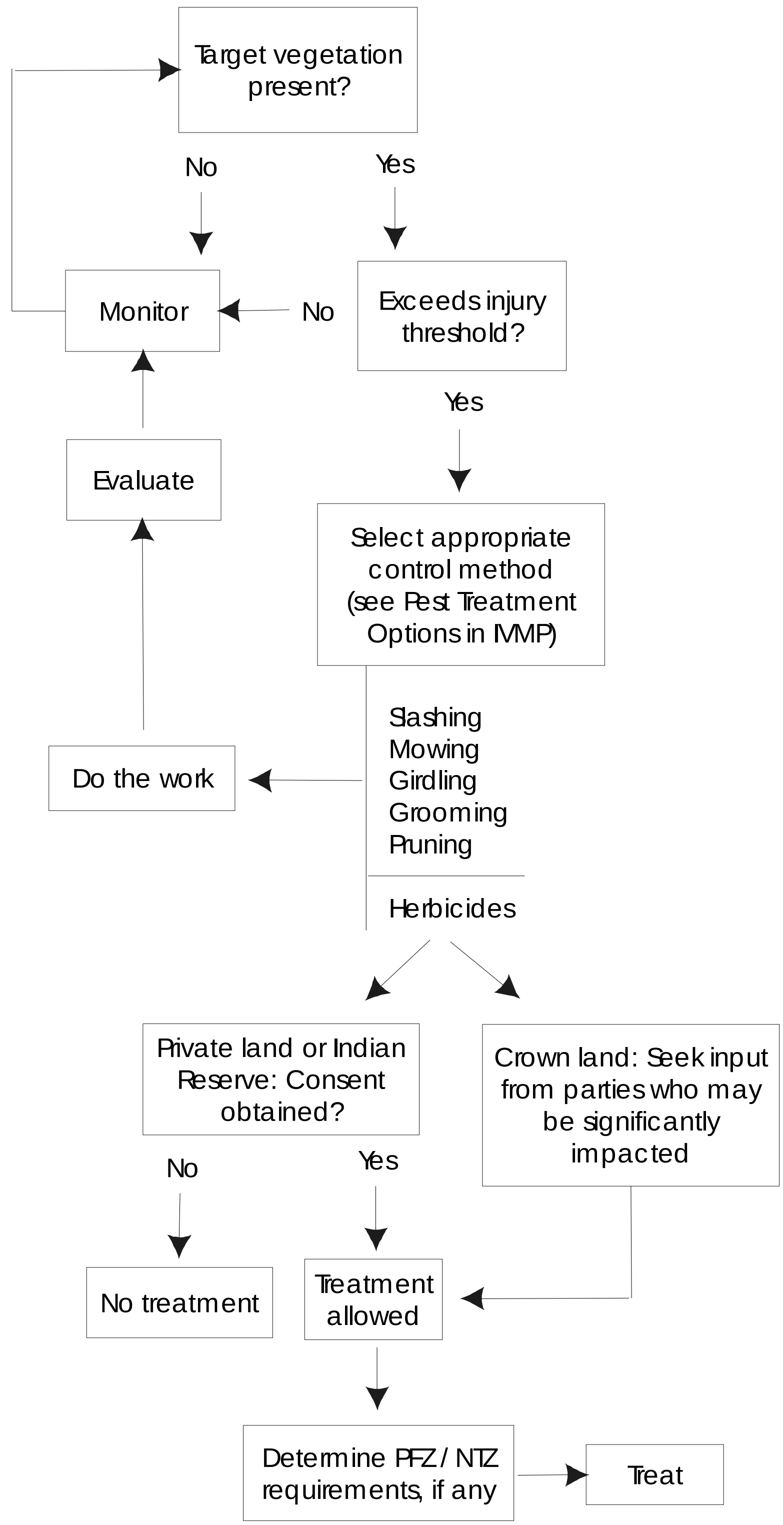
BC Hydro also generally notifies private landowners, parks boards, and other utilities when undertaking herbicide treatment on or adjacent to their land. Whenever notification is deemed necessary or prudent, it will be done before treatment begins, and will be in the form of personal letters or phone calls.

As per Section 64 of the *Integrated Pest Management Regulation*, notification signs will be posted on land being treated with herbicides. Signs will be clearly visible and legible from each approach to the treatment area used by the public. All approaches from highways must be posted. Signs may not be removed for at least 14 days after the herbicides have been applied. Records will be kept on how public notification was given and where notices were posted.

IVM Decision-Making Flowchart

The following flowchart shows the decision-making process that personnel will follow when choosing a vegetation management technique.

Integrated Vegetation Management Decision-Making Flowchart for Tall-growing Species



Evaluation, Section 58(2)(f)

After vegetation management work has been completed at a site, information is collected to evaluate the effectiveness of the vegetation management program, and measure the results against the site objectives.

The purpose of evaluating vegetation management work is to:

- achieve site objectives
- evaluate and adjust work plans accordingly
- determine the success of treatment techniques
- ensure no negative environmental impacts occurred
- take corrective action where necessary

The treatment method used is deemed effective if it resulted in the overall reduction of tall-growing target vegetation and the promotion of low-growing, stable, non-target plant communities.

Evaluation of the site also adheres to Section 35(2) of the *Integrated Pest Management Regulation*, which requires that records of treatment results, effectiveness, and impacts be kept.

Evaluation Methods

Visual evaluations are conducted on the ground. The exact timing and procedure will depend on the treatment methods used, the geographic area, the type and condition of the site, the vegetation being controlled, and the season. All areas treated with herbicide will be evaluated, but not 100% of each treatment area.

Within two days of the application, the site will be inspected for accuracy of application, with random visual evaluations conducted over 25% of the treatment area on the ground. The following is inspected:

- Cut surface – Look for marker dye on stumps.
- Basal – Look at the stem to ensure a proper wrap was made.
- Foliar – Check for coverage by looking for marker dye on foliage.
- Injection – Check the number and placement of cuts, capsules, drills, and plugs.

Any signs of overspray and incidental treatment of non-target species are identified by looking for signs of spray on species that are low-growing, compatible with powerlines, and were not to be treated. PFZs are inspected for potential spray drift.

About 14 days after application, the site will be inspected to ensure efficacy of application:

- Target vegetation was effectively controlled.
- Non-target vegetation was not affected.
- Herbicide treatment did not take place within pesticide-free zones (see page 44).

Within a year after application and during regularly scheduled patrols, the site will be evaluated for target mortality to ensure that program objectives were met.

Data Collected

Data collected during evaluations consists of qualitative and quantitative observations of mortality of targeted vegetation. These observations will be documented by photographs, field notes, and representative sample plot measurements.

Chapter 3, Herbicide Use and Handling

This section covers the responsible use and handling of herbicides, as per Section 58 of the *Integrated Pest Management Regulation* (information required for Pest Management Plans). It includes:

- transportation — Section 58(3)(a)(i)
- storage — Section 58(3)(a)(ii)
- mixing and loading — Section 58(3)(a)(iii)
- application — Section 58(3)(a)(iii)
- disposal — Section 58(3)(a)(iv)
- spill response plan — Section 58(3)(a)(v)
- application equipment — Section 58(3)(b)(v)

Requirements for Certified Applicator

Herbicide applications are to be performed or supervised by a Certified Pesticide Applicator (industrial vegetation and noxious weeds category). The name and certificate numbers of the applicator(s) who will supervise the work must be recorded on the Daily Operations Record (DOR).

The Certified Pesticide Applicator must:

- be in continuous attendance at the work site while herbicides are being applied
- supervise no more than four uncertified individuals at one time
- maintain continuous contact, auditory and/or visual, with each uncertified individual being supervised
- be within 500m of persons being supervised
- have proof of certification at or near the treatment location so it is readily available for inspection during herbicide use (if possible, the certificate should be kept at the mix site, in the vehicle used by an application crew during a treatment, or on the applicator's person at all times, such as in a wallet or pocket; the certificate can be a copy to avoid loss or damage of the original)

Pesticide Transportation, Section 58(3)(a)(i)

Personnel will follow these instructions to transport herbicides:

- Follow all applicable provincial transport requirements set out in the *Transport of Dangerous Goods Act*.

- Ensure that the herbicide is properly secured during transport so that accidental discharge or unauthorized removal is prevented, and also to prevent contamination of anything transported with the herbicides that is intended for animal or human consumption
- Read and understand the product label and Material Safety Data Sheet outlining the transportation requirements for each regulated product used by BC Hydro.
- Keep in the vehicle a first aid kit, fire extinguisher, spill contingency plan, and spill contingency kit. Vehicle operators will be trained to handle spills.
- Inspect containers for defects prior to transport and fasten them securely in the vehicle.
- Adhere to the standards contained in BC Hydro's standard contract,, which cover the safe use and handling of herbicides.
- Follow *Transport of Dangerous Goods Act* requirements for documentation, labels and markings, and placards.
- Follow *Integrated Pest Management Regulation* requirements (Sections 33(2) and 65).

Herbicide Storage, Section 58(3)(a)(ii)

Personnel will follow these instructions to store herbicides:

- Keep herbicides in their original containers and with original packaging, or in appropriate containers with trade name, name of active ingredient, concentration of active ingredient, and pesticide registration number affixed.
- Keep herbicides in storage facilities that are locked when unattended, accessible only to authorized persons. Facilities must be clean, well-marked, and ventilated to the outside.
- Storage facilities may be permanent, temporary, or mobile. Building materials will be fire-resistant wherever possible.
- Mark storage facility in block letters "WARNING: CHEMICAL STORAGE – AUTHORIZED PERSONS ONLY" so signs are visible to persons approaching each door providing access to the facility.
- Keep storage facilities separate from work and living areas, and away from anything intended for human or animal consumption, flammable materials, and bodies of water.

- Provide notice of the storage location to the fire department closest to that location.
- Keep a herbicide inventory log book, current product labels, Material Safety Data Sheets, and a copy of WorkSafe BC's *Occupational Health & Safety Regulation* at the storage facility.
- Store fumigants and other pesticides that release vapours or bear a poison symbol on the label in a storage facility that is not attached to or within a building used for living accommodations.
- Follow *Integrated Pest Management Regulation* requirements (Sections 33(1) and 66).

Mixing/ Loading Herbicides,
Section 58(3)(a)(iii)

Personnel will follow these instructions to mix and load herbicides:

- Ensure that persons mixing or loading herbicides are Certified Pesticide Applicators, and will use proper protective equipment and clothing.
- Before mixing, read the product label and Material Safety Data Sheet, and follow all safety precautions.
- Ensure that emergency wash facilities, first aid equipment, spill kits, and emergency phone numbers are close at hand.
- Use clean water free of any suspended particles. Use appropriate procedures to prevent backflow of herbicides into the water source.
- Conduct mixing and loading in areas selected to prevent any spilled herbicides from entering the pesticide-free zones for bodies of water, wells, and water intakes.
- When drawing water from a waterbody or an irrigation system, maintain a gap between the herbicide and the equipment to prevent backflow.
- Do not wash or submerge in a body of water any container used to prepare, mix, or apply herbicides.

Application Procedures,
Section 58(3)(a)(iii)

Personnel will follow these instructions to apply herbicides:

- Use the most practical, suitable, target-specific application techniques, such as low-volume, low-pressure backpack or hand-held sprayers and wick applicators.

- State the herbicides to be used, application rates, timing, quantities, treatment area, and species to be controlled on the Daily Operations Records, and closely follow all specifications.
- Do not use foliar applications if the wind speed exceeds 8km/hr.
- Do not apply herbicides from a distance of more than 1.5m from a targeted plant. Apply selectively to specific targets only.
- Follow directions and restrictions on product labels and *Material Safety Data Sheets* for all herbicides.
- Do not spray herbicides if it is raining.
- Do not apply any herbicide within a pesticide-free zone, no treatment zone, or buffer zone (see page 44).
- Do not spray herbicides on foliage covered by ice or frost.

Herbicide Disposal, Section 58(3)(a)(iv)

The disposal of herbicide waste is governed in British Columbia by the *Environmental Management Act* and *Hazardous Waste Regulation*.

Personnel will follow these instructions to dispose of herbicides:

- Plan all applications carefully to minimize excess and waste. Any leftover herbicide mix should be saved for future use or disposed of in an appropriate manner.
- Triple-rinse empty metal, glass, or plastic containers before disposal. Rinse sprayers and containers well away from any body of water or well.
- Puncture or break containers so that they cannot be reused, then discard at an approved sanitary landfill.

Spill Response Plan, Section 58(3)(a)(v)

If a herbicide spill occurs, personnel will follow these instructions:

- Ensure the safety of workers and public by limiting access to the area, protecting people from exposure, and ensuring wash facilities are nearby.
- Put on protective equipment before cleaning up the spill, including protective clothing, respirators, and eye protection.
- Contain the spill.

- Report spills to the Provincial Emergency Program (PEP) as per the Spill Reporting Regulation.
- Clean up the site.

Equipment Maintenance, Section 58(3)(b)(v)

Personnel must ensure that equipment used meets with the approval of BC Hydro and meets all applicable regulatory requirements.

- Application equipment must be properly calibrated at the beginning of the treatment contract to conform with the application rates on the pesticide label.
- Nozzles must be working properly or be replaced, and hose connections must not be leaking.
- Tools and equipment must be in good working order and properly cared for and stored.
- Tools that are prone to failure must be replaced, and spares must be available onsite.
- A regular maintenance schedule must be implemented for each piece of equipment.
- Contractors must keep a record for each piece of application equipment that requires calibration, when the equipment was calibrated, and the data upon which the calibration was based. Calibration records must be submitted with the DORs.

Chapter 4, Environmental Protection

This chapter covers the following, as per Section 58 of the *Integrated Pest Management Regulation* (information required for Pest Management Plans):

- protecting community watersheds and water sources — Section 58(3)(b)(i)
- protecting fish, wildlife, and habitat — Section 58(3)(b)(ii)
- preventing contamination of food — Section 58(3)(b)(iii)
- boundary marking procedures — Section 58(3)(b)(iv)
- weather monitoring — Section 58(3)(b)(vi)

Riparian Definitions

Pesticide free zone (PFZ) – an area of land that must not be treated with pesticides, and must be protected from pesticides moving onto it. PFZs are measured by the horizontal distance from the high water mark. PFZs will be flagged before starting any herbicide treatment.

No treatment zone (NTZ) – an area of land that must not be treated with pesticides.

Body of water – any watercourse or body of water, such as a stream, river, wetland, or lake, but not including a human-made, self-contained body or structure of water.

Stream – a watercourse that contains water on a perennial or seasonal basis, is scoured by water, or contains observable deposits of mineral alluvium, and which has a continuous channel bed that is 100m or more in length, or flows directly into a fish stream or a fish-bearing lake or wetland, or a licensed waterworks.

Wetland – a swamp, marsh, bog, or other similar area that supports natural vegetation, and which is distinct from adjacent upland areas.

Community watershed — a water source from a stream where the water is used for human consumption; the stream is licensed under the provincial *Water Act* for a waterworks purpose or a domestic purpose controlled by a water user's community, and the drainage area is not more than 500 square kilometres.

Protecting Watersheds and Water Sources, Section 58(3)(b)(i)

Pesticide-free zones (PFZs) will be maintained around community watershed intakes, as well as other water intakes and wells used for domestic and agricultural purposes. The locations of these water sources will be noted and all PFZs will be flagged before any herbicide treatment takes place. See Table 4, Water Protection Table, on the next page.

Measures to Protect Community Watersheds

The location of watersheds to be protected will be verified by checking the Community Watershed website of the Ministry of Sustainable Resource Management.

No herbicides will be mixed, loaded, or applied within:

- 10 metres of bodies of water within community watersheds
- 30 metres downslope of community watershed intakes
- 100 metres upslope of community watershed intakes

These pesticide-free zones will be measured and flagged in the field prior to treatment.

Measures to Protect Wells and Water Intakes

The PFZs and NTZs set out in Table 4: Water Protection Table will be used to protect water supply intakes or wells used for domestic and agricultural purposes that are located on or adjacent to ROWs. Locations of registered wells and intakes will be verified by searching applicable government websites. Attempts to identify and located unregistered wells and water intakes will be made by:

- identifying potential water users, such as private property owners or lessees, and asking them about intake and well locations (if occupant cannot be contacted, a pamphlet will be left)
- looking onsite for domestic or agricultural water use

Table 4: Water Protection Table

The following distances for no-treatment zones and pesticide-free zones are prescribed by the *Integrated Pest Management Regulation*. Section numbers are listed in the first column.

Pesticide-free zones are areas that must not be treated with pesticides – therefore, in order to maintain this area as pesticide-free, an adequate buffer zone must be implemented around the PFZ. This zone must account for sloped topography, weather at the time of treatment, or any other site factor that could cause the spread of the pesticides.

Section of IVMP Reg	Permitted Application	NTZ/PFZ	Notes
Glyphosate Applications			
71(3) Reg	Domestic and agricultural wells and water intakes, including all methods and pesticides.	30m NTZ	NTZ may be reduced if reasonably satisfied that a smaller NTZ will ensure no pesticide enters well or intake (70(4) Reg)
74(1)(a)(ii)	Along or around a body of water or classified wetland that: • is fish-bearing, or • that drains directly into a fish-bearing body of water, or • is along or around a dry stream that when wet is fish bearing or • drains directly into a fish bearing body of water	2m PFZ	Glyphosate must be applied using selective application methods.*
74(1)(c) Reg	Along or around a body of water if the body of water is: • not fish-bearing at any time of the year • does not drain directly into a fish-bearing body of water	2m NTZ	
74(1)(b) Reg	Along or around a body of water or a classified wetland that is: • fish-bearing, or • that drains directly into a fish-bearing body of water, or • along or around a dry stream that when wet is fish-bearing or drains directly into a fish-bearing body of water	5m PFZ	
74(2) Reg	Up to the high water mark of a temporary free-standing body of water and dry stream, that is: • not fish-bearing at any time of the year • does not drain directly into a fish-bearing body of water	0m NTZ	
Non-glyphosate applications			
73(1) Reg	Around or along a body of water or dry stream and classified wetland using any pesticide except glyphosate, subject to label restrictions and including all application methods.	10m PFZ	Except for glyphosate applications.
Noxious Weed and Invasive Plant Management			
77(2) Reg	Targeted application of glyphosate to noxious weeds and invasive plants if the application is used between 1m and 10m above the high water mark	1m PFZ	

*"Selective application" means the application of a pesticide to individual plants so that the vegetation between individual plants is not treated. For the purposes of BC Hydro's Pest Management Plan this includes cut surface, basal bark, directed foliar, and injection treatments.

Protecting Fish, Wildlife, Habitat,

Section 58(3)(b)(ii)

Work in riparian areas will be carefully planned in advance through an inventory and prescription process. Fish and riparian habitat will be protected as follows:

- identifying and mapping bodies of water through applicable sources of government data
- documenting bodies of water identified during field assessments in BC Hydro's mapping system
- classifying bodies of water as fish-bearing or non-fish-bearing (bodies of water that cannot be confirmed as fish-bearing will be managed as fish-bearing)
- managing fish-bearing bodies of water with appropriate pesticide-free zones and no treatment zones (see Table 4 above)

Measures to Protect Riparian Areas

These general precautions will be followed when working around bodies of water:

- Applicators will adhere to the pesticide-free zones in Table 4 above.
- Treatment methods will be directed only to target vegetation. As much vegetation as possible will be retained around bodies of water.
- Low-growing shrub or grass species will only be removed to protect safe working clearances from transmission lines.
- Herbicide use will not remove vegetation that is needed to:
  - prevent erosion of a streambank
  - prevent debris that would cause an unreasonable adverse impact from entering the stream
  - maintain slope stability in areas where landslides have occurred
- Trees will be directionally felled away from stream banks and shorelines to maintain safe working clearances from transmission lines.
- No deleterious substances will be allowed to enter the watercourse, including fuels, debris, sawdust, or sediment.
- Tracks or tires from heavy equipment will not enter the riparian area unless provided for in the prescription.
- Equipment or vehicles will not be washed at a stream or along the shores of any body of water.
- No power equipment or vehicles will be serviced or refueled any closer than 15m from a body of water. (Note: This distance may need to be greater depending on site-specific conditions.)

- Watercourses will not be diverted, blocked, or restricted, except temporarily to correct hazardous situations, or in an emergency.
- Machinery should only cross streams over a bridge or culvert. If there is no bridge or culvert available, only one crossing point will be selected and used, at a location where adverse effects can be minimized and mitigated.

Wildlife and Habitat

Information will be collected from the Conservation Data Centre on locations of rare and endangered species. Inventories of ROWs will be completed to identify areas of critical wildlife habitat. The provincial *Wildlife Act* and the federal *Species at Risk Act* will be adhered to.

Transmission ROWs are converted to a low-growing successional stage, which creates habitat for ungulates, ground-nesting birds, and other species. However, removal of tall-growing species means the loss of habitat for some species.

Wildlife and habitat will be protected as follows:

- Control noxious weeds (as designated under the *Weed Control Act).*
- Identify and protect certified wildlife trees.
- Leave to grow a diversity of low-growing shrubs and plants browsed by wildlife or used for habitat, including along the edges of ROWs.
- Do not use herbicides in or around known mineral licks.
- Ensure that herbicide use is directed only at target vegetation.
- Keep animal trails open and clear of cut brush.
- Do not disturb inhabited raptor and heron nests.
- Minimize soil erosion caused by vegetation management activities to reduce impact on desirable plants or wildlife.
- Identify sites where biological weed control organisms have been released, and prevent harm to those organisms.

Preventing Contamination of Food, Section 58(3)(b)(iii)

In general, food plants and medicinal plants are low-growing shrubs and herbaceous plants that are compatible with transmission line safety and reliability. The establishment of these species is encouraged and they are not actively controlled. However, tall-growing species and other vegetation that might interfere with transmission lines must be controlled regardless of their use by people.

Persons using the ROW to collect wild food or medicinal plants should notify BC Hydro. Areas with food and medicinal plants will be mapped, and these interests will be considered when planning vegetation management work.

Public notification of herbicide treatments will be posted at the treatment area according to the *Integrated Pest Management Regulation*, Section 64. BC Hydro will also notify landowners or users who have previously requested such notification. A Notice of Intent to treat will be sent to all First Nations communities near the treatment area. These measures will ensure that people understand the area has been treated and will not inadvertently gather food.

Herbicides will not be sprayed on areas used for agricultural crop production.

It is the responsibility of organic farmers to ensure an adequate buffer zone between their farm and an existing ROW.

Pre-treatment Inspection Procedures, Section 58(3)(b)(iv)

Before vegetation management is conducted at a specific site, a detailed contract is prepared by a pre-work consultant. At this stage, the work method is confirmed to ensure it is correct for the site. Specific environmental concerns are identified. The contractor receives a detailed map that shows where each method is to be used and shows any environmentally sensitive features. Before work begins, the edge of the ROW, work units, and environmentally sensitive areas are flagged in the field.

Before Work Starts

Personnel must ensure that the work area is properly defined and inspected before work begins, as follows:

- Check the *Notice of Intent to Treat* to ensure that the proposed treatment locations, the proposed treatment (including the herbicide and its method of application), and the total area of the treatment areas are correct.
- Ensure that the herbicide used is registered for the intended use as described on the herbicide label.

- Keep onsite the detailed map showing the proposed treatment areas and pesticide-free zones (PFZs) in the work area.
- Identify the boundaries of the treatment area and follow the flagging requirements in the contract to lay out the work.
- Post all herbicide use signs required for the treatment area.
- Inspect the treatment area to ensure that regulatory requirements and standards can be met when herbicides are applied.
- Ensure that domestic and agricultural water sources and soil used for agricultural crop production are protected.
- Perform a field check to look for drinking water sources, especially if there are houses in the vicinity, and flag any unregistered water intakes or wells.
- Wildlife habitat areas that change with the seasons or climate (such as moose browse) do not need to be identified for protection.
- If work is being conducted in an area where biological control agents have been released to control noxious weeds, make reasonable efforts to identify these sites and prevent harm to these organisms.

Before herbicide applications begin, personnel must ensure that each individual who will be using the herbicide is informed of:

- boundaries of the treatment area
- requirements for personal protection, including Material Safety Data Sheets
- herbicide use procedures required to protect human health and the environment
- the target species to be controlled and the desirable species to be protected during treatments and how to identify these plants/trees

During Work

During work, personnel must:

- Not exceed the area of treatment areas specified on the *Notice of Intent to Treat*.
- Take precautions to ensure that domestic water sources, agricultural water sources, and soil used for agricultural crop production are protected for their intended use.
- Take precautions to prevent unprotected human exposure to herbicides.

- Take precautions to avoid the use of pesticide over vertebrate wildlife or domestic animals that are visible to the user.
- Record and/or map any changes to the original treatment plan.
- Promptly refer any complaints regarding the herbicide applications by anyone to BC Hydro.

Weather Monitoring, Section 58(3)(b)(vi)

Personnel will carefully monitor weather and weather forecasts at the beginning and on a daily basis throughout the treatment program. Information will be collected from Environment Canada and other official sources.

For outdoor herbicide applications, the prevailing meteorological conditions including temperature, precipitation, and velocity and direction of wind, must be recorded for each treatment location and each day of use on the Daily Operations Record (DOR).

Stop Work Conditions

Herbicide applications must be stopped when any of the following conditions exist in the contract area. When herbicide label restrictions are more limiting, they will take precedence over the conditions below:

- temperatures exceeding 30°C or below freezing
- raining steadily (water running consistently down the lateral stems)
- ground wind speed exceeds 8km an hour (for foliar applications), i.e., gentle breeze, leaves, and twigs in constant motion
- foliage is covered by ice or frost, or water is flowing on the foliage overall conditions favour herbicide drift

Residual pesticides must not be used on water-saturated soil, during heavy rainfall, or if heavy rainfall is imminent.

Herbicides must be applied only between 30 minutes before sunrise and 30 minutes after sunset.

Drift Monitoring Procedures

Three factors contribute to drift: application techniques, weather conditions, and applicator error. The possibility of drift will be reduced through appropriate training and certification of workers, and by not conducting foliar applications in ground winds over 8km/h. Also, thickeners can be added to the herbicide to increase droplet size.

Spray drift will be monitored during foliar applications of herbicide to help ensure the accuracy of buffer zone establishment, and the integrity of PFZs.

Appendix J. Garter Snake Mitigation and Monitoring Workplan.

Garter Snake Mitigation and Monitoring Workplan

The terrestrial garter snake (*Thamnophis elegans*) and the common garter snake (*T. sirtalis*) are the two species that occur in the Local Assessment Area. In the Project's EIS (BC Hydro 2013) BC Hydro proposed to mitigate the potential effects of the Project on garter snakes associated with the loss of hibernacula by creating up to 30 snake den sites.

This workplan includes a brief description of garter snake biology, summarizes the potential impacts of the Project on snakes and their habitats[1], and outlines mitigation strategies. A monitoring program to assess snake use of downstream habitats is described.

Background

The terrestrial garter snake and the common garter snake have similar life histories and ecological associations. Garter snakes must overwinter in hibernacula (dens) that allow the snakes to access subterranean refuge below the frost line. Terrestrial garter snakes den as single individuals or small numbers, while common garter snakes will den in large numbers. Spring emergence appears to occur in late April to mid-May in the Peace Region, when the daytime high temperature exceeds 10^0C. This is later than in the southern part of the province where garter snakes typically emerge in March or early April (Matsuda et al. 2006). Common garter snakes mate upon emergence, while terrestrial garter snakes are thought to mate after they have left the den vicinity.

As spring temperatures continue to warm, garter snakes move away from the den to foraging habitat. This movement is relatively rapid and unlikely to be random as snakes typically know where productive foraging habitat is located and will move directly towards it. Gullies and creeks often serve as travel corridors.

Garter snakes are generalists when it comes to foraging and tend to take any small animal that does not pose a hazard to them, as they have no means of subduing their prey (such as venom) before they consume it. The most productive foraging habitats are wetlands, where minnows and amphibian larvae are plentiful. When the weather is cool, garter snakes will hunt in the wetland and then make short movements to warm slopes to digest their prey.

Garter snakes give birth to live young in late summer. A neonate (newborn) terrestrial garter snake was observed in the Peace River valley at denning habitat on 10 September 2011.

Existing Data

During field surveys in 2011, five terrestrial garter snake hibernacula were documented. All hibernacula are on the north side of the Peace River. Only 1-2 snakes were sighted at each site, suggesting that hibernacula used by multiple snakes are rare in this area.

[1] See EIS (BC Hydro 2013), Volume 2, Section 14 and Volume 2, Appendix R, Part 3.

The five hibernacula locations, 7 observations of snakes recorded during den surveys and an additional 38 incidental observations of snakes recorded on other field surveys between 2005 and 2012 were used to choose sites for artificial den creation.

Potential Impacts to Garter Snake Hibernacula

Garter snake hibernacula will be affected by the Project in three ways, which are summarized in Table 1 along with recommended mitigation activities.

Table 1. Summary of Potential Impacts to Garter snakes and Recommended Mitigation.

Potential Impact	Mitigation
Loss of hibernacula within reservoir inundation area and erosion impact line	Construct artificial dens outside of Erosion Impact Area and below new highway alignment prior to inundation.
Mortality to hibernating snakes if reservoir filling occurs in winter (October to April) while dens are occupied	If reservoir filling will occur in winter, relocate snakes returning to any dens discovered within the reservoir footprint prior to winter. Trap snakes as they return to dens by fencing the den area and installing funnel traps with earthen retreats. Relocate snakes to artificial dens, which must also be fenced to ensure the relocated snakes hibernate in the artificial den.
Loss of hibernacula along Highway 29	Survey Highway 29 re-alignments for hibernacula and mitigate impacts as necessary, either by avoidance or relocating population to artificial den.

Mitigation Measures – Artificial Dens

The concept of constructing artificial snake dens to enhance snake habitat has been in use for several decades (Zappalorti and Reinert 1994). Garter snakes have been found denning in a variety of man-made structures, including road beds, dikes, compost piles, basements and cellars (L. Andrusiak pers. obs.; M. Sarell pers. obs.; Takats 2002). In BC, artificial dens have been created as mitigation measures for hydro-electric substations, natural gas pipelines and residential subdivisions. Only one of these artificial dens was monitored and it was successful in attracting western skinks (*Eumeces skiltonianus*) and racers (*Coluber constrictor*) (Sarell 2006).

Artificial dens will be built along the reservoir shoreline, outside of the erosion impact line and prior to reservoir filling. The construction of artificial dens will take place as soon as possible (before clearing begins) to allow snakes to become familiar with the dens well in advance of the flooding of the reservoir. Artificial dens associated with the construction of bridges will be designed and constructed in concert with these construction activities, and will require the approval and co-operation of MOTI who is the owner of the highway.

The dispersal distance of garter snakes in the Peace area is unknown. Larsen (1987) documented dispersal distances of 6.5 to 9 km of 3 female *T. sirtalis* in Wood Buffalo National Park, Gregory and Stewart (1975) reported movements of 4.3 to greater than 17 km for the same species in Manitoba, while Kephart (1987, cited in Manier and Arnold 2005) found dispersal movements of less than 3 km for both *T. sirtalis* and *T. elegans* in California.

Artificial dens will be located on warm aspect slopes in open areas, separated by approximately 3 km as feasible. Based on the reservoir distance of approximately 83 km, this may allow for up to 30 artificial dens.

Bank Dens

Bank dens are constructed into a slope or bank. The steps involved in construction of an artificial bank den (Figure 1) include:

- Excavate a trench at least 4 m long and 2 m wide into the slope that is at least 3 m deep at the deepest (bank) end.
- Fill the trench with flat blasted rocks (minimum 5 cm, to a maximum of 15 cm overall dimension). Geotextile material will be overlain over the rocks to prevent infilling of the voids in the denning area.
- Ensure that the front rocks remain exposed when backfilling with the excavated soil to create entry points so snakes can access the interior of the artificial den.
- Seed disturbed soil with low-growing native plant species to allow basking opportunities at the den and reduce likelihood of colonization by invasive plants.

The artificial bank dens should not require future maintenance. Their stability and condition will be assessed every 2-3 years for up to 15 years after their construction.

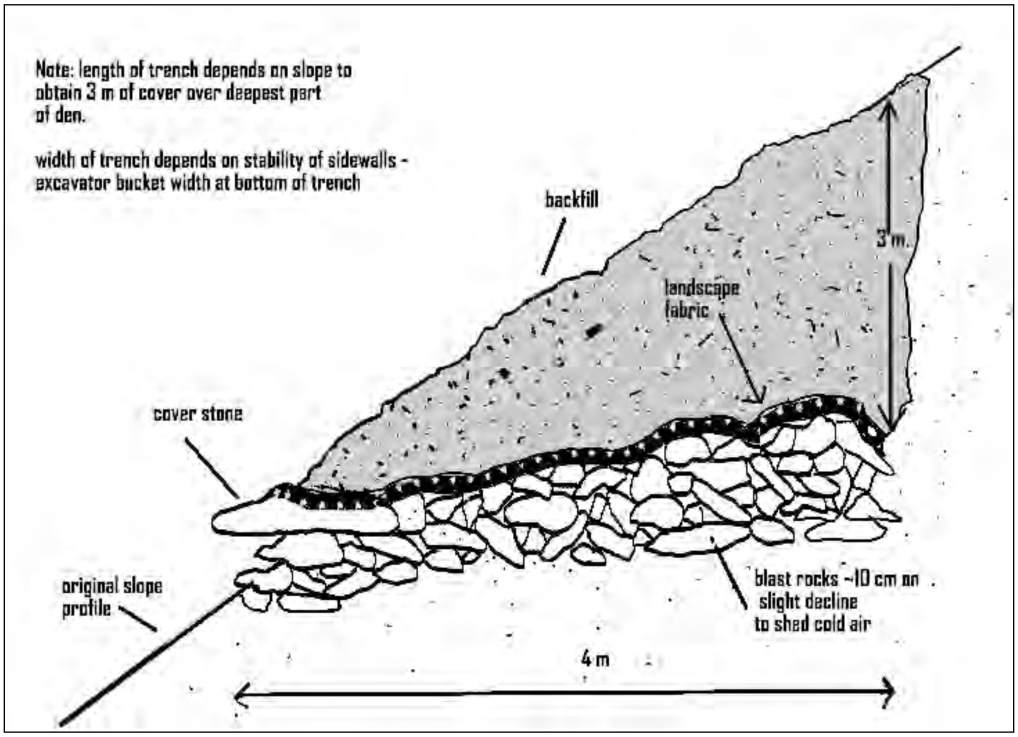


Figure 1. Bank Den Construction

Mound Dens

Mound dens are constructed in a similar manner and with similar materials as the bank dens described above, but are dug into flat ground instead of into a bank (Figure 2). On the south side of the Peace River, there are few warm sites suitable for artificial den construction. Dens in this area will be constructed on flat terrain built up as a mound about 8 m in diameter to provide a warm aspect (Cresswell et al. 2008). Concrete (preferred) or plastic pipes will be incorporated into the rock fill to provide access into the dens. At least 3 entrance pipes, oriented south, southeast, and southwest, will be placed just above ground level. Pipes will be at least 5 cm in diameter and capped. A series of 2.5 cm holes will be drilled along a 15 cm portion of pipe extending out of the den. Geotextile material will be overlain on the coarse material. Then a soil layer at least 2 m deep will be added to cap the den. The soil layer will insulate the den during the winter.

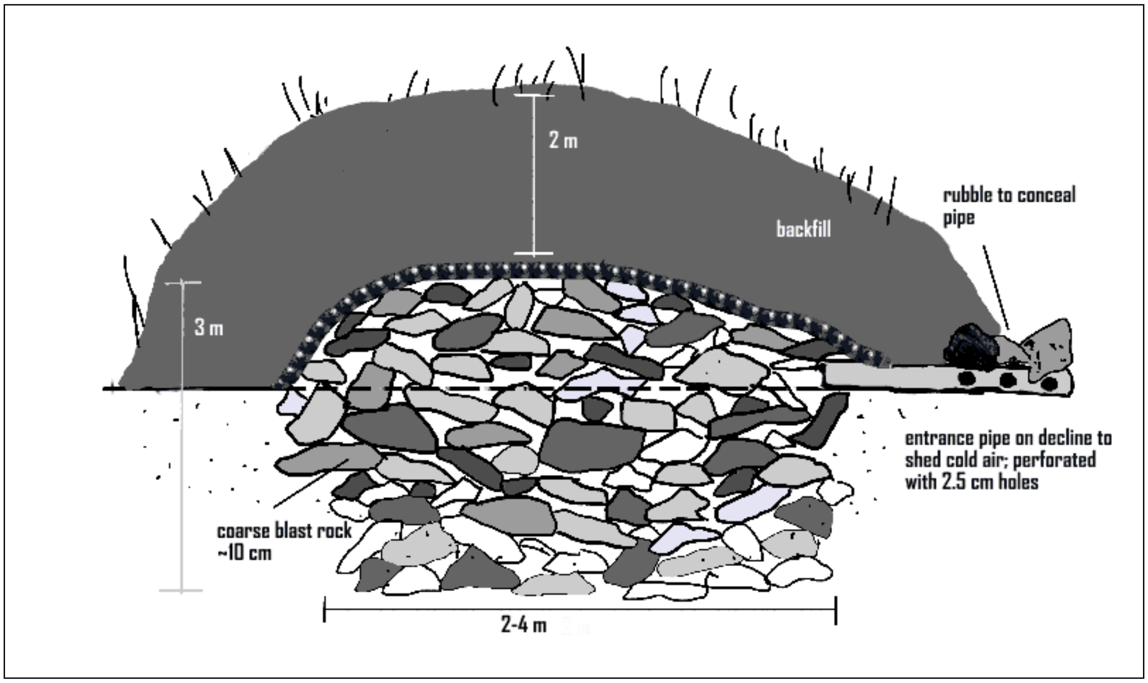


Figure 1. Mound den construction viewed from side. Only 1 entrance pipe is shown but 3 are preferred (see text).

Bedrock Dens

Bedrock dens are drilled out of solid rock and do not require excavation or backfilling. They can be constructed where rock outcrops are present on warm aspects.

Bedrock outcrops are scarce along most of the river valley but some rock faces are present near the Project dam site. Artificial dens can be created in bedrock sites near the Project dam site by drilling multiple 4 cm diameter holes along the toe of the bedrock that are at least 4 m deep to create a common chamber at the termination of the drill holes (Figure 3). Conversely a single bore could be made and the portal partially sealed to 2.5 cm in diameter to exclude potential predators. Drilled den features have not been tested but are expected to provide suitable hibernating conditions.

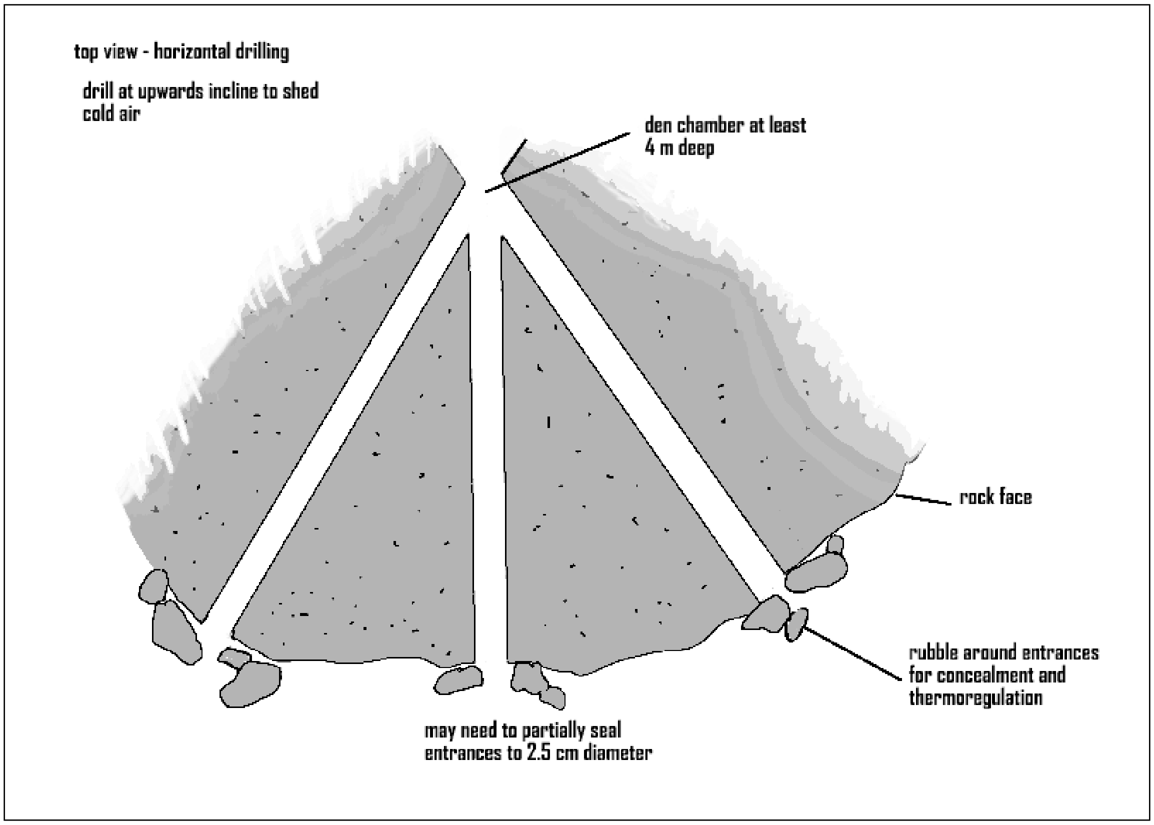


Figure 3. Bedrock den construction (viewed from top).

Siting Artificial Dens

The criteria that will be used for siting the artificial dens are:

- For every snake (or cluster of snake) observation below the erosion impact line, an artificial den will be planned above the erosion impact zone in suitable terrain, and generally within 500 m of the observation if suitable sites exist.
- Sites with a warm aspect (SE through W), sparsely treed and easily accessed, will be selected as available.
- On the north side of the river, artificial dens will be positioned between the erosion impact line and the new highway alignments.
- On the south side of the river, dens will be positioned above the erosion impact line.
- Dens will be placed on Crown lands or lands currently owned by BC Hydro.
- Sites at the southern (downslope) fill slopes at highway creek / ravine crossings will be selected for the construction of bank dens.
- Where no warm aspect slopes are available, mound dens are planned.

Using these criteria, to date 12 sites have been selected for artificial hibernacula, as follows:

- Three of these will be mound-style dens and the remaining nine will be bank-style dens.
- Of the bank-style dens, three would be incorporated into the earthen footings of bridges.
- Two artificial dens would be sited on the south side of the Peace River (where there are typically access limitations and a lack of south-facing slopes)

The 12 artificial dens that have been proposed to date were sited with the aid of orthophoto imagery and 20 m contour interval mapping. A site inspection will be required to accurately place the den site and to develop site-specific designs and construction plans.

After installation, these 12 dens will be monitored for 3 years. The data collected during monitoring will be used to inform the final site selection and den design for the remaining sites.

Suitable areas to host artificial den sites will be considered as follows:

- once full Project land acquisitions are completed, lands surplus to Project development will be reviewed;
- as final placement of construction of project access roads is identified on the south side of the Peace River these areas will be reviewed;
- As final design is completed for Highway 29 realignments, these will be reviewed;
- wetlands that are created or enhanced for the Project as part of the wetland mitigation and compensation plan will be reviewed, and where suitable may have snake dens built within 500 m of the wetland.

Appendix K. Proposed Bald Eagle Nest Mitigation Plan.

MITIGATION PLANS

INTRODUCTION

Large balsam poplar (*Populus balsamifera* ssp.) trees along the banks of Peace River and on islands within the river are used by Bald Eagle (*Haliaeetus leucocephalus)* for nesting. Surveys conducted in 2014 for the Site C Project baseline identified 28 Bald Eagle nests within the proposed reservoir footprint. Sixteen of the nests documented within the proposed reservoir footprint were classified as active in 2014 that is, they were being used by Bald Eagles. One nest was occupied by Canada geese and the activity status of one nest within the reservoir could not be determined as no birds were observed in or near the nest. By comparison, 19 active Bald Eagle nests were documented within the same area in 2011. Bald Eagle nests are protected under the *BC Wildlife Act* (Section 34b). A *Wildlife Act* permit is required to authorize removal of these nests.

Removal of the active Bald Eagle nests will be mitigated by the installation of up to 38 alternate nest platforms. This approach would provide two nest platforms for the maximum number of active nests (19) documented in the proposed reservoir area in 2011 (see EIS Volume 2, Section 14, Table 14.16).

PLATFORM DESIGN

The proposed platform design is provided on the attached drawing. Design was informed by platforms used to provide alternate nesting structures for Osprey (*Pandion haliaetus*) and a Bald Eagle nest located in a 500kv transmission tower. The platform has been designed to provide the required support for a 2000lb nest.

Platforms will be supported by either a Douglas Fir, Class 3 utility pole or a metal pole. The type of pole used will be determined on a site-by-site basis and will be based on the height of the existing surrounding/proximal forest. Platform height will be such that the platform height aligns with the upper 1/3 of the existing forest canopy. This will be determined on a site-by-site basis prior to installation of the platform. Utility poles will be used to support structures up to 22m (72ft). Metal poles will be used to support structures greater than 22m.

PLATFORM PLACEMENT

BC Hydro will erect up to 38 alternate nest platforms. This approach would provide two nest platforms for the maximum number of active nests (19) documented in the proposed reservoir area in 2011 (see

EIS Volume 2, Section 14, Table 14.16: BC Hydro, 2013). No Bald Eagle nests were observed within the Transmission Line right-of-way in 2014. Proposed platform locations on BC Hydro owned and crown land are provided on **Map 1** (attached). BC Hydro anticipates placing some platforms on private lands subject to agreements being reached with private property owners. The following criteria were used to determine platform placement:

- Place platforms as close to the active nest as possible. This maximizes the probability that the platform will remain in the pair's nesting territory
- Place platforms outside the Preliminary Stability Impact Line-the boundary beyond which land would not be expected to be affected by landslide events
- Place platforms along the edge of openings and existing forests so that they
    - Have an uninterrupted view of the reservoir
    - Will not interfere with agricultural operations
    - Are away from areas of high human use
    - Do not require the creation of new access routes

Platform installation will begin in the late summer-early fall of 2015 and continue through early Project operations.

REFERENCES

BC Hydro. 2013. Site C Clean Energy Project Environmental Impact Statement.