Peace Project Water Use Plan

Reservoir Wetland Habitat Monitoring

Implementation Year 4

Reference: GMSMON-15

Study Period: April 2014 to February 2015

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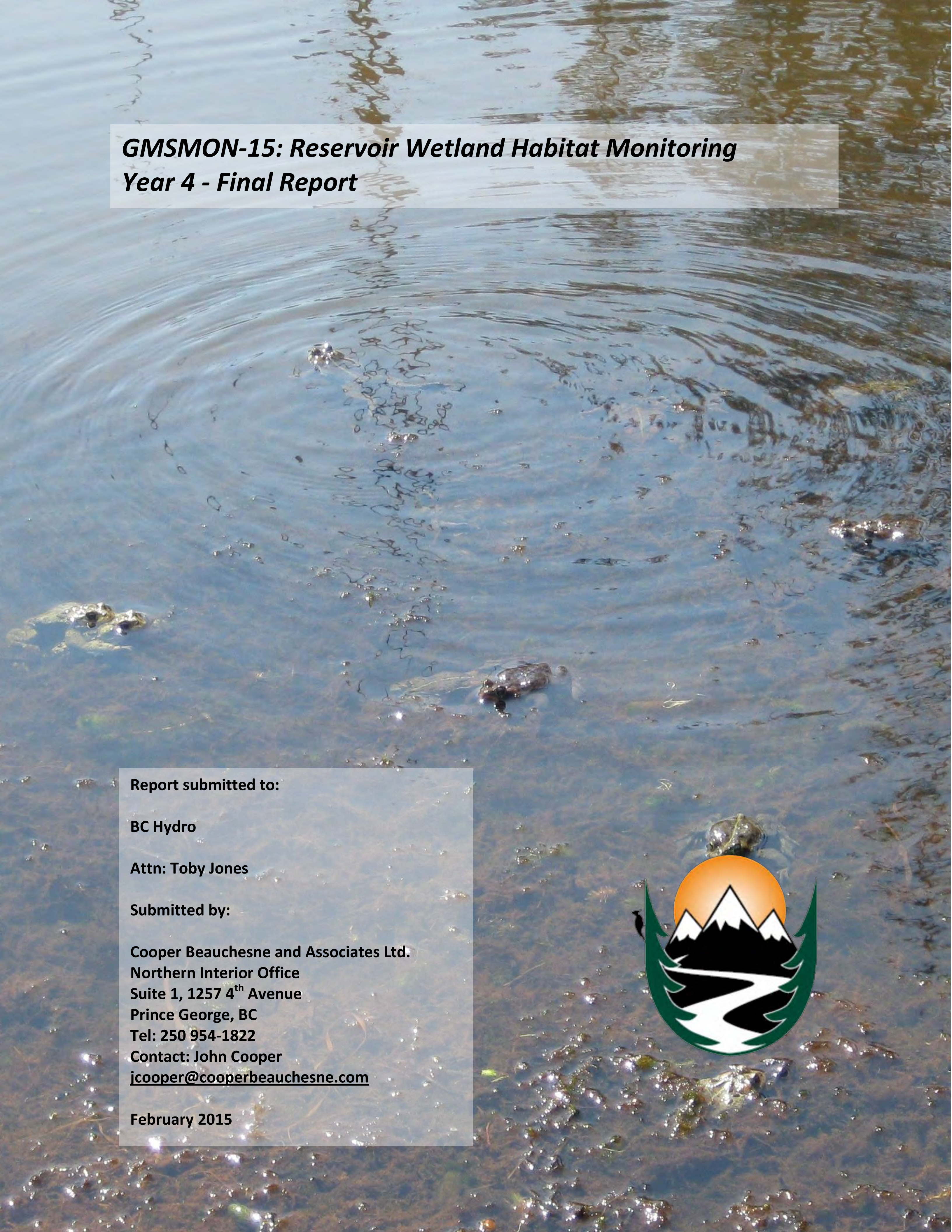

GMSMON-15: Reservoir Wetland Habitat Monitoring Year 4 - Final Report

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BC Hydro

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Cover photo: Western toad breeding aggregation on transect 25, WDS 6-2 (Airport Lagoon), 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 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 fourth year of monitoring under GMSMON-15. The results provide the first full year of post-construction data for the Airport Lagoon project (constructed in late May 2013) and additional baseline information as well as initial post-construction results from the Beaver Pond site. The Beaver Pond project was completed in late May 2014, mid-way through the Year 4 monitoring.

For terrestrial and aquatic vegetation, the additional data collected in Year 4 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). Aquatic plant sampling at Airport Lagoon showed areas that exist within the newly flooded permanent water body where aquatic plant species were sparse to absent. Over time, these areas may become colonized through the natural dispersal of seed from areas within the permanent water body where aquatic plants are well established. Coarse woody debris (CWD) distribution and density was mapped at the Airport Lagoon using high resolution orthophotos obtained in June 2014. Over the first four years of the project, CWD was observed to have an influence on the vegetation communities.

A total of 388 individuals representing 26 species of waterfowl and shorebirds were observed at the Airport Lagoon during the spring surveys. Mallard were the most common species detected, followed by, American Wigeon, Ring-necked Duck and Northern Pintails. The majority of individuals were detected during the May 1 survey. Species diversity was highest during the May 20th survey. No observations were recorded during the waterfowl and shorebird surveys at Beaver Pond. Waterfowl and shorebird habitat is limited at this site and disturbance from ongoing construction may have been a factor in the lack of detections. Incidental observations at Beaver Pond included Blue-winged Teal, Green-winged Teal, Spotted Sandpiper and nesting Killdeer.

A total of 58 species, encompassing 471 detections (551 individuals) were recorded acros both sites during the 2014 songbird point counts. Species richness was higher at the Airport Lagoon site with 54 species compared to 19 at Beaver Pond. An average of 15.6 (n=17) species per point count station were detected at Airport Lagoon compared to an average of 11.7 (n=3) at Beaver Pond. The larger area and more diverse habitat types adjacent to the Airport Lagoon

likely contributed to the higher abundance and diversity observed at that site. A shift in the highest frequency of detections from forested and shrub habitats to the drawdown zone, along with an increase in detections for water dependent genera (shorebirds, waterfowl and gulls) at the Airport Lagoon were recorded during point count surveys in 2014. This may reflect the change in following completion of the enhancement project in 2013. Lower songbird detection rates at Beaver Pond are likely associated with disturbance due to construction activities during the breeding season.

During the Year 4 amphibian surveys Western Toad, Long-toed Salamander, and Columbia Spotted Frog were observed, with Western Toad accounting for the majority of the observations. Western Toad and Long-toed Salamander were observed at both sites and two Columbia Spotted Frogs were observed at the Airport Lagoon. A record number of amphibians totalling 74 individuals (excluding tadpoles, egg masses and incidental observations) were recorded during the May 11 and 12 surveys. No amphibians were recorded during the earliest survey at Airport Lagoon. During all other surveys the number of detections were consistent with surveys during previous years. The high number of amphibians observed may have been affected by the timing of the survey and environmental conditions on May 11 and 12.

Fish population sampling was completed by backpack electrofishing, minnow traps, and fyke nets at both sites. The number and relative abundance of fish collected at the Airport Lagoon site was much higher than in previous years. The number and relative abundance of fish collected at the Beaver Pond site was lower than in 2013 but higher than the first two years of the program. A total of 16,982 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 3 were three Rainbow Trout and two 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 first year 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 this site are a combination of additional baseline data and initial post-construction observations. Although completed at a lower elevation than designed, it is expected that the project will improve wildlife habitat and increase wildlife use of these 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 4

Management Question	Management Hypothesis (Null)	Year 4 (2014) 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 first year of post-construction monitoring indicates that there has been an increase in the extent of aquatic vegetation associated with the new water level. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site
Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?		The single year of post-construction data from the Airport Lagoon project shows continued use by waterfowl and other wildlife. The Beaver Pond project was completed in spring 2014 and the first post-construction data will be collected in 2015.
	H_{02}: The species composition and density of waterfowl and songbirds does not change following enhancement.	The single year of post-construction data from the Airport Lagoon shows some changes in waterfowl and songbird species composition and density post enhancement. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site.
	H_{03}: Amphibian abundance and diversity in the wetland does not change following wetland enhancement.	The single year of post-construction data from the Airport Lagoon showed some changes in amphibian abundance. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site.
Is the area and quality of wildlife habitat created by the wetland enhancement maintained over time?		With only a single year of post-construction data from the Airport Lagoon site and the Beaver Pond project just completed in spring 2014 it is not possible to comment on the long term persistence and quality of habitat.

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Field work was completed by CBA staff Andrew MacInnis, Allan Carson, Vicki Prigmore, Catherine Craig, 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. Data analyses were completed by Harry van Oort. 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. If the projects were considered to be successful, then the potential for creating additional wetlands would be assessed (BC Hydro 2007).

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 fourth year of the GMSMON-15 monitoring program and include the first year of post-construction data from the Airport Lagoon site. Construction of the Beaver Pond project was completed in May 2014. Data collected from the Beaver Pond site is a combination of some additional baseline data (collected prior to construction) and some initial post-construction data from this project.

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 is 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 four years of this study (Year 1: 2011, Year 2: 2012, Year 3: 2013, and Year 4: 2013) 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 2014, the reservoir reached its lowest level of 658.3 m on April 26 which is similar timing to 2012 (April 25) and earlier than in 2011 (May 8) and 2013 (May 3). Water levels in 2014 increased relatively rapidly until the end of May when the rate of increase declined and the reservoir reached a maximum of 668.7 m on July 31 (BC Hydro CRO database). This is a lower maximum elevation than in the previous three years of the study and is just below long-term mean levels (Figure 1). Reservoir levels in all four years are higher than in 2010 when reservoir levels had only reached a level of 664.7 m in mid August and only reached a maximum of 665.54 m on November 8, 2010 (BC Hydro CRO database).

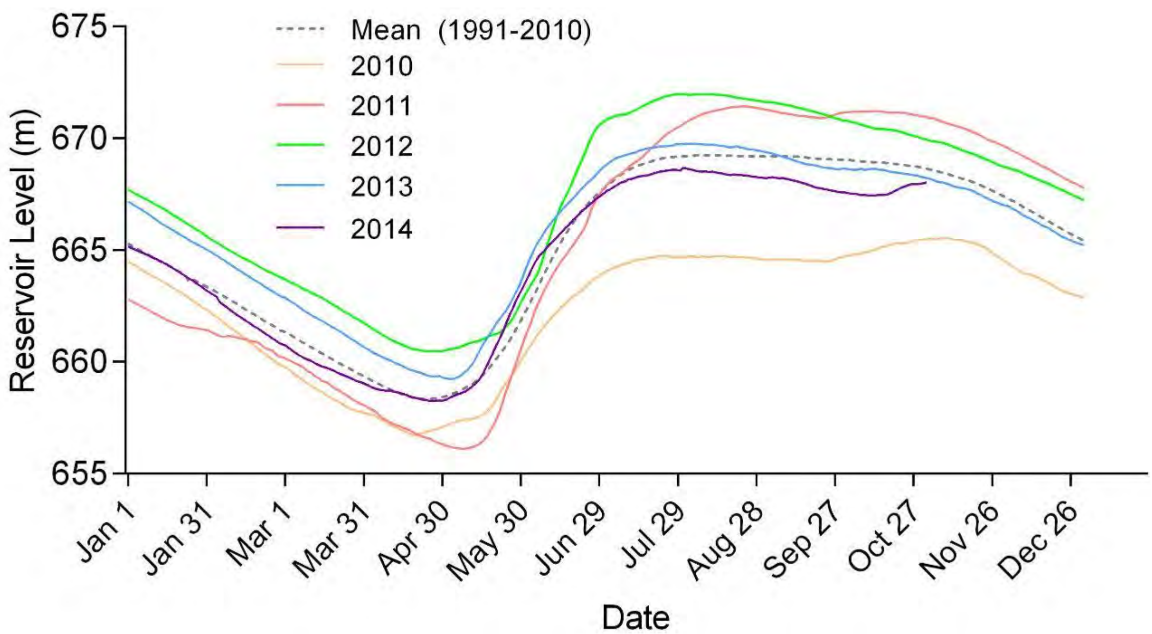

Figure 1. Spring and summer Williston Reservoir levels for 2010 to 2014.

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).

The post-construction water level in the 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. Water levels in the lagoon were approaching the design level on June 6, 2013 and are assumed to have reached the design level prior to the reservoir reaching the culvert elevation on June 16, 2013. The peak 2013 reservoir elevation of 669.8 m was reached on August 4. Water levels observed in the lagoon in spring 2014 were at the design levels as a result of inundation by the reservoir in 2013 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. Some variation in the lagoon water level was observed in 2014 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 after the May 1 waterfowl survey. The higher water level was likely associated with 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. With the exception of the stream and an adjacent area of groundwater seepage, this area is currently dry 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 approximate extent of flooding is included on the Beaver Pond maps based on the proposed berm, the as-built elevation, and water levels in the wetland observed on June 17, 2014. 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 uniqueness of both sites, along with the specific physical works proposed for each, means there are no associated control sites in this project.

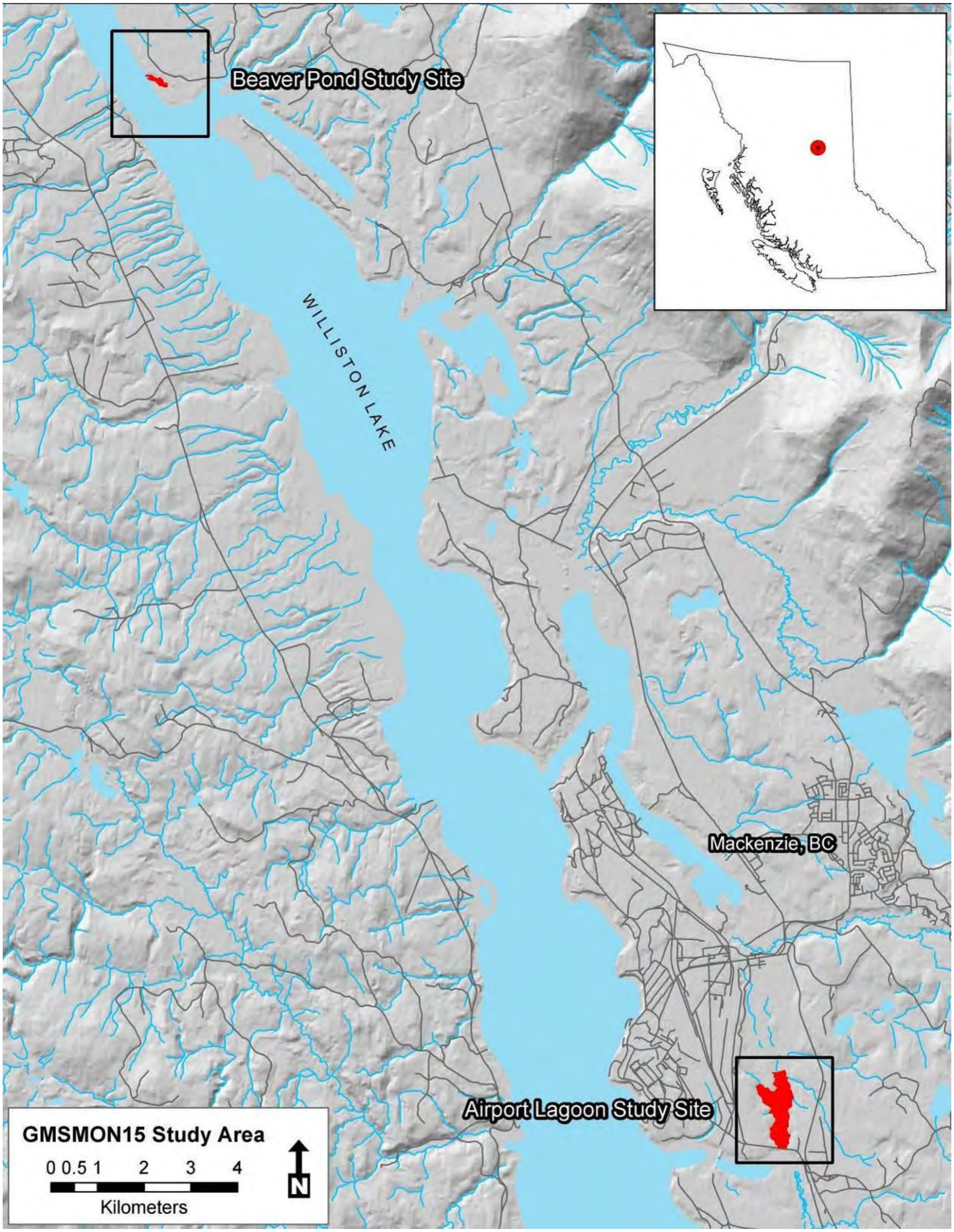

Figure 2. Location of the two wetland demonstration sites on the Parsnip Reach of Williston Reservoir.

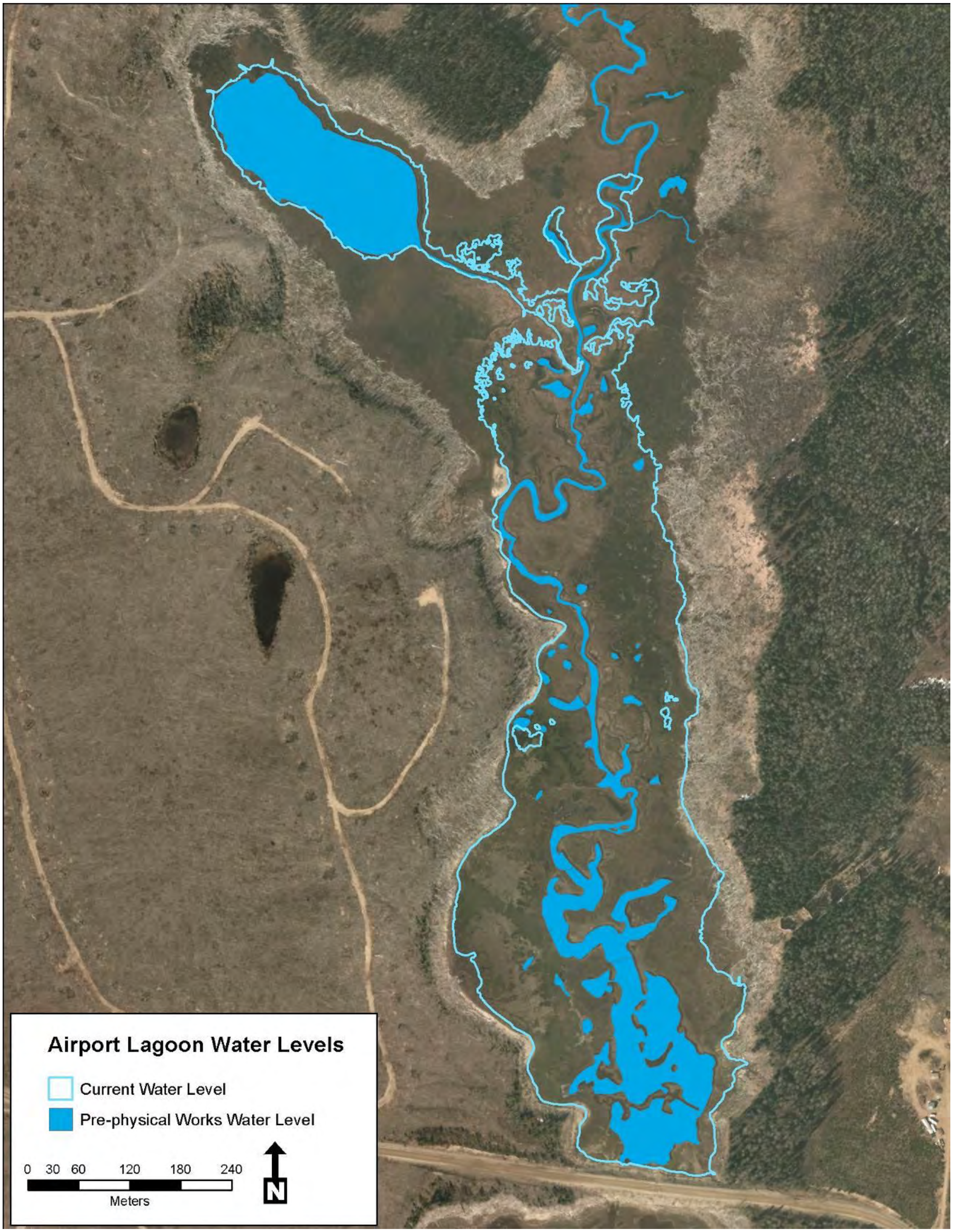

Figure 3. The pre- and post-enhancement permanent water levels at the Airport Lagoon.

4 METHODS

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 dam 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) provided by BC Hydro for both sites and a high resolution orthomosaic (5cm pixel resolution; 2014) provided by JR Canadian Mapping for Airport Lagoon were used as the background layer for delineating polygons. Furthermore, field notes on vegetation composition and structure from informal inspections of the study sites prior to the air photo interpretation 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 position 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 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 annual 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 both high resolution air photos collected in Year 4 and 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, general 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 4 (2014), ground sampling was completed at 11 of the previously established vegetation transects (eight transects at Airport Lagoon and three 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 areas. In addition, two new vegetation transects were established at Airport Lagoon to compensate for transects lost due to flooding. As reservoir flooding was not expected to reach an elevation above the new permanent flood area at Airport Lagoon and Beaver Pond until late June, ground sampling was conducted on June 14-17, 2014. 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 2014) was updated and reviewed.

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 x

0.5 m rectangles was laid out (Figure 3) 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. A photograph was taken at the start point and end point of the transect, each looking along the transect.

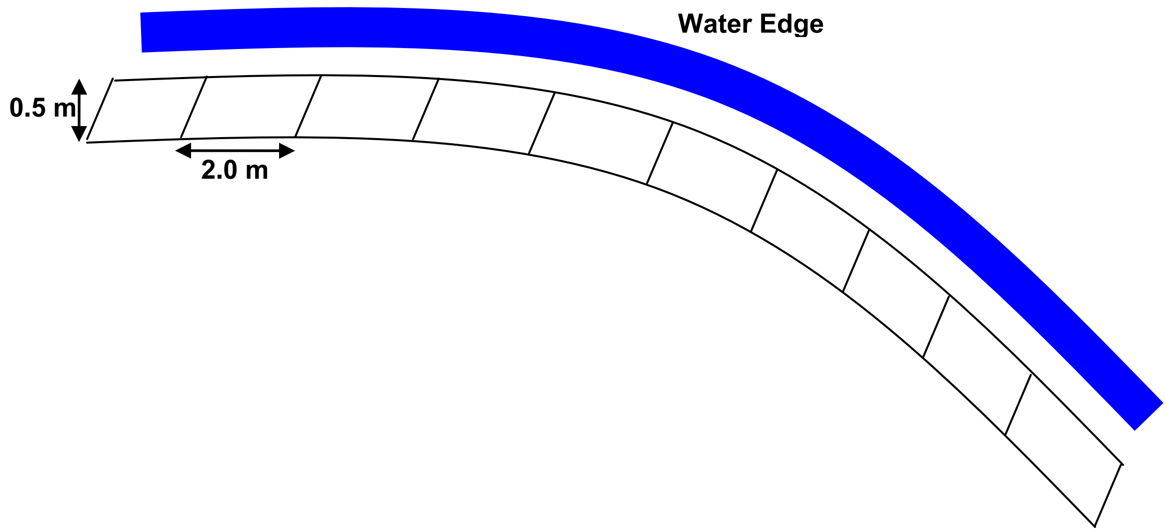

Figure 4. Belt-line quadrat transect for a sample site laid out adjacent to the riparian area.

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 as a result of 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 a. Surface sampling was completed in mid-July; this timing was selected to aid in the identification of aquatic plant species by attempting to observe species at the sites during a period when a majority of aquatic plant species were expected to be flowering.

Surface sampling for aquatic plants was completed at the Airport Lagoon site July 21-22, 2014. Surface sampling included visual observations of aquatic plant cover along the shoreline and shallow water of the flooded areas (where water depth was <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 post-construction changes of species composition.

Dredge sampling used a rake sampler constructed of two back to back garden rakes attached to a rope to collect plant samples from the bed of the flooded area. At each location selected for dredging, the rake was dropped to the bed of the flooded area and dragged along the bed for a distance of approximately 1 to 3m to collect samples. This method was repeated a total of 3 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 as a result of the increase in permanently flooded area.

Where identification of species during surface sampling 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), a plant taxonomy expert from UNBC was asked to confirm the initial result.

A brief reconnaissance of aquatic plant cover at the Beaver Pond site was also completed during the July fish sampling. The reconnaissance revealed no significant cover of aquatic plants within the project area. As a result, no sampling of aquatic plants was completed at the site.

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. Waterfowl surveys were completed on May 1, 11, and 20, and June 2 at the Airport Lagoon site and on May 12 and June 3 at the Beaver Pond site. Access issues (ice on Williston Reservoir and unfavourable weather conditions), combined with project construction resulted in only two surveys being completed at Beaver Pond. Surveys at both sites were completed at the previously established stations at each site (Figure 5 and Figure 6). 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 any unusual events (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.

From a 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, behavioural activity, and habitat within each polygon. Behaviour was recorded as one of several categories as were habitat descriptors for the polygon. Species codes followed RIC (2008).

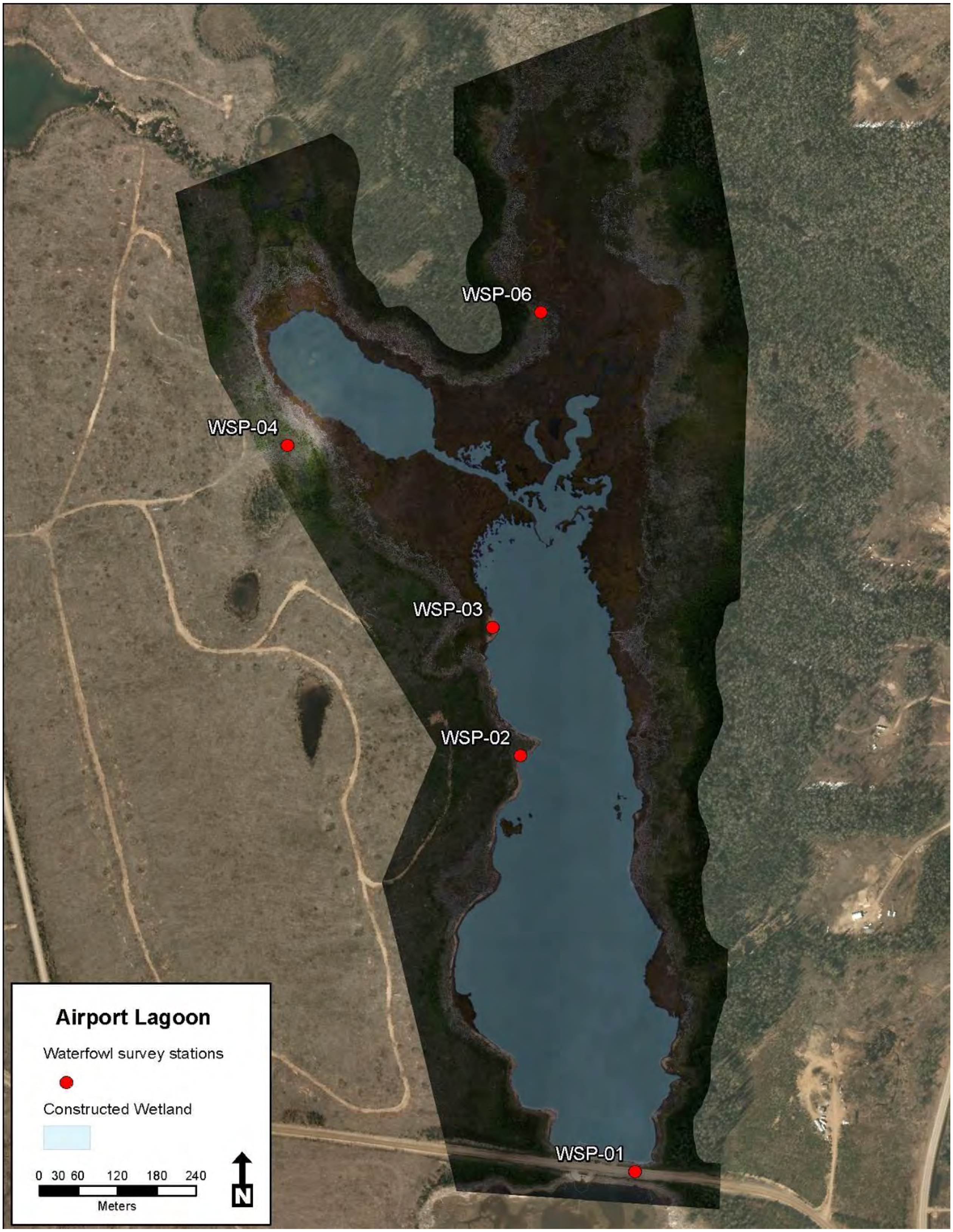

Figure 5. Waterfowl survey station locations at the Airport Lagoon site.

Figure 6. Waterfowl survey station locations at the Beaver Pond 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 3-8, 2014 at the Airport Lagoon and Beaver Pond 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 17 established survey stations at Airport Lagoon (Figure 7) and the three established survey stations at the Beaver Pond site (Figure 8). 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 15 Cedar Waxwings 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 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.

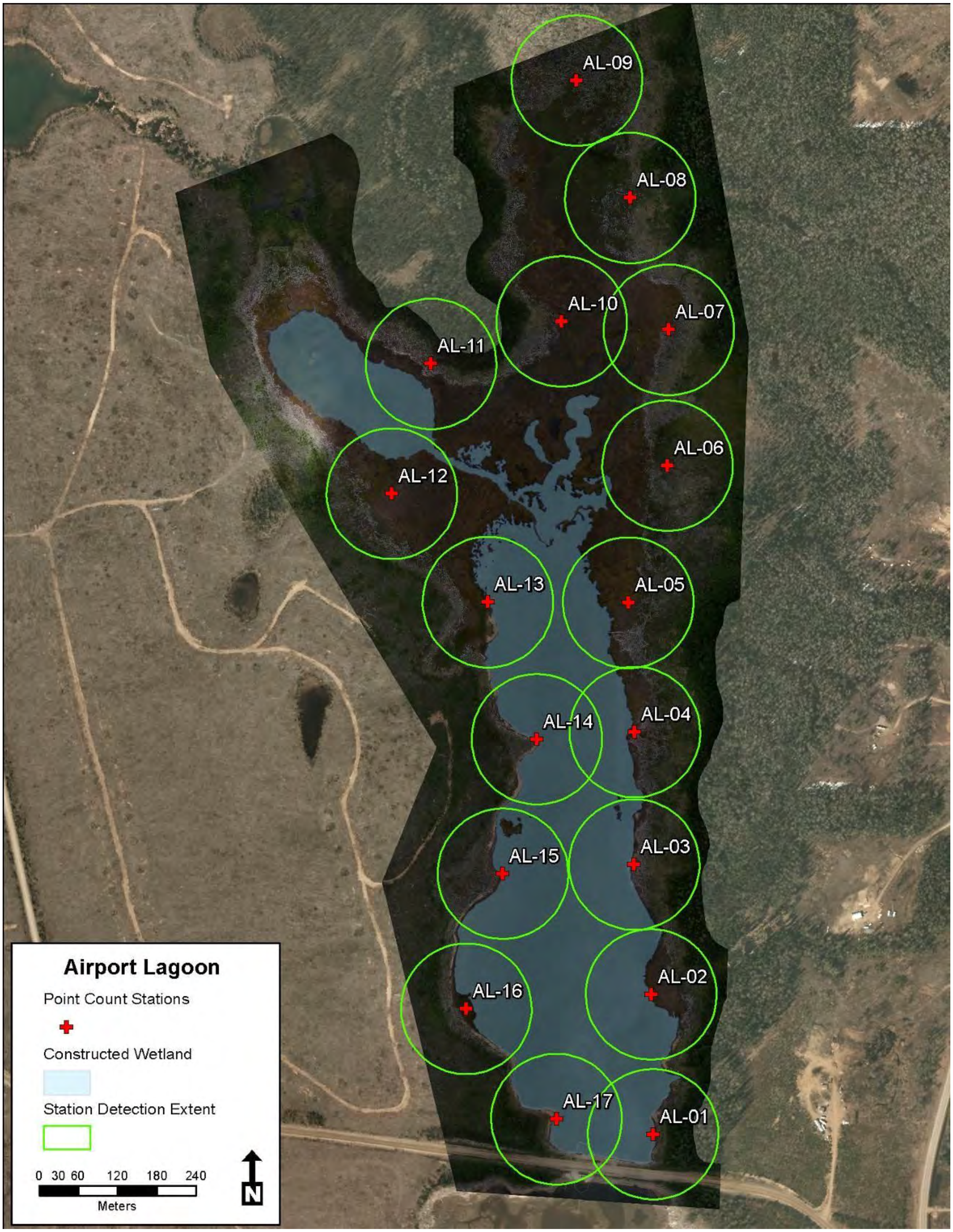

Figure 7. Point count station locations at the Airport Lagoon site.

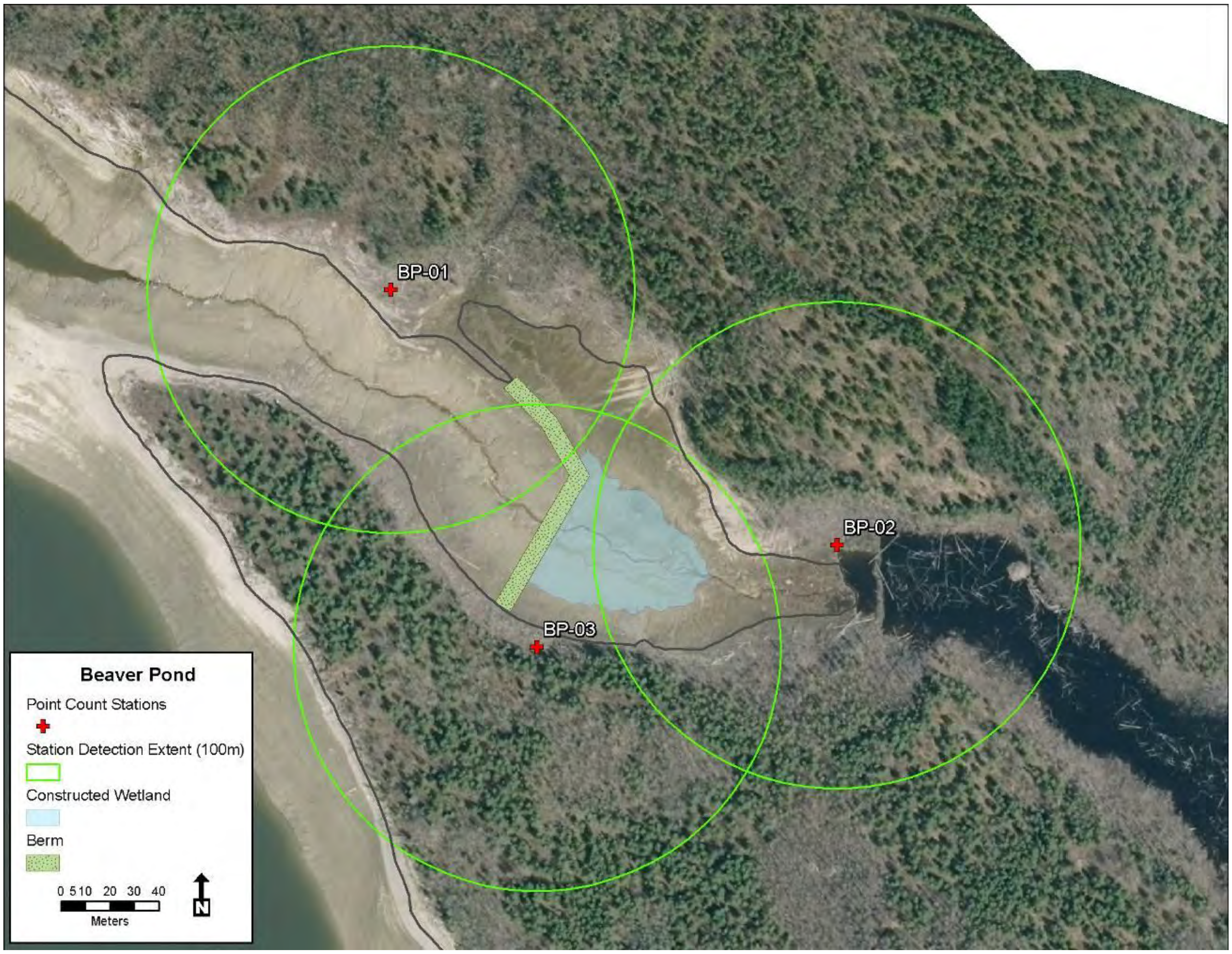

Figure 8. Point count station locations at the Beaver Pond site.

4.5 Amphibian Surveys

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 three years of this project (CBA 2012, 2013, 2014).

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 2 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, 11, and 22 and June 2. The two surveys at the Beaver Pond site were completed on May 12 and June 3. Early access to the Beaver Pond site was limited by ice cover on Williston Reservoir, poor weather conditions, and construction of the Beaver Pond project.

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 of the 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 9 and Figure 10, 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 three years of this project (CBA 2012, 2013, 2014). 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'.

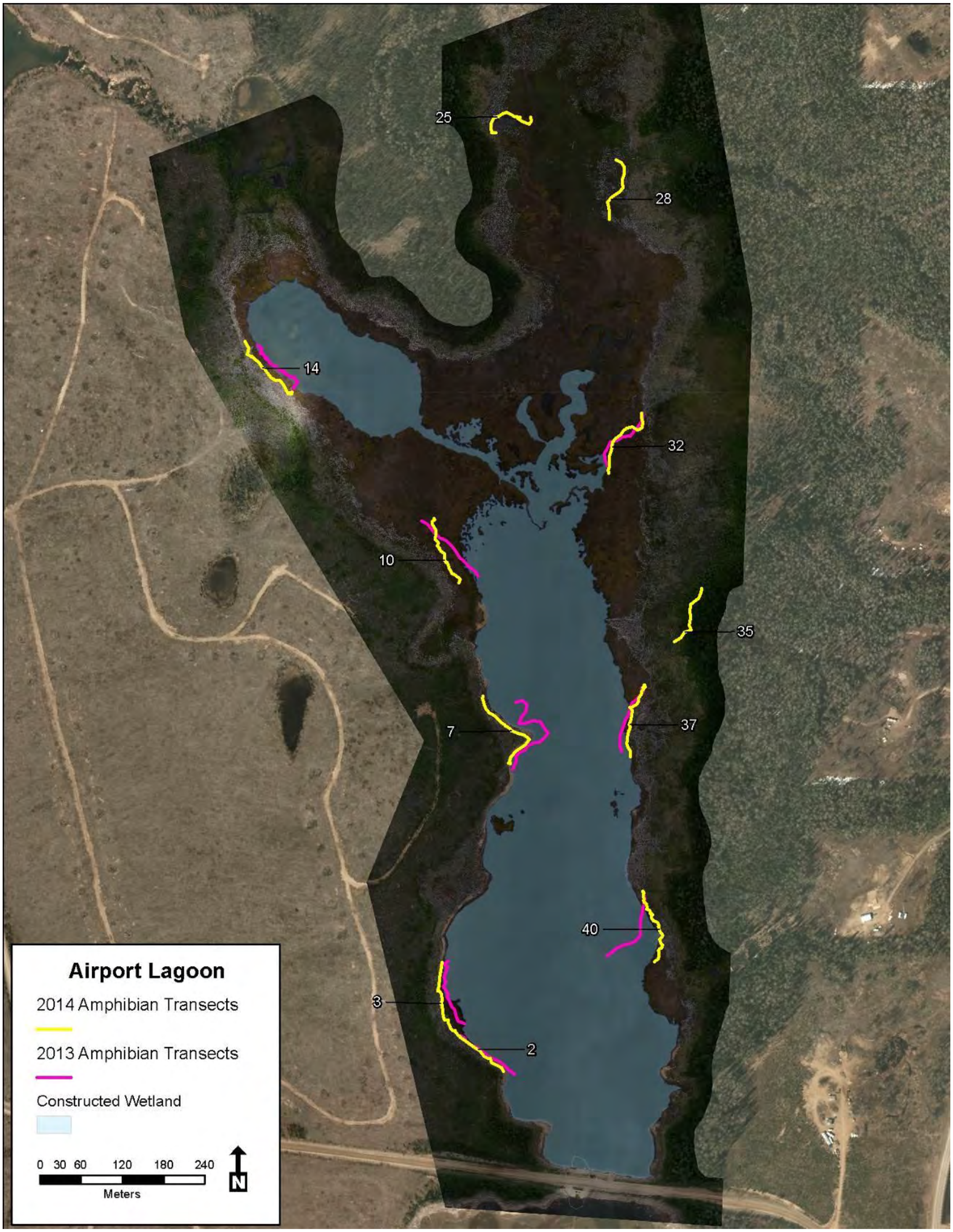

Figure 9. Amphibian survey transect locations at the Airport Lagoon site.

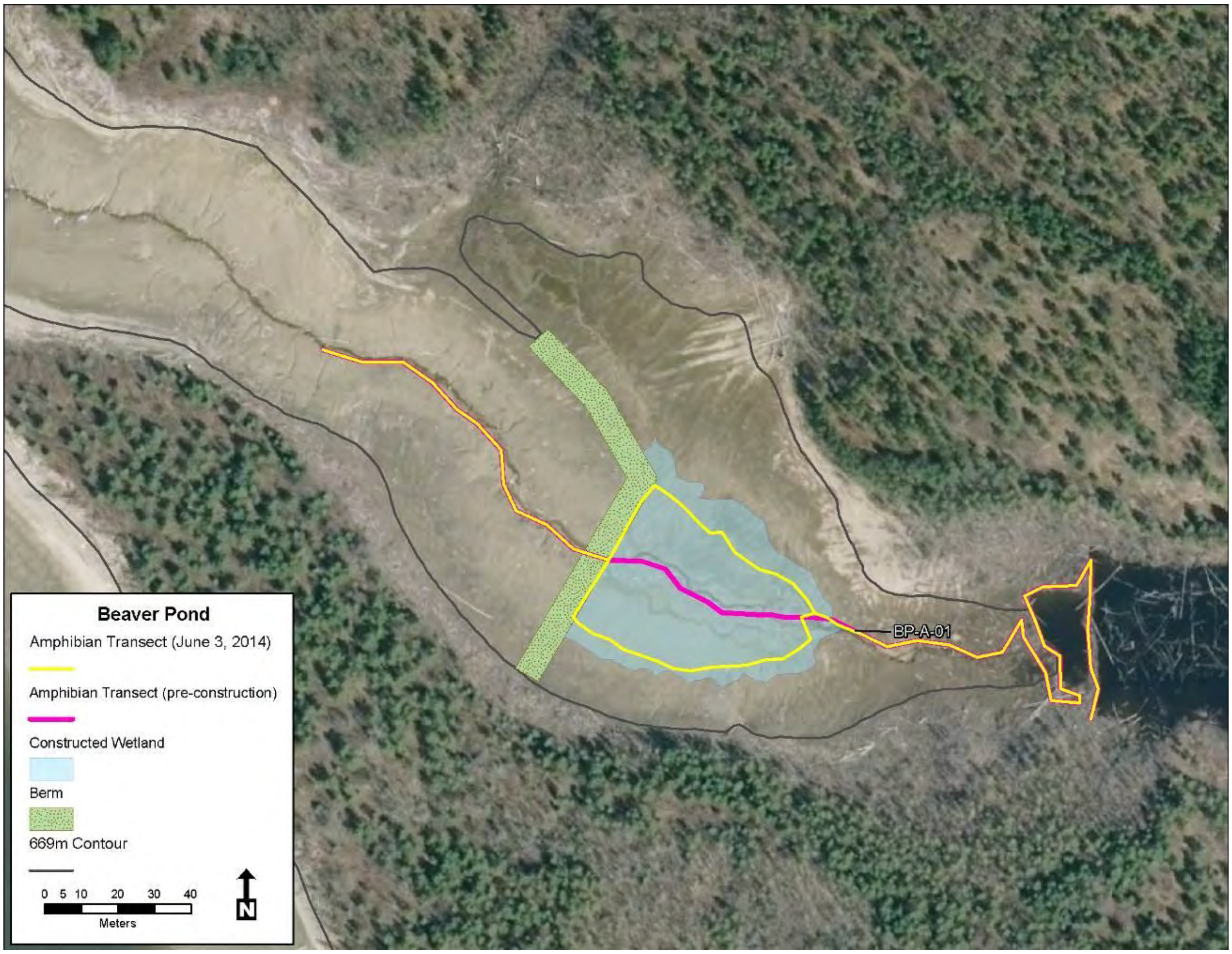

Figure 10. Amphibian survey tracks locations at the Beaver Pond site.

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 Fish Collection Permit PG14-94640 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. Fish sampling at the Beaver Pond and Airport Lagoon sites was completed using minnow traps, backpack electrofishing, and fyke nets.

Fish sampling was completed at the Airport Lagoon site on May 20-21 and July 21-22, 2014 and at the Beaver Pond site on May 12 (pre-construction) and July 23-24, 2014. The sampling locations are shown in Figure 11 and Figure 12 for the Airport Lagoon and Beaver Pond sites, respectively. The methods used on each date are summarized in Table 1. Two fyke nets were deployed at the Airport Lagoon during the May sampling. As in previous years, the upper pond in the northwest arm of the lagoon was only sampled with minnow traps as this location is not accessible by boat at early season water levels. The first fish sampling at the Beaver Pond site was completed prior to this area being inundated and prior to construction start-up.

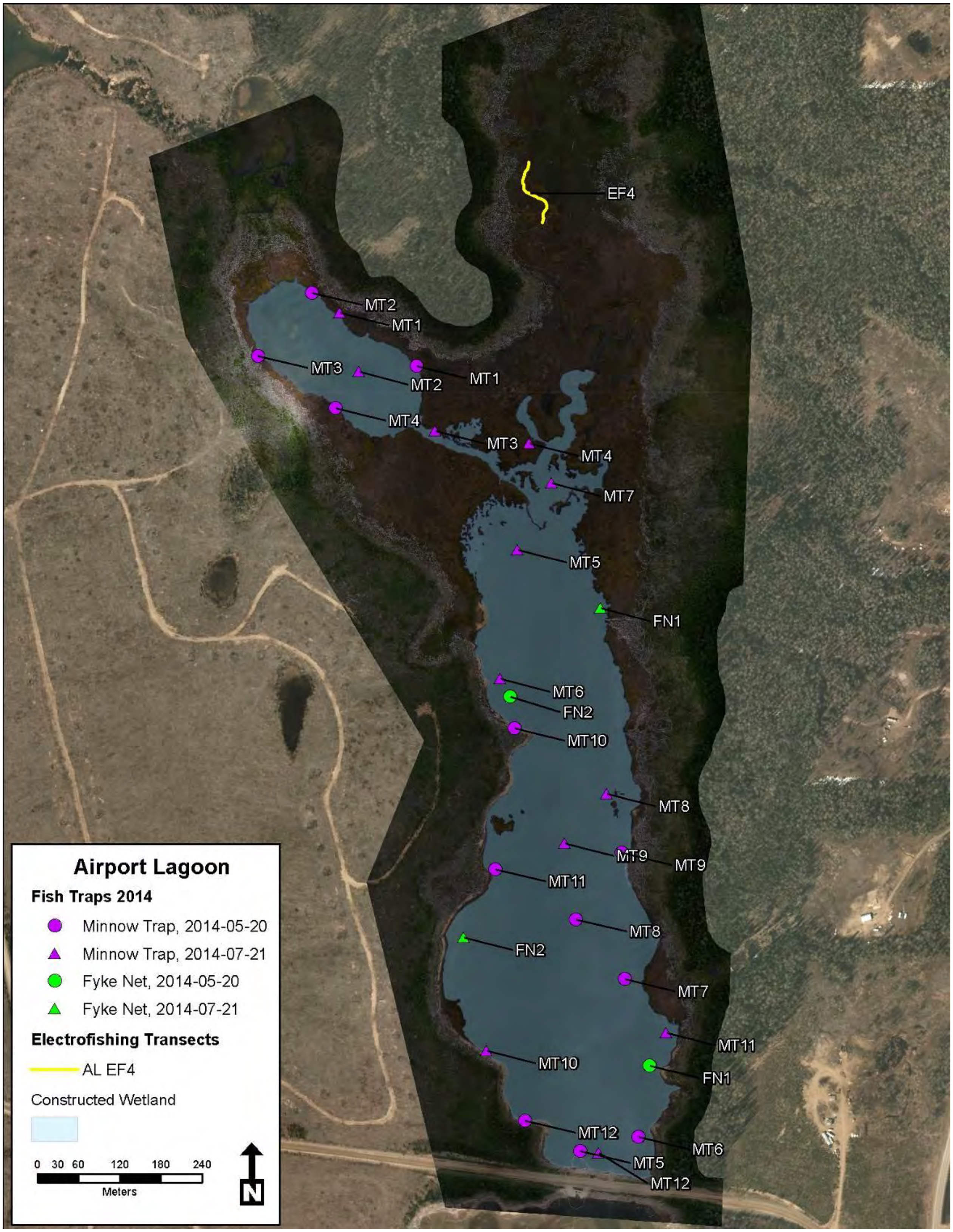

Figure 11. Fish sampling locations by date and method at the Airport Lagoon site.

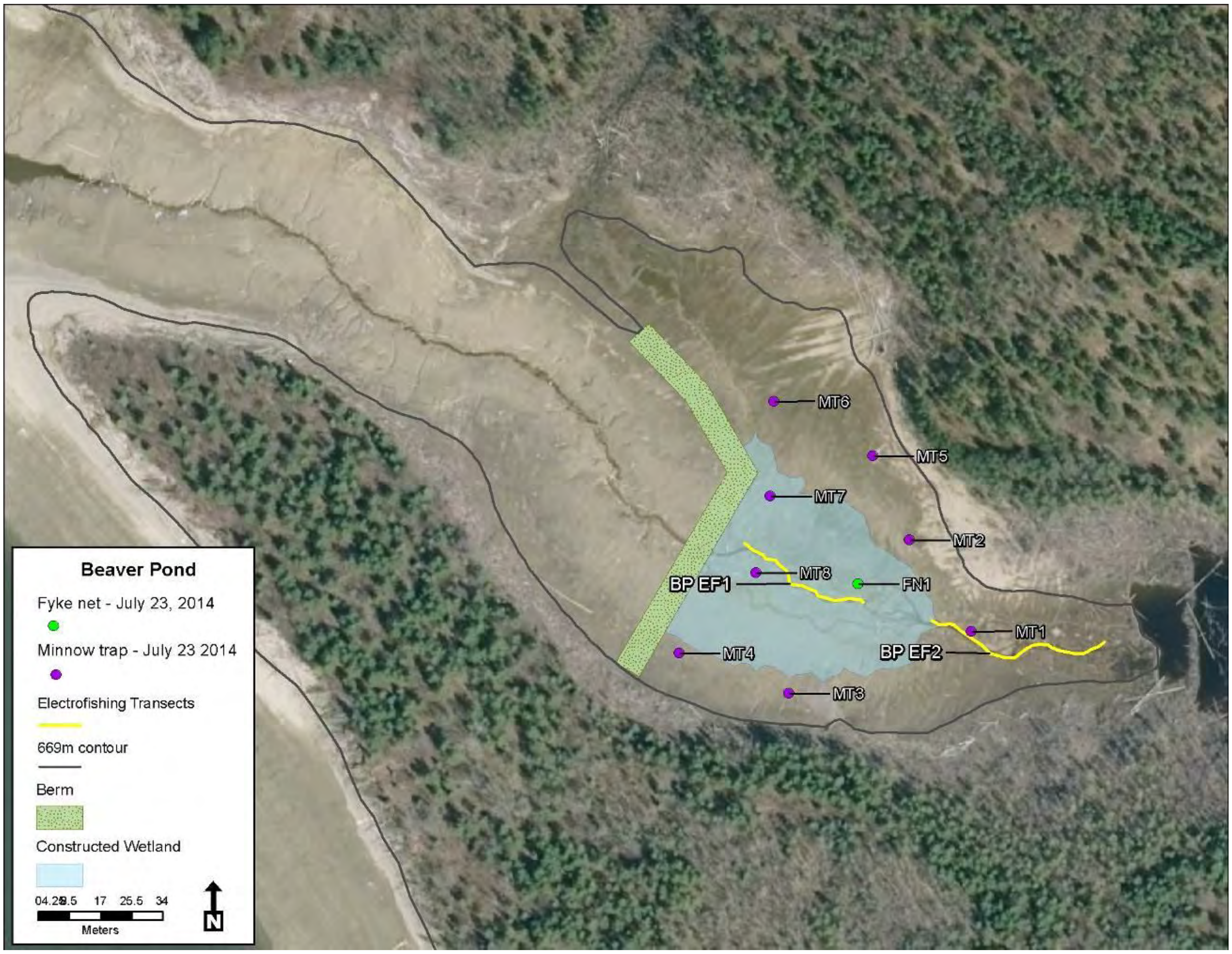

Figure 12. Fish sampling locations by date and method at the Beaver Pond site.

Table 1. Fish sampling methods in 2014 at the Airport Lagoon and Beaver Pond sites.

Site	Date	Method	Number of Samples
Airport Lagoon	May 20 -21	Minnow trap	12 traps
		Electrofishing	1 reach
		Fyke net	2 nets
	July 21-22	Minnow trap	12 traps
		Fyke net	2 nets
Beaver Pond	May 12	Electrofishing	2 reaches
	July 23-24	Minnow trap	8 traps
		Fyke net	1 net

Two minnow trap sampling sessions were completed at the Airport Lagoon and one was completed at the Beaver Pond. At the Airport Lagoon the first sampling session was completed prior to inundation and the second session was completed after inundation. Minnow trapping at the Beaver Pond site 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. At the Beaver Pond site, eight minnow traps were deployed at random locations during the July sampling session. Twelve minnow traps were used for each sampling session at the Airport Lagoon. During the first sampling session, four minnow traps set in random locations around the pond in the northwest arm of the lagoon and the other eight 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 11). This is the only one of the four previously sampled stream reaches at this site not affected by the new water level. The two stream reaches at the Beaver Pond site were sampled by electrofishing prior to construction (Figure 12).

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. A single net used to sample the Beaver Pond site in July. 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. All fish data were recorded on the RIC Fish Collection and Individual Fish Forms (Appendix 9).

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 2014 based on the number of fish captured. For all minnow traps and the May 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 high fyke net catches of small fish in July at the Airport Lagoon were subsampled by measuring a random sample of all small fish (<100 mm FL) in the catch until it was felt a reasonable sample of the catch composition and size range was recorded. The remaining small fish were enumerated but species was not 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 4 was also the first full year of post-construction data from the Airport Lagoon. Data collected at the Beaver Pond site is a combination of additional baseline data and initial post-construction observations. Initial comparisons of the post-construction results to the baseline are provided for the Airport Lagoon site. Further description of the baseline conditions for some of the indicator groups at the Beaver Pond are described and some initial observations of the post-construction conditions are provided. More detailed analyses are planned once additional years of post-construction data become available.

5 RESULTS

5.1 Environmental Conditions

In Year 4 (2014), temperatures in late April were close to average with warmer than average temperatures occurring at just prior to and during the start of the 2014 surveys (Figure 13). Temperatures throughout May 2014 were generally warmer than average and less variation than observed in previous years (Figure 13). Cumulative precipitation in Year 4 was average for April and well below average for May and June (Figure 14). With exception of the average precipitation in April 2014, Year 4 was the driest year observed in this monitoring program (Figure 14). Cumulative precipitation in both May and June 2014 was well below average and less than observed in the previous 3 years of this project. (Figure 14).

Based on degree days, Year 4 was similar to Year 3 during the survey period and was higher than the long term mean for accumulated degree days (Figure 15). The date when temperatures were consistently above 5°C in Year 4 (April 25) was the same as Year 2 and the long term average and similar to Year 3 (April 23). In Year 1, temperatures were not consistently above 5°C until May 3.

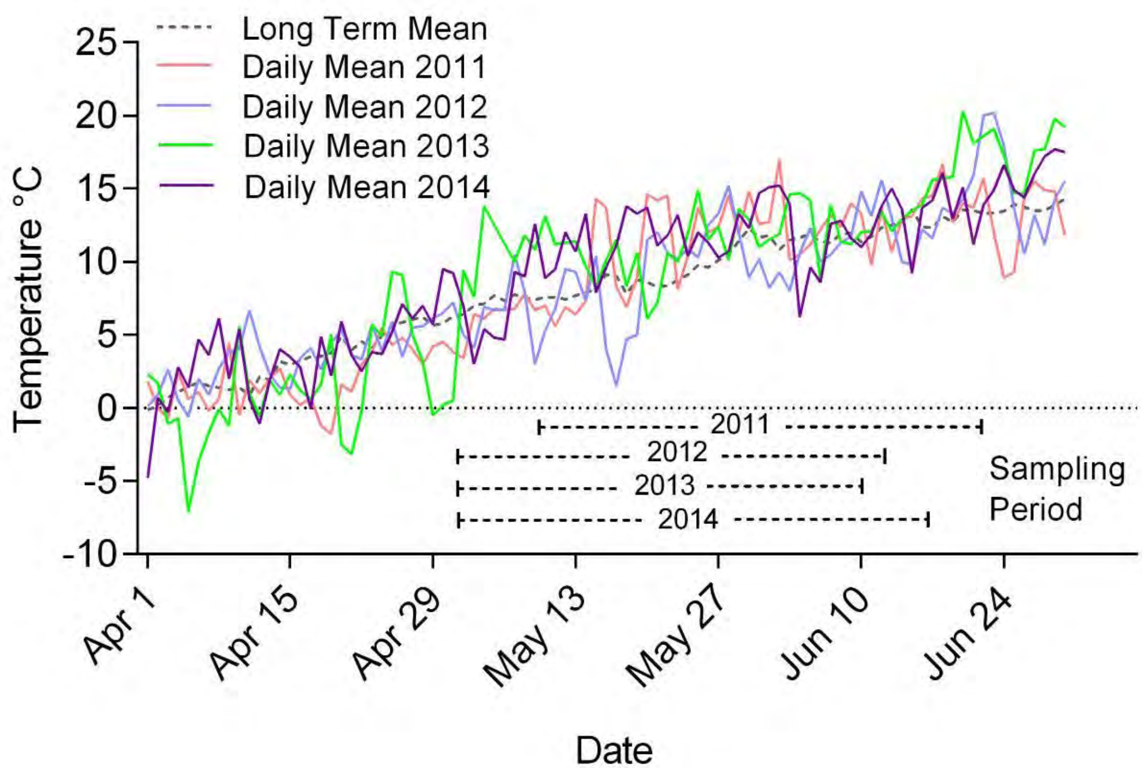

Figure 13. Daily mean air temperature and the long term mean in the study region. Data from Environment Canada and observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).

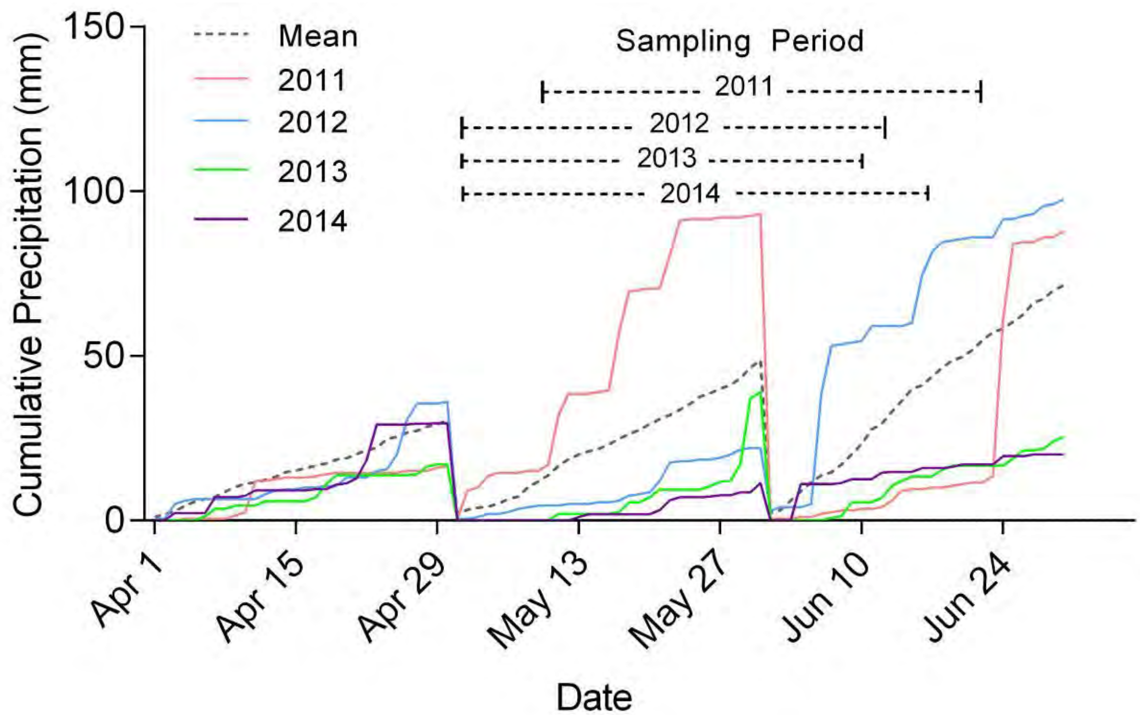

Figure 14. **Cumulative monthly total precipitation and the long term means in the study region. Data from Environment Canada and observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).**

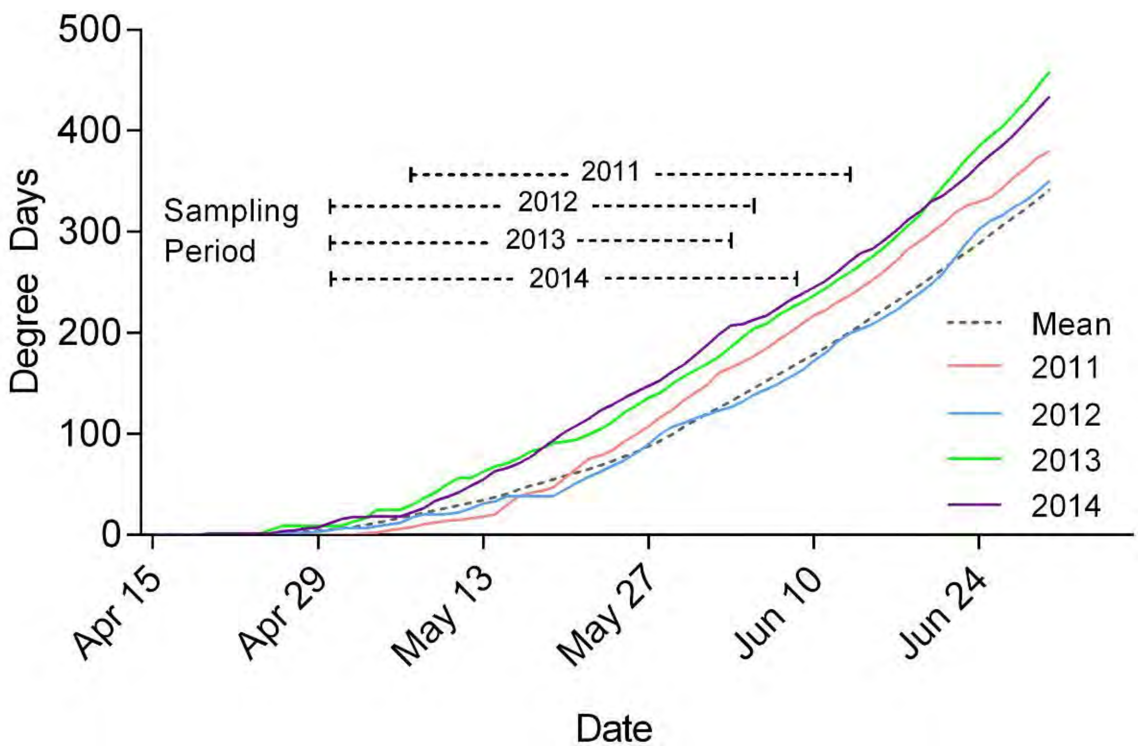

Figure 15. **Accumulated degree days (5°C base temperature) in the study region. Calculated from Environment Canada daily maximum and minimum temperatures observed at the Mackenzie Airport weather station (Station names: Mackenzie A and Mackenzie Airport Auto).**

5.2 Vegetation Surveys

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*] seedling). A few classes had a high percentage (≥50%) of coarse woody debris from driftwood accumulation. The habitat classifications and their spatial distribution was reassessed in Years 2 and 3 and the classifications and mapping refined as additional information was collected. As result, the original 19 classes were reduced to 16 in Year 3 (CBA 2014). Some of the habitat class names were also revised to more accurately reflect the expected annual vegetation cover and location.

In Year 4, the habitat class descriptions and their spatial distribution were again reviewed. This resulted in the identification of a new habitat class and the merger of two classes at the Airport Lagoon site. The total number of classes remained at 16. In addition, the delineation of habitat classes at Airport Lagoon was refined using the high resolution orthomosaic collected for the site in 2014. Changes to the Year 3 habitat classifications were based on information collected during Year 4 ground sampling and include:

- *A new habitat class, Floating Island (FI) was identified at Airport Lagoon*
  - In 2014, floating islands composed of masses of organic soil and woody debris were observed within main water body at Airport Lagoon. The islands appeared to be stable and were present during the initial and final site visit for the year (May to July).

- *Habitat Class Shoreline Clay (SC) was merged into Shoreline Sand (SS) at Airport Lagoon*
  - In Year 3, a majority of the area identified by the habitat class SC at Airport Lagoon was permanently flooded as a result of the wetland enhancement. Upon review of the site in Year 4, it was determined that no significant area designated as SC habitat class remained above the new water level.

A summary of the habitat classification schemes from Year 3 and the changes in Year 4 is provided in Table 2 and detailed descriptions of each class are provided in Appendix 10.

In Year 4, 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 16 and Figure 17, 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.

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%.

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. Final habitat classification summary for the Airport Lagoon and Beaver Pond sites including previous classes from Year 3.

Site	Year 4		Year 3		Comment
	Habitat Class	Habitat Class Description	Habitat Class	Habitat Class Description	
Airport Lagoon	BM	Basin Moss	BM	Basin Moss	
	BS	Basin Smartweed	BS	Basin Smartweed	
	FI	Floating Island	SP	Streams and Ponds	Newly formed habitat observed during Year 4 surveys
	SS	Shoreline Sand	SC	Shoreline Clay	SC merged into SS; no significant cover of SC present due to permanent flooding from the wetland enhancement.
	SD	Shoreline Driftwood	SD	Shoreline Driftwood	
	SG	Shoreline Grassland	SG	Shoreline Grassland	
	SP	Streams and Ponds	SP	Streams and Ponds	
	SS	Shoreline Sand	SS	Shoreline Sand	
	SW	Shoreline Willow	SW	Shoreline Willow	
	WD	Wetland Dead Trees	WD	Wetland Dead Trees	
	WH	Wetland Horsetail	WH	Wetland Horsetail	
	WS	Wetland Sedge	WS	Wetland Sedge	
	WW	Wetland Willow	WW	Wetland Willow	
Beaver Pond	BC	Basin Cryptantha	BC	Basin Cryptantha	
	SC	Shoreline Clay	SC	Shoreline Clay	
	SP	Stream Sedge	SE	Stream Sedge	
	SR	Shoreline Gravel	SR	Shoreline Gravel	
	SP	Streams and Ponds	SP	Streams and Ponds	
	SW	Shoreline Willow	SW	Shoreline Willow	

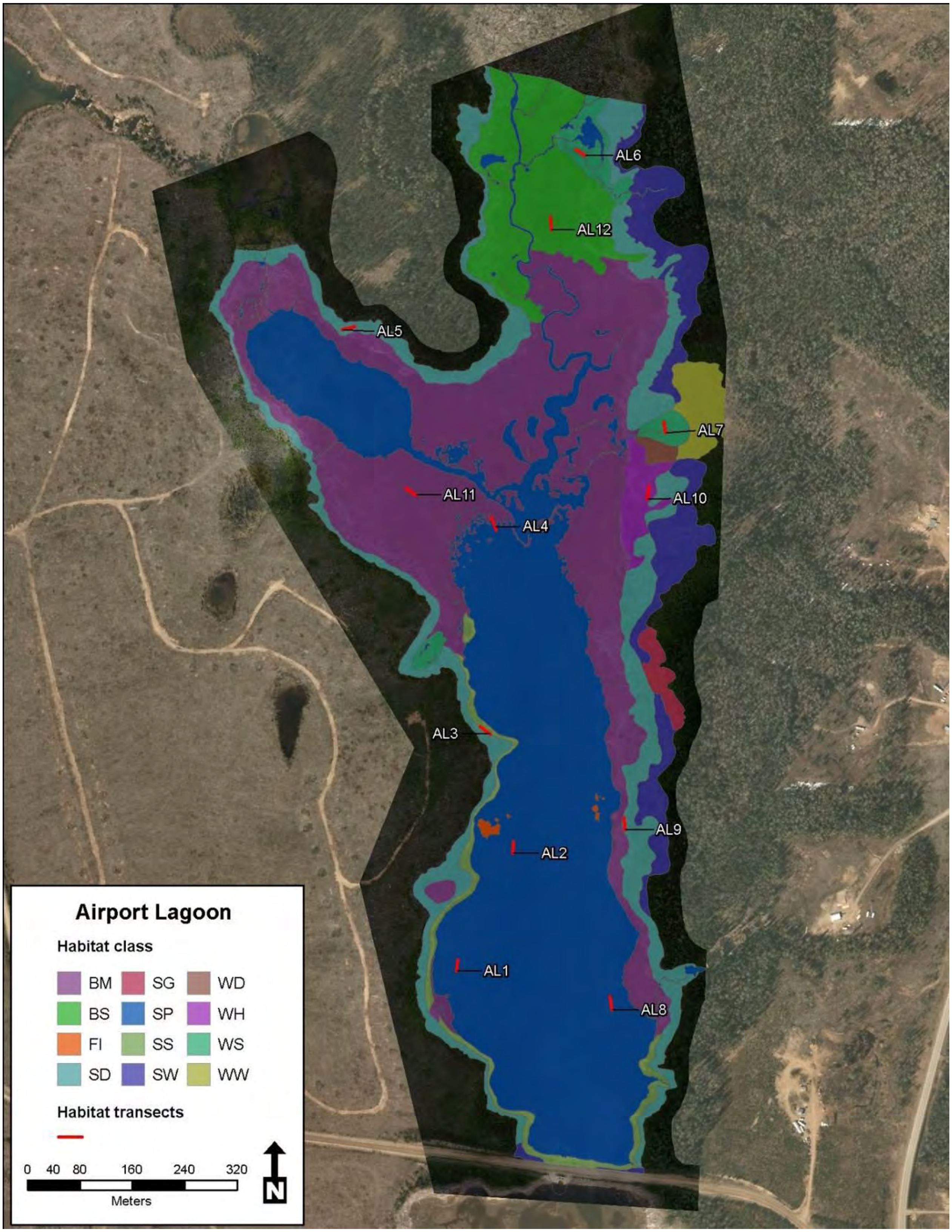

Figure 16. Post-construction habitat classes and transect locations in the Airport Lagoon site.

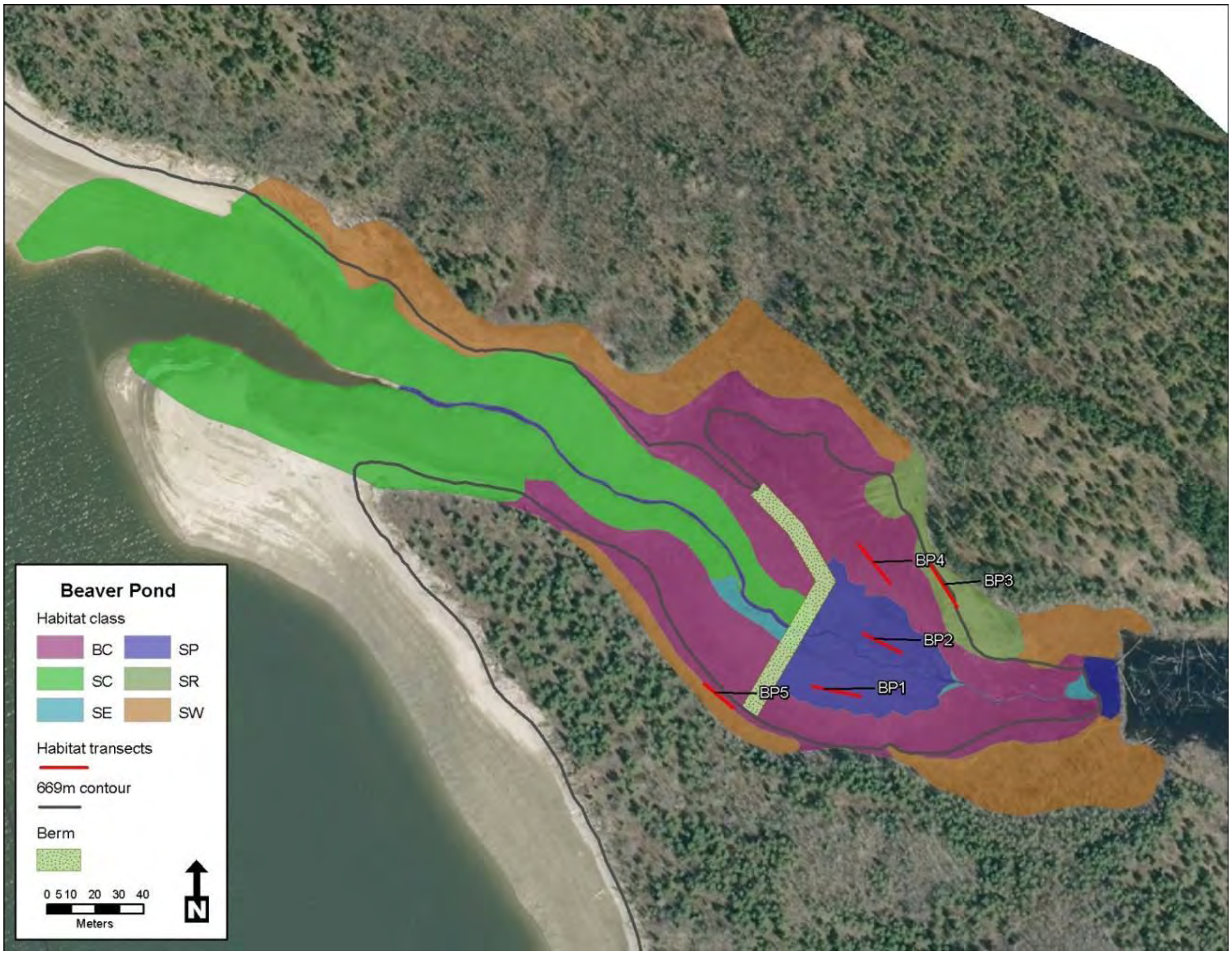

Figure 17. Post-construction habitat classes and transect locations in the Beaver Pond site.

Table 3. **Number of polygons and area for habitat classes identified during photo interpretation for the Airport Lagoon and Beaver Pond sites in Year 3 and Year 4. Refer to Appendix 10 for detailed descriptions of the habitat classes.**

Site	Habitat Class	Year 4 Number of Polygons	Year 4 Mean Area (ha)	Year 4 Total Area (ha)	Year 4 Percent of Total Area	Year 3 Number of Polygons	Year 3 Mean Area (ha)	Year 3 Total Area (ha)	Year 3 Percent of Total Area
Airport Lagoon	BM	33	0.54	17.98	27.57	19	0.55	10.39	15.10
	BS	5	0.96	4.82	7.40	3	1.78	5.34	7.76
	FI	7	0.01	0.08	0.13	-	-	-	-
	SC	-	-	-	-	2	0.09	0.18	0.26
	SD	8	1.01	8.08	12.39	5	3.09	15.46	22.47
	SG	1	0.43	0.43	0.65	1	0.46	0.46	0.67
	SP	49	0.53	26.10	40.03	18	1.53	27.48	39.94
	SS	3	0.39	1.18	1.82	5	0.17	0.85	1.24
	SW	5	0.73	3.63	5.56	3	1.52	4.55	6.61
	WD	1	0.17	0.17	0.26	1	0.29	0.29	0.42
	WH	1	0.75	0.75	1.15	1	1.41	1.41	2.05
	WS	7	0.15	1.06	1.63	3	0.28	0.85	1.24
	WW	1	0.92	0.92	1.41	1	1.54	1.54	2.24
	Totals	**121**		**65.21**	**100**	**62**		**68.80**	**100**
Beaver Pond	BC	2	0.66	1.32	31.86	2	0.73	1.45	33.03
	SC	4	0.40	1.60	38.79	2	0.80	1.60	36.45
	SE	6	0.01	0.04	0.92	3	0.05	0.16	3.64
	SP	2	0.03	0.07	1.60	1	0.08	0.08	1.82
	SR	1	0.15	0.15	3.74	1	0.15	0.15	3.42
	SW	4	0.24	0.95	22.98	4	0.24	0.95	21.64
	Totals	**19**		**4.13**	**100**	**13**		**4.39**	**100**

A total of four CWD density classes based on percent cover of CWD were identified and mapped at the Airport Lagoon Table 4. 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 18). 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 4. Density, number of polygons, and areas of CWD identified through photo interpretation for the Airport Lagoon.

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**

A total of four aquatic plant communities were identified and mapped along the water surface and shoreline at the Airport Lagoon (Table 5). The plant communities were identified by the dominant species for the community and include Fennel-leaved Pondweed, Lady's Thumb, Water Smartweed and Common Hornwort. A fifth non-aquatic plant community was identified (Non-aquatic); no significant cover of aquatic plant species was observed within this community.

Aquatic plant communities were distributed throughout the inundated portion of the site (Figure 19). The most common and widely distributed community was Lady's thumb, which occurred within shallow water (<1m depth) and along the shoreline. The Common Hornwort plant community occurred in deeper water (>2m 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 1-2m. The water Smartweed community was limited to an area at the north end of Airport Lagoon. Areas that were identified as a non-aquatic plant community were located within the site where permanent water cover was absent prior to the wetland enhancement constructed in Year 3.

The number of polygons for each aquatic plant community ranged from one (Fennel-leaved Pondweed, Water Smartweed and Common Hornwort) to eight (Lady's Thumb). The percentage of total area covered by the aquatic plant communities ranged from 0.21% (Water Smartweed) to 33.12% (Fennel-leaved Pondweed); the largest portion of the water surface and shoreline at Airport Lagoon was determined to be a non-aquatic plant community (Non-aquatic; 37.19%).

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

Site	Aquatic Plant Community	Number of Polygons	Area (ha)				Percent of Total Area
			Minimum	Maximum	Mean	Total	
Airport Lagoon	Fennel-leaved Pondweed	1	9.29	9.29	9.29	9.29	33.12
	Lady's Thumb	8	<0.01	5.19	0.68	5.41	19.29
	Water Smartweed	1	0.06	0.06	0.06	0.06	0.21
	Common Hornwort	1	2.86	2.86	2.86	2.86	10.12
	Non-aquatic	4	0.37	5.18	2.61	10.43	37.19
	Totals	**15**				**28.05**	**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 6). 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 6).

Vegetation transects at the Beaver Pond site were located on clay rich soils with gentle to moderate slopes and frequent to annual flooding (Table 6). 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 6).

During Year 4 ground sampling for terrestrial vegetation, a total of 40 herb species were recorded across 11 transects. Average percent herb cover by transect ranged from 2.5% to 63.2% (Table 7). Six species of moss were recorded during ground sampling on five of the 11 transects. On transects where moss species did occur, the percent cover ranged from 0.1% to 81.5% (Table 7). Shrub species only occurred on three of the 11 transects, and only in the C layer (0-15cm height). Willow (*Salix* spp.) was the only shrub species identified on the transects. A summary of the terrestrial plant species and percent cover for each transect is provided in Appendix 11.

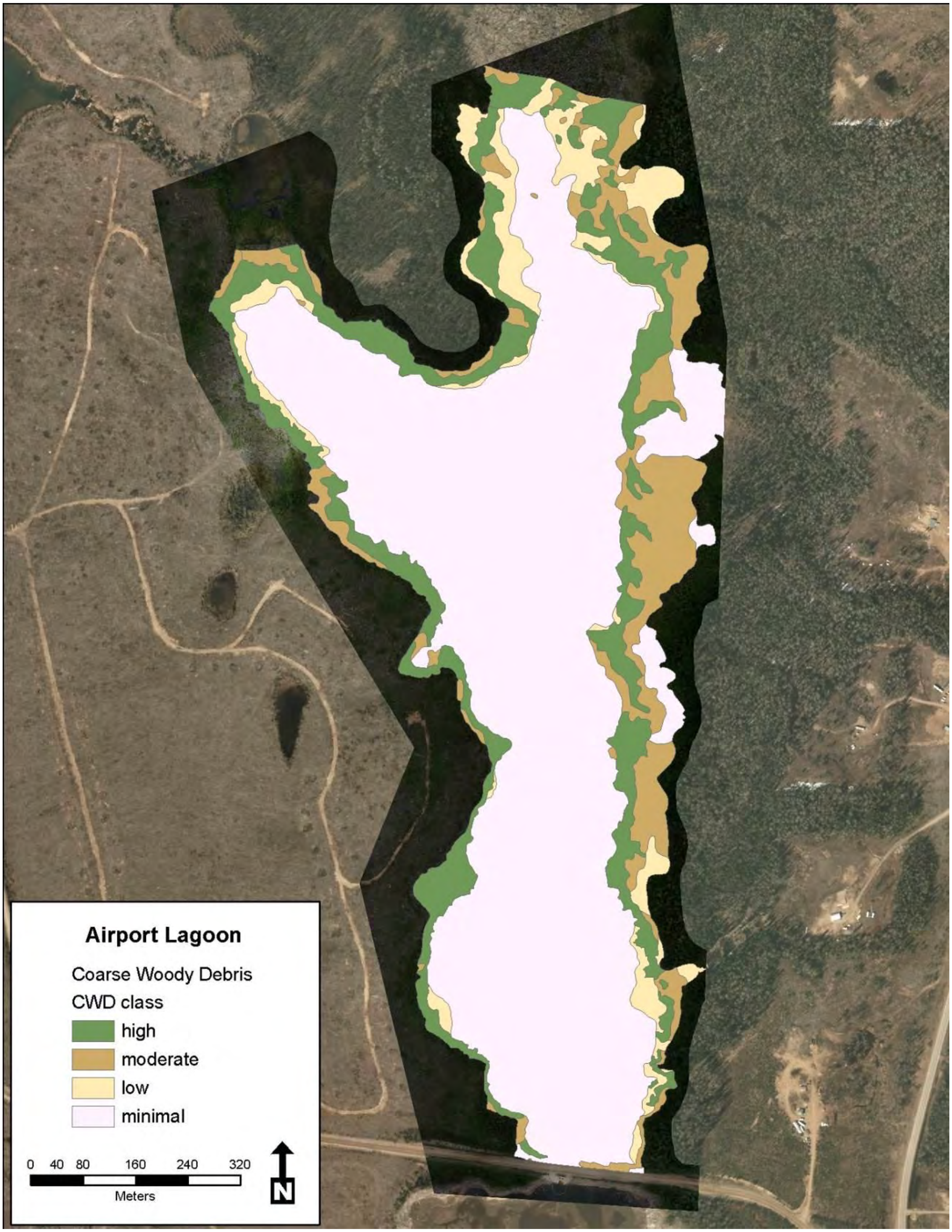

Figure 18. CWD density classes at the Airport Lagoon site in 2014.

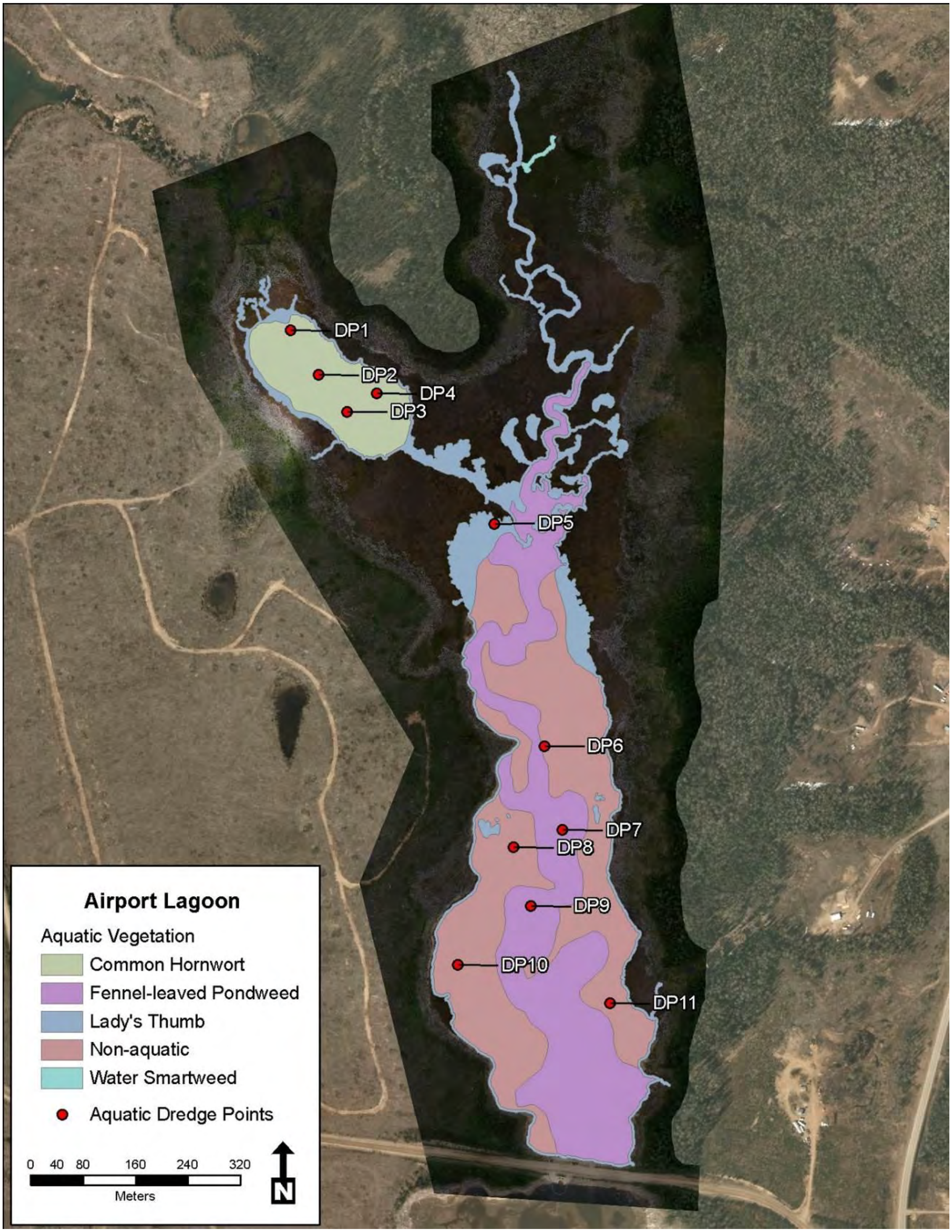

Figure 19. Post-construction aquatic vegetation distribution at the Airport Lagoon site.

Table 6. Site characteristics for vegetation transects sampled in Year 4 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					0	0	0	0	0	100	n/a	
	AL2[9]					n/a					0	0	0	0	0	100	n/a	
	AL3	SBSmk1	P	2	A	DC	2b	677	15	30	31	0	14	55	0	0	r	A
	AL4[9]					n/a											n/a	
	AL5	SBSmk1	P	3	B	DC	2b	679	15	169	2	0	42	56	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	95	0	4	0	0	0	v	F
	AL8[9]					n/a					0	0	0	0	0	100	n/a	
	AL9	SBSmk1	P	6	E	DC	2b	675	6	272	55	0	45	0	0	0	i	A
	AL10	SBSmk1	F	7	E	DC	2b	675	2	284	63	0	35	0	0	2	v	A-F
	AL 11	SBSmk1	G	6	E	DC	2a	676	0	999	99	0	1	0	0	0	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	0	31	2	67	0	0	r	A-F
	BP4	SBSmk2	G	7	D	DC	2a	673	5	227	0	0	3	97	0	0	m	A
	BP5	SBSmk2	P	4	D	DC	2b	685	20	44	80	0	20	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 2014.
[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 7. Vegetation cover summary for transects sampled in Year 4 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	10	2.5	0	0	0	0
	AL5	13	19.7	0	0	0	0
	AL6	12	63.2	2	8.3	0	0
	AL7	10	33.0	4	91.8	1	1.8
	AL9	13	12.3	3	0.8	0	0
	AL10	15	14.0	3	11.8	0	1.0
	AL11	4	8.4	1	1.6	0	0
	AL12	2	39.3	0	0	0	0
			24.1		**14.3**		**0.3**
Beaver Pond	BP3	16	8.6	0	0	0	0
	BP4	9	11.5	0	0	0	0
	BP5	14	17.6	0	0	0	0.1
			12.6		**0**		**0.03**

Values represent an average number of species and % cover based on plot surveys completed in 2014; the average for number of species are rounded up to whole numbers where necessary.

A majority of the terrestrial plant species were observed at the study sites during Year 4 ground sampling were common to habitat classes located in the upper elevations of the drawdown zone as lower 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*). 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), species that were also observed at the Airport Lagoon and Beaver Pond site.

During Year 4 surface sampling for aquatic plants, a total of 11 aquatic plant species were identified at Airport Lagoon (Table 8); in addition, three unidentified species were also observed. The most common and widely distributed aquatic plant species (those observed throughout the site) were Lady's thumb and spring water-starwort (*Callitriche palustris*). These species occurred within shallow water (<1m depth) and along the shoreline. Species that were common within a specific area of the site included common hornwort (*Ceratophyllum demersum*), fennel-leaved pondweed (*Stuckenia pectinata*), long-stalked potamogeton (*Potamogeton praelongus*) and water smartweed. Common hornwort and long-stalked potamogeton were observed in deeper water (>2m depth) on the west side of the site. Fennel-leaved pondweed was most commonly observed in the central area of the site at water depths of 1-2m. 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 12.

Table 8. Aquatic plant species identified during surface sampling in Year 4 at the Airport Lagoon study site.

Common Name	Latin Name
bladderwort	*Utricularia* spp.
common hornwort	*Ceratophyllum demersum*
fennel-leaved pondweed	*Stuckenia pectinata*
lady's thumb	*Persicaria maculosa*
long-stalked potamogeton	*Potamogeton praelongus*
small yellow water-buttercup	*Ranunculus gmelinii*
spring water-starwort	*Callitriche palustris*
variegated yellow pond-lily	*Nuphar variegata*
water smartweed	*Persicaria amphibia*
water-starwort	*Callitriche* spp.
white water-buttercup	*Ranunculus aquatilis*

5.3 Waterfowl and Shorebird Surveys

During Year 4 surveys, a total of 388 individuals representing 26 species of waterfowl and shorebirds were detected at the Airport Lagoon (Table 9). For the second consecutive year, no detections were made at the Beaver Pond site during the waterfowl surveys. Mallard and American Wigeon were the two most commonly observed species in Year 4. Ring-necked Duck, Northern Pintail, and Green-winged Teal were also common. Canada Goose, Mallard, American Wigeon, Northern Pintail, Ring-necked Duck, and Killdeer were detected during all four surveys (Table 9). As in previous years, the majority of individuals (142) were detected during the first survey on May 1 at the Airport Lagoon site.

Species richness was at its highest in Year 4 for waterfowl and shorebirds. Unlike previous years where species richness was also at its highest during the earliest survey, in Year 4, highest species richness was recorded during the third survey on May 20th. Pectoral Sandpiper, Wilson's Phalarope, Greater Scaup, Common Goldeneye, Red-breasted Merganser and Trumpeter Swan were detected for the first time during 2014 surveys. Semipalmated Plovers, Red-necked Grebe, Cinnamon Teal, and Greater White-fronted Goose observed during previous surveys were not detected this year. Incidental observations at Airport Lagoon included Common Merganser, Western Grebe, Least Sandpiper, and Wilson's Snipe. At Beaver Pond, 3 Green-winged Teal, a pair of Blue-winged Teal, a pair of Spotted Sandpipers, and a nesting pair of Killdeer were incidental observations and the only waterfowl or shorebirds recorded.

Table 9. Summary of waterfowl and shorebird observations in 2011, 2012, 2013 and 2014 at the Airport Lagoon site, Williston Reservoir, BC. No waterfowl or shorebirds were observed in 2013 nor 2014 during targeted surveys at the Beaver Pond site.

	2011[a]				2012					2013					2014				
	May 09	May 22	Jun 07	Total	May 01	May 09	May 16	May 31	Total	May 01	May 12	May 25	Jun 10	Total	May 01	May 11	May 20	Jun 02	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
American Wigeon	37			37	34		4		38	44			2	46	26	6	14	1	47
Mallard	6	4	4	14	9		3		12	49	3	7	30	89	16	42	25	14	97
Blue-winged Teal		3		3				1	1		14	2	3	19		1	7	3	11
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
Northern Pintail			1	1	9	6			15	5		2	5	12	18	9	3	2	32
Green-winged Teal	4	2		6	18	5	4		27	85	2		5	92	24	3	1		28
Canvasback						2			2								1		1
Ring-necked Duck	35	4	2	41	49				49	33				33	10	6	15	4	35
Lesser Scaup	15	3		18	6				6						9				9
Greater Scaup																	1		1
Bufflehead	5	4		9	7				7	22	1			23	5	2	1		8
Barrow's Goldeneye	4			4	1				1	17				17	6				6
Common Goldeneye																3			3
Hooded Merganser					2				2								1		1
Common Merganser					10				10	13				13					0
Red-breasted Merganser																		1	1
Common Loon						1	1		2							1		2	3
Red-necked Grebe	5	2		7	1				1										0
Trumpeter Swan															1				1
Semipalmated Plover						4	3		7		1			1					0
Killdeer						4	1	2	7	3	1	1	3	8	2	4	7	3	16
Spotted Sandpiper							3	1	4		1	1	3	5	1		4		5
Greater Yellowlegs							6	4	12	3				3	5		5		10
Lesser Yellowlegs					7		13		20		5	3		8	5	8	8		21
Semipalmated Sandpiper						6	1		7		5			5			3		3
Pectoral Sandpiper																	3		3
Long-billed Dowitcher							68		68							5	3		8
Wilson's Phalarope																	2		2
Totals	**151**	**33**	**37**	**221**	**184**	**33**	**118**	**26**	**363**	**289**	**37**	**28**	**63**	**417**	**142**	**100**	**109**	**37**	**388**

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

In addition to the higher species richness observed in 2014, the numbers of waterfowl and shorebirds in the post-construction surveys at the Airport Lagoon showed some increases over the baseline surveys and more consistently higher abundance on all survey dates (Figure 20). 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 21). 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 21). Smaller increases were also observed at WSP-04 (Figure 21) but field observations suggest that the areas of highest abundance may have shifted to the east (closer to the WSP-03 survey area).

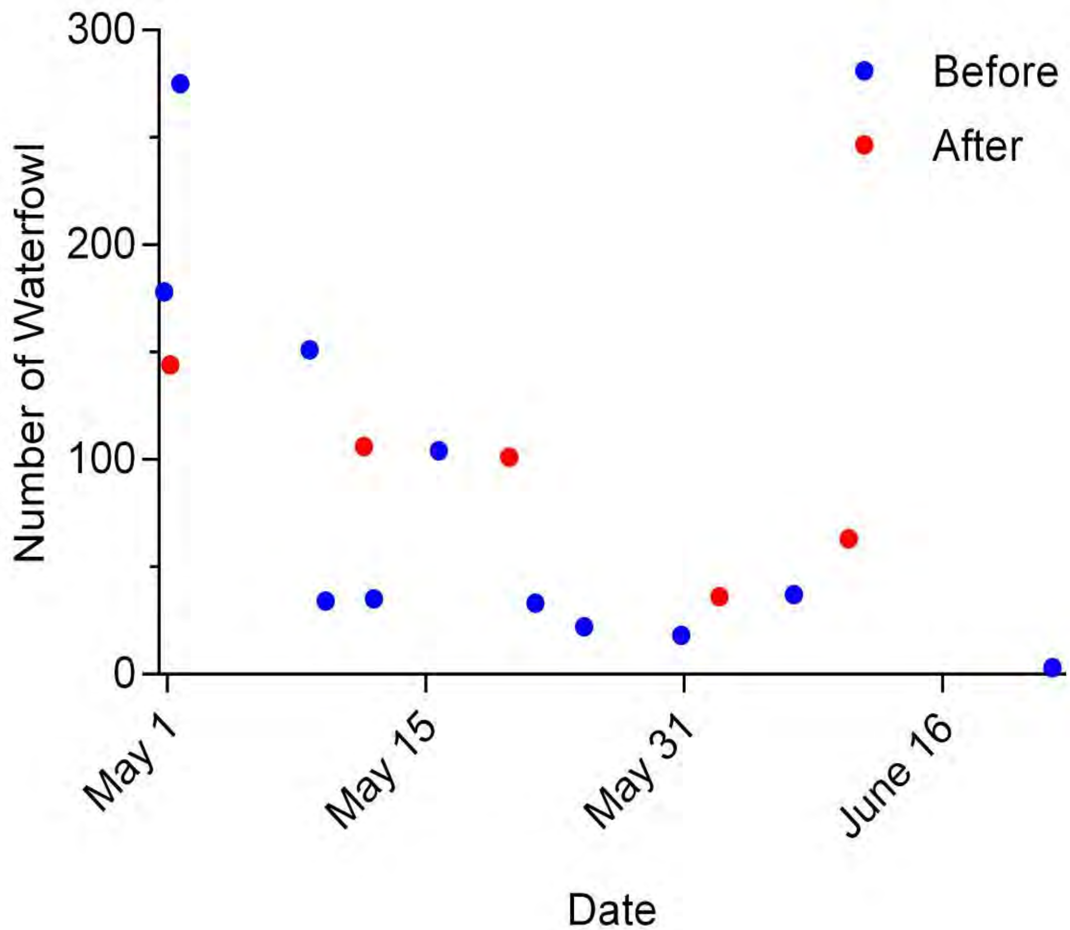

Figure 20. **Seasonal abundance of waterfowl and shorebirds at the Airport Lagoon site before and after completion of the wetland enhancement project.**

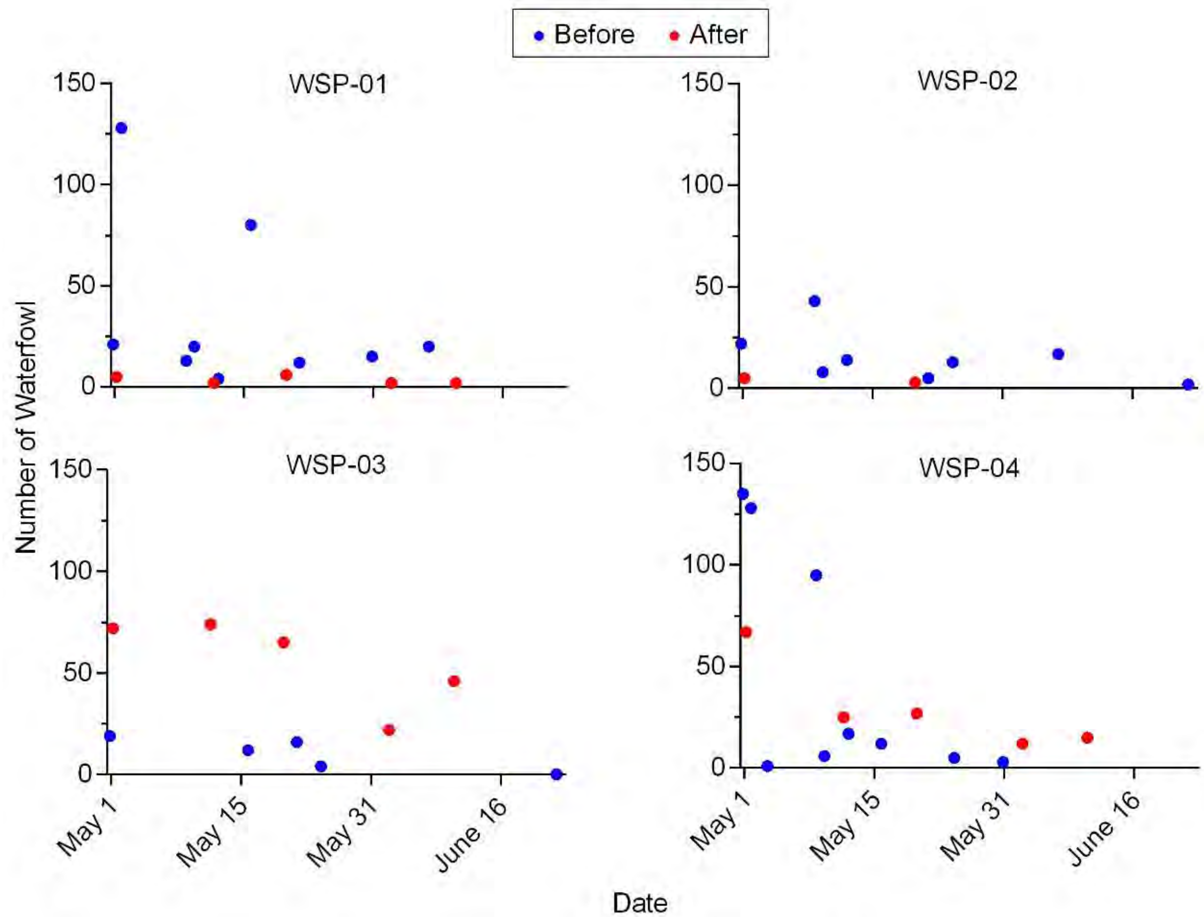

Figure 21. Seasonal abundance of waterfowl and shorebirds by survey station at the Airport Lagoon site before and after completion of the wetland enhancement project.

5.4 Songbird Surveys

A total of 471 detections representing 551 individuals from 58 species were recorded during 2014 songbird point count surveys. Species richness was higher at the Airport Lagoon site with 54 species compared to 19 at Beaver Pond.

Species richness at each site in 2014 was similar to previous years (

Table 10). An average of 15.6 (n=17) species per point count station were detected at Airport Lagoon compared to an average of 11.7 (n=3) at Beaver Pond. A summary of species detected at each station in Year 4 is included in Appendix 13.

The majority of detections were located within the drawdown zone at the Airport Lagoon site (30.8%, n=128) and within the forested area above the drawdown zone at Beaver Pond (78.6%, n=44) (Table 11). With the exception of two detections (0.5%) located in unknown habitat, the fewest detections at Airport Lagoon occurred as flyovers (15.2%, n=63). At Beaver Pond a total of six detections equally distributed between the drawdown zone (3.6%, n=2), flyovers (3.6%, n=2) and unknown habitat (3.6%, n=2), were the only observations recorded outside the forest and shrub habitats above the drawdown zone (Table 11).

The number of detections and species diversity in the Airport Lagoon was higher the Year 4 point counts than in previous years with 153 detections of 26 species (Table 12). The number of detections of water-dependent species (Waterfowl, shorebirds, and gulls) also increased in the Year 4 point counts compared to previous years with a total of 69 detections (Table 12). The number of water bird species was the same as in Year 3 (2013) (Table 12) but there were notable increases in the number of Killdeer and Common Loon detected compared to previous years as well as first time detections of Bonaparte's and Ring-billed Gulls.

As in previous years (CBA 2013), slight differences in species composition were observed during point count surveys. Seven (12.1%) of the species (Brewers Blackbird, Red-winged Blackbird, Yellow-headed Blackbird, Ruffed Grouse, Gadwall, Ring-billed Gull and Vaux Swift) recorded were unique to 2014 surveys. The majority of species detected in 2014 (72.4%, n=42) were also detected in at least two of the previous three years. Twelve species detected in at least two of the previous three surveys were not detected during point counts in 2014.

Nest searching surveys found a total of nine active nests used by five different species, with seven nests at Airport Lagoon and two nests at the Beaver Pond site. A single Killdeer nest was also located within the drawdown zone at Beaver Pond by construction crews. Nests were found both within the drawdown zone and in adjacent shrub and forest areas (up to ~50 m from edge of drawdown zone). At the Airport Lagoon, nests located in the drawdown zone during the point count surveys included Osprey, Dark-eyed Junco, Northern Flicker, Yellow-rumped Warbler and Chipping Sparrow. A number of very young Killdeer broods were observed within the drawdown zone of the Airport Lagoon site, indicating that nesting occurs within this habitat. Nesting behaviour was observed suggesting that Bonaparte's Gull and Belted Kingfisher may also have been nesting in the forested habitat to the north-west of the study site and at the south east edge of the drawdown zone at Airport Lagoon respectively, though nests were not located. At the Beaver Pond site, two Yellow-rumped Warbler nests were located in the forest on the edge of the drawdown zone.

Table 10. Summary of the number of species detected and mean species per station for songbird point count surveys in 2011, 2012, 2013 and 2014 at the Airport Lagoon and Beaver Pond sites.

	Year	Airport Lagoon	Beaver Pond	Combined Total
Number of Species	2011	57	21	59
	2012	56	24	59
	2013	57	23	61
	2014	54	19	58
Species per Station	2011	13.8	11.3	13.4
	2012	14.5	12	14.2
	2013	12.1	14.7	12.5
	2014	15.5	11.7	14.9
Number of Stations		17	3	20

Table 11. Summary of the detection locations for songbird point count surveys in 2012, 2013 and 2014 at the Airport Lagoon and Beaver Pond sites. Detection location was not recorded in 2011.

Year	Detection Location	Airport Lagoon Number of Detections	Airport Lagoon %	Beaver Pond Number of Detections	Beaver Pond %
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	

Table 12. Summary of drawdown zone detections during songbird point count surveys in 2012, 2013, and 2014 at the Airport Lagoon site. Detection location was not recorded in 2011.

		2012	2013	2014
All species	Detections	113	84	153
	No. of Species	22	21	26
Waterbirds[1]	Detections	43	47	69
	No. of Species	6	8	8

[1] – includes waterfowl, shorebirds, and gulls

5.5 Amphibian Surveys

During the 2014 systematic searches, three amphibian species were detected: western toad (*Anaxyrus boreas*), long-toed salamander (*Ambystoma macrodactylum*), and Columbia spotted frog (*Rana luteiventris*) (Table 13). A record number of amphibians, totalling 74.7% of all detections in 2014 were recorded during the May 11 and 12 surveys (Table 14). No amphibians were recorded during the earliest survey at Airport Lagoon.

As in previous years, the western toad, a blue-listed species in BC and a federal Species of Special Concern, represented the majority (83.8%) of detections (Table 13). The single Columbia spotted frog (*Rana luteiventris*) at Airport Lagoon on May 11, 2014 was the first detection of this species in the project. Long-toed salamanders (*Ambystoma macrodactylum*) were present at both sites during the May 11 and 12 surveys but they were not detected on any of the other survey dates (Table 14). Observers recorded 11 long-toed salamanders, of which 72.7% were found at the smaller Beaver Pond site.

Long-toed salamander egg masses were recorded at both sites on May 11 and 12, 11 clusters were observed at Beaver Pond. The remaining 6 clusters were recorded on transect 25 and incidentally at Airport Lagoon. Large groups (100-1000+) of predominantly western toad tadpoles, were recorded along transects (25 and BP-01) and incidentally at both sites in late May and early June. Incidental observations of note included 49 western toad and a second Columbia spotted frog at Airport Lagoon on May 11; and a western garter snake on transect 7 during the May 22 survey.

Table 13. Adult and juvenile amphibian detections with survey effort 2011 - 2014 at the Airport Lagoon and Beaver Pond sites.

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

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

Table 14. 2014 Adult and juvenile amphibian detections by transect and survey date at the Airport Lagoon and Beaver Pond sites.

		Species														
		Western Toad					Columbia Spotted Frog					Long-toed Salamander				
Site	**Transect**	**May 01**	**May 11**	**May 22**	**Jun 02**	**Total**	**May 01**	**May 11**	**May 22**	**Jun 02**	**Total**	**May 01**	**May 11**	**May 22**	**Jun 02**	**Total**
Airport Lagoon	2[a]															
	3[a]															
	7[a]															
	10[a]															
	14[a]															
	25		67	1	4	72		1			1		1			1
	28															
	32[a]			1	1	2										
	35															
	37[a]															
	40[a]												2			2
Total			**67**	**2**	**5**	74		**1**			**1**		**3**			3
			May 12		**Jun 03**			**May 12**		**Jun 03**			**May 12**		**Jun 03**	
Beaver Pond	BP-A-01[a]		4		5	9							8			8
Grand Total			**71**	**2**	**10**	**83**		**1**			**1**		**11**			11

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

5.6 Fish Surveys

A total of 16,698 fish representing 11 species were collected over the duration of the sampling program in Year 4. As in previous years, more fish and species were collected at the Airport Lagoon site (16,607 fish, 11 species) than at the Beaver Pond site (91 fish, 5 species) (Table 15). At the Airport Lagoon site the majority of fish were collected by fyke net (13,461 fish), followed by minnow trap (3,039 fish), and electrofishing (107 fish) (Table 15). Electrofishing was only completed on a single transect at the Airport Lagoon as the other transects were flooded following project construction. At the Beaver Pond site, fish were collected by fyke net (78 fish) and minnow trap (13 fish) (Table 15). No fish were captured by electrofishing at the Beaver Pond site in 2014.

The number fish captured in Year 4 at the Airport Lagoon was considerably higher than in the previous three years of the project with higher CPUE for both the minnow traps and fyke nets (Table 16). The high numbers were associated with both the minnow trap and fyke net methods while the number of fish captured by electrofishing was more consistent with previous years for transect 4 and lower than in Year 3 (Table 16).

The high CPUE from the minnow trap and fyke nets at the Airport Lagoon in 2014 was associated with high abundances of Brassy Minnow (*Hybognathus hankinsoni*), Lake Chub (*Couesius plumbeus*), and Redside Shiner (*Richardsonius balteatus)* abundance during both the May and July sampling sessions. Minnow trap catches were higher during the May sampling session while the opposite was observed for the fyke nets. With the exception of Brassy Minnow by minnow trap, the CPUE in Year 4 for all species captured by passive sampling (minnow trap and fyke net) was equal to or higher than in the previous years of the monitoring program (Table 16). Other than the high CPUE for the three most common species, an increase in the relative abundance was also observed for the three sucker species (Longnose Sucker [*Catostomus catostomus*], White Sucker [*C. commersoni*], and Largescale Sucker [*C. macrocheilus*]) and juvenile suckers that were too small to be identified to species. Previously, the highest relative abundance of juvenile suckers was by electrofishing in first year of the monitoring program (Table 16). Additionally, a Longnose Sucker in spawning colours with nuptial tubercles and a few Largescale Suckers with nuptial tubercles were captured during the May sampling session, indicating that these species are likely spawning in the Airport Lagoon.

At the Beaver Pond site, capture rates were similar to previous years with relatively low CPUE and were lower than observed in 2013 (Table 16). No fish were captured by electrofishing in 2014. However, electrofishing was completed on an earlier date than in previous years in order to obtain one more pre-construction sample. As in previous years, a school of small fish was observed at the stream outlet (base of the berm) during the June vegetation sampling.

As in previous years, the majority of fish species captured were non-sportfish. At the Airport Lagoon site, Brassy Minnow were the most commonly captured species, followed by Redside Shiner and Lake Chub. Other common species at the Airport Lagoon site included Northern Pikeminnow (*Ptychocheilus oregonensis*) and the three sucker species. The only sportfish species captured were juvenile Burbot (*Lota lota*) and Rainbow Trout (*Oncorhynchus mykiss*) at the Airport Lagoon. At the Beaver Pond site, Northern Pikeminnow and Peamouth (*Mylocheilus caurinus*) were the most commonly captured species followed by and Redside Shiner. The other species collected at this site were Longnose Sucker and Largescale Sucker.

Water quality data collected on each sampling date are included in Appendix 15.

Table 15. Summary of fish species captured by method in 2014 at the Airport Lagoon and Beaver Pond sites.

Site	Species	Method			Totals
		Electrofish	Minnow Trap	Fyke Net	
Airport Lagoon	Lake Chub	41	884	2025	2950
	Brassy Minnow	2	959	7117	8078
	Peamouth			5	5
	Northern Pikeminnow		7	90	97
	Redside Shiner	8	720	2646	3374
	Longnose Sucker	1	82	331	414
	White Sucker		62	437	499
	Largescale Sucker		37	188	225
	Sucker sp.	40	285	620	945
	Rainbow Trout		1	2	3
	Burbot	2			2
	Prickly Sculpin	13	2		15
	Totals	107	3039	13461	16607
	Effort[1]	2263	413.41	79.48	
	CPUE[2]	2.837	7.351	169.351	
Beaver Pond	Peamouth			16	16
	Northern Pikeminnow		10	41	51
	Redside Shiner		3	11	14
	Longnose Sucker			5	5
	Largescale Sucker			5	5
	Totals	0	13	78	91
	Effort	894	176.98	22.83	
	CPUE	0.000	0.073	3.416557	
Grand Totals		**107**	**3052**	**13539**	**16698**

[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 16. Fish CPUE[1] by method and species at the Airport Lagoon and Beaver Pond sites for 2011 – 2014 (Years 1-4).

			Species														
	Method	**Year**	**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**
Airport Lagoon	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
	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
	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
Beaver Pond	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															0.000
	Minnow trap	2011				0.008											0.008
		2012			0.007												0.007
		2013						0.007			0.007				0.020		0.298
		2014				0.057	0.017										0.073
	Fyke net	2011			0.460	0.184											0.644
		2012				0.044		0.044		0.044			0.044				0.176
		2013			3.176	2.235	0.941	0.176	0.118	0.353							7
		2014			0.701	1.796	0.482	0.219		0.219							3.417

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

6 DISCUSSION

As this is the fourth year 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 4 was to continue data collection from established survey stations and transects at both sites. Some modifications to the surveys were required to account for the post-construction changes at both sites. The Airport Lagoon project was completed in late May 2013, so the data collected from this site in Year 4 is the first 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 a combination of baseline and initial post construction observation. A summary of the progress towards addressing the management questions and hypotheses is provided in

Table 17.

6.1 Environmental Conditions

The general conditions observed at both sites in Year 4 were similar to Years 2 and 3. There was significantly less vegetation cover present in Year 3 compared to Year 1 (refer to Appendix 10 for examples of the differences in vegetation between years). The differences in vegetation cover are considered to be primarily a result of the different reservoir conditions prior to the surveys in each year. The Year 1 surveys occurred following a year of low reservoir levels that did not result in the 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), weather conditions during the sampling period may have influenced some of the survey results. In Year 4, similar to Year 3, temperatures were generally close to or above average. Unlike Years 1 and 2, temperatures in Year 4 during early to mid-May were usually warmer than average. 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 4 than in either Years 1 or 2. The accumulation of degree days in Year 4 was similar to Year 3. Precipitation in Year 4 was average in April and well below average in May and June with both months being the driest observed to date in the monitoring program.

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 both sites were different. However, the distribution of the habitat classes 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 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.

Table 17. The status of the GMSMON-15 management questions and hypotheses following completion of Year 4 of the monitoring program.

Management Question	Management Hypothesis (Null)	Year 4 (2014) 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 first year of post-construction monitoring indicates that there has been an increase in the extent of aquatic vegetation associated with the new water level. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site
Are the enhanced (or newly created) wetlands used by waterfowl and other wildlife?		The single year of post-construction data from the Airport Lagoon project shows continued use by waterfowl and other wildlife. The Beaver Pond project was completed in spring 2014 and the first post-construction data will be collected in 2015.
	H_{02}: The species composition and density of waterfowl and songbirds does not change following enhancement.	The single year of post-construction data from the Airport Lagoon shows some changes in waterfowl and songbird species composition and density post enhancement. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site.
	H_{03}: Amphibian abundance and diversity in the wetland does not change following wetland enhancement.	The single year of post-construction data from the Airport Lagoon showed some changes in amphibian abundance. Additional monitoring will be required for testing of this hypothesis. No post-construction data has been collected yet for the Beaver Pond site.
Is the area and quality of wildlife habitat created by the wetland enhancement maintained over time?		With only a single year of post-construction data from the Airport Lagoon site and the Beaver Pond project just completed in spring 2014 it is not possible to comment on the long term persistence and quality of habitat.

The habitat classes observed 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) and 2 (2012) 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, and 668.7 m at the end of July 2014. As a result, all transects and the majority of mapped habitat classes were inundated in both 2011 and 2012 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 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.

The distribution of aquatic plant communities (as defined by a dominant species) observed at the Airport Lagoon site 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., lady's thumb) 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.

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 2-4 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 4 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).

Aquatic plant species identified at Airport Lagoon during Year 4 were likely present during in Years 1-3 of the study and are expected to continue to be present in the years following. Within the areas in which 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., Lady's thumb) are found in shallow waters and along the shoreline and have a higher tolerance to changes in or removal of water cover.

6.3 Waterfowl and Shorebirds

The 2014 waterfowl survey results were similar to those in previous years, the inclusion of shorebirds annually since Year 2 increased species richness and overall detections in subsequent years. Survey dates were consistent with those in 2012 and 2013 and are considered to have accurately characterized habitat use by migrating waterfowl at Airport Lagoon and Beaver Pond.

Pre-enhancement data was collected at Airport Lagoon up until May 12, 2013, construction and the installation of new culverts was ongoing during the May 25, 2013 surveys. Water levels were at or close to design elevation by the time the last survey in Year 3 was completed on June 10th and it has remained at or above that level throughout 2014.

During Year 4 surveys, the total number of birds and the total number of waterfowl detected at Airport Lagoon were slightly higher than the pre-construction means, while shorebird detections were slightly lower (shorebird data was only available for 2012 and 2013). Note that number of shorebirds detected in 2012 was increased by the presence a large flock of Long-billed Dowitchers. Species richness was higher for waterfowl and shorebirds. The first post-construction survey (June 10, 2013) also identified higher numbers and diversity of waterfowl than the late season surveys in Years 1 and 2. These may be initial indicators that the project will result in increases in waterfowl abundance and diversity. It is however too early in the post-construction monitoring phase to draw any meaningful conclusions from this data. 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.

Killdeer were confirmed as nesting on both sites with the detection of a nest at Beaver Pond and incidental observations of very young fledglings at Airport Lagoon during the point count surveys. This brings the number of species detected during waterfowl and shorebird surveys which have been confirmed as nesting on site to three (Canada Goose and Spotted Sandpiper nests were confirmed in 2013)(CBA 2014). Since the sites were thoroughly nest-searched and based on the breeding habitat requirements of the waterfowl species recorded during surveys, the lack of good nesting habitat suggests that the vast majority of species detected at Airport Lagoon were migrants stopping over and then moving on to other breeding sites.

In time the extended hydroperiod and less extreme fluctuations in water level resulting from the habitat enhancements should improve the habitat quality (development of emergent and aquatic vegetation and well-vegetated grasslands/shrublands), increase the quantity of available wetland habitat and its proximity to potential nesting habitat.

Early spring access to the Beaver Pond site was once again limited due to ice cover on Williston Lake and unfavourable weather conditions. This pattern is expected to continue, resulting in fewer surveys being completed annually at Beaver Pond than at Airport Lagoon. As a result, if the beaver ponds are ice free before the reservoir it is possible that surveys will continue to fail to capture early season waterfowl and shorebird use of this site. No detections of waterfowl or shorebirds were recorded during surveys at Beaver Pond for the second consecutive year. Incidental observations included Canada Goose, Green-winged Teal, Blue-winged Teal, Spotted Sandpiper and nesting Killdeer. The small size of the wetland limits the availability of habitat, so it is unlikely that large numbers of waterfowl will be observed here. Construction was ongoing at the Beaver Pond site during the Year 4 waterfowl surveys. Noise and disturbance associated with the operation of jet boats and heavy machinery may have influenced survey results and water levels had not reached design levels. Construction of a larger wetland will increase the quantity and improve the quality of habitat, which should increase waterfowl abundance and diversity in the future.

6.4 Songbirds

The overall songbird survey results in 2014 were similar to the pre-enhancement monitoring records. Overall and when the sites were considered separately, species richness was slightly lower, but the average number of species per station was higher in comparison to previous years.

The larger area and more diverse habitat types adjacent to the Airport Lagoon likely contributed to the higher diversity observed during point count surveys at that site. With the exception of Bufflehead, Blue-winged Teal and Hammond's Flycatcher, all species detected at the Beaver Pond site were also detected at Airport Lagoon.

The total number of detections recorded at Airport Lagoon was higher in 2014 than at any time during the pre-enhancement surveys. Conversely the number of detections at the Beaver Pond site was the lowest since surveys started. Disturbance associated with ongoing construction at this site, likely reduced songbird use of the surrounding area during the 2014 breeding season. The lowest number of detections at Airport Lagoon were recorded in 2013 which also coincided with the construction phase of habitat enhancements at that site.

The frequency of detections in the different habitat categories (e.g. drawdown zone, shrubs, forest, etc.) at Beaver Pond in 2014, mirrors the patterns detected in previous surveys. Every year since 2012 (location data was not collected in Year 1), over 78% of detections at this site have been observed in the forested habitat above drawdown zone. Limited bird use of the small featureless drawdown zone has been observed over the course of pre-enhancement monitoring. Ongoing construction within this area likely compounded this trend as the relative frequency of detections recorded within the drawdown zone was even lower than in previous years.

At the Airport Lagoon site, for the first time the frequency of detections was highest (30.8%, n=128) within the drawdown zone. The relative frequency of detections within the shrub (27.7%, n=115) and forested (25.8%, n=107) habitats both decreased in comparison to the pre-enhancement surveys. This may be an early indication that habitat enhancements are increasing the habitat use and abundance of songbirds of this site.

The reduced vegetation cover observed in Year 2 (CBA 2013) and subsequent years compared to Year 1 resulted in some changes in use of the sites by some species or a shift in use to the peripheries of the sites. Since the location of detections was not recorded during the 2011 surveys, it is difficult to determine the effects this reduction in vegetation has had. However, three Bonaparte's Gull were observed at the Airport Lagoon site in 2014 for the first time since 2011. Prior to 2014 surveys, Savannah Sparrow detections at Airport Lagoon were highest in 2011 (10 individuals), they decreased slightly in 2012 and were not detected during 2013 surveys. Savannah Sparrows are grassland specialists, so the fifteen detections in 2014, may indicate that for some species habitat use and conditions in certain areas of the Airport Lagoon are more similar to those recorded prior to the reduction in vegetation cover following the Year 1 surveys. The lower water levels in 2013 would allow additional vegetation development in the upper portion of the drawdown zone and potentially improved habitat for some species. Stabilization of the water regime may allow for development of wetland and riparian vegetation at both sites and therefore increase habitat availability and use by songbirds. Further changes in use of the sites by some species would be expected as succession progresses.

Overall detections of species from water dependent genera (shorebirds, waterfowl and gulls) were all higher at Airport Lagoon during the first year of post-construction point count surveys than in previous years. Detections of Common Loon, which require larger bodies of water, were higher in 2014 than in any other year and Bufflehead which prefer smaller ponds were observed in 2013 yet absent in Year 4 (Evers et al. 2010 and Gauthier 2014). This may indicate that the elevated water levels and more stable water regime is already influencing habitat use by some species at the site.

Nest searching efforts in 2014 again included areas adjacent to the drawdown zone. Similar to the results in previous years, few nests were found. This is likely a result of random variability in nest searching success. While few nests were located, observations indicated that a number of other species were likely nesting in the area. Given the relatively small area of both sites and relatively large nesting territories of some species, small changes in nesting patterns by some species will result in variability in the number of nests found each year.

6.5 Amphibians

The first detections of Columbia Spotted Frogs at the Airport Lagoon site during 2014 surveys confirms the presence of all amphibian species anticipated within the study areas. Consistent with other inventory work within the Williston Reservoir watershed, Western Toad was the most commonly observed species (Hengeveld 2000). Long-toed Salamanders were detected at both sites during the May 11 and 12 searches, but in smaller numbers at Airport Lagoon. Wood Frogs have not been observed during surveys at Airport Lagoon since 2011, and none were recorded at the Beaver Pond site in 2012 or 2014. Similar to 2012 and 2013, and in an attempt to account for early breeding species such as the Wood Frog and Long-toed Salamander, amphibian surveys were initiated before ice and snow cover had melted and as early in the season as conditions allowed (Matsuda et al. 2006).

No amphibians were identified during the earliest survey at Airport Lagoon. A brief sighting of an unidentified adult frog or toad on transect 25, along with Long-toed Salamander tracks in the sand along transect 2 were the only evidence of early season amphibian activity. On May 1, Airport Lagoon was still partially ice covered and there was snow on the ground. Ice cover on Williston Lake precluded access to Beaver Pond.

With the exception of the May 11 and 12 surveys, detection rates this year were similar to previous survey results. Record numbers of Western Toad (71 plus incidental observations) and Long-toed Salamander (11) detections during the May 11 and 12 surveys are likely the result of environmental conditions and survey timing coinciding with peak migration and breeding season. Wood Frogs tend to breed earlier in the year and for a shorter period of time than other amphibian species, so it is likely the peak breeding season and migration period for this species did not coincide with the timing of surveys, which could explain the absence of detections (Matsuda et al. 2006). Amphibian populations are also known to vary considerably from year to year (RIC 1998, US EPA 2002).

As ectotherms, amphibian activity is limited by environmental conditions. They are more active during warm weather and after rainfall (RIC 1998). Amphibian observations during the first 3 years of this project were consistent with these assertions, with the highest number of detections occurring during Year 1 (warmer than average temperatures during the survey period in May and June with well above average precipitation in May) and the fewest number of detections in Year 2 (cooler than average temperatures and below average precipitation during the sampling period) (Figure 13 and Figure 14). Environmental conditions in Year 4 were similar to those in Year 3 (warmer than average with below average precipitation). In 2014, cumulative precipitation was average for April but well below average for May and June, making this the driest year of the study to date. Temperature remained average through Late April becoming warmer than average with less variation in May (Figure 13 and Figure 14). Daily mean temperatures changed from below to above average four days prior to the May 11 and 12 surveys and were above average at the time of the surveys (Figure 13). This may have triggered the movement of amphibians between seasonal terrestrial habitats and their breeding ponds, resulting in the unusually large number of observations during those surveys.

Other factors may have also contributed to the variation in amphibian detections during the four years of the project. Since 2014 was the first full year of post construction monitoring at Airport Lagoon and that construction was ongoing at the Beaver Pond site, it is unlikely that habitat enhancements will have had any positive impacts on amphibian populations at this time. The extent of vegetation cover, which decreased between Year 1 and Year 2 reducing the amount of cover and the quality of amphibian habitat at both sites had not recovered to pre-2012 levels (CBA 2013). In the longer term, is anticipated that the physical work to enhance habitat will reduce the extreme fluctuations in water levels, provide a more stable hydroperiod and improve the connectivity between seasonal terrestrial and breeding habitat. To assist in controlling variability related to annual differences in the timing of peak breeding activity due to weather conditions, future search efforts should be conducted under appropriate environmental conditions whilst maintaining consistency in the timing and number of surveys.

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 2014. All species collected in 2014 had been observed in previous years. Between the two sites a total of 13 fish species have been observed over the first four years of the project.

The fish sampling results for 2014 from the Airport Lagoon confirms the previous conclusion (CBA 2014) that this site has a resident fish population of cyprinids, suckers, and sculpins. In 2014, Brassy Minnow continued to be the most abundant species followed by Redside Shiner and Lake Chub. The relative abundance (CPUE) of all three species increased in 2014, primarily due to the high CPUE by fyke net. Increases in relative abundance were also observed for Northern Pikeminnow and the three suckers species present. The relative abundance of juvenile suckers was also higher than in the previous years of the project.

The increase in numbers of Brassy Minnow, Lake Chub, and Redside Shiner 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.

Based on the description of the Beaver Pond site (Golder Associates Ltd 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 four years of the monitoring project. High numbers of fish were captured by electrofishing in 2011 and 2013 (CBA 2012, 2014). However, only a single fish was captured by electrofishing in 2012 (CBA 2013) and no fish were captured by electrofishing in 2014. 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. At low reservoir levels, the lower part of the stream is considered impassable to small fish. Numerous small fish were captured during a fish salvage conducted during construction of the Beaver Pond project (DWB 2014). All species captured in the fish salvage conducted by DWB (2014) have been previously observed at the site, except for Slimy Sculpin (*Cottus cognatus*). A mixed school of small fish was also observed at the stream mouth during the vegetation sampling in mid-June 2014.

The relative abundance of fish based on captures by minnow trap and fyke net at the Beaver Pond site has increased over the first four years of the project. 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 additional years of monitoring will provide more information on variation in fish abundance at this site and factors that may influence the variability. With the completion of four years of fish sampling at this site it appears that the Beaver Pond site does provide rearing habitat for juvenile fish prior to inundation and some seasonal habitat for other fish following inundation. After inundation, the inlet has a large area of shallow water and stable shorelines that may result in higher productivity than in adjacent areas of the reservoir with steeply sloping and less stable, exposed shorelines.

7 CONCLUSIONS

The baseline data collected in Years 1 to 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 first year of post-construction observations at the Airport Lagoon in Year 4 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 results from Year 4 (one year post-construction) 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 construction of the Beaver Pond project in spring 2014 allowed for the collection of additional baseline data for amphibians, waterfowl, shorebirds, and fish at this site. The Year 4 point counts were completed in early June during construction of the project. However, the point counts were completed early each day prior to the start of construction activities on the site. It is expected that construction had some influence on the point count results this year. One of the amphibian surveys was completed during construction when the water was at an intermediate level and this will need to be considered during future data analyses. The July fish sampling in Year 4 is considered the first post-construction fish sampling as the project was complete and the reservoir elevation was approximately 1 m above the elevation of the berm on the sample date.

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 4 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). Aquatic plant sampling at the Airport Lagoon site identified showed areas within the created wetland where aquatic plant species were sparse to absent. It is expected that these areas will be colonized 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 songbird results were observed over the first three years of the monitoring program are considered to be a result of natural variability. For both waterfowl and songbirds, stabilization of the water regime may allow for development of wetland and riparian vegetation at both sites and therefore increase habitat availability. Depending on the time of ice off at the Airport Lagoon in relation to the reservoir following completion of the wetland enhancement, there may also be an increase in the numbers of spring migrants due to increased habitat area. 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 initial post-construction observations in June 2013 provided an early indication of this (CBA 2014). The results from 2014 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.

The differences in the songbird results observed in the first three years of the monitoring program were considered to be a result of natural variability. Some of the findings during the first post-enhancement surveys at Airport Lagoon may also be attributed to natural fluctuation in populations and habitat use.

While it is too early to draw any significant inferences from a single year of post-construction data at the Airport Lagoon site, the higher number of detections, the increase in the average number of species per transect and the fact that a majority of the detections were located within the drawdown zone rather than the surrounding shrub and forested habitats suggest that the enhancements are having the desired effects at this site. Increased detections and a change in species composition of the water dependent genera (shorebirds, waterfowl and gulls) during the point counts provide some indication that the enhancement project is achieving the desired result.

Since construction at the Beaver Pond is now complete, disturbance levels during post-enhancement surveys should be significantly lower than in 2014. The provision of a berm at this site will increase the size of the permanent wetland and provide a more stable water regime thus increasing the quantity and quality of habitat available within the drawdown zone. 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 (**Error! Reference source not found.**). This allows for the detection of even small changes in the species detected in the drawdown zone.

The ongoing evaluation of changes, particularly in the species detected within the drawdown zone will assist in determining the effectiveness of the wetland enhancements. The species detected in the drawdown zone habitat are expected to show the greatest degree of change post-enhancement with the change from a seasonally flooded to a permanently flooded habitat.

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. Since 2014 was the first year of post-construction monitoring, it is too early to draw inferences from the fact that a significantly higher number of detections were recorded at both sites. A number of confounding factors that contribute to annual variability in amphibian populations, particularly the timing of peak breeding season which likely coincided with surveys on May 11 and 12, may increas data.

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 habitat available. At the Airport Lagoon, additional comparisons among transects and within transects will also be possible.

While there were differences observed in the fish results between the three years of pre-enhancement sampling and the initial post-construction sampling at the Beaver Pond site, the results do confirm the use of the site by fish with seasonal differences that are associated with reservoir level. At low reservoir levels, the stream at the site appears to provide rearing habitat for juvenile fish, particularly suckers (*Catostomus* sp.). At high reservoir levels that inundate the site, use of the site appears to switch to primarily larger fish (juveniles and adults). The numbers of small fish may also be under-represented in the July sampling due to the use of different sampling methods. However, there is no habitat available for larger fish in the small stream at low reservoir levels.

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) and a school of small fish was observed at the base of the berm during vegetation sampling in June 2014 (post-construction). There is the potential for fish to become trapped in the wetland during years when reservoir levels exceed the height of the proposed berm. This likely does occur at some reservoir levels with the existing beaver dams at the site. However, it will be a more frequent occurrence in the constructed wetland due to the lower elevation. It is unknown if conditions in the wetland will provide suitable conditions for fish to overwinter (e.g., potential oxygen depletion under the ice). A single Longnose Sucker was captured in the lower pond in July 2013 suggesting that suitable overwintering conditions may occur. Early season fish sampling will continue at this site to determine the extent of fish use of the constructed wetland.

At the Airport Lagoon, the high numbers of fish captured in the 2014 sampling suggests that the project has increased the amount of habitat for fish due to reduced seasonal fluctuations in the amount of habitat available. Populations of the three most common species (Lake Chub, Brassy Minnow, and Redside Shiner) increased during the pre-construction monitoring period (CBA 2014) and the trend has continued in the first year of post-construction monitoring. 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). The new, higher elevation culverts and average reservoir levels in 2013 and 2014 have likely provided a better opportunity for fish to move into the lagoon than through the old culverts. The increased relative abundance of suckers in 2014 may be associated with the new culverts, reservoir levels, the enhancement project, or a combination of factors.

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. In the first year of post-construction monitoring at the Airport Lagoon, large increases in the relative abundance of Lake Chub, Brassy Minnow, and Redside Shiner were observed. Additionally, small increases in the relative abundances of Northern Pikeminnow and the three sucker species were also observed in 2014. A notable increase in the relative abundance of juvenile suckers was occurred suggesting that sucker abundance may increase again in 2015. 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.

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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

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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					SITE DIAGRAM
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	SITE DISTURB.	PHOTO ROLL
ELEV. m.	SLOPE %	ASPECT °	MESO SLOPE POS.	SURFACE TOPOG.	EXPOS. TYPE	FRAME NOS.

NOTES	SUBSTRATE (%)			
	ORG. MATTER		ROCKS	
	DEC. WOOD		MINERAL SOIL	
	BEDROCK		WATER	

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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:	

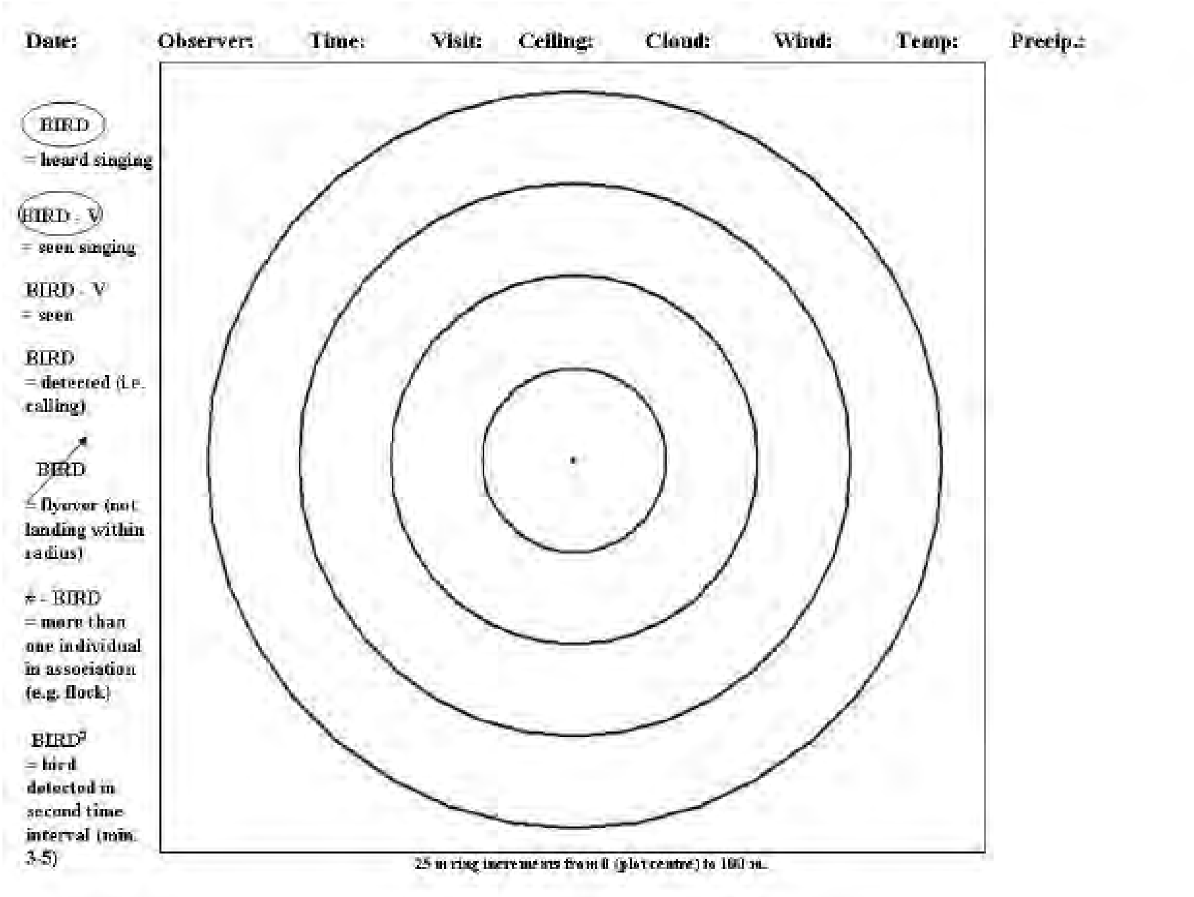

0 0.125 0.25 Kilometers


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. Field form for fish sampling.

FISH COLLECTION FORM

GAZETTED NAME (local) ☐ LAKE ☐ STREAM ☐ WETLAND

WATERSHED CODE

WATERBODY ID | ILP MAP # | ILP # | SITE/LAKE CARD ATTACHED ☐ Y ☐ N

PROJECT ID | REACH # – | FISH PERMIT #

DATE YY MM DD to YY MM DD | AGENCY | CREW | ☐ RE-SAMPLE

SITE / METHOD

SITE #	NID MAP #	NID #	SITE UTM (MTD)	MTD / NO.	STREAM CONDITION TEMP	CON	TURB.	COMMENTS

FISH SUMMARY

SITE #	MTD / #	H / P	SPECIES	STAGE	AGE	TOTAL #	MIN. LENGTH	MAX LENGTH	FISH ACT.	COMMENTS

GEAR SPECIFICATIONS

C	SITE #	MTD / #	HAUL	DATE IN	TIME IN	DATE OUT	TIME OUT	NET / TRAP SPECIFICATIONS: NET TYPE	LENGTH	DEPTH	MESH SIZE	SET	HAB.

ELECTROFISHER SPECIFICATIONS

	SITE #	MTD / #	PASS	TIME IN	TIME OUT	EF SEC.	LENGTH	WIDTH	ENCL	VOLTAGE	FREQ.	PULSE	MAKE	MODEL

COMMENTS

Rev. Apr. 1998

CARD ___ OF ___

INDIVIDUAL FISH DATA

FISH COLLECTION FORM #

C	SITE #	MTD / #	H / P	SPEC.	LENGTH	WEIGHT	SEX	MATUR.	AGE STRUCTURE	AGE SAMPLE #	AGE	VOUCHER #	GENETIC STRUCTURE	GENETIC SAMPLE #	COMMENTS	PHOTO
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
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																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __

INDIVIDUAL FISH DATA

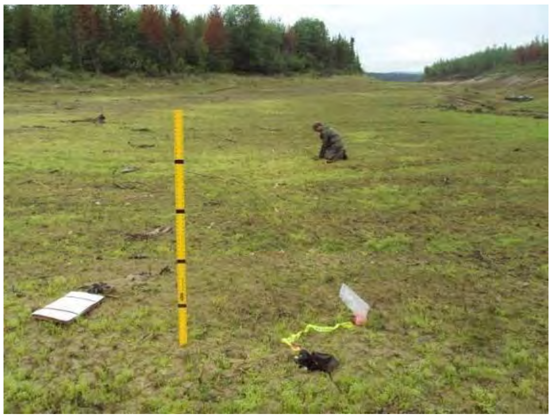
C	SITE #	MTD / #	H / P	SPEC.	LENGTH	WEIGHT	SEX	MATUR.	AGE STRUCTURE	AGE SAMPLE #	AGE	VOUCHER #	GENETIC STRUCTURE	GENETIC SAMPLE #	COMMENTS	PHOTO
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __
																R __ F __

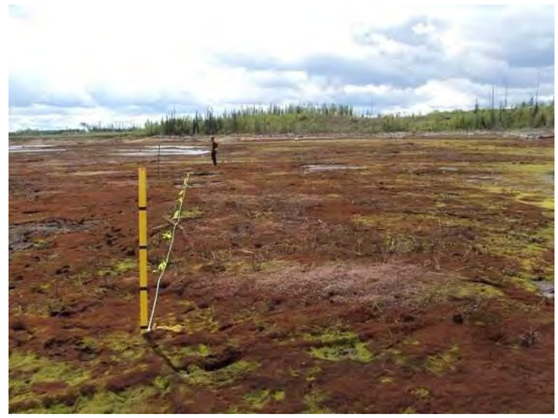
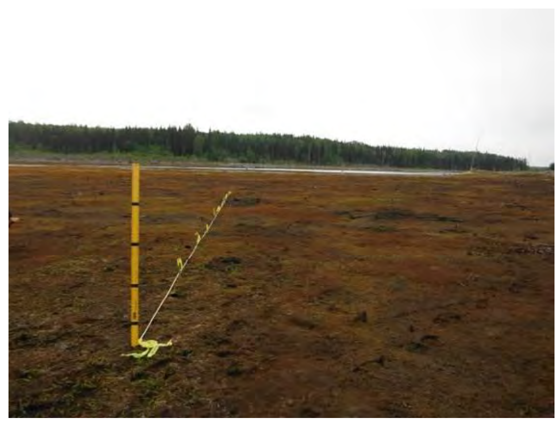
COMMENT

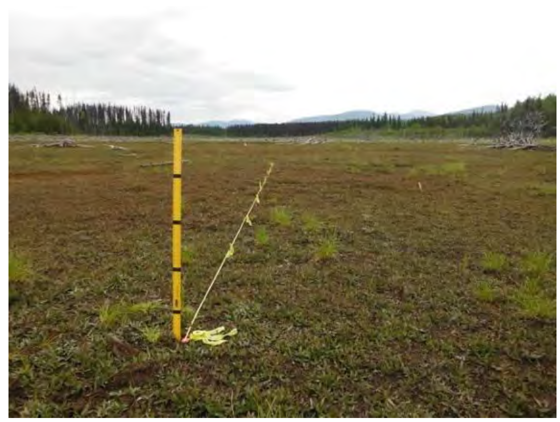
Rev. Apr. 1998

CARD ____ OF ____

Appendix 10. Habitat class descriptions in the draw-down zone at the Airport Lagoon and Beaver Pond sites.

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">BC</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">BM</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">Basin Moss (BM): Moderate to high bryophyte and low herbaceous perennial cover with low coarse woody debris cover on a plain to hummock surface depression. Dominating species include common hook-moss, lady’s thumb (Persicaria maculosa), common mare’s-tail (Hippularis vulgaris) and a few other unidentified herbaceous perennials. 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.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">BS</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td>Picture Not Available</td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">Basin Smartweed (BS): High cover of water smartweed (Persicaria amphibia) 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.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="4">FI</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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). 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="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SC</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td>No Picture Available</td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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) and Norwegian cinquefoil (Potentilla norvegica). Water source is precipitation and flooding is expected to be annual to frequent (every 2 to 5 years).</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="5">SD</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description
Shoreline Driftwood (SD): Low to Moderate, grass dominated vegetation cover with high coarse woody debris cover (ranging from 20-50%) on a gently sloping (3 to 15°) surface expression. Common species include bluejoint (Calamagrostis canadensis), common horsetail (Equisetum arvense), water smartweed (Persicaria amphibian) 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.</td></tr>
</table>

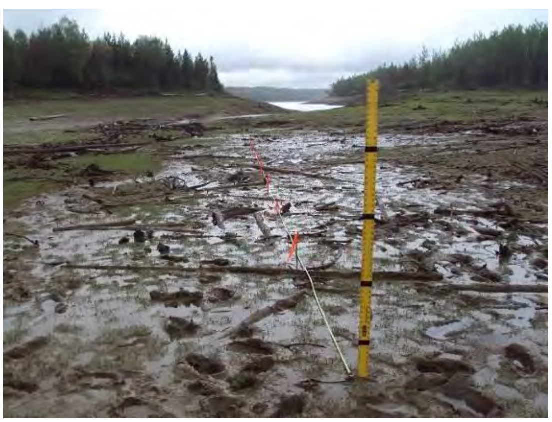
Habitat Class	**Representative Photographs**	
SG	**2011**	**2012**
		No picture available
	2013	**2014**
	No picture available	
	Description	
	Shoreline Grassland (SG): Very high grass dominated vegetation cover with low coarse woody debris cover on a gently sloping surface expression. Common species may include bluejoint, common horsetail, reed canarygrass, large-leaved avens (*Geum macrophyllum* ssp. *perincisum*) and a few unidentified grasses.	

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SR</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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 frequent.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SS</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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 (Carex aenea), marsh yellow cress (Rorippa palustris) and pink corydalyis (Corydalis sempervirens). 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>

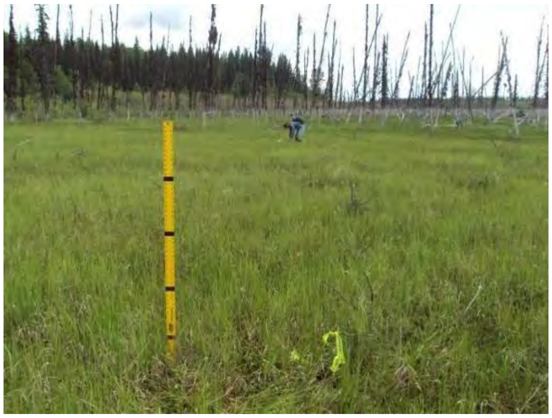
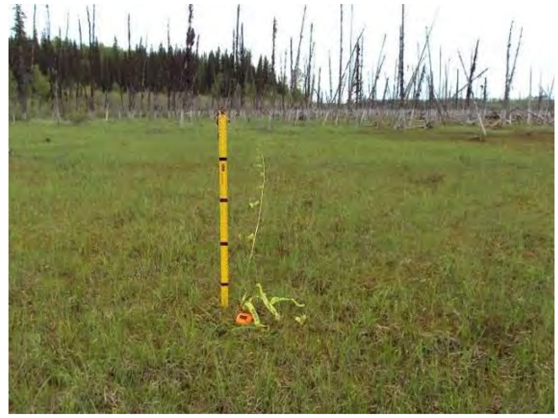
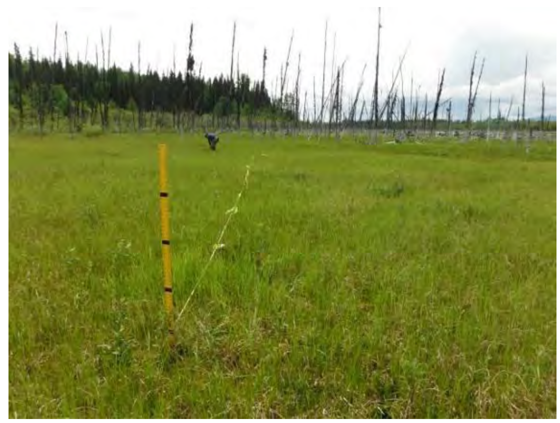
<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SW</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">Shoreline 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 and Norwegian cinquefoil 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.</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="4">SP</td><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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), and common hornwort (Ceratophyllum demersum).</td></tr>
</table>

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SE</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td>Picture Not Available</td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

Habitat Class	Representative Photographs	
WD		
		
	Description	
	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 (*Eriophorum gracile*). A low cover (approximately 15%) of standing dead black spruce (*Picea mariana*) trees is present. Groundwater is the main water source (surface and subsurface seepage), soils are very poorly drained and flooding is expected to be annual to frequent.	

Habitat Class	Representative Photographs	
	2011	**2012**
		
WH	**2013**	**2014**
		
	Description	
	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.	

<table>
<tr><th>Habitat Class</th><th colspan="2">Representative Photographs</th></tr>
<tr><td rowspan="6">WS</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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 [Carex spp.]), swamp horsetail (Equisetum fluviatile), small bedstraw (Galium trifidum), water smartweed (Persicaria amphibian), common mare's-tail (Hippuris vulgaris) and buckbean (Menyanthes trifoliata). 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="2">Representative Photographs</th></tr>
<tr><td rowspan="6">SW</td><td>2011</td><td>2012</td></tr>
<tr><td></td><td>No Picture Available</td></tr>
<tr><td>2013</td><td>2014</td></tr>
<tr><td>No Picture Available</td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">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 11. Summary of percent cover by plant species averaged across 10 quadrats in a 20 m belt-transect for vegetation transects sampled in Year 4 at Airport Lagoon and Beaver Pond study sites.

Group	Species	Transect											Total
		AL3	AL5	AL6	AL7	AL9	AL10	AL11	AL12	BP3	BP4	BP5	
Herbs/Forbs/ Graminoids	sedge sp.	0.0	0.1	1.0	4.7	0.1	0.0	0.1	0.5	0.8	0.5	0.7	**8.5**
	green sedge	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
	water sedge	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.4	**1.5**
	common spikerush	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**
	common horsetail	0.0	5.7	0.0	0.0	5.4	0.0	0.0	0.0	1.2	0.0	9.7	**22**
	swamp horsetail	0.0	0.0	33.4	0.2	0.0	4.8	0.0	0.0	0.0	0.0	0.0	**38.4**
	small bedstraw	0.0	0.4	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.7	**3.5**
	bluejoint	0.1	7.3	0.0	7.4	4.4	2.6	0.0	0.0	0.0	0.0	0.5	**22.3**
	little meadow foxtail	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	**0.1**
	reed canary grass	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**
	mares tail	0.0	0.0	0.1	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	**7.2**
	blackgirdle bulrush	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	fieldmint	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	buckbean	0.0	0.0	0.0	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**15.6**
	yellowcress	0.0	0.0	0.0	0.0	0.0	0.1	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	0.0	0.0	**0.5**
	marsh yellowcress	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	**0.3**
	water smartweed	0.0	0.4	16.5	1.3	1.3	1.0	0.0	38.8	0.2	0.0	0.0	**59.5**
	Norwegian cinquefoil	0.0	2.7	0.0	0.0	0.1	0.6	0.0	0.0	1.2	0.0	1.6	**6.2**
	marsh cinquefoil	0.0	0.0	0.0	3.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	**3.5**
	Pennsylvania buttercup	0.0	1.1	0.4	0.0	0.0	0.2	0.0	0.0	0.1	0.0	1.7	**3.5**
	marsh skullcap	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	**0.1**
	smooth hawksbeard	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
	Torreys cryptantha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	7.3	0.0	**7.5**
	purslane speedwell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	**1.3**
	umbellate starwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	**0.9**
	red sand-spurry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.3	0.0	**2.9**
	ladys thumb	2.3	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.8	0.0	**4.2**
	lamb’s quarters	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	**0.2**

Group	Species	Transect											Total
		AL3	AL5	AL6	AL7	AL9	AL10	AL11	AL12	BP3	BP4	BP5	
	hair bentgrass	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.7	**0.9**
	hairy bittercress	0.0	0.0	1.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	**1.8**
	grass family	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.5	0.8	0.5	**3.2**
	bedstraw sp.	0.0	0.0	6.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**6.5**
	unkn2	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.1	0.0	0.2	**1.6**
	unkn20	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	unkn21	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	**0.2**
	unkn43	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	**0.3**
	unkn72	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
	unkn79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	**0.3**
	unkn80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	**0.5**
	Herb/Forb/Graminoid Total	**2.5**	**19.5**	**61.3**	**33.1**	**11.7**	**13.8**	**8.4**	**39.3**	**8.2**	**11.5**	**17.7**	
	marsh threadmoss	0.0	0.0	0.2	4.3	0.1	3.7	0.0	0.0	0.0	0.0	0.0	**8.3**
	giant calliegron moss	0.0	0.0	0.0	81.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	**82**
	tree-moss	0.0	0.0	0.0	0.0	0.7	0.6	0.0	0.0	0.0	0.0	0.0	**1.3**
	Common hook-moss	0.0	0.0	8.1	0.5	0.0	6.8	1.6	0.0	0.0	0.0	0.0	**17**
	unkn32	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	**0.6**
	bryo10	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4**
	Moss Total	**0**	**0**	**8.3**	**90.3**	**1.4**	**11.6**	**1.6**	**0**	**0**	**0**	**0**	
Shrubs	Willow	0.0	0.0	0.0	1.8	0.0	1.0	0.0	0.0	0.0	0.0	0.1	**2.9**
	Shrub Total	**0**	**0**	**0**	**1.8**	**0**	**1**	**0**	**0**	**0**	**0**	**0.1**	

[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 12. Summary of the presence/not-detected of aquatic plant species at dredge points sampled in Year 4 at Airport Lagoon.

Species	Dredge Location[1]										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
bladderwort	-	-	-	-	-	P	-	-	-	-	-
common hornwort	-	P	P	P	-	-	-	-	P	-	-
fennel-leaved pondweed	P	-	P	-	-	-	P	-	-	-	-
lady's thumb	-	-	-	-	-	-	-	-	-	-	-
long-stalked potamogeton	-	-	P	-	-	-	-	-	-	-	-
unkn87	-	-	-	-	-	-	-	-	-	P	-
unkn88	-	-	-	-	P	-	-	-	-	-	-
common hook-moss	-	-	-	-	P	P	-	P	P	P	P

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

Appendix 13. Summary of bird detections by point count station in 2014 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	7			4			2			7	7		9	2			1				39
Gadwall													1								1
American Wigeon										1											1
Mallard					1								1			1					3
Blue-winged Teal																			2		2
Northern Pintail													7								7
Bufflehead																			1	1	2
Ruffed Grouse			1				1			1											3
Common Loon			6											6	2						14
Osprey	1	2			4	2								1	1						11
Bald Eagle			1																		1
Killdeer				2	6		6			1	1	6	7				1			1	31
Spotted Sandpiper					4		1				2		1	3							11
Solitary Sandpiper									3												3
Greater Yellowlegs		1		1							1	1	2	1	1						8
Lesser Yellowlegs					1			1	1	1					1	1					6
Wilson's Snipe			1						1												2
Bonaparte's Gull	1	6	1	3	2							1	4		1						19
Ring-billed Gull		1	1		1								2		1	1	1				8
Vaux Swift														2							2
Belted Kingfisher	1	1	1																		3
Hairy Woodpecker		1																			1
Northern Flicker		3	1						1					1							6
Alder Flycatcher					2	1	1														4
Least Flycatcher			1					2		1											4
Hammond's Flycatcher																		2			2
Dusky Flycatcher																		2	3		5
Warbling Vireo			1		2			2				1		1	2				1	1	11
American Crow	3	6	1	1	1	1			1	2	2	2		2	3	1	2				28
Common Raven		1		1							1										3

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	
Tree Swallow					3			2		2		3	4			3					17
Northern Rough-winged Swallow														2		2					4
Black-capped Chickadee	1	1	1					1					1								5
Ruby-crowned Kinglet	1	1	1						1	1							2		3		10
Mountain Bluebird						1	1	1		2											5
Swainson's Thrush		1		1					1	1	3			1		2	4	2		1	17
American Robin	2	4	3	2		2	2	2	1	1			1	1	4	5	2	1	1		34
Varied Thrush								1													1
Cedar Waxwing														2	1						3
Tennessee Warbler		2		3		3	5	1										2	2		18
Orange-crowned Warbler	1	2	3	2	1		1	1	1	1	3	1		1	1	3	1	2		2	27
Yellow Warbler	1				2			4	1			1	2		1	3	3	1		2	21
Yellow-rumped Warbler			3	1				1		1	4		1	2		1		1	2	1	18
Blackpoll Warbler							1				2										3
American Redstart			2				1			3	1		1	1		1	1		2	2	15
Northern Waterthrush	1				1		1	2	1	1	1			1		1	1	1	3	1	16
Common Yellowthroat						1															1
Wilson's Warbler		1			1					1		2	1	1			3		1		11
Chipping Sparrow	1					1	1	1				2	2		1		1		1		11
Savannah Sparrow						7		3	5												15
Song Sparrow	1					2			1	1											5
Lincoln's Sparrow	1							3	2	1	1	1									9
White-throated Sparrow	1	1														1		1		1	5
Dark-eyed Junco	3	1	1	1	1	1	1	3		3	2					2	2	2	4	1	28
Western Tanager		1																			1
Red-winged Blackbird												1									1
Yellow-headed Blackbird				1																	1
Brewer's Blackbird	1																				1
Station Totals	28	37	30	23	33	22	25	31	21	33	31	22	47	31	20	28	25	17	26	14	544

Appendix 14. 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
	11/05/2014	25	12:32	492444	6126954	Long-toed salamander	1	adult	
	11/05/2014	25	12:17	492436	6126933	Western toad	1	adult	One toad basking.
	11/05/2014	25	12:25	492442	6126948	Western toad	13	adult	Several pairs, amplexus.
	11/05/2014	25	12:28	492446	6126949	Western toad	4	adult	2 pairs, amplexus.
	11/05/2014	25	12:35	492449	6126941	Western toad	8	adult	4 pairs, amplexus. Several vocalizing.
	11/05/2014	25	12:40	492461	6126947	Western toad	50	adult	Several pairs in amplexus, some swimming singly. Several toads vocalizing.
	11/05/2014	25	12:51	492474	6126935	Columbia spotted frog	1	adult	A second spotted frog may have been present but dove before the ID could be confirmed.
	11/05/2014	28	13:40	492642	6126636	Western toad	7	adult	INCIDENTAL. Some pairs in amplexus. Some vocalizing.
	11/05/2014	28	13:43	492648	6126579	Western toad	20	adult	INCIDENTAL. Several pairs in amplexus.
	11/05/2014	32	13:53	492604	6126447	Western toad	13	adult	INCIDENTAL. Located 10 m west of transect 32. Several pairs in amplexus.
Airport Lagoon	11/05/2014	32	13:56	492606	6126433	Western toad	2	adult	INCIDENTAL.1 pair in amplexus.
	11/05/2014	40	14:45	492662	6125797	Long-toed salamander	1	adult	
	11/05/2014	40	14:52	492682	6125731	Long-toed salamander	1	adult	
	22/05/2014	25	14:42	492460	6126957	Western toad	1	juvenile	
	22/05/2014	25	14:44	492466	6126947	unknown	3	tadpole	
	22/05/2014	25	14:55	492473	6126946	unknown	200	tadpole	1000+ UNK tadpoles observed.
	22/05/2014	32	15:42	492649	6126494	Western toad	1	juvenile	
	02/06/2014	25	10:43	111653	6144014	Western toad	1	juvenile	
	02/06/2014	25	10:46	111657	6144022	Western toad	1	juvenile	
	02/06/2014	25	10:50	111671	6144026	Western toad	1	juvenile	
	02/06/2014	25	10:55	111694	6144005	Western toad	1	juvenile	
	02/06/2014	25	10:54	111687	6144011	unknown	200	tadpole	500+
	02/06/2014	32	11:51	111775	6143486	Western toad	1	juvenile	

Site	Date	Transect	Time	Easting	Northing	Species	Number	Age Class	Comment
Beaver Pond	12/05/2014	BP-A-01	9:58	479338	6148236	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:19	479407	6148215	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:21	479404	6148210	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:35	479414	6148254	Long-toed salamander	1	adult	Heard toads calling in upper pond, just outside of search area.
	12/05/2014	BP-A-01	10:41	479397	6148250	Long-toed salamander	2	adult	
	12/05/2014	BP-A-01	9:58	479338	6148236	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:19	479407	6148215	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:21	479404	6148210	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:35	479414	6148254	Long-toed salamander	1	adult	
	12/05/2014	BP-A-01	10:41	479397	6148250	Long-toed salamander	2	adult	
	12/05/2014	BP-A-01	10:40	479398	6148246	Western toad	2	adult	1 pair in amplexus.
	12/05/2014	BP-A-01	10:40	479398	6148246	Western toad	2	adult	In amplexus.
	03/06/2014	BP-A-01	8:57	100382	6166427	Western toad	1	adult	
	03/06/2014	BP-A-01	9:23	100457	6166397	Western toad	1	juvenile	
	03/06/2014	BP-A-01	9:23	100457	6166397	Western toad	1	juvenile	
	03/06/2014	BP-A-01	9:28	100463	6166401	Western toad	1	juvenile	
	03/06/2014	BP-A-01	9:58	100446	6166382	Western toad	1	juvenile	
	03/06/2014	BP-A-01	10:16	100335	6166399	Western toad	100	tadpole	
	03/06/2014	BP-A-01	8:53	100373	6166424	unknown	1	tadpole	
	03/06/2014	BP-A-01	7:33	100396	6166403	unknown	18	tadpole	
	03/06/2014	BP-A-01	7:36	100400	6166397	unknown	50	tadpole	
	03/06/2014	BP-A-01	9:14	100419	6166387	unknown	3	tadpole	
	03/06/2014	BP-A-01	9:25	100465	6166391	unknown	200	tadpole	1000+
	03/06/2014	BP-A-01	7:45	100480	6166411	unknown	200	tadpole	1000+
	03/06/2014	BP-A-01	9:45	100481	6166366	unknown	100	tadpole	
	03/06/2014	BP-A-01	9:48	100471	6166376	unknown	200	tadpole	over 1000

Appendix 15. Water quality data collected during fish sampling at the Airport Lagoon and Beaver Pond sites in 2014.

Site	Date	Location	Temperature (°C)	Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)	Turbidity[1]	Secchi Depth (m)
Airport Lagoon	May 20	EF4	13.2	232	7.11	-	C	
	May 21	surface	15.5	193	7.38	7.30	-	0.9
		bottom	15.2	193	6.77	7.58	-	-
	July 22	surface (upper pond)	21.5	172	8.3	9.12	-	1.98
		bottom (upper pond)	18.9	178	8.14	8.52	-	
		surface (mid-pond)	21.3	135	7.92	7.66	-	2.25
		bottom (mid-pond)	19.2	164	7.21	3.51	-	-
		surface (outlet)	21.5	133	7.76	7.63	-	2.1
		bottom (outlet)	19.5	125	7.28	6.68	-	-
Beaver Pond	July 24	surface	16.3	103	6.73	8.66	-	0.7
		bottom	16.3	104	7.01	8.26	-	-

[1] – Relative turbidity, see RIC (2001) for definitions.