Peace Project Water Use Plan

Reservoir Wetland Habitat Monitoring

Implementation Year 5

Reference: GMSMON-15

Study Period: April 2015 to February 2016

Cooper Beauchesne and Associates Ltd.
Northern Interior Office
Suite 1, 1257 4th Avenue
Prince George, BC

February 2016

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GMSMON-15: Reservoir Wetland Habitat Monitoring Year 5 – Final Report

Report submitted to:

BC Hydro

Attn: Toby Jones

Submitted by:

Cooper Beauchesne and Associates Ltd.
Northern Interior Office
Suite 1, 1257 4th Avenue
Prince George, BC
Tel: 250 954-1822
Contact: John Cooper
jcooper@cooperbeauchesne.com

February 2016

Suggested Citation:

MacInnis, A.J., V. Prigmore, and A. Carson. 2016. GMSMON-15: Reservoir Wetland Habitat Monitoring, Year 5 – Final Report. Unpublished report by Cooper Beauchesne and Associates Ltd., Prince George, BC, for BC Hydro Generation, Water Licence Requirements, Burnaby, BC. x + 66pp. + Appendices.

Keywords: Peace Water Use Plan, Riparian and Wetland Habitat Enhancement Management Plan, Williston Reservoir, amphibians, waterfowl, songbirds, riparian vegetation, wetland vegetation, fish, wetland demonstration sites

Cover photo: Long-toed salamander at the Beaver Pond site (WDS-34), Williston Reservoir. Photo © A. MacInnis, Cooper Beauchesne and Associates Ltd.

EXECUTIVE SUMMARY

Reservoir operations have created large unproductive areas within the drawdown zone of Williston Reservoir. This has resulted in limited aquatic and riparian habitats that reduce the area’s capacity to support fish and wildlife and potentially increase the risk of predation for terrestrial wildlife using the drawdown zone. To address these impacts, the Riparian and Wetland Habitat Management Plan was developed under the Peace Water Use Plan to investigate the possibility of creating or enhancing perched wetland areas to increase riparian and wetland habitat. An inventory of potential enhancement trial sites was completed under GMSWORKS-16 *Williston Reservoir Wetlands Inventory* and detailed designs for two locations were completed under GMSWORKS-17 *Williston Reservoir Trial Wetlands*.

The GMSMON-15 project is a 10-year program to monitor the effectiveness of the two demonstration wetland enhancement projects at improving wildlife habitat and maintaining the habitat over the life of the projects. Waterfowl, songbirds, amphibians, and vegetation were identified as the indicator groups for determining the effectiveness of the wetland projects. Fish populations are also being monitored, although improving fish habitat is not one of the goals of the wetland projects. This report presents the results from the fifth year of monitoring under GMSMON-15. The results provide the second full year of post-construction data for the Airport Lagoon project (constructed in late May 2013) and the first full year of post-construction data results from the Beaver Pond project (constructed in May 2014).

For terrestrial and aquatic vegetation, the additional data collected in Year 5 provided a better characterization of the vegetation types that remain following the completion of the wetland enhancement projects. The observed variation in terrestrial vegetation appears to be primarily associated with the peak reservoir elevation in the preceding year. The completion of the enhancement projects is expected to allow the development of aquatic vegetation that is currently non-existent (Beaver Pond) or limited in extent (Airport Lagoon). Aquatic vegetation sampling at the Airport Lagoon site identified areas within the new wetland where aquatic plant species were sparse to absent. The size of these areas was reduced compared to Year 4 as new areas were colonized through natural dispersal of established aquatic vegetation.

A total of 349 individuals representing 23 waterfowl and shorebird species were observed at the Airport Lagoon site during 2015 surveys. At the Beaver Pond site, 10 individuals representing 2 species of waterfowl and shorebirds were detected. At Airport Lagoon, American Wigeon were the most abundant waterfowl species followed by Canada Goose and Green-winged Teal. The second survey of the year conducted on May 10 was the most productive. Canada Goose and Spotted Sandpiper were the only species detected at Beaver Pond during the surveys. However, incidental waterbird observations at Beaver Pond included Killdeer, Greater Yellowlegs, Common Merganser, Mallard, and Blue-winged Teal. Additionally, nesting Killdeer pairs were recorded on two of the floating islands at Airport Lagoon. This is the first time that nesting habitat use can be directly attributed to changes resulting from the habitat enhancement work, since these islands were not present before the physical works were completed.

A total of 508 individuals representing 51 species were among the 406 detections recorded during the Year 5 songbird point count surveys. The species richness at the Airport Lagoon (49 species) was slightly lower than in previous seasons and average at the Beaver Pond (22 species). The average number of species detected per station was lower than in most previous years at both sites. The percentage of detections recorded in the drawdown zone at both sites were the highest since 2012 when the location of detections was added the data collected. The

lower number of detections recorded in 2015 is potentially attributable to natural variability. The number of detections of water dependent genera (shorebirds, waterfowl and gulls) was slightly lower than in 2014 but was still higher than the pre-construction results.

As in previous years, western toad accounted for the majority of detections at both the Airport Lagoon and Beaver Pond sites in 2015. The only other species observed at the Airport Lagoon were a single long-toed salamander and an incidental observation of a wood frog. Long-toed salamanders and wood frogs were also detected at the Beaver Pond site. At least one amphibian species was detected during each of the surveys in 2015. Year 5 had the highest number of detections at the Beaver Pond site and the second highest number of detections at Airport Lagoon. The post-construction surveys have recorded higher numbers of western toad and long-toed salamanders than in the pre-construction surveys at both sites.

Fish population sampling was completed by backpack electrofishing, minnow traps, and fyke nets. The number and relative abundance of fish collected at the Airport Lagoon site was again higher than in previous years, based on high catch rates during the May sampling. Few fish were captured at the Beaver Pond site but the only sampling conducted in Year 5 was electrofishing. A total of 24,462 fish were captured representing 11 of the 22 species potentially present in Williston Reservoir. The fish collected were primarily non-sportfish including Lake Chub, Redside Shiner, Northern Pikeminnow, Brassy Minnow, and three species of sucker. The only sportfish collected in Year 5 were seven Rainbow Trout and one juvenile Burbot from the Airport Lagoon site.

The data collected to date in the GMSMON-15 project appear to support the preliminary predictions for the wetland demonstration projects. The two years of post-construction data collected from the Airport Lagoon identified changes in all indicator groups that are likely associated with the new water level and associated habitat. The Beaver Pond project was completed in spring 2014 and the observations from the first year post-construction identified changes in some of the indicator groups. Although completed at a lower elevation than designed, it is expected that the project will improve wildlife habitat and increase wildlife use of this areas. Additional years of monitoring will be required to confirm what changes in the indicator groups are associated with the enhancement projects and those that are due to natural variability and reservoir levels.

MANAGEMENT SUMMARY: STATUS OF GMSMON-15 MANAGEMENT QUESTIONS AND HYPOTHESES – YEAR 5

Management Question	Management Hypothesis (Null)	Year 5 (2015) Status
Is there a change in the abundance, diversity and extent of vegetation in the enhancement area?	H_{01}: The density, diversity and spatial extent of riparian and aquatic vegetation does not change following enhancement.	No changes in riparian vegetation have been detected at the Airport Lagoon. The second year of post-construction monitoring shows a continued increase in the extent of aquatic vegetation associated with the new water level. No changes in riparian or aquatic vegetation were detected in the first post-construction monitoring at the Beaver Pond site.
Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?		The two years of post-construction data from the Airport Lagoon project shows continued use by waterfowl and other wildlife. The single year of post-construction data from the Beaver Pond project is consistent with the baseline data.
	H_{02}: The species composition and density of waterfowl and songbirds does not change following enhancement.	The two years of post-construction data from the Airport Lagoon show some changes in waterfowl and songbird species composition and density. The single year of post-construction data from the Beaver Pond project is consistent with the baseline data. Additional monitoring will be required for testing of this hypothesis.
	H_{03}: Amphibian abundance and diversity in the wetland does not change following wetland enhancement.	The two years of post-construction data from the Airport Lagoon showed some changes in amphibian abundance. The single year of post-construction data from the Beaver Pond site showed increases in amphibian abundance. Additional monitoring will be required for testing of this hypothesis.
Is the area and quality of wildlife habitat created by the wetland enhancement maintained over time?		With only two years of post-construction data from the Airport Lagoon site and a single year of post-construction data from the Beaver Pond project it is not possible to comment on the long term persistence and quality of habitat.

ACKNOWLEDGEMENTS

A number of people have contributed to completion of Year 5 of the GMSMON-15 project. BC Hydro WLR sponsored the project. Ongoing guidance and support was provided by Toby Jones with technical input by Mike McArthur.

Field work was completed by CBA staff Andrew MacInnis, Allan Carson, Vicki Prigmore, Karl Bachmann, and Emily Braam. Andrew MacInnis (CBA Senior Fisheries Biologist) was Project Manager with assistance from John Cooper the Project Advisor.

The report was written by Andrew MacInnis, Vicki Prigmore, and Allan Carson. Ryan Gill conducted the GIS analyses and prepared maps for the report. John Cooper provided a review of the draft report.

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1 INTRODUCTION

1.1 Background

During consultations under the Peace Water Use Plan (WUP), the Consultative Committee recognized that reservoir operations created large unproductive areas within the drawdown zone of Williston Reservoir (Anon. 2003). The resulting limited aquatic and riparian habitats were hypothesized to have two primary impacts: they limit the area's capacity to support fish and wildlife and they potentially increase the risk of predation for terrestrial wildlife utilizing the drawdown zone. The large area (~450 km^2) of the drawdown zone between the low and high water levels, provides little wildlife habitat when exposed during low water levels and little habitat for fish when inundated (Anon. 2003). The fluctuating water levels were also identified as affecting riparian productivity around the reservoir.

It was noted that when water levels recede during drawdown, pools and isolated backwater areas formed in some locations around the reservoir. The contribution of these pools and backwaters to wildlife and fish productivity is variable, depending on the location. The Riparian and Wetland Habitat Management Plan was developed within the WUP to investigate the possibility of creating or enhancing additional perched wetland areas to increase riparian and wetland habitat (Anon. 2003). The components of the plan were an inventory of sites that were potentially suitable for enhancement, selection of sites for implementation of demonstration wetland enhancement projects, and a monitoring program to test their effectiveness in improving riparian and foreshore habitat for wetland species over the life of the project.

The inventory of potential enhancement sites was completed under GMSWORKS-16 *Williston Reservoir Wetlands Inventory*. A total of 42 sites in the Parsnip Arm were reviewed as potential wetland enhancement sites by Golder (2010). Of the 42 sites reviewed, five candidate sites were identified for demonstration projects on the basis of a combination of factors including (but not limited to) cost, feasibility, and potential benefit to wildlife (Golder 2010). The second phase was completed under GMSWORKS-17 *Williston Reservoir Trial Wetland*. Two of the five candidate sites were selected as demonstration sites and detailed designs developed (Golder 2011). Monitoring of the effectiveness of the wetland demonstration projects in improving wildlife habitat on the reservoir will be completed under GMSMON-15 *Reservoir Wetland Habitat*.

1.2 Monitoring Plan Overview

The GMSMON-15 project is a 10-year monitoring program to assess the effectiveness of the demonstration wetland enhancement projects at improving wildlife habitat and maintaining the habitat over the life of the two projects (BC Hydro 2010). This effectiveness monitoring program is designed to determine the response of selected indicator groups to the wetland enhancements and to increase knowledge of wildlife use of the drawdown zone for the selected groups, particularly birds and amphibians. Monitoring the responses of all species is not feasible; therefore, BC Hydro (2010) identified waterfowl, songbirds, amphibians, and vegetation as the wildlife indicator groups to be used for monitoring in GMSMON-15. Fish populations were also identified for monitoring as fish were observed at both of the selected demonstration sites (Golder 2010, 2011). While improving fish habitat is not one of the goals of the wetland enhancement projects, little is known about the fish species composition and distribution at the selected locations (BC Hydro 2010).

This report presents the results from the fifth year of the GMSMON-15 monitoring program and includes the second year of post-construction data from the Airport Lagoon site and the first year of post-construction data from the Beaver Pond site.

2 MANAGEMENT QUESTIONS AND HYPOTHESES

The monitoring objectives and hypotheses for GMSMON-15 were stated in the Terms of Reference for the project (BC Hydro 2010). These are restated below along with a brief summary of how the testing of each hypothesis is approached in the study design.

Three key management questions regarding the effectiveness of the wetland enhancements were identified for the Reservoir Wetland Habitat monitoring program:

1. Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?
2. Is there a change in the abundance, diversity and extent of vegetation in the enhancement area?
3. Is the area and quality of wildlife habitat created by the wetland enhancement maintained over time?

Based on these management questions, the study was designed to test the following hypotheses stated in the Terms of Reference:

H_{01}: The density, diversity and spatial extent of riparian and aquatic vegetation does not change following enhancement;
H_{02}: The species composition and density of waterfowl and songbirds does not change following enhancement;
H_{03}: Amphibian abundance and diversity in the wetland does not change following wetland enhancement.

The monitoring program collects annual data on riparian and aquatic vegetation density, diversity, and spatial extent, waterfowl and songbird abundance and diversity, and amphibian abundance and diversity. The project tasks also include annual monitoring of fish diversity and abundance at the trial sites. There are no specific management questions or hypotheses for fish to be tested as the focus of the projects is on enhancing wildlife habitat rather than fish habitat.

The general approach is to sample each of the indicator groups at locations within the core area of the enhancement treatments and in peripheral riparian areas at both sites. Riparian vegetation is monitored using annual quadrat sampling and aerial photo analysis. Songbirds are surveyed using breeding bird point counts and nest searches. Waterfowl and shorebirds are surveyed by land-based observations. Amphibians are inventoried using systematic surveys to determine relative abundance. Fish population are sampled with minnow traps, fyke nets and by electrofishing.

3 STUDY AREA

Williston Reservoir is located in northeastern British Columbia and was created by construction of the W.A.C. Bennett Dam at the head of the Peace River Canyon, about 20 km west of Hudson's Hope, B.C (BC Hydro 2007). The reservoir extends for about 260 km along the Rocky Mountain Trench from the Finlay River in the north to the Parsnip River in the south. The reservoir is generally divided into three geographic regions (from north to south): Finlay Reach, Peace Reach and Parsnip Reach (BC Hydro 2007).

The reservoir is located within the Sub-Boreal Spruce and Boreal White and Black Spruce biogeoclimatic zones (Meidinger and Pojar 1991). The Sub-Boreal Spruce zone is the dominant zone and occurs as two subzones and variants at lower elevations along most of the reservoir (Meidinger and Pojar 1991). The Boreal White and Black Spruce zone occurs only at the northern end of the reservoir in the Finlay Arm (Meidinger and Pojar 1991). The drawdown zone consists of large areas of mud, sand and gravel flats with stranded large woody debris. Limited amounts of vegetation occur even following extended periods of drawdown.

The water level in the reservoir varies annually with reservoir filling and drafting. The spring and summer reservoir levels (April – August, low to full pool) for the first five years of this study (Year 1: 2011, Year 2: 2012, Year 3: 2013, Year 4: 2014, and Year 5: 2015) are shown in Figure 1 along with the mean reservoir level. The reservoir levels from 2010 are also included as they were below average and influenced the results observed in 2011.

In 2015, the reservoir reached its lowest level of 662.6 m on April 21. This is slightly earlier than in the previous years of the monitoring program (8 May 2011, 25 April 2012, 3 May 2013, and 26 April 2014). However, the minimum elevation in 2015 was more than 4 m above the average for this date and 2 m higher than on the same date in 2012 (the year with the next highest minimum elevation in the study period). Water levels in 2015 increased relatively rapidly until the end of May when the rate of increase declined and stayed well above reservoir elevations in previous years of the study until late June. The reservoir reached a maximum of 671.5 m on October 20 (BC Hydro Commercial Resource Optimization (CRO) database) which is near the full pool elevation of 672.08 m. This peak elevation is notable in that it occurred later than in the previous years of the study and occurred at a time of year when the reservoir elevation has started to decline (Figure 1). Reservoir levels in all five years are higher than in 2010 when the reservoir elevation only reached a maximum of 665.54 m on November 8, 2010 (BC Hydro CRO database).

The two locations identified for the wetland demonstration projects are both located on the east side of the Parsnip Reach of the reservoir (Figure 2). The Airport Lagoon site (WDS 6-2) is located approximately six kilometres south of Mackenzie and is an approximately 75 ha site on the upstream side of a forest service road causeway. Except for two culverts at the base of the causeway the area was isolated from the main reservoir. Water supply to the lagoon is primarily from two unnamed streams located at the north end of the lagoon. At reservoir elevations >664.5 m, the reservoir was connected to the lagoon and water levels in the lagoon correspond to reservoir levels. In May 2013, the existing culverts were removed and two new culverts were installed at an elevation of two new culverts at an elevation of 666.99 m for the west culvert and 667.05 m for the east culvert (Golder 2013). The goal of the project was to create a larger area of permanently flooded habitat and reduce water level changes that would allow for colonization by submergent and emergent vegetation as well as enhance the riparian zone to benefit waterfowl, wading birds and amphibians (Golder 2011).

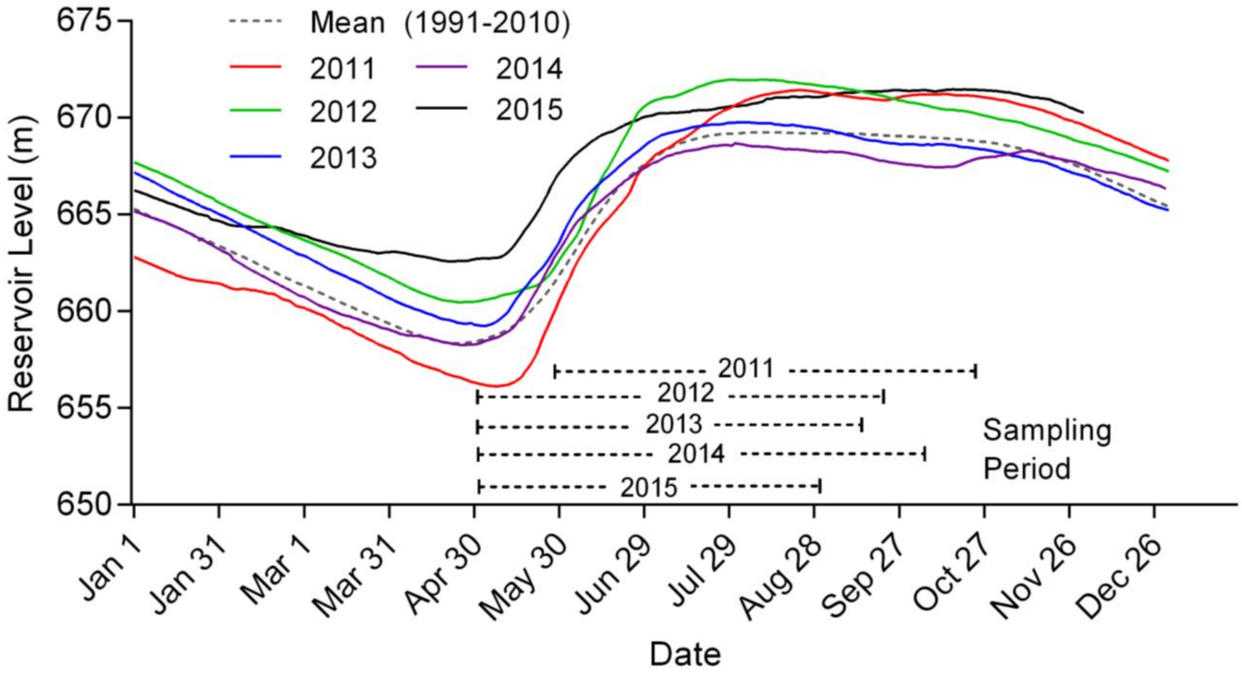

Figure 1. **Annual Williston Reservoir elevations for 2010 to 2015 (BC Hydro CRO database).**

Water levels observed in the lagoon in spring 2015 were at the design levels as a result of inundation by the reservoir in 2014 and natural inflows to the site. The new permanent water level in the lagoon is shown in Figure 3 along with the pre-construction water level. As in 2014, some variation in the lagoon water level was observed in 2015 as a result of changes in flow from upland areas. An estimated 0.2-0.3 m drop in water level was observed at the Airport Lagoon following the spring freshet in this low elevation watershed.

The Beaver Pond site (WDS 34) is located approximately 22 km northwest of Mackenzie at the end of a narrow inlet on Heather Point. There are two beaver ponds located at the head of the inlet with a small stream draining the ponds. The stream also appears to be partially supplied by an area of ground water seepage. The trial approach for this site was the installation of a berm to create a wetland of approximately 0.9 ha in area (Golder 2011). The proposed elevation for the berm was 669 m resulting in the wetland being directly connected to the reservoir during periods when it exceeds this elevation. Prior to construction, this area was dry (with the exception of the stream and an adjacent area of groundwater seepage) when water levels are below 666 m. The creation of an area with stable water levels is designed to allow for colonization by submergent and emergent vegetation, and enhance the riparian zone to benefit wading birds and amphibians (Golder 2011).

Construction of the Beaver Pond project was completed on May 24 – June 10, 2014. The berm was constructed in the planned location but did not reach the design elevation of 668.2 m due to challenges encountered during installation. The final elevation of the spillway was 667.25 m, reducing the area of the constructed wetland to approximately 0.3 ha. The new permanent water level in the lagoon is shown in Figure 4 along with the pre-construction water level. The extent of flooding is approximate and is based on the proposed berm, the as-built elevation, and observed post-construction water levels in the wetland. Elevation contours were generated from a digital elevation model (DEM) provided by BC Hydro. The shapefile of the proposed berm was provided by Golder Associates Ltd. (Golder 2011).

The post-construction water level in the Airport Lagoon was mapped using aerial imagery acquired by UAV on June 21, 2014 when the reservoir level was 666.6 m and below the new culvert outlet elevation of 666.8 m. The acquisition of high resolution aerial imagery by UAV for the Beaver Pond site is planned for spring 2016 to update the water level mapping at this site now that water levels have stabilised following construction. The acquisition of new UAV imagery for the Airport Lagoon site is also planned for spring 2016. New aerial imagery for the Williston Reservoir is also planned for 2018 under Peace Water Use Plan.

The uniqueness of both sites, along with the specific physical works proposed for each, means there are no associated control sites in this project.

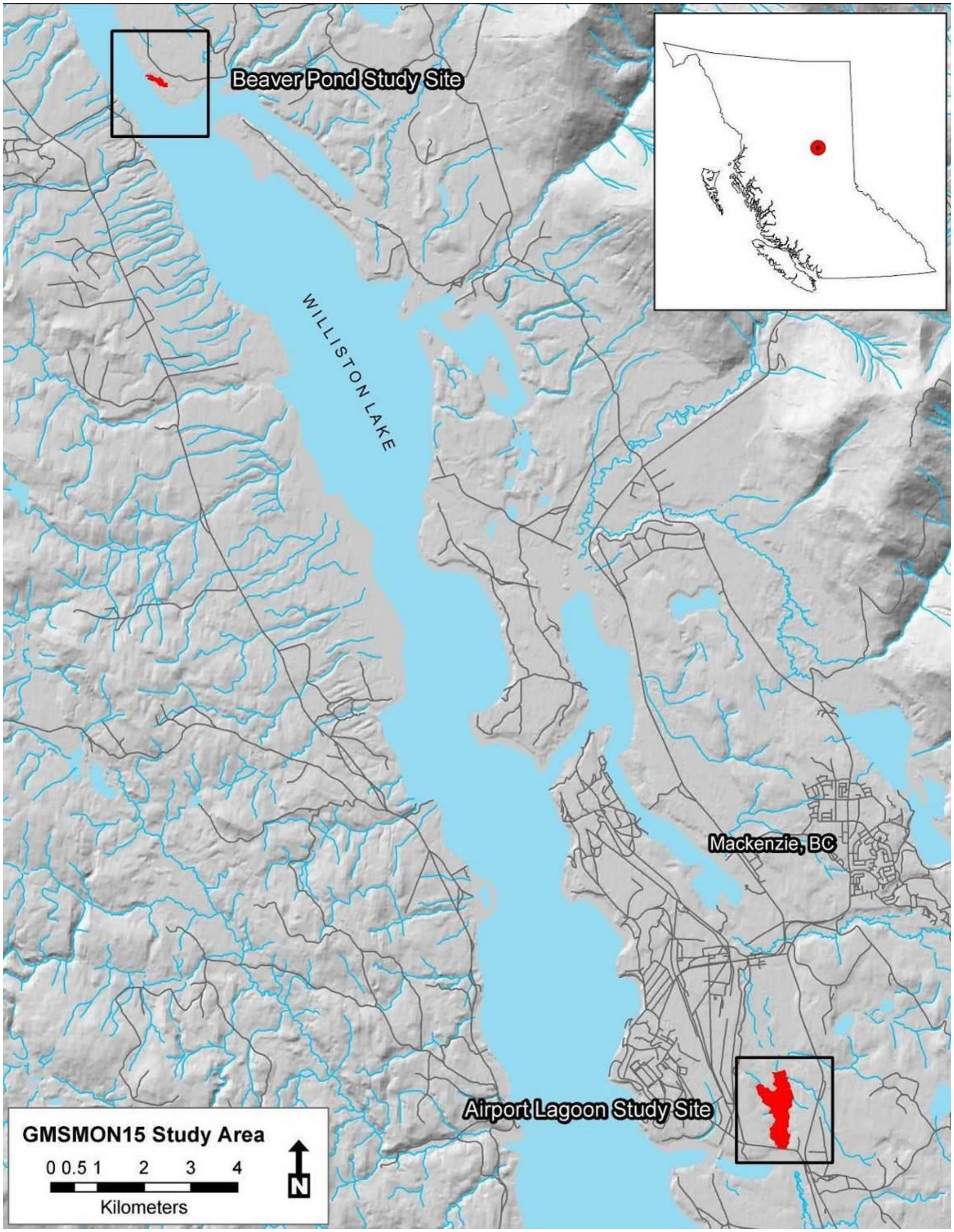

Figure 2. **Location of the two wetland demonstration sites on the Parsnip Reach of Williston Reservoir.**

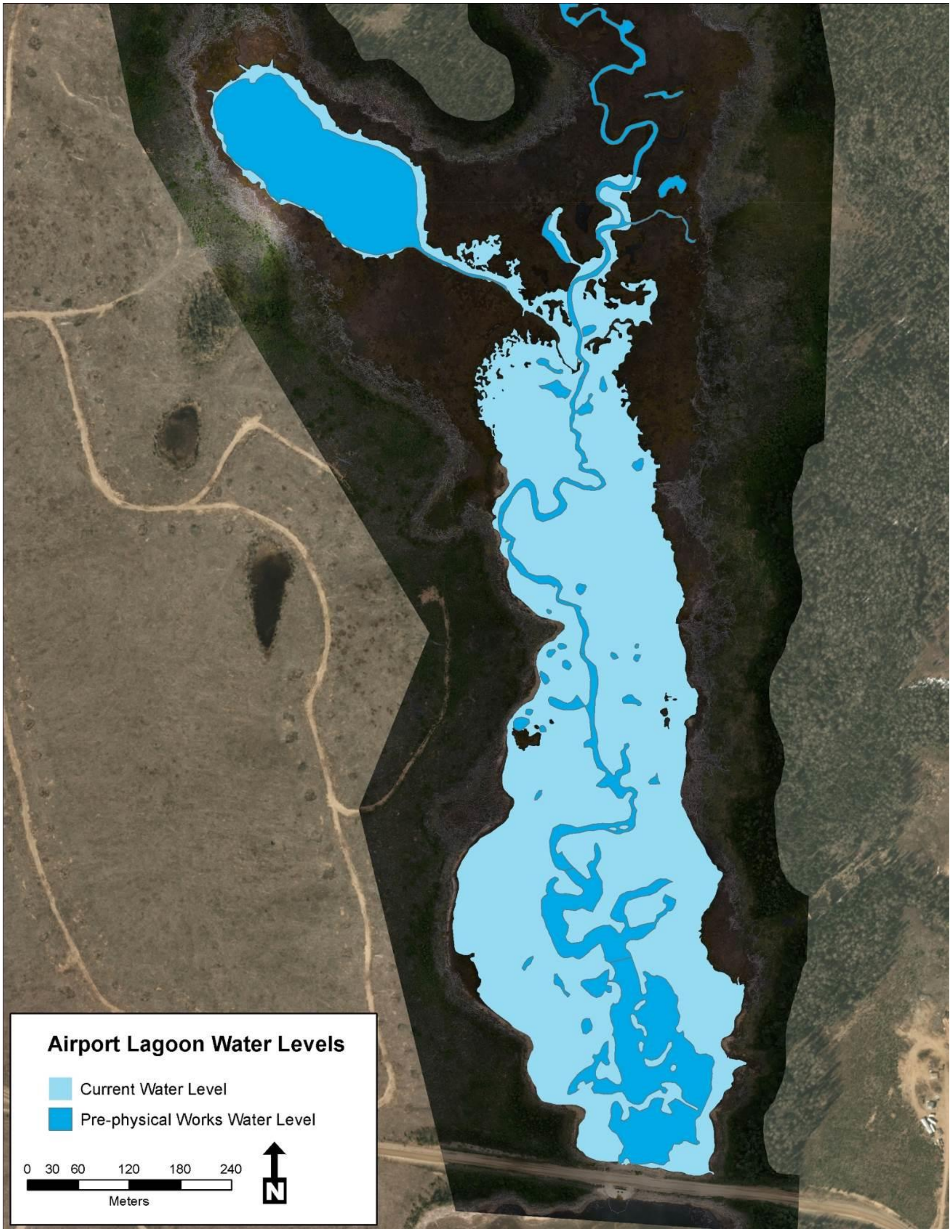

Figure 3. **The pre- and post-enhancement permanent water levels at the Airport Lagoon.**

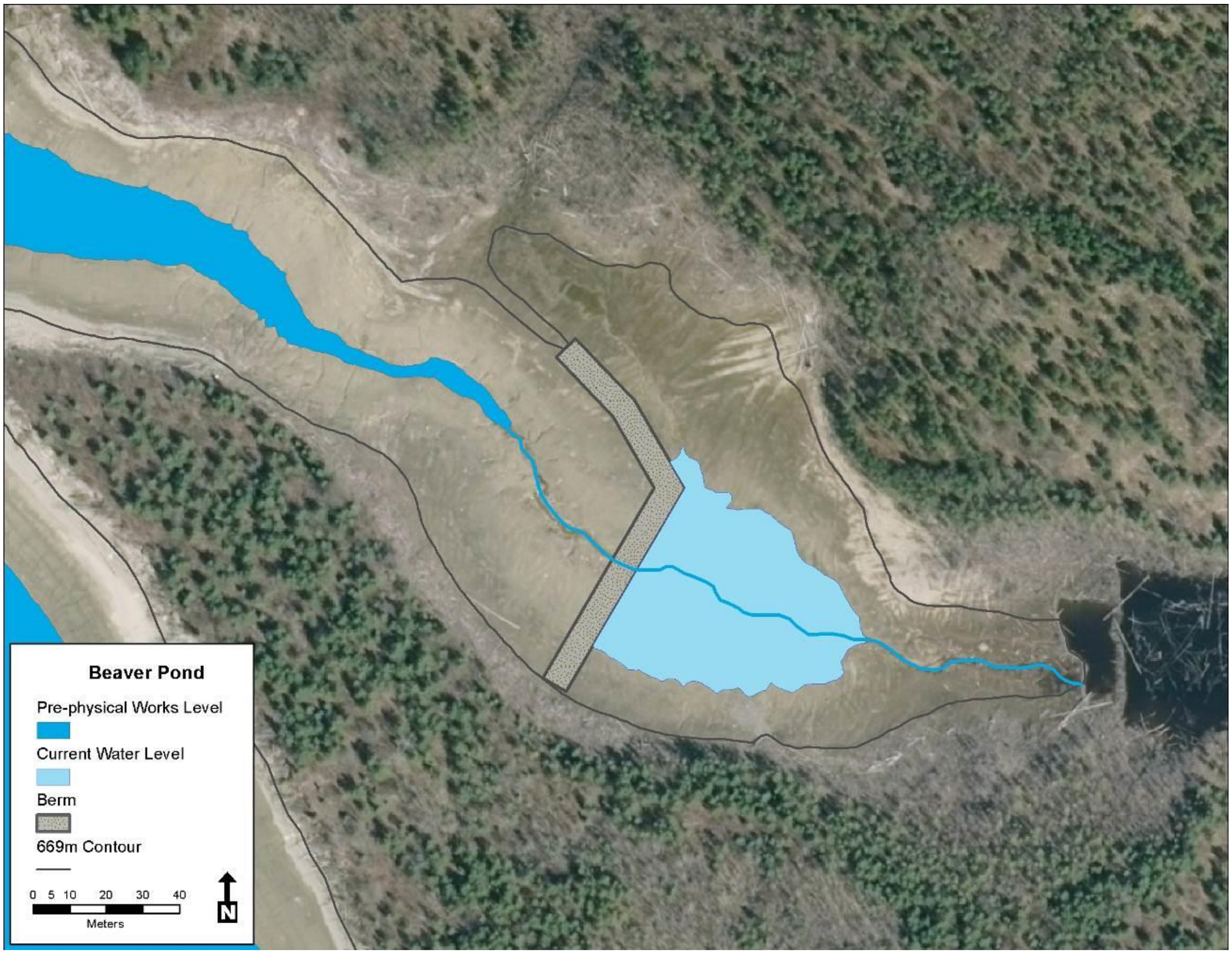

Figure 4. The pre- and post-enhancement permanent water levels at the Beaver Pond.

4 METHODS

The sampling methods used in Year 5 were consistent with those used in the previous years of the monitoring program. As in previous years, minor adjustments in the sampling program were required in Year 5 to account for changes in reservoir elevation and weather conditions. The sampling methods for each of the indicator groups are described below, along with any adjustments that were required due to reservoir elevation or weather conditions at the time of sampling.

4.1 Environmental Conditions

Environmental conditions specific to each survey type were recorded at the start of each survey and periodically during the surveys. Daily mean air temperature and precipitation data prior to and during the survey period were obtained from Environment Canada and observed at the Mackenzie Airport weather station (Station name: Mackenzie Airport Auto).

Accumulated degree days were also calculated using a base temperature of 5°C as an additional method to compare environmental conditions between years. The base temperature of 5°C was selected as an indicator of activity for breeding amphibians. A minimum night-time temperature of 5°C is used as an indicator for the timing of early season call surveys (e.g., USGS North American Amphibian Monitoring Program, Bird Studies Canada Marsh Monitoring Program).

4.2 Vegetation Surveys

A combination of air photo interpretation, ground sampling of terrestrial vegetation and surface sampling for aquatic plants was used to describe terrestrial and aquatic vegetation communities at the project sites (Parsons 2001, Province of British Columbia 2010, RISC 2010). The TEM standards (Province of British Columbia 2010) were used to complete ground sampling of terrestrial vegetation as the plant species assemblages and soil profiles identified within the project sites were not consistent with the wetland classes described by Mackenzie and Moran (2004). Mackenzie and Moran (2004) describe naturally recurring wetlands within British Columbia that are relatively stable in terms of their hydrologic cycle and plant species composition and have established over long periods of time. Due to variability of flood events in the drawdown zone from reservoir operations, the plant species assemblages identified in this project are in constant transition to a stable state. Aquatic plant sampling was initiated in 2014 (Year 4) and was used to describe aquatic plant communities at Airport Lagoon following the wetland enhancement. Protocols for surface inventories described by the Washington State Department of Ecology (Parsons 2001) were followed for the aquatic plant surface sampling effort.

All photo interpretation was completed in 2-D softcopy using ArcGIS (version 9.3, ESRI 2008). Digital ortho-rectified 1:5000 air photos (2011) of both sites provided by BC Hydro and a high resolution orthomosaic (5cm pixel resolution; 2014) of the Airport Lagoon provided by JR Canadian Mapping were used as the background layer for delineating polygons. Field notes on vegetation composition and structure from informal inspections of the study sites prior to the air photo interpretation also assisted with establishing and updating habitat classes.

A habitat classification scheme based on RISC (2010) was developed to capture all the habitat classes in the study area visible at the resolution available. Habitat classes were first determined from an overview of the study area to identify the larger vegetation features. As the study area was viewed at finer scales during photo interpretation more vegetation features were identified. As new vegetation features were encountered, additional habitat classes were created to accommodate them. Each habitat class was identified based on a common plant species assemblage and elevation within the drawdown zone. The spatial arrangement of habitat classes often followed a similar pattern. For example, at the Airport Lagoon, a band of coarse woody debris and grass/shrub cover parallel to the edge of the reservoir at full pool usually transitioned downslope into a band of sparsely vegetated sand followed by an area of sparsely vegetated mud adjacent to the water's edge.

The high resolution orthomosaic obtained for the Airport Lagoon in Year 4 allowed for the development of a coarse woody debris (CWD) density classification scheme. The objective for the classification scheme was to act as an additional aid for describing habitat, as well as for providing a benchmark for monitoring changes in distribution of CWD. The CWD density classes for the Airport Lagoon site were established by identifying and delineating areas of homogenous CWD cover. Areas representing a specific density class were delineated separately from the other classes, beginning with the highest density class and ending with the lowest. Once delineating polygons for a specific class was complete, all polygons for the class were reviewed to ensure that CWD densities were similar and representative.

The spatial extent of aquatic plant communities across the Airport Lagoon site was identified and delineated through the interpretation of the high resolution air photos collected in Year 4, the air photos collected in 2011 (Year 1), and information collected during the surface sampling for aquatic plants. Aquatic plant communities at the site were first defined based on a dominant plant species for each community. The spatial extent of each community was then estimated using known occurrences of the dominant species, relative water depth and the distribution of permanent water cover (i.e., ponds and perennial streams) prior to construction of the wetland enhancement.

Due to the relatively small area of both of the study sites, a map scale of 1:1000 was used as the initial resolution for polygon typing. Where required, a larger scale was used to differentiate similar or small area polygons. Overall, the scale varied roughly between 1:2000 and 1:200 throughout the interpretation process depending on the size of the habitat polygon.

Ground sampling of terrestrial vegetation was conducted to support the interpretation of habitat classes and provide a description (e.g., species composition) of plant communities at the sites. Ground sampling was completed along established vegetation transects each year at both sites in early to mid-June. The timing of ground sampling was selected to aid in the identification of plant species by attempting to observe species as close to the date of flowering as possible (as inflorescence is often required to identify a species), but prior to the sites being flooded by rising reservoir levels.

In Year 5 (2015), ground sampling was completed at nine of the previously established vegetation transects (seven transects at Airport Lagoon and two transects at Beaver Pond). Wetland enhancements completed in Year 3 at Airport Lagoon and at Beaver Pond in Year 4 resulted in the permanent flooding of seven of the existing vegetation transects (four transects at Airport Lagoon and two transects at Beaver Pond). Thus, ground sampling was completed at transects located above the new permanent flood level. Prior to the sampling effort, the list of species detected at the two study sites, along with the list of red and blue-listed plant species from the Conservation Data Centre (CDC; May 2015) was updated and reviewed.

Ground sampling was completed on June 4-6, 2015. Due to the well above average reservoir elevation for this time of year, some areas above the new permanent water level at the Airport Lagoon and Beaver Pond sites were already flooded. As a result, two existing transects (one at each site) were flooded and therefore not sampled.

As the habitats being surveyed were often linear in shape, a transect-based method for vegetation sampling was selected over a grid-based method (using design components from LGL (2007) and US EPA (2002a)). A 20 m long belt-line quadrat transect consisting of ten 2 m × 0.5 m rectangles was laid out (Figure 5) using a 30 m tape and 2 m measuring rod. UTM coordinates were recorded for the transect start and endpoints, and a spray-painted piece of re-bar was driven in the ground at both points. Photographs looking along each transect were taken at both the start and end points of each transect.

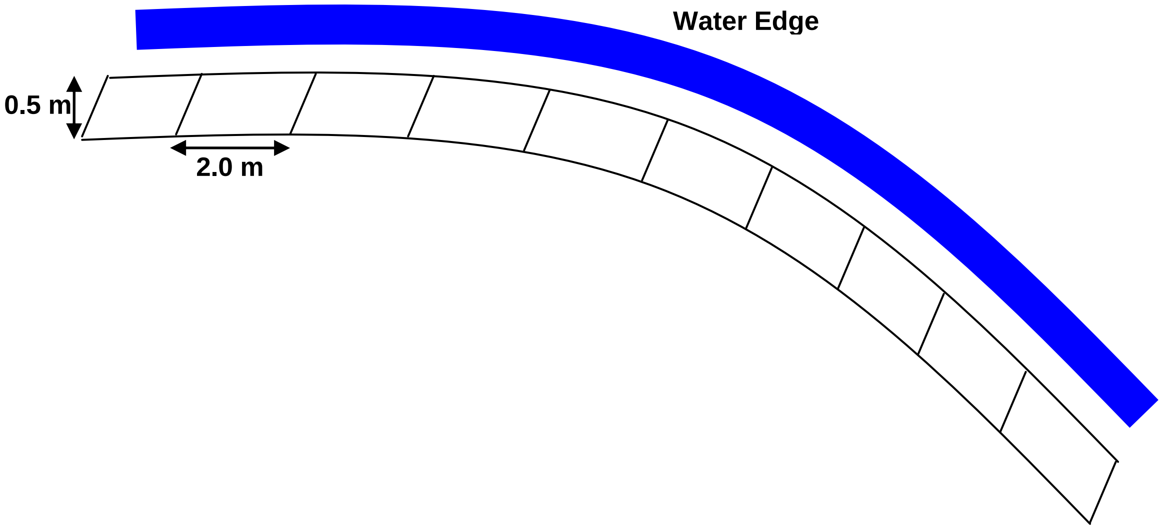

Figure 5. **Belt-line quadrat transect for a sample site laid out adjacent to the riparian area.**

Site and soil characteristics for the entire transect were recorded on provincial ecosystem field forms (Province of British Columbia 2010), including seral and structural stage characteristics (Appendix 2). Site characteristics representative of the whole site were recorded and a representative location was chosen for the soil pit. Within each quadrat, vegetation was identified to species and the percent cover of each species recorded. The terrestrial ecosystem keys (Province of British Columbia 2010) were used to describe soil characteristics and plant species were identified using MacKinnon et al. (1999). Where identification of species was not possible or uncertain, samples were taken and identified in the botany laboratory of the University of Northern British Columbia (UNBC) using the Illustrated Flora of British Columbia (Douglas et al. 1998) and Flora of the Pacific Northwest (Hitchcock and Cronquist 1973). Where species identification was still problematic or where correct identification was particularly important (i.e., a potential red-listed species), a plant taxonomy expert from UNBC was asked to confirm the initial result. Plants listed as rare or endangered at the provincial or federal level were recorded on a Rare Plant Observation Form and submitted to the BC Conservation Data Centre.

Beginning in Year 4, surface sampling for aquatic plants (Parsons 2001) was initiated at the Airport Lagoon site to monitor the development of aquatic plant communities associated with the new, stable water level. Prior to installation of the new culverts, aquatic vegetation was limited due to the annual drawdown of the site. The objective of the sampling was to identify the spatial extent and species composition of aquatic plant communities at the sites. This will allow for monitoring of changes in the abundance and distribution of aquatic vegetation over time now that the wetland enhancement has been completed. Surface sampling was completed in late-July. This timing was selected to aid in the identification of aquatic plant species by attempting to sample the sites during a period when a majority of aquatic plant species were expected to be flowering.

In Year 5, surface sampling for aquatic plants was completed at the Airport Lagoon site July 26 and 27. The Beaver Pond site was sampled on July 29. Surface sampling included visual observations of aquatic plant cover along the shoreline and shallow water areas (water depth <2m) as well as dredge sampling at various locations away from the shoreline where water depth limited visual observations of aquatic plant cover (>2m depth). Dredge sampling was also completed on the vegetation transects that were flooded as a result of the wetland enhancement to monitor the post-construction changes in species composition.

Dredge sampling for aquatic plants used a rake sampler constructed of two back to back garden rakes attached to a rope to collect plant samples from the bottom of the flooded area. At each location selected for dredging, the rake was dropped to the bottom and dragged for a distance of approximately 1 to 3 m to collect samples. This was repeated a total of three times at each dredge location to obtain information on species composition and relative abundance. The monitoring of the development of aquatic vegetation will assist in monitoring changes in aquatic habitat from the increase in the increase in permanently flooded area.

Where the identification of aquatic plant species was not possible or uncertain, samples were taken and identified in the botany laboratory at UNBC using the Illustrated Flora of British Columbia (Douglas et al. 2001a, 2001b) and Flora of the Pacific Northwest (Hitchcock and Cronquist 1973). Where species identification was still problematic or where correct identification was particularly important (i.e., a potential red-listed species), samples were sent to a taxonomic expert at the Royal BC Museum.

4.3 Waterfowl and Shorebird Surveys

Land-based surveys, following the protocols for absolute abundance inventories of waterfowl species (Resources Inventory Committee 1999a), were used to record waterfowl and shorebird occurrence at the study sites. The survey methods were the same as those used in the previous years of the monitoring program. Shorebirds have been included in the surveys since 2012 to provide additional detail on bird use of the sites. Surveys began in early spring to capture migrating waterfowl and continued through to late spring. The Year 5 waterfowl surveys were completed on May 1, 7, 19, and 31 at the Airport Lagoon site and on May 8 and 22, and June 1 and 5 at the Beaver Pond site. Surveys are planned to account for the fact that typically the timing of surveys at Beaver Pond is limited by access issues (ice on Williston Reservoir and unfavourable weather conditions). Surveys at both sites were completed at the previously established stations at each site (Figure 6 and Figure 7). Coordinates for the survey stations are provided in Appendix 3.

A combination of a modified RIC data form (1999a) and a map with an orthophoto background of each site was used to record waterfowl observations (Appendix 4). Survey conditions (temperature, wind direction, wind speed, precipitation, cloud cover, and ceiling height) were noted at the beginning and end of each survey, and unusual circumstances (if any) in the wetland area that may have affected survey results. Upon arrival at a station, the observer scanned the area with binoculars to obtain an overview of birds present and also note any bird or group of birds that may have taken flight upon arrival. Any birds that took flight on arrival at the station were recorded on the data form. Observers ensured that groups of birds were not double counted if they could be seen from more than one observation station. To avoid double counting birds, observers noted a suitable landmark to set the limit of the observations taken from that station. The location of such a boundary changed from survey to survey depending on water levels and the distribution of groups of waterfowl.

At each survey station, the respective survey area was slowly and systematically scanned at low magnification with binoculars. A spotting scope was used to identify birds or groups of birds that could not be identified with binoculars due to small size or distance from the observer. Observers drew a polygon with a unique ID number for every group of birds on field data maps created for this purpose (Appendix 4). Care was taken to draw the polygon as accurately as possible by matching up landmarks with their corresponding location on the orthophoto background. On the observation form, a new data line was recorded for all groups that could be defined by species and number of individuals, with associated information such as number of broods present, sex, behaviour, and habitat descriptors within each polygon. Species codes followed RIC (2008).

Figure 6. **Waterfowl survey station location at the Beaver Pond site.**

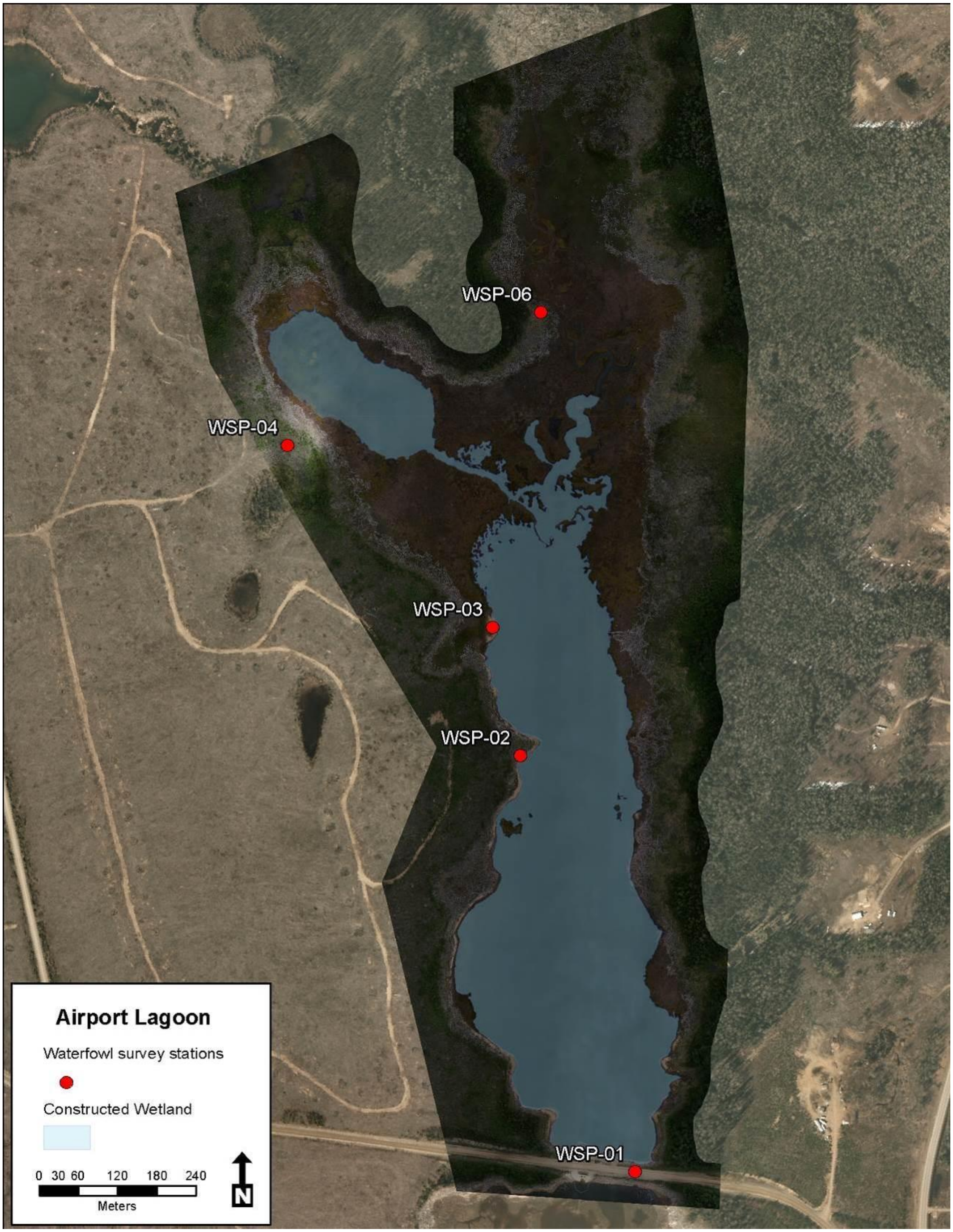

Figure 7. **Waterfowl survey station locations at the Airport Lagoon site.**

4.4 Songbird Surveys

Variable radius point counts and nest searches consistent with Bird Studies Canada and RIC methods (Resources Inventory Committee 1999b, Bird Studies Canada 2009) were used to record breeding bird occurrences at the study sites. Point count surveys were conducted from June 1-6, 2015 alternating between the Beaver Pond and Airport Lagoon sites. All surveys were completed during the breeding season (May 28-July 10) and within four hours of sunrise (Bird Studies Canada 2009). Based on previous experience conducting point count surveys in the cool, wet northern BC spring (Hentz and Cooper 2006, CBA 2008), surveys were conducted according to 'modified' RISC standards for environmental conditions (Resources Inventory Committee 1999b). These standards are as follows: wind speed ≤ Beaufort 3 (gentle breeze, leaves and twigs constantly move), precipitation = 'very' light rain, temperature > 3˚C. Species codes followed RIC (2008).

Previous studies also suggested that peak breeding season for songbirds in the area occurs in mid-June (Hentz and Cooper 2006, CBA 2008). Survey dates fell within this window and were consistent with the timing of pre-enhancement monitoring efforts. Three replicates were completed at each site to give a 'snapshot' of the breeding bird community (Resources Inventory Committee 1999b).

Consistent with survey effort in previous years, point counts were completed at the three established survey stations at the Beaver Pond site (Figure 8) and the 17 established survey stations at Airport Lagoon (Figure 9). Coordinates for the point count stations are provided in Appendix 5. Point count stations were distributed throughout the study sites to ensure maximum coverage. The centres of adjacent point count stations were located a minimum of 200 m apart to prevent overlap of the 100 m radius survey areas.

Survey stations were approached quietly to minimize disturbance. Upon arrival, observers waited silently at the point count station for one minute to allow any effects of disturbance on resident birds to dissipate before commencing the survey. Point counts were conducted for five minutes.

The data form was oriented to the north for each survey, and environmental variables (ceiling, cloud cover, wind, precipitation) (Appendix 7) and time of day were noted. All birds seen or heard during the survey were recorded. Each detection (can include more than one individual; e.g. a flock of 12 Pine Siskin could account for a single detection) within 100 m of the centre of the point count station was spatially mapped on a data sheet with concentric radii of 25, 50, 75 and 100 m (Appendix 6). Birds beyond 100 m were noted on the data sheets but not spatially located, as distance estimation at greater distances is problematic (Alldredge et al. 2007).

Detections were assigned to one of two time intervals (0-3 and 3-5 minutes) based on the time that they were initially noted. They were categorised as in the drawdown zone; in the shrub fringe at the upper edge of the drawdown zone; in forested habitat bordering the shrub fringe; as 'flying-over' and not associated with any vegetation type; or unknown.

Opportunistic nest searches were conducted daily, following the completion of point count surveys. Searches were focused on areas where breeding behaviour (e.g., carrying food or nest-building material) had been observed within the drawdown zone and adjacent areas (within 50 m of the drawdown zone). Data including UTM coordinates, type of nest, species using it, height above ground and coarse resolution of vegetation composition in the surrounding area were recorded for each nest.

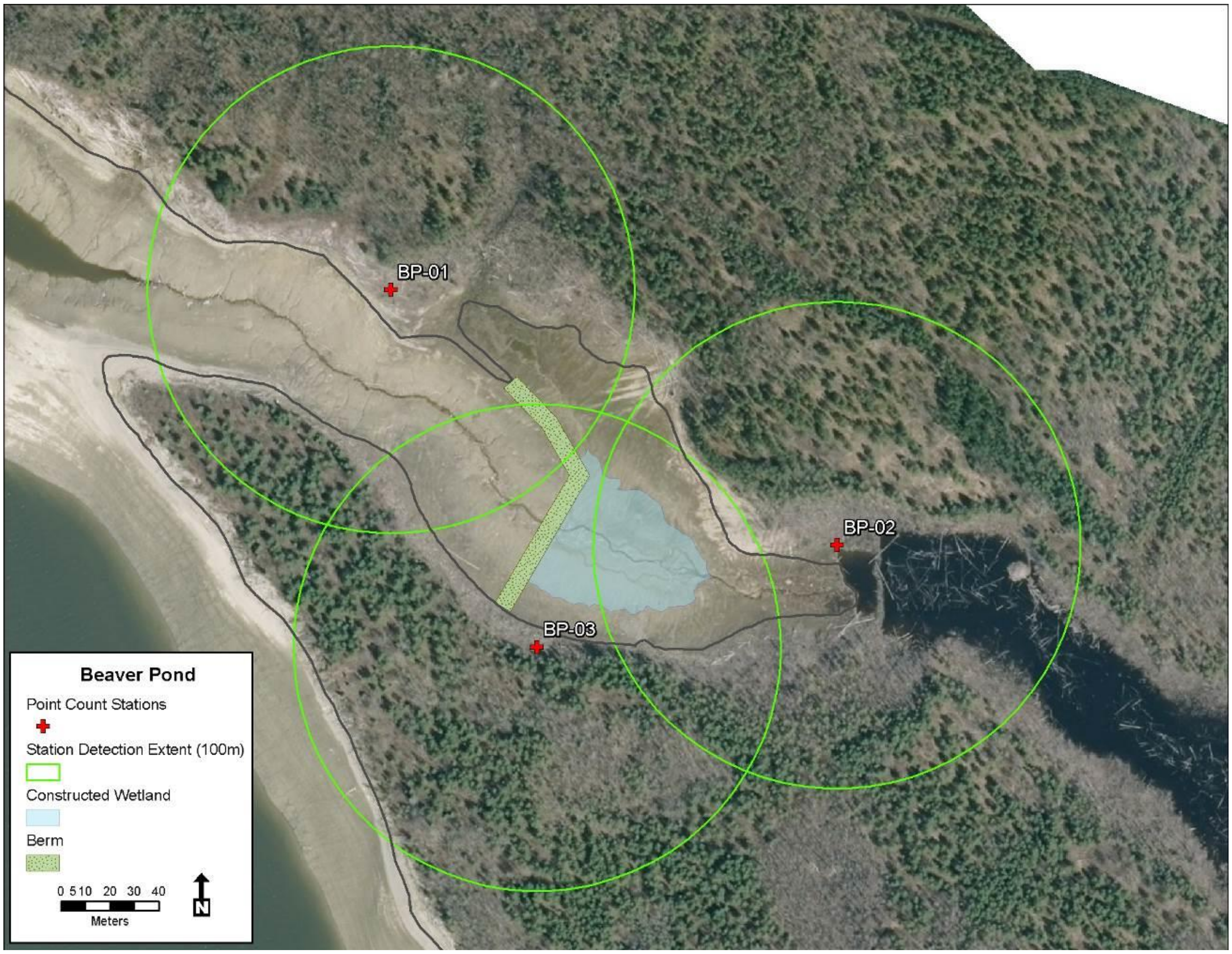

Figure 8. **Point count station locations at the Beaver Pond site.**

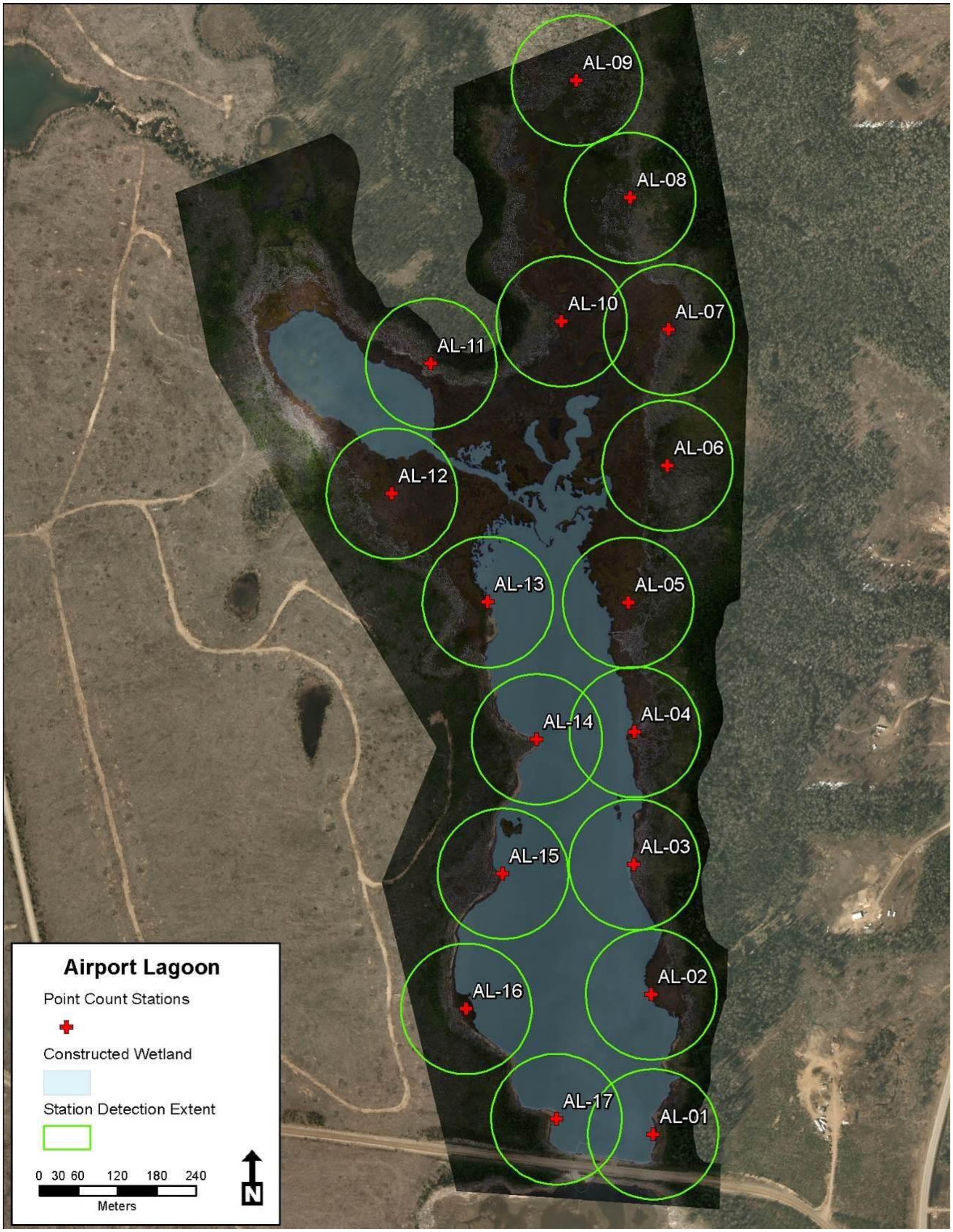

Figure 9. **Point count station locations at the Airport Lagoon site.**

4.5 Amphibian Surveys

Systematic surveys consistent with inventory methods for pond-breeding amphibians were used to determine the diversity and relative abundance of amphibian species at Airport Lagoon and Beaver Pond (RIC 1998). Due to a lack of obvious strata, both sites were treated as a single stratum (RIC 1998). Survey efforts included 4 replicates of 11 randomly distributed transects along the peripheries of the inundated area of Airport Lagoon and 3 replicates at Beaver Pond, where the entire site was considered as a single transect. Surveys were completed at the Airport Lagoon site on May 1, 7, 20 and 31. The four surveys at the Beaver Pond site were completed on May 8 and 22 and June 1 and 5.

Completion of the projects at both sites resulted in increased water levels that required the adjustment of eight of the original transects at Airport Lagoon and modifications to the Beaver Pond transect following construction of the berm. The potential for modification of some transects after project construction was anticipated during development of the monitoring program. The changes to the transects at the Airport Lagoon and Beaver Pond sites are illustrated in Figure 10 and Figure 11, respectively.

Prior to field surveys, a list of amphibian species likely to be encountered at each site was compiled based on the findings of Hengeveld (2000) along with the results from the first four years of this project (CBA 2012, 2013, 2014, 2015). A photograph was taken from the start point of each transect, oriented towards the end point. To allow for replication and calculation of detections per unit area, a hand-held Garmin 76CSx GPS unit was used to record the start and end points along with the survey tracks for all transects.

The search area included shallow water (<1m deep), the shorelines and areas within 3 m of the shoreline of the reservoir, ponds, streams and riparian areas. A zig-zag search pattern applied above the waterline along with a linear search of shorelines ensured complete coverage of the area. A standardized dip-net sweep at regular intervals was used in the shallow water zone. On the shore, observers checked for the presence of amphibians underneath pieces of woody debris and other potential cover objects before returning all materials to their original position. Individuals were only captured on rare occasions when identification was not possible during the initial sighting and all amphibians were released immediately upon identification. Matsuda et al. (2006) and an unpublished tadpole key from the Ministry of Environment in Fort St John were used to confirm species identification. Species codes followed RIC (2008).

Data was recorded on RISC animal observation forms for amphibians (Appendix 8). Survey conditions including precipitation, ambient temperature, wind speed, cloud cover, ceiling height, water temperature and condition (if applicable) were noted at the beginning and end of each transect. Species, developmental stage, behaviour and habitat variables were recorded for each adult, larvae and egg mass observed. Where it was not possible to exactly count large numbers of tadpoles (>100), they were simply recorded as 'tadpoles'.

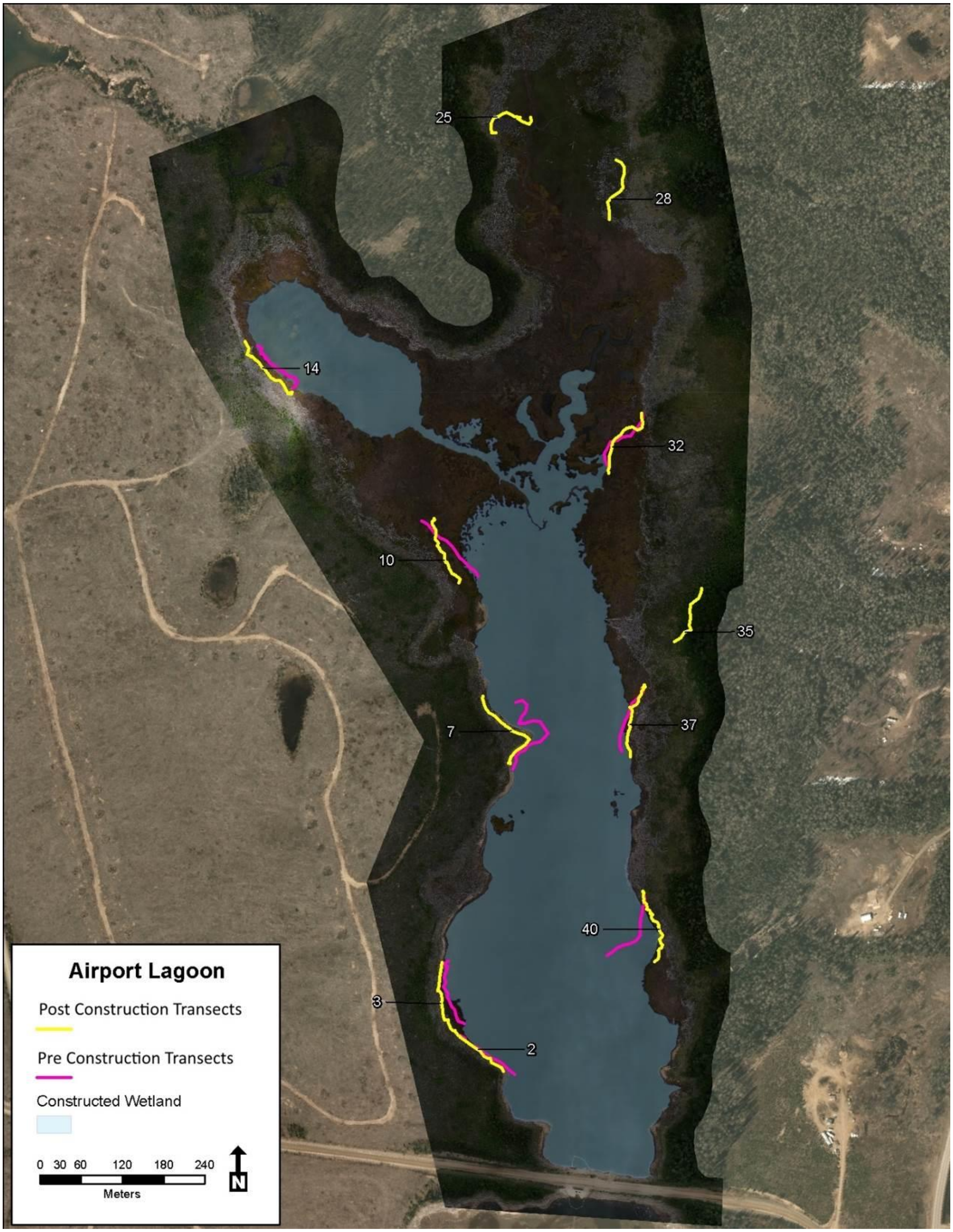

Figure 10. Amphibian survey transect locations at the Airport Lagoon site.

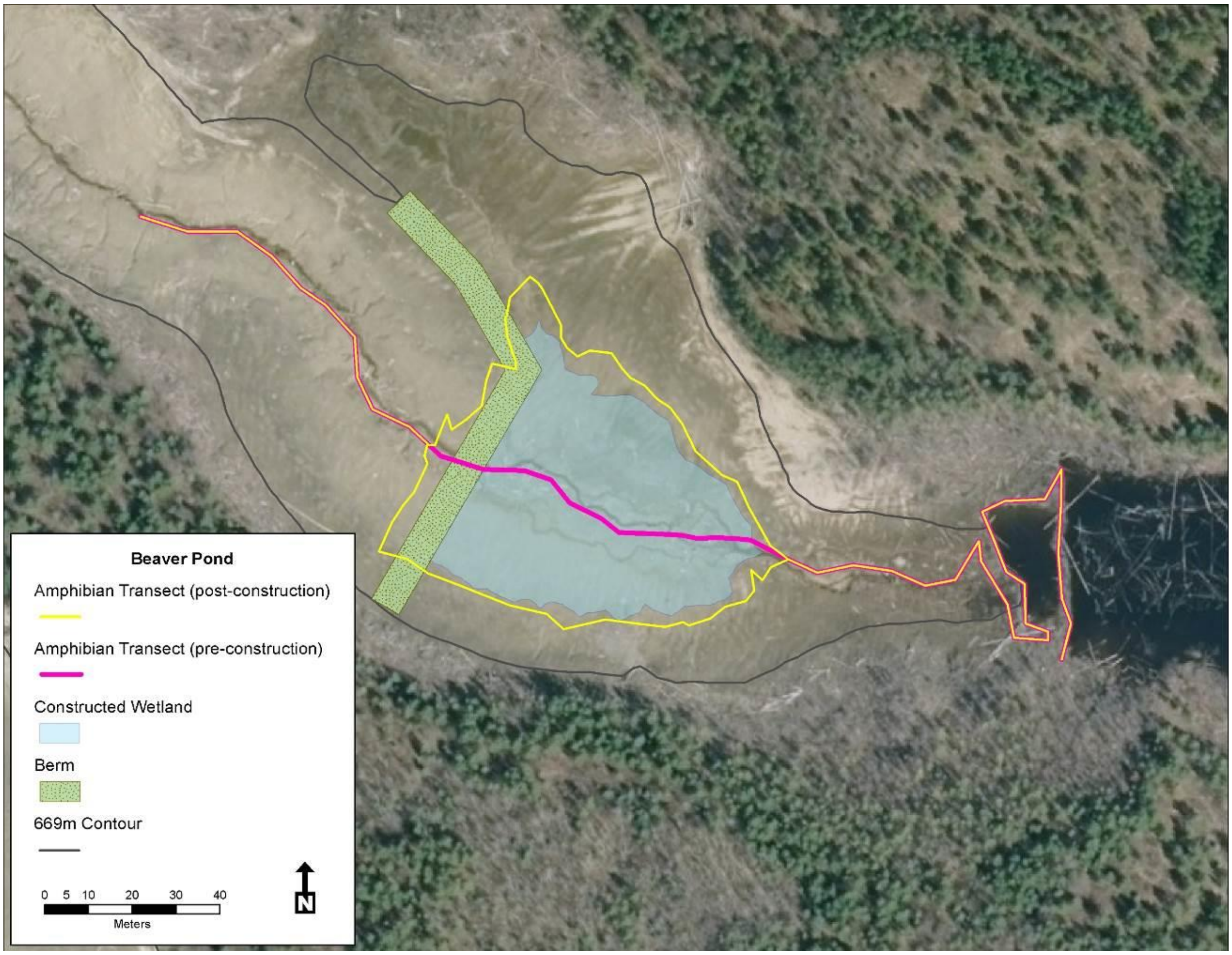

Figure 11. Amphibian survey tracks locations at the Beaver Pond site.

4.6 Fish Surveys

Fish populations were sampled at both sites using a combination of methods following RIC (2001) guidelines. Fish sampling was conducted under Scientific Fish Collection Permit PG15-169561 issued by the Ministry of Forests, Lands and Natural Resource Operations. A combination of methods was used to ensure sampling of both large and small fish at each site and the different habitats available at low and high reservoir levels. In Year 5, fish sampling at the Beaver Pond site was completed using electrofishing and at the Airport Lagoon site using minnow traps, backpack electrofishing, and fyke nets.

Fish sampling was completed at the Airport Lagoon site on May 19-21 and July 26-27, 2015 and at the Beaver Pond site on May 22, 2015. No July fish sampling was completed at the Beaver Pond site as high winds during the planned sampling period prevented access to the site for setting the nets and minnow traps. The sampling locations are shown in Figure 12 and Figure 13 for the Airport Lagoon and Beaver Pond sites, respectively. The methods used on each date are summarized in Table 1. As the upper pond in the northwest arm of the lagoon is not accessible by boat at early season water levels fish sampling was completed with minnow traps as this location. The May fish sampling at the Beaver Pond site was completed prior to this area being inundated.

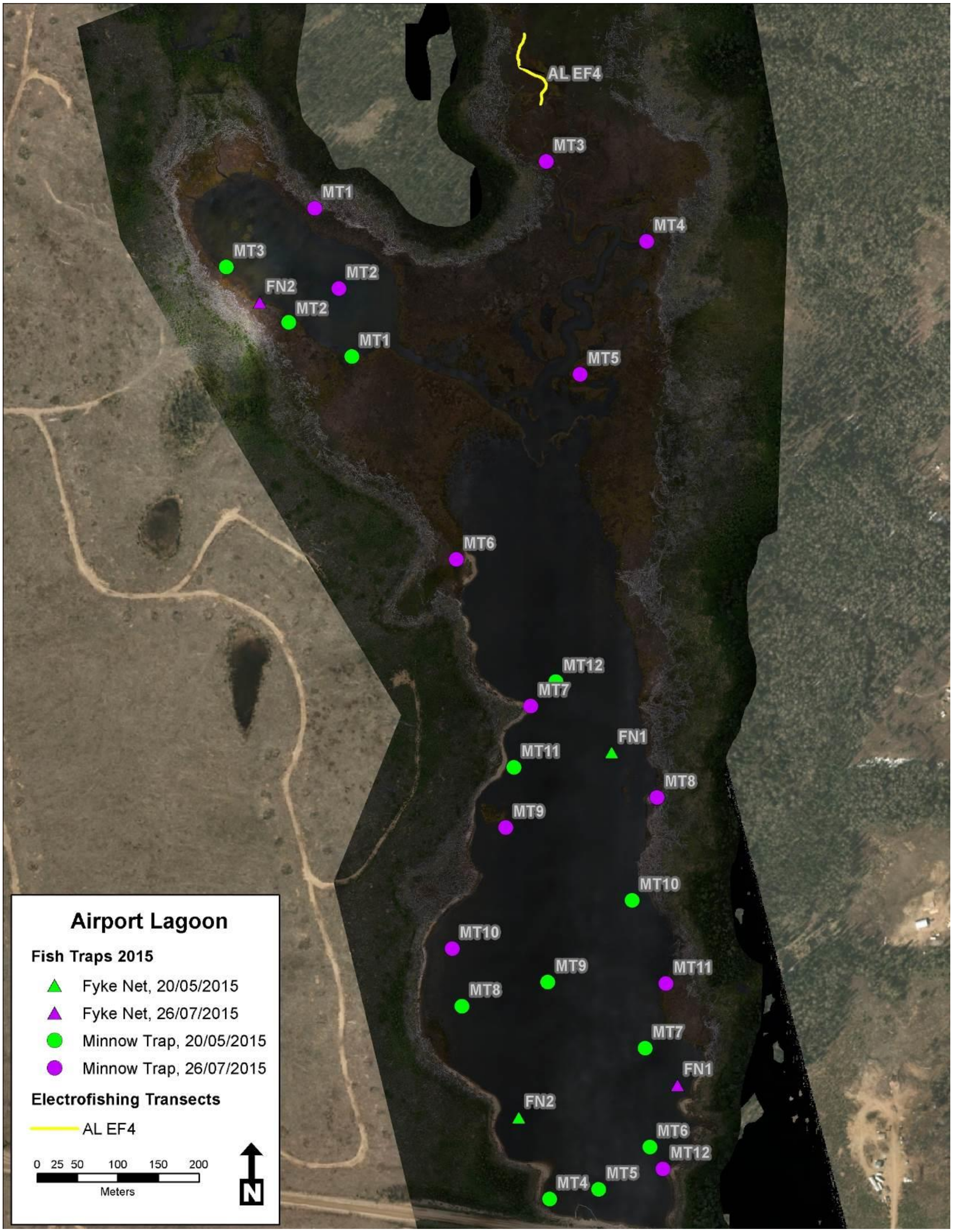

Figure 12. **Fish sampling locations by date and method at the Airport Lagoon site.**

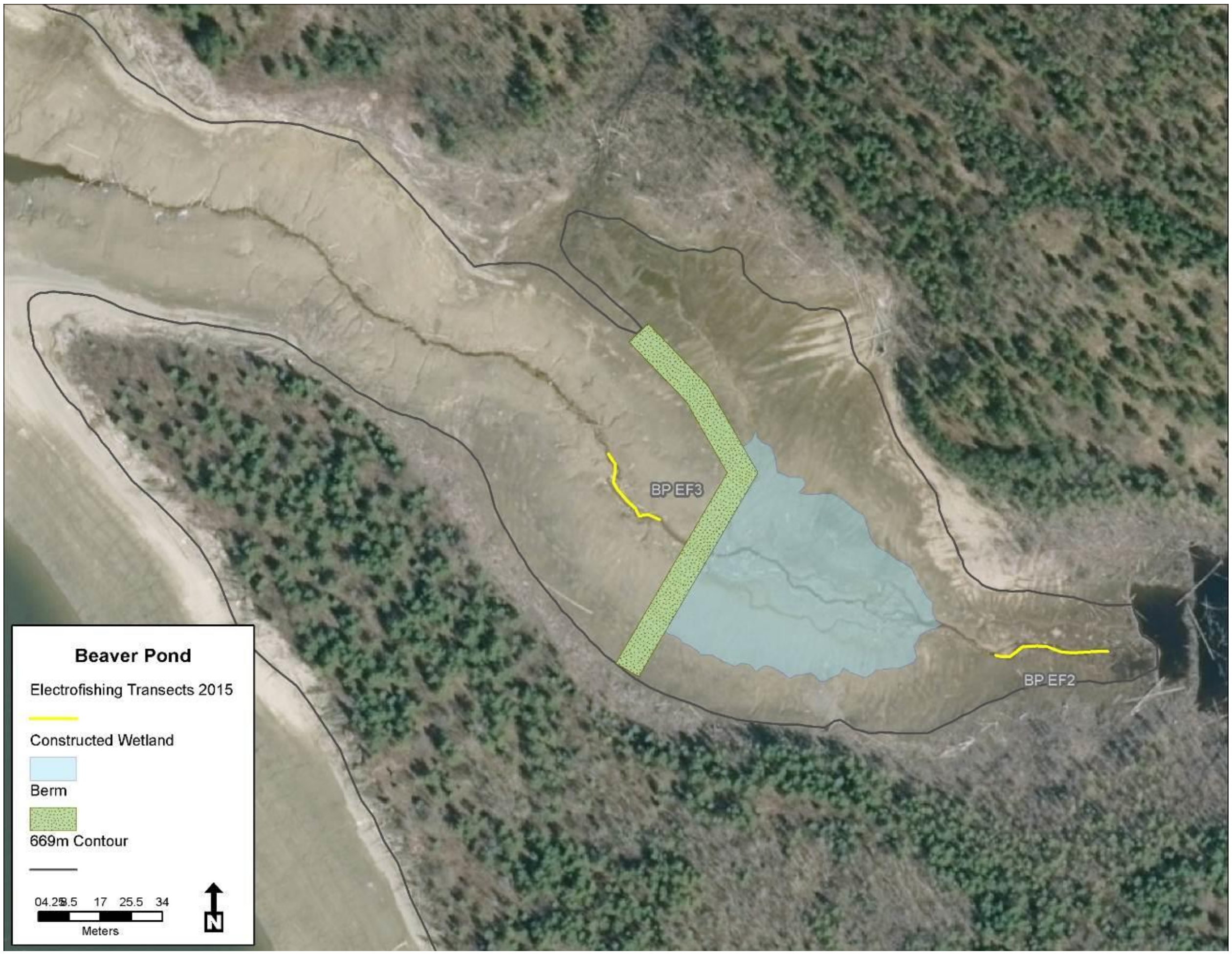

Figure 13. Fish sampling locations by date and method at the Beaver Pond site.

Table 1. Fish sampling methods in 2015 at the Airport Lagoon and Beaver Pond sites.

Site	Date	Method	Number of Samples
Airport Lagoon	May 19	Electrofishing	1 reach
	May 20 -21	Minnow trap Fyke net	12 traps 2 nets
	July 26-27	Minnow trap	12 traps
		Fyke net	2 nets
Beaver Pond	May 22	Electrofishing	2 reaches

In 2015, two minnow trap sampling sessions were completed at the Airport Lagoon only. No minnow trapping was completed at the Beaver Pond in 2015. At the Airport Lagoon the first sampling session was completed prior to inundation and the second session was completed after inundation. Minnow traps were baited with cat food and set for a minimum of 12 hours at random locations at each site. Twelve minnow traps were used for each sampling session at the Airport Lagoon. During the first sampling session, three minnow traps set in random locations around the pond in the northwest arm of the lagoon and the other nine minnow traps were set at random locations in the new pond created by the higher elevation culverts. During the second session (after inundation) the 12 minnow traps were deployed at random locations throughout the lagoon.

Backpack electrofishing (Smith-Root LR-20B) was used to sample the stream habitat that is present at both sites prior to inundation by the reservoir. A single reach was sampled at the Airport Lagoon site (Figure 12). This is the only one of the four previously sampled stream reaches at this site not affected by the new water level. Electrofishing at the Beaver Pond site occurred in the portions of the two stream reaches sampled in previous years that were not flooded by the new wetland (Figure 13).

Fyke net construction was based on the design in Bonar et al. (2000). Two nets were used at the Airport Lagoon during the May and July sampling. No sampling by fyke net was completed at the Beaver Pond site in 2015. Fyke nets were randomly deployed at each site with the lead anchored to the shore and the net set perpendicular to the shoreline. All sets were overnight for a minimum of 12 hours.

All collected fish were held in live wells after capture and processed as soon as the electrofishing pass, or net/trap haul was complete. Captured fish were anaesthetized using CO_2 to ease handling and reduce the potential for handling injury. Captured fish were identified to species, enumerated, and the fork length recorded to the nearest millimetre. All anaesthetized fish were allowed to fully recover prior to release.

Due to high catch rates from minnow traps and the fyke nets at the Airport Lagoon, subsampling was employed for the most abundant species to minimize holding and processing time. Subsampling was limited to fish less than 100 mm fork length (FL) and the most common species. Two different subsampling methods were used during 2015 based on the number of fish captured. For all minnow traps and most of the fyke nets, a sample of approximately 50 individuals of the most common species (e.g., Lake Chub, Brassy Minnow, Redside Shiner, and juvenile suckers) were measured and the remaining fish of the subsampled species were only counted. The extremely high catch of small fish in one of the May fyke nets at the Airport Lagoon was subsampled by volume. The number of fish were counted from one dipnet and the total number of dip nets of small fish in the catch was recorded. Separate subsamples were obtained for each gear type (minnow trap and fyke net) due to differences in selectivity between the methods (CBA 2014).

Environmental data were also collected during field visits to record the sampling conditions during each site visit. Additional data included water temperature, water depth, water clarity (relative turbidity or Secchi depth), pH, dissolved oxygen (DO), and conductivity. Water temperature, pH, DO and conductivity were recorded at the surface using a calibrated YSI 556 multi-parameter meter (YSI Inc., Ohio). Relative turbidity was recorded for each electrofishing reach according to RIC (2001) standards. Secchi depth (20 cm diameter disk) was used as a measure of turbidity for the inundated areas. The fish data collected were standardized to catch-per-unit-effort (CPUE) for each gear type (electrofishing = fish/minute, minnow traps and fyke nets = fish/hour) to allow for future interannual comparison of fish diversity and relative abundance to identify changes related to the wetland treatments.

4.7 Data Entry and Analysis

Immediately after a field survey was completed, data sheets were scanned into .pdf documents and stored in a redundant file storage system. Similarly, photographs taken during field surveys were labelled and filed by survey type. All data were entered into a customized database designed to minimize data entry errors by restricting the permissible range of values for a field or by using selections from drop-down lists.

Data were exported from the database to MS Excel to provide data summaries for each component of the monitoring project. Data from each vegetation transect were summarized to provide an overview of the vegetation community at each site. The vegetation % cover data from each of the ten quadrats in a belt-transect were pooled to provide an average % cover for each species. Waterfowl and amphibian survey results were summarized by survey date and site. As the intent of the breeding bird survey was to provide a snapshot of the breeding bird community at a site, data from all three replicates were pooled to provide summaries on species richness and relative abundance.

The collection of baseline data for the two sites is now complete with the construction of the Airport Lagoon project in May 2013 and the Beaver Pond project in 2014. Year 5 was the second full year of post-construction data from the Airport Lagoon and the first full year of post-construction data from the Beaver Pond site. Initial comparisons of the post-construction results to the baseline are provided for both sites. More detailed analyses are planned once additional years of post-construction data become available.

5 RESULTS

5.1 Environmental Conditions

In Year 5 (2015), temperatures in late April were close to or above average with a period of cooler than average temperatures occurring at just prior to and during the start of the 2015 surveys (Figure 14). Temperatures throughout the rest of the sampling period were generally warmer than average and less variation than observed in previous years (Figure 14). Cumulative precipitation in Year 5 was just below average for April and well below average for May and the first half of June (Figure 15). Precipitation in Year 5 was average in comparison to the previous years of the sampling program. The only exception to this was for May with it being the driest observed during the five years of the project until a single rainfall event during the last two days of May (Figure 15).

Based on degree days, Year 5 was similar to previous years at the start of the 2015 survey period and was higher than all previous years of the study from May 10 onwards (Figure 16). Unlike previous years, temperatures were not consistently above 5°C until May 6 which is later than the previous years of the project (Year 1: May 3, Year 2: April 25, Year 3: April 23, and Year 4: April 25). However, degree days began accumulating earlier in Year 5 than in the previous four years (Figure 16).

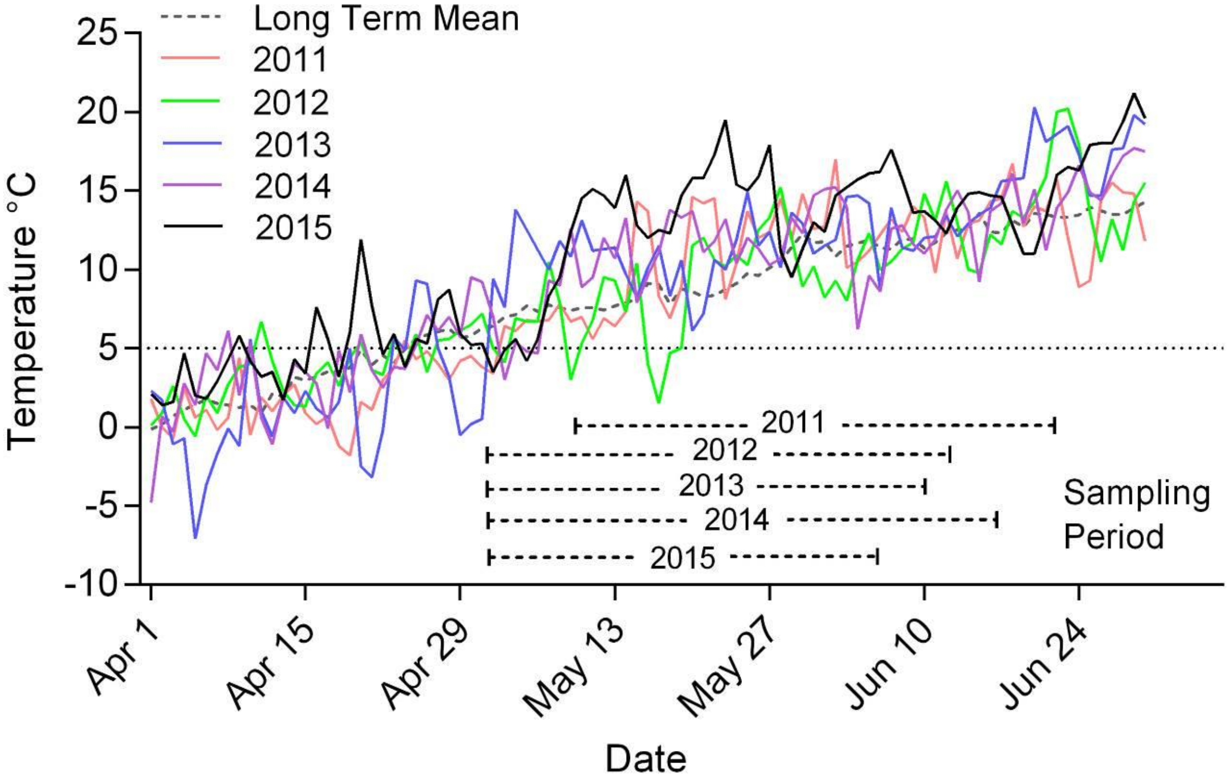

Figure 14. **Daily mean air temperature and the long term mean in the study region. Data from Environment Canada and observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).**

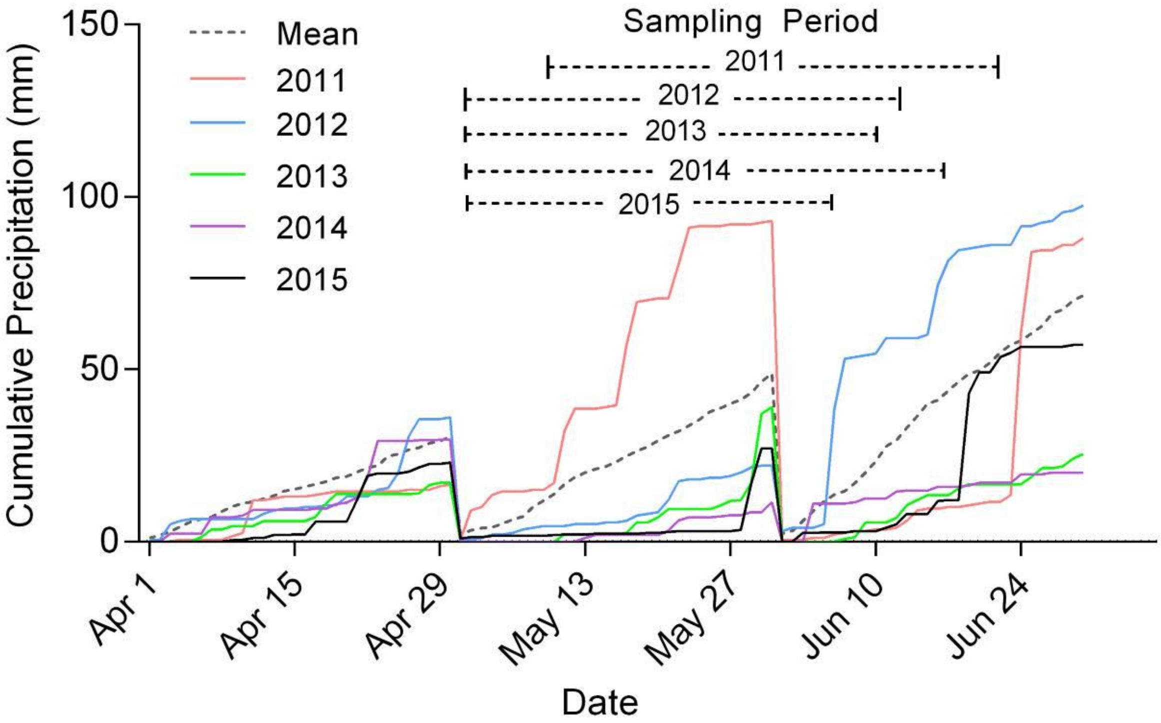

Figure 15. **Cumulative monthly total precipitation and the long term means in the study region. Data from Environment Canada and observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).**

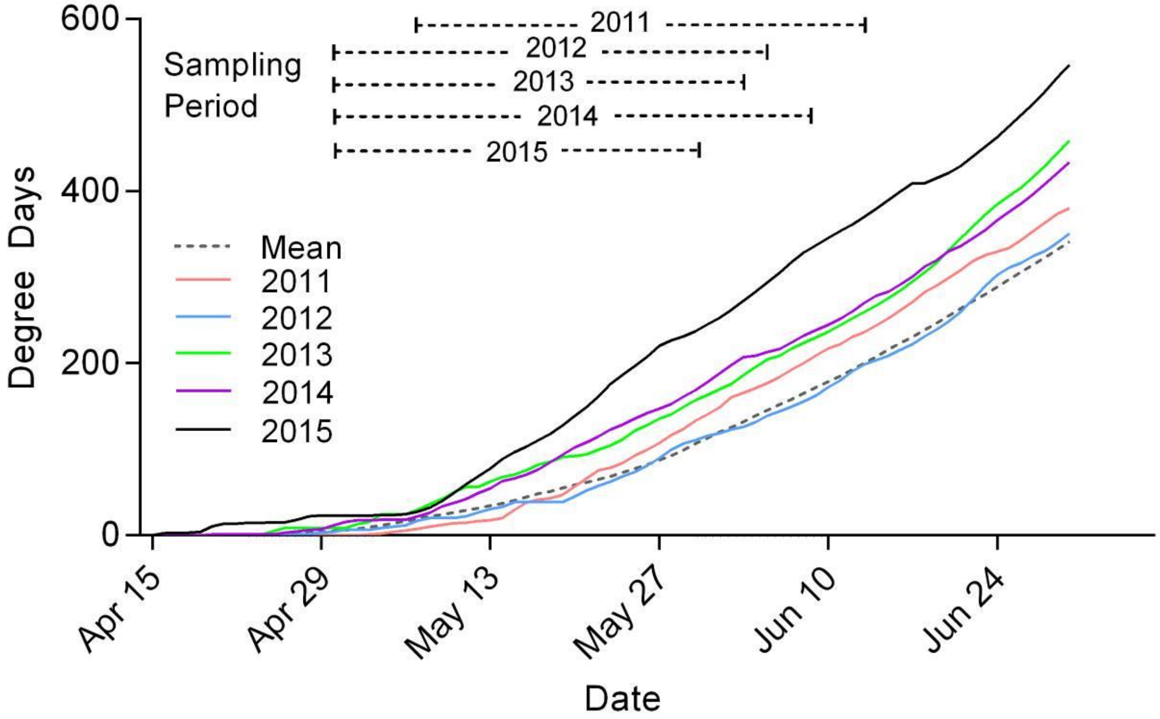

Figure 16. **Accumulated degree days (5°C base temperature) in the study region. Calculated from Environment Canada daily maximum and minimum temperatures observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).**

5.2 Vegetation Surveys

5.2.1 Drawdown Zone Vegetation

A total of 19 habitat classes describing vegetation communities at the Airport Lagoon and Beaver Pond sites were identified and mapped in Year 1 of the study (CBA 2012). A total of 13 habitat classes were identified at the Airport Lagoon site and eight habitat classes were identified at the Beaver Pond site. The plant species assemblages identified within habitat classes consisted mostly of herbaceous perennials (grasses and herbs) and bryophytes with minimal woody shrubs and no live tree cover (with the exception of occasional paper birch [*Betula papyrifera*] and trembling aspen [*Populus tremuloides*] seedlings). A few classes had a high percentage (≥50%) of coarse woody debris from driftwood accumulation. The habitat classifications and their spatial distribution were reassessed in Years 2, 3, and 4 and the classifications and mapping refined as additional information was collected. As result, the original 19 classes were reduced to 16 in Year 4 (CBA 2015). Some of the habitat class names were also revised to more accurately reflect the expected annual vegetation cover and location.

In Year 5, the habitat class descriptions and their spatial distribution were again reviewed. No substantial changes in the distribution and abundance of habitat classes were observed, resulting in the total number of classes remaining at 16. It is worth noting that minor changes in the location and number of floating islands was observed at Airport Lagoon. During aquatic plant surveys in July, it appeared that some of the smaller floating islands had drifted to new locations and it is possible that a few new small islands had formed. However, delineating the exact number and location of these smaller islands was not possible as high resolution aerial photos of the site were not collected in Year 5.

A summary of the habitat classification schemes for Year 5 is provided in Table 2 and detailed descriptions of each class are provided in Appendix 9.

In Year 5, a total of 12 habitat classes were identified and mapped at the Airport Lagoon, while at the Beaver Pond site six habitat classes were identified and mapped. Habitat class SW and SP were common to both sites, resulting in a total of 16 different habitat classes across both sites (Figure 17 and Figure 18, Table 2). A total of 140 polygons were identified and mapped across the two study sites covering 65.21 ha at the Airport Lagoon site and 4.39 ha at the Beaver Pond site (Table 3).

The number of polygons for each habitat class ranged from one (classes SG, WD, WH, WW, SP and SR) to 49 (class SP) (Table 3). The percentage of total area covered by habitat classes ranged from 0.13% (class FI) to 40.03% (class SP) at the Airport Lagoon and 0.92% (class SP) to 38.79% (class SP) at the Beaver Pond site (Table 3).

The most abundant habitat classes at the Airport Lagoon by number of polygons were SP (49 polygons), and BM (33 polygons). All other classes had eight or fewer polygons. By area, habitat classes SP and BM accounted for the largest area, covering 67.60% of the total area at the Airport Lagoon site. The next largest habitat class by area was class SD, accounting for 12.39% of the total area at this site. All other classes at this site had a cover of <8% (Table 3).

At the Beaver Pond site, the most abundant habitat class by number of polygons was SE (6 polygons); by area, habitat class SE accounted for 0.92% of the total area of the site. The largest habitat classes were SC, BC and SW, which accounted for 38.79%, 31.86% and 22.98%.of the total area respectively. The remaining three habitat classes each represented less than 4% of the total area (Table 3).

Table 2. **Habitat classification summary for the Airport Lagoon and Beaver Pond sites in Year 5.**

Site	Year 5		Site	Year 5	
	Habitat Class	Habitat Class Description		Habitat Class	Habitat Class Description
Airport Lagoon	BM	Basin Moss	Beaver Pond	BC	Basin Cryptantha
	BS	Basin Smartweed		SC	Shoreline Clay
	FI	Floating Island		SP	Stream Sedge
	SD	Shoreline Driftwood		SR	Shoreline Gravel
	SG	Shoreline Grassland		SP	Streams and Ponds
	SP	Streams and Ponds		SW	Shoreline Driftwood
	SS	Shoreline Sand			
	SW	Shoreline Willow			
	WD	Wetland Dead Trees			
	WH	Wetland Horsetail			
	WS	Wetland Sedge			
	WW	Wetland Willow			

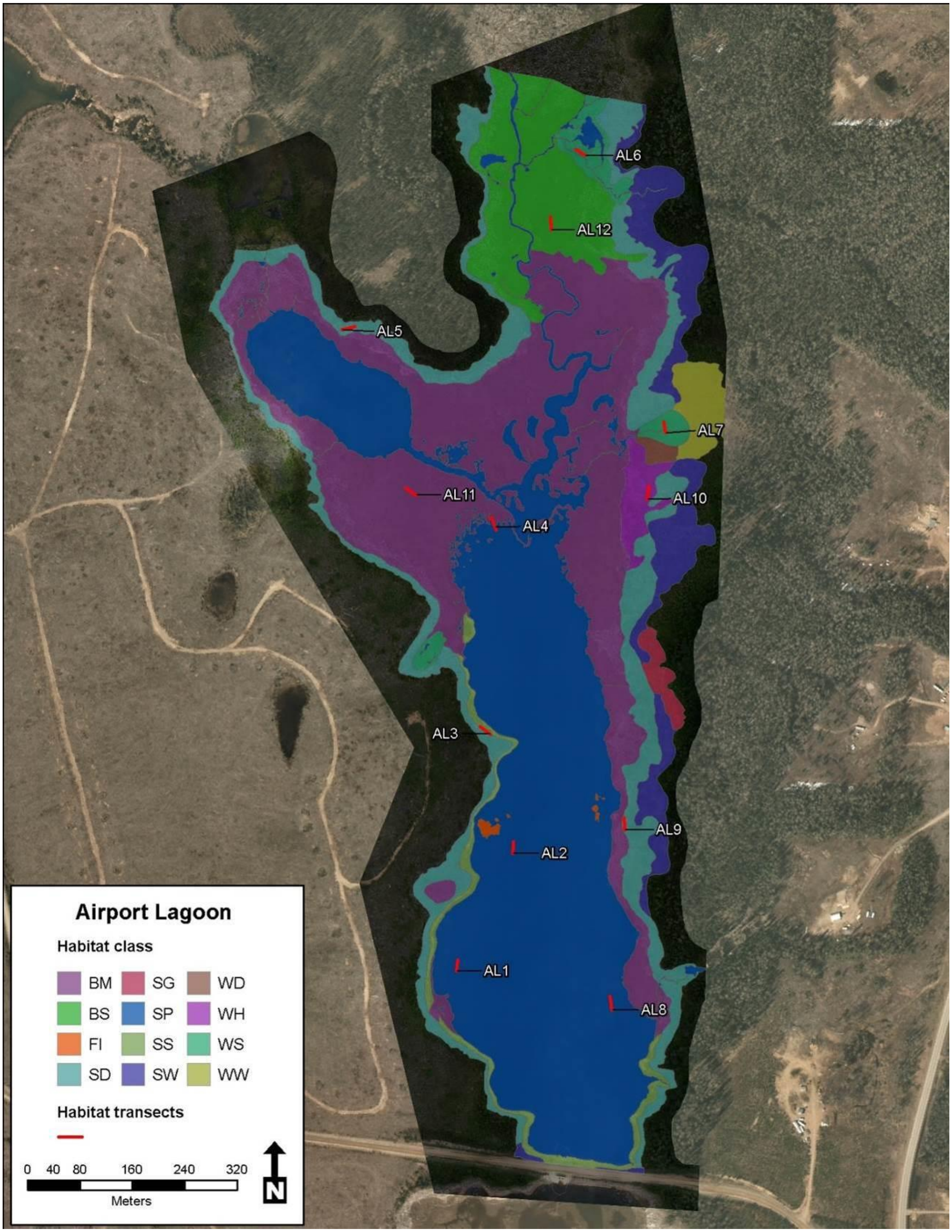

Figure 17. Post-construction habitat classes and transect locations in the Airport Lagoon site.

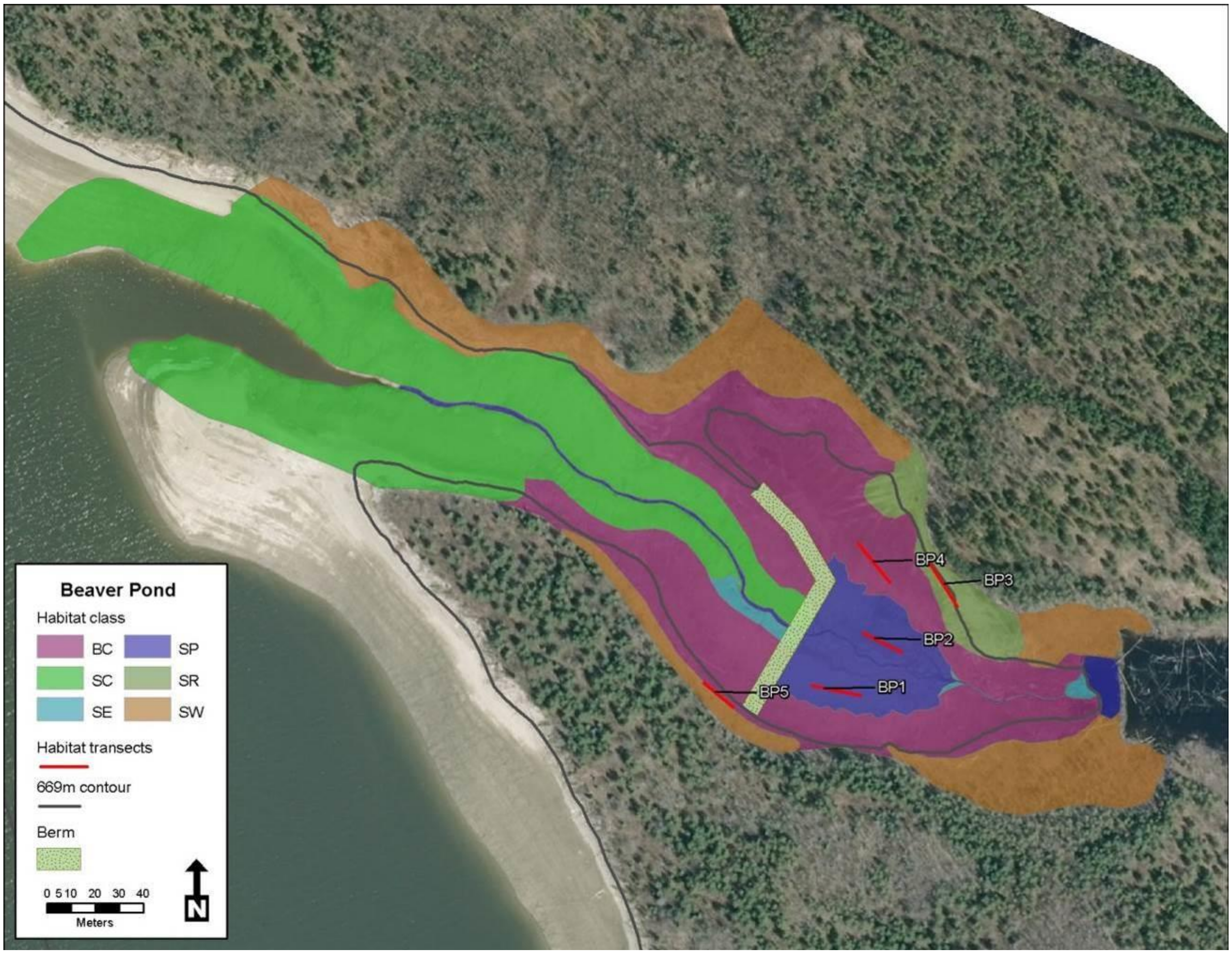

Figure 18. Post-construction habitat classes and transect locations in the Beaver Pond site.

Table 3. **Number of polygons and area for habitat classes identified during photo interpretation for the Airport Lagoon and Beaver Pond sites in Year 5. Refer to Appendix 10 for detailed descriptions of the habitat classes.**

Site	Habitat Class	Number of Polygons	Mean Area (ha)	Total Area (ha)	Percent of Total Area
Airport Lagoon	BM	33	0.54	17.98	27.57
	BS	5	0.96	4.82	7.40
	FI	7	0.01	0.08	0.13
	SD	8	1.01	8.08	12.39
	SG	1	0.43	0.43	0.65
	SP	49	0.53	26.10	40.03
	SS	3	0.39	1.18	1.82
	SW	5	0.73	3.63	5.56
	WD	1	0.17	0.17	0.26
	WH	1	0.75	0.75	1.15
	WS	7	0.15	1.06	1.63
	WW	1	0.92	0.92	1.41
	Totals	**121**		**65.21**	**100**
Beaver Pond	BC	2	0.66	1.32	31.86
	SC	4	0.40	1.60	38.79
	SE	6	0.01	0.04	0.92
	SP	2	0.03	0.07	1.60
	SR	1	0.15	0.15	3.74
	SW	4	0.24	0.95	22.98
	Totals	**19**		**4.13**	**100**

Vegetation transects at the Airport Lagoon site were generally located on moist, organic rich soils, with slight to gentle slopes and frequent to annual flooding (Table 4). All transects were in a graminoid-dominated structural stage (with the exception of habitat class SW). No mature tree cover was observed on any of the survey transects (dead standing trees were present within habitat class WD). The surface substrate at the site was dominated by organic matter or decayed wood, with a subset having a large percentage of exposed mineral soil (Table 4).

Vegetation transects at the Beaver Pond site were located on clay rich soils with gentle to moderate slopes and frequent to annual flooding (Table 4). All transects were in a graminoid-dominated structural stage (with the exception of habitat class SW). No mature tree cover was observed on any of the survey transects. The surface substrate at the site was dominated by exposed mineral soil with minimal woody debris and little to no organic matter (Table 4).

During Year 5 ground sampling for terrestrial vegetation, a total of 38 herb species were recorded across nine transects. Average percent herb cover by transect ranged from 5.7% to 25.6% (Table 5). Eight species of moss were recorded during ground sampling on six of the nine transects. On transects where moss species did occur, the percent cover ranged from 0.1% to 75.7% (Table 5). Three shrub species occurred on three of the nine transects, and only in the C layer (0-15cm height). A summary of the terrestrial plant species and percent cover for each transect is provided in Appendix 10.

Table 4. Site characteristics for vegetation transects sampled in Year 5 at the Airport Lagoon and Beaver Pond study sites.

Site	Transect	BGC Unit	Water Source[1]	Soil Moisture Regime[2]	Soil Nutrient Regime[3]	Successional Status[4]	Structural Stage[5]	Elevation (m)	Slope (%)	Aspect (°)	% Organic Matter[6]	% Rocks[6]	% Decayed Wood[6]	% Mineral Soil[6]	% Bedrock[6]	% Water[6]	Drainage[7]	Flood Regime[8]
Airport Lagoon	AL1[9]	n/a														100	n/a	
	AL2[9]	n/a														100	n/a	
	AL3	SBSmk1	P	2	A	DC	2b	677	15	30	50	0	47	3	0	0	r	A
	AL4[9]	n/a															n/a	
	AL5	SBSmk1	P	3	B	DC	2b	679	15	169	7	0	18	75	0	0	r	A-F
	AL6	SBSmk1	F	7	E	DC	2b	673	1	999	98	0	2	0	0	0	p	F
	AL7	SBSmk1	F	7	E	DC	2b	676	3	260	97	0	3	0	0	0	v	F
	AL8[9]	n/a														100	n/a	
	AL9	SBSmk1	P	6	E	DC	2b	675	6	272	57	0	43	0	0	0	i	A
	AL10	SBSmk1	F	7	E	DC	2b	675	2	284	69	0	30	0	1	2	v	A-F
	AL 11	SBSmk1	G	6	E	DC	2a	676	0	999	0	0	0	0	0	100	v	A
	AL 12	SBSmk1	G	6	E	DC	2a	666	0	999	99	0	1	0	0	0		
Beaver Pond	BP3	SBSmk2	P	3	B	DC	2b	675	25	230	1	20	4	76	0	0	r	A-F
	BP4	SBSmk2	G	7	D	DC	2a	673	5	227	0	0	0	0	0	100	m	A
	BP5	SBSmk2	P	4	D	DC	2b	685	20	44	79	0	21	0	0	0	m	A-F

[1] P=Precipitation, G=Groundwater, S=Snowmelt, F=Stream sub-irrigation and flooding, M=Mineral spring, T=Tidal, freshwater, E=Tidal, saltwater, Z=Permafrost

[2] 0=Very Xeric, 1 = Xeric, 2 = Subxeric, 3= Submesic, 4= Mesic, 5= Subhygric, 6=Hygric, 7=Subhygric, 8=Hydric

[3] A=Very poor, B=Poor, C=Medium, D=Rich E=Very rich, F=Saline

[4] DC = Disclimax

[5] 2a= Forb dominated – includes non-graminoid herbs and ferns; 2b= Graminoid dominated – includes grasses, sedges, reeds, and rushes

[6] Values represent observations in 2015.

[7] v=very poorly drained, p=poorly drained, i=imperfectly drained, m=moderately well drained, w=well drained, r=rapidly drained, x = very rapidly drained

[8] A=annual flood, O=occasional flooding, F=frequent flooding

[9] Transects that have been permanently flooded as a result of the wetland enhancement completed at Airport Lagoon in Year 3 (2013).

Table 5. **Vegetation cover summary for transects sampled in Year 5 at the Airport Lagoon and Beaver Pond sites.**

Site	Transect	No. herb species	Average % Herb cover	No. moss/ lichen species	Average % Moss/Lichen Cover	No. shrub species	Average % shrub cover
Airport Lagoon	AL3	15	5.7	0	0	0	0
	AL5	13	13.0	0	0	0	0
	AL6	15	25.6	1	8.0	0	0
	AL7	12	22.8	3	75.7	1	1.6
	AL9	13	14.2	2	0.5	0	0
	AL10	11	13.3	5	6.0	2	1.2
	AL12	6	11.6	1	2.0	0	0
			15.2		**13.2**		**0.4**
Beaver Pond	BP3	11	14.2	0	0	0	0
	BP5	15	19.2	0	0.1	2	0
			16.7		**0.1**		**0**

A majority of the terrestrial plant species were observed at the study sites during Year 5 ground sampling were common to habitat classes located in the upper elevations of the drawdown zone as the lowest elevations are now permanently flooded at both the Airport Lagoon and Beaver Pond sites. All species observed during the ground sampling were also observed during previous years of the study, with the possible exception of three observations that could not be identified to species.

Examples of the most common of these species (observed on 3 or more survey transects) include bluejoint (*Calamagrostis canadensis*), common horsetail (*Equisetum arvense)*, lady's thumb (*Persicaria maculosa*), Torrey's cryptantha (*Cryptantha torreyana*), water smartweed (*Persicaria amphibian*), sedges (*Carex* spp.), common mare's-tail (*Hippuris vulgaris*) red sand-spurry (*Spergularia rubra*) and common hook-moss (*Drepanocladus aduncus*). The common species are all assumed to be tolerant to some degree of flooding. In an experiment testing the tolerance of a few species of herbaceous perennials to a variety of flooding regimes, bluejoint was identified as a species with a relatively high tolerance to flooding (Kercher and Zedler 2004). Other species identified as having a high tolerance were sedges, reed canarygrass (*Phalaris arundinacea*), and common cattail (Kercher and Zedler 2004). These species were also observed at the Airport Lagoon and Beaver Pond sites.

5.2.1 Coarse Woody Debris

Mapping of CWD in Year 4 identified a total of four CWD density classes based on percent cover of CWD at the Airport Lagoon Table 6. The density classes include minimal (0-5%), low (6-10%), moderate (11-30%) and high (31-50%). The number of polygons for each density class ranged from five (minimal) to 35 (moderate). The percentage of total area covered by the density classes ranged from 15.87% (high CWD) to 66.44% (minimal CWD).

The CWD density classes were distributed throughout the Airport Lagoon site and were associated with elevation within the drawdown zone (Figure 19). The low, moderate and high density classes were located along the perimeter of the site in the upper portion of the drawdown zone, with the exception of some moderate density class areas identified above the upper drawdown on the east side of the site. The minimal density class occurred within remaining lower portion of the drawdown zone.

Table 6. **Density, number of polygons, and areas of CWD identified through photo interpretation for the Airport Lagoon in Year 4.**

Site	CWD Density	Number of Polygons	Area (ha)				Percent of Total Area
			Minimum	Maximum	Mean	Total	
Airport Lagoon	Minimal	5	0.02	41.20	8.66	43.32	66.44
	Low	25	0.01	0.84	0.12	4.40	6.75
	Moderate	35	0.01	2.22	0.20	7.13	10.94
	High	23	<0.01	2.76	0.45	10.35	15.87
	Totals	**88**				**65.21**	**100**

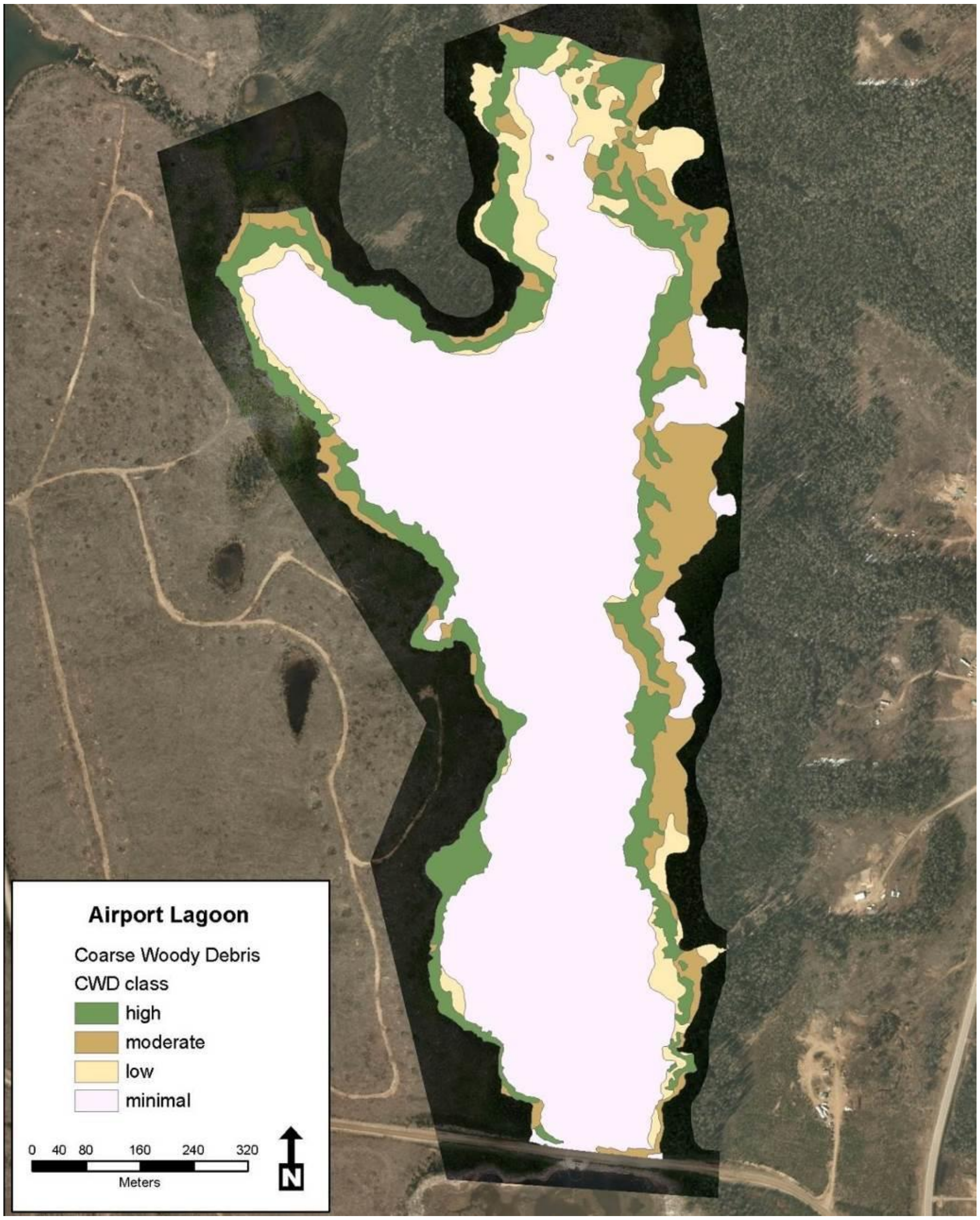

Figure 19. **CWD density classes at the Airport Lagoon site in Year 4.**

5.2.1 Aquatic Vegetation

In Year 5, a total of five aquatic plant communities were identified and mapped along the water surface and shoreline at the Airport Lagoon (Table 7, Figure 20). The plant communities were identified by the dominant species for the community and include Closed-leaved Potamogeton, Common Hornwort, Fennel-leaved Pondweed, Lady's Thumb, and Water Smartweed. A sixth non-aquatic plant community was also identified (Non-aquatic); no extensive cover of aquatic plant species was observed within this community.

Aquatic plant communities were distributed throughout the inundated portion of the site (Figure 20). The most common and widely distributed community was the Fennel-leaved Pondweed community, which was observed in the central area of the site at water depths of 1-2 m. The Common Hornwort plant community occurred in deeper water (>2 m depth) on the west side of the site. The Fennel-leaved Pondweed community was observed in the central area of the site at water depths of 1-2 m. The Lady's Thumb community occurred within shallow water (<1 m depth) and along the shoreline of the lagoon. The Water Smartweed community occurred in the area at the north end of the lagoon. Areas that were mapped as a Non-aquatic plant community were located in areas of the site that lacked permanent water cover prior to the construction of the wetland enhancement in Year 3.

The number of polygons for each aquatic plant community ranged from one (Closed-leaved Potamogeton, Fennel-leaved Pondweed, Water Smartweed, and Common Hornwort) to three (Lady's Thumb) (Table 7). The percentage of total area covered by the aquatic plant communities ranged from 3.35% (Water Smartweed) to 33.12% (Fennel-leaved Pondweed); the second largest portion of the water surface and shoreline at Airport Lagoon was determined to be a non-aquatic plant community (Non-aquatic; 27.02%) (Table 7).

Table 7. **Number of polygons and areas of aquatic plant community polygons identified during photo interpretation for the Airport Lagoon in Year 5.**

Site	Aquatic Plant Community	Number of Polygons	Area (ha)				Percent of Total Area
			Minimum	Maximum	Mean	Total	
Airport Lagoon	Closed-leaved Potamogeton	1	2.95	2.95	2.95	2.95	10.51
	Common Hornwort	1	2.86	2.86	2.86	2.86	10.20
	Fennel-leaved Pondweed	1	9.29	9.29	9.29	9.29	33.12
	Lady's Thumb	3	0.06	4.31	1.48	4.43	15.81
	Non-aquatic	10	<0.01	5.18	0.76	7.58	27.02
	Water Smartweed	1	0.94	0.94	0.94	0.94	3.35
	Totals	**17**				**28.05**	**100**

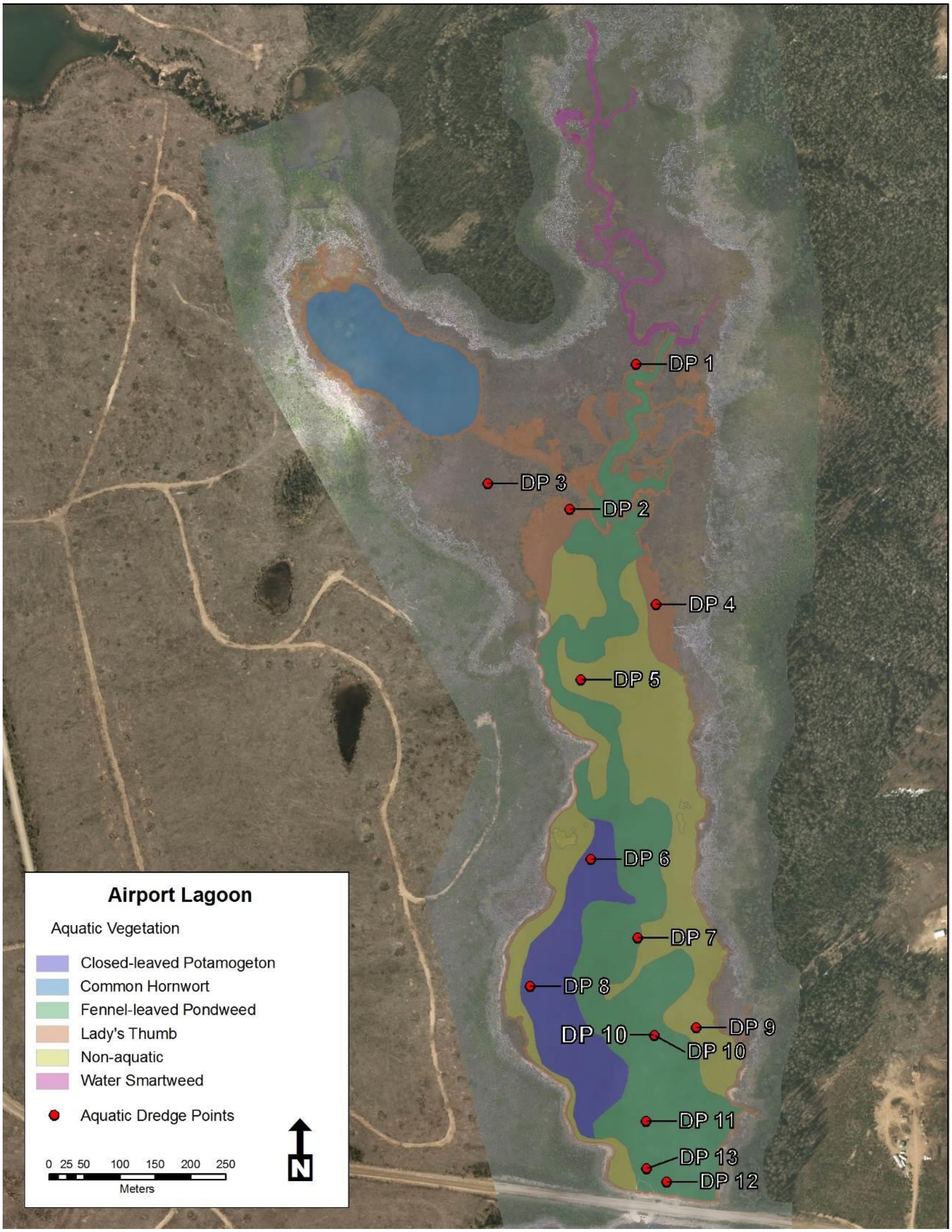

Figure 20. **Aquatic vegetation distribution at the Airport Lagoon site in Year 5.**

During Year 5 surface sampling for aquatic plants, a total of six aquatic plant species were identified at Airport Lagoon (Table 8). Species observed included closed-leaved potamogeton (*Potamogeton foliosus*), common hornwort (*Ceratophyllum demersum*), fennel-leaved pondweed (*Stuckenia pectinata*), stonewort (*Chara spp.*), verticillate watermilfoil (*Myriophyllum verticillatum*), water smartweed (*Persicaria amphibia*) and wavy water nymph (*Najas flexilis*). Closed-leaved potamogeton was observed along the southwest shoreline (1-2 m depth) of the lagoon; this species was not observed in this area in the previous year. Common hornwort and verticillate watermilfoil was observed in deeper water (>2 m depth) in the northwest arm of the lagoon; large mats of decayed verticillate watermilfoil were also observed along the shoreline in this area. Fennel-leaved pondweed was most commonly observed in the central area of the Lagoon at water depths of 1-2 m. Water smartweed was observed along the shorelines (1-2 m depth) at the north end of Airport Lagoon and provided substantial vegetation cover throughout the northeast arm. All other species were uncommonly observed across the site. A summary of the aquatic plant species detected at each of the sampled dredge points is provided in Appendix 11.

Dredge sampling for aquatic plants at the Beaver Pond site was also completed during the July fish sampling. The sampling revealed no cover of aquatic plants within the project area.

Table 8. **Aquatic plant species identified during surface sampling in Year 5 at the Airport Lagoon study site.**

Common Name	Latin Name
closed-leaved potamogeton	*Potamogeton foliosus*
fennel-leaved pondweed	*Stuckenia pectinata*
stonewort	*Chara* spp.
verticillate water-milfoil	*Myriophyllum verticillatum*
water smartweed	*Persicaria amphibia*
wavy water nymph	*Najas flexilis*

5.3 Waterfowl and Shorebird Surveys

A total of 23 waterfowl and shorebird species represented by 349 individuals were detected during the 2015 surveys (Table 10). During 2015 surveys, 339 individuals representing 23 species were recorded at the Airport Lagoon site. The total number of detections at Airport Lagoon was lower than the previous three years (Table 10). At this site in 2015, the highest number of detections (140) was recorded during the May 7 survey.

American Wigeon and Canada Goose were the most commonly recorded species (Table 10). Consistent with previous years, Green-winged Teal, Ring-necked Duck and Northern Pintail were also common. Greater Yellowlegs were the most commonly recorded shorebird. Canada Goose, Northern Pintail, Greater Yellowlegs and Killdeer were detected during all four surveys at Airport Lagoon (Table 10).

In Year 5, waterfowl and shorebird species richness (28 species) was slightly lower than the highest number (30) recorded in 2014 (Table 10). Similar to Year 4, species richness at Airport Lagoon was highest during the third survey which was conducted on May 19. At the Beaver Pond site, where no detections were recorded in the previous two years, species richness was also highest during the third survey of the year (June 5). Gadwall, Redhead, and Least

Sandpiper were detected for the first time during 2015 surveys (Table 10). Canvasback, Greater Scaup, Barrow's Goldeneye. Common Goldeneye, Red-breasted Merganser, Trumpeter Swan, Red-necked Grebe, Cinnamon Teal, Greater White-fronted Goose, Semipalmated Sandpiper and Pectoral Sandpiper observed during previous years surveys were not detected this year (Table 10).

When baseline and post-construction surveys were plotted by survey date, early season surveys recorded higher waterfowl and shorebird abundance before the habitat enhancements were initiated. For the second and subsequent surveys of the season, abundance was higher during the post-construction phase of the project (Figure 21). The abundance of waterfowl across survey dates was more consistent in the post-construction survey period than the baseline surveys. When the baseline and post-construction surveys where plotted by survey station, decreases were observed at WSP-01 and WSP-02 where the increased water depth resulted in a loss of shallow water habitat (Figure 22). The largest increase was observed at station WSP-03 where the early season habitat changed from exposed drawdown zone to a large are of shallow water habitat (Figure 22). Smaller increases were also observed at WSP-04 (Figure 22) but field observations suggest that the areas of highest abundance may have shifted to the east (closer to the WSP-03 survey area).

Incidental observations of 11 Ring-necked Duck, 6 Canada Goose, 1 Blue-winged Teal and 1 Wilson's Snipe were recorded at Airport Lagoon. At Beaver Pond, incidental observations included 4 Common Merganser, 3 Blue-winged Teal, 2 Green-winged Teal, 1 Common Loon, 1 Mallard, 1 Canada Goose, 1 Killdeer and 1 Greater Yellowlegs.

Table 9. **Summary of waterfowl and shorebird observations in 2011, 2012, 2013 and 2014 at the Airport Lagoon and Beaver Pond sites, Williston Reservoir, BC. Other includes water-dependent species (e.g., gulls, Osprey, Kingfisher).**

		Year	2011	2012	2013	2014	2015
No. of Individuals	**Airport Lagoon**	Waterfowl	225	296	387	320	277
		Shorebirds	*	125	30	68	62
		Other	*	0	2	20	20
		Total	225	421	419	408	359
	Beaver Pond	Waterfowl	6	0	0	0	4
		Shorebirds	*	2	0	0	6
		Total	6	2	0	0	10
	Combined Total		231	423	419	408	369
No. of Species	**Airport Lagoon**	Waterfowl	25	16	12	18	15
		Shorebirds	*	7	6	8	8
		Other	*	0	2	4	3
		Total	25	23	20	30	26
	Beaver Pond	Waterfowl	2	0	0	0	1
		Shorebirds	*	2	0	0	1
		Total	2	2	0	0	2
	Combined Total		27	25	20	30	28

* – Shorebirds were not a component of the 2011 surveys

Table 10. **Summary of waterfowl observations in 2011, 2012, 2014 and 2015 at the Airport Lagoon, Williston Reservoir, BC.**

	2011				2012					2013					2014					2015				
	May 9	May 22	June 7	Total	May 1	May 9	May 16	May 31	Total	May 1	May 12	May 25	June 10	Total	May 1	May 11	May 20	June 2	Total	May 1	May 7	May 19	May 31	Total
Greater White-fronted Goose	1			1																				0
Canada Goose	35	8	27	70	19	5	7	18	49	12	2	10	10	34	6	4	2	7	19	12	8	19	11	50
American Widgeon	37			37	34		4		38	44			2	46	26	6	14	1	47	22	39	4		65
Mallard	6	4	4	14	9		3		12	49	3	7	30	89	16	42	25	14	97	6	8	11		25
Blue-winged Teal		3		3				1	1		14	2	3	19		1	7	3	11		3	2		15
Cinnamon Teal		1		1							1			1										0
Northern Shoveler	4	2	3	9	12		4		16	3	1	2	2	8	8	6	3		17	1		8	1	10
Northern Pintail			1	1	9	6			15	5		2	5	12	18	9	3	2	32	4	12	2	8	26
Green-winged Teal	4	2		6	18	5	4		27	85	2		5	92	24	3	1		28	8	25	1		34
Canvasback						2			2								1		1					0
Ring-necked Duck	35	4	2	41	49				49	33				33	10	6	15	4	35	2	15	1		28
Lesser Scaup	15	3		18	6				6						9				9		2	2		4
Greater Scaup																	1		1					0
Bufflehead	5	4		9	7				7	22	1			23	5	2	1		8		3	1		4
Barrow's Goldeneye	4			4	1				1	17				17	6				6					0
Common Goldeneye																3			3					0
Hooded Merganser					2				2								1		1			1		1
Common Merganser					10				10	13				13					0	4	2			6
Red-breasted Merganser																		1	1					0
Common Loon						1	1		2							1		2	3	1		1	1	3
Gadwall																					2	2		4
Redhead																						2		2
Red-necked Grebe	5	2		7	1				1										0					0
Trumpeter Swan															1				1					0
	151	33	37	221	177	19	23	19	238	283	24	23	57	387	129	83	74	34	320	60	119	77	21	277

[a] – Shorebirds were not a component of the 2011 surveys.

Table 11. **Summary of shorebird observations in 2011, 2012, 2014 and 2015 at the Airport Lagoon, Williston Reservoir, BC.**

	2012					2013					2014					2015				
	May 1	May 9	May 16	May 31	Total	May 1	May 12	May 25	June 10	Total	May 1	May 11	May 20	June 2	Total	May 1	May 7	May 19	May 31	Total
Semipalmated Plover		4	3		7		1			1					0			1		1
Killdeer		4	1	2	7	3	1	1	3	8	2	4	7	3	16	2	5	2	1	10
Spotted Sandpiper			3	1	4		1	1	3	5	1		4		5		1	2	4	7
Greater Yellowlegs			6	4	12	3				3	5		5		10	6	9	8	5	28
Lesser Yellowlegs	7		13		20		5	3		8	5	8	8		21	1	2	4		7
Semipalmated Sandpiper		6	1		7		5			5			3		3					0
Pectoral Sandpiper													3		3					0
Long-billed Dowitcher			68		68							5	3		8		4			4
Wilson's Phalarope													2		2			3		3
Least Sandpiper																		2		2
Totals	**7**	**14**	**95**	**7**	**125**	**6**	**13**	**5**	**6**	**30**	**13**	**17**	**35**	**3**	**68**	**9**	**21**	**22**	**10**	**62**

* – Shorebirds were not a component of the 2011 surveys.

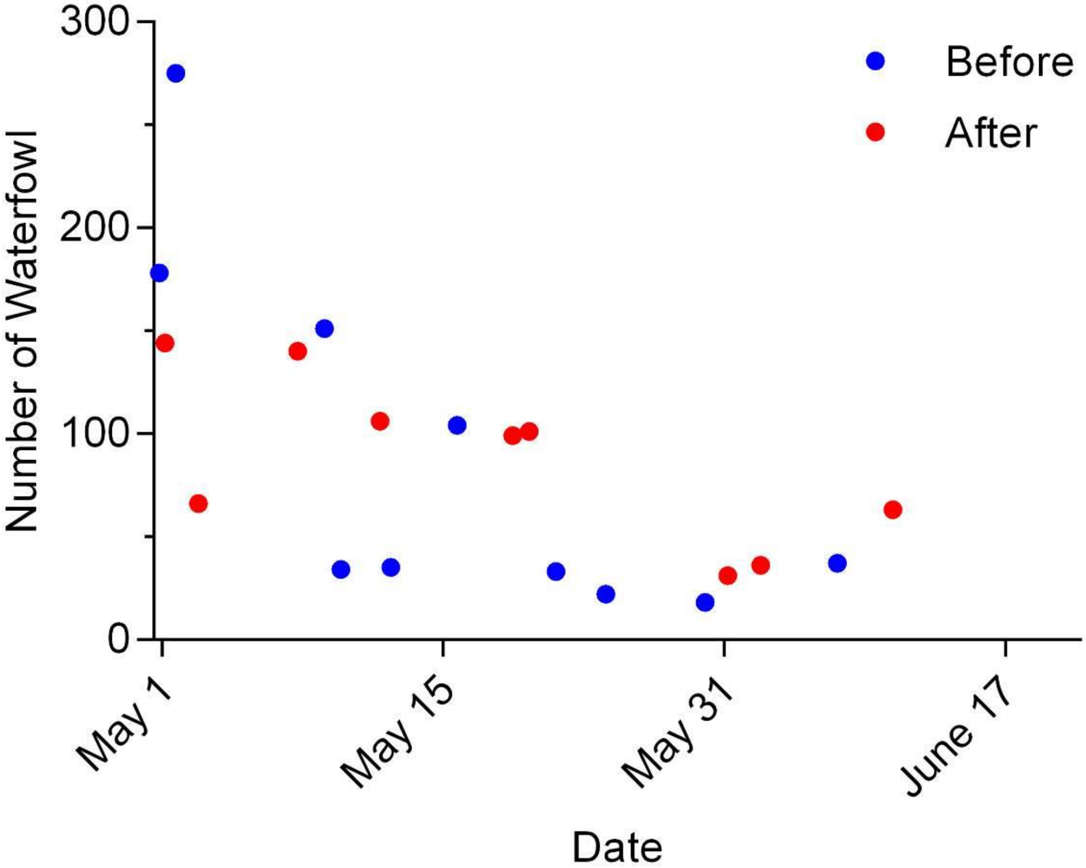

Figure 21. **Seasonal abundance of waterfowl and shorebirds at the Airport Lagoon site before and after completion of the wetland enhancement project.**

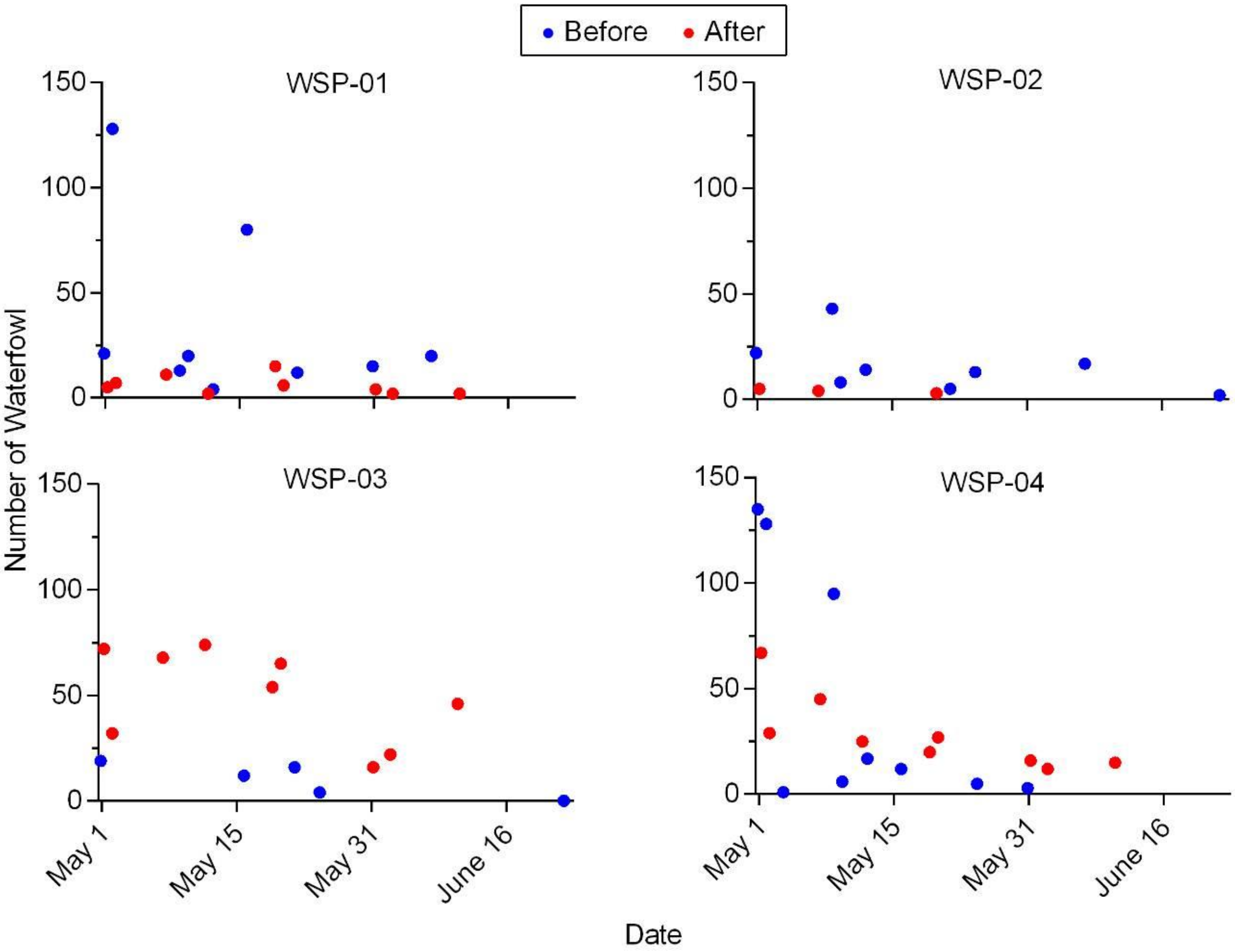

Figure 22. **Seasonal abundance of waterfowl and shorebirds by survey station at the Airport Lagoon site before and after completion of the wetland enhancement project.**

5.4 Songbird Surveys

Species richness during the 2015 point count surveys was slightly lower than in previous years (Table 12). A total of 406 detections were recorded, including 508 individuals representing 51 species. The species richness at both sites was consistent with previous seasons, with slightly lower species richness at Airport Lagoon (49) and average species richness at Beaver Pond (22) (Table 12). At Airport Lagoon an average of 13.4 (n=17) species per point count station were detected and 11.3 (n=3) species per station were detected at Beaver Pond (Table 12). A summary of species detected by station during Year 5 surveys is included in Appendix 12.

At the Airport Lagoon site, a majority of detections were recorded in the drawdown zone (32.9%, n=356). Most of the detections at Beaver Pond were recorded in the forested area above the drawdown zone (68%, n=50). The fewest number of detections occurred in the forested area above the drawdown zone (14.6%, n=356) at Airport Lagoon and in the shrubs (6%, n=50) at Beaver Pond (Table 13).

Although the number of detections in the drawdown zone (117) at Airport Lagoon in 2015 was slightly lower than in Year 4 (128), the species richness and number of individual birds observed was the highest recorded to date (Table 14). The number of detections (55) and the number of individual water-dependent birds (waterfowl, shorebirds, and gulls) (87) were both slightly lower than recorded in 2014, while species richness remained the same (Table 14).

Wilson's Phalarope (Airport Lagoon) and Rusty Blackbird (Beaver Pond) were detected for the first time during point count surveys in Year 5. During point count surveys at the Beaver Pond site 31.82% (n=22) of species detected had not been recorded in the previous four years. A total of 40.91% of species observed in 2015 have been recorded every year during point count surveys at Beaver Pond site. At the Airport Lagoon site 4.08% (n=49) of species were recorded during point count surveys for the first time in 2015. A total of 59.18% of species recorded during Year 5 point counts have been recorded every year to date. Cedar Waxwing and Lesser Yellowlegs had been recorded in each of the previous four years but were not detected in 2015.

No nests were recorded at the Beaver Pond site, while 15 active nests used by ten different species were located at Airport Lagoon during the 2015 surveys (Table 15).

Table 12. **Summary of the number of species detected and mean species per station for songbird point count surveys over five years at the Airport Lagoon and Beaver Pond sites.**

Site		Year					Number of Stations
		2011	2012	2013	2014	2015	
Airport Lagoon	Number of Detections	416	367	320	415	356	17
	Number of Species	57	56	56	54	49	
	Species per Station	13.8	14.5	12.1	15.5	13.4	
Beaver Pond	Number of Detections	63	73	81	56	50	3
	Number of Species	21	24	23	19	22	
	Species per Station	11.3	12	14.7	11.7	11.3	

Table 13. **Summary of the detection locations for songbird point count surveys in 2012, 2013, 2014 and 2015 at the Airport Lagoon and Beaver Pond sites. Detection location was not recorded in 2011.**

Year	Detection Location	Airport Lagoon		Beaver Pond	
		Number of Detections	%	Number of Detections	%
2012	Drawdown Zone	82	22.3	5	6.8
	Shrubs	112	30.5	9	12.3
	Forest	99	27	58	79.5
	Flyover	69	18.8	1	1.4
	Unknown	5	1.4		
	Total Detections	367		73	
2013	Drawdown Zone	61	19.1	7	8.6
	Shrubs	97	30.3	5	6.2
	Forest	120	37.5	66	81.5
	Flyover	42	13.1	3	3.7
	Total Detections	320		81	
2014	Drawdown Zone	128	30.8	2	3.6
	Shrubs	115	27.7	6	10.7
	Forest	107	25.8	44	78.6
	Flyover	63	15.2	2	3.6
	Unknown	2	0.5	2	3.6
	Total Detections	415		56	
2015	Drawdown Zone	117	32.9	7	14
	Shrubs	134	37.6	3	6
	Forest	52	14.6	34	68
	Flyover	53	14.9	6	12
	Total Detections	356		50	

Table 14. **Summary of drawdown zone detections during songbird point count surveys in 2012, 2013, 2014 and 2015 at the Airport Lagoon site. Detection location was not recorded in 2011.**

		2012	2013	2014	2015
All species	Detections	82	61	127	117
	No. of Individuals	108	76	157	168
	No. of Species	19	20	29	31
Waterbirds[1]	Detections	41	33	64	55
	No. of Individuals	63	41	90	87
	No. of Species	7	9	12	12

[1] – includes waterfowl, shorebirds, and gulls

Table 15. Summary of nests located at the Airport Lagoon site in 2015. No nests were recorded at Beaver Pond in 2015.

Species	Nests	Nest Location
Canada Goose	1	Platform on tall snag
Osprey	1	Platform on tall snag
American Kestrel	1	Cavity in conifer
Northern Flicker	2	Cavity in dead snag
Tree Swallow	2	Cavity in dead snag
Lincoln's Sparrow	2	Ground
Savannah Sparrow	2	Ground
Dark-eyed Junco	1	Ground
Bonaparte's Gull	1	Conifer branch
Killdeer	2	Floating island
Total	15	

5.5 Amphibian Surveys

Western toad (*Anaxyrus boreas*), long-toed salamander (*Ambystoma macrodactylum*) and wood frog (*Lithobates sylvaticus*) were the only three amphibian species detected during the systematic searches conducted during Year 5 (Table 16). Abundance and species richness were highest at Beaver Pond with 77% of detections representing three species were detected in 2015 (Table 16).

At the Beaver Pond site a majority (62.5%) of individuals were detected during the June 5 survey (Table 17). Most of the detections at the Airport Lagoon (67.9%) were recorded during the May 20 surveys (Table 17). Western toad which are blue-listed provincially and a federal species of special concern were the most commonly detected species (89.3%). They were detected during all four surveys at Airport Lagoon and during all but the earliest (May 8) survey at Beaver Pond (Table 17). Long-toed salamander were located at both sites during early season surveys, while wood frog were only detected at Beaver Pond during the last two surveys (Table 17).

Long-toed salamander egg masses (8) were recorded at the Beaver Pond site during the systematic search on May 8. The only record of long-toed salamander egg masses at the Airport Lagoon site was an incidental observation on May 7.

Large groups of up to several thousand predominantly western toad tadpoles were recorded above and below the beaver dam at Beaver Pond during the later three surveys (May 22, Jun 1 and 5). The highest numbers were recorded during the May 22 survey. At Airport Lagoon only two detections of western toad tadpoles were recorded, both during the May 31 survey. Incidental observations included a single western garter snake on transect 35 during the May 7 survey and a wood frog near transect 25 on May 19.

Table 16. Adult and juvenile amphibian detections with survey effort 2011 - 2015 at the Airport Lagoon and Beaver Pond sites.

Site	Transect	Species																				Survey Effort				
		Western Toad					Wood Frog					Columbia Spotted Frog					Long-toed Salamander									
		2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015
Airport Lagoon	2[a]																					0:17	0:55	0:31	0:35	0:35
	3[a]	1																				0:21	0:33	0:58	0:32	0:30
	7[a]		1				1												1			0:29	0:56	0:33	0:44	0:18
	10[a]	2		3																		0:22	0:55	1:19	0:33	0:34
	14[a]	2																				0:27	1:04	0:50	0:55	0:23
	25	7	4	6	72	23									1			2		1		0:51	1:33	1:31	2:08	1:14
	28																					0:29	0:43	1:02	0:51	0:42
	32[a]	1	1	1	2																1	0:24	0:52	0:40	1:09	0:44
	35		1																			0:29	0:43	0:42	0:39	0:27
	37[a]	3				3													1			0:22	0:27	0:42	0:48	0:50
	40[a]					1													1	2		0:29	0:46	0:31	0:55	1:09
Total		**16**	**7**	**10**	**74**	**27**	**1**								**1**			**2**	**3**	**3**	**1**	**5:00**	**9:27**	**9:19**	**9:49**	**7:26**
Beaver Pond	BP-A-01 [a]	3	1	2	9	82	10		1		4								1	8	8	1:13	3:02	2:59	2:59	2:50
Grand Total		**19**	**8**	**12**	**83**	**109**	**11**	**0**	**1**	**0**	**4**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**4**	**11**	**9**	**6:13**	**12:29**	**12:18**	**12:48**	**10:16**

[a] - Transect adjusted in 2014 to accommodate post-construction water levels.

Table 17. **Adult and juvenile amphibian detections by transect and survey date in 2015 at the Airport Lagoon and Beaver Pond sites.**

		Species														
		Western Toad					Wood Frog					Long-toed Salamander				
Site	**Transect**	**May 1**	**May 7**	**May 20**	**May 31**	**Total**	**May 1**	**May 7**	**May 20**	**May 31**	**Total**	**May 1**	**May 7**	**May 20**	**May 31**	**Total**
Airport Lagoon	2[a]															
	3[a]															
	7[a]															
	10[a]															
	14[a]															
	25	3	2	16	2	23										
	28															
	32[a]											1				
	35															
	37[a]			3		3										
	40[a]		1			1										
Total		3	3	19	2	27						1				
		May 8	**May 22**	**June 1**	**June 5**	**Total**	**May 8**	**May 22**	**June 1**	**June 5**	**Total**	**May 8**	**May 22**	**June 1**	**June 5**	**Total**
Beaver Pond	BP-A-01[a]		20	6	58	84			2	2	4	7	1			8
Grand Total		3	23	25	60	111			**2**	**2**	**4**	8	1	0	0	8

[a] Transect adjusted in 2014 to accommodate post-construction water levels.

5.6 Fish Surveys

A total of 24,462 fish representing 11 species were collected over the duration of the sampling program in Year 5. A total of 24,446 fish and 10 species were collected at the Airport Lagoon site and 16 fish and 5 species were collected at the Beaver Pond site (Table 18). At the Airport Lagoon site, the majority of fish were collected by fyke net (22,583 fish), followed by minnow trap (1,638 fish), and electrofishing (225 fish) (). Electrofishing was completed on the single transect at the Airport Lagoon that was not flooded following project construction. At the Beaver Pond site, fish were only collected by electrofishing (16 fish) (Table 18). No fish sampling by either fyke net or minnow trap was completed at the Beaver Pond site in 2015.

The number fish captured in Year 5 at the Airport Lagoon was considerably higher than in the previous four years of the project. The high numbers were associated with the May fyke net catches (Table 18) and primarily the catch from a single net (21,088 fish) representing 86% of the total catch at this site in 2015. As a result, the overall CPUE for fyke nets was considerably higher than in previous years (Table 19). However, the fyke net catches at the Airport Lagoon for July were lower than in previous years, except for Year 1 (2011) (Table 19). No fyke nets were set at the Beaver Pond site in July 2015 due to weather conditions.

The CPUE for minnow trapping was consistent with recent sampling (Table 19) and was primarily a result of high catches during the May sampling session (Table 18). As observed for the fyke net catches, the July minnow trap catches at the Airport Lagoon (Table 18) were considerably lower than what was observed in recent years (Table 19). The trend for electrofishing at the Airport Lagoon was also consistent with what was observed for the May minnow traps and fyke nets with a higher CPUE than in previous years (Table 19).

The Year 5 electrofishing at the Beaver Pond site was the first post-construction sampling at a low reservoir elevation. The construction of the wetland required modifications to the electrofishing transects with a change in the start of transect 2 (located upstream of the wetland) and the creation of a new transect of the downstream side of the berm. All fish captured at the Beaver Pond site in 2015 on the downstream side of the berm (Table 18). The capture rate was low but consistent with previous years (Table 20). No fish were captured in the transect upstream of the wetland. However, fish were incidentally observed in the new wetland on several occasions prior to inundation by the reservoir. As in previous years, a school of small fish was observed at the stream outlet during later sampling sessions prior to inundation by the reservoir.

The high CPUE from all sampling methods at the Airport Lagoon in 2015 was associated with high abundances of Brassy Minnow (*Hybognathus hankinsoni*), Lake Chub (*Couesius plumbeus*), and Redside Shiner (*Richardsonius balteatus*) abundance during the May sampling sessions. Minnow trap and fyke net catches were higher during the May sampling session than during the July sampling session. With the exception of Brassy Minnow by minnow trap, the CPUE in Year 5 for these three species captured by all sampling methods was similar to or higher than in the previous years of the monitoring program (Table 19). Capture rates for other species were variable but generally consistent with the higher rates observed since 2013 (Table 19).

Table 18. Summary of fish species captured by method in 2015 at the Airport Lagoon and Beaver Pond sites. Electrofishing was the only fish sampling completed at the Beaver Pond site in 2015.

Site	Species	Method and Sampling period					Totals
		Electrofish	Minnow Trap		Fyke Net		
		May	May	July	May	July	
Airport Lagoon	Lake Chub	66	884	5	3924		4879
	Brassy Minnow	28	31		9121		9180
	Northern Pikeminnow		12		76		88
	Redside Shiner	110	416	43	5686	60	6315
	Longnose Sucker	6	74		6		86
	White Sucker	1	23	6	63	1	94
	Largescale Sucker	8	40	4	108	2	162
	Sucker sp.	1	100		3525		3626
	Rainbow Trout	1			6		7
	Burbot	1					1
	Prickly Sculpin	3			4	1	8
	Totals	225	1580	58	22519	64	24446
	Effort	2142	226.47	192.13	38.81	30.05	
	CPUE	6.303	6.977	0.302	580.237	2.130	
Beaver Pond	Lake Chub	3					3
	Peamouth	2					2
	Northern Pikeminnow	2					2
	Redside Shiner	2					2
	Sucker sp.	2					2
	Prickly Sculpin	5					5
	Method Totals	16					16
	Effort	701					
	CPUE	1.369					
Grand Totals	**Fish**	**241**		**1638**		**22583**	**24462**
	Effort	**2843**		**418.6**		**68.86**	
	CPUE	**5.086**		**3.913**		**327.955**	

[1] – Electrofishing effort expressed in seconds (active sampling), minnow traps and fyke nets in hours (passive sampling)

[2] – Electrofishing CPUE = fish/minute; minnow trap and fyke net CPUE = fish/hour

Table 19. Fish CPUE[1] by method and species at the Airport Lagoon site for 2011 – 2015 (Years 1-5).

Method	Year	Species														
		Lake Chub	Brassy Minnow	Peamouth	Northern Pikeminnow	Redside Shiner	Longnose Sucker	White Sucker	Largescale Sucker	Sucker sp.	Rainbow trout	Bull trout	Burbot	Prickly sculpin	Slimy sculpin	Total
Electrofish	2011	0.567	0.026							0.670	0.052			0.026		1.340
	2012	0.151	0.025		0.075		0.025		0.025				0.427	0.050		0.780
	2013	1.794	1.623			0.883	0.085			0.028			0.171	0.114		4.699
	2014	1.087	0.053			0.212	0.027			1.061			0.053	0.345		2.837
	2015	1.848	0.784			3.081	0.168	0.028	0.224	0.028	0.028		0.028	0.084		6.303
Minnow Trap	2011	0.111	0.005			0.011							0.003	0.003	0.003	0.134
	2012	0.039	0.004		0.002	0.019			0.004				0.009	0.004		0.080
	2013	1.357	4.674		0.017	0.033	0.037		0.012	0.012						6.143
	2014	2.138	2.320		0.017	1.742	0.198	0.150	0.089	0.689	0.002			0.005		7.351
	2015	2.124	0.074		0.029	1.097	0.177	0.069	0.105	0.239						3.913
Fyke Net	2011				0.050		0.025						0.025			0.101
	2012	2.538	0.810	0.015	0.657	1.727	0.734	0.214	0.138				0.107			6.925
	2013	8.796	6.990		0.722	6.301	0.164		0.066							23.039
	2014	25.478	89.545	0.063	1.132	33.291	4.165	5.495	2.365	7.801	0.025					169.351
	2015	56.985	132.457		1.104	83.445	0.087	0.929	1.597	51.191	0.087			0.073		327.955

[1] – Electrofishing CPUE = fish/minute; minnow trap and fyke net CPUE = fish/hour

Table 20. **Fish CPUE[1] by method and species at the Beaver Pond site for 2011 – 2015 (Years 1-5). Electrofishing was the only fish sampling completed at the Beaver Pond site in 2015**

Method	Year	Species														
		Lake Chub	Brassy Minnow	Peamouth	Northern Pikeminnow	Redside Shiner	Longnose Sucker	White Sucker	Largescale Sucker	Sucker sp.	Rainbow trout	Bull trout	Burbot	Prickly sculpin	Slimy sculpin	Total
Electrofish	2011	0.057			0.057	0.515	0.229		0.057	2.462				0.057		3.435
	2012					0.067										0.067
	2013	0.190			0.038	0.038	0.114		0.038	2.013						2.430
	2014															
	2015	0.2568		0.1712	0.171	0.171				0.1712				0.428		1.369
Minnow Trap	2011				0.008											0.008
	2012			0.007												0.007
	2013						0.007			0.007				0.020		0.033
	2014				0.057	0.017										0.073
	2015															
Fyke Net	2011			0.460	0.184											
	2012				0.044		0.044		0.044			0.044				0.644
	2013			3.176	2.235	0.941	0.176	0.118	0.353							0.176
	2014			0.701	1.796	0.482	0.219		0.219							7
	2105															3.417

[1] – Electrofishing CPUE = fish/minute; minnow trap and fyke net CPUE = fish/hour

6 DISCUSSION

As this is Year 5 of a ten year monitoring program, the results presented provide additional information on the wildlife habitats and indicator groups at the project sites. The focus of field activities in Year 5 was continued data collection from established survey stations and transects for post-construction monitoring at both sites. The Airport Lagoon project was completed in late May 2013, so the data collected from this site in Year 5 is the second full year of post-construction monitoring. The Beaver Pond project was constructed in late May and early June 2014, so the data collected from this site is the first full year of post-construction observations. A summary of the progress towards addressing the management questions and hypotheses is provided in Table 21.

6.1 Environmental Conditions

The general conditions observed at both sites in Year 5 were similar to Year 4. There was more vegetation cover present in both Years 4 and 5 compared to Years 2 and 3 (refer to Appendix 9 for examples of the differences in vegetation between years). The differences in vegetation cover are considered to be primarily a result of the peak reservoir elevation in the year preceding the surveys (i.e., the peak elevation in 2014 affected the results of the 2015 vegetation surveys). The Year 4 and 5 surveys both occurred following a year of near average peak reservoir elevations (2-3 m lower than 2011 and 2012) that did not result in the full inundation of either site during the growing season. The Years 2 and 3 surveys occurred following a years where the reservoir either was close to (2011) or at (2012) full pool and both sites were inundated for an extended period during the growing season. The Year 4 survey occurred following a year of close to average reservoir levels (2-3 m lower than 2011 and 2012).

As noted in previous years (CBA 2012, 2013, 2014, 2015), weather conditions during the sampling period may have influenced some of the survey results. In Year 5, temperatures were generally above average for most of the sampling period and warmer than observed in the previous years of the sampling program. The warmer temperatures were also confirmed by degree day calculations (5°C base temperature) with more degree days accumulated on any given date in Year 5 than in any of the previous four years with the exception of a one week period in early May when temperatures were below average. Precipitation in Year 5 was below average in April and June but consistent with previous years. Precipitation in May was well below average until a single rainfall event at the end of the month.

6.2 Vegetation

The post-construction terrestrial vegetation mapping and ground-truthing identified 15 vegetated habitat classes and one non-vegetated (open water) habitat class at both sites. With the exception of one vegetated habitat class that was common to both sites (SW - Shoreline Willow), the vegetation communities documented at the sites were different. However, the distribution of the habitat classes (with the exception of floating islands) followed a similar pattern at both the Airport Lagoon and Beaver Pond sites. The general pattern of habitats was a band of coarse woody debris and shrub/grass cover parallel to the edge of the reservoir at full pool transitioning into a band of sparsely vegetated sand or clay to an area of sparsely vegetated mud adjacent to the water's edge.

The number and locations of the floating islands at Airport Lagoon in Year 5 appeared to differ in comparison to the previous year. These islands are likely to degrade overtime as a result of physical disturbances from the rise and fall of reservoir levels and so changes in the size, number and location of the islands is expected.

Table 21. **The status of the GMSMON-15 management questions and hypotheses following completion of Year 5 of the monitoring program.**

Management Question	Management Hypothesis (Null)	Year 5 (2015) Status
Is there a change in the abundance, diversity and extent of vegetation in the enhancement area?	H_{01}: The density, diversity and spatial extent of riparian and aquatic vegetation does not change following enhancement.	No changes in riparian vegetation have been detected at the Airport Lagoon. The second year of post-construction monitoring shows a continued increase in the extent of aquatic vegetation associated with the new water level. No changes in riparian or aquatic vegetation were detected in the first post-construction monitoring at the Beaver Pond site.
Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?		The two years of post-construction data from the Airport Lagoon project shows continued use by waterfowl and other wildlife. The single year of post-construction data from the Beaver Pond project is consistent with the baseline data.
	H_{02}: The species composition and density of waterfowl and songbirds does not change following enhancement.	The two years of post-construction data from the Airport Lagoon show some changes in waterfowl and songbird species composition and density. The single year of post-construction data from the Beaver Pond project is consistent with the baseline data. Additional monitoring will be required for testing of this hypothesis.
	H_{03}: Amphibian abundance and diversity in the wetland does not change following wetland enhancement.	The two years of post-construction data from the Airport Lagoon showed some changes in amphibian abundance. The single year of post-construction data from the Beaver Pond site showed increases in amphibian abundance. Additional monitoring will be required for testing of this hypothesis.
Is the area and quality of wildlife habitat created by the wetland enhancement maintained over time?		With only two years of post-construction data from the Airport Lagoon site and a single year of post-construction data from the Beaver Pond project it is not possible to comment on the long term persistence and quality of habitat.

The habitat classes observed at both sites have developed in response to the annual flooding regime from reservoir operations. As the timing of reservoir filling and the maximum elevation reached varies from year to year, the species present in each of the habitat classes is expected to be variable, particularly in higher elevation habitat classes that may not be flooded every year. In 2010 reservoir levels did not exceed 665 m during the growing season resulting in most of the mapped area at both sites not being flooded. This allowed for colonization by species that are less tolerant of inundation. The higher elevation of the new culverts reduces the influence of reservoir on lagoon water levels to only when the reservoir elevation exceeds 667 m. In years with low reservoir elevations (<667 m), lagoon water levels will be unaffected as they are maintained by existing, upstream inflows. Reservoir levels in subsequent years of the project were much higher with water levels near or at full pool in Years 1 (2011), 2 (2012) and 5 (2015) and near average water levels in Years 3 (2013) and 4 (2014). The maximum water levels reached were 671.4 m in late August 2011, 672 m at the end of July 2012, 669.8 m in early August 2013, 668.7 m at the end of July 2014 and 671.5 m in late October 2015. As a result, all transects and the majority of mapped habitat classes were inundated in 2011, 2012 and 2015 while the higher elevation transects were either not flooded or only partially flooded in 2013 and 2014.

The distribution of CWD at Airport Lagoon site in Year 4 was reflective of elevation within the drawdown zone with the highest densities of CWD occurring at the upper limits of the drawdown zone and decreasing densities with decreasing elevation. The one exception to this are areas at elevations above the high density CWD class on the east side of Airport Lagoon where the CWD density is moderate. Mapping of CWD will be updated in Year 6 to determine if there were any changes in extent or distribution following the high reservoir elevation in 2015.

The distribution of aquatic plant communities (as defined by a dominant species) observed at the Airport Lagoon site in Year 5 differed slightly from the previous year and was attributed to water depth (and thus elevation within the drawdown zone) and the distribution of permanent water cover prior to construction of the wetland enhancement. In terms of water depth, aquatic plant communities dominated by emergent species (e.g., water smartweed) occurred along the shoreline and shallow waters in comparison to communities dominated by submergent aquatic species (e.g., common hornwort) that occurred within deeper water at the site. Overall, aquatic plant communities were primarily located in areas of the site where permanent water cover (either stream or pond) existed prior to the construction of the wetland enhancement. In areas where a permanent water body did not exist prior to enhancement, the occurrence of aquatic plants was sparse to absent.

In Year 5, a new aquatic plant community, Closed-leaved Potamogeton, was observed along the southwest shoreline of Airport Lagoon. In Year 4, no aquatic plants were observed in this area. This observation suggests that the distribution of aquatic plants within Airport Lagoon may be expanding into areas previously uninhabited by these species as a result of permanent flooding from the wetland enhancement.

Terrestrial plant species identified at the study sites during Year 1 ground surveys that were not detected (either absent or only dead remains were observed) during the Year 2-5 ground surveys are likely to be intolerant to flooding events. Based on their life history, some of the species identified are adapted to dry to mesic soils (e.g., fireweed, red raspberry and trembling aspen) and therefore, their intolerance of flooding is expected. However, a few species identified are adapted to moist to wet soils and yet were still found to be intolerant to flooding (e.g., dead remains of Norwegian cinquefoil and common cattail were apparent across the Airport Lagoon site). Their intolerance may partly be related to the timing (early to middle of the growing season) of flooding but may also a result of the depth (can be >4 m) and duration of flooding (the remainder of the growing season).

All terrestrial species identified during Year 5 ground sampling are likely to be tolerant to flooding events. A majority of these species are adapted to wet soils that are often saturated for a portion of or the entire growing season (e.g., lady's thumb, common horsetail, water smartweed and common hook-moss). Many of these species have also been observed as regularly occurring within the drawdown zone of other reservoirs located in B.C (e.g., bluejoint, reed canarygrass, common and swamp horsetail and water sedge at Arrow Lakes and Kinbasket Lake).

Most of the aquatic plant species identified at Airport Lagoon during Year 5 were present in Year 4. Although no sampling of aquatic plants was conducted during Years 1-3, it is assumed that most species were also present in the areas of permanent open water that existed prior to construction. All species identified are expected to continue to be present at the site in future years. Within the areas where aquatic species were observed, species distribution was primarily based on life history (i.e., emergent versus submergent). Most submergent species (e.g., common hornwort) were only observed within areas where a permanent water body existed prior to wetland enhancement as they are intolerant to exposure to the air. In contrast, most emergent species (e.g., water smartweed) are found in shallow waters and along the shoreline and have a higher tolerance to changes in water level.

As with terrestrial plant species, the abundance and distribution of some aquatic plant species observed at Airport Lagoon is likely to vary from year to year as a result of the timing of reservoir filling and the maximum elevation reached. For example, during aquatic plant surveys in Year 4, lady's thumb was commonly distributed throughout the lagoon and provided substantial vegetation cover in shallow water along the shorelines; in contrast, lady's thumb was mostly absent from Airport Lagoon in Year 5. The opposite occurred with water smartweed as it provided considerably higher plant cover in the northeast arm of the lagoon in Year 5 compared to Year 4. Reservoir levels at Airport Lagoon in Year 5 were higher than in the previous year, which suggests that water smartweed may be able to tolerate deeper water in comparison to lady's thumb.

6.3 Waterfowl and Shorebirds

The Year 5 waterfowl and shorebird survey results were slightly lower than those recorded in preceding years. Survey dates were consistent with previous years, providing continuity in the characterization of habitat use by migrating and nesting species at the Airport Lagoon and Beaver Pond sites.

During the 2015 surveys, the total number of waterfowl detected at Airport Lagoon was the lowest recorded since Year 1, when only three surveys were conducted. Species richness (12) also matched the lowest diversity previously recorded in 2013. Conversely, the highest numbers of individuals were also recorded during the 2013 season when the physical works were completed. Record numbers of waterfowl including large flocks of Mallard and Green-winged Teal were recorded in Year 3 during the May 1 survey. The last survey of 2013 (June 10) was conducted after the construction had been completed and over a week later than in other years with a higher than usual number of birds were detected. In all other years, the highest number of individuals were recorded during the earliest survey of the season. In 2015, the second survey provided the highest record of abundance. Mild temperatures and dry conditions in spring 2015 may have impacted the timing of migration sufficiently to have produced this result. Differences in environmental conditions, timing, and route of migration from year to year are likely contributors to the variability in species composition detected during the surveys.

Shorebirds were not included in the Year 1 surveys but have been recorded annually since 2012. The total number of shorebirds and species richness recorded in 2015 was the same as in the previous year (68 individuals, 8 species). Shorebird species richness and abundance were lowest during the 2013 surveys, likely due to disturbance during construction of the wetland enhancement. A large flock of Long-billed Dowitcher (68 individuals accounting for 54.4% of detections) skewed the data in 2012. If that outlier is removed from the data set, the post-construction total shorebird numbers are consistent with pre-construction detections suggesting that, to date the enhancements have not impacted shorebird abundance at the Airport Lagoon site. However, there appears to be less variability in shorebird abundance between survey dates in the post-construction results than the baseline data. The planned additional monitoring will assist in confirming if shorebird abundance at the Airport Lagoon site is more consistent as a result of the wetland enhancement.

Nesting Killdeer pairs were recorded on two of the floating islands at Airport Lagoon. This is the first time that nesting habitat use can be directly attributed to changes resulting from the habitat enhancement work, since these islands were not present before the physical works were completed. Incidental observations of 3 Canada Goose pairs with broods during the point count surveys confirms the presence of productive nesting habitat in the area, most likely in the cutblocks above the drawdown zone.

Consistent with 2014 results, detections of Common Loon, which require larger bodies of water, were once again higher at the Airport Lagoon than in the pre-construction surveys. Conversely Bufflehead, a species preferring smaller ponds were recorded in lower numbers than in any previous year (Evers et al. 2010, Gauthier 2014). This may be an early indication that the elevated water levels and more stable hydroperiod is influencing habitat use by some species at the site.

The 2015 effort represents the first post-construction waterfowl and shorebird surveys at the Beaver Pond site. The addition of the berm has provided a larger permanent water body, potentially enhancing habitat for feeding and other water based activities. A number of shorebirds (Greater Yellowlegs, Spotted Sandpiper, and Killdeer) were observed feeding on large numbers of western toad tadpoles in shallow water along the peripheries of the new pond. The extended hydroperiod and less extreme water level fluctuations have yet to influence the surrounding vegetation. Subsequently, to date there has been no significant change to the quality or availability of nesting habitat. No shorebird nests were located at this site during the searches conducted during Year 5. Incidental observations included a pair of Spotted Sandpiper exhibiting nesting behaviours within the drawdown zone. A pair of Killdeer and several Greater Yellowlegs were frequently seen feeding at the site, leaving for a short period and returning from the same direction suggesting that they were potentially nesting off site in the near vicinity. Disturbance within the drawdown zone resulting from the construction phase in 2014 seems to have had little effect on the existing nesting and cover habitat.

As mentioned in previous years (e.g., CBA 2015), unfavourable weather conditions and ice cover on Williston Reservoir typically limit early spring access to the Beaver Pond site. The beaver ponds and the newly created pond are likely to be ice free before the reservoir so the surveys are unlikely to capture the full extent of waterfowl and shorebird use of the site early in the season.

Differences in environmental conditions, timing, and migration route from year to year are likely contributors to the variability in waterfowl and shorebird species composition detected during the surveys. The existing lack of high quality nesting habitat based on the breeding habitat requirements of waterfowl species detected during the study and the fact that extensive nest searching efforts have only confirmed three species (Spotted Sandpiper, Killdeer, and Canada Goose) as nesting, suggests that the majority of species recorded during surveys were migrants passing through to other breeding sites. It is expected to take several years before the wetland enhancements result in changes to the vegetation cover that would increase the availability of nesting habitat for most waterfowl species. Over time the reduced fluctuations in water level resulting from the extended hydroperiod should improve breeding habitat quality. The development of emergent and aquatic vegetation and well-vegetated grass and shrublands will increase the quality of available wetland habitat and its' proximity to potential nesting habitat. However, the development of riparian vegetation at both sites is still heavily influenced by annual reservoir fluctuations.

6.4 Songbirds

The songbird survey results in 2015 were similar to previous years. Species richness both at the Airport Lagoon site and for both sites combined was at the lowest recorded since surveys were initiated. Species richness was slightly higher at Beaver Pond than it was last year. The average number of species per station was also lower than all previous years with the exception of 2013 when the construction work at Airport Lagoon was carried out. The higher diversity consistently recorded at Airport Lagoon can be attributed to the larger area, more diverse habitat types and the amount of time and effort associated with the point counts (17 stations compared to 3 at Beaver Pond), All species detected at Beaver Pond with the exception of Red-breasted Sapsucker, Ruffed Grouse, and Rusty Blackbird were also detected at the Airport Lagoon site.

The total number of detections recorded at Beaver Pond was the lowest since surveys started, including 2014 when construction was ongoing at the site when the surveys were conducted. At Airport Lagoon and for both sites combined, the number of detections was also the lowest recorded with the exception of the 2013 surveys when the surveys coincided with construction of the wetland enhancements at the Airport Lagoon site.

In 2015, a higher percentage of the detections at both sites were recorded in the drawdown zone than in any of the previous years except for 2011 when no locations were recorded. In addition to this, in 2014 a majority of detections (30.8%, n=415) were recorded in the drawdown zone. This maybe an early indication that the distribution of songbirds at the Airport Lagoon is changing, with a larger percentage using the drawdown zone than in the pre-construction surveys. However, additional surveys will be required to determine if this is a result of the wetland enhancement or variability in the annual peak reservoir level.

Although the number of detections in the drawdown zone at Airport Lagoon was slightly lower than in 2014, the total number of individuals recorded and the species richness was higher than in any of the previous study years. When only water-dependent genera (shorebirds, waterfowl, and gulls) are considered, the number of detections and individuals were slightly lower than in 2014, while the species richness was the same. The number of detections, individuals, and species richness recorded in the drawdown zone at Airport Lagoon are higher during the post construction surveys compared to the pre-construction data both when all species are considered and when water dependent genera are considered separately.

Consistent with every other year at Beaver Pond, a majority of the detections were located in the forested area above the drawdown zone. Similar to the 2012 results, the highest number of detections at Airport Lagoon in 2015 were recorded in the shrubs around the periphery of the drawdown zone. The location of the majority of detections at the Airport Lagoon site is more variable from year to year than at the Beaver Pond site

The number of nests located in 2015 at the Airport Lagoon was more than double the seven recorded in 2014. The inherent variability in nest searching success along with the small size of the study area when compared to the nesting territories of some species means that even small changes in nesting patterns by some species will influence the number of nests located from year to year. While only ten species were confirmed to be nesting this year, observations (nesting and feeding behaviours) indicated that a number of other species were likely nesting in the area. A Canada Goose had occupied the Osprey nest from previous years during the early part of the season. The Osprey pair constructed a new nest on the nearest available tall snag. However, both nests failed before the final survey of the season was completed and there was no evidence to suggest a second attempt at nesting occurred in either. For the first time, an American Kestrel nest and a Bonaparte’s Gull nest were located in a large conifers just above the drawdown zone. Cavity nests for Tree Swallows and Northern Flicker were identified in snags along the waters' edge; and Dark-eyed Junco, Lincoln's and Savannah Sparrow nests were located on the ground within the drawdown zone.

For the second consecutive year, Savannah Sparrows were recorded in record numbers. Prior to 2014, detections of this grassland specialist species were highest in 2011 (10 individuals), numbers decreased slightly in 2012 and they were not recorded in the 2013 surveys. This pattern may indicate that habitat use and conditions in at least parts of the drawdown zone at Airport Lagoon have recovered following the reduced vegetation cover observed during Year 2 (CBA 2013) as a result of high water levels. This maybe the result of lower water levels in 2013 and 2014 which allowed for additional vegetation development in the upper portions of the drawdown zone that potentially improved habitat quality and availability for some species. The upcoming surveys in Year 6 should provide some confirmation of the effect of high reservoir elevations following the near full pool conditions in 2015.

6.5 Amphibians

Consistent with other inventory work in the Williston Reservoir watershed, including the previous four years of this project, western toad were the most commonly detected species (Hengeveld 2000). Three of the four amphibian species confirmed to breed in the study areas were detected in Year 5. Columbia spotted frog was not detected at either site and wood frogs were only detected at Beaver Pond during the surveys. A single wood frog was incidentally observed at the Airport Lagoon site in 2015. The only detection of Columbia spotted frog occurred at Airport Lagoon in 2014. Columbia spotted frogs have not been detected at Beaver Pond since this monitoring program was initiated in 2011.

The first survey of the season at Airport Lagoon is planned to account for early season breeding species such as wood frog and long-toed salamander. Depending on the spring conditions, it is usually initiated before ice and snow cover melts and as early in the season as conditions allow (Matsuda et al. 2006). However, unseasonably warm and dry conditions in early spring meant that there was no ice nor snow at the site when the May 1 survey was completed in Year 5. A single long-toed salamander and three western toad were the only early season detections. Typically access issues due to ice cover on Williston Reservoir and unfavourable weather conditions limit early access to the Beaver Pond site and surveys are planned accordingly. The first survey of the season for Beaver Pond was conducted on May 8, a total of eight long-toed salamanders were the only detections.

Similar to the previous four years, transect 25 at Airport Lagoon was the most productive with detections of western toad recorded during all four surveys but no other species were detected on this transect. The May 20 survey had the highest number of detections (16), this number was significantly lower than the 67 western toads recoded on the May 11, 2014 survey. The consistently high number of detections can be attributed to the fact that this transect circumnavigates a small permanent pond with a large amount of coarse woody debris and a diverse range of vegetated and unvegetated ground along the edges providing high amphibian habitat value. At the Beaver Pond site, environmental conditions and the survey timing on June 5 may have coincided with a peak movement period resulting in a high number (58 individuals) of western toad detections.

Western toad numbers have been higher in the post-construction surveys when compared to baseline data at both sites. Long-toed salamander numbers at Beaver Pond have also been higher in the Year 4 and 5 surveys than they were during the previous years.

As ectotherms, amphibian activity is limited by environmental conditions. They are more active during warm weather and after rainfall (RIC 1998). Pre-construction survey results were consistent with these assertions with the highest number of detections recorded in Year 1 (warmer than average temperatures and above average precipitation). Conversely the lowest number of detections were recorded in Year 2 (cooler with below average precipitation). Temperatures in Year 5 were generally above average with the exception of a few days immediately prior to the early season surveys, spikes in temperature occurred around the May 20 and 22 and June 5 surveys. Most of May 2015 was the driest conditions observed over the duration of this monitoring program. A single rainfall event on May 29 and 30 preceded final surveys at the Airport Lagoon and Beaver Pond sites.

A considerable degree of year to year variability in amphibian populations is also expected (RIC 1998, US EPA 2002). Variation in the adult amphibian population is often due to juvenile recruitment, predominantly larval survival. Survival in wood frogs is positively correlated with early metamorphosis and larval size at metamorphosis (Berven 1990). Mortality rates for the large number of western toad tadpoles recorded in the newly created pond behind the berm at the Beaver Pond site may affect the abundance of this species during the Year 6 and subsequent surveys. The shorter and earlier breeding season for wood frogs and long-toed salamander make it unlikely that surveys will coincide with peak breeding and migration periods for these species. This likely explains the low number of detections for these species, and the absence of long-toed salamanders in the late season surveys (Matsuda et al. 2006). The regular detections of long-toed salamander eggs and adults in the early season surveys suggests that they are breeding just prior to the survey dates.

The habitat enhancement efforts have only been recently constructed and it may take several years for the reduced fluctuations in water levels and more stable hydroperiod to have a positive impact on amphibian populations. High water levels between the 2011 and 2012 surveys decreased the amount of cover and quality of amphibian habitat at both Airport Lagoon and Beaver Pond. Vegetation has not returned to pre-2012 levels (CBA 2013). It will take time for succession to progress to a point where the connectivity between seasonal terrestrial and breeding habitat is sufficient to affect population abundance and habitat use, particularly following a year of with a high reservoir elevation like 2015.

6.6 Fish

Fish sampling by electrofishing, minnow trapping, and fyke nets continued to be effective sampling methods for monitoring fish populations at both wetland enhancement sites. The three methods of sampling resulted in the collection of 11 of 22 species known to occur in the reservoir in 2015. All species collected in 2015 have been observed in previous years. Between the two sites a total of 13 fish species have been observed over the first five years of the project. The low catch rates observed during the July 2015 sampling at the Airport Lagoon are considered to be a result of the high reservoir levels at the time of sampling.

At the time of sampling, the reservoir elevation was high enough to refloat stranded debris around the lagoon which limited access to the shore to anchor the lead of the fyke net. The upper elevations in the drawdown zone in the Airport Lagoon generally have steeper slopes requiring the fyke nets to be set water deeper than the net. The fyke nets are 1 m deep and setting them in water deeper than about 1.5 m reduces the effectiveness by providing more opportunity for fish to avoid the net. In both sets in July 2015, the cod end of the net was in water >2 m deep. The amount of floating debris along the shore also limited the access for shallow water sets of the minnow traps. The high reservoir elevation also increased the area of habitat available to the lagoon fish population so that trap and net encounter rates would be considerably lower compared to spring sampling at low water. The reservoir elevation at the time of sampling in 2015 was higher than during any of the previous July fish sampling at the Airport Lagoon. The reservoir elevation in 2012 was higher but the water level in the lagoon appeared to be approximately 2 m lower than in the reservoir. This was assumed to be the result of a blockage in the old culverts (the new culverts were installed in spring 2013).

The fish sampling results for 2015 from the Airport Lagoon confirms the previous conclusion (CBA 2014, 2015) that this site has a resident fish population of cyprinids, suckers, and sculpins. The most abundant species continued to be Lake Chub, Brassy Minnow, and Redside Shiner with varying abundance depending on the sampling gear and period. Based on the May 2015 fyke net catches, the abundance of these species may have continued to increase. The May 2015 minnow trap results suggest that the abundance may have levelled off although due to the high numbers of fish caught in each minnow trap it may not be possible to detect higher numbers of fish as each trap may be catching the maximum possible based on trap size and bait.

The increase in numbers of Brassy Minnow, Lake Chub, and Redside Shiner initially observed in 2013 was assumed to be the result of two years of high reservoir levels increasing the amount of suitable habitat available for these species (CBA 2014). The high reservoir levels in 2011 and 2012 were in contrast to 2010 when low water levels limited available habitat to the stream flowing through this site and the two ponds (adjacent to the causeway and in the northwest arm). The installation of the new culverts in May 2013 increased the amount of habitat available at lower reservoir levels and reduced seasonal variability in habitat area. This is assumed to be the primary reason for the increased fish abundance observed in 2014 (CBA 2015). While the results for 2015 showed some variability, fish abundance continued to be high confirming that the increase in habitat area has increased the fish population.

Based on the description of the Beaver Pond site (Golder 2010, 2011), it was originally expected that low numbers of fish would be encountered at this location. However, early season fish captures have been variable over the first five years of the monitoring project. High numbers of fish were captured by electrofishing in 2011 and 2013 (CBA 2012, 2014). Only a single fish was captured by electrofishing in 2012 (CBA 2013), no fish were captured by electrofishing in 2014, and a few fish were captured in 2015. Reservoir conditions and sampling date are considered to be the likely reasons for the observed differences. Sampling in 2012 and 2014 was completed at earlier dates and lower reservoir levels compared to 2011 and 2013. The reservoir elevation in 2015 was higher than during any of the previous years. At low reservoir levels, the lower part of the stream is considered impassable to small fish.

Due to weather conditions, no fish sampling by fyke net or minnow trapping was completed at the Beaver Pond site in 2015. Over the first four years of the project, the relative abundance of fish, based on captures by minnow trap and fyke net, at the Beaver Pond site has increased. The reasons for the increase are unclear and may be associated with the water level at the time of sampling in July or differences in water quality (temperature and turbidity). Different water levels can affect the effectiveness of the fyke net due to the limited number of suitable locations for setting at this site. For water quality, if the inlet has warmer temperatures or lower turbidity than the main reservoir it may offer preferred habitat. The construction of the wetland has changed the amount and type of habitat available to juvenile fish at low reservoir elevations. At reservoir elevations that inundate the site, conditions are unchanged. However, the presence of a new, permanent wetland may change the productivity of the site and increase its value to fish. Additional years of monitoring will provide more information on variation in fish abundance at this site and factors that may influence the variability.

7 CONCLUSIONS

The baseline data collected in Years 1 - 3 of the GMSMON-15 project (CBA 2012, 2013, 2014) were considered to support the preliminary impact and benefit predictions for the proposed wetland enhancements (Golder 2011). The two years of post-construction observations at the Airport Lagoon in Year 4 and Year 5 provide some indications that the project is achieving the desired results and that the survey methods will detect changes associated with the enhancement projects. General increases in relative abundance over the baseline data collected in Years 1 - 3 were observed for waterfowl, shorebirds, songbirds, amphibians, and fish. Additional years of post-construction monitoring data will be required to confirm if the increases are sustained and a result of the enhancement project. As observed in the baseline data, there is expected to be continued variability in the data due to natural variation and annual differences in reservoir and environmental conditions. Based on the post-construction results from Years 4 (Airport Lagoon) and 5 (Airport Lagoon and Beaver Pond) and assuming that the interannual variability in future years is similar to what has been observed, the existing monitoring protocols are expected to answer the management questions and hypotheses.

The smaller than planned and lower elevation wetland at the Beaver Pond site will likely reduce the magnitude of changes that occur at this site. The smaller size reduces the amount of habitat potentially available and the lower elevation increases the influence of the reservoir on the site. However, as the baseline use of the site by the indicator groups is low it is expected that even small changes will be detectable.

For terrestrial and aquatic vegetation, the additional data collected in Year 5 provided a better characterization of the vegetation types that remain following the completion of the wetland enhancement projects. The completion of the enhancement projects is expected to allow the development of aquatic vegetation that is currently non-existent (Beaver Pond) or limited in extent (Airport Lagoon). In Year 4, aquatic plant sampling at the Airport Lagoon site identified areas within the created wetland where aquatic plant species were sparse to absent. Observations from Year 5 suggest that some of these areas are now beginning to be colonized by aquatic plants and it is expected that further colonization is likely to occur over time through natural dispersal of seed from areas within the permanent water body where aquatic plants are well established.

The proposed wetland designs reduce the influence of reservoir conditions on these sites but do not entirely isolate them. Vegetation communities above the wetland enhancement design elevations are expected to be primarily influenced by annual reservoir elevations. Changes in vegetation communities as a result of the wetland enhancements are most likely to be observed in areas that are permanently flooded (change from drawdown zone to aquatic habitat) and in areas adjacent to the new wetlands as a result of the increased and stabilized water levels.

The differences in the waterfowl and shorebird results observed over the first three years of the monitoring program were considered to be a result of natural variability. Post-construction results are also likely to exhibit natural variability, which may explain the slightly lower results this year when compared to 2014 records. Depending on the time of ice off at the Airport Lagoon and Beaver Pond in relation to the reservoir following completion of the wetland enhancements, there may also be an increase in the numbers of spring migrants due to increased habitat area. Early season access limitations at Beaver Pond will continue to limit the available data at that site.

The change in habitat area at the Airport Lagoon was expected to result in some changes to the patterns of waterfowl use at the site and early post-construction observations in June 2013 and the 2014 season provided an early indication of this (CBA 2014, CBA 2015). The results from 2014 and 2015 provide additional support to this prediction with an increase in the number of detections in the later season surveys. Spatial analysis of waterfowl locations recorded during the surveys will assist in identifying changes once additional post-construction monitoring is completed. The small size of the completed Beaver Pond project will likely result in little change in use of the site by waterfowl or shorebirds. However, as there was little to no use of the Beaver Pond site by waterfowl or shorebirds prior to enhancement it will be possible to detect even small changes in use.

Stabilization of the water regime may allow for development of wetland and riparian vegetation at both sites and therefore increase habitat availability for both waterfowl and songbirds. The natural process of re-vegetation is likely to take several years. Therefore, it is possible that some of the long term vegetation changes due to the enhancement program may not be measurable within the scope of this project. The differences in baseline songbird results observed in the first three years of monitoring were considered to be the result of natural variability. The natural fluctuations in populations and habitat use are likely to continue with the post-construction survey results. Some of the variation observed may also be related to the annual peak reservoir elevation, with years of average elevation allowing for increased vegetation development and improved habitat for some species at the upper elevations of the drawdown zone.

While it is still too early to draw any significant inferences from the post-construction data at the Airport Lagoon site, the number of detections located within the drawdown zone in the post-construction phase is higher than the baseline results. Though lower than in 2014, the numbers of water-dependent genera (shorebirds, waterfowl, and gulls) detected in 2015 remained higher than the pre-construction results. These results maybe an early indication that the enhancements are having the desired effects at this site. The construction at Beaver Pond was completed in 2014 during the Year 4 point count survey period. Since construction was completed, the disturbance levels in Year 5 were significantly lower. However, the number of detections recorded were the lowest since surveys began. This is assumed to be the result of interannual variability.

Little annual variation was observed in the number of species detected in habitats affected or potentially affected by the wetland enhancements (drawdown zone and shrubs) at either site during the pre-enhancement surveys. This allows for the detection of even small changes in the species detected in the drawdown zone where the greatest degree of change in habitat use is anticipated. Despite the lower numbers overall, the percentage of detections in the drawdown zone at Beaver Pond was higher than in any of the other survey years. The berm at this site has increased the size of the permanent wetland which now sustains a more stable water regime. With the development of emergent and aquatic vegetation over time, the quantity and quality of habitat available within the drawdown zone would be expected to improve.

During the pre-enhancement phase of the monitoring program, the use of both sites by three species of breeding amphibians was confirmed. A fourth species was also detected at the Airport Lagoon site in 2014 during the first season of post-construction monitoring. The low abundance of amphibians detected at Beaver Pond (mean = 2.44) and Airport Lagoon (mean = 3.83) during baseline monitoring should assist in determining if the habitat enhancements result in increased abundance of amphibians at both sites (CBA 2014). Based on the low abundance, it is expected that a minimum increase in the mean abundance of four to five individuals will be detectable (CBA 2014) provided the variance is similar in the post-construction period. With the completion of two years of post-construction monitoring at the Airport Lagoon and the first year of post-construction monitoring at the Beaver Pond site, the initial observations is that there has been a slight increase in western toad populations at both sites. Additional monitoring will be required to determine if the increases are associated with the wetland enhancements.

Based on the mean annual abundance during the pre-enhancement phase, a minimum increase in mean abundance of four to five individuals at each site is expected to be detectable over the next several years. If the projects are effective at increasing amphibian populations, it is expected that larger increases will be observed. This is particularly true at the Beaver Pond site where the wetland enhancement will result in a large increase in the amount of amphibian breeding and rearing habitat available. At the Airport Lagoon, additional comparisons among transects and within transects will also be possible.

The completed Beaver Pond project has reduced the amount of stream habitat available prior to inundation by the reservoir but this is expected to have minimal effects on fish use of this area. Numerous small fish were captured at the stream mouth during construction (DWB 2014), a school of small fish was observed at the base of the berm during vegetation sampling in June 2014 (post-construction), and fish were captured downstream of the berm in 2015. The potential for fish to become trapped in the wetland during years when reservoir levels exceed the height of the proposed berm was confirmed in 2015 with incidental observations of fish jumping in the new wetland. The reservoir elevation was higher than the new wetland in 2014. The presence of fish jumping in 2015 indicates that the new wetland does offer suitable conditions for fish to overwinter. Early season fish sampling in the stream and the wetland will continue at this site to determine the extent of fish use of the constructed wetland.

At the Airport Lagoon, the continued high numbers of fish captured in the May 2015 sampling provides additional confirmation that the project has increased the amount of habitat for fish due to reduced seasonal fluctuations in the amount of habitat available. The catch per unit effort for the three most common species (Lake Chub, Brassy Minnow, and Redside Shiner) increased during the pre-construction monitoring period (CBA 2014) and the trend continued in the first year of post-construction monitoring. The results from May 2015 indicate that this trend may have continued two years post-construction. The pre-construction increases were considered to be associated with higher reservoir levels in 2011 and 2012 compared to 2010 that increased the amount of habitat available (CBA 2014). For other species, the high reservoir levels may have limited the potential for young-of-the-year fish to move into the lagoon (CBA 2014).

Other than the large increases in the populations of Lake Chub, Brassy Minnow, and Redside Shiner were observed during the pre-enhancement phase of the project, there was little interannual variability in the relative abundance (CPUE) of the other species collected by minnow traps or fyke net (CBA 2014). As there was little variability in most species, it was expected that the existing sampling methods would detect small increases in relative abundance for most species. Continued population monitoring will be required to determine if the populations of these species increase further or remain relatively stable at a the higher relative abundance than observed during in the first year of post construction monitoring. Additional sampling will also confirm if the low catches in July 2015 were anomalous and associated with the high reservoir elevation rather than a change in the Airport Lagoon fish population.

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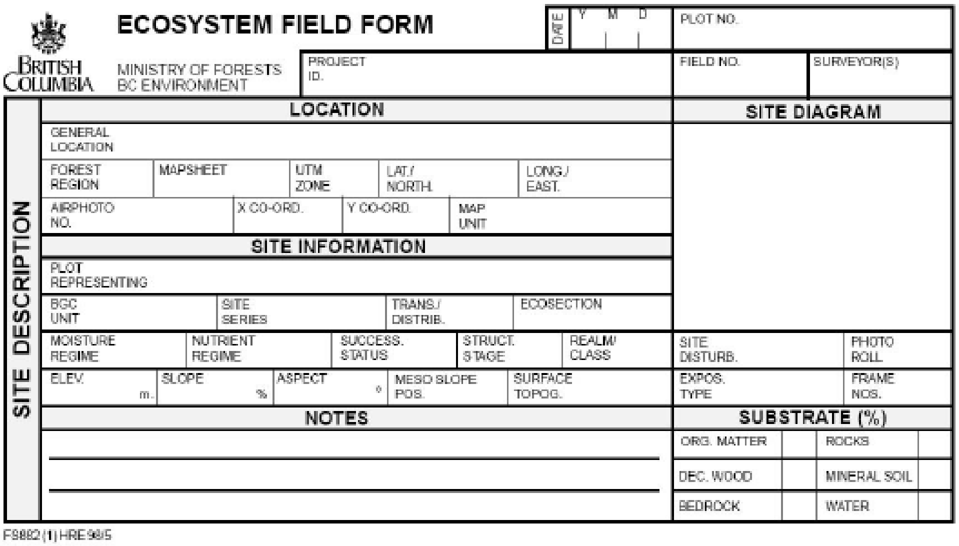
Appendix 1. Locations of vegetation belt-transects.

Site	Transect[1]	UTM Zone	Easting	Northing
Airport Lagoon	AL1-1	10U	492406	6125720
	AL1-2	10U	492404	6125703
	AL2-1	10U	492491	6125900
	AL2-2	10U	492490	6125882
	AL3-1	10U	492440	6126076
	AL3-2	10U	492456	6126064
	AL4-1	10U	492457	6126395
	AL4-2	10U	492465	6126375
	AL5-1	10U	492229	6126681
	AL5-2	10U	492249	6126686
	AL6-1	10U	492586	6126956
	AL6-2	10U	492601	6126947
	AL7-1	10U	492721	6126541
	AL7-2	10U	492723	6126524
	AL8-1	10U	492641	6125643
	AL8-2	10U	492638	6125664
	AL9-1	10U	492660	6125937
	AL9-2	10U	492661	6125918
	AL10-1	10U	492695	6126423
	AL10-2	10U	492698	6126442
	AL11-1	10U	492327	6126440
	AL11-2	10U	479231	6126428
	AL12-1	10U	492548	6126834
	AL12-2	10U	492548	6126853
Beaver Pond	BP1-1	10U	479296	6148230
	BP1-2	10U	479276	6148234
	BP2-1	10U	479313	6148248
	BP2-2	10U	479297	6148256
	BP3-1	10U	479335	6148268
	BP3-2	10U	479321	6148284
	BP4-1	10U	479307	6148277
	BP4-2	10U	479295	6148294
	BP5-1	10U	479243	6148225
	BP5-2	10U	479231	6148235

[1] -The ‘1’ suffix denotes the beginning of a transect and the ‘2’ suffix the end

.

Appendix 2. Ecosystem field forms used for ground sampling of vegetation polygons.



ECOSYSTEM FIELD FORM

BRITISH COLUMBIA
MINISTRY OF FORESTS
BC ENVIRONMENT

DATE Y M D
PLOT NO.
PROJECT ID.
FIELD NO. | SURVEYOR(S)

SITE DESCRIPTION

LOCATION

GENERAL LOCATION
FOREST REGION | MAPSHEET | UTM ZONE | LAT./NORTH. | LONG./EAST.
AIRPHOTO NO. | X CO-ORD. | Y CO-ORD. | MAP UNIT

SITE INFORMATION

PLOT REPRESENTING
BGC UNIT | SITE SERIES | TRANS./DISTRIB. | ECOSECTION
MOISTURE REGIME | NUTRIENT REGIME | SUCCESS. STATUS | STRUCT. STAGE | REALM/CLASS
ELEV. m. | SLOPE % | ASPECT ° | MESO SLOPE POS. | SURFACE TOPOG.

NOTES

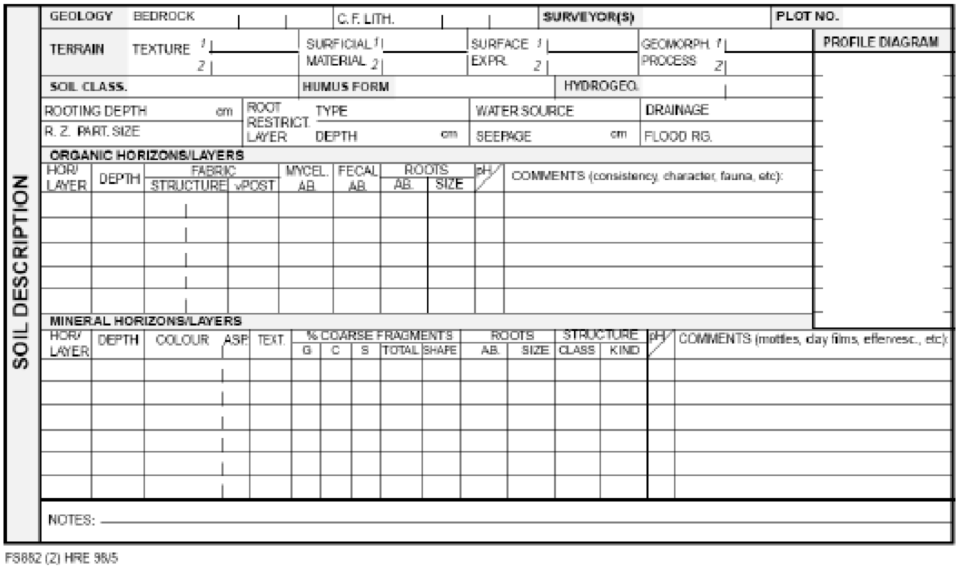
SITE DIAGRAM

SITE DISTURB. | PHOTO ROLL
EXPOS. TYPE | FRAME NOS.

SUBSTRATE (%)

ORG. MATTER		ROCKS	
DEC. WOOD		MINERAL SOIL	
BEDROCK		WATER	

FS882 (1) HRE 98/5



SOIL DESCRIPTION

GEOLOGY BEDROCK | C.F. LITH. | **SURVEYOR(S)** | **PLOT NO.**
TERRAIN TEXTURE 1 2 | SURFICIAL MATERIAL 1 2 | SURFACE EXPR. 1 2 | GEOMORPH. PROCESS 1 2
PROFILE DIAGRAM
SOIL CLASS. | **HUMUS FORM** | HYDROGEO.
ROOTING DEPTH cm | ROOT RESTRICT. LAYER TYPE | WATER SOURCE | DRAINAGE
R. Z. PART. SIZE | DEPTH cm | SEEPAGE cm | FLOOD RG.

ORGANIC HORIZONS/LAYERS

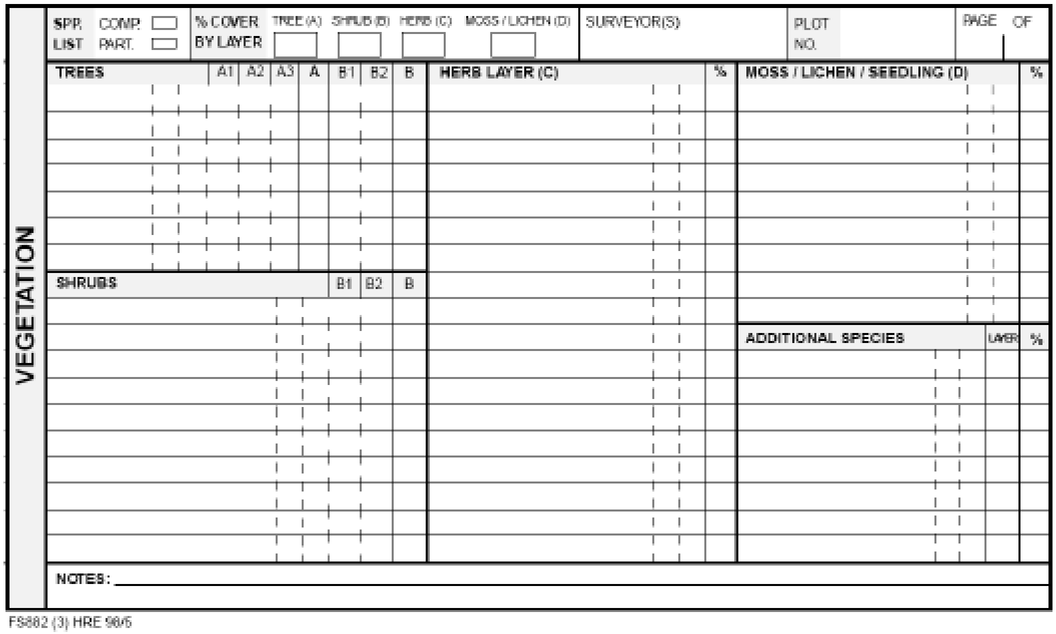
HOR/ LAYER	DEPTH	FABRIC		MYCEL. AB.	FECAL AB.	ROOTS		pH	COMMENTS (consistency, character, fauna, etc):
		STRUCTURE	vPOST			AB.	SIZE		

MINERAL HORIZONS/LAYERS

HOR/ LAYER	DEPTH	COLOUR	ASP.	TEXT.	% COARSE FRAGMENTS					ROOTS		STRUCTURE		pH	COMMENTS (mottles, clay films, effervesc., etc):
					G	C	S	TOTAL	SHAPE	AB.	SIZE	CLASS	KIND		

NOTES:

FS882 (2) HRE 98/5



VEGETATION

SPP. LIST COMP. ☐ PART. ☐

% COVER BY LAYER TREE (A) ☐ SHRUB (B) ☐ HERB (C) ☐ MOSS / LICHEN (D) ☐

SURVEYOR(S)

PLOT NO.

PAGE OF

TREES	A1	A2	A3	A	B1	B2	B

SHRUBS	B1	B2	B

HERB LAYER (C)	%

MOSS / LICHEN / SEEDLING (D)	%

ADDITIONAL SPECIES	LAYER	%

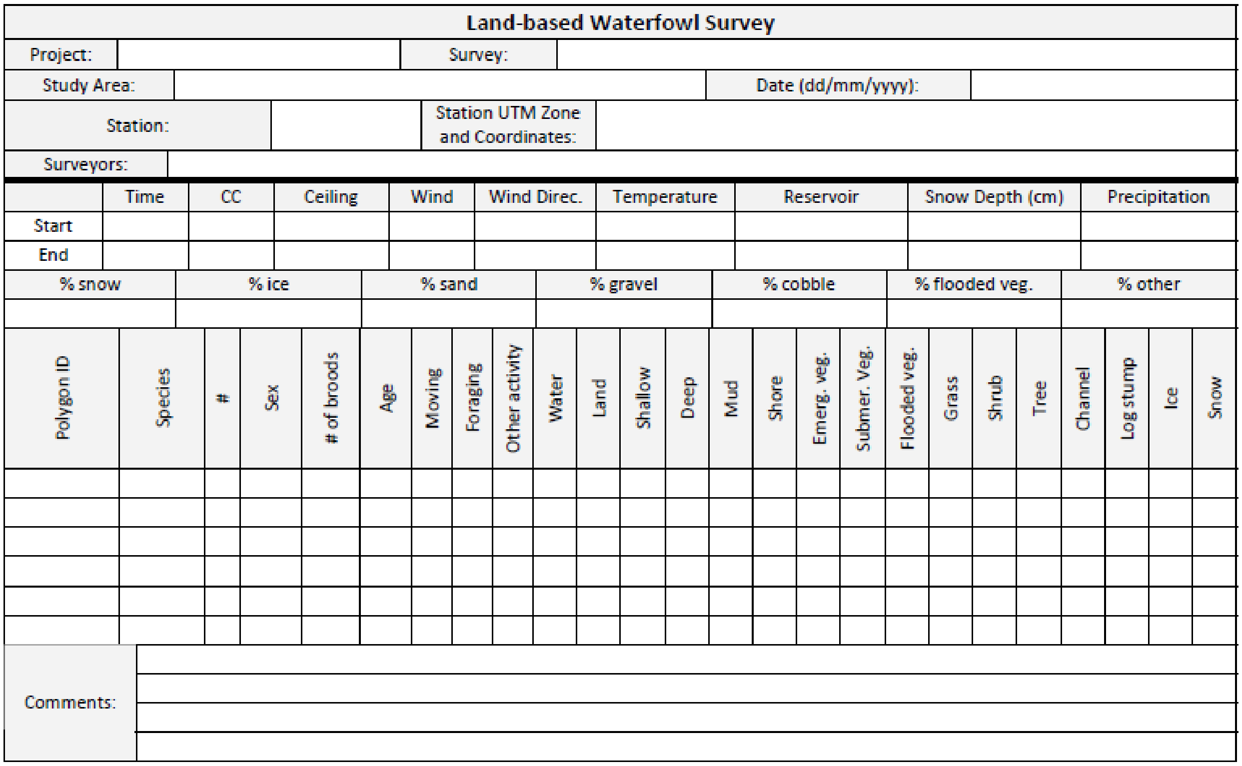
NOTES:

FS882 (3) HRE 98/5

Appendix 3. Waterfowl survey station UTM coordinates on Williston Reservoir, BC.

Site	Station	UTM Zone	Easting	Northing
Airport Lagoon	WSP-01	10U	492643	6125394
	WSP-02	10U	492468	6126031
	WSP-04	10U	492112	6126506
	WSP-03	10U	492426	6126227
	WSP-06	10U	492500	6126710
Beaver Pond	WSP-05	10U	479160	6148304

Appendix 4. Field form and site maps for waterfowl surveys.



Land-based Waterfowl Survey

Project:		Survey:	
Study Area:		Date (dd/mm/yyyy):	
Station:		Station UTM Zone and Coordinates:	
Surveyors:			

	Time	CC	Ceiling	Wind	Wind Direc.	Temperature	Reservoir	Snow Depth (cm)	Precipitation
Start									
End									

% snow	% ice	% sand	% gravel	% cobble	% flooded veg.	% other

Polygon ID	Species	#	Sex	# of broods	Age	Moving	Foraging	Other activity	Water	Land	Shallow	Deep	Mud	Shore	Emerg. veg.	Submer. Veg.	Flooded veg.	Grass	Shrub	Tree	Channel	Log stump	Ice	Snow

Comments:	

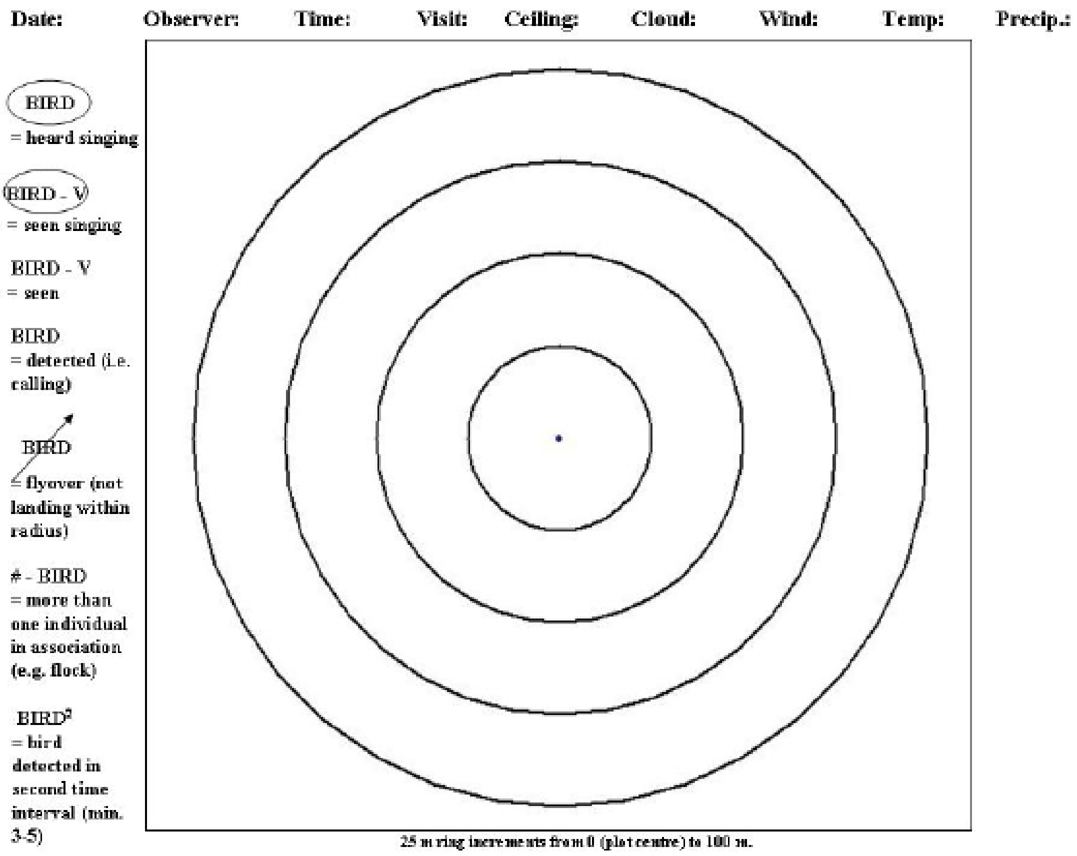

Airport Lagoon Exit
0 0.125 0.25 Kilometers


Beaver Pond
0 0.05 0.1 Kilometers
N

Appendix 5. **UTM coordinates of point count stations at the Airport Lagoon and Beaver Pond sites on Williston Reservoir, BC.**

Site	Point Count Station	UTM Zone	Easting	Northing
Airport Lagoon	AL-01	10U	492671	6125451
	AL-02	10U	492668	6125665
	AL-03	10U	492642	6125864
	AL-04	10U	492643	6126067
	AL-05	10U	492633	6126265
	AL-06	10U	492693	6126475
	AL-07	10U	492695	6126683
	AL-08	10U	492636	6126885
	AL-09	10U	492554	6127065
	AL-10	10U	492531	6126696
	AL-11	10U	492331	6126631
	AL-12	10U	492271	6126432
	AL-13	10U	492418	6126266
	AL-14	10U	492493	6126056
	AL-15	10U	492441	6125850
	AL-16	10U	492385	6125643
	AL-17	10U	492523	6125474
Beaver Pond	BP-01	10U	479204	6148354
	BP-02	10U	479387	6148249
	BP-03	10U	479264	6148207

Appendix 6. Field form for breeding bird surveys.



Date: **Observer:** **Time:** **Visit:** **Ceiling:** **Cloud:** **Wind:** **Temp:** **Precip.:**

BIRD
= heard singing

BIRD - V
= seen singing

BIRD - V
= seen

BIRD
= detected (i.e. calling)

BIRD
= flyover (not landing within radius)

- BIRD
= more than one individual in association (e.g. flock)

BIRD^2
= bird detected in second time interval (min. 3-5)

25 m ring increments from 0 (plot centre) to 100 m.

Appendix 7. Environmental variable codes and definitions for breeding bird surveys.

Ceiling:

The height of cloud cover. Record the average height of clouds during the survey.

ATT = Above Tree-tops
BTT = Below Tree-tops
AR = Above Ridge
BR = Below Ridge
H = High
VH = Very High

Cloud Cover (CC):

The extent of cloud cover during the survey period.

1 = clear, 0% cloud cover
2 = scattered clouds, <50% cloud cover
3 = scattered clouds, >50% cloud cover
4 = unbroken clouds, 100% cloud cover

Wind:

The strength of the dominant wind over the survey period using the Beaufort Scale. If wind strength split evenly between 1 or more classes, choose that which best characterized the conditions and detectability of birds. Acceptable conditions are Winds 0-3. >3 is considered unacceptable for conducting point counts.

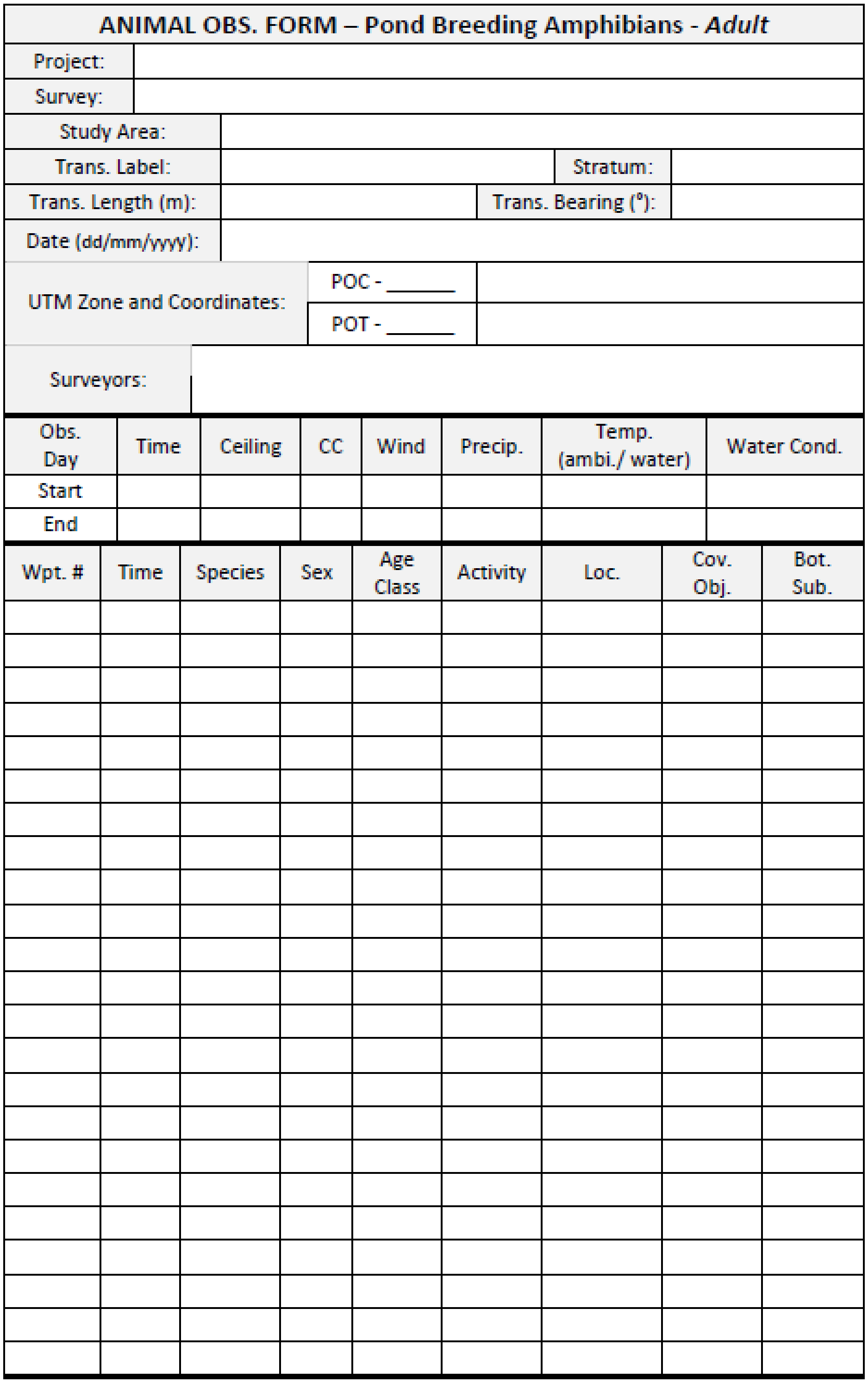
0 = calm (<2 km/h)
1 = light air (2-5 km/h)
2 = light breeze, leaves rustle (6-12 km/h)
3 = gentle breeze, leaves and twigs constantly move (13-19 km/h)
4 = moderate breeze, small branches move, dust rises (20-29 km/h)
5 = fresh breeze, small trees sway (30-39 km/h)
6 = strong breeze, large branches moving, wind whistling (40-49 km/h)
7 = moderate gale+, whole trees in motion (≥50 km/h)

Precipitation:

The type of precipitation (if any) during the survey period. Acceptable conditions are no rain through very light drizzle.

N = None
F = Fog
M = Misty Drizzle
D = Drizzle
LR = Light Rain
HR = Hard Rain
LS = Light Snow/Flurries
HS = Heavy Snow

Appendix 8. Field form for systematic amphibian surveys.



ANIMAL OBS. FORM – Pond Breeding Amphibians - *Adult*

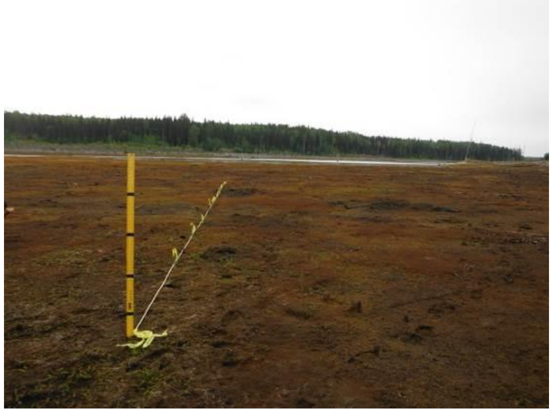
Project:			
Survey:			
Study Area:			
Trans. Label:		Stratum:	
Trans. Length (m):		Trans. Bearing (°):	
Date (dd/mm/yyyy):			
UTM Zone and Coordinates:	POC - ______		
	POT - ______		
Surveyors:			

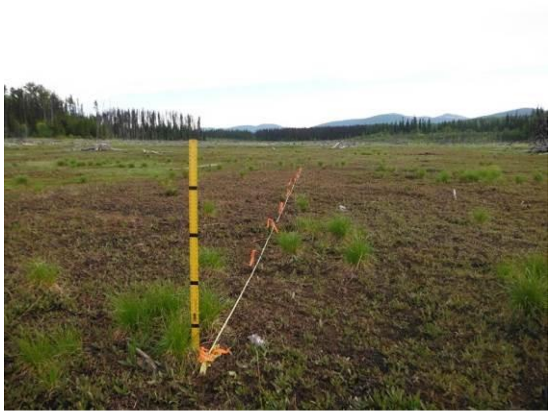
Obs. Day	Time	Ceiling	CC	Wind	Precip.	Temp. (ambi./ water)	Water Cond.
Start							
End							

Wpt. #	Time	Species	Sex	Age Class	Activity	Loc.	Cov. Obj.	Bot. Sub.

Appendix 9. Habitat class descriptions in the draw-down zone at the Airport Lagoon and Beaver Pond sites.

Habitat Class	**Representative Photographs**		
BC	**2011**	**2012**	**2013**
			
	2014	**2015**	
			
	Description		
	Basin Cryptantha (BC): Moderate herbaceous perennial cover with negligent coarse woody debris and low coarse rock cover (5%) on a plain to gentle sloping surface expression. Common species includes Torrey’s cryptantha (*Cryptantha torreyana*), purslane speedwell (*Veronica peregrina* var. *xalapensis*), red sand-spurry (*Spergularia rubra*) and Arctic pearlwort (*Sagina saginoides*). Soils are composed of a deep clay mineral layer; organic layer is absent. Groundwater is the main water source, soils are very poorly drained and reservoir flooding is expected to occur annually.		

Habitat Class	Representative Photographs		
	2011	**2012**	**2013**
BM			
	2014	**2015**	
		Picture Not Available	
	Description		
	Basin Moss (BM): Moderate to high bryophyte and low to moderate herbaceous perennial cover; low coarse woody debris cover on a plain to hummock surface depression. Dominating species include common hook-moss, lady's thumb (*Persicaria maculosa*), water smartweed (*Persicaria amphibia*), common mare's-tail (*Hippularis vulgaris*) and Norwegian cinquefoil (*Potentilla norvegica*). Soils are composed of a shallow to moderate organic layer (at least 30 cm) overlying a clay mineral layer. Groundwater is the main water source, soils are very poorly drained. Reservoir flooding is expected to occur annually.		

Habitat Class	Representative Photographs		
BS	**2011**	**2012**	**2013**
		Picture Not Available	
	2014	**2015**	
			
	Description		
	Basin Smartweed (BS): High cover of water smartweed and sedge (*Carex spp.*), with low to high coarse wood debris cover (0-50%) on a plain to hummock surface expression. Other species present may include lady's thumb and common hook-moss. Soils are composed of shallow to moderate organic layer (approx. 25 cm depth) overlying a clay mineral layer. Groundwater is the main water source, soils are imperfectly drained and reservoir flooding is expected to occur annually.		

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="4">FI</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td colspan="3">Floating Island (FI): Large, persistent, floating masses of organic matter, coarse woody debris and mineral soil. High bryophyte cover and low to moderate perennial herb cover. Common species include common hook-moss, lady’s thumb, water smartweed and spring water-starwort (*Callitriche palustris*), purple-leaved willowherb (*Epilobium ciliatum ssp. Ciliatum*) and a variety of sedges. The elevation of these islands is expected to rise and fall with water levels.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="3">SC</td><td></td><td></td><td></td></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td colspan="3">Shoreline Clay (SC): Sparse herbaceous vegetation cover with low coarse woody debris and coarse rock cover on gentle to moderate sloping surface expression. The most common species present are lady’s thumb, lamb’s quarters (*Chenopodium album ssp. striatum*) common horsetail (*Equisetum arvense*) and Norwegian cinquefoil. Water source is precipitation and flooding is expected to be annual to frequent (every 2 to 5 years).</td></tr>
</table>

Habitat	Representative Photographs		
	2011	**2012**	**2013**
SD			
	2014	**2015**	
			
	Description		
	Shoreline Driftwood (SD): Low to Moderate, grass dominated vegetation cover with high coarse woody debris cover (20-50%) on a gently sloping (3 to 15°) surface expression. Common species include bluejoint (*Calamagrostis canadensis*), common horsetail, water smartweed (*Persicaria amphibian*), uplifting suncress (*Boechera divaricarpa*) and reed canarygrass (*Phalaris arundinacea*). A diversity of bryophytes such as marsh thread moss (*Bryum pseudotriquetum*), tree moss (*Climancium dendroides*) and purple horn-toothed moss (*Ceratodon purpureus*) may be present. Soils consist of a shallow (1-10 cm depth) organic layer overlying a moderate (11-30 cm) sandy mineral layer. Precipitation is the main water source, soils are rapidly drained and reservoir flooding expected to be annual to frequent.		

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="4">SG</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td colspan="3">Shoreline Grassland (SG): Very high grass dominated vegetation cover with low coarse woody debris cover on a gently sloping surface expression. Common species may include bluejoint, common horsetail, reed canarygrass, large-leaved avens (*Geum macrophyllum* ssp. *perincisum*) and a few unidentified grasses.</td></tr>
</table>

Habitat Class	Representative Photographs		
SR	**2011**	**2012**	**2013**
			
	2014	**2015**	
			
	Description		
	Shoreline Gravel (SR): Low to moderate grass dominated vegetation cover with negligent coarse woody debris and moderate coarse rock cover on a gently to moderate sloping surface expression. Dominant species include bluejoint, bronze sedge (*Carex aenea*), purslane speedwell, red sand-spurry and Norwegian cinquefoil. Soils are composed of a deep sand and gravel mineral layer; organic layer is absent. Precipitation is the main water source, soils are rapidly drained and reservoir flooding is expected to be rare (only during extreme events).		

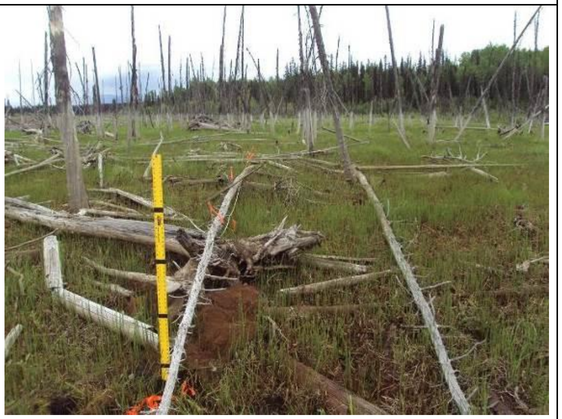
<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="6">SS</td><td>2011</td><td>2012</td><td>2013</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2014</td><td>2015</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Description</td></tr>
<tr><td colspan="3">Shoreline Sand (SS): Sparse herbaceous vegetation cover with low (5 to 15%) coarse woody debris cover on a gentle to moderate (15 to 26°) sloping surface expression. Common species include bluejoint, lady’s thumb, Norwegian cinquefoil, bronze sedge (<i>Carex aenea</i>), marsh yellow cress <i>(Rorippa palustris</i>) and pink corydalis (<i>Corydalis sempervirens</i>). Soils are composed of a deep (30-50 cm) sandy mineral layer; organic layer is absent. Precipitation is the main water source, soils are rapidly drained and reservoir flooding is expected to be annual to frequent.</td></tr>
</table>

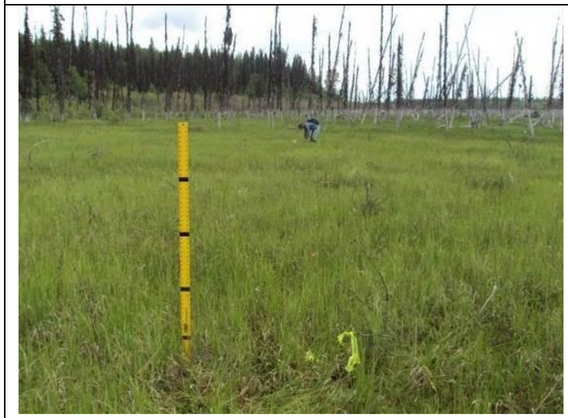
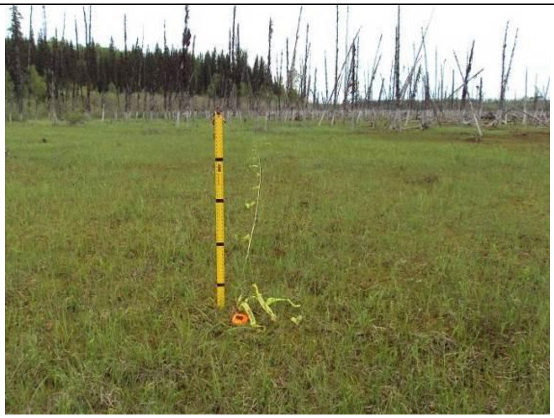
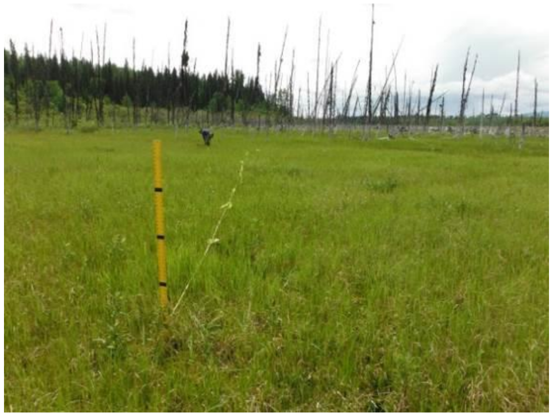
Habitat Class	**Representative Photographs**		
SW	**2011**	**2012**	**2013**
			
	2014	**2015**	
			
	Description		
	Shoreline Willow (SW): High grass and shrub dominated vegetation cover with high coarse woody debris cover on a gently to moderate sloping surface expression. Common species include common horsetail, fireweed, bluejoint, Norwegian cinquefoil and small bedstraw (*Galium trifidum*) with patches of live and dead willow (e.g., Alaska willow [*Salix alaxensis*], Barclay's willow [*Salix barclayi*]. Soils are composed of a shallow organic layer overlying a clay mineral layer. Precipitation is the main water source, soils are moderately well drained and flooding is expected to be frequent to rare.		

Habitat Class	Representative Photographs
SP	    
	Description
	Streams and Ponds (SP): Areas of open water and perennial water flow. Emergent or submergent vegetation identified include lady's thumb, white water-buttercup (*Ranunculus aquatilis*), spring water-starwort, common mare's-tail, water smartweed, fennel-leaved pondweed (*Stuckenia pectinata*), variegated yellow pond-lily (*Nuphar variegata*), common hornwort (*Ceratophyllum demersum*), verticillate water-milfoil (*Myriophyllum verticillatum*), wavy water nymph (*Najas flexilis*) and closed-leaved potamogeton (*Potamogeton foliosus*).

Habitat Class	Representative Photographs		
SE	**2011**	**2012**	**2013**
			
	2014	**2015**	
	Picture Not Available	Picture Not Available	
	Description		
	Stream Sedge (SE): Moderate to high sedge and bryophyte cover with negligible coarse woody and low water cover on a plain to gently sloping surface expression. Common species include sedges sp., bluejoint, lady's thumb, Torrey's cryptantha and spring water-starwort. Soil are composed of a minor organic layer (10 cm depth) overlying a clay and sand mineral layer. Surface and groundwater are the main water sources, soils are very poorly drained and annual flooding is expected to occur.		

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="6">WD</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Description</td></tr>
<tr><td colspan="3">Wetland Dead Trees (WD): High herbaceous perennial and low dead standing tree (snag) cover with low to moderate coarse woody debris cover on a gently sloping surface expression. Common species include swamp horsetail, water smartweed, buckbean, sedges and slender cottongrass (<i>Eriophorum gracile</i>). A low cover (approximately 15%) of standing dead black spruce (<i>Picea mariana</i>) trees is present as well as a variety of bryophytes. Groundwater is the main water source (surface and subsurface seepage), soils are very poorly drained and flooding is expected to be annual to frequent.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="6">WH</td><td>2011</td><td>2012</td><td>2013</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2014</td><td>2015</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Description</td></tr>
<tr><td colspan="3">Wetland Horsetail (WH): High horsetail and bryophyte dominated vegetation cover with low to moderate coarse woody debris cover on a plain to gently sloping surface expression. Common species include swamp horsetail, Norwegian cinquefoil, buckbean, small bedstraw, willows, and a diversity of bryophytes (marsh thread moss, giant calliergon moss, glow moss and purple horn-toothed moss). Soils are composed of a moderate organic layer; mineral layer is absent. Groundwater is the main water source surface and subsurface seepage), soils are very poorly drained and flooding is expected to be annual to frequent.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="6">WS</td><td>2011</td><td>2012</td><td>2013</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2014</td><td>2015</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Description</td></tr>
<tr><td colspan="3">Wetland Sedge (WS): High sedge and bryophyte dominated vegetation cover with negligible coarse woody debris cover on a plain to depressed surface expression. Common species include hook moss, marsh thread moss, giant calliergon moss, common cattail, bronze sedge (along with 2 to 3 other species of sedges [<i>Carex</i> spp.]), swamp horsetail (<i>Equisetum fluviatile</i>), small bedstraw (<i>Galium trifidum</i>), water smartweed (<i>Persicaria amphibian</i>), common mare's-tail (<i>Hippuris vulgaris</i>) and buckbean (<i>Menyanthes trifoliata</i>). Soils are composed of a deep organic layer either overlying a clay mineral layer or mineral layer absent. Groundwater is the main water source (surface and subsurface seepage), soils are very poorly drained and reservoir flooding is expected to be annual to frequent.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="3">Representative Photographs</th></tr>
<tr><td rowspan="3">WW</td><td></td><td></td><td></td></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td colspan="3">Wetland Willow (WW): Moderate shrub and high grass/sedge dominated vegetation cover with negligible coarse woody debris cover and a gentle sloping surface expression. Species present consist of a variety of willows, sedges, grasses and bryophytes. Flooding is expected to be frequent to rare.</td></tr>
</table>

Appendix 10. **Summary of percent cover by plant species averaged across 10 quadrats in a 20 m belt-transect for vegetation transects sampled in Year 5 at Airport Lagoon and Beaver Pond study sites.**

Group	Species	Transect									Total
		AL3	AL5	AL6	AL7	AL9	AL10	AL12	BP3	BP5	
Herbs/Forbs/ Graminoids	american_wintercress	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**
	bluejoint	0.0	8.9	0.0	0.0	5.5	0.0	0.0	0.0	1.0	**15.3**
	bronze_sedge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.4	**3.2**
	buckbean	0.0	0.0	0.0	9.8	0.0	0.0	0.0	0.0	0.0	**9.8**
	clover_sp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**
	common_horsetail	0.0	1.2	0.0	0.0	5.4	0.0	0.0	1.3	6.4	**14.2**
	common_spikerush	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	**0.4**
	fieldmint	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	**0.1**
	grass_sp	0.0	0.3	5.7	6.9	0.0	4.3	0.0	0.8	0.0	**17.9**
	green_sedge	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**
	hair_bentgrass	0.0	0.4	0.0	0.0	0.5	0.0	0.0	0.0	3.5	**4.3**
	ladys_thumb	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
	large_leaved_avens	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	little_meadow_foxtail	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.1**
	marsh_cinquefoil	0.0	0.0	0.0	2.1	0.2	0.3	0.0	0.0	0.0	**2.5**
	marsh_skullcap	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	marsh_yellowcress	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.8**
	norweg_cinquefoil	0.9	0.7	0.0	0.0	1.1	1.6	0.1	7.8	3.6	**15.9**
	penns_bittercress	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	penns_buttercup	0.1	0.1	0.3	0.0	0.0	0.1	0.0	0.3	0.0	**0.9**
	pink_corydalis	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	purslane_speedwell	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**0.7**
	sedge_sp	0.2	0.5	2.3	1.8	0.0	0.1	4.1	0.0	0.0	**9.0**
	small_bedstraw	0.0	0.0	1.3	0.3	0.1	0.2	0.5	0.0	0.5	**2.8**
	smooth_hawksbeard	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	spreadingpod_rockcress	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**

	swamp_horsetail	0.0	0.0	12.6	0.1	0.8	4.8	0.0	0.0	0.5	**18.8**
	tower_mustard	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	umbellate_starwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	**1.1**
	water_sedge	0.0	0.0	0.3	0.0	0.0	0.0	0.0	1.7	0.4	**2.4**
	watersmartweed	0.0	0.3	2.5	1.4	0.6	1.3	6.8	0.0	0.0	**12.9**
	willowherb_sp	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.5	0.6	**1.6**
	unkn20	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	unkn43	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	**0.4**
	unkn79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**0.1**
	unkn95	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	unkn99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	**0.2**
	unkn100	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.1	**0.3**
	Herb/Forb/Graminoid Total	**5.7**	**13.0**	**25.6**	**22.8**	**14.2**	**13.3**	**11.6**	**14.2**	**19.2**	
	common_hook_moss	0.0	0.0	8.0	6.2	0.0	2.2	1.7	0.0	0.0	**18.1**
	giant_calliegron_moss	0.0	0.0	0.0	60.5	0.0	1.4	0.0	0.0	0.0	**61.9**
	little_yellowrattle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	**0.1**
	marsh_threadmoss	0.0	0.0	0.0	9.0	0.0	1.4	0.0	0.0	0.0	**10.4**
	treemoss	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	**0.6**
	unkn32	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	**0.4**
	unkn33	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	**0.1**
	Bryum creberrimum	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	**0.4**
	Moss Total	**0.0**	**0.0**	**8.0**	**75.7**	**0.5**	**6.0**	**1.7**	**0.0**	**0.1**	
Shrubs	paper_birch	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	**0.1**
	sitka_alder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	**0.8**
	willow_sp	0.0	0.0	0.0	1.6	0.0	1.2	0.0	0.0	0.2	**3.0**
	Shrub Total	**0.0**	**0.0**	**0.0**	**1.6**	**0.0**	**1.2**	**0.0**	**0.0**	**1.0**	

[a] - Values represent average number of species and % cover based on plot surveys in 2012. Surveys of these plots were not completed in 2013 as plots were located in areas recently flooded due to physical works;

[b] - Values represent an average number of species and % cover based on plot surveys completed in 2012 and 2013; the average for number of species are rounded up to whole numbers where necessary.

Appendix 11. Summary of the presence/not-detected of aquatic plant species at dredge points sampled in Year 5 at Airport Lagoon.

Species	Dredge Location[1]												
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13
common hook-moss	P	P	P	P	P	P	P	P	P	-	-	-	-
closed-leaved potamogeton	-	-	-	P	P	P	-	P	-	-	-	-	-
fennel-leaved pondweed	-	P	-	-	-	-	-	-	-	P	-	-	P
stonewort	-	-	-	-	-	-	P	-	-	-	P	-	-
verticillate water-milfoil	-	-	P	-	-	-	-	-	-	-	-	-	-
wavy water nymph	-	-	-	-	-	-	-	P	-	-	-	-	-

[1] For each dredge location (D), species were either present (P) or not-detected (-).

Appendix 12. **Summary of bird detections by point count station in 2015 across three replicates at the Airport Lagoon and Beaver Pond sites, Williston Reservoir, BC.**

Species	Point Count Station																				Species Totals
	AL-01	AL-02	AL-03	AL-04	AL-05	AL-06	AL-07	AL-08	AL-09	AL-10	AL-11	AL-12	AL-13	AL-14	AL-15	AL-16	AL-17	BP-01	BP-02	BP-03	
Canada Goose	12	7			12	1			8									3			43
Mallard															1						1
Blue-winged Teal					1																1
Northern Shoveler					4		1														5
Ruffed Grouse																		1			1
Common Loon					2																2
Osprey	1	3		1	2									1		1					9
Bald Eagle															1						1
Red-tailed Hawk								1		1											2
American Kestrel				2																	2
Killdeer					1		2		1		3	5	2								14
Greater Yellowlegs			1		7	5	9			3	1	5	4		2	1		1	1		40
Spotted Sandpiper										1		1	2			1	2	3		2	12
Solitary Sandpiper									1												1
Wilson's Snipe							1	3	2	1		1									8
Wilson's Phalarope							1														1
Bonaparte's Gull		1											2	7		1					11
Ring-billed Gull		1	1	1	2	1	2				3				2		4	1			18
Rufus Hummingbird							1														1
Belted Kingfisher	1	1	1						1	1				1			2				8
Red-breasted Sapsucker																		1			1
Northern Flicker														1		1					2
Alder Flycatcher						4	3														7
Least Flycatcher								2											1		3
Dusky Flycatcher								2				1	2		2			2			9
Warbling Vireo					2			1				1			1			2		3	10

Species	Point Count Station																				Species Totals
	AL-01	AL-02	AL-03	AL-04	AL-05	AL-06	AL-07	AL-08	AL-09	AL-10	AL-11	AL-12	AL-13	AL-14	AL-15	AL-16	AL-17	BP-01	BP-02	BP-03	
American Crow					3		1		1	2			1	1							9
Common Raven	2								1			1			1	1			1		7
Tree Swallow	2			3		7	2	1		16		1	2		1	1	2		4	1	43
Red-breasted Nuthatch			1		1		2														4
Ruby-crowned Kinglet	3				2	1			1									1			8
Swainson's Thrush		1	2			1							1			1	1				7
Hermit Thrush										1	1	1		1							4
American Robin				1	1		2	1	2	3	3	1	1		1	1	1	1		1	20
Tennessee Warbler			1		1	3	3	2													10
Orange-crowned Warbler	1	2		3	2	1	2	1					2			2		2	2		20
Yellow Warbler	1				1		3	1				1	1								8
Magnolia Warbler	2																		1	1	4
Yellow-rumped Warbler	2	1	1	1		2	1				1	1	2		1	3	3	1	2	1	23
American Redstart	2	1	2	4			2	1	1		1							1	3	4	22
Northern Waterthrush	3	1			1					1	1								2		9
Common Yellowthroat						1															1
Wilson's Warbler							1		1												2
Chipping Sparrow			1	1	5	3	1	1					2	2					2		18
Savannah Sparrow								2	9	1					1	2					15
Song Sparrow				1	1							1									3
Lincoln's Sparrow	1		1		1	3		5	1	2	2					1					17
White-throated Sparrow						1	2					3	2	1		2	2	1			14
Dark-eyed Junco		1	1			1		1			2	1			4	3	3	2		1	20
Western Tanager	2					1															3
Red-winged Blackbird						1															1
Rusty Blackbird																			1		1
Station Totals	35	20	13	18	52	37	42	25	30	33	18	25	26	15	18	22	20	23	20	14	506

Appendix 13. UTM coordinates of amphibian detections at the Airport Lagoon and Beaver Pond sites on Williston Reservoir, BC.

Site	Date	Transect	Time	Easting	Northing	Species	Number	Age Class	Comment
Airport Lagoon	01/05/2015	25	11:57	492438	6126935	Western toad	1	juvenile	
	01/05/2015	25	12:10	492443	6126965	Western toad	1	adult	
	01/05/2015	25	12:15	492447	6126965	Western toad	1	adult	
	01/05/2015	32	13:20	492635	6126501	Long-toed salamander	1	adult	
	07/05/2015	25	11:38	492469	6126944	Western toad	2	adult	Pair of ANBO in amplexus.
	07/05/2015	32	12:33	492607	6126438	unknown	1	adult	Species UNK but most likely an ANBO. Eyes seen on the water's surface just before a ripple and the amphibian was gone.
	07/05/2015	40	13:40	492681	6125765	Western toad	1	juvenile	Juv. ANBO hopping along the ground.
	20/05/2015	25	10:26	492435	6126946	Western toad	1	juvenile	
	20/05/2015	25	10:28	492437	6126950	Western toad	1	juvenile	
	20/05/2015	25	10:28	492437	6126950	Western toad	3	juvenile	
	20/05/2015	25	10:31	492440	6126949	Western toad	2	juvenile	
	20/05/2015	25	10:35	492446	6126954	Western toad	1	juvenile	
	20/05/2015	25	10:37	492452	6126957	Western toad	1	juvenile	
	20/05/2015	25	10:39	492453	6126953	Western toad	1	juvenile	
	20/05/2015	25	10:40	492454	6126954	Western toad	2	juvenile	
	20/05/2015	25	10:40	492455	6126958	Western toad	3	juvenile	
	20/05/2015	25	10:45	492473	6126948	Western toad	1	juvenile	
	20/05/2015	37	11:47	492656	6126115	Western toad	1	juvenile	
	20/05/2015	37	11:50	492656	6126107	Western toad	2	juvenile	
	31/05/2015	25	11:40	492473	6126955	Western toad	1	juvenile	
	31/05/2015	25	11:42	492483	6126947	Western toad	1	juvenile	
	31/05/2015	32	12:10	492605	6126435	Western toad	700	tadpoles	
	31/05/2015	7	14:26	492425	6126119	Western toad	1	tadpoles	In main lagoon
Beaver Pond	08/05/2015	BP-A-01	10:11	479354	6148228	Long-toed salamander	1	adult	
	08/05/2015	BP-A-01	10:15	479366	6128229	Long-toed salamander	1	adult	
	08/05/2015	BP-A-01	10:19	479372	6128235	Long-toed salamander	1	adult	

Site	Date	Transect	Time	Easting	Northing	Species	Number	Age Class	Comment
	08/05/2015	BP-A-01	10:43	479401	6148212	Long-toed salamander	1	adult	
	08/05/2015	BP-A-01	10:52	479390	6148228	Long-toed salamander	3	adult	The 3 AMMA were each under a separate log, but within 1.5 meters of each other.
	22/05/2015	BP-A-01	10:24	479291	6148283	Western toad	7000	tadpoles	Estimated number.
	22/05/2015	BP-A-01	10:28	479304	6148276	Western toad	100	tadpoles	Both sides of channel
	22/05/2015	BP-A-01	10:31	479331	6148249	Western toad	5000	tadpoles	Estimated number - includes both sides of channel
	22/05/2015	BP-A-01	10:33	479338	6148240	Western toad	2000	tadpoles	Estimated number.
	22/05/2015	BP-A-01	10:35	479343	6148234	Western toad	2000	tadpoles	Estimated number.
	22/05/2015	BP-A-01	10:42	479372	6148235	Long-toed salamander	1	adult	
	22/05/2015	BP-A-01	10:46	479378	6148239	Western toad	1	juvenile	
	22/05/2015	BP-A-01	10:54	479388	6148247	unknown	1	adult	
	22/05/2015	BP-A-01	10:58	479406	6148255	Western toad	7000	tadpoles	Estimated number.
	22/05/2015	BP-A-01	11:08	479404	6148212	Western toad	3	juvenile	
	22/05/2015	BP-A-01	11:25	479375	6148226	Western toad	1	juvenile	
	22/05/2015	BP-A-01	11:28	479368	6148225	Western toad	1	juvenile	
	22/05/2015	BP-A-01	11:28	479363	6148225	Western toad	2	juvenile	
	22/05/2015	BP-A-01	11:38	479276	6148219	Western toad	1	juvenile	
	22/05/2015	BP-A-01	11:40	479267	6148223	Western toad	1	juvenile	
	22/05/2015	BP-A-01	11:40	479270	6148227	Western toad	10	tadpoles	
	22/05/2015	BP-A-01	11:41	479259	6148231	Western toad	8	juvenile	
	22/05/2015	BP-A-01	11:44	479252	6148240	Western toad	2	juvenile	
	22/05/2015	BP-A-01	11:46	479265	6148252	Western toad	10	tadpoles	Along berm.
	01/06/2015	BP-A-01	9:11	479253	6148298	Western toad	2	juvenile	
	01/06/2015	BP-A-01	9:14	479280	6148295	Western toad	3000	tadpoles	Several thousand all along water’s edge.
	01/06/2015	BP-A-01	9:17	479329	6148258	Western toad	1	juvenile	
	01/06/2015	BP-A-01	9:24	479389	6148241	Wood frog	1	adult	
	01/06/2015	BP-A-01	9:26	479391	6148234	Western toad	300	tadpoles	Several hundred
	01/06/2015	BP-A-01	9:28	479395	6148223	Wood frog	1	adult	
	01/06/2015	BP-A-01	9:31	479379	6148228	Western toad	1	juvenile	

Site	Date	Transect	Time	Easting	Northing	Species	Number	Age Class	Comment
	01/06/2015	BP-A-01	9:41	479249	6148234	Western toad	1	juvenile	
	01/06/2015	BP-A-01	9:44	479229	6148270	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:01	479214	6148279	Western toad	4	juvenile	
	05/06/2015	BP-A-01	9:02	479219	6148265	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:02	479219	6148265	Western toad	2	adult	
	05/06/2015	BP-A-01	9:03	479223	6148258	Western toad	2	adult	
	05/06/2015	BP-A-01	9:03	479223	6148258	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:04	479222	6148257	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:05	479231	6148244	Western toad	1	adult	
	05/06/2015	BP-A-01	9:05	479231	6148244	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:05	479236	6148238	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:06	479237	6148236	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:07	479244	6148229	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:07	479255	6148224	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:08	479262	6148216	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:09	479265	6148214	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:09	479273	6148214	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:10	479271	6148215	Western toad	1	adult	
	05/06/2015	BP-A-01	9:11	479292	6148209	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:12	479297	6148209	Western toad	2	adult	
	05/06/2015	BP-A-01	9:12	479297	6148208	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:14	479332	6148213	Western toad	3	juvenile	
	05/06/2015	BP-A-01	9:15	479332	6148214	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:15:00	479336	6148217	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:16	479337	6148222	Western toad	50	tadpoles	
	05/06/2015	BP-A-01	9:17	479351	6148221	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:18	479357	6148226	Western toad	100	tadpoles	At least 100

Site	Date	Transect	Time	Easting	Northing	Species	Number	Age Class	Comment
	05/06/2015	BP-A-01	9:20	479373	6148226	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:22	479394	6148228	Wood frog	1	adult	
	05/06/2015	BP-A-01	9:24	479390	6148241	Wood Frog	1	adult	
	05/06/2015	BP-A-01	9:27	479362	6148238	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:27	479359	6148237	Western toad	2	adult	
	05/06/2015	BP-A-01	9:27	479359	6148237	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:30	479339	6148243	Western toad	3000	tadpoles	Estimated number.
	05/06/2015	BP-A-01	9:33	479311	6148285	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:34	479328	6148263	Western toad	1000	tadpoles	Estimated number.
	05/06/2015	BP-A-01	9:35	479303	6148295	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:36	479287	6148296	Western toad	500	tadpoles	Estimated number.
	05/06/2015	BP-A-01	9:37	479279	6148312	Western toad	2	juvenile	
	05/06/2015	BP-A-01	9:38	479261	6148313	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:39	479258	6148312	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:39	479258	6148311	Western toad	4	juvenile	
	05/06/2015	BP-A-01	9:40	479257	6148300	Western toad	1	juvenile	
	05/06/2015	BP-A-01	9:43	479210	6148333	Western toad	1	juvenile	

Appendix 14. Water quality data collected during fish sampling at the Airport Lagoon and Beaver Pond sites in 2015.

Site	Date	Location	Temperature (°C)	Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)	Secchi Depth (m)
Airport Lagoon	July 27	surface (upper pond)	18.3	141.2	7.75	7.36	-
		bottom (upper pond)	18	144.8	7.85	7.48	-
		surface (mid-pond)	18.4	138.9	7.56	6.60	2.1
		bottom (mid-pond)	18.0	138.4	7.52	6.32	-
		surface (outlet)	18.4	136.1	7.45	7.07	2.07
		bottom (outlet)	17.9	134.6	7.17	3.30	-
Beaver Pond	July 29	surface	16.6	110.6	8.0	7.09	-
		bottom (inside berm)	16.3	110.7	7.79	6.80	-
		bottom (outside berm)	16.3	111.0	7.95	6.15	-