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ENVIRONMENTAL EVALUATION

Halkirk 2 Wind Power Project

Submitted to:
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REPORT

Report Number: 1543760

Golder Associates

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Acronym	Definition
ABMI	Alberta Biodiversity Monitoring Institute
ACIMS	Alberta Conservation Information Management System
ACT	Alberta Culture and Tourism
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AGRASID	Agricultural Region of Alberta Soil Inventory Database
AIES	Alberta Interconnected Electric System
ANPC	Alberta Native Plant Council
ASRD	Alberta Sustainable Resource Development
AT	Alberta Transportation
ATCO	ATCO Electric
ATPR	Alberta Tourism, Parks and Recreation
AUC	Alberta Utilities Commission
AUS	Avian Use Study
AWA	Alberta Wildlife Act
AWCS	Alberta Wetland Classification System
Capital Power	Capital Power Corporation
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
ESA	Environmentally Significant Area
ESRD	Alberta Environment and Sustainable Resource Development
FWMIS	Fisheries and Wildlife Management Information System
GIS	Geographic Information System
GPS	global positioning system
HRA	*Historical Resources Act*
IBA	Important Bird Area
MBCA	*Migratory Bird Convention Act*
NAD	North American Datum
O&M	Operations and Maintenance
PAMZ	Parkland Airshed Management Zone
PCMMP	post-Construction Mitigation and Monitoring Program
RAP	restricted activity period
ROW	rights-of-way
SARA	*Species At Risk Act*
SCADA	supervisory control and data acquisition
SoJ	Statement of Justification
sp.	species
spp.	multiple species
the Project	proposed Halkirk 2 Wind Power Project
UTM	Universal Transverse Mercator
VC	Valued Component

Unit	Definition
%	percent
+	plus
<	less than
>	greater than
≥	greater than or equal to
°C	degrees Celsius
µm	micrometre
cm	centimetre
ha	hectare
km	kilometre
km^2	square kilometre
kV	kilovolt
m	metre
m/s	metres per second
m^2	square metre
m^3	cubic metre
mm	millimetre
MW	megawatt
ppb	parts per billion
rpm	rotations per minute
V	volt

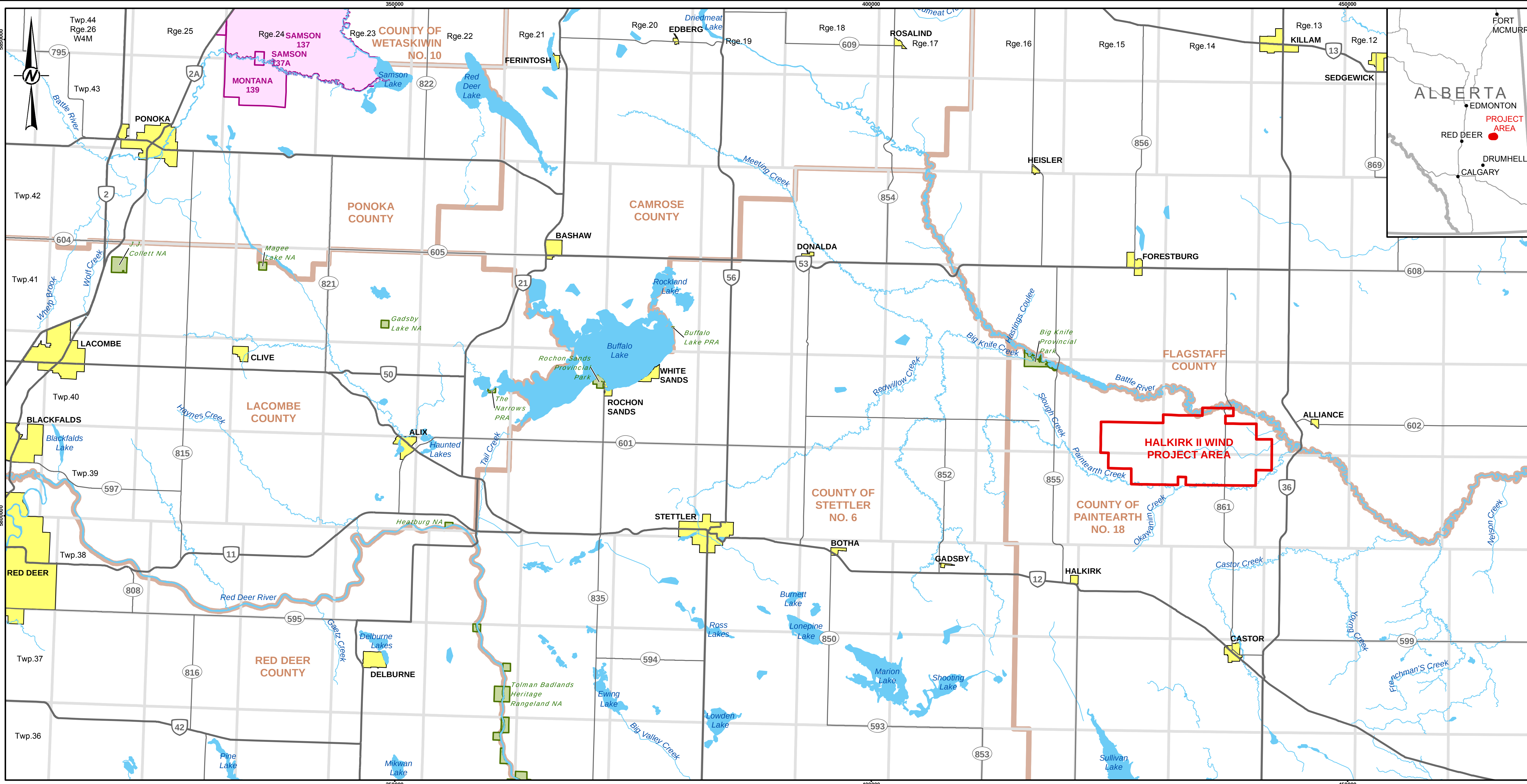
1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Capital Power Corporation (Capital Power) to prepare an Environmental Evaluation of their proposed Halkirk 2 Wind Power Project (the Project). The Environmental Evaluation describes baseline environmental conditions, identifies potential environmental effects of the Project, describes mitigation measures to be implemented during construction, operation and decommissioning of the Project, and assesses the predicted residual effects. This Environmental Evaluation was prepared to support Capital Power's application to the Alberta Utilities Commission (AUC) for a permit to construct and a licence to operate the Project. Specifically, the Environmental Evaluation addresses AUC Rule 007 information requirements PP10, PP16, PP17, TS35, TS39 and TS40.

1.1 Project Description

The proposed Halkirk 2 Wind Project (the Project) is located within the County of Paintearth approximately 12 kilometres (km) northeast of Halkirk, Alberta, within portions of Townships 39 and 40, Ranges 13, 14 and 15, W4M (Figure 1.1-1). The Project consists of 74 Vestas V110 2-megawatt (MW) wind turbines, for a total installed nominal nameplate capacity of 148 MW. The Project also includes access roads, an underground electrical collector system, and a substation, as described in the following sections. The Project will also require the construction of a permanent lattice or mono pole meteorological tower installed at the wind turbine generator hub height of 95 m. This tower will collect data during the operation phase of the Project.

The Project substation will be connected to the Alberta Interconnected Electric System via a short overhead transmission line (approximately 2 km) to the existing Tinchebray substation located in the northeast quarter section of Section 26, Township 39, Range 15 and west of the fourth meridian (26-39-15 W4M). This transmission line and any proposed changes to the existing substation are subject to a separate application to the Alberta Utilities Commission (AUC) by ATCO Electric, the intended Transmission Facility Operator. The transmission infrastructure, including any potential environmental effects are directly assigned by the Alberta Electric System Operator to ATCO Electric for planning, construction, and operation.



LEGEND

- PROJECT AREA
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- INDIAN RESERVE
- MUNICIPAL BOUNDARY
- PARK / PROTECTED AREA
- POPULATED PLACE
- WATERBODY

0 15 30

1:400,000 KILOMETRES

REFERENCE(S)
1. PARKS AND PROTECTED AREAS OBTAINED FROM ALBERTA PARKS, GOVERNMENT OF ALBERTA.
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PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	CS
PREPARED	SK
REVIEWED	CS
APPROVED	JM

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
REGIONAL AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1.1-1

1.1.1 Turbines

The technical specifications of the Vestas V110 – 2-MW wind turbines are provided in Table 1-1.1. The Vestas V110 has a three-bladed upwind rotor system and a 'flat-topped' nacelle, which houses the generator and gearbox.

Table 1.1-1: Vestas V110-2-Megawatt Turbine Technical Specifications

Specification	Detail
cut-in wind speed	3 m/s
cut-out wind speed	20 m/s
nominal power wind speed	7.5 m/s
number of blades	3
rotor diameter	110 m
rotor swept area	9,503 m^2/turbine
rotor swept height	150 m
rotor speed (variable)	Nominal 14.9 rpm, range 8-15.2 rpm
tower (hub) height	95 m
gearbox	Conventional three stage design with one planetary and two parallel stages
generator	6-pole Doubly Fed Induction Generator with a partial power converter
braking system	Three independent aerodynamic brakes to slow the rotor in the event of a fault or normal shutdown
yaw system	Ring gear and 6 pinions/yaw drives mounted on the nacelle
tower design	Four-piece tubular steel sections with flange connections

Note: m/s = metres per second; m = metres; m^2 = metres squared; rpm = rotations per minute

The Universal Transverse Mercator (UTM) coordinates of the 74 turbine locations are provided in Table 1.1-2.

Table 1.1-2: Wind Turbine Coordinates

Turbine ID	Easting (Zone 12, NAD 83)	Northing (Zone 12, NAD 83)
T001B	424232	5808951
T002	425195	5808892
T003C	426080	5808699
T007	425069	5807825
T008	425540	5807771
T009A	426329	5807763
T011B	426007	5806943
T012C	426605	5806973
T014A	426071	5805530
T015A	426910	5805521
T018B	427993	5804307
T019A	427720	5805345
T020	428288	5805247
T021C	428574	5805467
T022A	428558	5806009

Table 1.1-2: Wind Turbine Coordinates

Turbine ID	Easting (Zone 12, NAD 83)	Northing (Zone 12, NAD 83)
T025C	428596	5807689
T026	428340	5808415
T027B	428815	5808476
T028A	429535	5808488
T029B	429570	5809279
T030B	428826	5809126
T031B	427693	5809452
T033C	430448	5809232
T034	430859	5809253
T038B	430960	5808611
T039B	431921	5808281
T040A	432555	5808338
T041C	432923	5808693
T042	431261	5806965
T047A	431557	5804732
T049A	432469	5805516
T051	434214	5803866
T052B	434109	5805114
T053B	435198	5804714
T055A	434476	5805481
T057A	434086	5807143
T061A	433293	5808466
T062A	433707	5808723
T063A	434225	5808714
T066	435963	5810742
T067B	436508	5811016
T069	437343	5809459
T073A	436805	5808380
T078	436694	5806227
T080A	435883	5804646
T084C	435350	5804267
T085A	437631	5803645
T086B	438224	5803805
T088	439139	5803459
T089C	439251	5803817
T090	438346	5804578
T091B	438979	5804403
T092A	439358	5804983
T094A	438473	5805407
T100	441848	5806632
T103	441454	5805006

Table 1.1-2: Wind Turbine Coordinates

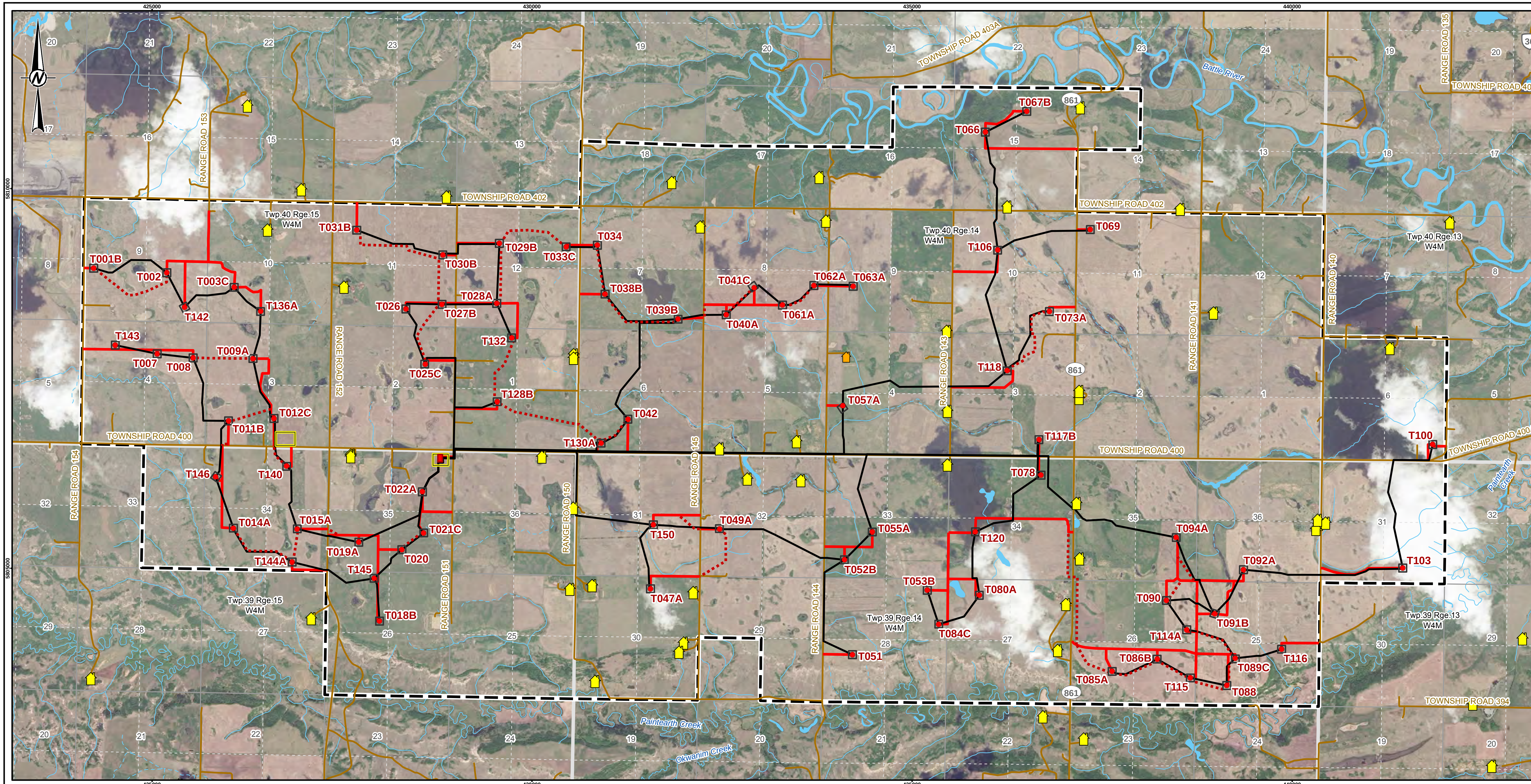
Turbine ID	Easting (Zone 12, NAD 83)	Northing (Zone 12, NAD 83)
T106	436125	5809189
T114A	438613	5804193
T115	438659	5803560
T116	439860	5803937
T117B	436668	5806694
T118	436250	5807601
T120	435832	5805482
T128B	429540	5807194
T130A	430908	5806648
T132	429731	5808034
T136A	426429	5808382
T140	426771	5806344
T142	425429	5808436
T143	424517	5807939
T144A	426844	5805085
T145	427922	5804870
T146	425835	5806207
T150	431596	5805574

1.1.2 Collector System

Each of the 74 wind turbines will have a transformer within its nacelle to increase the voltage generated by the wind turbine from 690 volts (V) to 34.5 kV. The cables entering and exiting the wind turbines will be installed underground.

Power generated by the wind turbines will be conveyed to the substation through an underground collector system, which will consist of seven 34.5 kV circuits of underground distribution aluminum power cables buried to a minimum depth of approximately 1 m (or 915 millimetres) as per the Canadian Electrical Code. Each circuit typically includes three individual cables; one cable for each electrical phase for 3-phase power. Approximately 29 km of cable for each of the seven circuits will be installed by direct ploughing and/or trench excavation, using sand bedding for protection against mechanical damage. A fibre optic cable and plastic warning tape will be installed at the same elevation as the power cables. Where possible and/or practical, routing of the cables will follow construction roads and avoid existing infrastructure wherever practical (Figure 1.1-2).

Junction boxes will be installed, where needed, to join the various segments of the collector line within each circuit. Junction boxes have been strategically located, where possible and/or practical, within the existing Project footprint (e.g., near turbine towers or at the edges of landowners' properties) to minimize impacts to the environment and landowners' use (e.g., farming operations with heavy equipment) of their lands.



LEGEND

PROJECT AREA

PROPOSED PROJECT INFRASTRUCTURE

PERMANENT FOOTPRINT COMPONENTS

- TURBINE
- OPERATIONAL ROAD
- SUBSTATION

TEMPORARY FOOTPRINT COMPONENTS

- TURBINE TEMPORARY WORKSPACE
- CRANE PATH / CONSTRUCTION ROAD
- UNDERGROUND COLLECTOR SYSTEM
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE

- RESIDENCE
- FORMER RESIDENCE
- ROAD/HIGHWAY
- WATERCOURSE
- INDEFINITE WATERCOURSE
- WATERBODY

0 2 4

1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

REFERENCE(S)
1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
2. IMAGERY OBTAINED FROM THE CLIENT.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
SITE LAYOUT

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1.1-2

PATH: I:\2015\1543760\Mapping\MXD\General\Final\1543760_Site_Layout_Rev0.mxd PRINTED ON: 2017-01-27 AT: 3:48:08 PM

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1.1.3 Substation and Operation & Maintenance (O&M) Building

The substation will be located in northeast quarter section of Section 35, Township 39, Range 15 and west of the fourth meridian (NE 35-39-15 W4M; UTM: 428790 E, 5806451 N, NAD 83, Zone 12). The substation will mainly consist of electrical equipment, including a power transformer, high and medium voltage circuit breakers and disconnect switches. The substation area will be fenced to prevent unauthorized access. A control building will be located inside the substation, and a separate Operation and Maintenance (O&M) building will be located within or next to the existing Halkirk 1 O&M building which is located in the Village of Halkirk, Alberta. The new or expanded O&M building for Halkirk 2 will mainly consist of an electrical room, workshop, supervisory control and data acquisition (SCADA) room, parts room, conference room, and office spaces. The substation will occupy an area of approximately 100 m by 60 m (0.6 hectares [ha]).

1.1.4 Access Roads

Permanent operational roads will be required to access and maintain the wind turbines during the operational life of the Project (Figure 1.1-2). The permanent operational roads will consist of a combination of all-weather gravelled access roads and seasonal lighter duty trails. The Project will require approximately 43 km of permanent operational roads that are approximately 25 m wide during construction and approximately 7.5 m wide during operation. Where practical, routing of the permanent operational roads will give consideration to minimizing disturbance to landowners' agricultural practices and interfacing with existing roads, undeveloped municipal road allowances, and infrastructure in the area. Landowner input has been given considerable consideration in the road design layout for the Project.

Temporary crane paths and construction roads will also be required during construction. The primary purpose for the temporary crane paths will be to move the assembled crane from turbine to turbine and to avoid additional crane breakdowns and travel on county roads. In some cases, the temporary crane paths will also be used as temporary construction roads for the delivery of wind turbine components, construction materials, and equipment to the wind turbine locations. The major components of the wind turbines, including the blades and tower sections, are relatively long; thus, the construction roads tend to follow paths that minimize excessive slopes, grades, and turning radius. Where practical, the temporary crane paths and construction roads will share routing with the collector systems (Figure 1.1-2). The Project will require approximately 21 km of temporary crane paths and construction roads that will be approximately 15 m wide.

1.1.5 Temporary Workspace

A temporary workspace adjacent to each wind turbine location will be required during construction to temporarily store turbine components and equipment. Each area will consist of a crane pad and laydown area and will be approximately 1 ha in size.

A temporary laydown yard will be constructed in the southeast quarter section of Section 3, Township 40, Range 15, W4M (SE 3-40-15 W4M), to provide a secure location for managing and storing materials, tools and equipment during construction and to accommodate the contractor site offices. The temporary laydown yard will be approximately 250 m by 175 m (4.4 ha) in size.

A temporary workspace will also be required at the substation for temporary equipment and materials storage. The substation temporary workspace will occupy approximately 3.0 ha.

1.1.6 Batch Plant

It is unknown at this time whether a temporary on-site batch plant will be constructed or whether concrete will be delivered to the site by truck. If a temporary on-site batch plant is necessary, it is expected that the third party concrete supply firm will comply with the requirements of Alberta Environment and Park's (AEP) *Code of Practice for Concrete Producing Plant* (September 1996), as well as follow best management practices for concrete batch plants with respect to soil and groundwater protection.

1.2 Project Activities

1.2.1 Pre-Construction Phase

Project planning and site selection were based on a number of factors, including the wind resource, terrain and topography, County bylaw requirements (updated in June 2016), environmental considerations, access to interconnection and transmission, and landowner interest. After the Project Area was determined to be suitable for wind power development, a preliminary wind turbine layout was developed, that took the following factors into consideration:

- results from wind profile studies and meteorological data (e.g., turbine layout and array design to optimize wind energy yield);
- topography, slopes, and terrain conditions;
- potential effect on landowners and area residents;
- existing land use and site access;
- existing industrial activity and infrastructure;
- environmental setback requirements (AEP 2017a) and historical resources information (e.g., location of historical resources); and
- other regulatory setback requirements from other regulatory agencies, namely:
  - County of Paintearth Land Use Bylaw - No. 593-09 (June 2016)
  - Alberta Utilities Commission Rule 012 – Noise Control (April 2013)

The Project components (i.e., wind turbines, substation, access roads, and electrical collector lines) were sited to optimize the power output of the Project while minimizing the Project's potential environmental effects. The site layout is shown on Figure 1.1-2. The Project includes the following components:

- 74 turbines;
- underground 34.5 kV collector system;
- substation building;
- permanent operational roads;
- temporary crane paths and construction roads;
- temporary workspaces at the turbine and substation locations; and
- temporary laydown yard.

Baseline environmental surveys have been undertaken; however, other pre-construction activities (e.g., geotechnical assessment, final legal survey of turbine locations, and final detailed engineering and design) will take place prior to construction.

The activities for the construction, operation, and decommissioning phases of the Project components are described below.

1.2.2 Construction Phase

Typical construction equipment used for road construction, foundation excavation and construction, erection of wind turbines, substation construction, and collector system installation, includes tracked bulldozers, graders, compactors, excavators, cranes and assorted trucks. Various large truck and trailer combinations will be used to transport the turbine components to the site and ready-mix concrete trucks will haul concrete from either an onsite batch plant or local ready-mix facility in the area to the turbine foundation locations. Typically, two to three cranes will be used to erect the turbines at each location. Additional vehicles will be used for personnel and small equipment transport to, from, and at the site.

Table 1.2-1 provides a description of the construction phase by component and construction activity.

Table 1.2-1: Description of Project Construction Activities

Project Component and Activity	Description
Surveying	The boundaries of the construction areas, including wind turbine sites, substation site, access roads and collector system, and temporary workspaces will be surveyed and staked. All existing buried infrastructure, such as pipelines and cables will be located and marked using the Alberta One-Call System. The site will be surveyed prior to the start of construction.
Access Roads	The Project will be accessed via existing public roads. Access to the turbine sites will require approximately 43.3 km of permanent operational access roads that are approximately 25 m wide during construction and approximately 7.5 m wide during operation. The operational roads will consist of a combination of all-weather gravelled access roads and seasonal, lighter-duty trails and will be maintained for use during Project operation. Culverts may be required to maintain drainage in ditches at junctions with existing roads. The Project will also require approximately 21 km of 15 m wide temporary crane paths and construction roads. The primary purpose for the temporary crane paths will be to move the assembled crane from turbine to turbine and to avoid additional crane breakdowns and travel on county roads. In some cases, the temporary crane paths will also be used as temporary construction roads for the delivery of wind turbine components, construction materials, and equipment to the wind turbine locations. Permanent access roads and temporary construction roads will be built using tracked bulldozers and graders to strip topsoil and upper subsoil, as required, to create an even travel surface. Soil management will be incorporated into the construction of the permanent access roads and temporary construction roads to facilitate site reclamation. Existing vegetation will be cleared and grubbed with the topsoil, which will be conserved and stockpiled separately from upper subsoil (a two-lift procedure) and stabilized as necessary to prevent erosion. When Project construction is complete, stripped upper subsoil and topsoil will be replaced. Lease roads within private land are subject to the Alberta Energy Regulator (AER) standards for surface lease construction in regards to soil horizon's preservation and reclamation as per the County of Paintearth's Land Use Bylaw (No. 593-09). Temporary crane paths that will not be used as temporary construction roads will only be used once when the assembled crane moves from turbine to turbine. As such, soil stripping will not be required along temporary crane paths unless grading is required where a two-lift procedure will then take place similar to the permanent access roads. Movement along the temporary crane paths will be restricted to dry or frozen conditions, where possible. In areas of disturbed soil (e.g., cultivated land), soil will be tilled or harrowed during reclamation to reduce soil compaction.

Table 1.2-1: Description of Project Construction Activities

Project Component and Activity	Description
Delivery of Equipment	Equipment will be delivered by truck and trailer as needed throughout the construction phase, and will be stored as necessary at temporary storage facilities at the site, as well as directly on the each of the 74 wind turbine pads. As necessary, a traffic management plan will be developed using Alberta Transportation standards to limit traffic disturbance, particularly to school bus traffic, on public roads.
Turbine Sites	During construction, the temporary workspace at each turbine location will be approximately 100 m by 100 m (1 ha). The size of the turbine base and vehicle turn-around area that will remain disturbed after construction and reclamation (i.e., the area that cannot be used for cultivation) will be approximately 25 m in radius from tower centre (0.20 ha). The turbine sites will be prepared using graders, compacters, tracked bulldozers, and hoes to strip topsoil and upper subsoil (a two-lift salvage procedure) to create an even work surface. Soil management will be incorporated into this process to facilitate site reclamation. Existing vegetation will be cleared and grubbed with the topsoil and stockpiled separately from stripped or excavated upper subsoil. After the turbines assembly, stripped or excavated subsoil and topsoil will be replaced, as appropriate. Turbine sites within private land are subject to the AER standards for surface lease construction in regards to soil horizon's preservation and reclamation as per the County of Paintearth's Land Use Bylaw (No. 593-09).
Foundations	The foundation will follow a typical concrete mat design that is approximately 20 m in diameter at its widest point and approximately a 3 m depth. The excavation for construction of the foundation will be approximately 25 m in diameter and will be backfilled approximately one to two weeks after the concrete foundation is poured and the turbine base is installed. Excess backfill materials will be redistributed onsite, will be transported to other areas of the Project for use as fill (where required), or disposed of off-site and/or on-site in cooperation with, and only as directed and approved, by landowners. No excess soils will be transported off-site or to other landowners' properties without the authorization and consent of both the source and receiving landowners. The foundations will be allowed to cure for up to 28 days prior to erection of the turbines. It is expected to take approximately six to seven days to excavate and construct each turbine foundation, pending appropriate weather conditions.
Turbine Assembly and Installation	Seventy-four (74) turbines are planned to be constructed. The turbine towers come in four sections that are assembled and erected onto the foundation by crane. The nacelle is lifted onto the tower by crane. The hub is lifted with the nacelle. Each blade is then installed separately aboveground using a crane to lift the blade to the hub. Each turbine will be 95 m high to the hub, with 110 m diameter rotors. The cranes will travel between turbine sites along the construction access roads or over existing terrain, which may require some grading. Soil management will be incorporated into this process to facilitate site reclamation. The assembly of all 74 turbines is anticipated to take approximately four months.
Substation	The substation consists primarily of electrical equipment including one power transformer, high and medium voltage circuit breakers, disconnect switches, and a control building. The substation will occupy an area of approximately 200 m by 150 m (3 ha) during construction and approximately 100 m by 60 m (0.6 ha) during operation, within NE 35-39-15 W5M. The substation site will be excavated to allow for the installation of a ground grid and the construction of concrete foundations. The final grade of the substation will consist of gravel or rock that provides an insulating barrier to electric shock during an electrical fault. The substation equipment will be mounted on the concrete and/or pile foundations and all metal components of the substation will be connected to the ground grid. This area will be fenced to prevent unauthorized access. Depending upon local conditions at the time of construction, it is anticipated to take approximately nine months to construct the substation.

Table 1.2-1: Description of Project Construction Activities

Project Component and Activity	Description
Temporary Laydown Yard	A temporary laydown yard will be constructed to provide a secure location for managing and storing materials, tools and equipment, and to accommodate the contractor site offices. The laydown yard will be located on cultivated lands in SE 3-40-15 W4M, and will remain in place throughout the construction period. As required, the yard will also be stripped of topsoil and upper subsoil, geotextile matting applied, and a gravel base set. Temporary power will also be provided to the temporary laydown yard. Following construction of the Project, the gravel, geotextile matting, and power supplies will be removed and the topsoil and upper subsoil replaced.
Interconnection Cabling	The collector system will include 34.5 kV underground distribution cable and a fibre optic communication cable. Each of the seven circuits will require approximately 29.1 km of disturbance for the installation of the cables, much of which will follow access routes or other underground cabling; however, for the purposes of the assessment, the entire 29.1 km is considered a disturbance area. Underground cables may be installed using a plough with a single cut tooth that splits the earth apart and allows the cables and sand bedding along with warning tape to be installed. No backfilling or compaction is required when using the ploughing method. Alternatively, the cables may be installed in a trench using a wheel-ditcher or Ditch Witch (a wheel-like or bar-like mechanism similar to a chainsaw which will be used to cut a narrow (approximately 0.15 m) trench and place the cable). The topsoil and upper subsoil removed from the trench will be placed adjacent to the trench separately to prevent admixing. A backhoe or small bobcat will be used to push the subsoil, followed by the topsoil back into place, and to re-compact and re-contour the disturbed area.
Gates and Fencing	The turbine sites or access roads will generally not be fenced or gated, unless requested by landowners. The substation will be fenced to limit uncontrolled access and for public safety. Where the Project's access roads intersect public road, gates may be installed as per landowner request.
Parking Areas	The primary construction parking areas will be at the temporary laydown yard. During operation, parking will be at the substation.
Clean-Up and Reclamation	Garbage and debris will be collected and disposed of at an approved location. All construction equipment and vehicles will be removed from the construction area following the completion of construction. Compacted soils will be de-compacted and stripped soils will be replaced and re-contoured at the temporary workspaces and laydown yard. The disturbed areas (including trenches) will be re-seeded as appropriate or left in a condition specified by the landowner. Site clean-up and reclamation will be conducted concurrently with construction, as appropriate. Lease roads and turbine sites on private land are subject to the AER standards for surface lease construction in regards to soil horizon's preservation and reclamation as per the County of Paintearth's Land Use Bylaw (No. 593-09).
Wind Turbine Commissioning	Turbine commissioning will occur once the wind turbines have been mechanically completed and inspected and when the Alberta Electrical System Operator is ready to accept grid interconnection. Commissioning involves testing and inspection of electrical, mechanical, communications and control function operability. A detailed set of operating instructions will be followed to connect with the electrical grid.

The anticipated Project construction schedule outlined in Table 1.2-2 accounts for a potential delay in equipment arrival, and adverse weather conditions. If regulatory approval is substantially delayed, subsequent construction delays may result due to a corresponding construction start in unfavourable season/poor weather conditions that would prolong construction activities.

Table 1.2-2: Construction Schedule

Activity	Period (a)
Surveying	March 2018
Construction:	
Soil stripping and salvage	April – September 2018
Development of access roads	April – September 2018
Grading and installation of turbine foundations	April – September 2018
Installation of underground distribution	April – September 2018
Equipment lay down and assembly	August 2018
Assembly and erection of wind turbine generators	September – December 2018
Substation and Operations and Maintenance building	April – December 2018
Transmission line interconnection (b)	April – December 2018
Testing and commissioning	January – March 2019
In-service date	Q1 2019
Final clean-up and reclamation	Q2 – Q3 2019

(a) Subject to change pending AUC approval and AESO Stage 4 Completion anticipated for February 2018 and March 2018, respectively
(b) Pending ATCO transmission facility availability

1.2.3 Operation Phase

The wind turbine technology selected for the Project operates automatically and is monitored and controlled through a remote SCADA system. Modern wind turbines are designed to require minimal ongoing maintenance. Oil changes (e.g., gearbox and hydraulic systems) and general maintenance will be regularly scheduled throughout the wind turbine's life span.

Preventative maintenance is likely to be conducted every three to four months during the first operational year (as per manufacturers recommended "break-in" period). Other routine servicing will be conducted at that time, as required. Following the "break-in" period, the regularly scheduled maintenance cycle is every six months, notwithstanding unplanned maintenance visits, as required. Used oil and other wastes will be disposed of at an approved facility following each maintenance visit.

1.2.4 Decommissioning Phase

At the end of the useful life of the turbines, decommissioning activities would be implemented. The decommissioning and restoration process includes the removal of above-ground structures, removal of below-ground structures to a depth of approximately 1 m below surface, and re-vegetation and seeding.

Aboveground structures include the wind turbines (including blades, nacelles, and towers), crane pads, substation, and access gates. Below ground structures include wind turbine pedestals and foundations, foundations for the substation, underground collector lines, and drainage structures.

The process of removing structures involves evaluating and categorizing all components and materials into categories of recycled or disposed at a certified landfill. For increased efficiency and minimal transportation effects, components and material may be stored on-site in a pre-approved location until the bulk of similar components or materials are ready for transport. The components and material will be transported to the appropriate facilities for reconditioning, salvage, recycling, and/or disposal.

When decommissioning occurs, reclamation standards at the time of decommissioning will be followed, but are generally expected to require the creation of temporary workspaces and access roads, and the use of equipment similar to that used for Project construction, as described in Section 1.2.1. Soil management will be incorporated into this process to facilitate site reclamation. As previously stated, lease roads and turbine sites on private land are subject to the Alberta Energy Regulator standards for surface lease construction in regards to soil horizon's preservation and reclamation as per the County of Paintearth's Land Use Bylaw (No. 593-09).

The turbines will be disassembled and removed from the site. The equipment, parts, and other materials removed during the decommissioning process will be recycled (i.e., salvaged and reconditioned) and/or disposed of as appropriate. Gravel, where used, will be removed from the sites.

Underground cables will be terminated and capped at connection points (from a practical perspective) in perpetuity. As they are to be buried to a depth of at least 1 m, unless future farming practices use ploughing techniques of greater than 1 m, limited adverse effects to land-use would be anticipated. Additionally, landowners will be consulted post-Project decommissioning with regard to any concerns that may arise. The wind turbine's concrete pedestal will be removed to a depth of 1 m below surface, and the excavation backfilled with subsoil to match the natural grade. Removal of below-ground structures to a depth of approximately 1 m is expected to provide a sufficient soil profile to allow successful revegetation and typical land-use practices (i.e., ploughing, seeding, harvesting, grazing croplands and/or pasture), despite the underlying remnant concrete foundation. Buried concrete is commonly associated with decommissioned industrial facilities (i.e., oil/gas wells) that have been successfully reclaimed in the past. Additional mitigation measures at turbine foundation locations include the removal of surface gravels, and soil decompaction.

After the infrastructure is removed, the turbine sites, and access/cabling routes may be ploughed as appropriate to alleviate soil compaction, and graded to restore terrain profiles. Topsoil will be replaced and prepared for seeding on cultivated areas. All waste material and equipment will be removed from the Project site.

1.3 Project Setting

1.3.1 Natural Region and Subregion

The Project is located within the Central Parkland Natural Subregion of the Parkland Natural Region (NRC 2006). Only 5% of the Central Parkland Subregion remains native vegetation. The area has been intensively cultivated for over a century. Native plant communities within the Central Parkland Natural Sub-region are subdivided into a southern grassland-dominated portion and northern aspen (*Populus tremuloides*)-dominated portion. Grassland communities within the Central Parkland Natural Subregion are composed mainly of blue grama grass (*Bouteloua gracilis*), dryland sedges (*Carex* spp.), June grass (*Koeleria macrantha*), needle and thread (*Hesperostipa comate),* and Western porcupine grass (*Stipa curtiseta*). Balsam poplar (*Populus balsamifera*) is often present with aspen and white spruce (*Picea glauca*) on moist, rich sites with lush, diverse understories throughout the Natural Subregion.

Wetlands mainly occur as temporary marshes and willow shrublands and seasonal ponds (NRC 2006). Common species identified in marshes include willow (*Salix* spp.), cattails (*Typha latifolia*), rushes (*Juncus* spp.), and sedges (*Carex* spp.).

Terrain within the Project Area varies considerably and includes areas of undulating to rolling plateau, narrow coulees and ravines, and steep, tree covered slopes. Undulating till plains and hummock uplands are the dominant landform. Lacustrine fluvial deposits are locally common in the northern and eastern parts of the natural Subregion, and some significant eolian deposits exist (NRC 2006).

1.3.2 Existing Infrastructure and Populated Places

The Project Area spans the County of Paintearth. Highway 12 is to the south of the Project Area and Highway 36 is to the east. Secondary Highway 861 runs north-south through the eastern half of the Project Area. The Project Area is located in an area supporting oil and gas activity, including well sites and associated infrastructure (e.g., access roads and pipelines). Other infrastructure includes communication towers and transmission facilities.

Overall, residential density is consistent with an agricultural area in rural Alberta. The town of Halkirk is located approximately 12 km south of the Project Area (population 121) (Statistics Canada 2011).

1.3.3 Regional Land Use Plans and Policies

The Project is located within Paintearth County and lies parallel to Battle River, which is part of the Battle River Basin, located in east-central Alberta (Alberta Urban Municipalities Association (AUMA) 2016). Battle River is part of the North Saskatchewan Region of Alberta. The following regional land use plan and policies would apply to the Project:

- Water Management Plan for the Battle River Basin:
  - The primary emphasis of this plan is on the need to live within the means of the watershed and the need to improve the health of the aquatic ecosystem (GOA 2014a).
- Red Deer Regional Plan:
  - At the time of filing this application, the land-use plan for the Red Deer Region was not yet started (AEP 2016a).
- County of Paintearth No. 18:
  - Land Use Bylaw No. 593-09, Part 7:
    - An application for a Wind Energy Conversion Systems must meet all the requirements in General Land Use Regulation No. 49.
  - Municipal Development Plan Volume Two – Goals and Policies states that:
    - The County will take measures to encourage the protection and management of Environmentally Significant Areas (ESAs) and conservation and enhancement of wildlife habitats (County of Paintearth No. 18 2004).
    - Care will be taken to ensure the areas of landscape value are not negatively impacted by visually intrusive developments (County of Paintearth No. 18 2004).

2.0 ENVIRONMENTAL EVALUATION METHODS

2.1 Approach to the Assessment

The purpose of this Environmental Evaluation is to describe the Potential effects of the Project on the environment, using an environmental assessment approach. This section describes the methodology used to identify and address the likely effects of the Project on environmental resources, and to analyze and classify the residual effects (i.e., the effects remaining after implementing mitigation measures). This Environmental Evaluation was undertaken using the following steps:

- determine the scope of the Project and assessment, including identification of issues to be addressed, characteristics of the natural environment to be assessed, and spatial and temporal boundaries;
- determine the existing environmental setting (i.e., baseline conditions) in the area potentially affected by the Project based on available desktop data and the field studies conducted in 2016;
- identify potential interactions between assessed characteristics of the natural environment and Project activities;
- identify technically and economically feasible mitigation measures to avoid, reduce, or eliminate potential effects;
- describe the likely Project residual effects on assessed characteristics of the natural environment following implementation of proposed mitigation measures and predict the significance of the residual effects; and
- develop a monitoring plan to evaluate the predictions of the Environmental Evaluation and the success of applied mitigation measures.

This Environmental Evaluation was conducted by qualified professionals and discipline experts. The following sub-sections describe the steps taken to conduct the assessment.

2.2 Scope of the Project

The Project includes the construction, operation, and decommissioning of a proposed 148 MW (nominal) wind power project located approximately 12 km northeast of Halkirk, Alberta. The Project assessed in this Environmental Evaluation includes the following Project components (as described in Sections 1.1 and 1.2):

- 74 turbines;
- underground 34.5 kV collector system;
- substation;
- permanent operational roads;
- temporary crane paths and construction roads;
- temporary workspaces at the turbine and substation; and
- temporary laydown yard.

The Project substation will be connected to the Alberta Interconnected Electric System via a short overhead transmission line to the existing Tinchebray substation. This transmission line and any proposed changes to the existing substation are subject to a separate application to the AUC by ATCO Electric, the intended Transmission Facility Operator. The transmission infrastructure, including any potential environmental effects, is beyond the scope of this Environmental Evaluation because it is directly assigned by the Alberta Electric System Operator to ATCO Electric for planning, construction, and operation.

2.3 Scope of the Assessment

The scope of the assessment is defined by the interactions between Project activities and the existing natural environment. The assessment of this interaction requires a study area that includes regional and local considerations and is dependent on the activity being undertaken. The environmental baseline information and potential environmental issues addressed in the Environmental Evaluation were identified through a variety of sources, including:

- review of best available information, including government databases and available technical reports and maps;
- field surveys;
- information received from stakeholder consultation activities; and
- input from regulators.

2.4 Identification of Valued Components

To describe and assess the potential effects of the Project, Valued Components (VCs) were identified. The VCs include any part of the natural environment that is considered important by the proponent, members of the public, or scientists and government agencies involved in the assessment process. Importance may be determined on the basis of cultural value or scientific concern and was assessed for the Project based on proponent and assessor experience with similar projects, regulatory requirements, and stakeholder consultation.

The VCs selected to address the potential environmental effects in relation to this Project and the rationale for their selection are presented in Table 2.4-1.

2.4.1 Identifying Project and Environment Interactions

All relevant Project works or activities were screened individually, to determine if there is a plausible mechanism for an effect on each VC during normal Project conditions. The screening was based on professional judgement and experience of the assessment team with regard to the physical and operational features of the Project and their potential for interaction with the environment.

Table 2.4-1 illustrates where the Project may potentially interact with the VC and where adverse effects are possible. The interactions identified in the table were used to focus the description of the baseline conditions, and to focus the effects assessment and design of mitigation measures. Where interactions between the Project component and a VC are not predicted, a rationale for that prediction is provided in Table 2.4-1, and no further analysis is provided in the effects assessment.

Table 2.4-1: Valued Components, Project Interactions and Rationale

Valued Components	Potential Interaction	Rationale
Land cover	Yes	▪ Provides an indication of both how the land is being used by local landowners and of the potential for the land to support sensitive wildlife and vegetation species
Environmentally sensitive areas	Yes	▪ Represent lands that have been assigned a level of environmental protection, or indicate lands that may have a higher level of environmental sensitivity
Terrain and Soil	Yes	▪ Potential for altered terrain to affect land use and other environmental components (e.g., surface water, vegetation) ▪ Ecosystem conservation concern; importance to ecosystem diversity and interrelation with other components (e.g., groundwater, vegetation) ▪ Importance of soil productivity in maintaining agricultural capability
Vegetation	Yes	▪ Potential implications to wildlife habitat potential, species, and community diversity ▪ Regulatory requirement: potential adverse effect on federally listed plant species (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2015; *Species at Risk Act* [SARA] 2015); and provincially listed plant species (General Status of Alberta Wild Species [ASRD 2012]; or plant species of conservation concern (Alberta Conservation Information Management System [AEP 2016b]). ▪ Regulatory requirement to control noxious or prohibited noxious weeds (Alberta *Weed Control Act*)
Surface water, Aquatic Species and Habitat	Yes	▪ Regulatory requirements (Alberta *Water Act*) ▪ Response to alteration may include erosion and instability ▪ Potential to alter natural local / regional drainage patterns ▪ Consideration of regional users, regulations (e.g., Alberta *Environmental Protection and Enhancement Act*), and general public concern ▪ Regulatory requirement: Environment Canada is responsible for administration and enforcement of the *Fisheries Act* pollution prevention provisions dealing with the deposition of deleterious substances into water frequented by fish ▪ Potential to alter water quality and affect aquatic life ▪ Ecosystem conservation concerns; importance to ecosystem diversity and inter-relation to other environmental components (e.g., wildlife) ▪ Regional users and potential Aboriginal and public concern ▪ Regulatory requirement; potential to cause serious harm to fish and fish habitat as defined under the *Fisheries Act*
Groundwater	Yes	▪ Regulatory requirement: Alberta *Water Act* and associated *Water Ministerial Regulation* (AR205/1998) ▪ Potential public concern and importance of water wells to landowners.

Table 2.4-1: Valued Components, Project Interactions and Rationale

Valued Components	Potential Interaction	Rationale
Wetlands	Yes	▪ Provincial regulatory requirements (Alberta *Water Act* and the Alberta Wetland Policy [AEP 2016d]) ▪ Potential implications to wildlife habitat potential and plant species habitat potential ▪ Potential implications to species and community level biodiversity ▪ Potential implications to water quality and water attenuation within wetlands ▪ Regulatory requirement to control noxious weeds and eliminate prohibited noxious weeds (Alberta *Weed Control Act*)
Wildlife and wildlife habitat	Yes	▪ Economic importance (i.e., hunting licenses), recreational importance, and ecological importance ▪ Regulatory requirement to comply with applicable provincial (Alberta *Wildlife Act,* January 2017 AEP's Wildlife Directive for Alberta Wind Energy Projects [AEP 2017a]) and federal (COSEWIC, SARA) regulations
Air quality	Yes	▪ Regulatory requirement to comply with applicable provincial *(Environmental Protection and Enhancement Act*) and federal ambient air quality standards and objectives (ESRD 2013a, Health Canada 2006, Government of Canada 2013) ▪ Consideration of potential health implications and nuisance effects
Historic resources	Yes	▪ Regulatory requirement (Alberta *Historical Resources Act*) ▪ The potential to disrupt or destroy heritage resource sites is a concern due to its potential effect on our ability to understand the prehistory / history of the region ▪ Aboriginal and public concern

2.5 Spatial Boundaries

The spatial boundaries of the assessment were determined based on the extent of potential direct and indirect environmental effects resulting from the Project. The spatial boundaries must be able to capture scale-dependent processes and activities that influence the geographic distribution or movement patterns specific to each VC.

This assessment uses two spatial boundaries for the assessment of potential Project effects on the VCs: Project footprint and Project Area. These study areas were defined to capture the direct and indirect effects of the Project on each VC, as well as to understand the context within which effects of the Project are expected to occur.

- Project footprint: Represents the area where direct effects are expected to occur during construction, operation, and decommissioning. The Project footprint includes the following components:
  - turbine area (approximately 100 m by 100 m pad during construction and a circle with an approximate 25 m radius during operation);
  - temporary crane paths and construction roads (approximately 15 m wide during construction);
  - permanent operational roads (approximately 25 m wide during construction and approximately 7.5 m wide during operation);
  - substation (approximately 200 m by 150 m during construction and approximately 100 m by 60 m during operation);
  - underground collector system (approximately 10 m wide during construction); and
  - temporary laydown yard (approximately 250 m by 175 m during construction).
- Project Area: The Project Area represents the general area that is suitable for wind power development based on the preliminary siting and constraints analysis. The Project Area includes the Project footprint and adjacent land (Figure 1.1-2). The Project Area is expected to be large enough to describe the potential direct and indirect effects for most VCs.

2.6 Temporal Boundaries

The temporal boundaries of this Project are linked to the following:

- project development phases (i.e., construction, operation, and decommissioning of the Project); and
- predicted duration of effects from the Project, which may extend beyond decommissioning (i.e., post-closure).

Thus, the temporal boundary for a VC is defined as the amount of time between the start and end of a relevant Project activity or stressor, plus the duration required for the effect to be reversed.

2.7 Determination of Baseline Conditions

Published reports and government databases were reviewed for information about existing environmental conditions in the Project Area. Discussions were held with regulators and stakeholders to identify potential constraints to development and to identify environmental features of potential concern. Site surveys were conducted in 2016 to characterize the following:

- land cover;
- vegetation communities, listed plant species and plant communities and listed weeds;
- wetlands; and
- wildlife and wildlife habitat including:
  - Winter birds;
  - Sharp-tailed grouse;
  - Richardson's ground squirrel;
  - Spring and fall bat migration;
  - Raptor nests;
  - Breeding bird; and
  - Avian use (spring and fall migration).

2.8 Project and Valued Component Interactions

This assessment considers the potential interactions between the Project and the VCs. Project interactions with VCs may occur directly as a result of a Project activity or component affecting a VC, or indirectly as a result of a change to another VC.

Development of mitigation measures to avoid, reduce, or eliminate potential effects on VCs occurs during:

- the engineering design phase;
- planning, consultation, and engagement activities;
- construction planning and execution;
- Project operation; and
- decommissioning planning and execution.

Consideration is focused on mitigation strategies that are technically and economically feasible. Mitigation measures will be continually incorporated into the Project as part of the planning process and are identified in the effects assessment section for each VC.

For this assessment, an effect is considered to occur where anticipated future conditions resulting from the Project differ from the conditions otherwise expected from natural change. The determination of potential Project and VC interactions assumes that identified mitigation measures have been implemented. Effects to VCs that are anticipated even after the application of mitigation measures are identified as residual effects. Where residual effects are predicted, the VC is carried forward in the effects assessment. For VCs where no residual effects are anticipated, the effects assessment is complete and the VCs are not carried forward for further analysis.

2.9 Effects Analysis

The environmental assessment approach is based on the *Canadian Environmental Assessment Act*, *2012* and the AEP assessment principles and methodology, as guided by the following documents:

- "Operational Policy Statement: Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the *Canadian Environmental Assessment Act, 2012*" (Canadian Environmental Assessment Agency 2015); and
- "Guide to Preparing Environmental Impact Assessment Reports in Alberta" (ESRD 2013a).

2.9.1 Assessment of Predicted Residual Effects

During the Environmental Evaluation process, Golder considered the existing baseline environmental conditions, the likely effects associated with the Project, and the mitigation measures proposed to reduce or avoid potential environmental effects of the Project on environmental components. Taking into consideration the proposed mitigation measures, the importance of the residual effects was evaluated based on the following criteria:

- direction;
- magnitude;
- geographic extent; and
- duration.

The criteria used to describe a predicted residual effect are defined in Table 2.9-1.

Table 2.9-1: Definition of Criterial Used to Describe Predicted Residual Effects

Criteria	Definition	Environmental Description
Direction	Direction relates to the value of the effect in relation to the environment.	▪ Positive – net gain or benefit; effect is desirable ▪ Neutral – no change compared with baseline conditions and trends ▪ Negative – net loss or adverse effect; effect is undesirable
Magnitude	Magnitude is the intensity of the effect, or a measure of the degree of change from existing (baseline) conditions.	▪ Minimal – no detectable change is expected from baseline values ▪ Low – effect occurs that might be detectable, but is expected to be within the range of baseline or guideline values, or within the range of natural variability ▪ Medium – effect is expected to be at or to slightly exceed the limits of baseline or guideline values – clearly an effect but unlikely to be a management concern[(a)] ▪ High – effect is expected to exceed the limits of baseline or guideline values – the effect can pose a serious risk and represents a management concern[(a)]

Table 2.9-1: Definition of Criterial Used to Describe Predicted Residual Effects

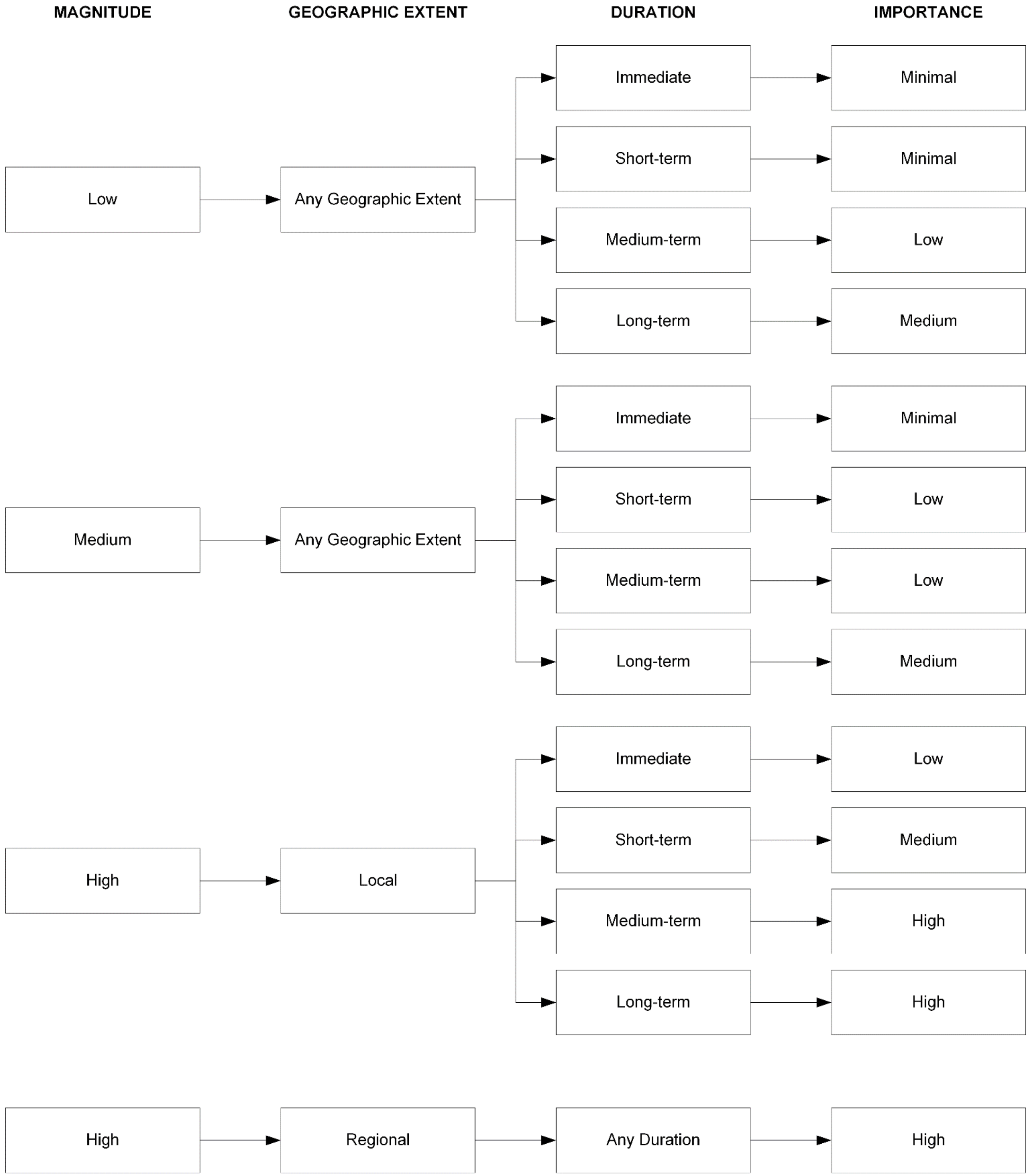
Criteria	Definition	Environmental Description
Geographic Extent	Geographic extent refers to the spatial extent over which a Project effect will occur.	▪ Local – the effect is confined to the Project Area ▪ Regional – the effect extends beyond the Project Area
Duration	Duration is the period of time over which the environmental effect will be present. The amount of time between the start and end of a Project activity or stressor (which relates to Project development phases), plus the time required for the effect to be reversed. Duration and reversibility are functions of the length of time the VC are exposed to Project activities.	▪ Immediate – the effect occurs during construction or decommissioning; ▪ Short-term – the effect occurs during construction or decommissioning, and is reversible less than three years beyond completion of construction or decommissioning; ▪ Medium-term – the effect occurs during the life of the Project; or ▪ Long-term – the effect persists beyond decommissioning, but is reversible; and ▪ Permanent – the effect persists beyond decommissioning and is irreversible.

[(a)] An effect that poses a management concern may require actions such as research, monitoring, or recovery initiatives.

2.9.2 Assessment of Importance of Predicted Residual Effects

The importance of the predicted residual effects is determined by considering the magnitude, geographic extent and duration, as shown in Figure 2.9-1. The level of importance of a residual effect is described as minimal, low, medium, or high. Table 2.9-2 provides a narrative description of importance that corresponds with the ratings assigned in Figure 2.9-1.

Figure 2.9-1: Predicted Residual Effect Attributes Leading to Importance



The assessed levels of importance of the residual effects are defined in Table 2.9-2. The predicted residual effects for each VC are assessed using a combination of criteria, professional judgement, and these definitions as guidelines.

Table 2.9-2: Definitions of the Assessed Levels of Importance of Predicted Residual Effects

Level	Definition
Minimal	Potential **negative** effect could result in a slight decline in the resource in the study area during Project construction and/or decommissioning, but the resource should return to baseline levels following construction.
	Potential **positive** effect could result in a slight improvement in the resource in the study area during Project construction and/or decommissioning, but the resource should return to baseline levels following construction and/or closure.
Low	Potential **negative** effect could result in a slight decline in the resource in the study area during the life of the Project. Research, monitoring, and/or recovery initiatives would not normally be required.
	Potential **positive** effect could result in a slight improvement in the resource in the study area during the life of the Project.
Medium	Potential **negative** effect could result in a decline in the resource to lower-than-baseline, but stable levels in the study area after Project closure and into the foreseeable future. Regional management actions such as research, monitoring, and/or recovery initiatives may be required.
	Potential **positive** effect could result in an improvement in the resource to better-than-baseline levels in the study area after Project closure and into the foreseeable future.
High	Potential **negative** effect could threaten sustainability of the resource and should be considered a management concern. Research, monitoring, and/or recovery initiatives should be considered.
	Potential **positive** effect could result in an improvement of a resource condition that is currently a management concern, so that the existing resource concern is resolved.

2.9.3 Likelihood

In addition to their importance, residual effects are characterized by their likelihood. Likelihood refers to the probability that a Project activity will result in an effect. For this assessment, likelihood is characterized as none, unlikely, possible, or likely (Table 2.9-3):

Table 2.9-3: Likelihood

Likelihood	Definition
None	No evidence to support the occurrence of the effect in similar projects.
Unlikely	The effect is not likely to occur. The effect has been reported only rarely for similar projects.
Possible	The effect may occur, but is not likely. Evidence supports the occurrence of the effect in some, but less than half, of similar projects.
Likely	The effect is likely to occur. The effect is considered common for similar projects.

2.9.4 Determination of Significance

Sustainable development (i.e., satisfying the needs of present generations without compromising the ability of future generations to meet their own needs) is a key consideration in determining the significance of the effects on the natural environment. An effect was considered significant if it compromised the objectives of sustainable development. Three sustainable development objectives were considered:

- to preserve environmental integrity;
- to improve social equity; and
- to contribute to sustained economic development.

Sustainable development objectives are based on established public objectives such as land use plan or policy; government commitment on the use/conservation of resources; legislation, regulation or guideline. The objectives identified above were considered during the Project effects assessment to determine significance.

The significance of Project-related effects on the VCs is defined as follows:

- **Not Significant***:* The effect is detectable, but is not likely to result in substantial change that will alter the VC's status or integrity beyond an acceptable level.
- **Significant:** The effect is measureable and results in a change to the VC that will alter its status or integrity beyond an acceptable level.

3.0 ENVIRONMENTAL EVALUATION

3.1 Land Cover

3.1.1 Introduction

Land cover is considered in the Environmental Evaluation because it provides an indication of both how the land is being used by local landowners and of the potential for the land to support sensitive wildlife and vegetation species.

This section of the report contains the results of a desktop land cover assessment within the Project Area, and the field survey, during which a subset of the mapped land cover types were field-verified.

3.1.2 Baseline Data Collection Methods

3.1.2.1 Desktop Assessment

A preliminary constraints mapping exercise was performed to identify and delineate land cover type polygons within the Project Area. The following data sources were used for desktop land cover mapping:

- Grassland vegetation inventory obtained from AEP (AEP 2016c)
- Alberta Biodiversity Monitoring Institute (ABMI) Human Footprint 2012 Version 3 obtained from ABMI (2010)
- Environmentally Significant Areas data (County of Paintearth No. 18 2004)

During desktop mapping, the Golder vegetation ecologist used 1.5 m resolution aerial photography and ArcView GIS software to map potential land cover type polygons at a 1:10,000 scale. Land cover type polygons were classified into one of six categories:

- agricultural/pasture;
- native prairie;
- wooded;
- wetland;
- farmyard/residential; and
- developed.

3.1.2.2 Field Assessment

In addition to the desktop assessment, land cover within the Project Area was field-verified during the early listed plant and wetland surveys (from May 25 to June 2, 2016) and the late listed plant surveys (August 11 and 12, 2016). The land cover field surveys were conducted in areas where land access permission was granted within the Project Area.

Field surveys were conducted on foot, using a truck for overall access within the Project Area, while traveling between wetlands and when completing listed plant meanders. For field surveys, the original six land cover types were further refined into the following eight land cover types to better capture ground conditions:

- cultivated land;

- modified pasture;
- native prairie;
- wooded;
- wetland permanence Class I-II;
- wetland permanence Class III-V;
- farmyard/residential; and
- developed.

These cover types were noted and delineated during the field surveys, and photographs and GPS points were taken at each survey location. Areas that could not be field verified as cultivated land or modified pasture due to a lack of land access permission or time constraints were classified in the more general agricultural/pasture land cover type. Some areas of prairie/pasture contained both native and non-native species in various percentages. Native and non-native prairie/pasture polygons at least 100 m wide were mapped separately. If a single land cover polygon contained a mix of native and non-native species, the polygon was classified native prairie if at least one half of the vegetation cover was native species and if there was no obvious evidence of ground disturbance (i.e., plowing). Otherwise the polygon was classified as modified pasture.

3.1.3 Baseline Conditions

All surveyed areas supported some type of agricultural activity, including all areas of native prairie, wooded areas, and wetlands. The land cover types observed within the Project Area during the desktop assessment and 2016 field surveys, and the approximate percentage of each type are provided in Table 3.1-1 and shown on Figures A1 to A15 in Appendix A. The nine land cover classes are presented on Figures A1 to A15 in Appendix A and in Table 3.1-1. The most common land cover types within the Project Area are cultivated land and agricultural/pasture occupying 3,814.8 ha (34%) and 2,972.1 ha (27%), respectively. Modified pasture is the third most common land cover type with patches distributed throughout the Project Area, occupying 1,835.2 ha (16%).

Native prairie occupies 1,369.4 ha (12%) of the Project Area and is mainly located along the southern, western, and northern limits of the Project Area, primarily associated with the Paintearth Creek and Battle River valleys (Figures A1 to A15 in Appendix A). The wetland land cover types (i.e., permanence Classes I-II and III-V) represent a total of 879.5 ha (8%) of the Project Area, whereas the wooded land and farm yard/residential land cover types represent 1% of the Project Area each. Developed areas are a less common land cover type, with a total of 38.2 ha (<1%) (Table 3.1-1 and Figures A1 to A15 in Appendix A). In total, modified land cover types (i.e., agricultural/pasture, cultivated land and modified pasture) occupy 77% of the Project Area (Table 3.1-1).

Table 3.1-1: Land Cover Type within the Project Area

Land Cover Type	Desktop		Field Verified		Total	
	Area (ha)	Percent of Project Area (%)	Area (ha)	Percent of Project Area (%)	Area (ha)	Percent of Project Area (%)
Native Vegetation						
Native Prairie	1179.9	23	189.5	3	1369.4	12
Wooded	97.9	2	48.8	1	146.7	1
Subtotal native vegetation	*1277.8*	*25*	*238.3*	*4*	*1,516.10*	*14*
Wetlands						
Wetland Permanence Class I-II	116.9	2	15.4	<1	132.3	1
Wetland Permanence Class III-V	577.1	11	170.2	3	747.3	7
Subtotal wetlands	*694.0*	*14*	*185.6*	*3*	*879.6*	*8*
Modified Vegetation						
Agricultural/Pasture	2972.1	59	0.0	0	2,972.1	27
Cultivated Land	0.0	0	3,814.8	62	3,814.8	34
Modified Pasture	0.0	0	1,835.2	30	1,835.2	16
Subtotal modified vegetation	*2972.1*	*59*	*5,650.0*	*92*	*8,622.1*	*77*
Miscellaneous						
Developed	34.4	1	3.8	<0.1	38.2	<1
Farm Yard / Rural Residential	86.5	2	30.6	1	117.1	1
Subtotal miscellaneous	*120.9*	*2*	*34.4*	*1*	*155.3*	*1*
Total	**5,064.8**	**100**	**6,108.3**	**100**	**11,173.1**	**100**

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values.

3.1.4 Potential Effects, Mitigation and Predicted Residual Effects

3.1.4.1 Potential Effects

The Project has the potential to adversely affect land cover in the Project footprint due to vegetation removal and soil disturbance during construction and due to the presence of turbines and other facilities during operation. Table 3.1-2 provides the area of each land cover type disturbed by Project construction and operation activities, and indicates the number of turbines located within each land cover type category.

Table 3.1-2: Potential Project Effects on Land Cover

Land Cover Types	Project Area (ha)	Number of Turbines	Construction [a]						Operation					Total Project Footprint		
			Turbine Temporary Workspace (ha)	Access Roads (ha) [b]	Underground Collector System	Substation Temporary Workspace and Laydown Yard (ha)	Total Construction Footprint		Turbine (ha)	Permanent Operational Roads (ha)	Substation (ha)	Total Operation Footprint		Area (ha)	Percent of Project Area (%)	Percent of Project Footprint (%)
							Area (ha)	Percent of Project Area (%)				Area (ha)	Percent of Project Area (%)			
Native Vegetation																
Native Prairie	1369.4	-	0.0	<0.1	0.0	0.0	<0.1	<0.01	0.0	0.0	0.0	0.0	0.00	<0.1	<0.01	<0.1
Wooded	146.7	-	0.0	1.0	<0.1	0.0	1.1	<0.01	0.0	0.4	0.0	0.4	<0.01	1.1	<0.01	<1
Subtotal Native Vegetation	*1,516.10*	-	*0.0*	*1.0*	*<0.1*	*0.0*	*1.1*	*<0.01*	*0.0*	*0.4*	*0.0*	*0.4*	*<0.01*	*1.1*	*<0.01*	*<1*
Wetlands																
Wetland Class I-II	132.3	-	0.0	0.5	0.1	0.0	0.6	*<0.01*	0.0	0.1	0.0	0.1	<0.01	0.6	*<0.01*	<1
Wetland Class III-V	747.3	-	0.0	1.0	0.6	0.0	1.6	<0.1	0.0	0.2	0.0	0.2	<0.01	1.6	<0.1	1
Subtotal wetlands	*879.6*	-	*0.0*	*1.4*	*0.7*	*0.0*	*2.2*	*<0.1*	*0.0*	*0.4*	*0.0*	*0.3*	*<0.01*	*2.2*	*<0.1*	*1*
Modified Vegetation																
Agricultural/Pasture	2,972.1	4	3.1	13.4	8.1	4.4	29.1	<1	0.7	3.7	0.0	4.4	<0.1	29.1	<1	11
Cultivated Land	3,814.8	47	39.5	80.4	36.1	2.5	158.5	1	8.2	18.4	0.6	27.3	<1	158.5	1	58
Modified Pasture	1,835.2	23	20.2	40.5	21.1	0.0	81.8	1	4.1	9.4	0.0	13.5	<1	81.8	1	30
Subtotal Modified Vegetation	*8,622.1*	*74*	*62.8*	*134.3*	*65.3*	*6.9*	*269.3*	*2*	*13.0*	*31.6*	*0.6*	*45.1*	*<1*	*269.3*	*2*	*98*
Miscellaneous																
Developed	34.4	-	0.0	<0.1	<0.1	0.0	<0.1	<0.01	0.0	<0.01	0.0	<0.01	<0.01	<0.1	<0.01	<0.1
Farm Yard / Rural Residential	86.5	-	0.0	0.2	1.5	0.0	1.7	<0.1	0.0	<0.01	0.0	<0.1	<0.01	1.7	<0.1	1
Subtotal Miscellaneous	*120.9*	-	*0.0*	*0.2*	*1.5*	*0.0*	*1.7*	*<0.1*	*0.0*	*<0.1*	*0.0*	*<0.1*	*<0.01*	*1.7*	*<0.1*	*1*
Total	**11,173.1**	**74**	**62.8**	**137.0**	**67.6**	**6.9**	**274.3**	**2**	**13.0**	**32.3**	**0.6**	**45.9**	**<1**	**274.3**	**2**	**100**

[a] Construction areas include areas that will continue to be affected during operation

[b] Includes temporary crane paths, temporary construction roads and 25 m temporary construction area for permanent operational roads

-= no turbines present.

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values

The Project has the potential to adversely affect 274.3 ha of land (2% of the Project Area) during construction, of which 45.9 ha (<1% of Project Area) will be permanently affected during operation. Approximately 98% of the Project footprint is located on modified land cover types including agricultural/pasture (29.1 ha; 11% of the Project footprint), cultivated land (158.5 ha; 58% of the Project footprint) and modified pasture (81.8 ha; 30% of the Project footprint). In addition, all turbines will be located within these modified land cover types. No native prairie, wooded or wetland land cover types are anticipated to be affected by the construction or operation of the turbines, substation temporary workspace, or temporary laydown yard.

Although no turbines are being placed directly on native prairie, the Project will adversely affect less than 0.1 ha (<0.01% of Project Area) of native prairie during construction of the access roads. However, these adverse effects will be temporary and no permanent infrastructure will be located within native prairie. The Project will also adversely affect 1.1 ha (<0.01% of Project Area) of wooded land during construction and 0.4 ha during operation (e.g., permanent effects) (Table 3.1-2). A total of 0.6 ha of wetland permanence Class I-II, and 1.6 ha of wetland permanence Class III-V will be adversely affected during construction and operation. Project effects to native vegetation are discussed in Section 3.4, while Project effects to wetlands are discussed in Section 3.7.

The removal of Project equipment during decommissioning will be carried out in a manner similar to equipment installation during construction, including the re-widening of access roads and temporary workspace using bulldozers and excavators, and the removal of turbine assemblies, foundations (to a depth of 1 m) and other equipment using excavators, cranes, heavy trucks and trailers. Agricultural land use (i.e., cultivation or pasture) within the Project footprint is expected to be returned as a result of final reclamation, considering the landowners' preferences.

3.1.4.2 Mitigation

To limit adverse effects on land cover, vegetation, and soil disturbance will be restricted to the extent necessary to safely construct, operate and decommission the Project. Grading will be restricted to what is required for the access and safe operation of equipment and vehicles. All vehicle traffic and equipment will remain within the Project footprint. Construction may occur during the crop growing or haying season; however, consultation with landowners will be ongoing to avoid damage to crops and haylands, where possible. All construction and decommissioning equipment will enter construction areas in a clean condition to limit the potential for introduction of weeds or disease. Vehicles and equipment that can potentially interact with the environment (i.e., that will leave and/or clear the access road) may be pressure washed before entering the workspace. Following the completion of construction, areas not containing permanent facilities or operational access roads will be reclaimed to the extent possible to an equivalent land cover capability in accordance with landowner expectations and regulatory requirements, as appropriate.

3.1.4.3 Predicted Residual Effects

The predicted residual Project effects on land cover are:

- loss or alteration of agricultural/pasture, cultivated land, and modified pasture; and
- loss or alteration of wetlands, native prairie and wooded land;
- reclamation of cultivated land and modified pasture; and
- introduction or spread of weeds and/or non-native species.

Predicted residual effects to native prairie and wooded land are discussed further in Section 3.4 while predicted residual effects to wetlands are discussed in Section 3.7. The remaining residual effects are discussed further in the section below.

3.1.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on land cover and the importance of the predicted residual effects are provided in Table 3.1-3. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.1-3: Predicted Residual Project Effects Description and Importance for Land Cover

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Loss or alteration of agricultural/pasture, cultivated land, and modified pasture	Construction, operation and decommissioning	Negative	Medium	Local	Short-term to Medium-term	Likely	Low
Reclamation of cultivated land and modified pasture	Decommissioning	Positive	Medium	Local	Short-term	Likely	Low
Introduction or spread of weeds and/or non-native species	Construction, operation and decommissioning	Negative	Low	Local	Medium-term	Possible	Minimal

Loss or alteration of agricultural/pasture, cultivated land and modified pasture land cover types

Loss or alteration of agricultural/pasture, cultivated, and modified pasture during construction, operation and decommissioning will be negative in direction and medium in magnitude because there will be a net loss to these land cover types where turbines, access roads, and substation infrastructure will be located. The geographic extent is not expected to extend beyond the Project Area, and is therefore local. The loss or alteration of agricultural/pasture, cultivated, land and modified pasture land cover types is expected to be short-term to medium-term; following the construction of permanent facilities, areas not containing permanent facilities or operational access roads will be returned to cultivated or modified pasture. The probability of this occurrence is likely, but is considered common for similar projects. Overall the loss or alteration of agricultural/pasture, cultivated, and modified pasture land cover types is considered to be of low importance.

Reclamation of cultivated land and modified pasture

During decommissioning, Project infrastructure will be removed and the land will be returned to equivalent land cover capability in accordance with landowner expectations and regulatory requirements, as appropriate. In general, land is expected to be returned to either cultivated land or modified pasture. This will result in a positive effect of medium magnitude as land previously occupied by Project infrastructure is returned to a more natural state. The geographic extent is not expected to extend beyond the Project Area, and is therefore local. The activity will take place during decommissioning and is therefore considered short-term. The probability of this occurrence is likely. Overall the reclamation of cultivated land and modified pasture is considered to be of low importance.

Introduction or spread of weeds and/or non-native species

The introduction or spread of weeds and non-native species will be negative in direction and low in magnitude because implemented mitigation measures will limit vehicle traffic and equipment to the Project footprint, reducing the potential to introduce or spread weeds. Additionally, all construction equipment will enter construction areas in a clean condition to limit the potential for the introduction of weeds. Cleaning of equipment prior to moving between worksites within the Project Area will also limit the potential for the spread of weeds. The geographic extent is not expected to extend beyond the Project Area, and is therefore local. The introduction or spread of weeds and non-native species is expected to be medium-term. Capital Power will abide by the Alberta *Weed Control Act and Regulations* (2010), eradicate any prohibited noxious weed species populations, and control any noxious weed species populations identified within the Project footprint. The introduction or spread of weeds can be expected to occur infrequently throughout the life of the Project. The probability of this occurrence is possible. Weeds and non-native species may be introduced or spread, but the implementation of mitigation measures will reduce the likelihood of this occurrence. Overall, the introduction or spread of weeds and non-native species is considered to be of minimal importance.

3.1.6 Determination of Significance

The effect of the Project on the loss or alteration of agricultural-pasture, cultivated land, and modified pasture is considered to be of low importance. Effects will be limited to the Project footprint, of which 98% is currently agricultural/pasture, cultivated land and modified pasture land cover types (Table 3.1-1). Outside of where permanent infrastructure components are located, the effects are reversible, as the temporary disturbances will be seeded, where applicable, and land cover restored following construction. The effect of the Project on the introduction or spread of weeds and/or non-native species is considered to be of minimal importance. The implementation of mitigation measures for the control of prohibited noxious and noxious weeds will assist in the re-establishment of desired plant species in the Project area.

Given the mitigation measures that will be implemented to minimize the introduction or spread of weeds and/or non-native species and given the limited loss or alteration of agricultural/pasture, cultivated land, and modified pasture, land cover types as a result of the Project, the residual effect on land cover is predicted to not result in a change that will alter the sustainability of the land cover beyond a manageable level, and is predicted to be not significant.

3.2 Environmentally Sensitive Areas

3.2.1 Introduction

Environmentally sensitive areas are considered in the Environmental Evaluation because they represent lands that have been assigned a level of environmental protection, or indicate lands that may have a higher level of environmental sensitivity. Activity timing restrictions, restrictions on the location, type or scale of development and the implementation of enhanced mitigation measures may be required within environmentally sensitive areas.

3.2.2 Baseline Data Collection Methods

Various spatial data sets were mapped in GIS and used to determine the location of designated environmentally sensitive areas relative to the Project Area. Spatial data files showing the locations and boundaries of designated environmentally sensitive areas were obtained from Alberta Tourism, Parks and Recreation (ATPR) (ATPR 2011), Fish and Wildlife Internet Mapping Tool (FWIM-T) (ESRD 2014), Important Bird Areas (IBAs) Canada (IBA 2015), National Wildlife Areas (Environment Canada 2012), and Migratory Bird Sanctuaries (Environment Canada 2012).

Information on ESAs associated with the Project Area was obtained from ESRD (2014) and is based on Fish and Wildlife Management Information System (FWMIS), ACIMS and other publicly available data sets, which are used to gather baseline data about areas which may contain unique or rare elements. The updated ESA inventory uses a GIS based multi-criteria decision analysis to organize ESAs into a hierarchy of sub-components, including sub-criteria and indicators, with weighted indicators for each criterion. The ESA framework and associated provincial map generated from this process are intended for land-use planning and do not represent government policy or designate legal land protection (Fiera 2014).

The County of Paintearth also maintains a separate ESA dataset, which contains important and/or unique environmental attributes within The County of Paintearth that are designated as either provincially or regionally significant.

3.2.3 Baseline Conditions

Parks and Protected Areas

There are no provincially or federally designated parks or protected areas within the Project Area. The Paintearth Coulee Natural Area is located approximately 800 m west of the Project Area and the Big Knife Provincial Park is located approximately 7 km northwest of the Project Area (Figure 1.1-1).

Environmentally Significant Areas – Provincial

Approximately 15% of the Project Area is classified as an ESA by AEP (ESRD 2014).

Environmentally Significant Areas – The County of Paintearth

Approximately 16% of the Project Area is designated by the County of Paintearth as an ESA of provincial (12%) or regional (4%) significance. The provincially significant ESA is associated with the Paintearth Creek valley located along the southern border of the Project Area. The regionally significant ESA is associated with the Battle River valley, located along the norther border of the Project Area.

Important Bird Areas

IBAs are discrete sites that support either listed avian species, large groups of birds, or avian species that are restricted by either their population range or habitat requirements (IBA 2015). No IBAs are located within the 10 km of the Project Area.

Key Wildlife and Biodiversity Zones

The Project Area does not overlap with any Key Wildlife and Biodiversity Zones.

Grizzly Bear Zone

The Project Area does not overlap with the Grizzly Bear Zone.

The Special Access Zone

The Project Area does not overlap with the Special Access Zone.

3.2.4 Potential Effects, Mitigation and Predicted Residual Effects

3.2.4.1 Potential Effects

The Project footprint does not encroach on any parks, protected areas, IBAs, Key Wildlife and Biodiversity Zones, Grizzly Bear Zone or the Special Access Zone, and no direct effects on these areas are expected.

Environmentally Significant Areas can contain native habitat, sensitive wildlife species, and large natural areas, which may be affected by the Project during construction, operation and decommissioning. None of the turbines are located within these ESAs; however, some supporting infrastructure (e.g., access roads and underground collector system) are located within these ESAs. Potential effects from the Project on native vegetation are discussed further in Section 3.4 and potential effects from the Project on wildlife and wildlife habitat, including sensitive species, are included in Section 3.8.

The Project also has the potential to affect sensitive areas associated with steep slopes and native vegetation within the County of Paintearth ESAs.

3.2.4.2 Mitigation

Turbines were sited a minimum of 168 m from Paintearth Creek and Battle River coulees, a terrain feature that tends to concentrate migratory bird species (e.g., Kerlinger 1989). Mitigation measures to limit adverse effects on native habitat and sensitive wildlife species are discussed in Section 3.4 and 3.8, respectively.

3.2.4.3 Predicted Residual Effects

Turbine siting is expected to limit adverse effects to steep slopes within the County of Paintearth ESAs and no predicted residual effects are expected. Predicted residual effects related to native vegetation and sensitive wildlife species within the Project Area are discussed in Section 3.4 and 3.8, respectively.

3.3 Soils and Terrain

3.3.1 Introduction

Soils and terrain form the foundation of a healthy terrestrial ecosystem. Vegetation and ultimately wildlife habitat reflect soil and terrain conditions at a particular time. This section will assess potential changes to the soil and terrain's capability to support healthy ecosystems.

The soils and terrain assessment was conducted for the Project Area at a desktop level to identify potential sensitive areas that may be affected by Project disturbance. The assessment was based on activities occurring during the construction phase that represents the largest spatial disturbance. The removal of Project equipment during decommissioning will use similar mitigation strategies as during construction and is expected to have similar or reduced effects. Terrain features assessed include parent material and slope. Soil quality features that were evaluated include: wind and water erosion risk, compaction ratings, and salinity.

3.3.2 Baseline Data Collection Methods

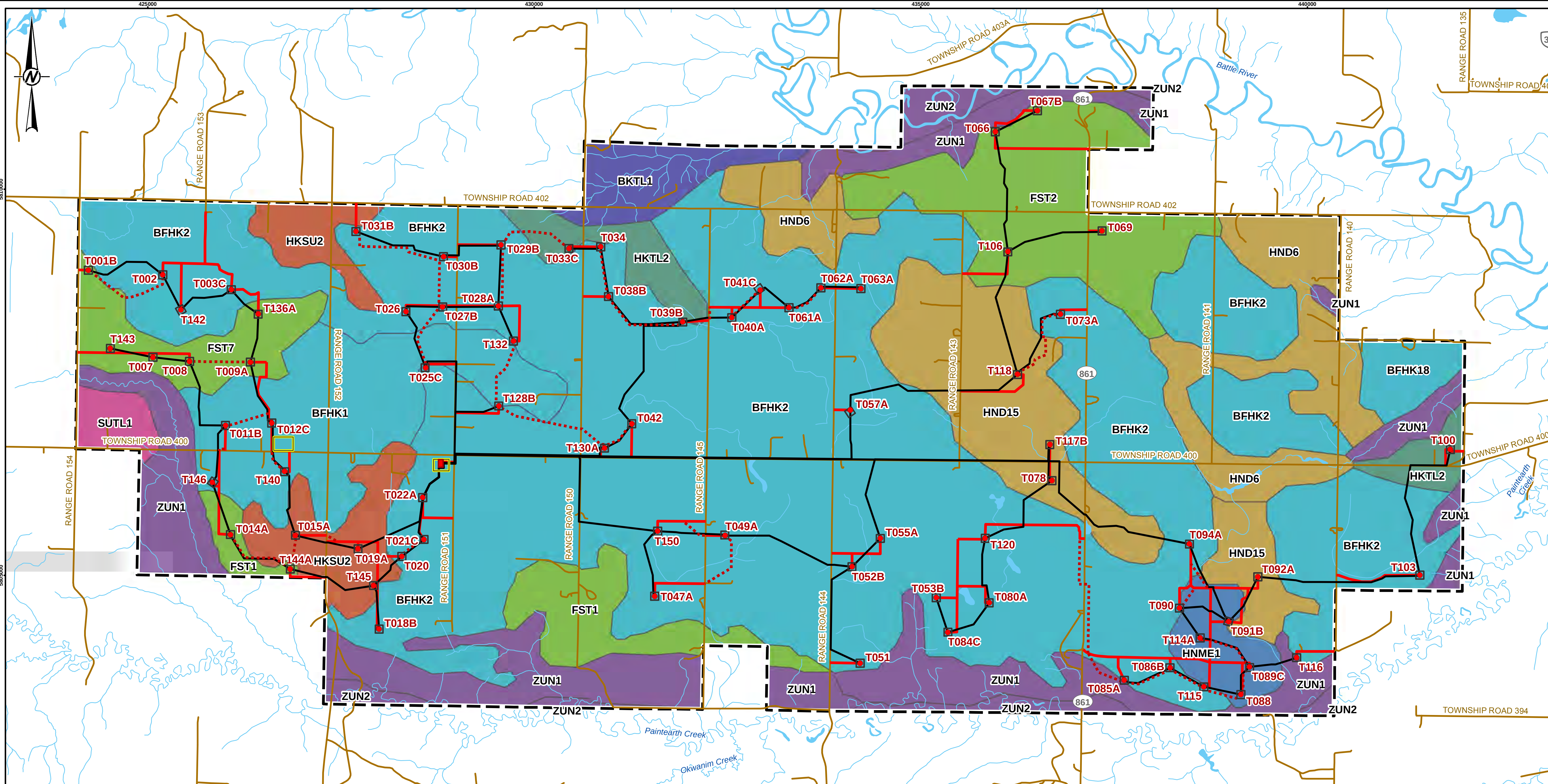
3.3.2.1 Desktop Assessment

Soils and terrain information was gathered from the digital Agricultural Region of Alberta Soil Inventory Database (AGRASID) (Alberta Agriculture and Forestry 2015). Soil profile descriptions and soil characteristics such as modal topsoil depth, horizon textures, soil parent material, salinity and wind and water erosion risk were obtained from Soil Series Information outlined in Reclamation Planning in Alberta (Pedocan 1993). Compaction ratings for soils in the Project footprint were determined using modified criteria from Lewis et al. (1989). Slope information was gathered from both AGRASID 2015 and Pedocan 1993.

3.3.3 Baseline Conditions

The Project Area lies entirely within Soil Correlation Area 4. Soils in Soil Correlation Area 4 are predominantly Dark Brown Chernozemic and Solonetzic, with Regosolic located in steep valleys. Poorly drained Gleysols are found in isolated depressional and water discharge areas (Pedocan 1993). Soil map units and soil series properties in the Project Area are provided in Figure 3.3-1 and Table 3.3-1.

Table 3.3-1 provides the information on the individual soil series in the Project Area. Soil map units in the Project Area are composed of hybrids of individual soil series. The majority of the Project footprint (approximately 67%) is composed of map units with approximately 50/50 proportion of Brownfield and Halkirk soil series (AGRASID 2015). Flagstaff soils make up approximately 12% of the Project footprint, with the remaining 21% of the Project footprint a mix of Hughenden, Metisko, Sullivan Lake and the miscellaneous undifferentiated material (AGRASID 2015). The Sutherland/Torlea soils map unit was found in 04-40-15 W4M, and the Bigknife soil series was found in 7, 17, 18-40-15 W4M, but neither occur within the Project footprint.



LEGEND

PROJECT AREA

PROPOSED PROJECT INFRASTRUCTURE

PERMANENT FOOTPRINT COMPONENTS

- TURBINE
- OPERATIONAL ROAD
- SUBSTATION

TEMPORARY FOOTPRINT COMPONENTS

- TURBINE TEMPORARY WORKSPACE
- CRANE PATH / CONSTRUCTION ROAD
- UNDERGROUND COLLECTOR SYSTEM
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE

- ROAD/HIGHWAY
- WATERCOURSE
- WATERBODY

SOIL MAP UNITS

- BFHK
- BKTL
- FST
- HKSU
- HKTL
- HND
- HNME
- SUTL
- ZUN

0 2 4

1:50,000 KILOMETRES

REFERENCE(S)
1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
2. AGRASID SOIL MAP UNITS OBTAINED FROM ALBERTA AGRICULTURE, FOOD AND RURAL DEVELOPMENT.
DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	KH
PREPARED	SK
REVIEWED	CS
APPROVED	JM

TITLE
SITE LAYOUT AND SOIL MAP UNITS

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	3.3-1

25mm

Table 3.3-1: Dominant Soil Series and Map Units found in the Project Area

Soil Series	Soil Series Symbol	Description	Associated Soil Map Units	Colour Contrast Between Topsoil and Subsoil	Saline or Sodic Soils
Bigknife	BKF	An Orthic Regosol, with a 5-10 cm loamy topsoil, overlying a dark brown clay loam gleyed B horizon. These soils are developed from medium textured fluvial material and are well with temporary ponding conditions at certain times of year.	BKTL1	not obvious	yes
Brownfield	BFD	A Dark Brown Solod, with typically 10-15 cm of very dark grayish brown loam topsoil (Ap) horizon overlying a clay loam textured Bnt horizon. These soils have developed from moderately fine till material and are poorly drained with temporary ponding.	BFHK1 BFHK2	not obvious	yes
Flagstaff	FST	A solonetzic dark brown chernozem with a 5-15 cm loam topsoil (Ap) over clay loam B horizon. Developed on moderately fine till, and are moderately well drained.	FST1 FST2 FST7	not obvious	yes
Halkirk	HKR	A dark brown solodized solonetz with loamy 10-20 cm topsoil (Ap) horizons over clay loam B horizons. Developed on moderately fine till, these soils are poorly drained with temporary ponding.	HKTL2	not obvious	yes
Hughenden	HND	An Orthic Dark Brown Chernozem, with typically 10 to 20 cm of very dark grayish brown loam textured topsoil (Ap horizon) overlying a loam textured Bm horizon. These soils are found on moderately fine till material, and are well drained.	HND15	not obvious	no
Metisko	MET	An Orthic Dark Brown Chernozem, with typically 10 to 20 cm of very dark grayish brown sandy loam textured topsoil (Ap horizon) overlying a sandy loam textured Bm horizon. These soils are found on moderately coarse glaciofluvial material, and are rapidly drained.	HNME1	obvious	no
Miscellaneous Undifferentiated Material	ZUN	These soils are typically undeveloped regosolic soils associated with steep slopes, and have variable textures.	ZUN1	undefined	no
Sullivan Lake	SUL	A dark brown solodized solonetz developed on loam to sandy-loam A horizons (Ap over Ae) between 15-25 cm thick over loam to sandy-loam B horizons. These soils are found on moderately coarse glaciofluvial over till parent materials and are well drained to approximately 1 m.	HKSU2 SUTL1	obvious	yes

3.3.3.1 Terrain

Parent Material and Slopes

The dominant parent material in the Project Area is a moderately fine textured till on 'very gentle' (1-5%) 'gentle', (5% to 9%) and 'moderate' (9% to 15%) slopes. Terrain is typically undulating to hummocky with 'very strong' (30% to 45%) slopes associated with valleys. The moderately fine till parent material occurs in conjunction with water laid coarse textured glaciofluvial parent materials in the Sullivan Lake soil series. The soils within the majority of the Project footprint are slightly stony with some stones present that could hinder cultivation slightly (AGRASID 2013). A summary of terrain and slope information for each soil series is outlined in Table 3.3-2.

Table 3.3-2: Terrain and Slope Information for Soil Series found in the Project Footprint

Soil Series	Terrain (Landscape Model)	Parent Material	Typical Slopes (%)
Brownfield	U1h – Undulating (low relief) H1l - Hummocky (low relief)	Till	1-5
Flagstaff	U1h – Undulating (low relief) H1l - Hummocky (low relief)	Till	2-15
Halkirk	U1h – Undulating (low relief)	Till	2-9
Hughenden	U1h – Undulating (low relief) H1m – Hummocky (moderate relief)	Till	2-30
Metisko	H1l - Hummocky (low relief)	Till	2-15
Miscellaneous Undifferentiated Material	I3h – Inclined to steep (high relief) I4h - Inclined with bedrock (high relief)	Undifferentiated	30-45
Sullivan Lake	U1h – Undulating (low relief)	Glaciofluvial	1-5

3.3.3.2 Soil Quality

Wind and Water Erosion

Wind and water erosion risk primarily applies to disturbed or exposed soils because vegetated soils are at a much lower risk to erosion. The wind erosion risk ratings were adapted from "Wind Erosion Risk" (Coote and Pettapiece 1989), and the water erosion risk ratings were adapted from "Water Erosion Risk" (Pedocan 1993; Tejak and Coote 1993) and are dependent on slope information obtained from the landscape models.

The potential for soil erosion by water is affected by soil texture, organic matter content, water content, permeability, topography, slope gradient, and vegetation cover. In areas where slope gradient and slope length increases, so does the potential for soil erosion regardless of soil texture. Therefore, water erosion risk for exposed soil was calculated for each mapped soil series and associated landscape model unit. The wind and water erosion risks for each soil series are presented in Table 3.3-3.

Table 3.3-3: Wind and Water Erosion Risk of Soil Series within the Project Footprint

Soil Series	Wind Erosion Risk	Water Erosion Risk Rating per Landscape Model Unit
Brownfield	Medium	Undulating (low relief) - Moderate Hummocky (low relief) - High
Flagstaff	Medium	Undulating (low relief) - Moderate Hummocky (low relief) - High
Halkirk	Medium	Undulating (low relief) - Moderate
Hughenden	Low	Undulating (low relief) - Moderate Hummocky (moderate relief) - High
Metisko	High	Hummocky (low relief) - Moderate
Miscellaneous Undifferentiated Material	Medium	Inclined to steep (high relief) - High Inclined with bedrock (high relief) - High
Sullivan Lake	High	Undulating (low relief) - Moderate

Source: Coote and Pettapiece 1989; Pedocan 1993.

Soil series found within the Project footprint are rated as having low to high wind erosion risk and moderate risk for water erosion on undulating terrain, moderate to high water erosion risk on inclined terrain and high erosion risk for inclined terrain.

The wind and water erosion risk ratings for the Project footprint are presented in Table 3.3-4 and Table 3.3-5, respectively. Approximately 9% of the Project footprint is located on soils with high wind erosion risk, and approximately 31% of the Project footprint is located on soils that have a high water erosion risk rating.

Table 3.3-4: Wind Erosion Risk of Soils within the Project Footprint Area

Wind Erosion Risk Rating	Permanent Operational Roads[a]		Collector System		Temporary Crane Paths and Construction Roads		Turbines		Substation Temporary Workspace and Laydown Yard	
	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)
Low	5.9	5	7.2	11	1.0	3	3.6	6	0	0
Medium	84.6	79	54.1	80	26.0	87	53.3	85	6.9	100
High	16.7	16	6.3	9	2.9	10	6.0	9	0	0
Total	107.1	100	67.6	100	30.0	100	62.8	100	6.9	100

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values.

[a] Includes the 25 m temporary construction area for permanent operational roads

Table 3.3-5: Water Erosion Risk of Soils within the Project Footprint

Water Erosion Risk Rating	Permanent Operational Roads[a]		Collector System		Temporary Crane Paths and Construction Roads		Turbines		Substation Temporary Workspace and Laydown Yard	
	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)
Low	0	0	0	0	0	0	0	0	0	0
Moderate	78.0	73	55.7	82	23.4	78	48.4	77	2.5	36
High	29.1	27	11.9	18	6.5	22	14.4	23	4.4	64
Total	107.1	100	67.6	100	30.0	100	62.8	100	6.9	100

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values.
[a] Includes the 25 m temporary construction area for permanent operational roads

Compaction

Compaction ratings for soils in the Project footprint were determined using the criteria outlined in Table 3.3-6, under moist conditions. Compaction ratings for soil series are outlined in Table 3.3-7 and compaction ratings for the various Project components are outlined in Table 3.3-8. Generally, coarse textured soils (e.g., sandy loam, loamy sand) have low compaction risk, and moderately fine to fine textured soils have moderate to high compaction risk depending on soil moisture conditions. Approximately 85% of the Project footprint is located on land with a high sensitivity to soil compaction.

Table 3.3-6: Criteria for Determining Compaction Ratings of Soils

Soil Texture[a]	Compaction Rating[b]		
	Dry	Moist	Wet
Sandy (S, LS)	Low	Low	Moderate
Loamy (SL, L)	Low	Moderate	High
Silty (Si, SiL)	Moderate	High	Very High
Clayey (SC, SiCL, SCL, CL, SiC, C)	High	Very High	Very High

Source: Modified from Lewis et al. (1989).
[a] S = sand; LS = loamy sand; SL = sandy loam; L = loam; Si = silt; SiL = silty loam; SC = sandy clay; SiCL = silty clay loam; SCL = sandy clay loam; CL = clay loam; SiC = silty clay; C = clay
[b] Based on a coarse fragment content of less than 35% (if coarse fragment content is between 35% and 70% loamy and silty are grouped together and compaction rating is moderate, and clayey is high)

Table 3.3-7: Compaction Risk of Soils within the Project Footprint

Soil Series	Sensitivity to Soil Compaction and Rutting
Brownfield	high
Flagstaff	high
Halkirk	high
Hughenden	moderate
Metisko	low
Miscellaneous Undifferentiated Material	low
Sullivan Lake	moderate

Table 3.3-8: Sensitivity to Soil Compaction Areas within the Project Footprint

Soil Compaction Rating	Permanent Operational Roads [a]		Collector System		Temporary Crane Paths and Construction Roads		Turbines		Substation Temporary Workspace and Laydown Yard	
	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)	Area (ha)	Percent of Total Disturbance (%)
Low	11.5	11	3.35	5	2.4	8	4.3	7	0	0
Moderate	12.2	11	10.3	15	2.2	7	6.1	10	0	0
High	83.0	78	53.9	80	25.3	85	52.5	83	6.9	100
Very High	0	0	0	0	0	0	0	0	0	0
Total	107.1	100	67.6	100	30.0	100	62.8	100	6.9	100

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values.
[a] Includes the 25 m temporary construction area for permanent operational roads

Salinity/Sodicity

Typically, the soluble salts responsible for salinization include calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), magnesium sulphate ($MgSO_4$), sodium chloride (NaCl), and sodium sulphate (Na_2SO_4). Excluding species that are tolerant to these growing conditions, salt accumulation in soils can result in reduced plant growth, poor germination of plant seeds, and plant death (Richards 1954; Henry et al. 1992). Reductions in crop growth of sensitive agricultural crops (e.g., peas) can occur at electrical conductivity levels of 4 to 8 deciSiemens per metre (dS/m) and in tolerant crops (e.g., canola, wheat, barley) at 8 dS/m (Henry et al. 1992).

Sodic soils are often variable throughout the landscape and have highly variable chemical (e.g., sodium adsorption ratio, sodium content) and physical (e.g., A horizon thickness) properties (Miller and Brierley 2010). High levels of sodium and low electrical conductivity can result in clay dispersion and poor soil structure. Further, calcium deficiencies associated with high sodium content can restrict crop growth. Mixing of sodic subsoil with topsoil can result in surface water ponding (from poor infiltration) and poor seedling emergence (Miller and Brierley 2 p010; Sparks 2003).

Approximately 86% of the Project footprint is located on soils with salinity or sodicity characteristics that include the Brownfield, Flagstaff, Halkirk and Sullivan lake soil series (Table 3.3-1).

3.3.4 Potential Effects, Mitigation and Predicted Residual Effects

3.3.4.1 Potential Effects

This section describes the potential effects on soils and terrain associated with construction of the Project.

Terrain

Overall, terrain within the Project footprint is largely undulating or hummocky, which does not typically result in restrictions for construction. Where steep slopes occur, within valleys in the Miscellaneous soil series, construction will likely not be practical. While changes to existing slopes and natural drainage conditions through construction (grading) and operation have the potential to affect terrain stability, especially on slopes, it is not anticipated that Project activities will cause terrain stability issues.

Soils

Surface disturbances associated with the Project that may affect soils include earthmoving and vehicle/equipment operation on the access roads, turbine locations, underground collector lines, and temporary workspaces. Construction, operation and maintenance of the Project, if not properly mitigated, could result in the following effects on soils:

- **Soil Erosion:** The physical loss of topsoil lowers the capability of the land to support plant growth by decreasing the amount of available nutrients and organic matter in the root zone. The severity of this potential effect is directly related to the proportion of soil lost. The problem is more severe when topsoils are thin (<15 cm) or coarse textured. Soil loss from wind erosion may occur if soil handling, from either stripping or replacement, occurs during dry, windy conditions. Soil loss from water erosion is more likely to occur on exposed soil, along slopes and in wet areas within the Project footprint.
- **Compaction/loss of soil structure:** The capability of soil to support plant growth required for reclamation can be reduced if the soil is compacted. Compaction affects soil capability by restricting root penetration and elongation, and restricting air and water movement. In addition, there could be loss of soil structure that could adversely affect water infiltration and aeration, seedling emergence and root growth. Compaction and loss of soil structure will be greatest if soil handling and equipment movement occurs during wet soil conditions and/or repeated handling.
- **Salinity/Sodicity and Soil admixing:** During construction, salvage of the topsoil separately from the subsoil is important because organic matter and macro- and micro-organisms are less diluted in the topsoil, which maintains growth support capability, and can potentially serve as a seed source for re-vegetation on non-cultivated lands. Admixing of soils (e.g., calcareous, saline and/or sodic soils) can affect the capability of the soil to support vegetation. The potential for soil admixing may be higher if clear distinctions between topsoil and subsoil (Table 3.3-1) in soil profiles is not apparent (i.e., poor colour contrast between topsoil and upper subsoil).

3.3.4.2 Mitigation

This section describes the proposed mitigation that will be applied to limit the potential for adverse environmental effects on soils and terrain.

Terrain

In areas of steep slopes within the Project footprint (within the Miscellaneous Undifferentiated Material map units), geotechnical investigations will be conducted prior to construction, as appropriate. The following measures are planned to mitigate the potential for terrain failure at steep slopes, following geotechnical evaluations:

- selection of appropriate structure (i.e., turbine) locations;
- establishing good surface and subsurface run-off control (drainage ditches and culverts); and
- re-establishing vegetation.

Soil

For the purposes of this assessment, it is assumed that all crane paths will be used as temporary construction roads and that the installation of the underground collector system will be done via trenching. Topsoil and upper subsoil stripping will take place for both of these activities. In the event that the crane paths are not used as temporary construction roads (i.e., used only for a single pass of the crane) and/or the underground collector system is installed by direct plow-in, soil stripping will not be conducted for these Project components. Based on the soil series located within the Project footprint, which have topsoil depths ranging from 5 cm to 25 cm, and the area to be disturbed by the Project components, the estimated topsoil volumes to be stripped may range from approximately 186,720 m^3 to 350,070 m^3 (Table 3.3-9).

Table 3.3-9: Estimated Topsoil Stripping Volumes for the Project Footprint

Soil Series	Topsoil Thickness Range (m)	Area (m^2)	Minimum Topsoil Volume to be Stripped (m^3)	Maximum Topsoil Volume to be Stripped (m^3)
Brownfield	0.05 – 0.10	1,824,400	91,220	182,440
Flagstaff	0.10 – 0.15	335,600	33,560	50,340
Halkirk	0.10 – 0.20	59,100	5,910	11,820
Hughenden	0.10 – 0.20	176,700	17,670	35,340
Metisko	0.10 – 0.20	185,900	18,590	37,180
Miscellaneous Undifferentiated Material	N/A	N/A	N/A	N/A
Sullivan Lake	0.15 – 0.25	131,800	19,770	32,950
		Total	**186,720**	**350,070**

Erosion

The amount of soil stripping in areas of sensitive soils will be limited to the extent possible. Limiting the area of disturbance and the time between salvage, storage and reclamation is expected to reduce the potential for loss of salvaged topsoil resulting from wind erosion. Soil handling activities will not occur in coarse textured soils (e.g., sand and loamy sand) and moderately coarse textured soils (e.g., sandy loam) during windy conditions. Tackifers or seeding the stockpiles may be used to stabilize soil stockpiles, if necessary. After soil replacement, tackifiers, shredded straw or other mulches may be spread over coarse or moderately coarse soils to reduce loss of topsoil, prior to re-vegetation. Soil stabilization by re-vegetation will be achieved within the Project footprint by seeding disturbed areas with seed mixes selected in consultation with the landowner, as appropriate.

Earthwork-related construction activities will be either shut down during wet weather or conducted after appropriate mitigation measures are applied. Such mitigation measures may include limiting equipment travel, restricting activities to areas where topsoil has been removed (i.e., the travel lane and those temporary workspaces that have been stripped) and using equipment with low ground pressure tires or wide-pad tracks to reduce rutting. In the absence of effective mitigation procedures, construction will be suspended. Effective mitigation procedures can be determined in consultation with an environmental field monitor, and on-site contractor or coordinator/supervisor, if one of the following occurs:

- excessive rutting;
- spinning tires;
- build-up of mud on equipment;
- formation of standing water in the work areas; or
- tracking mud down access roads as vehicles leave the development area.

In addition, erosion or sediment control measures such as silt fences will be placed along Project components where required. Follow-up inspections of the workspaces and communication with landowners will occur so that potential erosion issues are addressed in a proactive manner.

Compaction/Loss of Soil Structure

Heavy equipment activities and soil handling will be restricted on fine (i.e., clay, sandy clay) and moderately fine-textured (i.e., clay loam, sandy clay loam) soils during wet conditions. Heavy equipment and vehicles will operate on these soils during dry or frozen ground conditions, and on previously disturbed areas, wherever possible. Construction will also be carried out using equipment with low ground pressure tires or wide-pad tracks, wherever possible. Rig matting or geotextile material may be used in areas identified as sensitive to compaction/loss of soil structure. Addition of organic matter may be used to ameliorate the soil structure on replaced soils, particularly on coarse textured soils where structure may have been altered by soil handling.

Salinity/Sodicity and Soil Admixing

Potential for admixing can occur whenever surface soils are disturbed. The amount of soil stripping in areas of sensitive soils will be limited to the extent possible. In areas where soil will be salvaged, the topsoil (A horizons) will be stripped and stored separately from subsoil (B or C horizons) to limit the potential for admixing.

3.3.4.3 Predicted Residual Effects

The predicted residual Project effects on soils and terrain are:

- Loss or alteration soil capability and terrain to support healthy ecosystems.

3.3.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on soils and terrain and the importance of the predicted residual effects are provided in Table 3.3-10. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.3-10: Predicted Residual Project Effects Description and Importance for Soils and Terrain

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Loss or alteration of soil capability and terrain to support healthy ecosystems	Construction and decommissioning	Negative	Low	Local	Medium-term	Likely	Low

Loss or alteration of soil capability and terrain to support healthy ecosystems

Development of the Project is expected to change soil quantity and distribution. These changes can affect other VCs such as vegetation and wildlife. Site clearing and the movement of soil from the landscape is required to develop the Project. Site clearing and construction of the Project, particularly through the process of soil stripping and excavation, are expected to result in changes to soil quantity and distribution and will be negative in direction. The loss or alteration of soil capability and terrain is expected to be of low magnitude, provided the appropriate mitigations are implemented during construction and decommissioning. The geographic extent is not expected to extend beyond the Project footprint, and is therefore local. The loss or alteration of soil capability and terrain is expected to be medium-term; following the construction of permanent facilities, areas not containing permanent facilities or operational access roads will be reclaimed. The probability of this occurrence is likely, but is considered common for similar projects. Overall the loss or alteration of soil capability and terrain is considered to be of low importance.

3.3.6 Determination of Significance

The effect of the Project on the loss or alteration of soil capability and terrain is considered to be of low importance. Outside of where permanent infrastructure components are located, the effects are reversible, as the temporary disturbances will be reclaimed following construction. Given the mitigation that will be implemented to minimize the loss or alteration of soil capability and terrain as a result of the Project, the residual effect on soils is predicted to not result in a change that will alter the sustainability of the soil beyond a manageable level, and is predicted to be not significant.

3.4 Vegetation

3.4.1 Introduction

Much of the native vegetation in the Project Area has been modified or removed by agricultural activity during the last 100 years. Native vegetation, particularly native prairie, is regarded by AEP as a resource to be managed and protected, due to its reduced extent across central and southern Alberta. This vegetation assessment was conducted to determine the location and amount of native vegetation in the Project Area.

Provincial and federal agencies maintain lists of plant species and ecological communities of conservation concern. In Alberta, the Alberta Conservation Information Management System (ACIMS) maintains an on-line database for sensitive vegetation species (AEP 2016b) and ecological communities (Allen 2010). Species on the tracking list are of high priority because they are listed or of conservation concern in some other way (Kemper 2009). Although species on the watch list are not of immediate conservation concern, ACIMS endeavours to gather more information about the abundance and distribution of these species throughout the province.

Similarly, COSEWIC assesses and designates plants and fungi (and animals) that are in danger of disappearing from Canada (COSEWIC 2015). There are seven COSEWIC status categories: Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk, and Data Deficient. Species can also be designated by COSEWIC as Candidate Wildlife Species, which are species that have not yet been assessed by COSEWIC, but are suspected of being at some risk of extinction or extirpation. The federal government periodically reviews the COSEWIC list to determine if a listed species should be protected by law. The *Species at Risk Act* (SARA) establishes Schedule 1 as the official List of Wildlife (including plants and fungi) Species at Risk (Government of Canada 2015). As such, listed plant and ecological community surveys were conducted to identify the location of listed plant species and ecological communities in the Project Area.

The spread of invasive weed species across the landscape is a concern for landowners, agricultural producers and managers of natural areas. By knowing the locations of weed species in the Project Area, mitigation strategies can be focused to reduce the introduction or spread of weeds.

3.4.2 Baseline Data Collection Methods

3.4.2.1 Desktop Assessment

The ACIMS database lists 41 tracked and watched plant species and 21 ecological communities in the Central Parkland Subregion (ACIMS 2015a). A desktop assessment was conducted to determine the occurrence and potential occurrence of listed plant species and communities in the Project Area, and to identify potential mitigation and reclamation strategies to protect natural habitat in the Project Area. A complete list of ACIMS (2015a) tracked and watched plant species and ecological communities in the Central Parkland Natural Subregion are presented in Appendix B.

Listed Plant Species and Communities

Data on previously identified occurrences of provincially listed vascular and non-vascular plant species and communities in the vicinity of the Project were downloaded from the ACIMS database on May 24, 2016 and again on July 28, 2016 (ACIMS 2015b), with no significant changes identified between downloads. The ACIMS (2015a) list of all tracked and watch listed vascular and non-vascular plant species and communities previously documented in the Central Parkland Natural Subregion was also downloaded for use by the field crews during the vegetation survey (Appendix B). The Alberta conservation status rank definitions (ACIMS 2016) used to rank the listed plant species and ecological communities are presented in Appendix C.

Listed Weed Species

Plant species listed as noxious or prohibited noxious were obtained from the *Weed Control Act* (GOA 2012).

3.4.2.2 Field Assessment

Field surveys were conducted to characterize vegetation communities within the Project Area and to determine the occurrence and potential occurrence of listed plant species and ecological communities. The Alberta Native Plant Council (ANPC) rare plant survey guidelines require listed plant surveys to be conducted during the time of the growing season when potentially occurring listed species are most likely to be identifiable (ANPC 2012). Therefore, surveys were scheduled to capture seasonal and ephemeral habitats, early in the growing season from May 25 to June 2, 2016 and late in the growing season on August 11 and 12, 2016.

Minimum requirements for a listed plant survey dictate that the Project Area be surveyed with reasonable geographic coverage of each representative plant community. Modified pasture, cultivated land, native prairie and wooded lands were surveyed with GPS units and using the random meander search pattern (ANPC 2012). This search pattern was used to cover all habitat variations and microsites within the Project Area.

If a plant species or plant community listed by Kemper (2009) or Allen (2010) was identified at a survey site, the following information was collected:

- a UTM waypoint at the specific site of the listed species or community occurrence;
- one or more digital photographs of the occurrence;
- the approximate area covered by the listed species;
- a count or estimate of the number of individuals of the listed species;
- the current vegetative and/or reproductive state of the listed species; and
- notes on micro-habitat of the listed species occurrence.

Plants that were not immediately identifiable at a survey site were subsequently identified using reference books including the Flora of Alberta (Moss 1983).

Listed Weed Species Survey

A search for weed species listed by the Alberta *Weed Control Act and Regulation* (GOA 2010) was conducted with the listed plant species and listed community survey. The search for weed species was conducted in both areas of native vegetation and within disturbed areas. When a weed species was encountered the following data were collected:

- species identification;
- one or more UTM waypoints;
- one or more digital photographs;
- the approximate area covered by the weed species; and
- a count or estimate of the number of individuals of the species.

3.4.3 Baseline Conditions

3.4.3.1 Vegetation Communities

Vegetation communities found within the Project Area during the desktop and field assessments are presented in Table 3.4-1. Nine land cover classes are presented on Figures A1 to A15 in Appendix A and in Table 3.4-1. Areas that could not be field verified as cultivated land or modified pasture due to lack of land access permission or time constraints are classified as the more general agricultural/pasture land cover type.

The Project Area is dominated by cultivated land, modified pasture and agricultural/pasture land cover types (Table 3.4-1 and Figures A1 to A15 in Appendix A). Common species identified on cultivated lands within the Project Area included wheat (*Triticum spp.*), barley (*Hordeum spp.*), canola (*Brassica spp.)* and pea (*Psium sativa*). Non-native weed species commonly found in agricultural areas and other disturbed areas include black bindweed (*Polygonum convolulus*), Canada (creeping) thistle (*Cirsium arvense*), perennial sow thistle (*Sonchus arvensis*), and stinkweed (*Thlaspi arvense*).

Modified pasture has generally been planted with agronomic species that are highly palatable to livestock and able to withstand grazing. Common modified pasture vegetation species in the Project Area include fringed brome (*Bromus ciliolatus*) and crested wheatgrass (*Agropyron cristatum*). Signs of livestock use, such as cropped vegetation, soil compaction, flattened vegetation where animals were resting, livestock excrement, and/or livestock in field were observed. This land cover type is often left idle during early summer and mowed in mid to late summer to be used as winter feed for livestock. Overall, low species diversity exists in modified pasture, with few to no native species present.

Table 3.4-1: Land Cover Type within the Project Area

Land Cover Type	Desktop		Field Verified		Total	
	Area (ha)	Percent of Project Area (%)	Area (ha)	Percent of Project Area (%)	Area (ha)	Percent of Project Area (%)
Native Vegetation						
Native Prairie	1,179.9	23	189.5	3	1369.4	12
Wooded	97.9	2	48.8	1	146.7	1
Subtotal native vegetation	*1,277.8*	*25*	*238.3*	*4*	*1,516.1*	*14*
Wetlands						
Wetland Permanence Class I-II	116.9	2	15.4	<1	132.3	1
Wetland Permanence Class III-V	577.1	11	170.2	3	747.3	7
subtotal wetlands	*694.0*	*14*	*185.6*	*3*	*879.6*	*8*
Modified Vegetation						
Agricultural/Pasture	2,972.1	59	0.0	0	2,972.1	27
Cultivated Land	0.0	0	3814.8	62	3,814.8	34
Modified Pasture	0.0	0	1835.2	30	1,835.2	16
subtotal modified vegetation	*2,972.1*	*59*	*5,650.0*	*92*	*8,622.1*	*77*
Miscellaneous						
Developed	34.4	1	3.8	<0.1	38.2	<1
Farm Yard / Rural Residential	86.5	2	30.6	1	117.1	1
subtotal miscellaneous	*120.9*	*2*	*34.4*	*1*	*155.3*	*1*
Total	**5,064.8**	**100**	**6,108.3**	**100**	**11,173.1**	**100**

Note: Some numbers are rounded for presentation purposes; totals may not equal the sum of the individual values.

Native prairie can be native grassland or native pasture. Differences between idled native grassland and pasture result from the periodic or continuous presence of livestock, which alters the structure and composition of vegetation to varying degrees, depending on the intensity of grazing. This alteration of structure and composition in turn influences wildlife use. While heavy grazing is easily identifiable, it is not always easy to distinguish between light grazing and a naturally patchy landscape that can develop, for example, in areas of low moisture or nutrients (e.g., slopes). If the presence of livestock is uncertain, it is acceptable to identify the land cover as “native prairie”.

Native prairie patches are mainly distributed in the southern, northern and western portion of the Project Area with a total of 1,369.4 ha (12% of Project Area) (Table 3.4-1). Native prairie is dominated by native shrub, grass and a diversity of forb species. Dominant native shrubs are western snow berry (*Symphorocarpos occidentalis*), Saskatoon (*Amelancher alnifolia*), silverberry (*Eleagnus commutata*), and prickly rose (*Rosa acicularis*). Dominant grass species include blue grama (*Bouteloua gracilis*), western wheatgrass, rough fescue (*Festuca campestris* and *Festuca hallii*), Kentucky bluegrass (*Poa pratensis*), and June grass (*Koeleria macrantha*). The most common forb species include common yarrow (*Achillea millefolium*), Goat’s beard (*Tragopogon dubius*), golden bean (*Thermopsis rhombifolia*), lesser spikemoss (*Selaginella densa*), pasture sagebrush (*Artemisia frigida*), purple milkvetch (*Astragalus agrestis*), small-leaved everlasting (*Antennaria parvifolia*), prairie smoke (*Geum triflorum*), wild vetch (*Vicia americana*), and wild strawberry (*Fragaria virginiana*).

Remnant native wooded patches are scattered throughout the Project Area covering 146.7 ha (1% of Project Area) (Figures A1 to A15 in Appendix A) and consist of balsam poplar (*Populus balsamifera*) and trembling aspen (*Populus tremuloides*).

Plant species associated with the wetlands in the Project Area included common cattail (*Typha latifolia*), common dandelion (*Taraxacum officinale*), dock species (*Rumex* spp.), fowl bluegrass (*Poa palustris*), fringed brome (*Bromus ciliatus*), Kentucky bluegrass (*Poa pratensis*), reed canary grass (*Phalaris arundinacea*), sedge species (*Carex* spp.) and slough grass (*Beckmannia syzigachne*). Canada (creeping) thistle, which is a noxious weed in Alberta, was often observed in the transition zone between wetland vegetation and adjacent, upland vegetation (often cultivated or tame/modified pasture or hay). Additional information on wetlands is provided in Section 3.7 of this document.

3.4.3.2 Listed Plant Species and Plant Communities

During the desktop assessment, clammy hedge-hyssop (*Glatiola negleta*) (S3G5) was identified by ACIMS (2015b) as previously occurring in the Project Area; however, it was not found during 2016 field surveys.

The Project Area has a low-suitability for listed plant species due to the extent of lands either altered (77% of Project Area), including agricultural/pasture, cultivated land, or modified pasture land cover types, farm yard/ rural residential (1% of Project Area) or developed (<1% of Project Area). However, lands associated with wetlands and native prairie were identified as having a potential for listed plant species and these areas were investigated during the 2016 surveys. No plant species or ecological communities listed provincially by ACIMS (2015a), the Alberta *Wildlife Act* (2014), federally by COSEWIC (2012) or *SARA* (2016) were identified during the wetland and listed plant field surveys or incidentally during other field surveys.

3.4.3.3 Weed Species

Two noxious weeds, Canada (creeping) thistle and perennial sow thistle were observed throughout the Project Area within the vegetation communities described in Section (3.4.3.1).

3.4.4 Potential Effects, Mitigation and Predicted Residual Effects

3.4.4.1 Potential Effects

The Project has the potential to remove or alter native vegetation, including listed plant species or plant communities. The Project has the potential to adversely affect less than 0.1 ha (<0.01% of Project Area) of native prairie within the temporary construction area associated with the construction of the access roads. However, these adverse effects will be temporary and no permanent infrastructure will be located within native prairie. The Project will also adversely affect 1.1 ha (<0.01% of Project Area) of wooded land during construction and 0.4 ha during operation (e.g., permanent impacts) (Table 3.1-2). The Project also has the potential to introduce or spread weed species listed as noxious or prohibited noxious by the *Weed Control Act* (GOA 2010). Project effects to non-native vegetation are discussed in Section 3.1, while Project effects to wetlands are discussed in Section 3.7.

3.4.4.2 Mitigation

Avoidance of sensitive native vegetation, including native prairie and wooded land is the primary mitigation employed for the Project and was an important factor in the initial constraints analysis used for the siting of turbines and ancillary infrastructure. Less than 1% of the Project footprint is located within native prairie and wooded land habitat (Table 3.4-1). All construction equipment will enter the Project footprint in a clean condition to limit the potential for introduction of weeds. To limit potential effects on native prairie and other sensitive land cover types, the following guidelines will be applied to development activities in areas of native vegetation (i.e., native prairie and wooded land):

- upon finalization of the Project design, a targeted listed plant and ecological survey will be conducted where the Project footprint occurs in native prairie or wooded land;
- the width of access roads and the size of workspaces will be limited to what is required to safely execute the Project;
- where possible, existing access trails and roads will be used;
- sod, topsoil and subsoil will be conserved *in situ* where stripping is not required;
- all construction equipment will be washed/steam cleaned outside the site prior to arrival to minimize risk of introducing invasive weed species; and
- the amount of topsoil stripping and grading will be limited through the use of matting, geo-textiles and/or working during frozen or dry ground conditions.

Grading will be restricted to what is required for the access and safe operation of equipment and vehicles. All vehicle traffic and equipment will be required to remain within the Project footprint.

For immediate/short-term disturbances (e.g., collector system routing) in wooded land, alternative methods such as sod salvage and replacement may be attempted; however, for longer duration disturbances (i.e., access routes) the viability of the sod may limit its application.

Following Project construction, areas not containing permanent facilities or operational access roads will be re-vegetated as soon as reasonably possible to limit the potential establishment of weeds on disturbed ground. Only certified weed-free seed mixes will be used, selected in consultation with the landowner. The Project Area will be regularly monitored for weeds infestations during operation, and plant species defined as prohibited noxious or noxious (Province of Alberta 2010) will be eliminated or controlled. Controlled techniques will reflect site conditions and the nature of infestation, and could include a combination of hand pulling, mowing and spot spraying.

3.4.4.3 Predicted Residual Effects

The predicted residual Project effects on vegetation are:

- the loss or alteration of native prairie and wooded land, including listed plant species and ecological communities; and
- the introduction or spread of weeds and/or non-native species.

Predicted residual effects to non-native vegetation are discussed in Section 3.1 while predicted residual effects to wetlands are discussed in Section 3.7.

3.4.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on vegetation and the importance of the predicted residual effects are provided in Table 3.4-2. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.4-2: Predicted Residual Project Effects Description and Importance for Vegetation

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Loss or alteration of native prairie and w ooded land	Construction	Negative	Low	Local	Short to Medium term	Likely	Low
Reclamation of w ooded land	Decommissioning	Positive	Low	Local	Short-term	Likely	Low
Introduction or spread of w eeds and/or non-native species	Construction, operation and decommissioning	Negative	Low	Local	Medium-term	Possible	Minimal

Loss or alteration of native vegetation

Loss or alteration of native prairie and wooded land will be negative in direction and low in magnitude, because there will be a net loss of native vegetation where access roads and the underground collector system will be constructed (Section 3.1, Table 3.1-2). The effects are not expected to extend beyond the Project Area, so geographic extent is local. The loss or alteration of native prairie is expected to be short-term as only temporary construction access will be required through native prairie (<0.1 ha) and the disturbed area will be fully reclaimed following construction. The loss or alteration of wooded land is expected to be medium-term. Access roads within wooded land will require 1.0 ha during construction and 0.4 ha during operation. Underground collector systems will require 0.1 ha of temporary disturbance through wooded land. Following construction, areas not occupied by permanent facilities will be reclaimed to equivalent land cover capability; however, for wooded land a temporal lag for the re-establishment of woody vegetation will occur. The effect to wooded land is expected to occur continually during the life of the Project; therefore, the frequency is continuous. The probability of this occurrence is likely, but is considered common for similar projects. Overall, the loss or alteration of native prairie and wooded land is considered to be of low importance.

Reclamation of wooded land

During decommissioning, Project infrastructure will be removed and the land will be returned to equivalent land cover capability in accordance with landowner expectations and regulatory requirements, as appropriate. In areas previously occupied by wooded land it is expected that reclamation will focus on establishing similar native, wooded land, if requested by the landowner. This will result in a positive effect of low magnitude as land previously occupied by Project infrastructure is returned to a more natural state. The effects are not expected to extend beyond the Project Area, so the geographic extent is local. The activity will take place during decommissioning and is therefore considered short-term. The probability of this occurrence is likely. Overall the reclamation of wooded land is considered to be low importance.

Introduction or spread of weeds and/or non-native species

The introduction or spread of weeds and non-native species will be negative in direction and low in magnitude, because mitigation measures will limit vehicle traffic and equipment to the Project footprint. Additionally, all construction equipment will enter construction areas in clean condition to limit the potential for introduction of weeds. Cleaning of equipment prior to moving between worksites within the Project Area will limit the potential for the spread of weeds. Effects are not expected to extend beyond the Project Area, so the geographic extent is local. The introduction or spread of weeds and non-native species is expected to be medium-term; Capital Power will abide by the Alberta *Weed Control Act and Regulations* (2010) and eradicate any prohibited noxious weed species populations and control any noxious weed species populations. The introduction or spread of weeds can be expected to occur infrequently throughout the life of the Project. The probability of this occurrence is possible. Weeds and non-native species may be introduced or spread, but the mitigation practices will reduce the likelihood of this occurrence. Overall, the introduction or spread of weeds and non-native species is considered to be of minimal importance.

3.4.6 Determination of Significance

The effect of the Project on the loss or alteration of native prairie and wooded land is considered to be of low importance. Effects will be limited to small portions of the Project footprint. Within areas of temporary disturbance, the effects are reversible, as the disturbance areas will be reclaimed with native species, and land cover will be restored following construction. The effect of the Project on the introduction or spread of weeds and/or non-native species is considered to be of minimal importance. The implementation of mitigation for the control of prohibited noxious and noxious weeds will assist in the re-establishment of desired plant species in the Project footprint.

Given that Project infrastructure has been largely sited to avoid permanent and temporary impacts within areas of native vegetation, and that mitigation will be implemented to minimize the introduction or spread of weeds and/or non-native, the residual effect on vegetation is predicted to not result in a change that will alter the sustainability of the vegetation beyond a manageable level, and is predicted to be not significant.

3.5 Surface Water, Aquatic Species, and Habitat

3.5.1 Introduction

Waterbodies are recognized as valuable resources in the landscape, as they provide wildlife habitat and vital ecosystem services, such as aquifer recharge (AENV 2007a,b; Alberta Water Council 2008). Under the provincial *Water Act*, the Government of Alberta requires that an approval be obtained prior to affecting any waterbodies (GOA 2000).

This section provides a description of existing surface water drainage patterns, watercourses, and fish and fish habitat within the Project Area, based on a desktop review.

3.5.2 Baseline Data Collection Methods

3.5.2.1 Desktop Assessment

The surface water desktop assessment was conducted using GIS mapping software and a 1:20,000 AltaLIS watercourse layer to identify drainage pathways and watercourses. Assessments of fish and fish habitat were based on existing data obtained from the AEP FWMIS database. Fisheries-specific FWMIS data was accessed using AEP's Fish and Wildlife Internet Mapping Tool (FWIMT; AEP 2017b).

All surface water crossings were conservatively identified as watercourses (i.e., having defined bed and banks and flow may be permanent or intermittent) during the desktop assessment. Each watercourse crossing was assigned a class and restricted activity period (RAP) based on Alberta Environment and Sustainable Resource Development's (ESRD) Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body (ESRD 2013b) and Code of Practice for Watercourse Crossings (ESRD 2013c).

3.5.3 Baseline Conditions

The Project includes 33 watercourse crossings, consisting of 25 collector system crossings, five permanent access road crossings, and three temporary crane path crossings. The Project is located entirely within the Battle River watershed, and each crossing location drains either directly into the Battle River or through Paintearth Creek. All watercourses crossed by the Project are unnamed.

Based on the desktop assessment, no fish or fish habitat assessments were previously conducted at any watercourse crossing locations. Fish and fish habitat data were available for the Battle River and Paintearth Creek, which were used to determine potential fish species assemblages for the area. FWMIS data for the Battle River and Paintearth Creek near the Project footprint identified 11 fish species that include three sport fish species (Goldeye [*Hiodon alosoides*], Northern Pike [*Esox Lucius*], and Walleye [*Sander vitreus*]). None of the 11 species captured near the Project footprint are listed federally (SARA [2017], COSEWIC [2017]) or provincially (AEP 2014).

In the absence of surface water field assessments, all watercourse crossings were conservatively identified as watercourses having defined bed and banks. Of the 33 watercourse crossings identified, eight cross mapped Class C watercourses, according to Schedule 6 of the Alberta Water Act - Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body (Red Deer Management Area Map; ASRD 2006). All other watercourses are unmapped and flow into mapped Class C watercourses. All watercourses were conservatively labelled as Class C with a RAP of April 16 to June 30. Following field assessment, the RAP for several of the crossings may be removed if the crossing is determined to be an undefined drainage (i.e., having no defined bed or banks) instead of a watercourse, following field assessments.

3.5.4 Potential Effects, Mitigation and Predicted Residual Effects

3.5.4.1 Potential Effects

The Project has limited potential to alter the hydrology and topography of the crossed unnamed watercourses. The collector lines will be installed underneath watercourses using trenchless (i.e., horizontal directional drilling) or isolated open-cut methods when water is present, and the culvert crossings will be installed in isolation of flowing water when required. Water quality within the watercourses could be affected by sedimentation resulting from installation of the collector system lines and culvert crossings, or from erosion or spills during operation.

3.5.4.2 Mitigation

All construction activities below the ordinary high water mark of a watercourse will be conducted in isolation when the watercourse is flowing with the bed and banks returned to conditions equal to or better than conditions prior to construction. If flowing water is present, timing of isolated open-cut construction activities will occur outside of the RAP. Where trenchless crossing methods are used, the risk of increased sediment due to an accidental release of drilling fluid (frac-out) will be mitigated by monitoring drilling fluid volume and pressure, on-land monitoring for frac-outs, and monitoring sediment concentrations in the watercourse during construction (when water is present). An appropriate frac-out contingency response plan will be created, and in the event of an on-land or in-stream frac-out, the response plan will be followed to quickly contain the product and minimize the potential to affect aquatic and riparian habitats and biota.

If other construction activities take place within the vicinity of the watercourses, measures will be taken to minimize the potential for contamination due to silt or spills. No vehicle and equipment refueling, maintenance, or washing will occur within 100 m of a water body. Watercourse crossing construction activities will take place during periods of low or no flow whenever possible to prevent or limit downstream sedimentation. For all watercourse crossings, the applicable Code of Practice notification will be submitted to AEP prior to affecting any watercourse or waterbody. All Best Management Practices and mitigations described under the Water Act Codes of Practice (ESRD 2013a,b), Alberta Transportation Fish Habitat Manual (AT 2001) and Measures to Avoid Causing Harm to Fish outlined by Fisheries and Oceans Canada (DFO 2017) will be followed.

For watercourse crossings, all culverts will be designed to allow for sufficient drainage, based on drainage areas and predicted flood levels. Design of each crossing structure will mitigate watercourse erosion and ensure potential fish passage. Sediment and erosion control measures will be installed at each watercourse crossing and routinely inspected for damage and effectiveness over the duration of the Project and repaired and/or altered if needed

3.5.4.3 Predicted Residual Effects

The predicted residual Project effects on surface water are:

- redirection of runoff;
- potential for localized scour or bank erosion;
- disturbance or alteration of riparian vegetation;
- disturbance or alteration of in-stream fish habitat; and
- increase in sediment load and sediment deposition at and downstream of the crossing locations.

3.5.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on surface water and the importance of the predicted residual effects are provided in Table 3.5-1. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.5-1: Predicted Residual Project Effects Description and Importance for Surface Water

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Redirection of runoff	Construction	Negative	Low	Local	Short-term	Possible	Minimal
Potential for localized scour or bank erosion	Construction	Negative	Low	Local	Short-to-medium-term	Possible	Minimal to low
Disturbance or alteration of riparian vegetation	Construction	Negative	Low	Local	Short-to-medium-term	Likely	Minimal to low
Disturbance or alteration of in-stream fish habitat	Construction	Negative	Low	Local	Short-term	Likely	Minimal
Increase in sediment load and sediment deposition at and downstream of the crossing locations	Construction	Negative	Low	Local	Short-term	Possible	Minimal

Redirection of Runoff

The predicted residual effect of construction on the natural flow patterns of watercourses is described as negative, even with the implementation of appropriate mitigation, as flow paths will be temporarily modified from their natural course. The magnitude of the effect is considered low because industry standard mitigation will be used to minimize adverse effects. The geographic extent is considered local, as diversions will be limited to the Project footprint. The effect is considered to be of short-term duration and will occur infrequently, because any diversions will be temporary, intermittent, and removed following completion of construction at the watercourse crossing. Although this residual effect is possible, the importance is expected to be minimal.

Potential for Localized Scour or Bank Erosion

The predicted residual effect of Project construction on the lateral and vertical stability of watercourses is described as negative because disturbance to riparian vegetation will increase the potential for erosion at watercourses crossings until re-vegetation is complete. The magnitude of the effect is considered low, as mitigation will be applied to protect exposed surfaces until re-vegetation is complete, and little potential exists for progression beyond minor scour or bank erosion over winter (i.e., low flow) conditions. The geographic extent is considered local, as the disturbance will be limited to watercourse crossings within the Project footprint. The effect is considered to be of short to medium-term duration, infrequent, and reversible, because the disturbed areas will occur intermittently and will be re-vegetated; however, it may take several years for the vegetation to re-establish and be effective. Although this residual effect is possible, the overall importance is expected to be minimal to low.

Disturbance or Alteration of Riparian Vegetation

For fish and fish habitat, the predicted residual effect of alteration of riparian vegetation is described as negative in direction due to the direct loss of riparian habitat during construction. The magnitude of effect is considered low since only the riparian vegetation directly associated with the Project footprint will be affected and revegetation will occur over time. The geographic extent is considered local as the riparian zone disturbance will be limited to the aquatic Project footprint. The effect is considered to be of short- to medium-term duration and infrequent because the riparian zones will be re-vegetated as soon as practicable following construction. Although this residual effect is likely, its importance is expected to be minimal to low.

Disturbance or Alteration of In-stream Fish Habitat

The predicted residual effect of disturbance or alteration of instream habitat is described as negative in direction and low in magnitude because only areas within the Project footprint where permanent culverts are installed will be affected, provided appropriate mitigation is applied at temporary vehicle crossings and collector line crossings. The geographic extent is local as the instream disturbance will be limited to the aquatic footprint. The effect will be of short-term duration and infrequent because the instream bed and banks will be restored to pre-construction conditions immediately after trench backfilling and habitat improvements may be realized where gravel or cobble trench caps are used. Although this residual effect is likely, its importance is expected to be minimal.

Sediment Increase

The predicted residual effect of increased suspended sediment load and sediment deposition associated with trenchless, isolated, or open-cut construction is described as negative in direction. This effect is considered to be low in magnitude because the trenched watercourse crossings will be conducted under isolated or dry (frozen) conditions, trenchless crossings will be monitored for frac-outs, and a contingency response plan will be in place to mitigate potential frac-outs. Sediment entrained during Project construction may be suspended for a short-term (days) and will be deposited in close proximity to the crossing site because of either low flows or impounded watercourses. Although short-term residual effects may occur infrequently as a result of sediment deposition, the sediments are expected to be flushed out the following spring during freshet. The probability of occurrence for increased suspended sediment deposition is possible, as construction will be conducted under isolated or trenchless conditions, when water is present. Failure of the isolation or frac-outs from trenchless crossing methods are not expected to occur. The overall effect of increased sediment load and deposition is considered to be of minimal importance.

3.5.6 Determination of Significance

Effective implementation of proven mitigation will reduce the duration and magnitude of potential adverse effects. Collector system watercourse crossings will be constructed using trenchless (i.e., horizontal directional drill) or trenched techniques (i.e., isolated or dry open-cut) and culverts will be installed in isolation if flowing water is present. Natural flow patterns diverted around isolated crossing construction will be immediately reintroduced to the downstream watercourse. Bank scour, resulting from the removal of vegetation during construction, is not expected to persist due to restoration activities. The zones of sediment deposition are expected to be limited to within close proximity of the crossing locations, as construction during low/no flow periods will reduce the downstream transport of sediment. The predicted residual effects of the Project on surface water and aquatic species and habitat are not predicted to result in a change that will alter the sustainability beyond an acceptable level, and are therefore considered to be not significant.

3.6 Groundwater

3.6.1 Introduction

A desktop evaluation was conducted to determine baseline conditions and areas of potential effects on groundwater resulting from the construction, operation, and decommissioning of the Project. The groundwater evaluation considered the local hydrogeology within a regional context, and identified aquifer resources and wells within the Project Area.

The following sections outline the methods used to assess groundwater within the Project Area, identifies potential effects that the Project may have on groundwater, and summarizes proposed mitigation.

3.6.2 Baseline Data Collection Methods

3.6.2.1 Desktop Assessment

Geological and hydrogeological map information that was reviewed, applicable to the Project Area, includes bedrock topography, bedrock thalwegs (buried channels), drift (overburden) thickness, sand and gravel deposits, surficial geology and hydrogeology. The map information was obtained from the Alberta Geological Survey archives, including:

- Bedrock Topography, Map 602 (AGS 2015);
- Bedrock Geology, Map 600 (AGS 2013a);
- Surficial Geology, Map 601 (AGS 2013b);
- Drift Thickness, Map 227 (AGS 2012);
- Aggregate Sand Gravel, Map 270-278 (AGS 2009);

- Hydrogeological Map of Wainwright (AGS 2005a);
- Hydrogeological Map of Red Deer Area (AGS 2005b); and
- Bedrock Thalwegs, Map 226 (AGS 2005c).

A search of provincial water well records, maintained by the Groundwater Information Centre (AEP 2017c), was conducted for the Project Area.

3.6.3 Baseline Conditions

Surficial Geology

Within the Project Area, the overburden geology varies from morainal till deposits characterized by un-stratified clay, silt, and sand in the west, to glaciofluvial (meltwater) materials characterized by coarse to fine-grained sediment in the central and eastern areas. Isolated areas of fluvial (river) material characterized by sand and gravel are present along Battle River, located in the northeast portion of the study area. In addition, colluvium materials characterized by slump deposits are present along the northern and southern boundaries of the Project Area. Slump deposits, which are associated with the Battle River along the northern boundary and Paintearth Creek along the southern boundary, are typically confined to valley sides and floors and can include bedrock, surficial (till deposits) or fluvial deposits. These overburden materials are approximately 15 m in thickness.

Bedrock within the Project Area is documented as consisting of the Horseshoe Canyon Formation, characterized by sandstone. The bedrock appears to be unconfined by the sand and gravel overburden of fluvial material (associated with Battle River and its tributaries) to the north, east and west of the Project Area.

Water Wells

A search of provincial water well records, maintained by the Groundwater Information Centre (AEP 2017c), identified 80 water well records within the Project Area (Table 3.6-1). The locations of these mostly historic wells are typically not surveyed (i.e., often assigned to the centre of quarter sections) and some appear to be abandoned or decommissioned. The water well records document well constructions with total depths ranging from 2 m in surficial materials, to over 100 m deep bedrock wells (Table 3.6-1).

Other potential occurrences of shallower groundwater may be present in the northeast portion of the Project Area, within the Battle River valley. Within the valley, groundwater in the coarser-grained overburden and underlying sandstone bedrock could potentially 'daylight' as seepage lines or isolated seeps, typically associated with steeper slope faces.

Groundwater elevation contours, within the bedrock, decrease across the Project Area to the north (i.e., towards Battle River) and towards the south (i.e., towards Paintearth Creek). These contours confirm groundwater within the upper bedrock is flowing towards, and discharging into the Battle River and Paintearth Creek valleys.

Table 3.6-1: Water Wells within the Project Area

Well ID[(a)]	LSD	SEC	TWP	RGE	M	Static Water Level [m]	Well Depth [m bgs]	Proposed Use
40057	11	01	040	15	4	1.52	12.80	Domestic
155894	NE	01	040	15	4	-	54.86	Domestic
162923	NW	10	040	15	4	-	26.21	Domestic
163136	14	01	040	15	4	-	15.24	Industrial
163196	NE	10	040	15	4	6.10	25.91	Domestic
184034	NE	25	039	15	4	8.53	10.97	Unknown
184036	NE	25	39	15	4	9.14	21.34	Domestic
184042	NW	26	039	15	4	8.23	9.14	Domestic & Stock
184044	NW	34	039	15	4	6.10	45.72	Domestic & Stock
184046	SW	35	039	15	4	36.58	97.54	Domestic
184060	SW	35	039	15	4	0.00	36.58	Domestic
184067	SW	35	039	15	4	0.00	54.86	Domestic
184075	NW	35	039	15	4	4.57	12.19	Domestic
184077	NW	35	039	15	4	2.44	18.90	Domestic & Stock
184080	SW	36	039	15	4	4.88	7.92	Domestic & Stock
184084	NW	36	039	15	4	6.71	9.45	Stock
184088	NE	36	039	15	4	3.05	9.14	Domestic & Stock
184091	NE	36	039	15	4	9.45	24.69	Domestic
184970	NE	01	040	15	4	0.00	56.69	Domestic & Stock
184975	NE	01	040	15	4	0.00	50.60	Domestic & Stock
151562	NE	33	039	14	4	121.92	58.22	Domestic
153572	NW	35	039	14	4	11.28	2.44	Domestic & Stock
155671	NW	30	039	14	4	9.14	-	Domestic
169031	NE	27	039	14	4	5.18	-	Domestic
183764	NE	22	039	14	4	31.70	9.14	Domestic & Stock
183766	NE	22	039	14	4	43.89	12.19	Domestic & Stock
183772	NE	22	039	14	4	15.24	8.84	Domestic
183774	NE	22	039	14	4	25.60	7.62	Domestic & Stock
183786 (abandoned)	NE	22	039	14	4	31.70	-	Domestic & Stock
183787	NE	22	039	14	4	18.29	-	Unknown
183789	SW	25	039	14	4	9.14	-	Domestic
183790	SW	26	039	14	4	8.84	-	Unknown
183791	SE	27	039	14	4	11.58	6.71	Unknown
183792	NE	29	039	14	4	0.00	-	Domestic & Stock
183793	NE	31	039	14	4	38.10	5.79	Domestic
183794	NW	32	039	14	4	7.32	3.66	Domestic
183795	NW	32	039	14	4	28.96	5.18	Stock
183796	NW	32	039	14	4	27.43	-	Domestic
183797	NW	32	039	14	4	22.86	9.14	Domestic & Stock
183798	SE	33	039	14	4	6.71	-	Unknown
184915	09	01	040	14	4	-	13.11	Unknown
184920	SW	02	040	14	4	3.05	10.67	Domestic
184922	SW	02	040	14	4	2.44	17.37	Unknown

Table 3.6-1: Water Wells within the Project Area

Well ID[(a)]	LSD	SEC	TWP	RGE	M	Static Water Level [m]	Well Depth [m bgs]	Proposed Use
184927	SW	02	040	14	4	3.66	15.24	Domestic
184930	NW	02	040	14	4	-	15.24	Domestic
184931	SE	03	040	14	4	4.27	7.01	Domestic
184936	01	03	040	14	4	-	6.10	Unknown
184976	NE	10	040	14	4	-	54.86	Domestic
184977	13	10	040	14	4	-	9.14	Unknown
184979	08	12	040	14	4	-	4.27	Unknown
184983	SW	12	040	14	4	4.27	6.10	Domestic
184994	SE	14	040	14	4	-	4.27	Domestic
185050	01	15	040	14	4	-	9.14	Unknown
185052	SW	15	040	14	4	-	100.58	Unknown
185058	06	15	040	14	4	0.15	18.29	Unknown
186116 (abandoned)	03	15	040	14	4	0.00	87.48	Domestic
258217	SW	15	040	14	4	3.35	7.92	Domestic
258218 (abandoned)	SW	15	040	14	4	-	66.14	-
1590028	1	9	40	14	4	7.77	15.24	Stock
2096357	1	4	40	14	4	-	52.43	Investigation
40659	01	18	040	14	4	40.54	67.06	Domestic & Stock
151603	NW	04	040	14	4	4.57	15.54	Stock
151604	SE	05	040	14	4	54.25	75.29	Domestic
158887	NE	07	040	14	4	16.76	60.96	Domestic
165828	06	04	040	14	4	1.83	14.94	Domestic
184937	NW	04	040	14	4	19.51	73.15	Domestic
184939	NW	04	040	14	4	48.77	62.79	Domestic & Stock
184941	NW	04	040	14	4	3.96	41.15	Domestic
184944	SE	05	040	14	4	3.35	4.57	Domestic
184945	SE	05	040	14	4	7.62	74.37	Domestic & Stock
184950	SW	05	040	14	4	18.29	42.67	Domestic & Stock
184952	SW	05	040	14	4	48.77	74.68	Domestic
184954	SW	05	040	14	4	48.77	74.98	Domestic & Stock
184959	SE	07	040	14	4	-	60.96	Domestic
184962	NE	07	040	14	4	-	42.67	Domestic & Stock
184963	NE	07	040	14	4	-	0.00	Domestic
184965	NE	08	040	14	4	6.10	33.53	Domestic
184965	NE	08	040	14	4	11.89	33.53	Domestic
184971	NE	08	040	14	4	5.49	30.48	Domestic
227677	SW	05	040	14	4	-	54.86	Domestic

Source: AEP (2017c).
- = Not available

3.6.4 Potential Effects, Mitigation and Predicted Residual Effects

3.6.4.1 *Potential Effects*

Excavation for wind turbine foundation construction, trenching for the installation of the collector system, and excavation for the substation building foundations may intersect the groundwater table, and groundwater quality may be impacted. If groundwater is encountered during excavation, foundations and dewatering operations could temporarily affect the water levels of nearby wells. Groundwater contamination may result from spills during any construction or decommissioning activity.

3.6.4.2 *Mitigation*

The following mitigation measures will be implemented to limit adverse effects to groundwater:

- Wind turbines will be set back from residences/wells to minimize the potential for impacts on residential wells. The closest wind turbine to a residence is located at a distance of approximately 567 m.
- All Project activities will follow standard construction practices to minimize the potential for spills. Any spill site will be reported to the appropriate authorities if necessary and remediated in a timely manner.

3.6.4.3 *Predicted Residual Effects*

The predicted residual Project effects on groundwater are:

- change in water levels of wells; and
- groundwater contamination.

3.6.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on groundwater and the importance of the predicted residual effects are provided in Table 3.6-2. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.6-2: Predicted Residual Project Effects Description and Importance for Groundwater

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Change in water levels of wells	Construction and decommissioning	Negative	Low	Local	Short-term	Possible	Minimal
Groundwater contamination	Construction operation and decommissioning	Negative	Negligible	Local	Short-term	Unlikely	Minimal

Change in water levels of wells

The predicted residual effect of changing water levels on groundwater is described as negative because even with the use of appropriate mitigation, groundwater levels could be altered. The magnitude of the effect is considered low and is unlikely to be a management concern once the Project is operational because the appropriate mitigation will be used to minimize adverse effects. The geographic extent is considered local, as the impact to water levels will be limited to the Project footprint and nearby wells. The effect is considered to be of short-term duration, because the impacts will be temporary and not applicable following completion of construction and decommissioning. The effect is expected to occur infrequently during construction and decommissioning. Although this residual effect is possible, the importance is expected to be minimal.

Groundwater contamination

The predicted residual effect of groundwater contamination is described as negative. However, with the use of appropriate mitigation, groundwater is unlikely to become contaminated through spills during construction or decommissioning. The magnitude of the effect is considered negligible because the use of hazardous substances will be limited. The effects are unlikely to be a management concern once the Project is operational because the appropriate mitigation will be used to minimize adverse effects. The geographic extent is considered local, as impacts will be limited to the Project footprint. The effect is considered to be of short-term duration, because the impacts will be temporary and removed following completion of construction and decommissioning. The effect is expected to occur infrequently during construction and decommissioning. Although this residual effect is possible, the importance is expected to be minimal.

3.6.6 Determination of Significance

Effective implementation of proven mitigation will reduce the duration and magnitude of potential adverse effects. The potential for residual impacts on the water levels of groundwater wells is associated with possible temporary dewatering operations while constructing the foundation of the turbines and removal of the foundations during decommissioning. Once the foundations are installed or removed, the groundwater levels are expected to return to their natural state. All Project activities will follow standard construction practices to minimize the potential for spills. Any spill site will be reported to the appropriate authorities, as required and remediated in a timely manner. The predicted residual effects of the Project on groundwater are not predicted to result in a change that will alter the sustainability beyond an acceptable level, and are therefore considered to be not significant.

3.7 Wetlands

3.7.1 Introduction

An approval is required under the Alberta *Water Act* for any Project activity that may impact wetlands. The new Alberta Wetland Policy (AEP 2016d) was implemented in the White Area (i.e., Settled Area) of the province on June 1, 2015, and Albertans requesting approval for wetland impacts in the White Area are now required to submit applications under the new wetland policy using all directives, guides, and tools therein (AEP 2016d, GOA 2015a, b, c, d and e [updated in 2016]). In addition, an approval under the *Public Lands Act* is required for activities impacting Crown-claimed wetlands. If wetland ownership is not specified on the existing land title, this must be formally assessed for wetlands that have seasonal or more extended water permanence (GOA 2014b [updated in 2016]).

An applicant is expected to follow the wetland mitigation hierarchy from the ‘most preferred’ to ‘least preferred’ option is as follows (AEP 2016d, GOA 2015e [updated in 2016]):

- avoid impacts or loss of the wetland;
- minimize wetland impacts and provide applicable compensation; and
- compensate for unavoidable wetland impacts or loss.

This section of the Environmental Evaluation contains the results of a desktop assessment in which wetlands were delineated and classified, and a field survey consisting of a subset (≥ 10%) of the mapped wetlands that were field verified.

3.7.2 Baseline Data Collection Methods

3.7.2.1 Desktop Assessment

A preliminary constraints mapping exercise was performed to identify and delineate wetland boundaries within the Project Area. The following data sources were used for desktop wetland mapping:

- Alberta Merged Wetland Inventory data obtained from AEP (GOA 2014b), which shows Alberta wetlands for the period of 1998 to 2009. This is a very coarse dataset mapped with SPOT 20 m resolution imagery.
- Alberta Biodiversity Monitoring Institute (ABMI) Human Footprint 2012 Version 3 obtained from ABMI (ABMI 2010).
- Central Parkland Native Vegetation Inventory obtained from AEP (GOA 2012).
- Alberta Ground Cover Classification obtained from AEP (GOA 2013).
- AltaLIS 20K waterbodies AltaLis© (GOA 2015f).

During desktop mapping, Golder Interim Wetland Science Practitioners (IWSPs) used 1.5 m resolution aerial photography and ArcView GIS software to map potential wetland locations. Wetlands were delineated at a 1:5,000 scale, and a preliminary wetland permanence class was assigned following the Alberta Wetland Classification System (AWCS) (Alberta Environment and Sustainable Resource Development [ESRD] 2015). In addition to the three naturally occurring AWCS wetland classes expected within the Project Area (i.e., Marsh, Shallow Open Water, and Swamp), two other water body categories were used: (1) Anthropogenic Water Body/Modified Natural Wetland and (2) Natural Water Bodies, which include Ephemeral (Class I) Water Bodies and Natural Drainages (Table 3.7-1). Wetland permanence categories are shown in Table 3.7-2.

Table 3.7-1: Description of Project Area Water Bodies and Applicable Guidelines

Water Body Type	Description	Applicable Guidelines	
		Alberta Wetland Policy[a]	Alberta *Water Act*
Natural Wetlands			
Marsh[a]	Dominated by graminoid vegetation in the deepest wetland zone covering more than 25% of the total wetland area.	yes	yes
Shallow Open Water[a]	Dominated by shallow (i.e., <2 m deep at midsummer) open water in the deepest wetland zone covering more than 25% of the total wetland area; floating and/or submersed aquatic vegetation is common in the shallow open water zone, but sometimes aquatic vegetation is absent.	yes	yes
Swamp[a]	Woody plant cover, such as willows (*Salix* spp.), comprises more than 25% of the total wetland area.	yes	yes

Table 3.7-1: Description of Project Area Water Bodies and Applicable Guidelines

Water Body Type	Description	Applicable Guidelines	
		Alberta Wetland Policy[(a)]	Alberta *Water Act*
Anthropogenic Water Bodies/Modified Natural Wetlands			
Anthropogenic Water Body/ Modified Natural Wetland	Man-made water body; possibly, but not necessarily, occurring within a natural wetland. When it can be demonstrated that they occur within a natural wetland basin, they should be treated as a regulated water body under the Alberta *Water Act* and as a wetland under the provincial Wetland Policy (GOA 2015g).	maybe	maybe
Natural Water Bodies[(b)]			
Ephemeral (Class I) Water Body[(a)]	Surface water is present in most years, but only for a brief period of time after snowmelt or a heavy rainfall. While some water tolerant plant species may be present, they are not dominant and are intermixed with a majority of upland species.	no	yes
Natural Drainage	Area where water flow is generally intermittent, often connected to one or more wetland basins. The Natural Drainage feature does not meet the AWCS definition of a wetland (i.e., land that is saturated with water long enough to promote formation of water altered soils, growth of water tolerant vegetation, and various kinds of biological activity that are adapted to wet environments [ESRD 2015]), but it does meet the definition of a water body in the Alberta *Water Act*, which includes “any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or only occurs during a flood”. While not to be included in the Wetland Assessment and Impact Report (GOA 2015a), Natural Drainages that will be impacted should be included in the *Water Act* application. More permanent watercourses are considered in the Surface Water section of this document.	no	yes

(a) ESRD 2015.
(b) Not considered w etlands under AWCS (ESRD 2015).

Table 3.7-2: Wetland Permanence Categories

Permanence[a]	Hydroperiod
Temporary (II)	Surface water is present for a short period of time after snowmelt or a heavy rainfall.
Seasonal (III)	Surface water is present throughout the majority of the growing season, but is typically dry by the end of summer.
Semi-permanent (IV)	Surface water is present for most or all of the year, except in periods of drought.
Permanent (V)	Surface water is present throughout the year.
Intermittent (VI)	Alternates between saline open water and exposed bottom.

(a) Roman numerals in parentheses are equivalent to wetland classes by Stewart and Kantrud (1971).
Source: ESRD 2015

3.7.2.2 Field Assessment

Desktop-delineated wetlands were plotted on field maps at a 1:5,000 scale, and a wetland field verification survey was carried out by two of Golder's IWSPs from May 25 to June 2, 2016 and on August 11 and 12, 2016. Wetlands within 150 m of proposed turbine locations were considered the highest priority for field verification, and additional wetlands were visited to bring the field verification total to ≥10% of desktop-delineated wetlands.

At each mapped wetland, the desktop-derived water body type (i.e., wetland class for natural wetlands) (Table 3.7-1) and permanence (Table 3.7-2) were evaluated and updated as required, and dominant plant species were noted. Soils were assessed, as needed, to determine wetland boundaries, and desktop wetland delineations were adjusted using a GPS track file, if necessary. The presence of weed species and any wetland impacts associated with human activities were noted, as applicable, and photographs were taken at each wetland. Following the field assessment, the delineations of field verified wetlands were revised, as needed, to reflect field observations.

3.7.3 Baseline Conditions

In total, 1,329 wetlands occupying 879.6 ha were documented in the Project Area (Table 3.7-3; Figures A1 to A15 in Appendix A). There were 519 occurrences of Class I-II wetlands, which covered approximately 132.3 ha of the Project Area (Table 3.7-3). The remaining 810 wetlands within the Project Area were Class III-V, and covered approximately 747.4 ha of the Project Area (Table 3.7-3).

One hundred twenty-seven (127) wetlands were visited during the field verification survey (Table 3.7-3; Appendix D). Seasonal (Class III) marshes were encountered most frequently during the field survey with 46 occurrences (36%), and they occupied 40.7 ha of the Project Area (Table 3.7-3). Temporary (Class II) marshes were encountered second-most frequently in the field with 35 occurrences (28%), and they occupied 10.8 ha of the Project Area (Table 3.7-3). While semi-permanent (Class IV) marshes were documented only 11 times in the field, they covered more area than any other field verified wetland class (i.e., 62.6 ha or approximately one third of the Project Area wetlands; Table 3.7-3). Plant species associated with the wetlands in the Project Area are described in the Vegetation section of this document (Section 3.4).

Natural drainages and ephemeral (Class I) water bodies were included in the Class I-II wetland group during desktop delineation. These features will be considered separately from natural wetlands during the permitting stage, as any proposed impacts to natural drainages or ephemeral (Class I) water bodies will require *Water Act* approval, but compensation under the Alberta *Wetland Policy* (AEP 2016d) is not required, as outlined in Table 3.7-1.

Table 3.7-3: Wetlands within the Project Area

Water Body Type/ Wetland Class and Form[a]	Permanence[a,b]	Desktop		Field Verified		Total	
		Number	Area [ha]	Number	Area [ha]	Number	Area [ha]
Class I-II							
Ephemeral (Class I) Water Body[c]				18	4.3		
Graminoid Marsh	Temporary (II)	465	116.9	35	10.8	519	132.3
Shrubby Swamp	Temporary (II)			1	0.3		
Class I-II Total		*465*	*116.9*	*54*	*15.4*	*519*	*132.3*
Class III-V							
Graminoid Marsh	Seasonal (III)			46	40.7		
	Semi-permanent (IV)			11	62.6		
Shrubby Swamp	Seasonal (III)			2	7.6		
Wooded Swamp	n/a	737	577.1	3	8.9	810	747.4
Shallow Open Water[d]	Seasonal (III)			1	1.1		
	Semi-permanent (IV)			6	11.9		
	Permanent (V)			4	37.4		
Class III-V Total		*737*	*577.1*	*73*	*170.2*	*810*	*747.4*
Total		**1,202**	**694.0**	**127**	**185.6**	**1,329**	**879.6**

n/a = not applicable.
[a] ESRD 2015.
[b] Roman numerals in parentheses are equivalent to w etland classes by Stewart and Kantrud (1971).
[c] Not considered w etlands under AWCS (ESRD 2015); see Table 3.7-1.
[d] Includes vegetated and bare forms.

3.7.4 Potential Effects, Mitigation and Predicted Residual Effects

3.7.4.1 Potential Effects

The Project has the potential to alter wetland condition, through changes in the hydrology and topography of wetlands within the Project footprint. Water quality within wetlands could also be affected by siltation or spills from either direct or indirect construction or operation activities.

Where possible, Project infrastructure has been sited to avoid wetlands; however, 15 wetlands have the potential to be affected during Project operation (Table 3.7-4 and Figures A1 to A15 in Appendix A). Project infrastructure is expected to permanently affect less than 5% of the original wetland area for 12 of these 15 wetlands, and impacts will cover 8% to 26% of the original area of the other three wetlands, with a total area of 0.4 ha of permanently disturbance (Table 3.7-4). Ten of the wetlands to effected are in Class III-V, and the remaining five wetlands are in Class I-II (Table 3.7-4 and Figures A1 to A15 in Appendix A). As outlined in Table 3.1-2, all turbines and the substation have been located in upland, agricultural land cover types and there will be no permanent impacts to wetlands from turbine or substation Project components. Permanent impacts to wetlands result from access roads that must remain in operation throughout the life of the Project.

During Project construction, 24 wetlands have the potential to be temporarily affected (Table 3.7-4). Seventeen of the wetlands to be temporarily affected are in Class III-V, and the remaining seven wetlands are in Class I-II (Table 3.7-4). Temporary effects to wetlands result from construction-related Project activities, including the construction of temporary crane paths and access roads and the installation of the underground collector system.

Table 3.7-4: Potential Direct Project Effects on Wetlands During Construction and Operation

Wetland Class Range	Operation			Construction		
	Number	Wetland Area [ha]	Wetland Area to be Impacted [ha]	Number	Wetland Area [ha]	Wetland Area to be Impacted [ha]
Permanence Class I-II	5	0.8	0.1	7	2.9	0.1
Permanence Class III-V	10	21.9	0.2	17	27.3	0.7
Total	**15**	**22.7**	**0.4**	**24[(a)]**	**30.2**	**0.8**

[(a)] Permanent effects also apply to 14 of these wetlands.

3.7.4.2 Mitigation

Avoidance of wetlands and ephemeral waterbodies will be the primary mitigation employed during construction and operation of the Project. All turbines, the substation and laydown yard have been sited to avoid permanent wetland effects. If construction activities are required in the vicinity of wetlands or watercourses, measures will be taken to limit the potential for silt or spills to reach these areas. Other Project infrastructure, including temporary crane paths and construction roads, permanent operational access roads and the underground collector system, were also sited to minimize either permanent or temporary effects on wetlands, where possible. Access roads are expected to temporary affects approximately 0.8 ha of wetlands and permanently affect 0.4 ha of wetlands within the Project Area (Table 3.6-2).

Mitigation measures for the protection of wetlands will include construction during dry ground conditions to the extent possible, and the employment of rig matting, geotextiles, vegetated buffer zones, earthen berms and/or silt fencing, as appropriate. Safety fencing will be installed to prevent vehicle traffic from entering wetlands, as appropriate. Construction access roads and workspaces in the vicinity of wetlands will be re-vegetated as quickly as feasible after construction to reduce the potential for siltation. Permanent erosion and spill control measures will be employed around facilities and operational access roads, including re-vegetation or placement of large diameter rock on slopes and the installation of permanent berms, as appropriate.

3.7.4.3 Predicted Residual Effects

The predicted residual effects on wetlands are:

- loss or alteration of wetlands and;
- introduction or spread of weeds and/or non-native species.

3.7.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on wetlands and the importance of the predicted residual effects are provided in Table 3.7-5. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.7-5: Predicted Residual Project Effects Description and Importance for Wetlands

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Loss or alteration of w etlands	Construction, operation and decommissioning	Negative	Medium	Local	Long-term	Likely	Medium
Introduction or spread of w eeds and/or non-native species	Construction, operation and decommissioning	Negative	Low	Local	Medium-term	Possible	Minimal

Loss or alteration of wetlands

Loss or alteration of wetlands will be negative in direction and medium in magnitude, because there will be a net loss of wetlands where permanent infrastructure (i.e., access roads) will permanently affect wetlands. The effects not expected to extend beyond the Project Area, so the geographic extent is local. The loss or alteration of wetlands is expected to be long term because following the construction of permanent facilities, wetlands will be re-vegetated as quickly as feasible and as permanent adverse effects to wetlands will be compensated through the *Water Act*. The probability of this occurrence is likely, but is considered common for similar projects. The loss or alteration of wetlands is considered to be medium importance.

Introduction or spread of weeds and/or non-native species

The introduction or spread of weeds and non-native species will be negative in direction and low in magnitude because implemented mitigation will limit vehicle traffic and equipment to the Project footprint, reducing the potential to introduce or spread weeds. Additionally, all construction equipment will enter construction areas in a clean condition to limit the potential for the introduction of weeds. Cleaning of equipment prior to moving between worksites within the Project Area will limit the potential for the spread of weeds. The geographic extent is not expected to extend beyond the Project Area, and is therefore local. The introduction or spread of weeds and non-native species is expected to be medium-term; Capital Power will abide by the Alberta *Weed Control Act and Regulations* (GOA 2010) and eradicate any prohibited noxious weed species populations and control any noxious weed species populations associated with the Project components. The introduction or spread of weeds can be expected to occur intermittently throughout the life of the Project; therefore, infrequent in temporal context. The probability of this occurrence is possible. Weeds and non-native species may be introduced or spread, but the mitigation practices will reduce the likelihood of this occurrence. Overall, the introduction or spread of weeds and non-native species is considered to be minimal.

3.7.6 Determination of Significance

The effect of the Project on the loss or alteration of wetlands is considered to be low to medium importance. Effects will be limited to the Project area, of which 8% is covered by wetlands (Table 3.7-3). The effects of temporary disturbance are reversible, as the disturbed areas will be seeded, where appropriate, and wetlands will be restored following construction. The effect of the Project on the introduction or spread of weeds and/or non-native species is considered to be of minimal importance. The implementation of mitigation for the control of prohibited noxious and noxious weeds will assist in the re-establishment of desired plant species in the Project area.

Given the mitigation that will be implemented to minimize temporary effects and the limited permanent loss or alteration of wetlands as a result of the Project, the residual effect to wetlands is not predicted to result in a change that will alter the sustainability of wetlands beyond a manageable level, and is predicted to be not significant.

3.8 Wildlife and Wildlife Habitat

3.8.1 Introduction

The Project is located entirely in the Central Parkland Subregion of the Parkland Natural Region (NRC 2006). The Project Area falls within a sharp-tailed grouse range and sensitive raptor range for prairie falcon (AER 2013). Much of the Project Area has been cleared and designated for agricultural use and provides low quality habitat for most wildlife species. Some areas of natural vegetation and wetland areas occurring in the Project Area provide suitable wildlife habitat for several species.

Wildlife field surveys were conducted to determine the occurrence of wildlife, particularly listed species or species with setback restrictions (AEP 2017a), up to 1 km from the Project Area boundary. Based on species range and habitat requirements, wildlife species listed under Schedule 1 of the SARA with the potential to occur within the Project Area include: Canada warbler, common nighthawk, loggerhead shrike, olive-sided flycatcher, peregrine falcon, piping plover, red knot, rusty blackbird, short-eared owl, Sprague’s pipit, whooping crane, little brown myotis, northern myotis, and western toad (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2016). All listed wildlife species observed during the wildlife surveys were noted.

The following sections provide a summary of the wildlife survey findings, potential effects that the Project may have on wildlife, and proposed mitigation measures. Appendix E contains additional details regarding the methods used to conduct the wildlife surveys, and detailed results of each survey conducted.

3.8.2 Baseline Data Collection Methods

3.8.2.1 Desktop Review

Wildlife surveys required to support regulatory applications for the Project were identified using Wildlife Guidelines for Alberta Wind Energy Projects (ASRD 2011a) and align with the AEP Wildlife Directive for Alberta Energy Projects (the Directive; AEP 2017a). Specific surveys requirements were determined using available habitat and wildlife information within the Project Area (including data from the FWMIS database and known species range) and feedback obtained during consultation AEP (Herdman 2016, pers. comm.).

Site-specific wildlife surveys were initiated in the winter of 2016 and continued throughout the spring, summer, and fall (Appendix E, Table 1). The wildlife surveys conducted in the Project Area include:

- Winter bird survey;
- Sharp-tailed grouse survey;
- Richardson’s ground squirrel survey;
- Spring and fall bat migration study;

- Raptor nest survey;
- Breeding bird survey; and
- Avian use study (AUS) (spring and fall migration).

Surveys were conducted throughout the Project Area and along the nearby, publicly-accessible roads within a 1 km buffer of the Project Area (Appendix E, Figure 2).

The avian use, bat and breeding bird survey locations and sharp-tailed grouse survey areas are shown in Figure 2 in Appendix E. Figure 2 also provides the wildlife and wildlife habitat features observed during the field assessments.

3.8.3 Baseline Conditions

3.8.3.1 Wildlife Habitat

Land cover was delineated in the Project Area, as described in Section 3.1. Native prairie, wooded land, and Class III-IV wetlands are more likely to be used by wildlife (particularly sensitive species) than agriculture/pasture, cultivated land, modified pasture, and disturbed land cover types.

Cultivated land, agriculture/pasture, and modified pasture represent the largest land cover type in the Project area at 8,622 ha (74%), approximately 269 ha (98%) of the Project Footprint occurs on this land cover type (Table 3.1-2). Approximately 1369 ha (12%) of the Project Area consists of native prairie; less than 0.04 ha (0.1%) of the Project Footprint occurs on this land cover type. Approximately 147 ha (1%) of the Project Area consists of wooded land cover, of which 1.06 ha (<1%) will be lost or altered due to the Project Footprint. Approximately 747 ha (7%) of the Project Area consist of Class III-V wetland, of which 2 ha (<1%) of the Project Footprint occurs on this land cover type. Approximately 132 ha (1%) of the Project Area consists of Class I-II land cover, of which 0.6ha (<1%) will be lost or altered due to the Project Footprint. The remaining land cover types traversed by Project components include 2 ha (1%) of farmyard/rural residential and <1 ha (<0.01%) of developed land cover types.

3.8.3.2 Winter Bird Survey

Winter bird surveys were conducted from January 21 to 22 and February 24 to 26, 2016 to determine bird species presence and use of the Project Area, including resident or short distance migrants that overwinter within the Project Area.

A total of sixty-five point counts were conducted in the Project Area over the two survey rounds. The most common bird species observed during the winter surveys were Canada goose, common redpoll, and black-billed magpie. Of the species observed during the winter wildlife surveys, none were listed provincially (ASRD 2012) or federally (COSEWIC 2016).

Appendix E provides additional details regarding the findings of the winter bird surveys.

3.8.3.3 Sharp-tailed Grouse Survey

The sharp-tailed grouse survey was conducted between April 11 to 20 and April 29 to May 13, 2016. One active lek was found during the sharp-tailed grouse survey; this lek and the associated 500 m setback are outside the Project Area (12 U 443071E 5807268N).

Appendix E provides additional details regarding the sharp-tailed grouse survey.

3.8.3.4 Richardson's Ground Squirrel Survey

The Richardson's ground squirrel survey was conducted from April 16 to 19, 2016. Richardson's ground squirrels were observed at 18 of 27 plots surveyed. A total of 64 individuals were observed in cultivated cropland, hayland, modified pasture, and native pasture habitat types.

Appendix E provides additional details regarding the Richardson's ground squirrel survey

3.8.3.5 Avian Use Study

To assess migratory bird activity within the Project Area, a standardized survey methodology referred to as an Avian Use Study (AUS) was conducted. The principal goals of the AUS were to quantitatively describe the temporal and spatial use of the Project Area by birds during spring and fall migration using diurnal point count surveys, and to assess the potential effect of wind power development on birds within the Project Area.

Three survey rounds were conducted in the spring (March 22 to 25, April 12 to 15, and May 8 and 10 to 12, 2016), and two survey rounds were conducted in the summer (June 21 and 23 to 28, and July 10 to 14, 2016). Twenty-eight (28) AUS plots were established within the Project Area. Details of each plot are provided in Table 4 of Appendix E. All birds observed within or flying over the AUS plot were recorded during 20-minute sample events, conducted twice daily (morning and afternoon). Each AUS plot was surveyed twice (morning and afternoon) as weather conditions permitted. This resulted in 503 plot visits, which equates to approximately 168 hours of direct observation.

Surveys were conducted to provide appropriate coverage of the Project Area and the associated habitats (Appendix E, Figure 2). The AUS plots were established at locations with the greatest opportunity to view the entire 800 m radius plot; however, in some cases a 360º view was not feasible due to terrain features, such as buildings and/or trees.

During the 2016 AUS surveys, a total of 27,918 birds were observed composed of 3,448 flocks. Overall, waterfowl were the most commonly observed species group in the spring (7,738 individuals from 292 flocks) and fall (8,165 individuals from 234 flocks) (Appendix E, Table 12; Table 28). Passerines were the most commonly observed species group in the summer (2,147 individuals from 947 flocks), and the second-most common in the spring (5,422 individuals from 777 flocks) and fall (2,739 individuals from 541 flocks) (Appendix E, Table 12; Table 20; Table 28). The average number of individual birds observed at each AUS plot ranged from 23.42 individuals/plot during the summer to 81.06 individuals/plot during the spring. The total number of avian species observed during the entire AUS survey was 101 (Appendix E, Table 12; Table 20; Table 28).

Based on the collision risk index derived from data collected during the spring and fall AUS surveys, and assuming a rotor-swept height of 40 m to 150 m, the species groups with highest collision risk in the spring are waterfowl (2.379) and passerines (1.199). In the summer, passerines (2.314) and raptors (0.105) are the species groups with highest collision risk, whereas, in the fall, waterfowl (12.236) and passerines (0.190) are the species groups with highest collision risk (Appendix E, Table 18; Table 26; Table 34). The collision risk index for all species observed in the Project Area is 5.252 in the spring, 2.773 in the summer, and 24.896 in the fall (Appendix E, Table 18; Table 26; Table 34).

Areas of highest use by migratory birds varied by season, but was generally concentrated around the perimeter of the Project Area and in the centre of the Project Area. During spring surveys, the plots with the largest numbers of birds observed were AUS20, AUS21, AUS14 and AUS11 (Appendix E, Figure 11). During summer surveys, the largest numbers of birds observed were at plots AUS28, AUS10, and AUS27 (Appendix E, Figure 13). During fall surveys, the largest numbers of birds observed were at plots AUS1, AUS20, AUS06, AUS27, and AUS13 (Appendix E, Figure 15). All of these plots were either located near the center of the Project Area (Aus20, Aus21) or near the perimeter of the Project Area (AUS 06, AUS 10, AUS 11, AUS 13, AUS 14, AUS 28) except for AUS 27, which was located in the northeast section of the Project Area.

Appendix E provides additional details regarding the findings of the AUS.

3.8.3.6 Bat Migration Study Survey

The principal goal of the bat migration monitoring surveys was to quantitatively describe the bat activity within the Project Area during the spring and fall migration seasons, using nocturnal acoustic detection devices. Bat activity monitoring was conducted in the Project Area in 2016 from April 28 or 29 through June 9, 10, 11 or 12 to monitor the peak bat spring migration period and July 13 or 14 through October 16 to monitor the peak fall bat migration period. Eight bat detectors were deployed at six locations in the Project Area, including two detectors raised to a height of 30 m, each of the raised detectors was paired with a ground-level detector.

Within the Project Area, overall bat activity levels recorded were low, relative to bat activity levels recorded at other wind power facilities within the province. 1.89 bat passes/detector night were recorded in the spring and 3.66 bat passes/detector night were recorded in the fall. Bat activity levels recorded at other wind power facilities in southern Alberta range from 0.78 to 14.81 bat passes/detector night (Baerwald and Barclay 2009).

The bat survey results indicate that multiple bat species passed through, and/or use the Project Area. Four species of bats were positively identified, including big brown bat, silver-haired bat, hoary bat, and red bat. The latter three are listed provincially as “Sensitive” based on their susceptibility to mortality associated with wind power facilities (ASRD 2012).

Bat activity varied throughout the monitoring period, with three identified bat detection peaks occurring in 2016 on May 17, May 23, and May 26 in the spring and July 22, 24, and 29 in the fall. During these peaks in detection, the most common species were hoary bats and “low frequency” bats in the spring and “high frequency” and low frequency bats in the fall.

In the spring, 10.8% of bat passes were identified as hoary bats, 5.3% as silver-haired bats, and 0.6% as red bats. In the fall, bat activity levels were the lowest at raised detectors compared to corresponding paired detectors at ground level. In the fall, 6.5% of bat passes were identified as silver-haired bats, 5.1% as hoary bats, and 1.3% as red bats. An estimated 168 migratory bat passes or 2.75 bat passes/detector night were also detected in the fall at the detectors deployed at a 30 m height.

Appendix E provides additional details regarding the findings of the bat surveys.

3.8.3.7 Raptor Nest Survey

A raptor nest search was conducted in the Project Area and 1 km buffer of the Project Area in conjunction with rounds one and two of the breeding bird survey conducted from June 7 to 12 and June 21 to 24, 26, 28, 2016. Four active red-tailed hawk nests and two active Swainson’s hawk nests were found. Eight other active raptor nests were incidentally observed during the 2016 wildlife surveys. These included seven additional red-tailed hawk nests, and one Swainson’s hawk nest.

3.8.3.8 Breeding Bird Survey

Breeding bird surveys were conducted over two site visits during the summer of 2016 (June 7 to 12 and June 21 to 24, 26 and 28).

A total of 807 individual birds of 36 species were observed at 85 plots. The most common species detected were clay-coloured sparrow, savannah sparrow, and red-winged blackbird.

Listed species observed included Baird's sparrow (1), barn swallow (14), common yellowthroat (3), eastern phoebe (2), least flycatcher (6) and Sprague's pipit (2).

Appendix E provides additional details regarding the findings of the breeding bird surveys.

3.8.3.9 Incidental Observations

All incidental wildlife sightings were noted during each wildlife survey, and incidental wildlife observations of species of special concern were made. A total of 30 listed species were observed incidentally. Of these observations, Baird's sparrow, barn swallow, Loggerhead shrike, short-eared owl and Sprague's pipit are federally listed (ASRD 2012; COSEWIC 2016).

Appendix E contains a full list of incidental wildlife observations.

3.8.3.10 Species of Special Concern

Species of special concern include all species provincially (*Alberta Wildlife Act*) or federally (COSEWIC 2016; SARA 2016) listed as Endangered, Threatened or Special Concern, as well as species identified as "May Be at Risk" or "Sensitive" through the Alberta General Status (ASRD 2012). Thirty provincially and / or federally listed wildlife species were observed within the Project Area (Table 3.8-1). Appendix E contains a full list of list species of special concern with the potential to occur in the Project Area.

Table 3.8-1: Listed Wildlife Species Observed

Common Name	Latin Name	Provincial Status[a]	Federal Status – Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[b]	*Species at Risk Act* Registry[c]
American green-winged teal	*Anas crecca*	Sensitive	-	-
American kestrel	*Falco sparverius*	Sensitive	-	-
American white pelican	*Pelecanus erythrorhynchos*	Sensitive	Not At Risk	-
Baird's sparrow	*Ammodramus bairdii*	Sensitive	Special Concern	-
bald eagle	*Haliaeetus leucocephalus*	Sensitive	Not At Risk	-
barn swallow	*Hirundo rustica*	Sensitive	Threatened	-
black tern	*Chlidonias niger*	Sensitive	Not At Risk	-
broad-winged hawk	*Buteo platypterus*	Sensitive	-	-
common yellow throat	*Geothlypis trichas*	Sensitive	-	-
eastern phoebe	*Sayornis phoebe*	Sensitive	-	-
golden eagle	*Aquila chrysaetos*	Sensitive	Not At Risk	-
great blue heron	*Ardea herodias*	Sensitive	-	-
least flycatcher	*Empidonax minimus*	Sensitive	-	-
lesser scaup	*Aythya affinis*	Sensitive	-	-
loggerhead shrike (Prairie population)	*Lanius ludovicianus excubitorides*	Sensitive	Threatened	Schedule 1: Threatened

Table 3.8-1: Listed Wildlife Species Observed

Common Name	Latin Name	Provincial Status[a]	Federal Status – Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[b]	*Species at Risk Act* Registry[c]
northern harrier	*Circus cyaneus*	Sensitive	Not At Risk	-
northern pintail	*Anas acuta*	Sensitive	-	-
pied-billed grebe	*Podilymbus podiceps*	Sensitive	-	-
pileated woodpecker	*Dryocopus pileatus*	Sensitive	-	-
plains garter snake	*Thamnophis radix*	Sensitive	-	-
prairie falcon	*Falco mexicanus*	Sensitive	Not At Risk	-
sandhill crane	*Grus canadensis*	Sensitive	-	-
sharp-tailed grouse	*Tympanuchus phasianellus*	Sensitive	-	-
short-eared owl	*Asio flammeus*	May Be At Risk	Special Concern	Schedule 1: Special Concern
sora	*Porzana caroline*	Sensitive	-	-
Sprague's pipit	*Anthus spragueii*	Sensitive	Threatened	Schedule 1: Threatened
Swainson's hawk	*Buteo swainsoni*	Sensitive	-	-
upland sandpiper	*Bartramia longicauda*	Sensitive	-	-

(a) ASRD 2012.

(b) COSEWIC 2016.

(c) SARA 2016.

3.8.4 Potential Effects, Mitigation and Predicted Residual Effects

3.8.4.1 Potential Effects

The potential effects of the Project on wildlife and wildlife habitat include:

- mortality – due to site clearing and construction, collision with wind turbines, increased vehicle-wildlife collisions, or attraction to waste at work sites that result in ingestion of hazardous material or management actions to deter/remove wildlife;
- habitat loss and fragmentation – due to vegetation clearing and construction of Project infrastructure; and
- habitat avoidance or reduced reproductive success – due to sensory disturbance.

Potential effects on wildlife and wildlife habitat are summarized in Table 3.8-2. Effects on wildlife and wildlife habitat are expected during construction, operation, and decommissioning of the Project.

Table 3.8-2: Potential Effects of the Project on Wildlife and Wildlife Habitat

Potential Effect	Project Phase	Short Description of Potential Effect	Potential Wildlife Taxa Affected
Mortality	Construction	In the event wildlife is exposed to hazardous materials, wildlife mortality may occur	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
		In the event clearing and construction activities occur within the main wildlife breeding periods, wildlife mortality may occur	Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Amphibians
		Collision with construction vehicles	Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
	Operation	Collision with turbines	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds
		Collision with operation/maintenance vehicles	Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
	Decommissioning	In the event wildlife is exposed to hazardous materials, wildlife mortality may occur	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians

Table 3.8-2: Potential Effects of the Project on Wildlife and Wildlife Habitat

Potential Effect	Project Phase	Short Description of Potential Effect	Potential Wildlife Taxa Affected
		Collision with construction vehicles used for decommissioning	Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
		In the event clearing and decommissioning activities occur within the main wildlife breeding periods, wildlife mortality may occur	Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
Habitat loss and fragmentation	Construction	Vegetation clearing to support construction of the Project will result in site-specific habitat loss and fragmentation and may affect wildlife habitat use, species richness and abundance.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
	Operation	Project infrastructure will reduce the amount of suitable habitat available for wildlife and may affect wildlife habitat use, species richness, abundance and the dynamics of the ecosystem.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
	Decommissioning	Vegetation clearing to support decommissioning of the Project will result in site-specific habitat loss and may affect wildlife habitat use.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
Habitat avoidance or reduced reproductive success	Construction	Increased human activity levels and sensory disturbance in association with the construction of the Project may cause wildlife to avoid habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians

Table 3.8-2: Potential Effects of the Project on Wildlife and Wildlife Habitat

Potential Effect	Project Phase	Short Description of Potential Effect	Potential Wildlife Taxa Affected
	Operation	Presence of turbines and increased human activity associated with operation/maintenance of the Project may cause wildlife to avoid habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians
	Decommissioning	Increased human activity levels and sensory disturbance in association with decommissioning of the Project may cause wildlife to avoid habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project.	Migrating and resident bats Raptors Grassland birds Migrating songbirds Shorebirds Sharp-tailed grouse Mammals Amphibians

3.8.4.2 Mitigation

Mitigation measures will be implemented to reduce the potential effects of the Project on wildlife. Capital Power will/has implemented the following mitigation measures during the planning, construction, operation and decommissioning of the Project:

1) There are no named lakes located within the Project Area.
2) Turbines and other Project components were sited in agricultural/pasture, cultivated land and modified pasture land cover types (representing 98% of the Project footprint); these land cover types represent low suitability habitat for most wildlife species, particularly for species of special concern.
3) Where possible, existing access roads will be used.
4) Turbines were not sited in rows and are spaced a minimum of 360 m apart to avoid acting as a barrier to bird and bat movement.
5) Turbines were sited a minimum of 168 m from Paintearth Creek and Battle River coulees, a terrain feature that tends to concentrate migratory bird species (e.g., Kerlinger 1989).
6) Turbines were set back a minimum of 160 m from Class III-V wetlands.
7) Turbines were set back a minimum of 260 m from known Swainson's hawk and red-tailed hawk nests.
8) No Project components will be constructed within 500 m of known sharp-tailed grouse leks.
9) The *Migratory Bird Convention Act* (MBCA) applies to most migratory birds. Birds not falling under federal jurisdiction within Canada include grouse, quail, pheasants, ptarmigan, hawks, owls, eagles, falcons, cormorants, pelicans, crows, jays, kingfishers, and some species of blackbirds. Most bird species not covered by the MBCA are covered by the *Alberta Wildlife Act. C*onstruction activities may occur within the nesting period for migratory birds (April 17 to August 28, for this bird conservation region). To the extent possible all vegetation including agricultural/pasture, cropland and modified pasture will be cleared outside of the migratory bird nesting period. In the event of clearing activities occur within the Restricted Activity Period for migratory birds (April 17 to August 28), non-intrusive methods will be used to conduct an area search for evidence of nesting (e.g., presence of singing birds, territorial male, alarm calls, distraction displays, non-intrusive nest surveys) in advance of clearing and construction activities to avoid effects on nesting birds. Capital Power will develop a Project specific Breeding Bird and Nest Management Plan that applies to federal and provincial species of concern, including migratory birds. This plan will outline due diligence activities, timing for required nest sweep surveys and will outline site-specific mitigation measures (e.g., clearly marked species-specific protective buffer around the nest) for each nest found with follow-up recommendations.

10) Prior to any construction activities occurring within 100 m of Class III-V wetlands, a non-intrusive field survey will be conducted by a qualified wildlife specialist to avoid effects on breeding amphibians. In the event that breeding habitat is found, it may be subject to site-specific mitigation measures (e.g., deferring construction, species-specific protective buffer around the breeding area, amphibian relocation) based on discussions with AEP. Effects on breeding ponds can be mitigated during construction to prevent disturbance to the breeding period for amphibians through enclosures/exclosures and/or relocation.

11) Construction activities will be avoided during non-daylight periods, where practical, as many species of concern are nocturnal.

12) Reduced traffic speeds will be in effect on access roads.

13) Lighting for ground infrastructure will be reduced, downshielded, and controlled by proximity sensors. The minimum number of lights required by Transport Canada will be used on the turbines, with the minimum number of synchronized flashes per minute and minimum flash duration. Lighting for on-ground facilities will be minimized, down-shielded, and controlled by proximity sensors, wherever possible.

14) Temporary disturbance from the underground collector system and temporary access roads not required for operation, will be reclaimed following construction. Approximately 0.04 ha of native prairie will be temporarily disturbed during construction of access roads. Where native prairie is disturbed, sod will be stripped, conserved and replaced in as short a time as possible following construction. Native grass and forb seed mixes will be used as appropriate.

15) Wildlife will not be fed or harassed.

16) Construction activities will follow best management practices for collection and disposal of all construction-related garbage, debris, wastes, and hazardous materials.

17) The following will be implemented to reduce construction noise;

    a. vehicles and construction equipment with internal combustion engines used during construction and operation will be fitted with muffler systems in good working order;

    b. vehicle and machinery emissions will be minimized by turning vehicles and equipment off when not in use (no idling unless necessary);

    c. equipment will be operated at optimum rated loads;

    d. routine equipment maintenance procedures will be followed; and

    e. all vehicles and machinery will be in good working order.

18) A draft Post-Construction Mitigation and Monitoring Plan (PCMMP) has been developed for the Project (Appendix G), and will be finalized in consultation with AEP. The PCMMP will be implemented to characterize the effects of Project operation on birds and bats and to evaluate the need for operational mitigation.

19) It is recommended vegetation clearing for Project infrastructure (i.e., access road, underground collector lines, and temporary work space) occurs outside of the 100 m buffer of known active raptor nests during the raptor nesting period (March 15 to July 15). If this is not feasible and activity is scheduled to occur within the buffers during the raptor nesting period, a Breeding Bird Nest Management Plan will be implemented.

3.8.4.3 Predicted Residual Effects

The predicted residual Project effects on wildlife and wildlife habitat are presented in Table 3.8-3.

Table 3.8-3: Predicted Effects of the Project on Wildlife and Wildlife Habitat

Potential Effect	Project Phase	Mitigation [(a)]	Description of Predicted Residual Effect	Summary of Residual Effect[(b)]
Mortality	Construction	15, 16	Change in wildlife abundance due to attraction and exposure to hazardous materials during construction may harm or kill wildlife in the Project Area. The implementation of the mitigation summarized in Section 3.9.4.2 is expected to minimize wildlife interactions during construction and mortality due to hazardous materials is predicted to have a negligible net effect on wildlife populations in the Project Area.	No Residual effect
		2, 6, 7, 8, 9, 10	Nests, roosts or dens for a variety of wildlife taxa could be destroyed during clearing and construction for Project infrastructure and turbine locations. The *Migratory Birds Convention Act*, 1994 (MBCA 2003) prohibits the destruction of migratory bird nests (e.g., passerines and waterfowl) during the breeding season. The *Alberta Wildlife Act* (AWA) is provincial legislation that restricts disturbance to a house, nest or den of prescribed wildlife species and provides additional protection for species that may not be covered under the MBCA (e.g., raptors). The implementation of the mitigation summarized in Section 3.9.4 are expected to avoid and minimize wildlife mortality during construction and result in compliance with the MBCA and AWA. Vegetation clearing and construction is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
		3, 11, 12	The development of new access roads and increase in vehicles during construction could increase wildlife mortality through vehicle-animal collisions (Jalkotzy et al. 1997; Trombulak and Frissell 2000). These incidents are considered to be rare, but could occur more frequently on local secondary roads where construction traffic volumes (and speeds) are greater. The implementation of the mitigation summarized in Section 3.9.4.2 is anticipated to result in minor changes to survival and reproduction of wildlife from vehicle strikes. New access and increased vehicles is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
	Operation	1, 2, 4, 5, 6, 7, 13, 18	Collision with turbines could cause injury or mortality to birds and bats. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize collision risk; however, collision mortality is predicted to have a residual effect on bird and bat populations in the Project Area.	**Residual effect**
		11, 12	The use of access roads during operational maintenance could increase wildlife mortality through vehicle-animal collisions. Small, less mobile species, such as amphibians, may be affected by traffic associated with operation of the proposed Project. The implementation of the mitigation summarized in Section 3.9.4.2 is anticipated to result in minor changes to survival and reproduction of wildlife from vehicle strikes. Use of access roads during operational maintenance is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
	Decommissioning	15, 16	Change in wildlife abundance due to attraction and exposure to hazardous materials during decommissioning may harm or kill wildlife in the Project Area. The implementation of the mitigation summarized in Section 3.9.4.2 is expected to minimize wildlife interactions during construction and mortality due to hazardous materials is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
		3, 11, 12	The use of access roads and increase in vehicles during decommissioning could increase wildlife mortality through vehicle-animal collisions. These incidents are considered to be rare, but could occur more frequently on local secondary roads where decommissioning traffic volumes (and speeds) are greater. Small, less mobile species, such as amphibians, may be affected by traffic associated with decommissioning of the Project. The implementation of the mitigation summarized in Section 3.9.4.2 is anticipated to minimize wildlife mortality from vehicle strikes. Use of access roads during decommissioning is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
		2, 6, 7, 8, 9, 10	Nests, roosts or dens for a variety of wildlife taxa could be destroyed during activities associated with decommissioning and reclamation. The implementation of the mitigation summarized in Section 3.9.4.2 is expected to avoid and minimize wildlife mortality during construction and result in compliance with the MBCA and AWA. Activities associated with decommissioning are predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
Habitat loss and fragmentation	Construction	1, 2, 3, 6, 8, 10, 14, 19	Habitat loss and fragmentation may affect wildlife habitat use during construction and may alter species richness and abundance in the Project Area. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize effects due to changes in habitat' however, habitat loss and fragmentation are predicted to have a residual effect on wildlife populations in the Project Area.	**Residual effect**
	Operation	1, 2, 3, 4, 5, 6, 7, 8, 14, 19	Habitat loss and fragmentation may affect wildlife habitat use during operation and may alter species richness and abundance in the Project Area, may increase nest predation, brood parasitism or change the predator community composition and behaviour. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize effects due to changes in habitat; however, habitat loss and fragmentation are predicted to have a residual effect on wildlife populations in the Project Area.	**Residual effect**
	Decommissioning	1, 2, 3, 8, 14, 19	Habitat loss may affect wildlife habitat use during decommissioning and may alter species richness and abundance in the Project Area. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize effects due to changes in habitat. Habitat loss during decommissioning will be temporary while turbines are disassembled and associated infrastructure is removed. Habitat will be reclaimed to pre-construction land use and access roads will be removed from the landscape. There is reasonable certainty in the success of reclamation because over 98% of the Project footprint is comprised of cultivated land, agriculture or tame pasture under baseline conditions. Therefore, following decommissioning the effects of habitat loss and alteration are predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
Habitat avoidance or reduced reproductive success	Construction	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 13, 17, 19	Increased human activity levels and sensory disturbance may cause wildlife to avoid habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project due to increased physiological stress. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize effects due to sensory disturbance; however, sensory disturbance during construction is predicted to have a residual effect on wildlife populations in the Project Area.	**Residual effect**
	Operation	1, 2, 3, 4, 5, 6, 7, 8, 13, 18	Presence of turbines and increased human activity associated with operation/maintenance of the Project may cause wildlife to avoid habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project. Noise generated during operation is less than that during construction and decommissioning because there is no heavy machinery or concentrated activities that would generate noise. Human disturbance at the site is minimal during operation and only a few onsite personnel are required for occasional maintenance of turbines. Some grassland species (e.g., Sprague's pipet) may avoid anthropogenic disturbance, however, a recent study in Alberta mixed-grass prairie suggests that reproductive success of grassland songbirds is not correlated with anthropogenic noise (Bernath-Plaisted and Koper 2016). Effects on wildlife due to habitat loss and fragmentation is addressed separately above. Wildlife avoidance or reduced reproductive success due to sensory disturbance in the Project Area during operation is predicted to have a negligible net effect on wildlife populations in the Project Area.	No residual effect
	Decommissioning	1, 2, 3, 5, 6, 7, 8, 9, 11, 13, 17, 19	Increased sensory disturbance (e.g., noise) associated with decommissioning of the Project could cause temporary wildlife avoidance of habitat adjacent to the Project or may reduce reproductive success of wildlife in habitat adjacent to the Project due to increased physiological stress. The implementation of the mitigation summarized in Section 3.9.4.2 is predicted to minimize effects due to sensory disturbance; however, sensory disturbance during decommissioning is predicted to have a residual effect on wildlife populations in the Project Area.	**Residual effect**

(a) Mitigation cited in this table corresponds to the mitigation defined in Section 3.9.4.2

(b) Residual effects after mitigation are **bolded** and evaluated in Section 3.9.5. Potential effects with no predicted residual effect after mitigation are not further evaluated.

3.8.5 Evaluation of Predicted Residual Effects of the Project

The residual effects on wildlife and wildlife habitat are based on residual effects criteria presented in Table 2.9-1. For wildlife, magnitude is a function of the numerical and qualitative changes in measurement parameters and the associated influence on the abundance and distribution of the wildlife and wildlife habitat VCs. Changes in physical (e.g., habitat quantity, quality, and fragmentation) and biological (e.g., survival, reproduction, movement, and behaviour) measurement parameters result in effects on the abundance and distribution of populations. The magnitude of residual effects is assessed at the population level because the maintenance of self-sustaining and ecologically effective wildlife populations is a common objective for wildlife managers and is an indicator of environmental integrity. Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating random demographic processes (Reed et al. 2003). Ecologically effective populations are those that are large enough to maintain ecosystem function (e.g., pest control by bats).

Critical thresholds such as amount of quality habitat required to maintain a self-sustaining population or the specific number of individuals required for an ecologically effective population size are not available for wildlife evaluated in this assessment. Moreover, ecological thresholds vary by species, landscape type, and spatial scale (Fahrig 1997; Swift and Hannon 2010). Consequently, a qualitative discussion of the predicted effects associated with changes to wildlife populations in general, with reference to species-specific examples as appropriate is provided. The discussion is supported with available scientific literature, baseline data collected for the Project, logical reasoning and experience of the practitioners completing the assessment (a reasoned narrative approach). Because of the uncertainty regarding the effects of development on the wildlife and wildlife habitat VCs, magnitude classification was applied conservatively to avoid underestimating effects.

A summary of the residual effects evaluation is provided in Table 3.8-4 and a rationale for the classification is provided in the sections below.

Table 3.8-4: Predicted Residual Project Effects Description and Importance for Wildlife and Wildlife Habitat

Predicted Residual Effect	Effects Assessment Criteria[a]				Importance	Likelihood
	Direction	Magnitude	Geographic Extent	Duration		
Bird and bat mortality due to collision with turbines during operation	Negative	Medium	Regional	Medium-term	Low	Likely
Changes in wildlife habitat use due to habitat loss and fragmentation during construction and operation	Negative	Low	Local	Long-term	Low	Likely
Habitat avoidance or reduced reproductive success due to increased sensory disturbance during construction and decommissioning	Negative	Low	Local	Short-term	Minimal	Likely

[a] Effects assessment criteria are defined in Table 2.9-1. Importance and likelihood are defined in Table 2.9-2 and Table 2.9-3, respectively.

Bird and bat mortality due to collision with turbines during operation

Collision with turbines could cause injury or mortality to birds and bats during operation. High bird and bat mortality can occur in areas with high bird or bat densities, areas with landscape features that funnel bird or bat movement (e.g., ridges, steep slopes and valleys) and occasionally as a result of extreme weather conditions. Appropriate siting of turbines is the most effective mitigation to reduce mortality risk due to collision with turbines.

Generally, the potential for bird and bat collision was reduced by the following mitigation techniques incorporated into the early planning stages of the Project, as outlined in the Directive (AEP 2017a). Most of the Project Area is characterized by open, flat, cultivated land or modified pasture (Section 3.1). However, landscape features including the Battle River valley located north of the Project Area and the Paintearth Creek located south of the Project Area and their associated coulees, draws, and native habitat are considered to be higher potential habitat for birds and bats. Pre-construction wildlife surveys were conducted to identify wildlife features such as sharp-tailed grouse leks and raptor nests. Sensitive species, such as sharp-tailed grouse and ferruginous hawk, were not identified in the Project Area. Fifteen active red-tailed hawk and Swainson's hawk nests (including one presumed Swainson's hawk nest) were identified and for seven of these, Capital Power has adhered to a 500 m setback from all Project infrastructure. Turbines were set back a minimum of 260 m from the remaining known Swainson's hawk and red-tailed hawk nests. Project infrastructure will encroach on the 100 m setback requirements of three raptor nests including:

- a permanent access road within 100 m of red-tailed hawk nest 06;
- underground collector line within 100 m of red-tailed hawk nest 07; and
- temporary workspace for the substation within 100 m of Swainson's hawk nest 02 (Appendix E, Figure 1).

To minimize the probability of nest abandonment, it is recommended that vegetation clearing within 100 m of these nests will be conducted outside of the raptor nesting period (March 15 to July 15), if this is not feasible and activity is scheduled to occur within the buffers during the raptor nesting period then a Breeding Bird Nest Management Plan will be implemented. Temporary surface disturbance will be reclaimed following construction.

A precautionary estimate of migratory bat activity documented at the detectors deployed at a 30 m height within the Project Area between August 1 and September 10, 2016 was 2.75 bat passes/detector night. According to AEP's Bat Mitigation Framework (ESRD 2013d), the Project Area is rated as having "potentially high risk" of bat fatalities because the bat activity documented within the Project Area is greater than 2 migratory bat passes/detector night. Bat detectors located in closest proximity to the Battle River and associated draws and coulees and the Paintearth Creek and associated coulees which contain a tributary to the Battle River had the highest migratory bat activity levels (Appendix E, Figures 6 and 10). It is anticipated that proximity to these habitat features contributes to the higher levels of bat activity recorded during the fall migration monitoring. Careful planning and design led to the placement of turbines outside these areas of highest bat migration with the exception of T051 (Appendix E, Figure 1). The results of predicted effects on bats are low after mitigation is applied. Capital Power will engage with AEP about possible operational mitigation and post-construction monitoring to help ensure Project effects on migratory bats are acceptable.

Collision risk was highest for waterfowl and passerines during spring and fall migration and several listed species had a non-zero collision risk index including sandhill crane, Swainson's hawk, northern harrier, northern pintail, and American white pelican. Areas of highest use by migratory birds varied by season but was generally concentrated around the perimeter of the Project Area and in the centre of the Project Area (Section 3.8.3). The placement of turbines has largely avoided these areas (Appendix E, Figure 1). Lighting requirements on wind turbines can attract migrating birds and increase their collision risk. The implementation of the mitigation summarized in Section 3.8.4.2 is predicted to minimize collision risk for migratory birds due to lighting. Capital Power has developed a post-construction monitoring and mitigation plan (Appendix G) to help ensure effects on migratory birds are acceptable.

Increased wildlife mortality during operation due to collision with turbines is predicted to be negative in direction and medium in magnitude because after mitigation, mortality of bat species listed provincially as “Sensitive” (e.g., hoary bat, silver-haired bat) is likely to occur, but not at rates that would affect the population status of those species. Mortality of federally Endangered little brown *myotis* is likely, and mortality of provincially “Sensitive” and federally Threatened Sprague’s pipit is possible because these species were detected in the Project Area during baseline surveys (Appendix E). Most of the breeding bird plots where Sprague’s pipit was detected are located at least a quarter section away from the nearest turbine, suggesting collision risk for this species is minimal. Turbines 106 and 033 are located in proximity to breeding bird plots where Sprague’s pipit was detected at baseline. These pairs of Sprague’s pipet may experience increased mortality during the breeding season due to their aerial display behaviour. However, Sprague’s pipit is sensitive to habitat fragmentation (Koper et al. 2009; Thompson et al. 2015), and may be displaced during construction and operation, thereby reducing its mortality risk due to collision with turbines. It is likely that breeding pairs would establish breeding territories elsewhere, where suitable habitat exists.

The geographic extent is regional. Although mortality events would be restricted to the Project Area, effects on migrating birds and bats could affect wildlife populations that extend beyond the Project Area. The effect is reversible over the medium-term because mortality due to collision with turbines will cease when turbines are decommissioned. These effect characteristics lead to an overall effect of low importance and the effect is considered likely to occur (Table 3.8-4).

Changes in wildlife habitat use due to habitat loss and fragmentation during construction and operation

Vegetation clearing during construction will result in site-specific habitat loss. Fragmentation due to Project infrastructure may reduce the quality of remaining habitat patches throughout operation. Adverse effects of increased habitat fragmentation may include increased nest predation and brood parasitism (Gates and Gysel 1978; Johnson and Temple 1990), and may change predator community composition and behavior (Bernath-Plaisted and Koper 2016). It’s important to note that the existing Project Area consists approximately of greater than 78% disturbed habitat such as agricultural/pasture, cultivated land and modified habitat. Approximately 12% of the Project area consists of native prairie, wetlands comprise 8% and wooded or treed habitat comprises 1% of the Project Area. In addition, there are 40 residences in the Project Area.

Habitat loss was minimized by siting turbines primarily in disturbed areas that provide lower quality habitat for wildlife compared to native prairie. Habitat fragmentation was minimized using existing access, where possible. In addition, portions of the Project footprint not required for operation will be reclaimed following construction. Where native prairie is disturbed (i.e., approximately 0.4 ha; Table 3.1-2) sod will be stripped, conserved and replaced in as short a time as possible following construction. Native grass and forb seed mixes will be used as appropriate. After mitigation, Project infrastructure will likely lead to a small incremental increase of habitat fragmentation in the

Project Area and may result in reduced abundance of species that are sensitive to human disturbance, such as Sprague's pipit.

Amphibians may be particularly sensitive to habitat fragmentation due to their low mobility. Increased access in the Project Area may limit or alter amphibian movement and their use of remaining habitat if roads are sited between breeding ponds and foraging or overwintering habitat. Baseline surveys for amphibians were not conducted with the understanding that Project infrastructure would be sited 100 m from all Class III or higher wetlands that support breeding amphibians. Turbine siting has adhered to the 100 m setback requirement; however, the substation is located approximately 76 m from a Class III or higher wetland. An estimated 126 Class III or higher wetlands fall within 100 m of access roads or the underground collector system during construction. Of these, 74 will remain within the 100 m setback during operation. An estimated 17 Class III or higher wetlands are predicted to be directly disturbed due to access roads or the underground collector system, of which 10 would be permanently disturbed during operation. Prior to any construction activities occurring within 100 m of Class III-V wetlands, a non-intrusive field survey will be conducted to determine presence of breeding individuals and avoid effects on breeding amphibians. Capital Power will discuss findings and the need for additional mitigation with AEP to help ensure potential effects on amphibians are acceptable. Additional mitigation and best management practices described in Section 3.7 are predicted to minimize adverse effects of temporary and permanent disturbance of wetlands in the Project Area.

Habitat loss/alteration during Project construction and operation is predicted to be negative in direction and low in magnitude because 98% of temporary and permanent disturbance is located in habitat with existing human disturbance (i.e., agriculture/pasture, cultivated land and modified pasture). The geographic extent is local because habitat loss and fragmentation is restricted to the Project Area and is therefore predicted to affect wildlife in the Project Area. The effect is predicted to be reversible over the long-term because habitat will be restored when turbines and associated infrastructure are decommissioned. These effect characteristics lead to an overall effect of low importance and the effect is considered likely to occur (Table 3.8-4).

Habitat avoidance or reduced reproductive success due to increased sensory disturbance during construction and decommissioning

Increased sensory disturbance (e.g., noise) associated with the construction and decommissioning of the Project could cause temporary wildlife avoidance of habitat in the Project Area or reduced reproductive success due to physiological stress (Dahlgren and Korschgen 1992). In general, sensory disturbance effects on wildlife abundance are most detrimental at key times of the year, such as during the reproductive season (spring or early summer), when wildlife are raising young (Kuck et al. 1985; Yarmoloy et al. 1988). Depending on the timing and level of stress, other potential stresses to animals from noise can include interference with communication and reduced reproductive success, particularly for bird and amphibian species (Habib et al. 2007). Noise levels in the Project Area will be elevated during Project construction as a result of clearing, grading, foundation building, and turbine assembly. However, noise dissipates quickly. In addition, the duration of construction at any one location along the Project will be limited and intermittent in different areas of the Project layout; thereby reducing the amount of time a given location will be exposed to Project-related noise and the presence of construction workers.

Little information is available regarding the physiological effects of sensory disturbance on wildlife indicators. Physiological stress as a result of sensory disturbance has not been measured directly, as the less apparent long-term effects on wildlife physiology and reproduction are difficult to observe and predict. A recent study by Bernath-

Plaisted and Koper (2016) in Alberta mixed-grass prairie suggests that reproductive success of grassland songbirds is not correlated with noise associated with oil and gas infrastructure, but did not evaluate the more intense, but temporary, noise associated with construction equipment and activities. Heavy equipment (i.e., large cranes) associated with turbine assembly and installation may displace animals, cause stress, and result in reduced breeding success. Potential mitigation to limit such impacts include clearing vegetation outside of the typical migratory bird nesting period (April 17 to August 28), reducing construction noise by fitting vehicles and construction equipment with internal combustion engines with muffler systems, minimizing vehicle and machinery emissions by turning vehicles and equipment off when not in use, ensuring all vehicles and machinery are in good working order and restricting construction activities to the surveyed Project footprint.

Habitat avoidance and reduced reproductive success during construction and decommissioning of the Project due to sensory disturbance is predicted to be negative in direction and low in magnitude because vegetation clearing and is scheduled to occur outside of the typical migratory bird nesting period (April 17 to August 28) to remove suitable nesting habitat from the Project footprint and mitigation do reduce construction noise will be implemented during construction and decommissioning. The geographic extent is local because sensory disturbance is predicted to affect wildlife in the Project Area. The effect is predicted to be reversible upon completion of construction and decommissioning. These effect characteristics lead to an overall effect of minimal importance and the effect is considered likely to occur (Table3.8-4).

3.8.5.1 Determination of Significance

Residual effects (i.e., after mitigation) were predicted for the following Project effects on wildlife:

- bird and bat mortality due to collision with turbines during operation;
- changes in wildlife habitat use due to habitat loss and fragmentation during construction and operation; and
- habitat avoidance or reduced reproductive success due to sensory disturbance during construction and decommissioning.

Project effects were considered to be of minimal to low importance and likely to occur are determined to be not significant. Therefore, with implementation of mitigation measures described in Section 3.8.4.2, the predicted residual effects of the Project on wildlife and wildlife habitat are not expected to result in a change that will alter the sustainability of wildlife and wildlife habitat beyond a manageable level.

There is a moderate level of confidence in the predictions for wildlife and wildlife habitat because the Project has been appropriately sited in agricultural/pasture, cultivated land and modified pasture land cover types. The largest source of uncertainty is related to mortality of listed species of birds and bats due to collisions with turbines. If the population status of these species (e.g., hoary bat, silver-haired bat, Sprague's pipit), or others (e.g., little brown *myotis*) deteriorate during operation of the Project, then potential sources of mortality become increasingly important to manage. Capital Power will address this uncertainty through adaptive management as outlined in its proposed PCMMP (Appendix G).

3.9 Air Quality

3.9.1 Introduction

A desktop evaluation was conducted to determine baseline air quality conditions and the potential effects of Project construction, operation, and decommissioning on air quality. The following sections outline the methods used to assess air quality within the Project Area, identify potential effects that the Project may have on air quality, and describe proposed mitigation measures.

3.9.2 Baseline Data Collection Methods

3.9.2.1 Desktop Assessment

The Project Area is located in a rural area, approximately 130 km east of Red Deer. The air quality in the vicinity of the Project Area is influenced by power generation, mining (coal for power generation), oil and gas activity (including oil batteries and compressor stations), and agricultural activities (e.g., harvesting) that are present in the area.

Environment Canada operates a network of stations that collect climate data; climate normals, averages, and extremes are available for stations with at least 15 years of data collected between 1981 and 2010 (Environment Canada 2017). The closest Environment Canada climate station with the most complete data is the Forestburg Plant Site station, located approximately 15 km northwest of the Project near the Battle River Generating Station. Data for temperature and precipitation are available for this station, but wind data is not. Given the proximity of the station to the Project Area, the Forestburg site climate normals can be considered representative of the Project Area.

The Project Area does not lie within any of the operational airsheds in Alberta. The closest operational airshed, the Parkland Airshed Management Zone (PAMZ), encompassing 42,000 square kilometres including Red Deer and extending through central Alberta to the western Alberta border. The eastern edge of this airshed is approximately 80 km west of the center of the Project Area. The PAMZ operates four continuous air quality monitoring stations and a network of 34 passive monitoring stations.

The continuous monitoring stations, one located south of Caroline, two in Red Deer and the fourth portable station that changes location throughout the year, are all located some distance from the Project Area and would not be representative of air quality conditions in the Project Area. Data from the passive monitoring stations were thus used to characterize the air quality in the Project Area. The closest passive station is located near the eastern edge of the PAMZ at Alix, approximately 82 km east of the Project. Sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3) are monitored at all of the passive stations (PAMZ 2016).

3.9.3 Baseline Conditions

Data recorded by Environment Canada (2017) at Forestburg Plant Site (1981 to 2010) show that the daily average annual temperature ranges between -10.2 degrees Celsius (°C) in January to 18.4°C in July. The daily average temperature annually was 4.6°C between 1981 and 2010. The average annual total precipitation is 399 millimetres (mm), of which 322 mm is rain. Table 3.9-1 summarizes the climatological data recorded by Environment Canada at the Forestburg station.

Table 3.9-1: Climate Data at Forestburg Station, 1981 to 2010

Climate Parameter	Annual Average Value
daily average temperature	4.6°C
daily maximum temperature	10.0°C
daily minimum temperature	-0.8°C
extreme maximum temperature	37.5°C
extreme minimum temperature	-45.0°C
average annual rainfall	322.1 mm
extreme daily rainfall	81.8 mm
extreme daily snowfall	23.3 cm
average number of days with measurable precipitation	101.4 days

Source: Environment Canada 2017.

A summary of the passive monitoring results was included in the PAMZ 2015 Annual Report (PAMZ 2016). In 2015, the annual average SO_2 concentration at the Alix station was 0.5 parts per billion (ppb). The highest monthly average was 1.0 ppb, which occurred in January and February, and the lowest monthly average of 0.2 ppb was recorded in September. The annual average NO_2 concentration at the Alix station was 2.1 ppb. The highest monthly average of 4.9 ppb was recorded in December and the lowest monthly average of 1.0 ppb was recorded in May. The annual average O_3 concentration was 38.7 ppb at the Alix station. The highest monthly average of 53.7 ppb was recorded in February and the lowest monthly average of 28.4 ppb was recorded in December. These concentrations are well below the annual average SO_2 and NO_2 Alberta Ambient Air Quality Objectives of 8 and 24 ppb, respectively (AEP 2016e). Alberta does not have an annual average objective for ozone.

3.9.4 Potential Effects, Mitigation and Predicted Residual Effects

3.9.4.1 Potential Effects

All Project construction and decommissioning activities are expected to affect air quality through exhaust emissions and dust generation. The changes in air quality due to construction and decommissioning activities can affect other environmental components such as soil, vegetation, human and wildlife health, and water quality.

There are two primary sources of air emissions associated with Project construction and decommissioning that may affect air quality: road dust and mobile equipment exhaust. On-site vehicular traffic will be the primary source of dust from the Project during the construction and decommissioning activities. Mobile equipment includes cranes, haul trucks, dozers, excavators, and other support vehicles. The key emissions from mobile equipment exhaust are SO_2, oxides of nitrogen, carbon monoxide, and particulate matter with a diameter of less than 2.5 micrometres (µm) ($PM_{2.5}$).

3.9.4.2 Mitigation

The following mitigation measures will be implemented during construction and decommissioning to limit adverse effects to air quality:

- Stationary and mobile equipment will adhere to federal emission standards and will be regularly maintained. There are no Alberta emission standards for non-road diesel mobile equipment.

- Dust suppressant or water will be applied to construction areas in proximity to highways and residences to mitigate dust, as appropriate.
- Project traffic will be restricted to County or Project access roads.
- Project traffic will adhere to posted speed limits on County roads, County road bans, and reduced speed limits will be implemented on Project access roads.

3.9.4.3 Predicted Residual Effects

The predicted residual Project effect on air quality is:

- Adversely affect local air quality through combustion emissions and fugitive dust generation.

3.9.5 Evaluation of Predicted Residual Effects of the Project

A description of the potential effects of the Project on air quality and the importance of the predicted residual effects are provided in Table 3.9-2. The characterization of residual effects is based on the residual effects criteria presented in Table 2.9-1.

Table 3.9-2: Predicted Residual Project Effects Description and Importance for Air Quality

Predicted Residual Effect	Project Activity	Effects Assessment Criteria					Importance
		Direction	Magnitude	Geographic Extent	Duration	Probability of Occurrence	
Adversely affect local air quality through combustion emissions and fugitive dust generation	Construction and Decommissioning	Negative	Low	Local	Immediate	Likely	Minimal

Adversely affect local air quality through combustion emissions and fugitive dust generation

The residual effects on air quality from Project construction and decommissioning are expected to be negative and of low magnitude given mitigation measures will be in place to limit combustion emissions and fugitive dust. The effects are not expected to extend beyond the Project Area, so the geographic extent is local. The duration is immediate and infrequent, as it will occur only during construction and decommissioning. The importance of the residual effects on air quality is, therefore, expected to be minimal.

3.9.6 Determination of Significance

Combustion emissions and fugitive dust generation are expected to be produced only intermittently during construction and decommissioning and are considered to be of minimal importance. Mitigation will be implemented to minimize combustion emissions and fugitive dust and as a result, the Project is not expected to result in a substantial change to air quality that would result in exceedances of Alberta Ambient Air Quality Objectives. Therefore, the residual effects on air quality from the Project are predicted to be not significant.

3.10 Historical Resources

3.10.1 Introduction

Historic resources are defined by the Alberta *Historical Resources Act* (2000) as:

> *any work of nature or of humans that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest, including but not limited to, a palaeontological, archaeological prehistoric, historic or natural site, structure or object.*

The Alberta *Historical Resources Act* (2000) requires that proposed projects obtain *Historical Resources Act (HRA)* approval prior to initiating any development activities if those activities are likely to result in the alteration of, damage to or destruction of a historic resource. To comply with this requirement, a Statement of Justification (SoJ) and Historic Resources application for the Project were submitted to Alberta Culture and Tourism (ACT). Discussed below are the results of the SoJ, as well as the potential impacts to historic resources and mitigation measures to be implemented.

3.10.2 Baseline Data Collection Methods

3.10.2.1 Desktop Assessment

The desktop assessment of historic resources for the Project Area consisted of the preparation of a Statement of Justification (SoJ). The SoJ and Historic Resources application were submitted to Alberta Culture and Tourism (ACT) on August 31, 2016. This submission was based on a preliminary version of the Project layout. Alberta Culture and Tourism determined that a Historical Resource Impact Assessment is not required and granted Historical Resource Act (*HRA*) approval (HRA Number: 4941-16-0008) for Version 4 of the Project. The Final Version of the layout was compared against Version 4 to determine if additional studies are likely required. No additional studies are anticipated based on this comparison. An additional Historic Resources application was submitted on January 6, 2017 to ACT to review minor footprint changes in the Final Layout design and to obtain approval for the Project. The *HRA* approval letter for the preliminary Project layout is included in Appendix F.

3.10.2.2 Field Assessment

No field studies are required for the Project.

3.10.3 Baseline Conditions

The majority of the Project infrastructure is proposed to occur on lands that have been previously disturbed by agriculture or other industrial activities. As such, the likelihood that intact, previously unrecorded historic resources will be present within the Project footprint is considered low. Three previously recorded sites (FcOx-4, 12 and FcPa-8) are located within 50 m or less of Project infrastructure. All three of these sites are located in previously cultivated lands, indicating prior disturbance, and are all rated with a Historical Resource Value of 0 indicating that no further work is required for them and that they have low significance. Project effects on these sites are considered not significant, as the sites have already been impacted. No other known historic resources are likely to be affected by the Project.

3.10.4 Potential Effects, Mitigation and Predicted Residual Effects

3.10.4.1 Potential Effects

During land clearing and excavation activities for access road construction, foundation construction, use of temporary workspaces, use of temporary storage areas, installation of the electric collector system, and the electrical substation construction, historic resources may be discovered. Potential effects include damage to or destruction of artifacts. As the areas selected for Project infrastructure were identified as having low potential for historic resources, it is anticipated that no historic resources will be encountered during Project construction. Effects are not anticipated during decommissioning; any excavation or clearing that might occur during decommissioning would occur in areas previously disturbed during construction.

3.10.4.2 Mitigation

The following mitigation measures will be implemented:

- Project infrastructure is sited on lands with low potential for historic resources.
- In the unlikely event that historic resources are uncovered during ground disturbance activities, Project crews will be instructed to temporarily cease construction activities at that location and a Project representative will contact ACT for further instruction.

This strategy is in accordance with Section 31 of the *HRA,* which includes a condition attached to every approval stating that, should any historic resources be encountered during the conduct of any activities, the appropriate ACT staff must be contacted.

3.10.4.3 Predicted Residual Effects

Residual effects on historic resources are not anticipated.

4.0 POST-CONSTRUCTION MONITORING AND MITIGATION

Capital Power has prepared and committed to undertaking a post-construction monitoring and mitigation program, as required under the Directive (AEP 2017a). A draft PCMMP is provided in Appendix G. The PCMMP has been designed to document direct effects of Project operation on wildlife (i.e., birds and bats), by duplicating pre-construction inventory surveys and conducting mortality searches. The PCMMP will assess the effectiveness of ongoing mitigation efforts and determine whether additional or modified mitigation measures are warranted.

Post-construction monitoring for the Project will be carried out during the first three years of Project operation, and will consist of the following:

- duplication of select pre-construction wildlife inventory surveys;
- weekly bird and bat mortality searches at one-third of the turbines (25 of the 74 turbines), between March 1 and October 30. The same plots will be used for both bird and bat mortality searches;
- three searcher efficiency trials each season (i.e., spring, summer and fall) for each search technician;
- three scavenger impact trials, equally spaced out (i.e., early, middle and late), during each season;
- preparation and submission of annual reports that document the results of the searches and total mortality of birds and bats within the search areas.

The annual post-construction monitoring reports will be submitted to the AUC for review. If the AUC (in consultation with AEP) determines that bird and/or bat mortality rates exceed acceptable levels, operational mitigation measures will be implemented, as required.

5.0 SUMMARY OF ENVIRONMENTAL EVALUATION

Table 5.0-1 summarizes the predicted residual environmental effects and their significance, as described in the previous sections.

Table 5.0-1: Summary of Predicted Residual Effects(a)

VCs Subject to Effects	Project Phase	Potential Effects – Short Description	Summary of Mitigation Measures	Residual Predicted Effects	Predicted Level of Importance[(c)]	Significance[(d)]
Land cover	Construction, operation and decommissioning	– Loss or alteration of agricultural/pasture, cultivated land, and modified pasture	– -restrict disturbance to areas necessary for safe construction – restrict activity to Project footprint – reclamation is expected to return land to equivalent land cover capability	– Loss or alteration of agricultural/pasture, cultivated land, and modified pasture – Predicted residual effects related to native land cover and wetlands within the Project Area are discussed in Section 3.4 and 3.7, respectively.	Low	Not significant
	Decommissioning	– Reclamation of cultivated land and modified pasture	– Not applicable	– **Reclamation of cultivated land and modified pasture**	Low	
	Construction, operation and decommissioning	– Introduction or spread of weeds and/or non-native species	– all construction and decommissioning equipment will enter construction areas in a clean condition – vehicles and equipment that can potentially interact with the environment may be pressure washed before entering the workspace – eradicate any prohibited noxious weed species populations and control any noxious weed species populations identified within the Project footprint	– Introduction or spread of weeds and/or non-native species	Minimal	
Environmentally sensitive areas	Construction, operation and decommissioning	– Adverse effect to steep slopes – Adverse effects to native vegetation, sensitive species and large natural areas	– siting Project components outside of designated areas – Turbines were sited a minimum of 168 m from Paintearth Creek and Battle River coulees	– Predicted residual effects related to native habitat and sensitive species within the Project Area are discussed in Section 3.4 and 3.8, respectively.	n/a	n/a
Soils and Terrain	Construction and decommissioning	– Loss or alteration of soil capability and terrain	– topsoil and upper subsoil will be stripped and stockpiled for reclamation in areas of high Project disturbance – soil stripping in areas of sensitive soils will be limited to the extent possible – soil handling activities will not occur in coarse textured soils and moderately coarse textured soils during windy conditions – areas of steep terrain were avoided during Project siting – existing roads and trails will be used to the extent practical – heavy equipment and vehicle traffic will be restricted to Project footprint – heavy equipment activity will be restricted if wet soil conditions occur	– Loss or alteration of soil capability and terrain to support healthy ecosystems	Low	Not significant
Vegetation	Construction	– loss or alteration of native prairie and wooded land (including listed plant species to plant communities)	– upon finalization of the Project design, a targeted listed plant and ecological survey will be conducted where the Project footprint occurs in native prairie or wooded land; – the width of access roads and the size of workspaces will be limited to what is required to safely execute the Project; – where possible, existing access trails and roads will be used; – sod, topsoil and subsoil will be conserved in situ where stripping is not required; – the amount of topsoil stripping and grading will be limited through the use of matting, geo-textiles and/or working during frozen or dry ground conditions.	– loss or alteration of native pasture and wooded land (including listed plant species to plant communities)	Low	Not significant
	Decommissioning	– Reclamation of wooded land	– Not applicable	– **Reclamation of wooded land**	Low	
	Construction, operation and decommissioning	– Introduction or spread of weeds and/or non-native species	– all construction and decommissioning equipment will enter construction areas in a clean condition – - vehicles and equipment that can potentially interact with the environment (i.e., that will leave and/or clear the access road) may be pressure washed before entering the workspace – eradicate any prohibited noxious weed species populations and control any noxious weed species populations identified within the Project footprint	– Introduction or spread of weeds and/or non-native species	Minimal	
Surface water	Construction	– Redirection of runoff	– construction activities below the ordinary high water mark of a watercourse will be conducted in isolation when the watercourse is flowing, and bed and banks will be returned to conditions equal to or better than conditions prior to construction. – If flowing water is present, timing of construction activities will occur outside of the RAP. – If other construction activities take place within the vicinity of the watercourses, measures will be taken to minimize the potential for contamination due to silt or spills.	– Redirection of runoff	Minimal	Not significant
	Construction	– Potential for localized scour or bank erosion		– Potential for localized scour or bank erosion	Minimal to low	
	Construction	– Disturbance or alteration of riparian vegetation		– Disturbance or alteration of riparian vegetation	Minimal to low	

Table 5.0-1: Summary of Predicted Residual Effects(a)

<table>
<tr><th>VCs Subject to Effects</th><th>Project Phase</th><th>Potential Effects – Short Description</th><th>Summary of Mitigation Measures</th><th>Residual Predicted Effects</th><th>Predicted Level of Importance(c)</th><th>Significance(d)</th></tr>
<tr><td rowspan="2"></td><td>Construction</td><td>– Disturbance or alteration of in-stream fish habitat</td><td rowspan="2">– No vehicle and equipment refueling, maintenance, or washing will occur within 100 m of a water body.
– Watercourse crossing construction activities will take place during periods of low or no flow whenever possible to prevent or limit downstream sedimentation.
– For all watercourse crossings, the applicable Code of Practice notification will be submitted to AEP prior to affecting any watercourse or waterbody.
– All Best Management Practices and mitigations described under the Water Act Codes of Practice (ESRD 2013b,c), Alberta Transportation Fish Habitat Manual (AT 2001) and Measures to Avoid Causing Harm to Fish outlined by Fisheries and Oceans Canada (DFO 2017) will be followed.
– For watercourse crossings, all culverts will be designed to allow for sufficient drainage, based on drainage areas and predicted flood levels. Design of each crossing structure will mitigate watercourse erosion and ensure fish passage. Sediment and erosion control measures will be installed at each watercourse crossing and routinely inspected for damage and effectiveness over the duration of the Project and repaired and/or altered if needed
– For trenchless watercourse crossings, monitoring of drilling fluid volume and pressure, on-land monitoring for frac-outs, and monitoring of sediment concentrations in the watercourse (when water is present) will be completed.
– An appropriate frac-out contingency response plan will be in place and understood by crews on site, and all materials listed in the frac-out contingency response plan will be readily available to quickly contain the released drilling fluid in the event of a frac-out.</td><td>– Disturbance or alteration of in-stream fish habitat</td><td>Minimal</td><td rowspan="2"></td></tr>
<tr><td>Construction</td><td>– Increase in sediment load and sediment deposition at and downstream of the crossing locations</td><td>– Increase in sediment load and sediment deposition at and downstream of the crossing locations</td><td>Minimal</td></tr>
<tr><td rowspan="2">Groundwater</td><td>Construction and decommissioning</td><td>– Change in water levels of wells</td><td>– Wind turbines will be set back from residences/wells to minimize the potential for impacts on residential wells
– Water in all residential wells within 500 m of construction will be tested and background water levels will be measured. Testing will be conducted prior to the start of construction to establish baseline conditions, and will be conducted again one year following cessation of ground disturbance to test for damage or contamination potentially caused by construction.</td><td>– Change in water levels of wells</td><td>Minimal</td><td rowspan="2">Not significant</td></tr>
<tr><td>Construction, operation and decommissioning</td><td>– Groundwater contamination</td><td>– All Project activities will follow standard construction practices to minimize the potential for spills. Any spill site will be reported to the appropriate authorities if necessary and remediated in a timely manner.</td><td>– Groundwater contamination</td><td>Minimal</td></tr>
<tr><td rowspan="2">Wetlands</td><td>Construction, operation and decommissioning</td><td>– Loss or alteration of wetlands</td><td>– all turbines, the substation and laydown yard have been sited to avoid permanent wetland effects
– equipment will be routed around wetlands where possible
– Project construction will occur during dry ground conditions to the extent possible
– rig matting, geotextiles, vegetated buffer zones, earthen berms and/or silt fencing, will be employed as appropriate
– safety fencing will be installed to prevent vehicle traffic from entering wetlands, as appropriate
– all disturbed areas not used for subsequent operation will be reclaimed following construction to minimize erosion and siltation</td><td>– Loss or alteration of wetlands</td><td>Medium</td><td rowspan="2">Not Significant</td></tr>
<tr><td>Construction, operation and decommissioning</td><td>– Introduction or spread of weeds and/or non-native species</td><td>– all construction and decommissioning equipment will enter construction areas in a clean condition
– vehicles and equipment that can potentially interact with the environment (i.e., that will leave and/or clear the access road) may be pressure washed before entering the workspace
– eradicate any prohibited noxious weed species populations and control any noxious weed species populations identified within the Project footprint</td><td>– Introduction or spread of weeds and/or non-native species</td><td>Minimal</td></tr>
</table>

Table 5.0-1: Summary of Predicted Residual Effects(a)

VCs Subject to Effects	Project Phase	Potential Effects – Short Description	Summary of Mitigation Measures	Residual Predicted Effects	Predicted Level of Importance(c)	Significance(d)
Wildlife	Construction	– wildlife disturbance – habitat loss/alteration – wildlife mortality	– Turbines and other Project components were sited in agricultural/pasture, cultivated land and modified pasture land cover types – Where possible, existing access roads will be used. – Turbines were not sited in rows and are spaced a minimum of 360 m apart – Turbines were sited a minimum of 168 m from Paintearth Creek and Battle River coulees – Turbines were set back a minimum of 160 m from Class III-V wetlands. – Turbines were set back a minimum of 260 m from known Swainson's hawk and red-tailed hawk nests. – No Project components will be constructed within 500 m of known sharp-tailed grouse leks. – To the extent possible all vegetation including agricultural/pasture, cropland and modified pasture will be cleared outside of the migratory bird nesting period. In the event of clearing activities occur within the Restricted Activity Period for migratory birds (April 17 to August 28), non-intrusive methods will be used to conduct an area search for evidence of nesting in advance of clearing and construction activities to avoid effects on nesting birds. – Capital Power will develop a Project specific Breeding Bird and Nest Management Plan that applies to federal and provincial species of concern, including migratory birds. – Prior to any construction activities occurring within 100 m of Class III-V wetlands, a non-intrusive field survey will be conducted by a qualified wildlife specialist to avoid effects on breeding amphibians. – Construction activities will be avoided during non-daylight periods, where practical, as many species of concern are nocturnal. – Reduced traffic speeds will be in effect on access roads. – Lighting for on ground infrastructure will be reduced, downshielded, and controlled by proximity sensors. – Temporary disturbance from the underground collector system and temporary access roads not required for operation, will be reclaimed following construction. Where native prairie is disturbed, sod will be stripped, conserved and replaced in as short a time as possible following construction. Native grass and forb seed mixes will be used as appropriate. – Wildlife will not be fed or harassed. – Construction activities will follow best management practices for collection and disposal of all construction-related garbage, debris, wastes and hazardous materials. – The following will be implemented to reduce construction noise; o ensure that vehicles and construction equipment with internal combustion engines used during construction and operation are fitted with muffler systems in good working order; o minimize vehicle and machinery emissions by turning vehicles and equipment off when not in use (no idling unless necessary); o operate equipment at optimum rated loads; o follow routine equipment maintenance procedures; and o ensure all vehicles and machinery are in good working order. – A post-construction monitoring program, the details of which will be agreed upon with AEP, will be conducted following commissioning of the Project to determine the impact Project operation on birds and bats and to evaluate the need for operational mitigation. – It is recommended vegetation clearing for Project infrastructure (i.e., access road, underground collector lines, and temporary work space) occurs outside of the 100 m buffer of known active raptor nests during the raptor nesting period (March 15 to July 15). If this is not feasible and activity is scheduled to occur within the buffers during the raptor nesting period, a Breeding Bird Nest Management Plan will be implemented.	– wildlife disturbance – habitat loss/alteration – wildlife mortality	Minimal to low	Not Significant
	Operation	– wildlife disturbance – wildlife mortality	– Turbines and other Project components were sited in agricultural/pasture, cultivated land and modified pasture land cover – Where possible, existing access roads will be used. – Turbines were not sited in rows and are spaced a minimum of 360 m apart – Turbines were sited a minimum of 168 m from Paintearth Creek and Battle River coulees – Turbines were set back a minimum of 160 m from Class III-V wetlands. – Turbines were set back a minimum of 260 m from known Swainson's hawk and red-tailed hawk nests. – No Project components will be constructed within 500 m of known sharp-tailed grouse leks. – Lighting for on ground infrastructure will be reduced, downshielded, and controlled by proximity sensors. Lighting for on-ground facilities will be minimized, down-shielded and controlled by proximity sensors wherever possible.	– wildlife disturbance – wildlife mortality	Minimal to low	Not Significant

Table 5.0-1: Summary of Predicted Residual Effects(a)

VCs Subject to Effects	Project Phase	Potential Effects – Short Description	Summary of Mitigation Measures	Residual Predicted Effects	Predicted Level of Importance(c)	Significance(d)
	Decommissioning	- wildlife disturbance - habitat loss/alteration - wildlife mortality	- To the extent possible all vegetation including agricultural/pasture, cropland and modified pasture will be cleared outside of the migratory bird nesting period. In the event of clearing activities occur within the Restricted Activity Period for migratory birds (April 17 to August 28), non-intrusive methods will be used to conduct an area search for evidence of nesting in advance of clearing and construction activities to avoid effects on nesting birds. - Capital Power will develop a Project specific Breeding Bird and Nest Management Plan that applies to federal and provincial species of concern, including migratory birds. - Prior to any construction activities occurring within 100 m of Class III-V wetlands, a non-intrusive field survey will be conducted by a qualified wildlife specialist to avoid effects on breeding amphibians. - Construction activities will be avoided during non-daylight periods, where practical, as many species of concern are nocturnal. - Reduced traffic speeds will be in effect on access roads. - Lighting for on ground infrastructure will be reduced, downshielded, and controlled by proximity sensors. Lighting for on-ground facilities will be minimized, down-shielded and controlled by proximity sensors wherever possible. - Wildlife will not be fed or harassed. - Construction activities will follow best management practices for collection and disposal of all construction-related garbage, debris, wastes and hazardous materials. - The following will be implemented to reduce construction noise; o ensure that vehicles and construction equipment with internal combustion engines used during construction and operation are fitted with muffler systems in good working order; o minimize vehicle and machinery emissions by turning vehicles and equipment off when not in use (no idling unless necessary); o operate equipment at optimum rated loads; o follow routine equipment maintenance procedures; and o ensure all vehicles and machinery are in good working order.	- wildlife disturbance - habitat loss/alteration - wildlife mortality	Minimal	Not Significant
Air quality	Construction and decommissioning	– Adversely affect local air quality through combustion emissions and fugitive dust generation	– stationary and mobile equipment will adhere to federal emission standards and will be regularly maintained. There are no Alberta emission standards for non-road diesel mobile equipment. – dust suppressant will be applied to construction areas in proximity to highways and residences to mitigate dust, as appropriate. – Project traffic will be restricted to County or Project access roads. – Project traffic will adhere to posted speed limits on County roads and reduced speed limits will be implemented on Project access roads.	– Adversely affect local air quality due to combustion emissions and fugitive dust generation	Minimal	Not Significant
Historic resources	Construction	– Destruction of historic resources	– avoidance of native pasture areas and historic structures – Project infrastructure is sited on lands with low potential for historic resources. – In the unlikely event that historic resources are uncovered during ground disturbance activities, Project crews will be instructed to temporarily cease construction activities at that location and a Project representative will contact ACT for further instruction.	None	Not Applicable	Not Applicable

(a) **Bold** indicates residual effects that are considered to be positive.
(b) The criteria for direction, geographic extent, duration, occurrence, and magnitude are described in Section 2.0.
(c) Level of Importance of residual impacts is described in Table 2.9-1.
(d) Determination of significance is described in Section 2.9.4

6.0 CONCLUSION

Capital Power is planning to construct, operate, and decommission a 148 MW (nominal) wind power project located approximately 12 km northeast of Halkirk, Alberta. The proposed Project is located in an area of heavy agricultural activity. Approximately 98% of the Project footprint is located on modified land cover types including agricultural/pasture, cultivated land and modified pasture; all turbines will be located within these modified land cover types.

Golder was retained by Capital Power to conduct an Environmental Evaluation of the Project. This Environmental Evaluation assessed baseline environmental conditions, identified the potential environmental effects of the Project, described the mitigation measures to be implemented during Project construction, operation and decommissioning, and assessed the predicted residual effects of the Project. The Environmental Evaluation followed a systematic approach to characterizing the Project's predicted residual effects on the environment and the significance of these effects, in the context of sustainable development objectives.

The potential effects of the Project were assessed for ten VCs. These ten VCs were selected based on their importance to the public, to scientists and/or to government agencies, and based on the experience of Capital Power and Golder with similar projects.

The effects assessment approach was based on the *Canadian Environmental Assessment Act*, *2012* and the AEP assessment principles and methodology, as guided by the following documents:

- "Operational Policy Statement: Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the *Canadian Environmental Assessment Act, 2012*" (Canadian Environmental Assessment Agency 2015); and
- "Guide to Preparing Environmental Impact Assessment Reports in Alberta" (ESRD 2013a).

The effects assessment considered the direction, magnitude, geographic extent, and duration of potential effects, after the implementation of mitigation measures. These criteria were then used to assign a level of importance to the predicted residual effects of the Project on each VC. Overall, the importance of predicted residual effects on the VCs is predicted to be minimal to low, with the exception of the loss or alteration of wetlands, which is considered to be of medium importance. None of the residual effects are predicted to alter the sustainability of the VC beyond a manageable level, and the residual effects on all VCs are therefore predicted to be not significant.

Based on the information provided in this Environmental Evaluation, it is the professional opinion of the assessors that the Project is not likely to cause significant adverse environmental effects, when taking into account the implementation of appropriate mitigation measures.

7.0 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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https://golderassociates.sharepoint.com/sites/10018g/multiple user/master_ee_working_file/1543760_halkirk2_environmental_evaluation.docx

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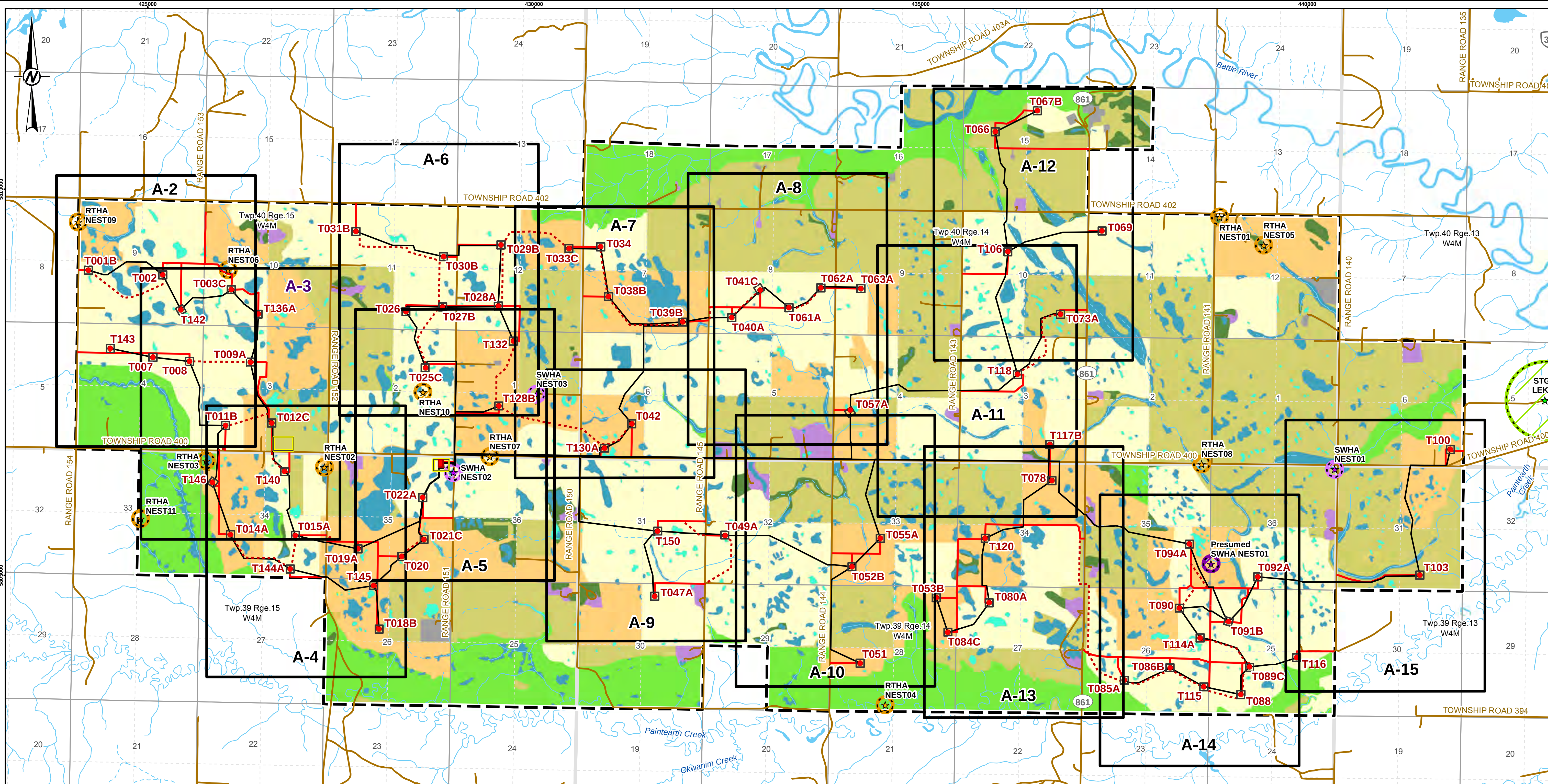
APPENDIX A

Project Footprint and Environmental Features Overview



LEGEND

PROJECT AREA
MAPBOOK WINDOW

PROPOSED PROJECT INFRASTRUCTURE

PERMANENT FOOTPRINT COMPONENTS
- TURBINE
- OPERATIONAL ROAD
- SUBSTATION

TEMPORARY FOOTPRINT COMPONENTS
- TURBINE TEMPORARY WORKSPACE
- CRANE PATH / CONSTRUCTION ROAD
- UNDERGROUND COLLECTOR SYSTEM
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE

- ROAD/HIGHWAY
- WATERCOURSE
- INDEFINITE WATERCOURSE

LAND COVER [A,B]
- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

WILDLIFE HABITAT FEATURES
- RED-TAILED HAWK NEST
- SHARP-TAILED GROUSE LEK
- SWAINSON'S HAWK NEST
- PRESUMED SWAINSON'S HAWK NEST

WILDLIFE HABITAT FEATURE SETBACKS
- RED-TAILED HAWK NEST 100 m
- SHARP-TAILED GROUSE LEK 500 m
- SWAINSON'S HAWK NEST 100 m
- PRESUMED SWAINSON'S HAWK NEST 100 m

0 2 4

1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

NOTE(S)

[A]LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
[B]STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES OVERVIEW

PROJECT NO.	CONTROL	REV.	FIGURE
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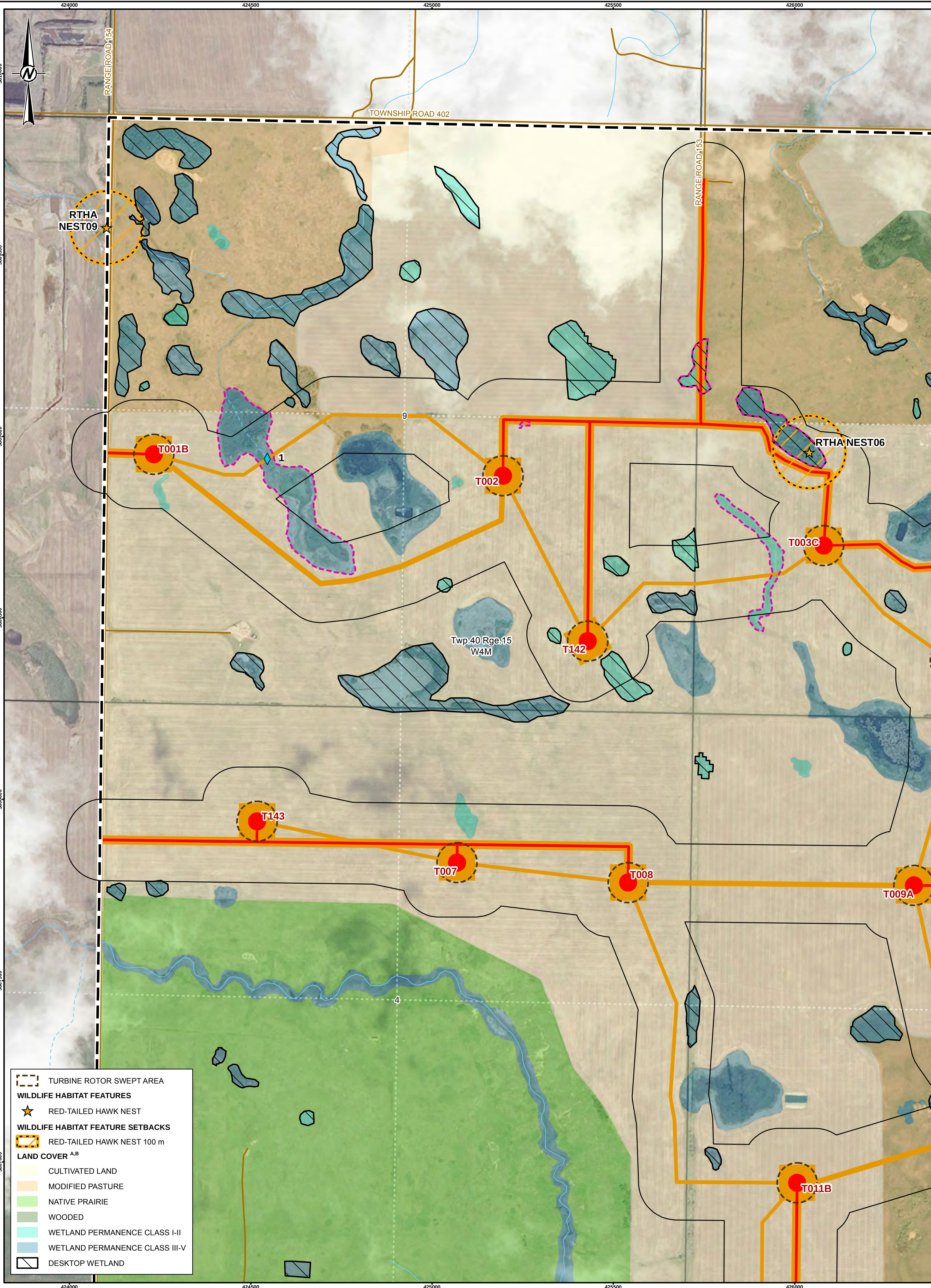

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800
1:10,000 METRES

CLIENT
Capital Power

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

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REFERENCE(S)
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IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
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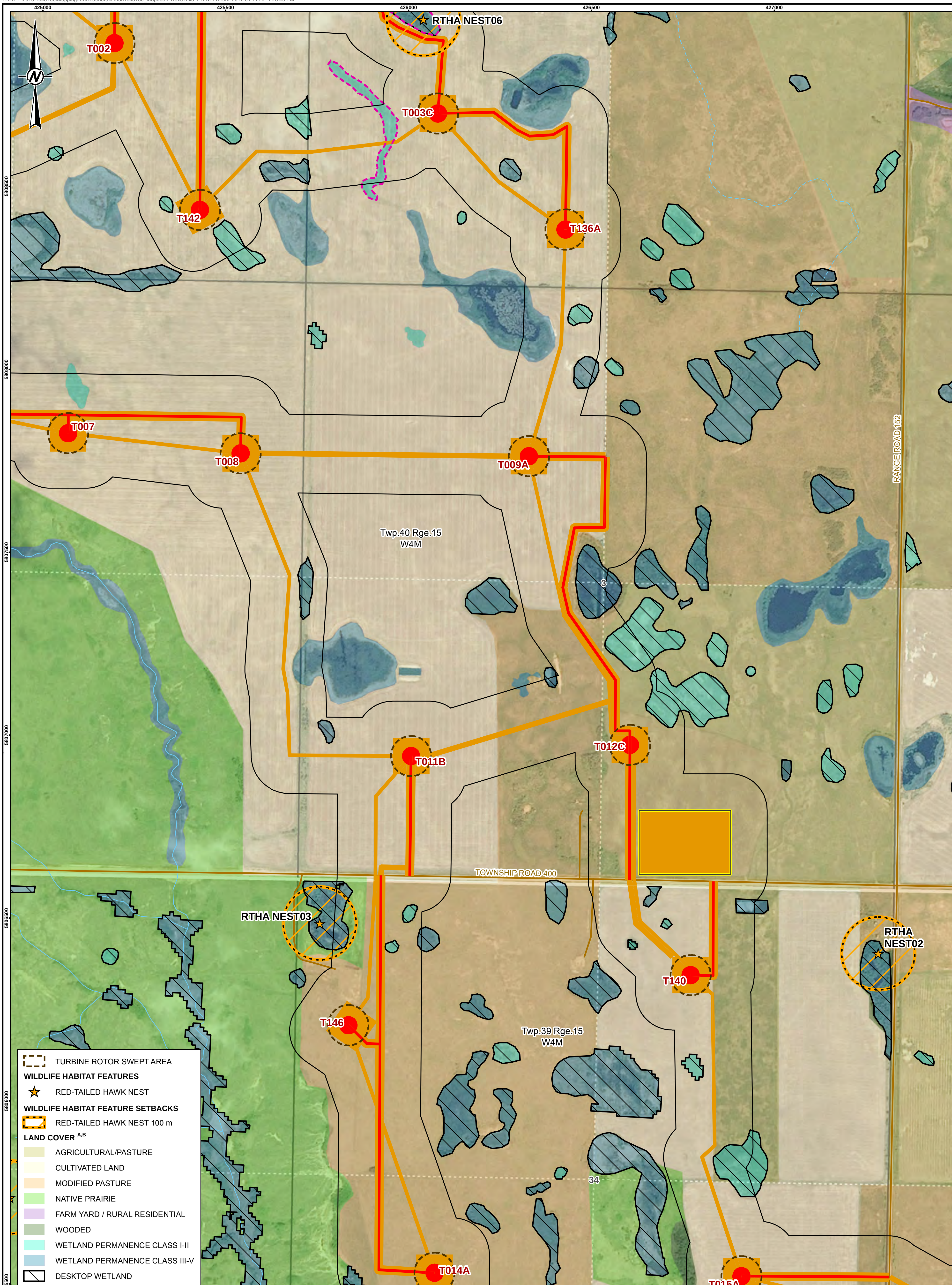

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
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PREPARED	SK
REVIEWED	CS
APPROVED	JM

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REFERENCE(S)

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IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
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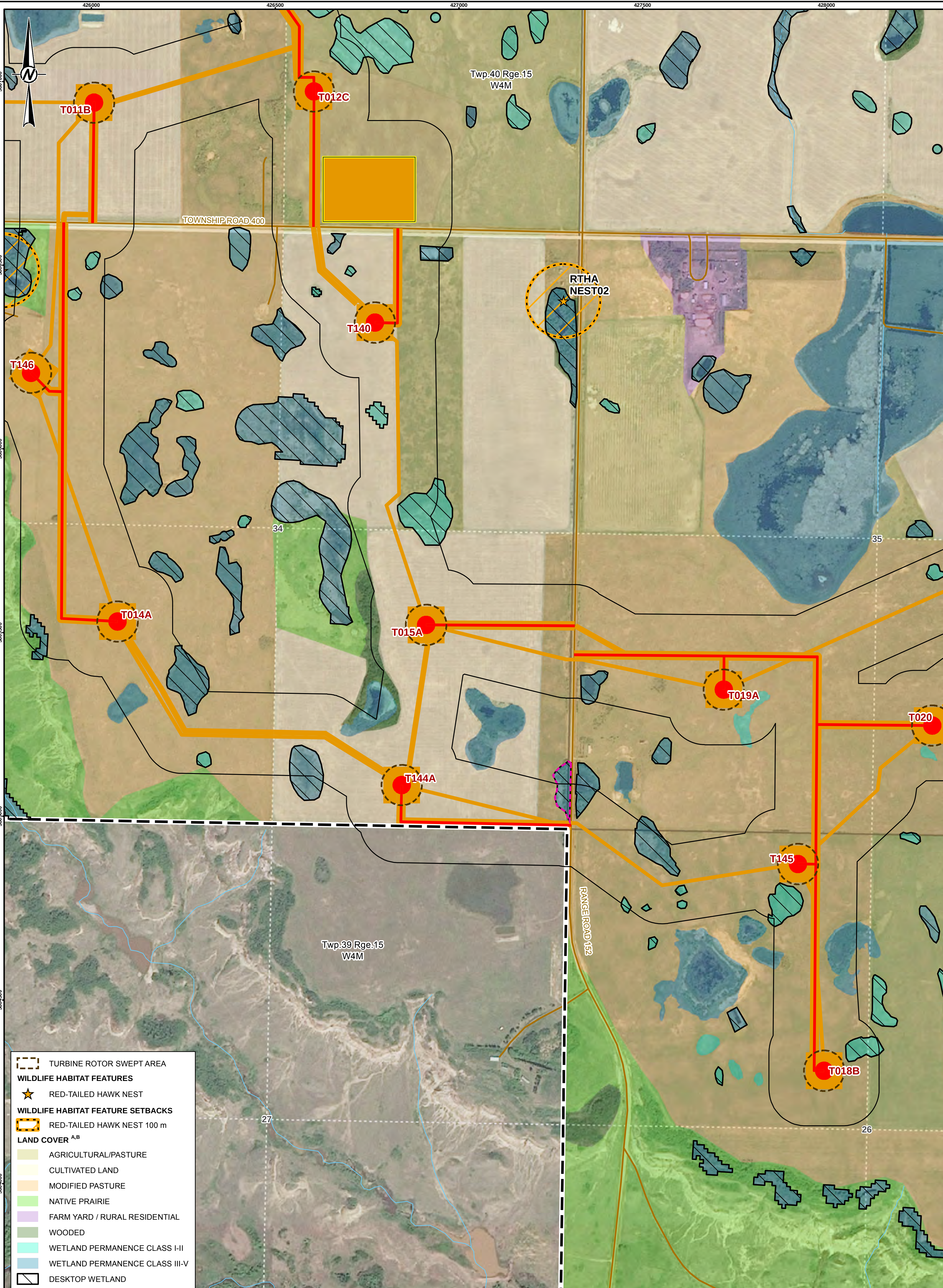

LEGEND

- PROJECT AREA
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- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
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PREPARED	SK
REVIEWED	CS
APPROVED	JM

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TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
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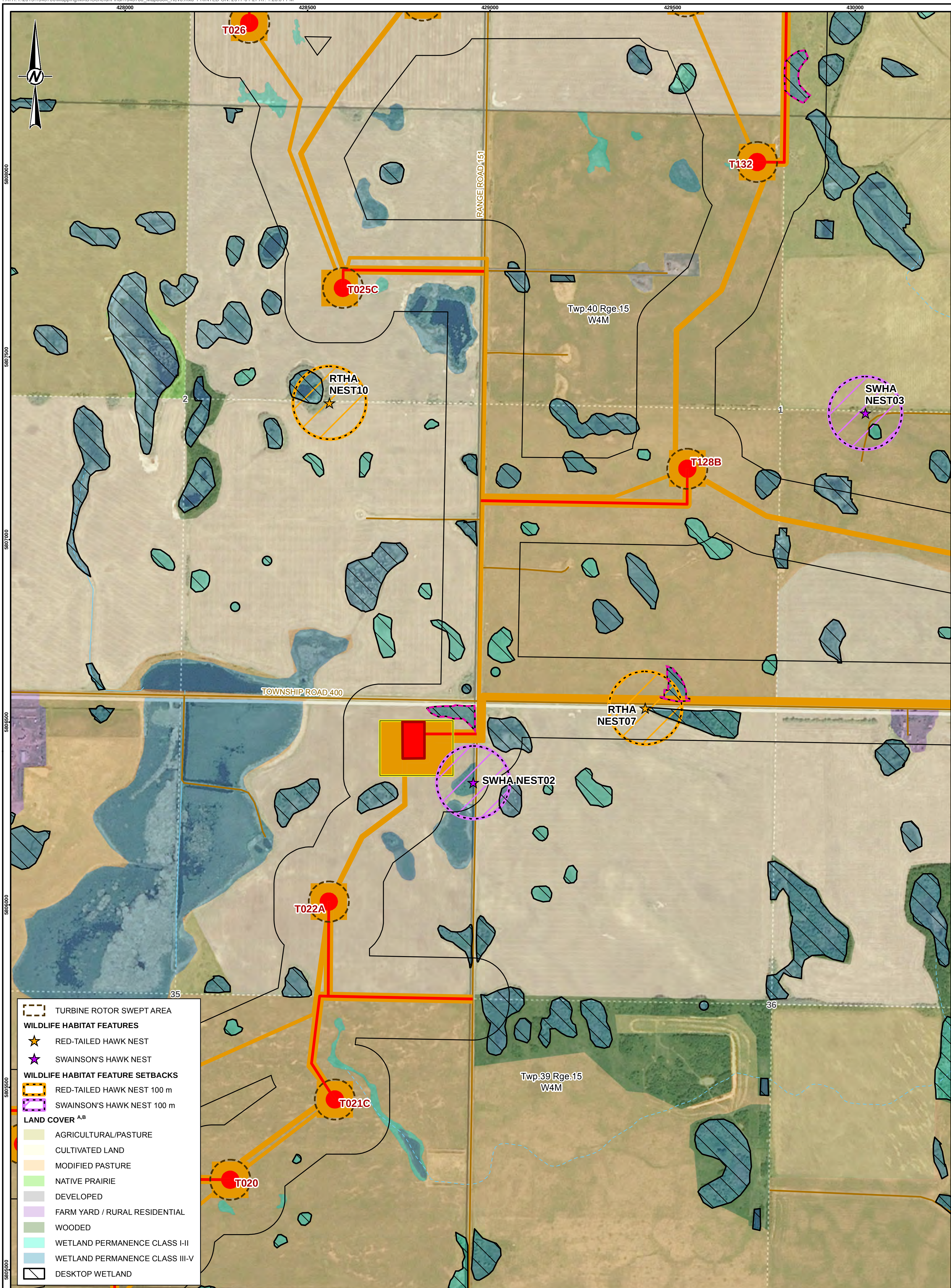

LEGEND

- PROJECT AREA
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- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- SUBSTATION
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

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DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

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PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	A-5

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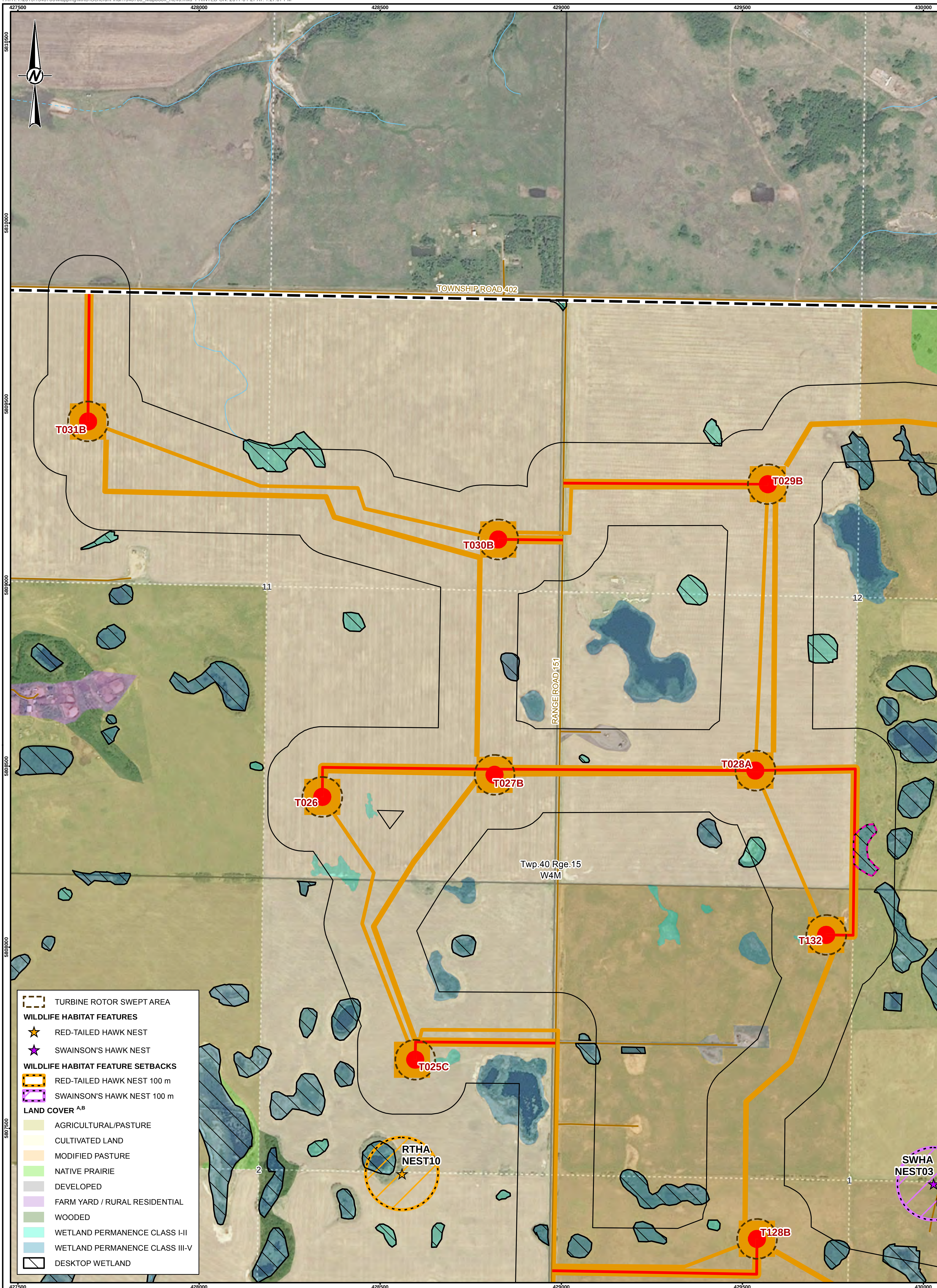

LEGEND

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- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

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CLIENT

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REVIEWED	CS
APPROVED	JM

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
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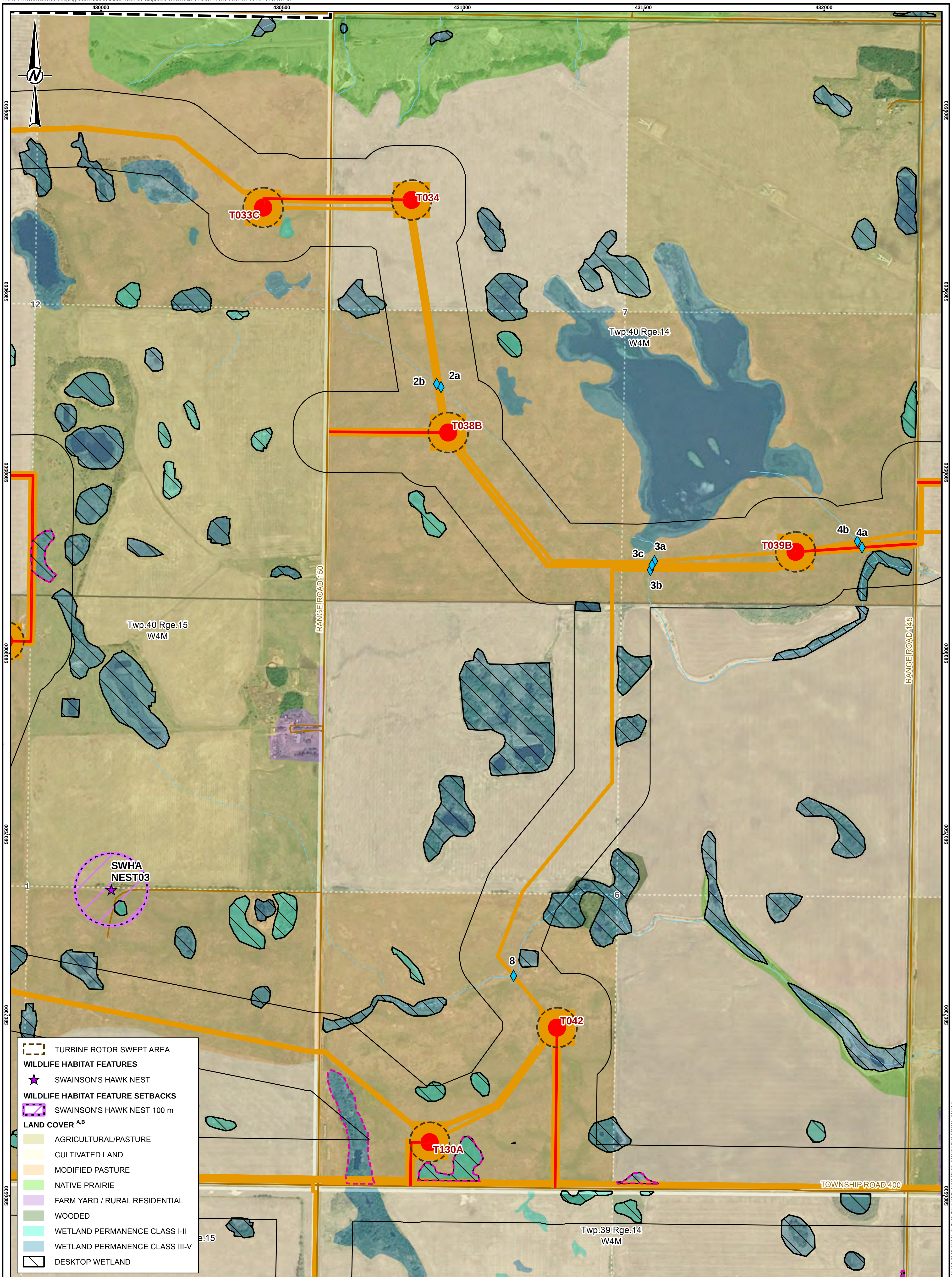

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- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

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CLIENT

Capital Power

CONSULTANT

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PREPARED	SK
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APPROVED	JM

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	A-7

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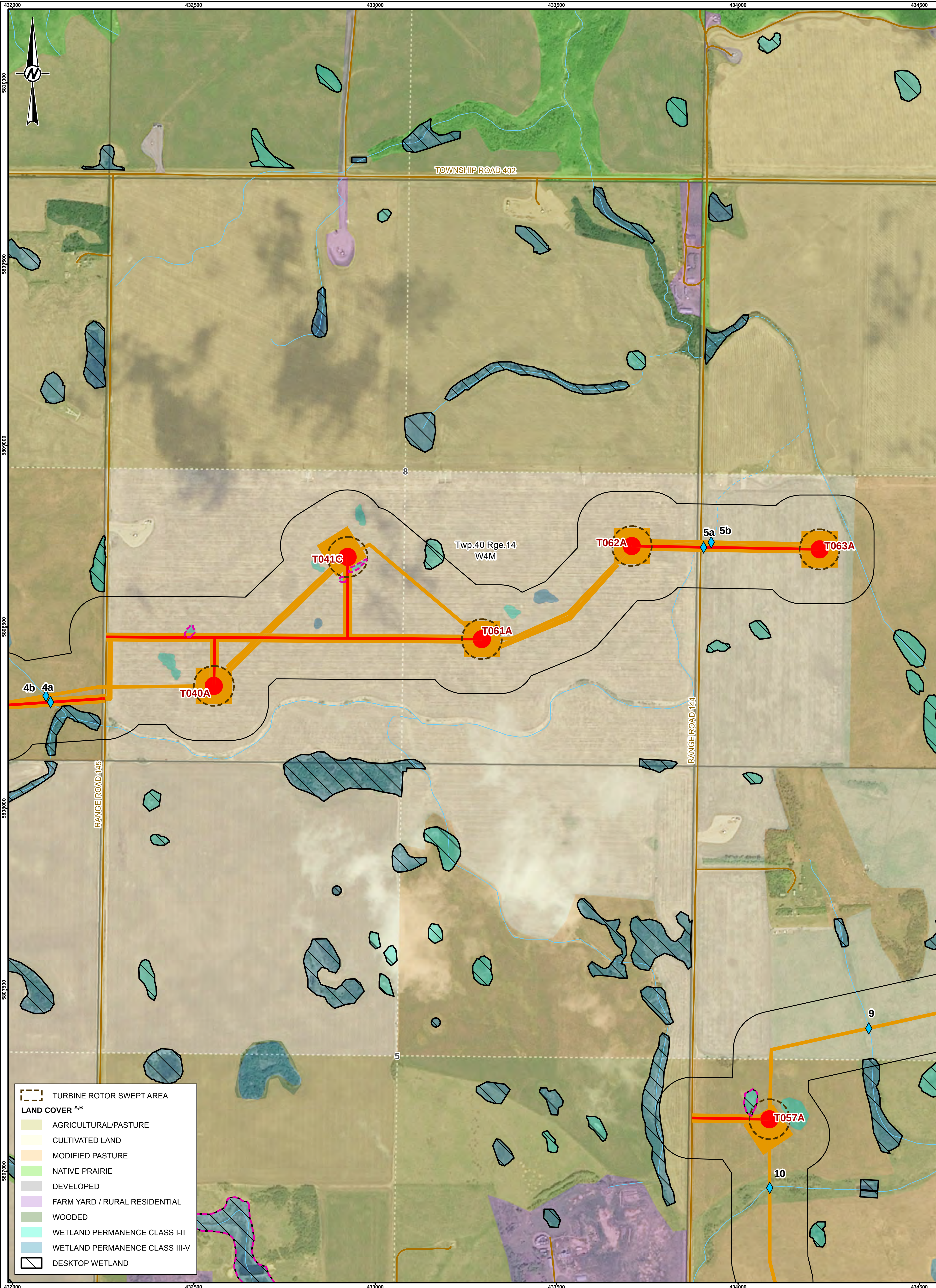

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- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

Capital Power

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PREPARED	SK
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APPROVED	JM

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	A-8

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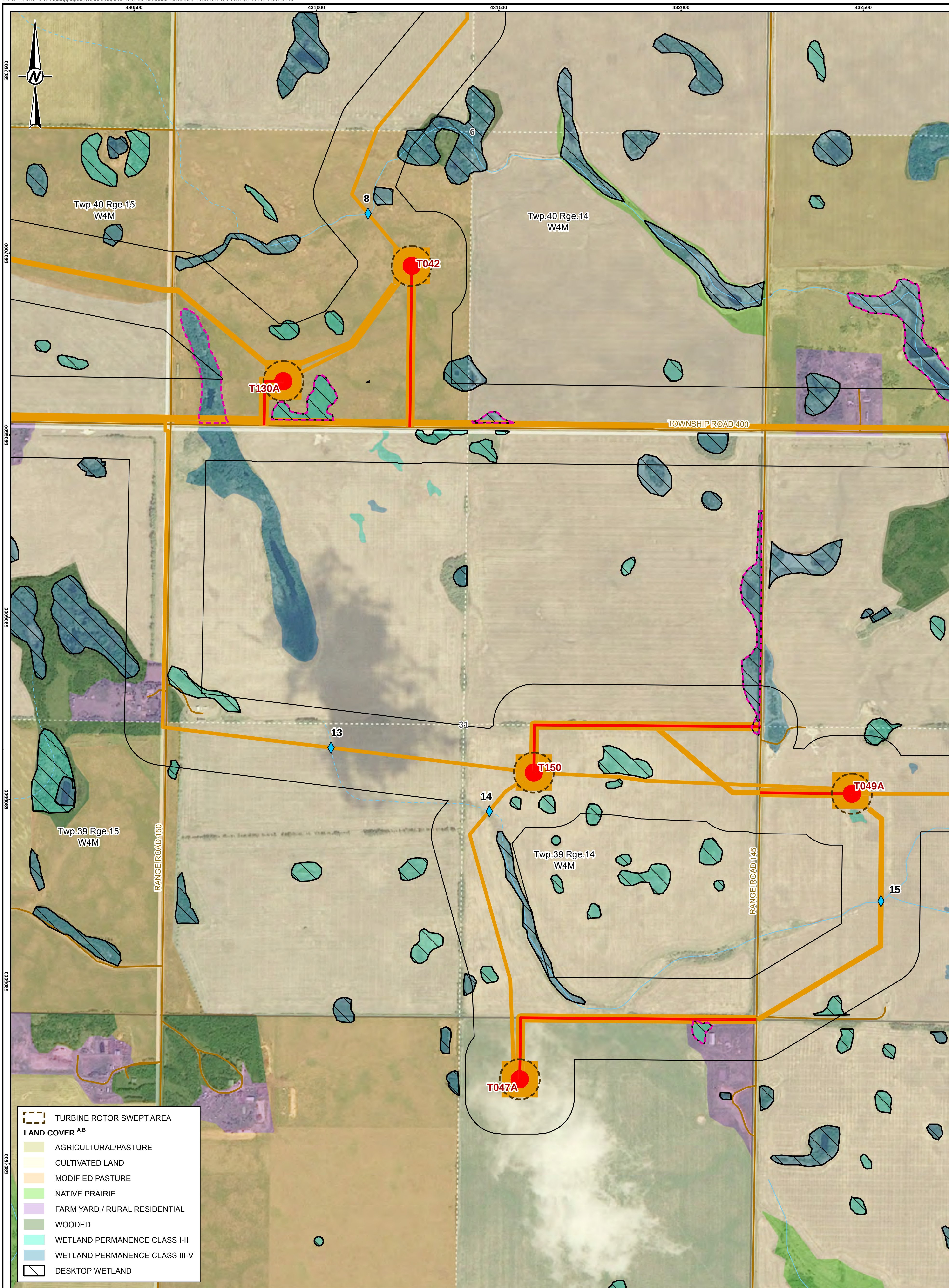

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- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800
1:10,000 METRES

CLIENT
Capital Power

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
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PREPARED	SK
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PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
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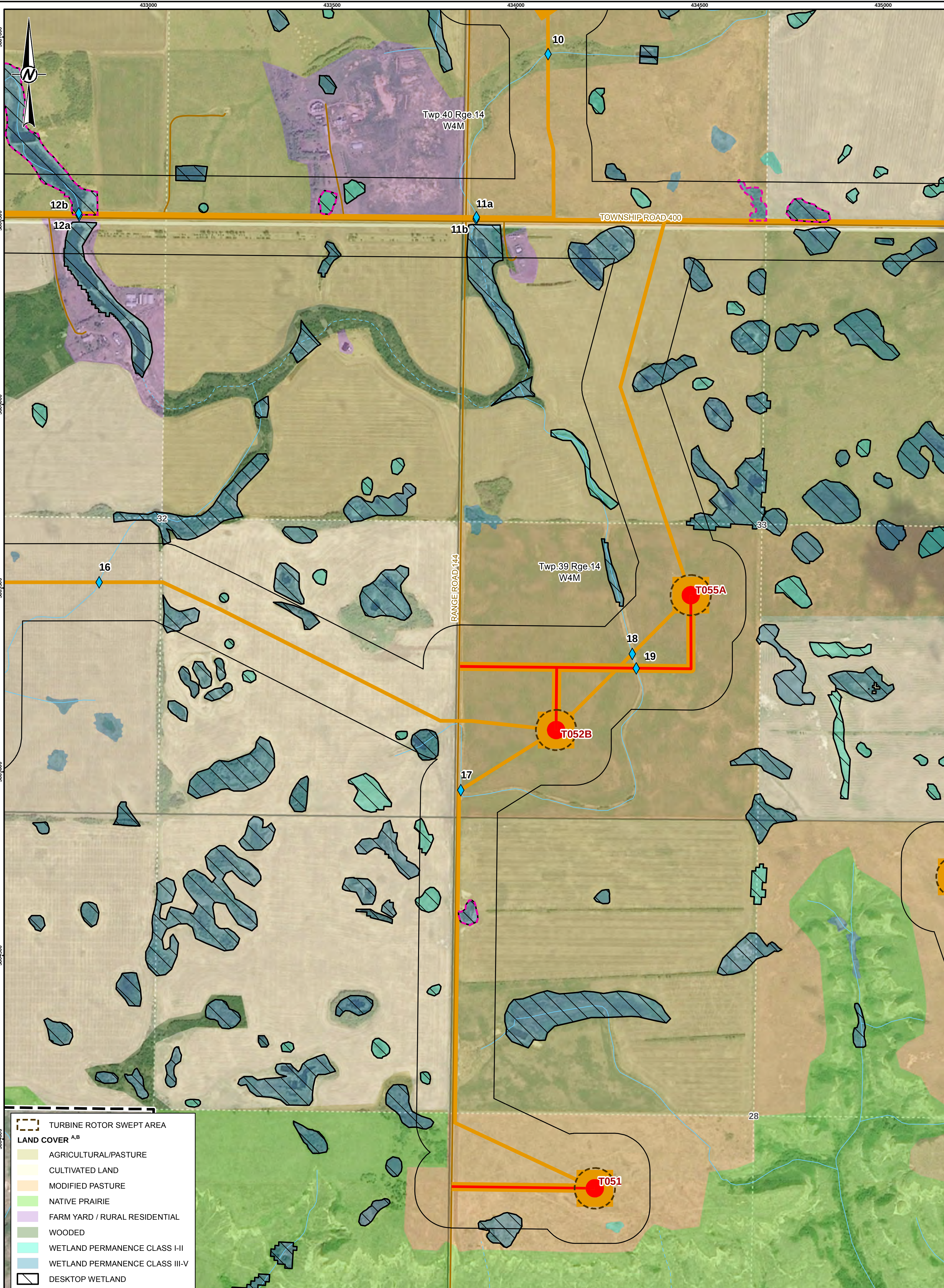

LEGEND

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- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

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PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	A-10

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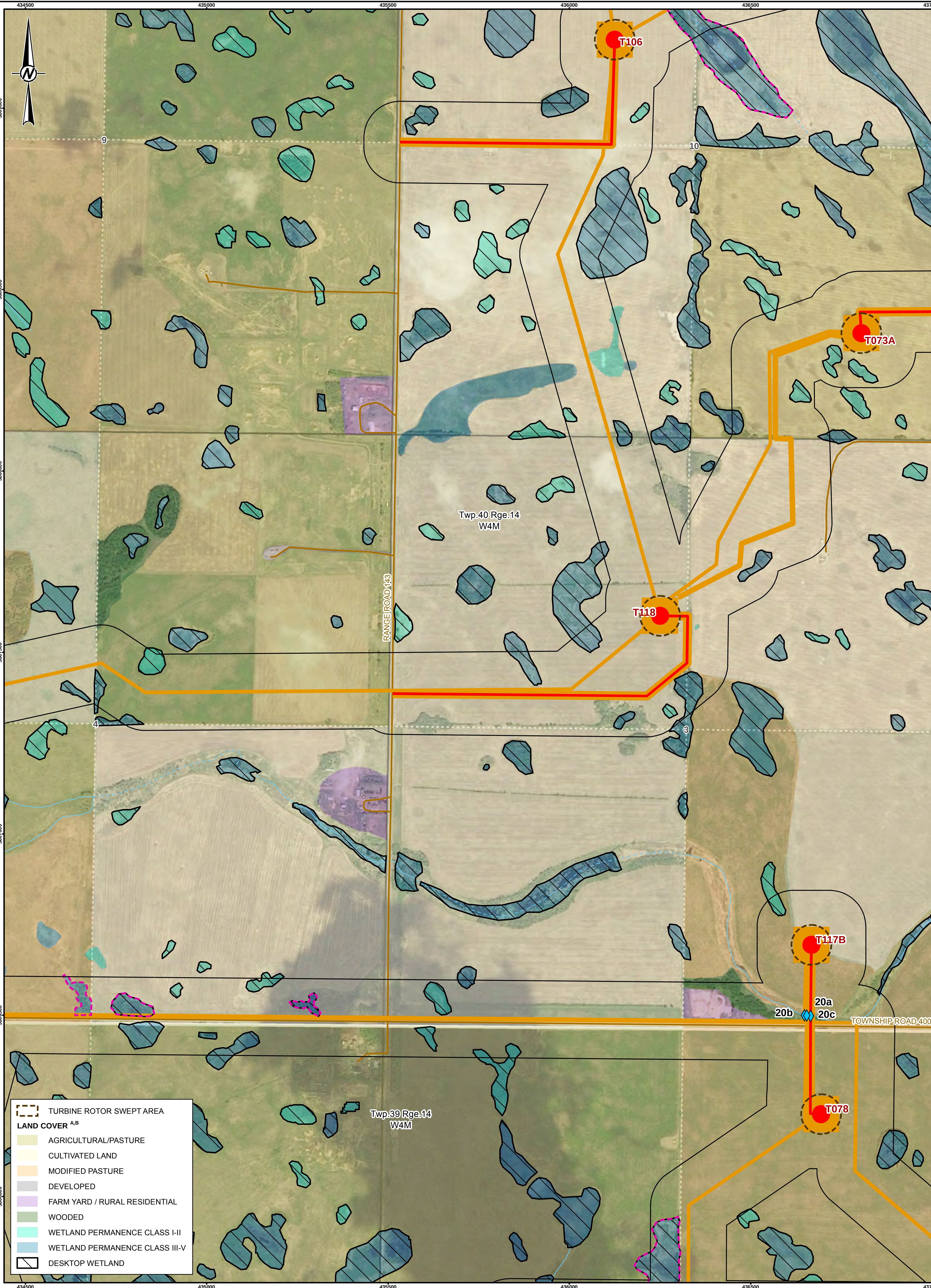

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

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PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

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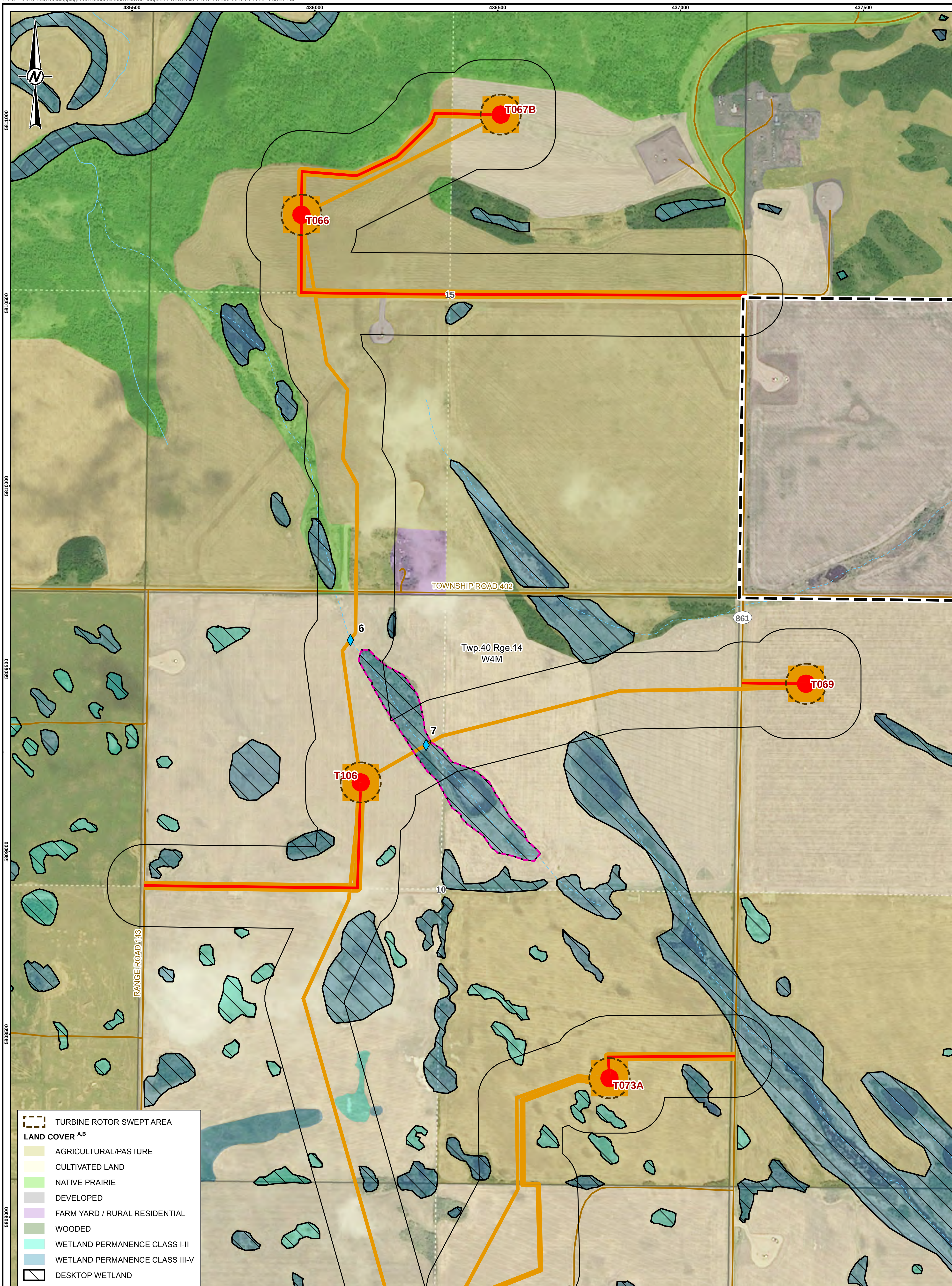

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REFERENCE(S)

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PROJECT

HALKIRK 2 WIND PROJECT

TITLE

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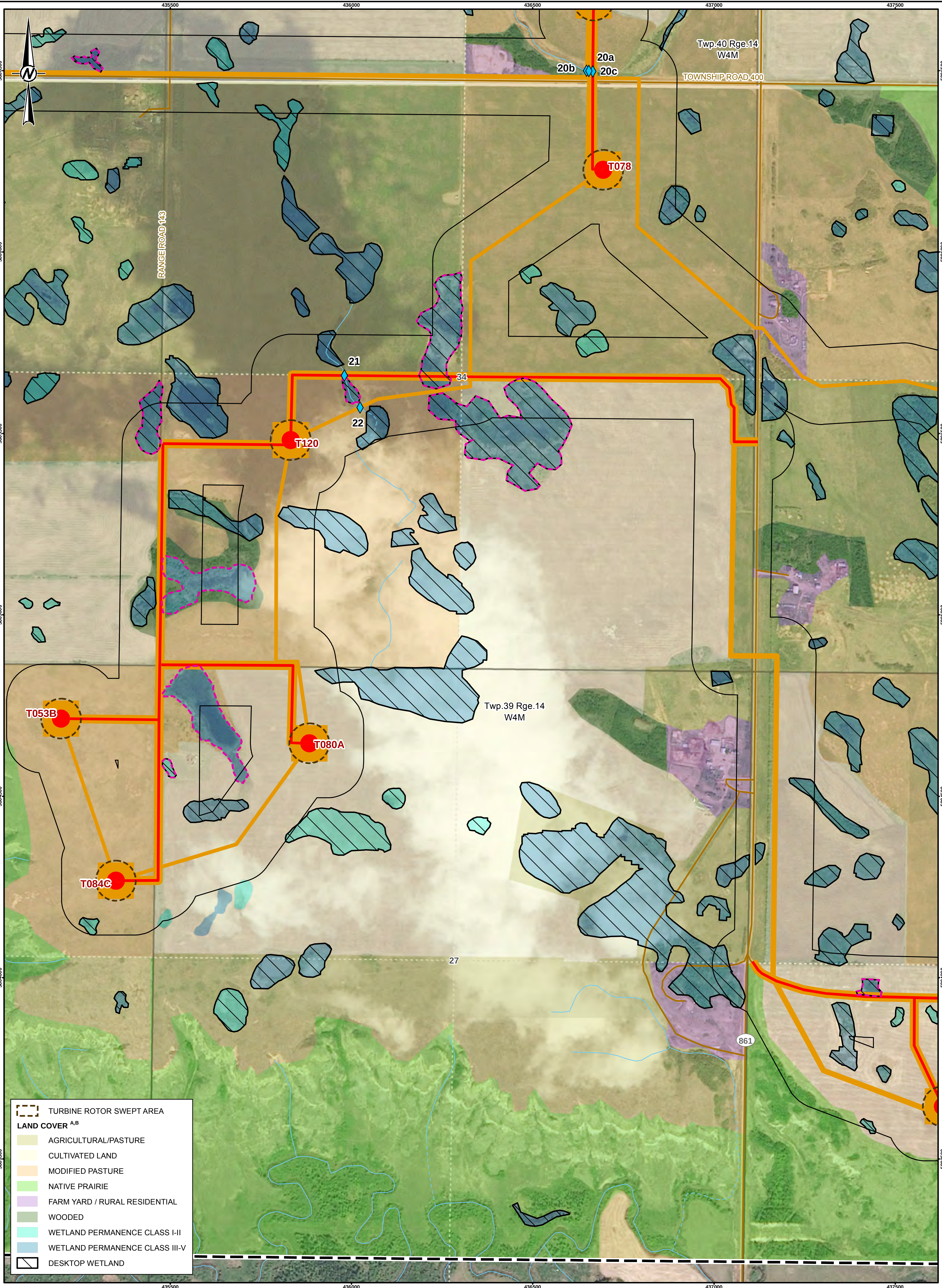

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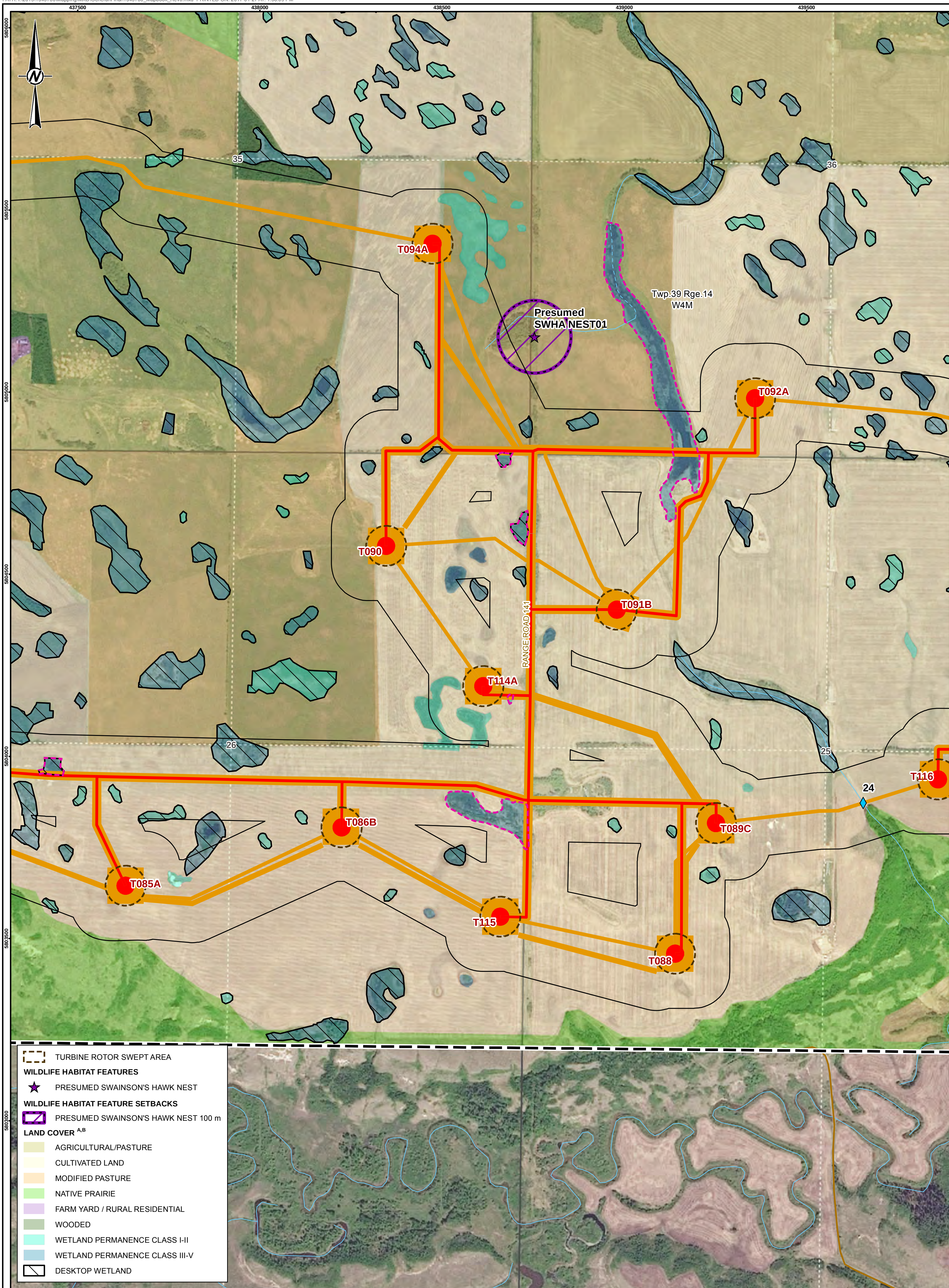

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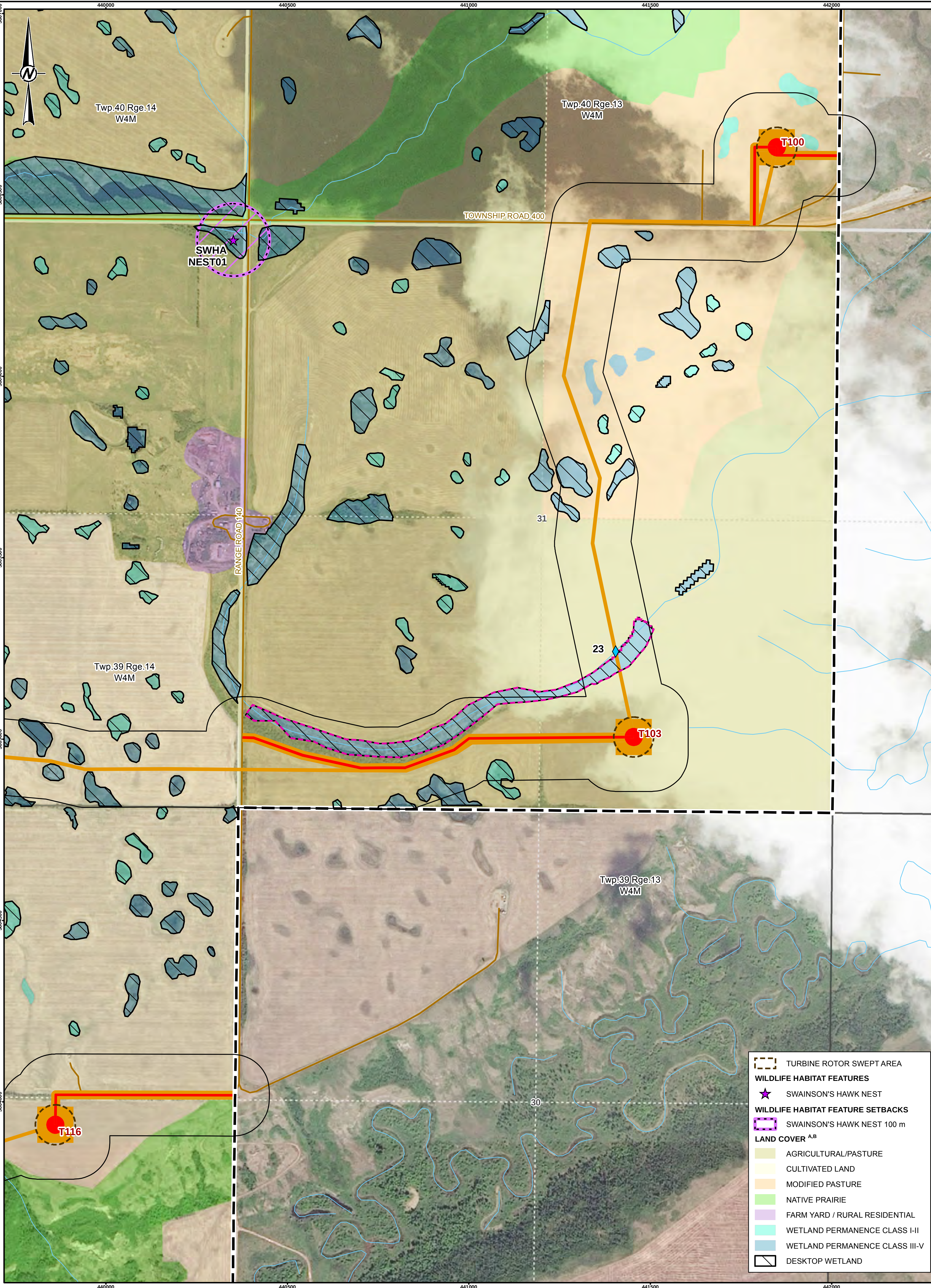

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APPENDIX B

Central Parkland Subregion Previously Identified ACIMS Occurrences

Table B1- List of Tracked Plant Species in the Central Parkland Natural Subregion

Scientific Name	Common Name	Provincial List [a]	Provincial Rank [b]	Global Rank [b]
Almutaster pauciflorus	few-flowered aster	T	S3	G4
Bolboschoenus fluviatilis	river bulrush	T	S1	G5
Botrychium campestre	field grape fern	T	S3	G3G4
Botrychium simplex	dwarf grape fern	T	S2	G5
Botrychium spathulatum	spatulate grape fern	T	S3	G3
Bromus latiglumis	Canada brome	T	S1	G5
Carex aperta	open sedge	T	S2	G4
Carex crawei	Crawe's sedge	T	S3	G5
Carex hystericina	porcupine sedge	T	S2	G5
Carex vulpinoidea	fox sedge	T	S3	G5
Chenopodium atrovirens	dark-green goosefoot	T	S1	G5
Chenopodium fremontii	Fremont's goosefoot	T	S2	G5
Corispermum pallasii	Pallas' bugseed	T	S2	G4?
Cryptantha kelseyana	Kelsey's cat's eye	T	S3	G4
Cynoglossum virginianum var. boreale	wild comfrey	T	S1	G5T4T5
Dichanthelium leibergii	Leiberg's millet	T	S1	G5
Dichanthelium wilcoxianum	Wilcox's panicgrass	T	S2	G5
Doellingeria umbellata var. pubens	flat-topped white aster	T	S3	G5T5
Echinochloa muricata var. microstachya	rough barnyard grass	T	S1	G5T5
Eleocharis ovata	ovate spikerush	T	S1	G5
Gentiana fremontii	marsh gentian	T	S3	G4
Gratiola neglecta	clammy hedge-hyssop	T	S3	G5
Houstonia longifolia	long-leaved bluets	T	S3	G4G5
Juncus nevadensis	Nevada rush	T	S1	G5
Lactuca biennis	tall blue lettuce	T	S3	G5
Lysimachia hybrida	lance-leaved loosestrife	T	S3	G5
Malaxis paludosa	bog adder's-mouth	T	S2S3	G4
Marsilea vestita	hairy pepperwort	T	S3	G5
Mimulus glabratus	smooth monkeyflower	T	S1	G5
Munroa squarrosa	false buffalo grass	T	S3	G5
Najas flexilis	slender naiad	T	S3	G5
Oenothera serrulata	shrubby evening-primrose	T	S3	G5
Osmorhiza longistylis	smooth sweet cicely	T	S3	G5
Piptatherum canadense	Canadian rice grass	T	S2	G5
Potentilla lasiodonta	sandhills cinquefoil	T	S3	G2G4Q
Potentilla plattensis	low cinquefoil	T	S2	G4
Ranunculus flabellaris	yellow water-crowfoot	T	S1	G5
Rhynchospora capillacea	slender beak-rush	T	S2	G4
Rorippa curvipes	blunt-leaved watercress	T	S3	G5

Table B1- List of Tracked Plant Species in the Central Parkland Natural Subregion

Scientific Name	Common Name	Provincial List [a]	Provincial Rank [b]	Global Rank [b]
Ruppia cirrhosa	widgeon-grass	T	S3	G5
Shinnersoseris rostrata	annual skeletonweed	T	S3	G5?
Viola pedatifida	crowfoot violet	T	S3	G5
Wolffia columbiana	Columbia watermeal	T	S2	G5

(a)) Tracked (T) or Watched (W) ACIMS lists serve as focus for data gathering.

(b) Provincial Conservation ranking definitions can be found in Appendix D (ACIMS 2016).

APPENDIX C

Subnational Conservation Status Ranks Definitions

Table C1- Alberta Conservation Information Management System Rare Plant Ranking Definitions

Rank	Definition
SX	Taxon is believed to be extirpated from the province.
	Not located despite intensive searches of historical sites and other appropriate habitat.
	Virtually no likelihood that it will be rediscovered.
SH	Known from only historical records but still some hope of rediscovery.
	Evidence that the taxon may no longer be present but not enough to state this with certainty.
S1	Known from five or fewer occurrences or especially vulnerable to extirpation because of other factor(s).
S2	Known from twenty or fewer occurrences or vulnerable to extirpation because of other factors.
S3	Known from 100 or fewer occurrences, or somewhat vulnerable due to other factors, such as restricted range, relatively small population sizes, or other factors.
S4	Apparently secure.
	Taxon is uncommon but not rare.
	Potentially some cause for long term concern due to declines or other factors.
S5	Secure - taxon is common, widespread, and abundant.
Variant Subnational Conservation Status Ranks	
S#S#	A numeric range rank is used to indicate any range of uncertainty about the status of the taxon. Example - S2S3 or S1S3.
	Ranges cannot skip more than two ranks. Example - SU is used rather than S1S4.
SU	Taxon is currently not able to be ranked due to lack of information or substantially conflicting information. Example - native versus non-native status not resolved.
SNR	Not ranked
	Conservation status not yet assessed.
SNA	Not applicable.
	A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities. Example - introduced species.
Subnational Conservation Status Rank Qualifiers	
Qualifier	**Definition**
S#?	Inexact numeric rank.
	Applied when a specific rank is most likely appropriate but for which some conflicting information or unresolved questions remain. Example - S2? Believed to be 6 to 20 occurrences but some uncertainty.
Global Status Ranks	
G1	Rare and vulnerable
G2	Uncommon and potentially vulnerable
G3	Potentially vulnerable
G4	Globally apparently secure
G5	Globally secure, common and abundant

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Photo 2: Ephemeral (Class I) Water Body impacted by cultivation. May 27, 2016.

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Photo 4: Temporary Graminoid Marsh (M-G[II]). May 26, 2016.

Photo 5: Seasonal Graminoid Marsh (M-G[III]). May 27, 2016.

Photo 6: Seasonal Graminoid Marsh (M-G[III]). May 28, 2016.

Photo 7: Semi-permanent Graminoid Marsh (M-G[IV]). May 30, 2016.

Photo 8: Semi-permanent Graminoid Marsh (M-G[IV]). August 11, 2016.

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Photo 10: Permanent Shallow Open Water (W-B[V]). May 28, 2016.

Photo 11: Seasonal Shrubby Swamp (S-S[III]). June 1, 2016.

Photo 12: Wooded Deciduous Swamp (S-Wd). June 1, 2016.

APPENDIX E

Wildlife Baseline Report

February 2017

REPORT

Wildlife Baseline Report for the Halkirk 2 Wind Power Project

Submitted to:
Capital Power Corporation
EPCOR Tower, Suite 1200
10423 101 Street NW
Edmonton, AB T5H 0E9

Report Number: 1543760

Distribution:

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Golder Associates

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APPENDICES

APPENDIX A
Historical and Incidental Wildlife Observations

1.0 INTRODUCTION

Capital Power Corporation (Capital Power) retained Golder Associates Ltd. (Golder) to conduct wildlife studies in 2016 to support the Alberta Utilities Commission application for the proposed Halkirk 2 Wind Power Project (the Project), located approximately 12 km northeast of Halkirk, Alberta.

Wildlife surveys were conducted following the recommendations outlined in the Alberta Environment and Parks (AEP) Wildlife Guidelines for Alberta Wind Energy Projects (ASRD 2011) and Sensitive Species Inventory Guidelines (ESRD 2013a). All surveys were conducted using standardized techniques to allow repeat surveys in subsequent years, or potentially during post-construction.

This report describes the approach used to identify appropriate wildlife studies for the Project, methods used to conduct the wildlife studies, and the results of the completed studies.

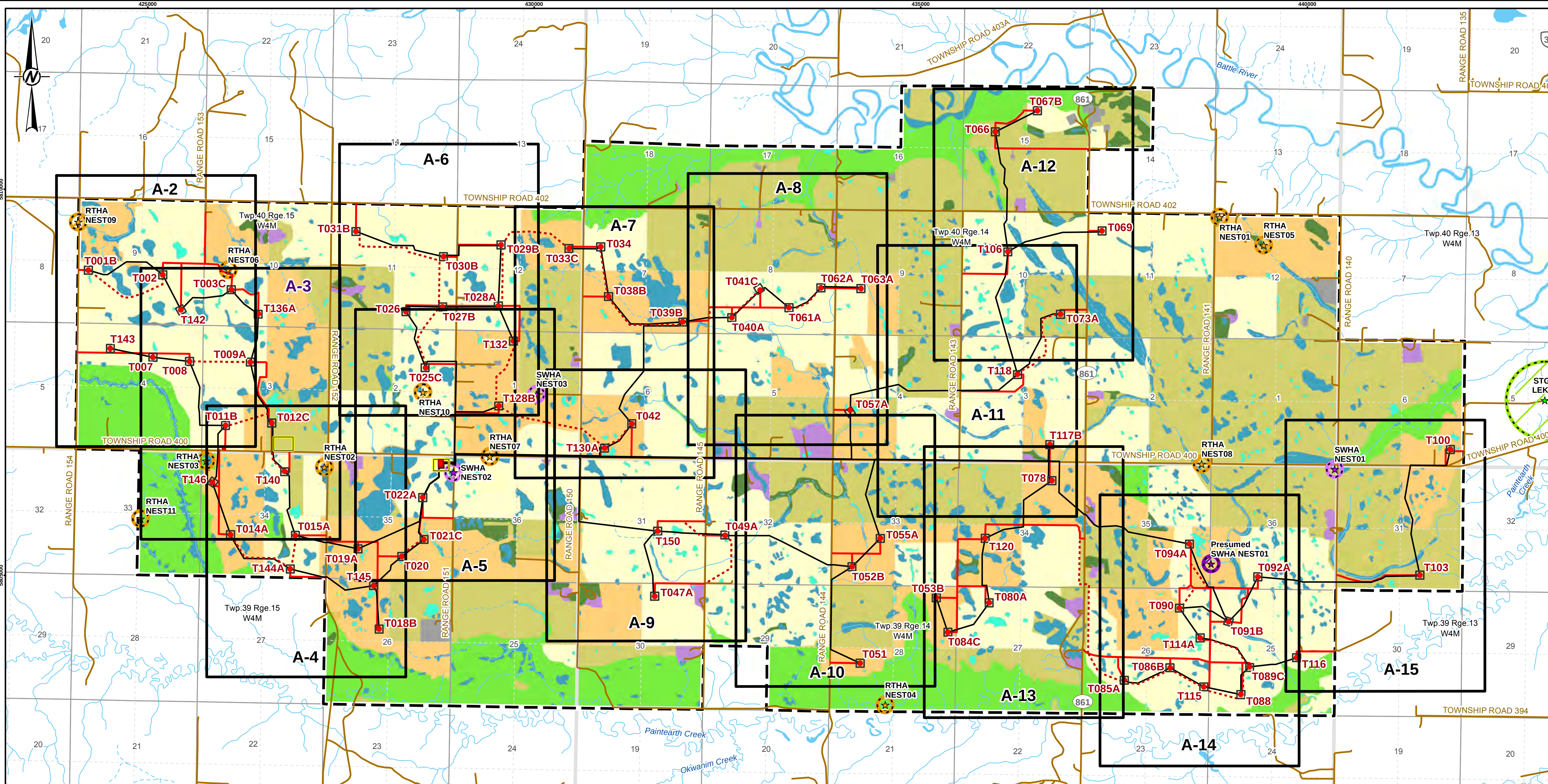
2.0 APPROACH

Wildlife surveys required to support regulatory applications for the Project were identified using Wildlife Guidelines for Alberta Wind Energy Projects (ASRD 2011) and align with the Wildlife Directive for Alberta Energy Projects (AEP 2017). Surveys were undertaken within the Project Area that includes sections and quarter sections potentially affected by developments associated with the Project (Figure 1). For some surveys, an additional 1 km buffer beyond the Project Area was also surveyed to capture species specific setbacks.

The specific surveys required to support the Project were identified using available habitat and wildlife information within the Project Area and feedback obtained during consultation with CWS and AEP (Gregoire 2016, pers. comm.; Herdman 2016, pers. comm.). Wildlife data from the Fish and Wildlife Management Information System (FWMIS) database and known species ranges informed the listed wildlife surveys that may be required.

Based on a review of available information in consultation with AEP’s regional biologist, the following wildlife studies were identified as important for the Project:

- Winter bird survey;
- Sharp-tailed grouse survey;
- Richardson’s ground squirrel survey;
- Spring and fall bat migration study;
- Raptor nest survey;
- Breeding bird survey; and
- Avian use study (AUS) (spring and fall migration).



LEGEND

PROJECT AREA

MAPBOOK WINDOW

PROPOSED PROJECT INFRASTRUCTURE

PERMANENT FOOTPRINT COMPONENTS

- TURBINE
- OPERATIONAL ROAD
- SUBSTATION

TEMPORARY FOOTPRINT COMPONENTS

- TURBINE TEMPORARY WORKSPACE
- CRANE PATH / CONSTRUCTION ROAD
- UNDERGROUND COLLECTOR SYSTEM
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE

- ROAD/HIGHWAY
- WATERCOURSE
- INDEFINITE WATERCOURSE

LAND COVER [A,B]

- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

WILDLIFE HABITAT FEATURES

- RED-TAILED HAWK NEST
- SHARP-TAILED GROUSE LEK
- SWAINSON'S HAWK NEST
- PRESUMED SWAINSON'S HAWK NEST

WILDLIFE HABITAT FEATURE SETBACKS

- RED-TAILED HAWK NEST 100 m
- SHARP-TAILED GROUSE LEK 500 m
- SWAINSON'S HAWK NEST 100 m
- PRESUMED SWAINSON'S HAWK NEST 100 m

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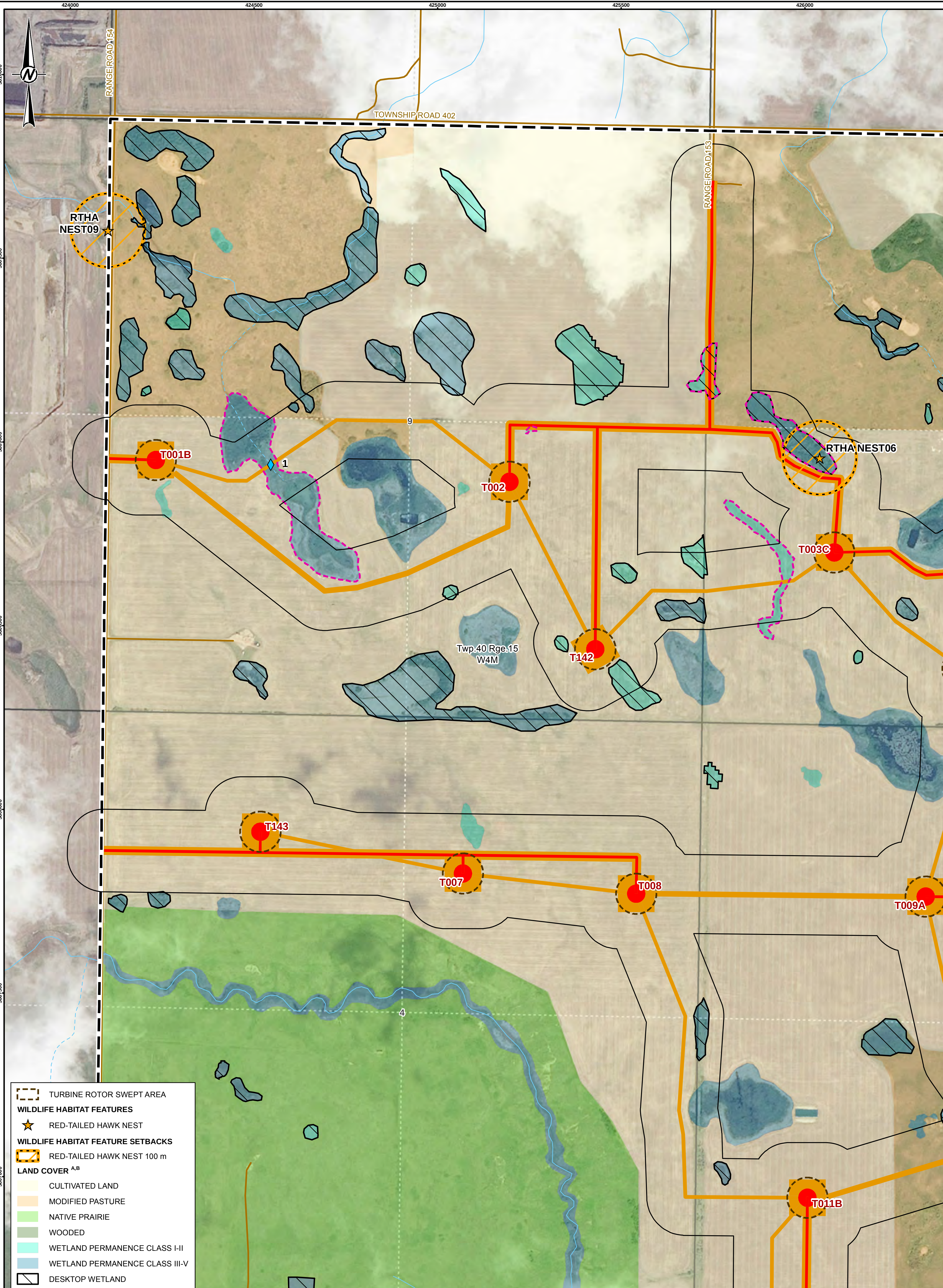

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REFERENCE(S)
ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
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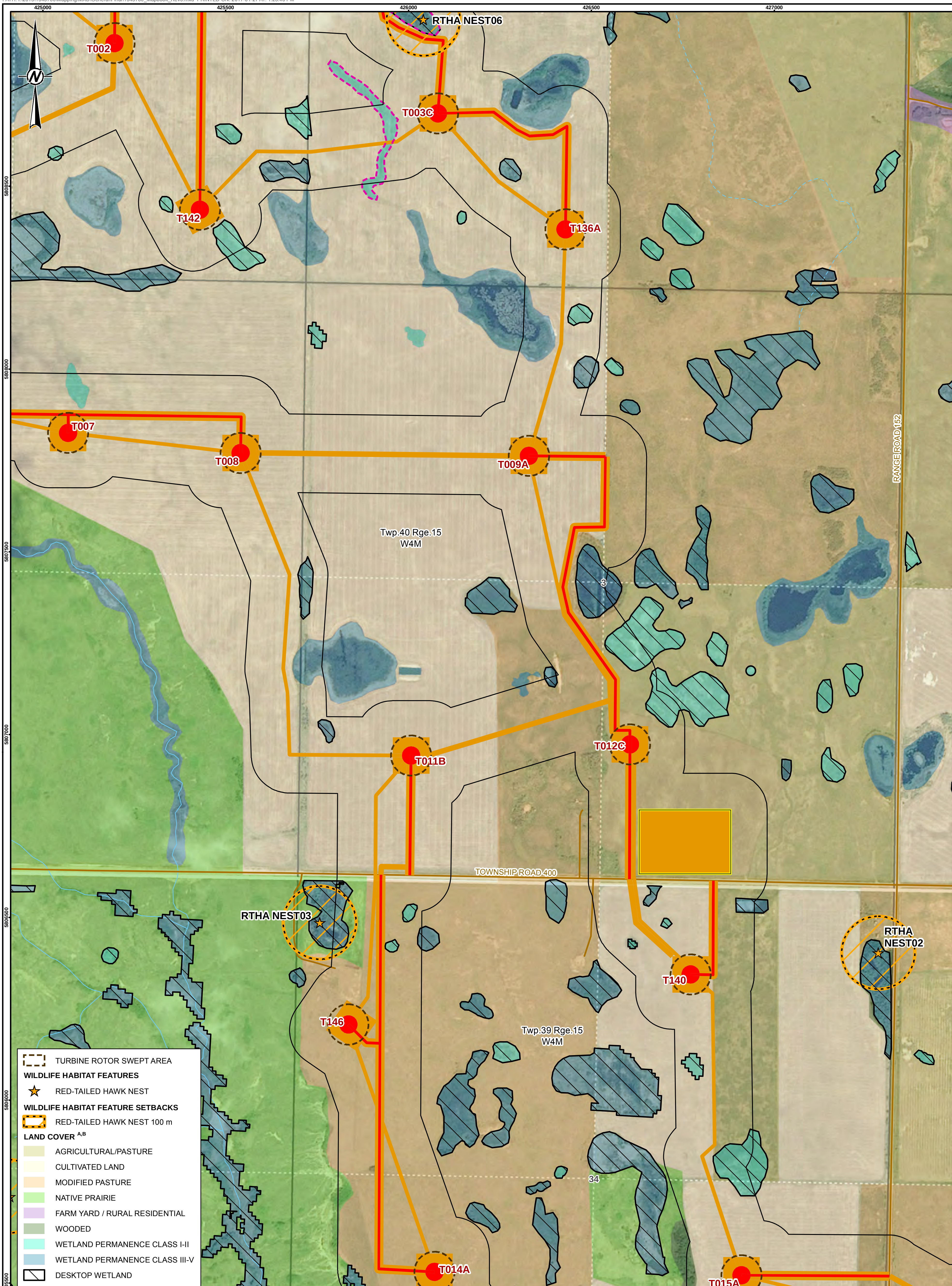


LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

A LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
B STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

Capital Power

PROJECT

HALKIRK 2 WIND PROJECT

CONSULTANT

Golder Associates

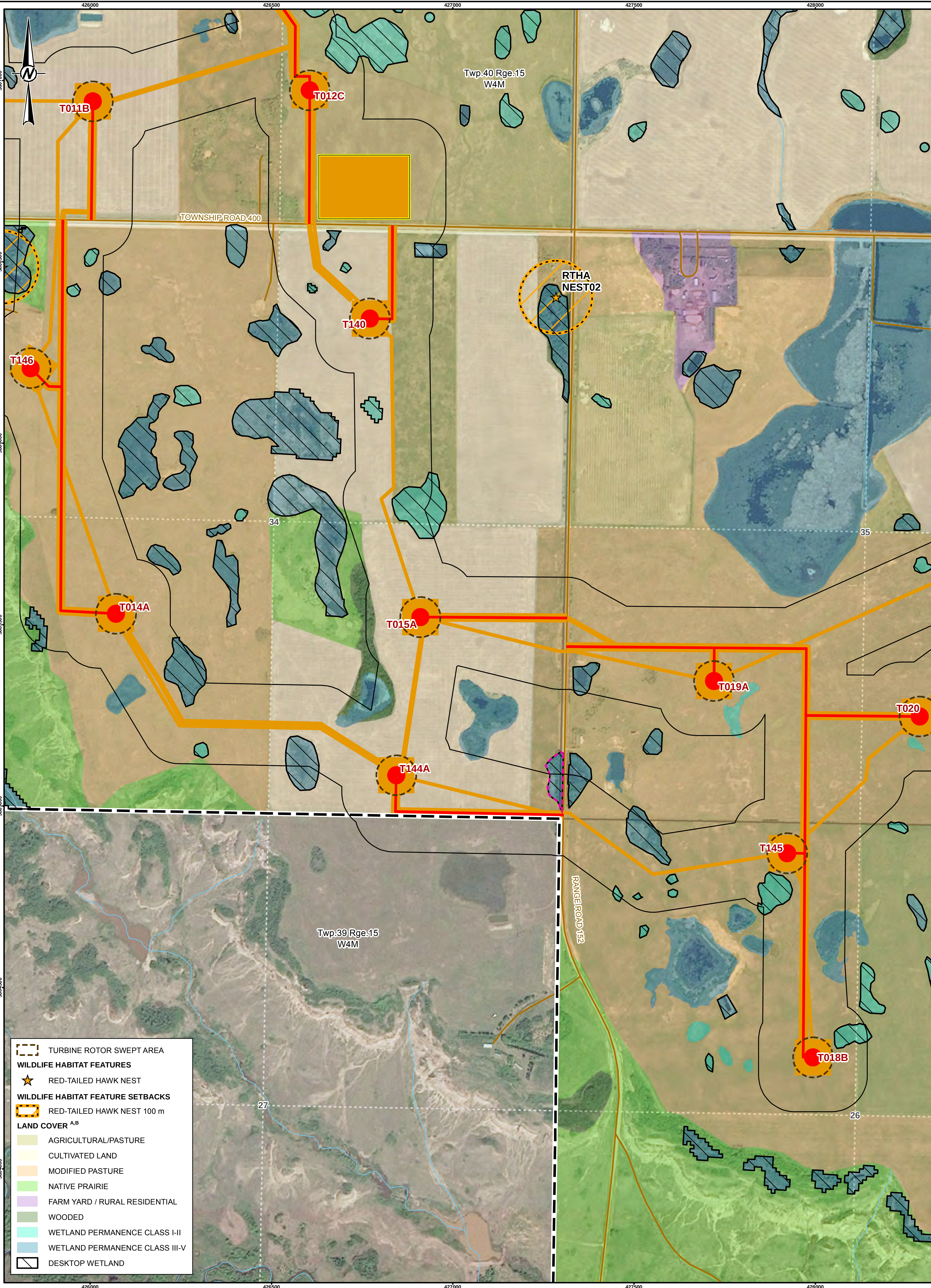
YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-3

25mm
0



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LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

NOTE(S)

[A]LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
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REFERENCE(S)

ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-4

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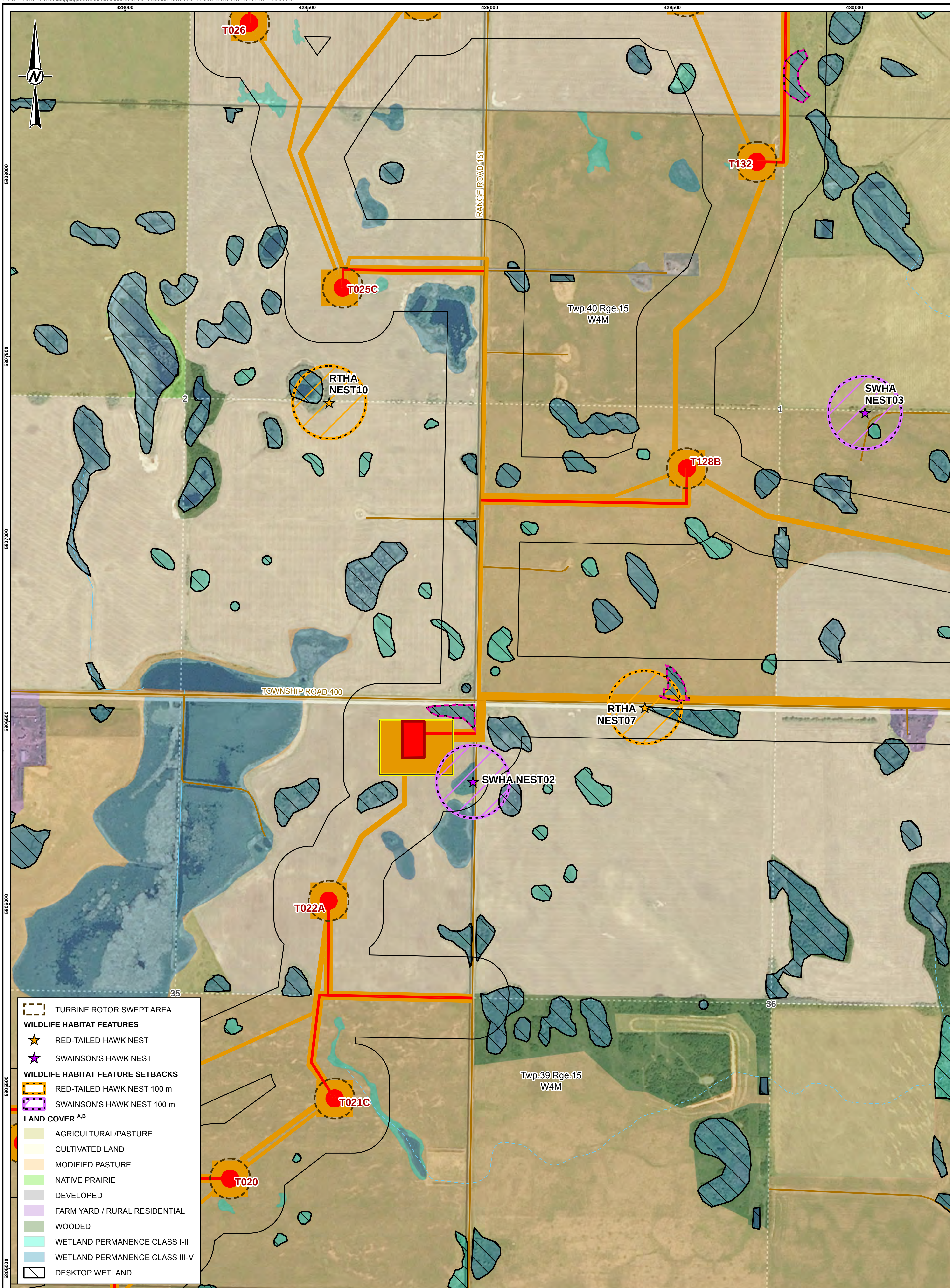

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- SUBSTATION
- TEMPORARY LAYDOWN YARD AND SUBSTATION TEMPORARY WORKSPACE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

NOTE(S)

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REFERENCE(S)

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IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

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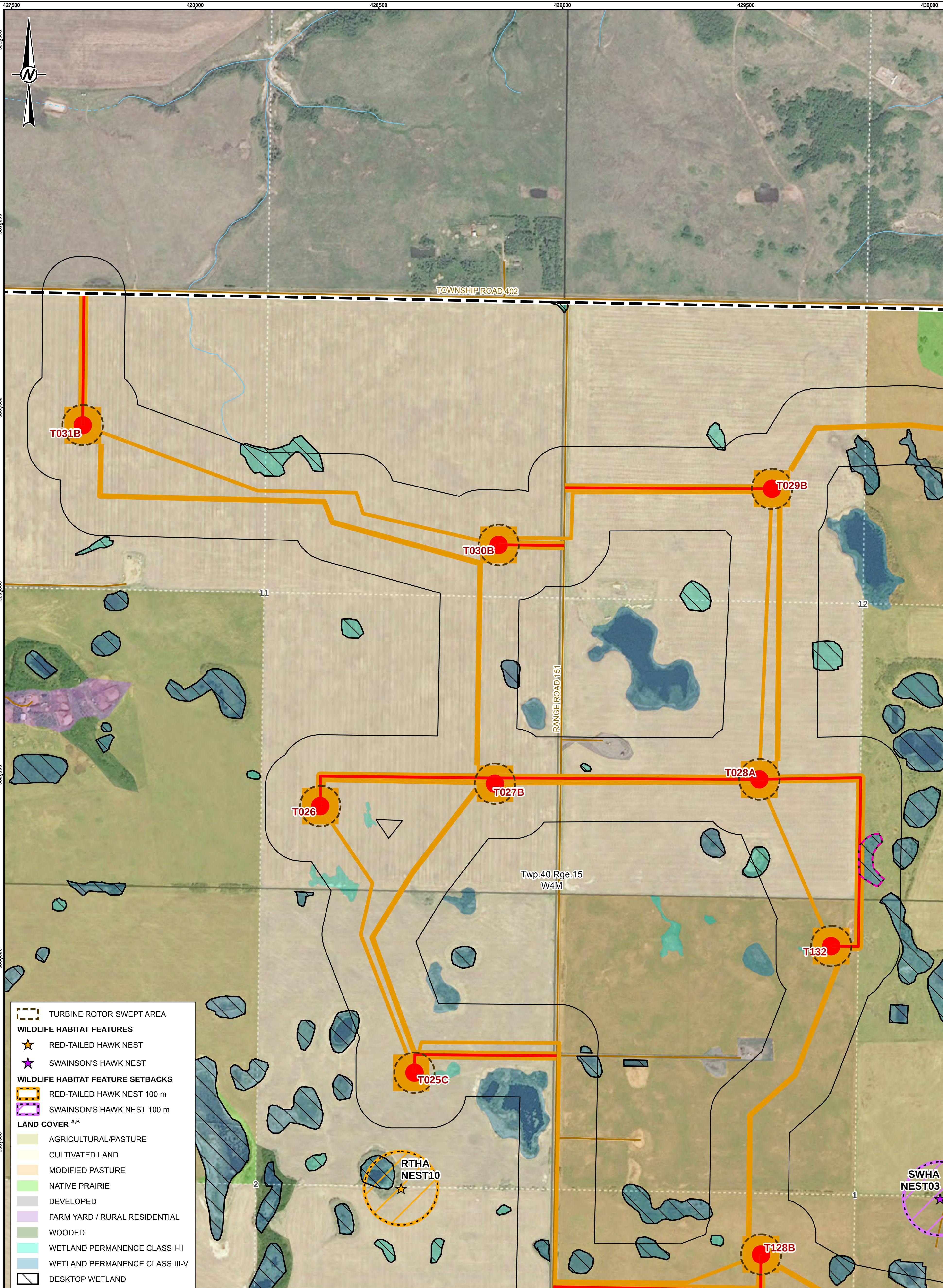

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

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REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

Capital Power

PROJECT

HALKIRK 2 WIND PROJECT

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

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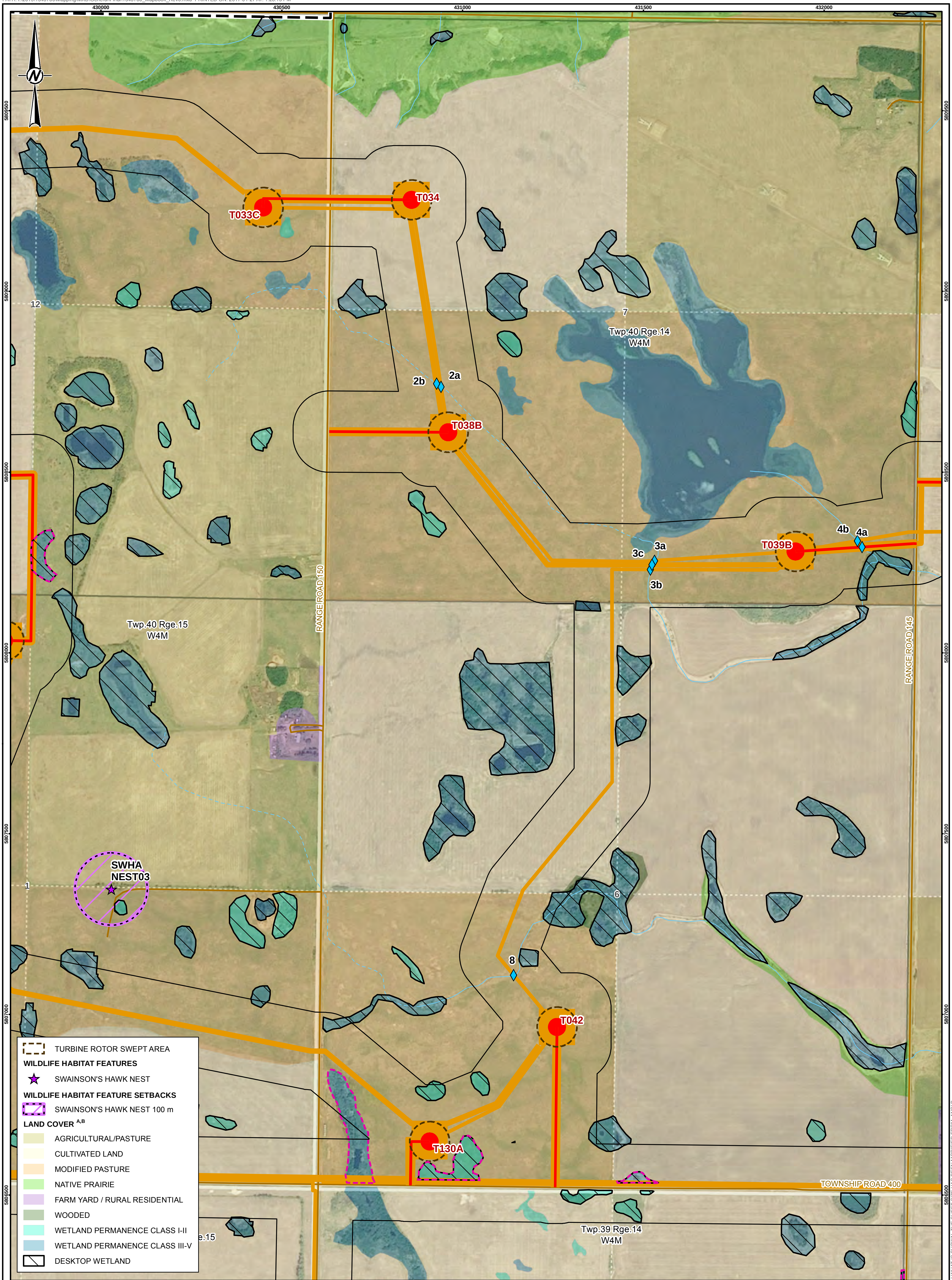

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

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PREPARED	SK
REVIEWED	CS
APPROVED	JM

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REFERENCE(S)

ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

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DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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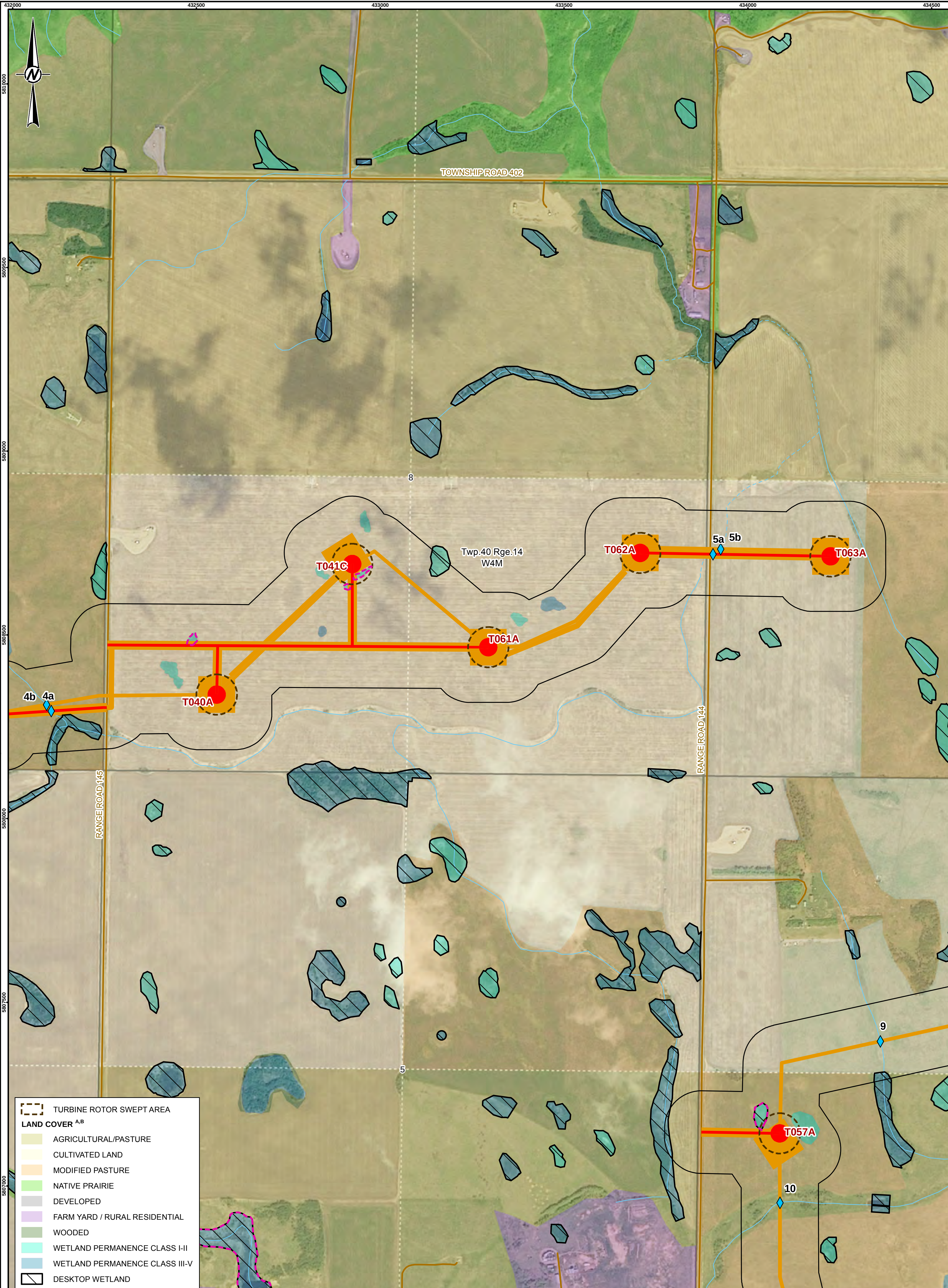

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

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REFERENCE(S)

ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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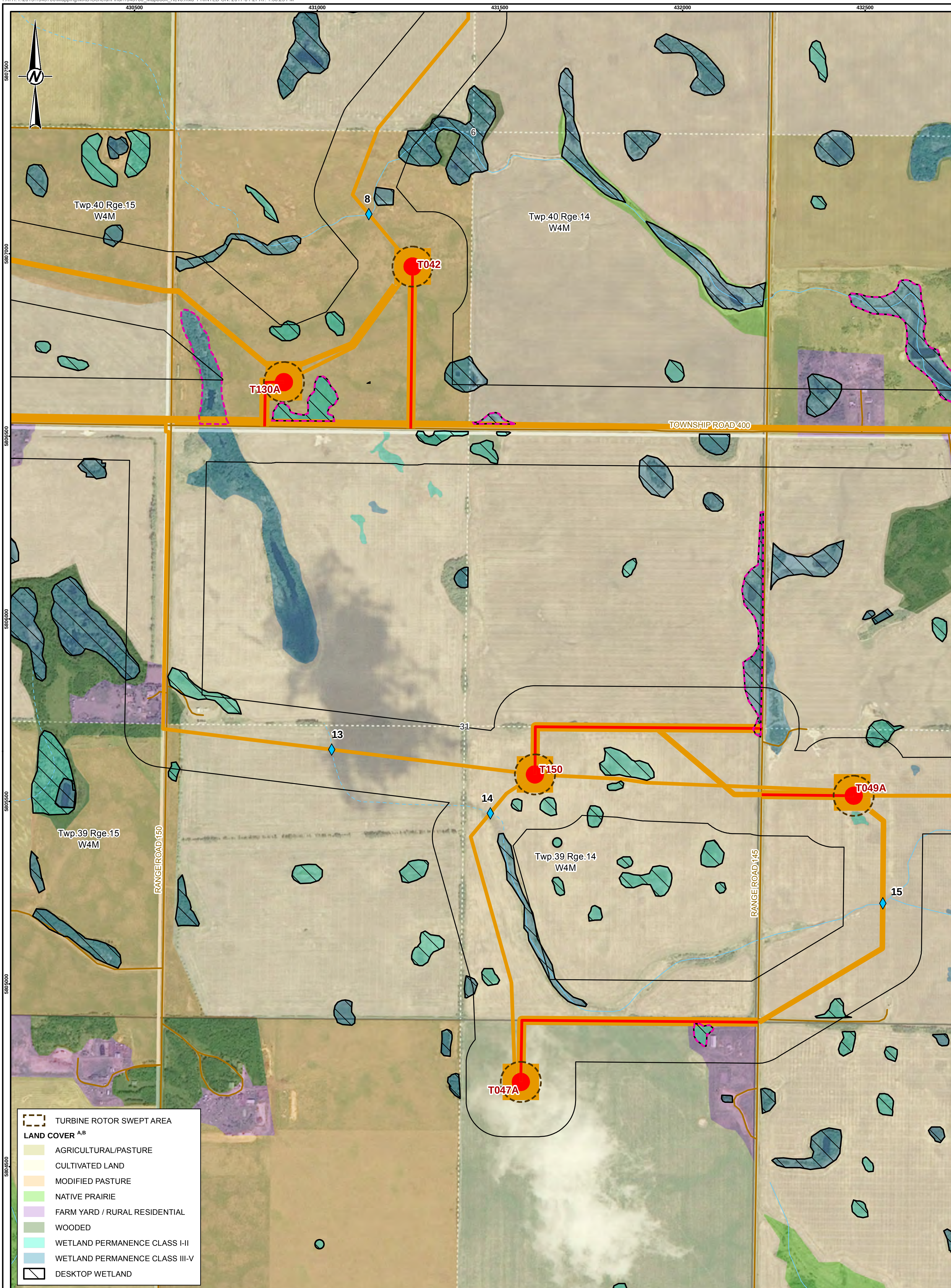

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

NOTE(S)

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REFERENCE(S)

ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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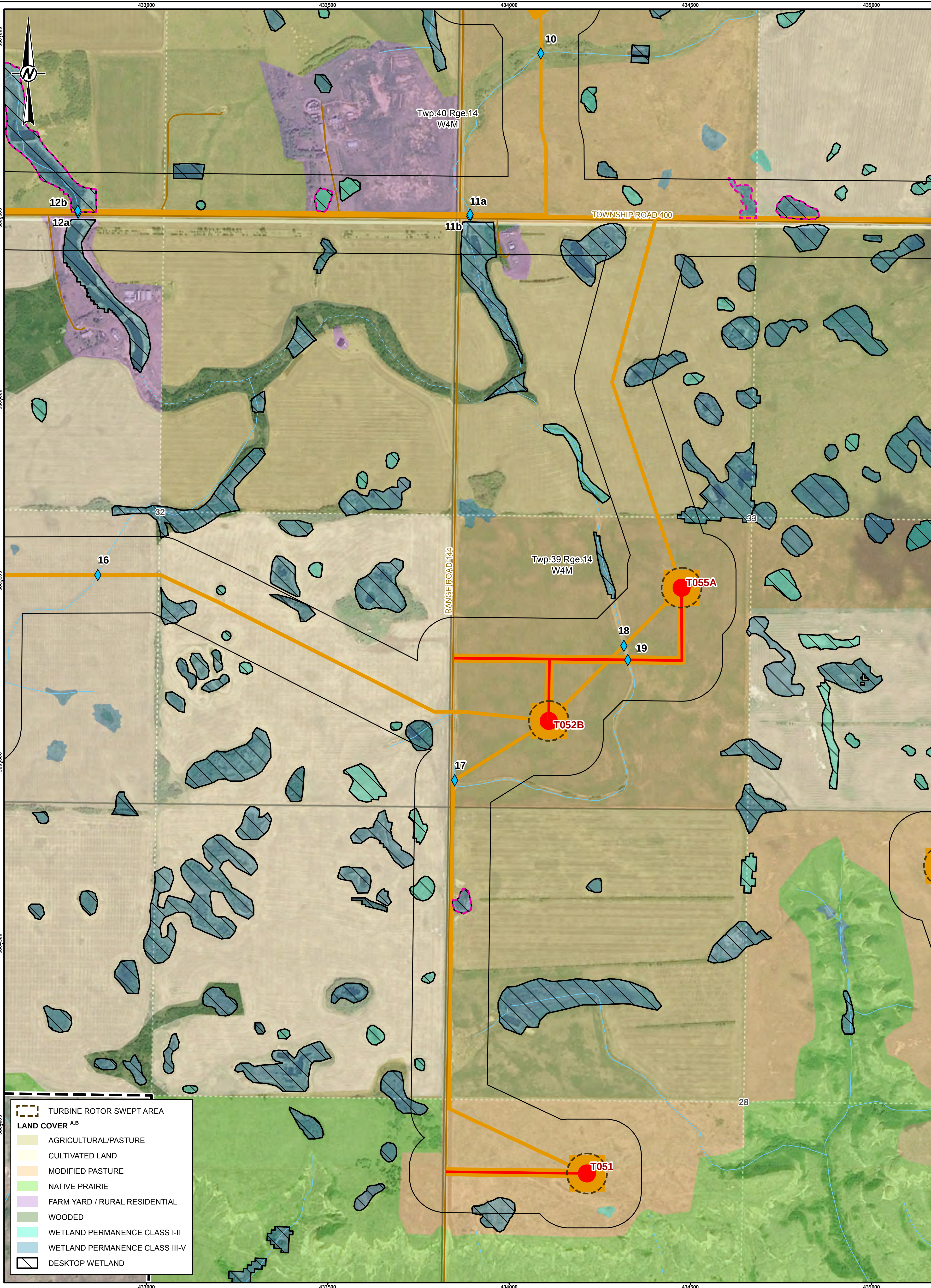

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)
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B STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)
ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-10

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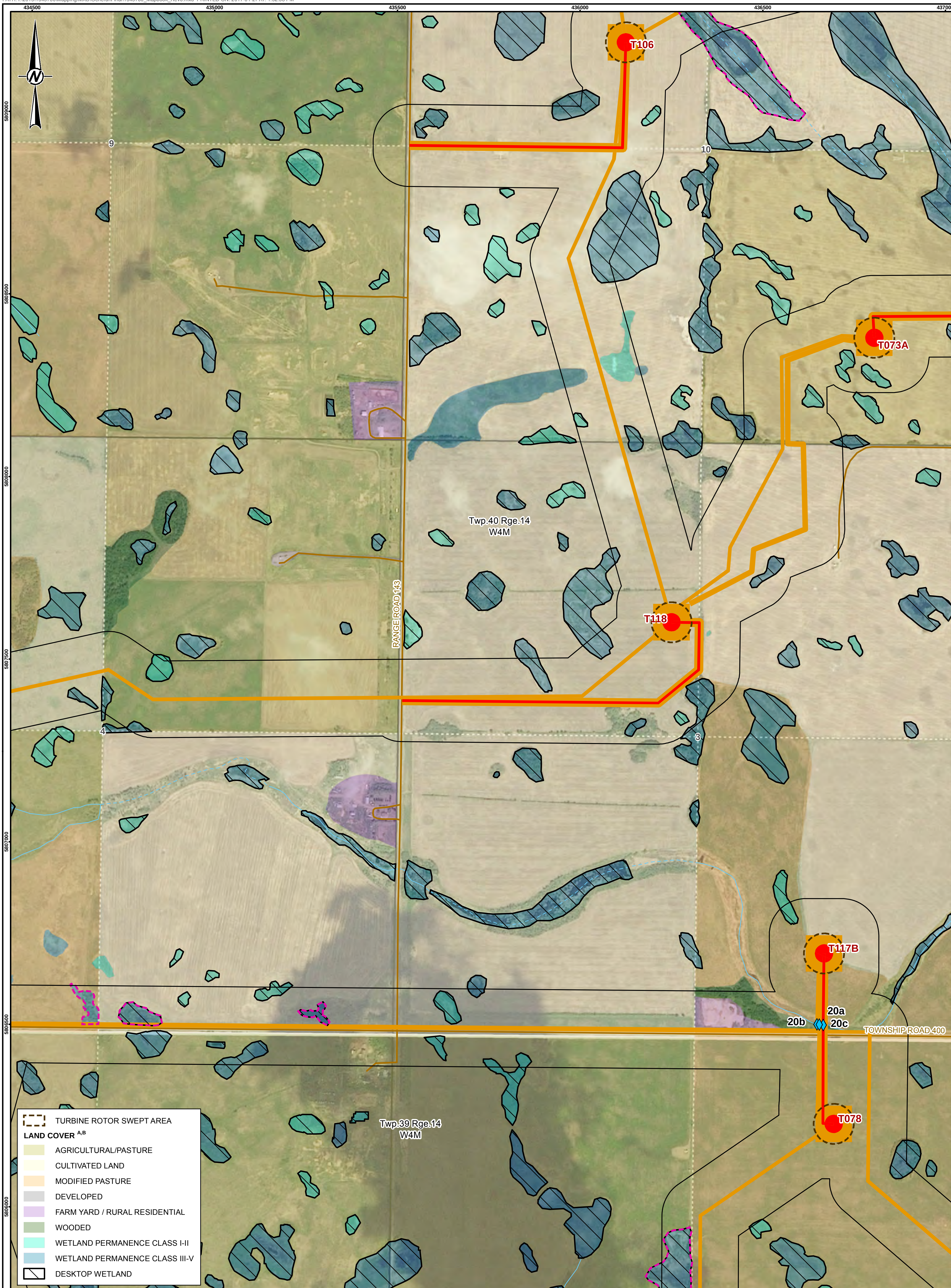

LEGEND
- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800
1:10,000 METRES

NOTE(S)
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REFERENCE(S)
ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
Capital Power

PROJECT
HALKIRK 2 WIND PROJECT

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-11

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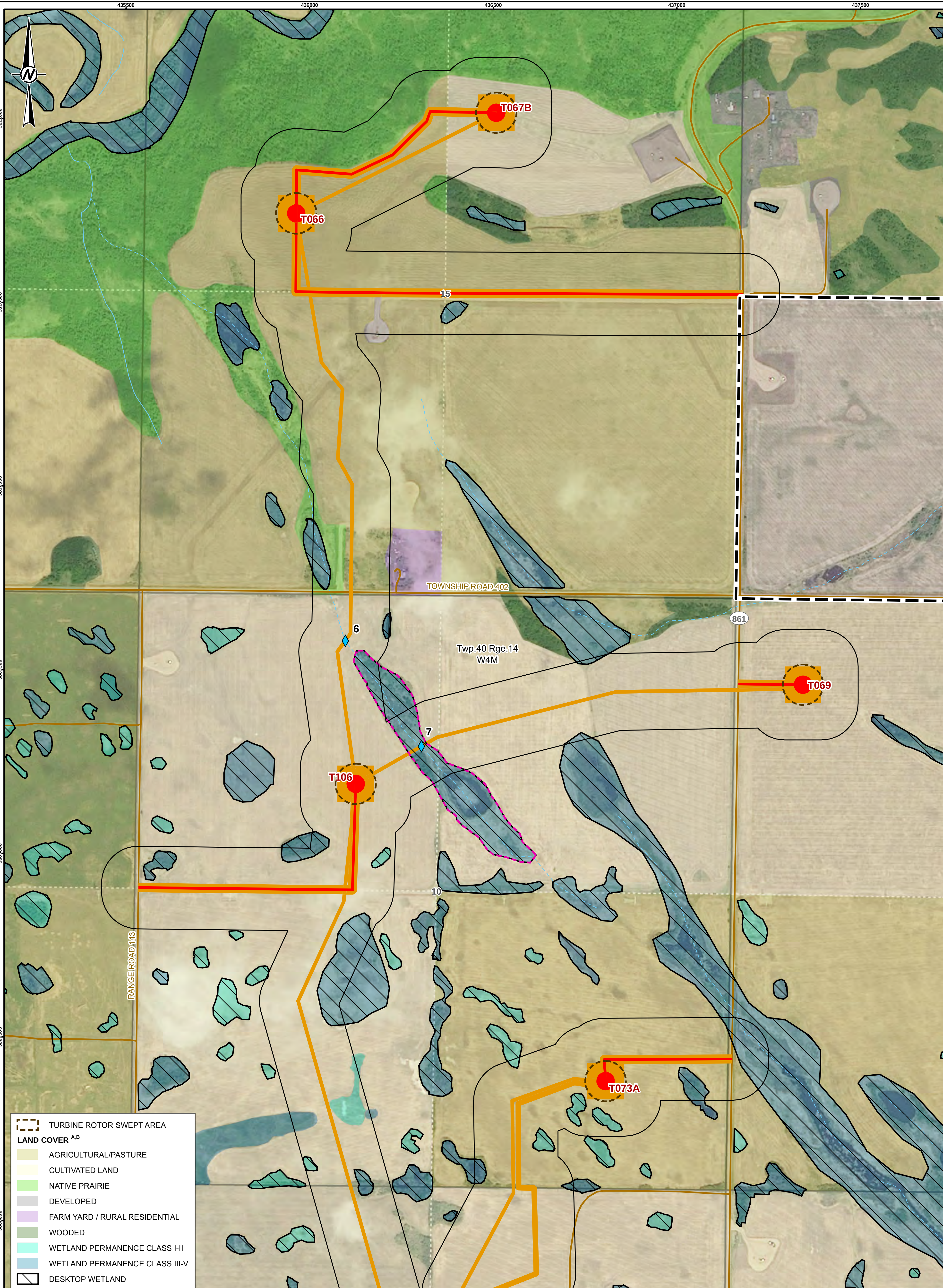

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
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NOTE(S)

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REFERENCE(S)

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IMAGERY OBTAINED FROM THE CLIENT
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-12

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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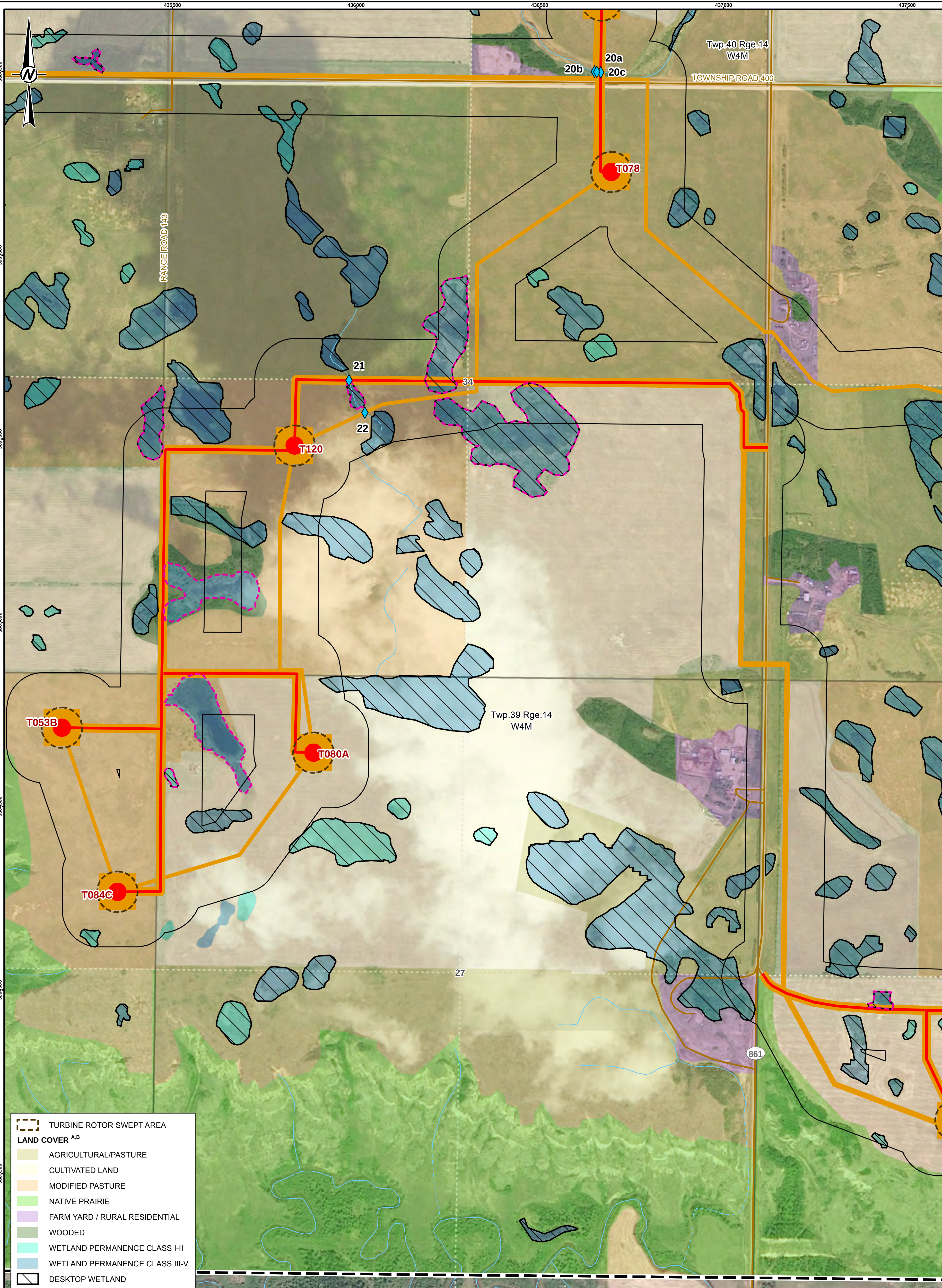

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
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NOTE(S)

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REFERENCE(S)

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PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-13

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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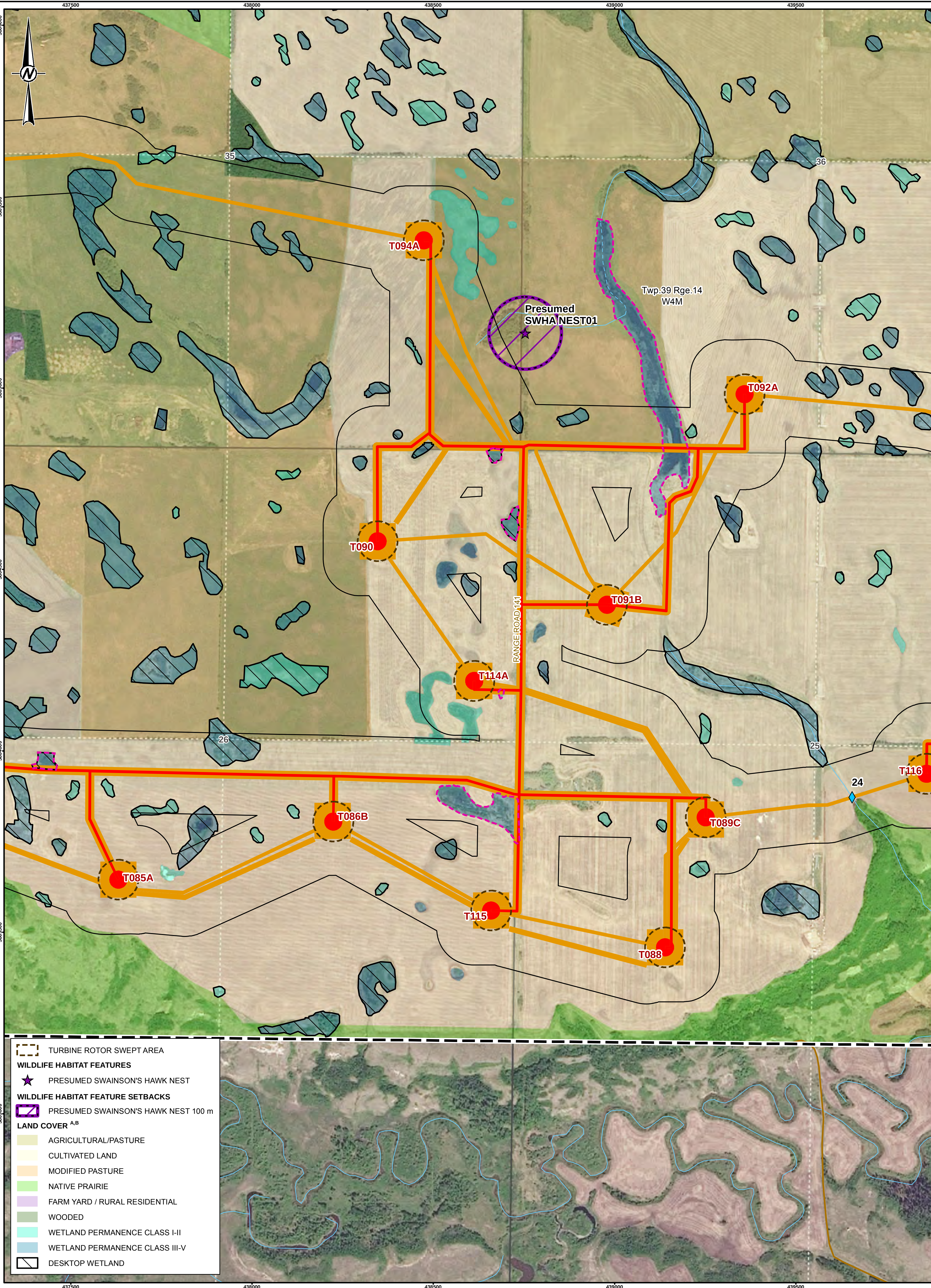

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)

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REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT

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CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-20
DESIGNED	AO
PREPARED	SK
REVIEWED	CS
APPROVED	JM

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-14

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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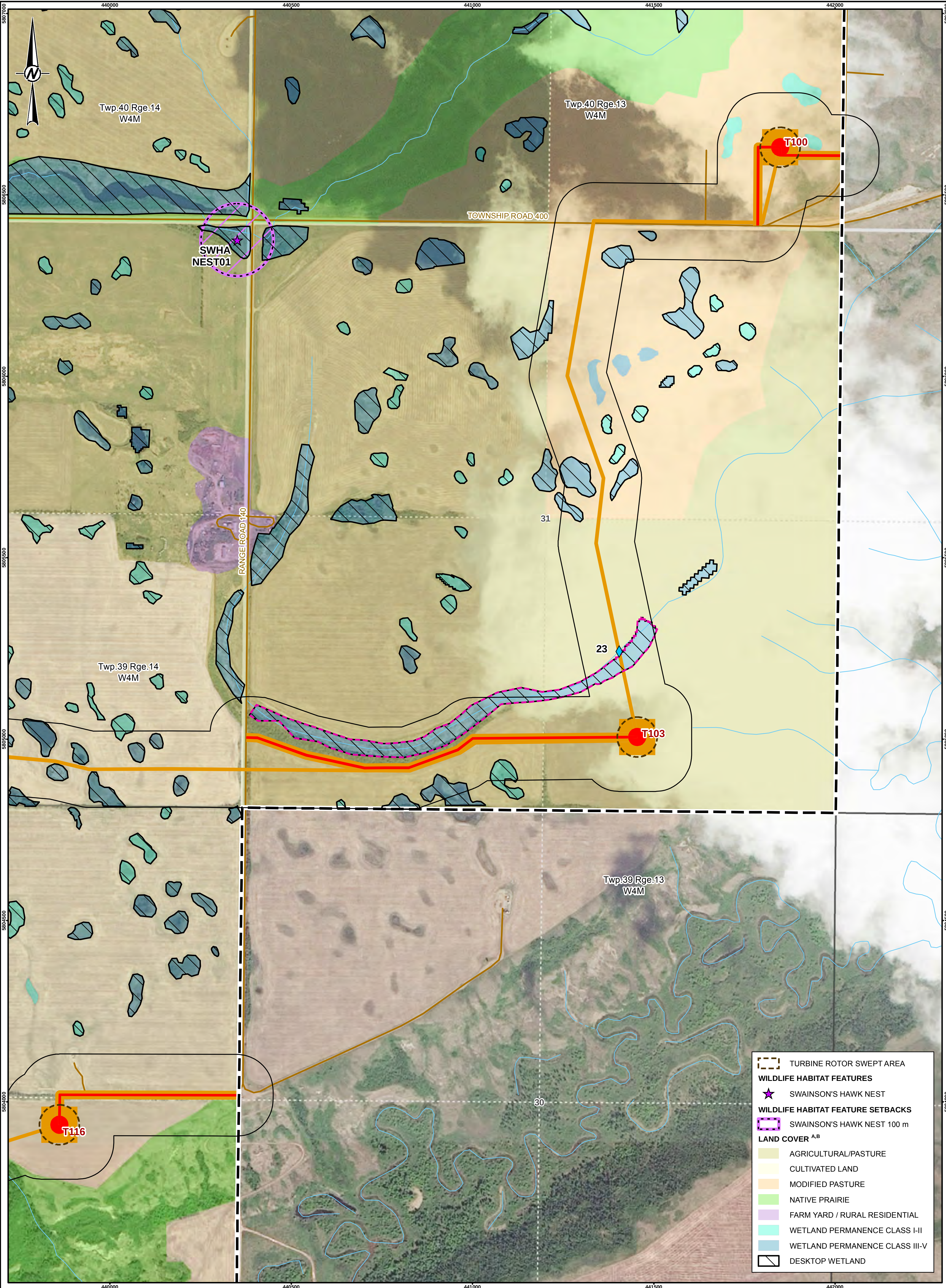

LEGEND

- PROJECT AREA
- PERMANENT PROPOSED PROJECT INFRASTRUCTURE
- TEMPORARY PROPOSED PROJECT INFRASTRUCTURE
- CONSTRUCTION FOOTPRINT 100 m BUFFER
- WATERCOURSE CROSSING
- WETLAND INTERSECTED BY CONSTRUCTION FOOTPRINT
- ROAD/HIGHWAY
- INDEFINITE WATERCOURSE
- WATERCOURSE

0 400 800

1:10,000 METRES

NOTE(S)
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CONSULTANT
Golder Associates

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PROJECT
HALKIRK 2 WIND PROJECT

TITLE
PROJECT FOOTPRINT AND ENVIRONMENTAL FEATURES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1-15

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

Aerial imagery and National Topographic System (NTS) maps were used to identify habitat and topographical features that attract wildlife or are more likely to be used for movement by flying animals (e.g., ridge tops, wetlands), and this information was used during survey design (Figure 1). Previous FWMIS records (e.g., sharp-tailed grouse) and knowledge of the field biologist conducting the surveys were also used to direct survey locations and effort.

The 11,173 hectare (ha) Project Area consists primarily of cultivated land (34%), agricultural/pasture (27%) and modified pasture (16%) interspersed with native prairie (12%), wetlands (8%), wooded (1%) and disturbed (1%) Figure 1). A query of the Canadian Important Bird Areas (IBA) database indicates that there are no designated IBAs within 10 km of the Project Area. A review of aerial imagery and on-site verification confirmed the presence of coulees/ridgelines bordering the Project Area to the north and south.

Wildlife studies were conducted in the Project Area between December 2015 and October 2016 (Table 1).

Table 1: Wildlife and Wildlife Habitat Studies Conducted for the Halkirk 2 Wind Power Project

Wildlife Study	Survey Timing	Details
Winter Bird Survey – early winter	December to early January	January 21 to 22, 2016
Winter Bird Survey – late winter	late January to end February	February 24 to 26, 2016
Sharp-tailed Grouse Lek	mid-March to mid-May	April 11 to 20 and April 29 to May 13, 2016
Richardson’s Ground-Squirrel	mid-April	April 16 to 19, 2016
Spring Bat Migration	Throughout May (continuous monitoring)	8 detectors: April 28 or 29 to June 9, 10, 11 or 12, 2016
Raptor Nest	late May to late June	June 7 to 12 and June 21 to 24, 26, 28 2016
Breeding Bird	late May to late June (2 survey rounds)	June 7 to 12 and June 21 to 24, 26, 28, 2016
Fall Bat Migration	July 15 to October 15 (continuous monitoring)	8 detectors: July 13 or 14 to October 16, 2016
Avian Use Study	Monthly, March to October	March 22 to 25, 2016 April 12 to 15, 2016 May 8 to 12, 2016 June 7 to 12, 2016 July 10 to 14, 2016 August 18 to 20, 2016 September 11 to 13, 2016 October 4 to 7, 2016

3.0 METHODS

The following sections detail the pre-field database review, field survey, and data analysis methods.

3.1 Desktop Review

A request was submitted to AEP on April 8, 2016 for FWMIS historic wildlife records for the Project Area and surrounding region. AEP’s *Wildlife Sensitivity Maps* were also reviewed. All of the key wildlife range layers were checked for possible overlap with the Project Area AEP (2016). The Project Area falls within a sharp-tailed grouse range and sensitive raptor range for prairie falcon AEP (2016).

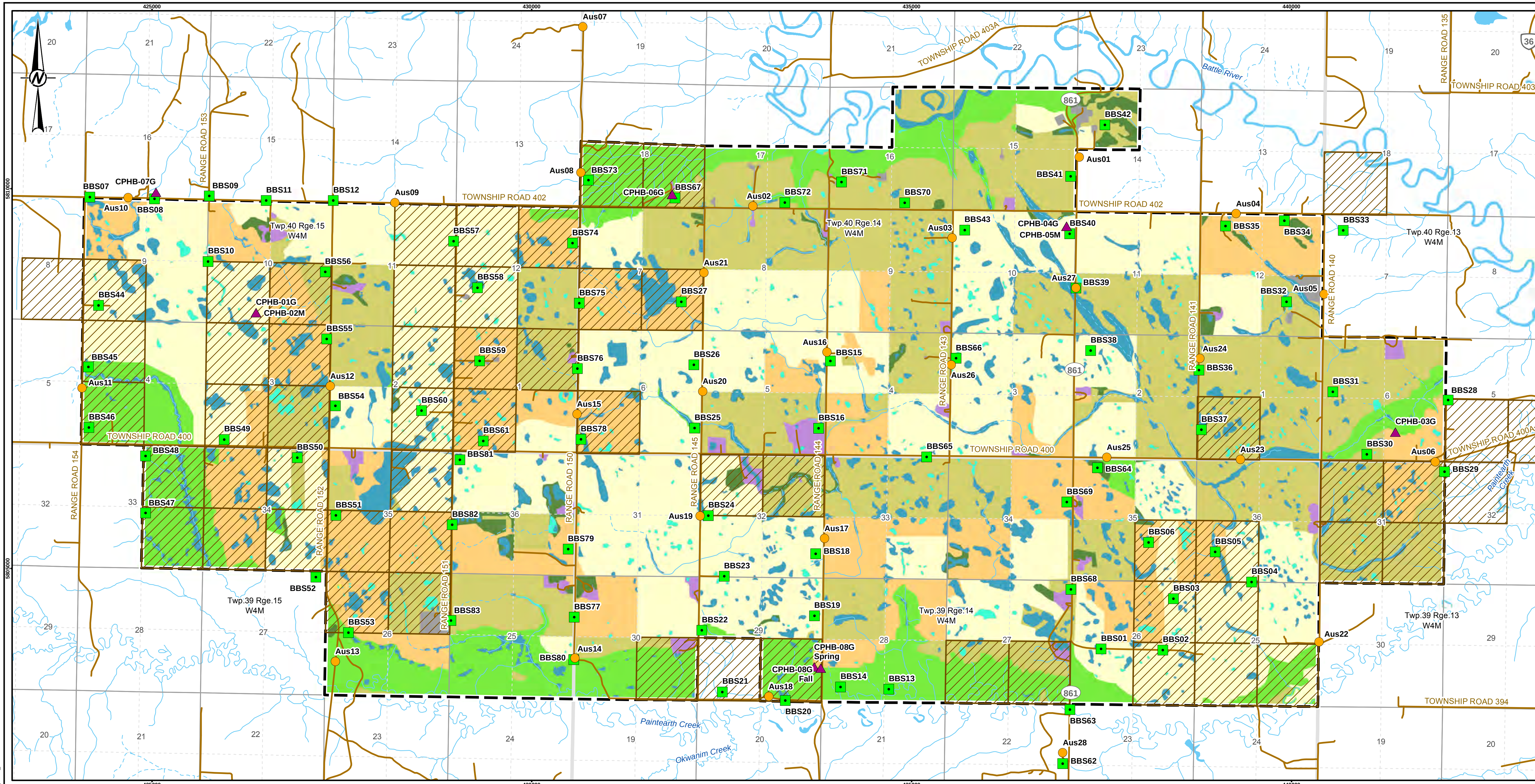
Winter bird surveys were conducted using a standardized Breeding Bird Survey (BBS) point count method adapted from the North American Breeding Bird Survey (Ralph 1993) and the Sensitive Species Inventory Guidelines (ESRD 2013a). The location of each point count plot was pre-selected to ensure dominant habitats within the Project Area were sampled, and plots were spaced appropriately to avoid double-counting individuals (Figure 2). The winter bird surveys were conducted over two site visits during the winter of 2016 (January 21 to 22 and February 24 to 26). Each point count consisted of a 5-minute survey during daylight hours. Habitat type and all birds heard and/or seen were noted within a 100 m radius of the plot centre.

3.2 Sharp-tailed Grouse Survey

Sharp-tailed grouse surveys were conducted within the Project Area and a 500 m buffer of the Project Area in 2016 from April 11 to April 20 and April 29 to May 13. (Figure 2). Sharp-tailed grouse surveys consisted of evening scouting and early morning lek searches, conducted by walking on foot or standing and listening and visually scanning areas of potential habitat within the Project Area and a 500 m buffer of the Project Area. Morning searches began one hour before sunrise and continued until approximately three hours after sunrise. Surveys consisted of listening and scanning the landscape for five minutes and recording all active lek locations and non-lekking sharp-tailed grouse, as appropriate.

3.3 Richardson’s Ground Squirrel Survey

Because Richardson’s ground squirrels represent an important prey base for many raptor species, such as prairie falcon, a Richardson’s ground squirrel survey was conducted in conjunction with the sharp-tailed grouse survey. Survey protocol followed AEP’s recommended technique for visual surveys (Downey 2003). Point count surveys involved the biologist stopping every 800 m along a 12.8 km predetermined transect. Using binoculars and rotating 360 degrees (four 90 degree quadrants) each ground squirrel observed was counted in a two-minute period. Where 200 m could not be surveyed due to obstructions, the biologist moved up to 400 m along the transect until the view was clear. The number of individuals and dominant habitat type were recorded at each plot.



LEGEND

- BAT SURVEY LOCATION
- BREEDUNG BIRD SURVEY LOCATION
- AVIAN USE STUDY (AUS) SURVEY LOCATION
- SHARP-TAILED GROUSE SURVEY AREA
- PROJECT AREA
- ROAD/HIGHWAY
- WATERCOURSE
- INDEFINITE WATERCOURSE

LAND COVER [A,B]

- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

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1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	CS
PREPARED	SK
REVIEWED	CS
APPROVED	JM

NOTE(S)

[A]LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
[B]STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
HALKIRK 2 WIND PROJECT

TITLE
AVIAN USE SURVEY, BAT DETECTOR AND BREEDING BIRD SURVEY LOCATIONS AND SHARP-TAILED GROUSE SURVEY

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	2

3.4 Spring Bat Migration

The principal goal of the spring bat migration study was to quantitatively describe bat activity within the Project Area during the spring migration period, using nocturnal acoustic detection devices.

3.4.1 Data Collection

Bat activity monitoring followed recommendations within the *Bats and Wind Turbines - Pre-Siting and Pre-Construction Survey Protocols* (Lausen et al. 2008). The Lausen et al. (2008) protocol was updated in 2010 and is endorsed by the Alberta Bat Action Team. Lausen et al. (2008) recommends a four-week period of acoustic monitoring during the spring (May) using AnaBat® bat detection / recording units.

To assess the level of bat activity within the Project Area, eight AnaBat® units were installed. Four of these detectors were positioned approximately 2 m above ground and were affixed to available vertical structures (e.g., fence posts). Four detectors were set up on meteorological towers with two detectors positioned approximately 30 m above ground and the other two approximately 2 m above ground. This paired design permitted comparison of bat activity at each height. Table 2 provides the deployment details, surrounding habitat and terrain features at each detector location. The detectors were deployed before sunset on April 28 or 29, 2016, and were collected between June 9 and 12, 2016 for a total of 32 to 45 potential nights of recording at each location. Detector locations in the Project Area are displayed in Photos 1 and 2.

Table 2: 2016 Spring Bat Detector Deployment Details

Detector	Location (UTM)[a]		Set-up Details		Surrounding Habitat	Proximity to Roosting Habitat[d]	Proximity to Water[e]	Topographical Position
	Easting	Northing	Height (m)[b]	Aspect[c]				
CPHB-01G	426370	5808368	2	135°	cultivated cropland	150	300	hillcrest
CPHB-02M	426369	5808369	30	135°	cultivated cropland	120	300	hillcrest
CPHB-03G	441366	5806797	2	45°	hayland, deciduous forest	10	250	hillcrest/coulee ridge
CPHB-04G	437037	5809503	2	45°	cultivated cropland	100	500	flat terrain
CPHB-05M	437036	5809505	30	45°	cultivated cropland	100	500	flat terrain
CPHB-06G	431845	5809924	2	0°	modified pasture	100	100	hillcrest/coulee ridge
CPHB-07G	425053	5809952	2	0°	modified pasture	20	75	hillcrest/coulee ridge
CPHB-08G	433717	5803708	2	135°	modified pasture	40	50	hillcrest/coulee ridge

(a) UTM = Universal Transverse Mercator in Zone 12U.
(b) Height = detector microphone height in metres above ground level.
(c) Aspect = direction in which the detector was pointed (varied depending on wind direction at deployment).
(d) Proximity to Roosting Habitat = approximate distance to features that could provide roosting habitat for bats (i.e., trees, buildings).
(e) Proximity to Water = approximate distance to open water available for foraging bats.
m = metres

At each location, an AnaBat® SD1 CF bat detector was equipped with a Hi-Mic transducer (microphone), and an auxiliary battery. To limit exposure of the bat detection equipment to rain, the detectors were deployed in weatherproof containers, and the microphones were placed in weatherproof housings and pointed down at a 45° angle towards a lexan acoustic reflector (Siders 2005) mounted parallel to the ground (Photos 1 and 2).

Photo 1

Example of ground mounted AnaBat® bat detector with Hi mic transducer mounted at approximately 2 m height.

Photo 2

AnaBat® Hi-mic transducer mounted within PVC pipe, and aimed at a lexan reflector.

Bat activity (i.e., high frequency auditory signals) was digitally recorded, by the AnaBat® SD1, onto compact flash 1-gigabite (1 GB) memory cards. The memory cards were downloaded during weekly maintenance checks of the AnaBat® units.

Prior to deployment, each AnaBat® unit was calibrated and set to a sensitivity level of 6.5. However, upon deployment of each unit, the sensitivity was adjusted slightly to reduce any noise interference that may have been unique to each individual location (i.e., noise from vegetation). This slight adjustment of sensitivity does not alter the detection capabilities of each AnaBat® unit and therefore they remain comparable across the Project Area.

To monitor the bat detection equipment performance, a strict testing protocol was implemented during the monitoring program. Prior to each deployment, during weekly checks, and upon instrument recovery, each piece of bat activity detection equipment was thoroughly inspected to confirm proper functionality. During the weekly checks, data from each detector were downloaded to a laptop computer and fully charged batteries were inserted into all detector units.

3.4.2 Data Analysis

Data analysis was conducted by Kristine Sare (Golder), a biologist who, in addition to having extensive experience analysing bat acoustic signals, received formal training in the identification of bat echolocation auditory signatures by attending the Bat Conservation International Acoustic Monitoring Workshop in 2009, and a two-day course hosted by Cori Lausen, Ph.D. in 2008. The analysis consisted of a tally of all bat ‘passes’, and assigning the passes to bat species or species group based on characteristics of the echolocation recording (Lausen 2008). A bat ‘pass’ is attributed to a bat flying through the detection radius of the bat detector. Because an individual bat may be recorded making multiple passes, the data presented are a measure of bat activity in the vicinity of the bat detectors, not a direct measure of the numbers of bats within or passing through the Project Area/region.

3.5 Raptor Nest Survey

The Project Area is in the range of nesting raptor species, in particular, the ferruginous hawk, northern harrier, red-tailed hawk, and Swainson’s hawk (Federation of Alberta Naturalists 2007).

Raptor nest surveys were conducted using a standardized grassland raptor nest survey, as outlined in the Sensitive Species Inventory Guidelines (ESRD 2013a). Raptor nest searches were conducted in conjunction with the BBS in 2016 from June 7 to 12 and June 21 to 24, 26 and 28. The surveys focused on the Project Area and a 1 km buffer beyond the Project Area boundary for the presence of raptor nests.

Areas of potential raptor nesting habitat (including trees and cliffs) were identified using areal imagery and by driving roads within the Project Area as per ESRD 2013a. If potential nesting habitat was found and land access permission was obtained, the biologist surveyed the area on foot with binoculars and recorded active nests by handheld global positioning system (GPS). If land access had not been obtained, potential nesting habitats were surveyed from the roadside with binoculars and active nests waypoints were projected to their approximate location. In areas without landowner access permission, every effort was made to identify active raptor nests; however, without a raptor nest survey on foot, active raptor nests within the Project Area could have potentially remained undetected because of visual obstruction or distance from the nearest road.

In addition to the formal raptor nest survey, information on potential raptor nests was collected throughout the suite of wildlife surveys. Specifically, when large stick-nests of suitable size to accommodate raptor nesting were identified during subsequent wildlife surveys, the locations were recorded on Project Area maps. While not all of the stick-nests were occupied at the time of the surveys, the location of known nests provides a starting point for subsequent raptor nest searches, as necessary.

3.6 Breeding Bird Survey

Breeding songbirds were surveyed using a standardized BBS point count method, which was adapted from the North American Breeding Bird Survey (Ralph 1993) and the Sensitive Species Inventory Guidelines for grassland birds (ESRD 2013a). The location of each point-count plot was pre-selected to ensure dominant habitats within the Project Area were sampled, and plots were spaced appropriately to avoid double-counting individuals. The BBS was conducted over two site visits during the summer of 2016 (June 7 to 12 and June 21 to 24, 26 and 28).

Each point count was conducted from one half hour before sunrise until 10 a.m. Each point-count consisted of a 5-minute survey. Habitat type and all birds heard and/or seen were recorded within a 100 m radius of the plot centre.

Following the morning of each BBS, the Project Area and a 1 km buffer of the Project Area were searched for the presence of raptor nests.

3.7 Fall Bat Migration Study

The principal goal of the fall bat migration study is to quantitatively describe bat activity within the Project Area during the fall migration period, using nocturnal acoustic detection devices.

Nocturnal acoustic detection devices were deployed in 2016 from July 13 and 14 to October 16. Data collection and data analysis followed the same methods outlined in the Spring Bat Migration Study (Sections 3.4.1 and 3.4.2).

3.7.1 Data Analysis

Data analysis was again conducted by Kristine Sare (Golder). The fall data contained numerous 'noise' files. To correct for this, the analysis consisted of passing the data through a noise filter to remove the majority of the 'noise' files (i.e., wind/insect/vehicle/vegetation induced noise), then manually examining the remaining 'bat' files to acquire a tally of all bat 'passes', and assigning the passes to bat species or species group based on characteristics of the echolocation recording. The error rate for missed bats filtered was calculated as [(bat passes filtered out as noise)/(bat passes filtered out as noise + sum of bat passes)×100]. Any bat passes that were filtered out as noise were manually corrected.

3.8 Avian Use Study

The principal goal of the baseline AUS is to quantitatively describe the temporal and spatial use of the Project Area by birds during spring and fall migration, as well as summer residents using diurnal point count surveys.

Key questions addressed by the study include:

- What species use or pass through the Project Area during the spring and fall migration of 2016?
- Where in the Project Area do the birds occur during the spring and fall migration of 2016?
- What species use or pass through the Project Area during summer months of 2016?
- Where in the Project Area do the birds occur during the summer months of 2016?

The protocol used for the AUS is similar to protocols used at numerous other wind power developments throughout North America (Golder 2001; Golder 2005; Golder 2010a, b; Johnson et al. 2003; Erickson et al. 1999; Erickson et al. 2000; Strickland et al. 2001; Strickland et al. 2003).

3.8.1 Data Collection

Twenty-eight circular AUS plots of 800 m radius were surveyed to provide appropriate coverage of the Project Area and the associated habitats (Figure 2). The AUS plots were established at locations that provided the greatest opportunity to view the entire 800 m radius plot; however, in some cases, a 360° view was not possible due to terrain features, buildings, and/or trees. Plot centres were geo-referenced with hand-held GPS. When available, landmarks were used to identify the boundaries of each AUS plot. AUS plots were established in March 2016 and were surveyed monthly from March to October.

All birds observed within or flying over the 800 m radius AUS plot were recorded during 20-minute sample events, conducted twice daily at each location (morning and afternoon), during three survey rounds in the spring of 2016 (March 22 to 25, April 12 to 15, and May 8 and 10 to 12), two survey rounds in the summer of 2016 (June 21 and 23 to 28, and July 10 to 14), and three survey rounds in the fall of 2016 (August 18 to 20, September 10 to 13, and October 4 to 7). Each observation was assigned a unique observation number, and consisted of species (or species group), number of individuals, sex and age class, distance from plot centre (first observed and closest), altitude above-ground (first observed, lowest, and highest), activity, and habitat(s) (observed in or flying over). All observations were recorded on Project specific data sheets. Activity categories include perching, flapping, soaring, circle-soaring, hovering, and other. When the species could not be positively identified, often due to distance from the observer, brief observation, mixed species flocks and / or poor light conditions, the birds were identified to species group (e.g., unidentified passerine, unidentified duck). At each AUS plot, the date, plot number and the start / end times were recorded along with weather information, including temperature, wind speed (low and high) and direction, cloud cover, and precipitation.

Data collected during the AUS surveys represents an index of the birds present within the Project Area and not a complete census of all birds within the plots. Difficulties detecting smaller birds at longer distances and lack of a 360º view at all plots prevented a complete census.

All AUS plots were surveyed by biologists familiar with the survey methods and identification of bird species encountered during the study.

3.8.2 Data Analysis

Following collection of the AUS data in the field, the data were entered into a database for analysis. Various database queries were conducted to summarize the appropriate data for each calculation (i.e., mean use, % composition, % frequency, mean flight height, % flying). Calculations were conducted for each species and species group by lumping similar species together.

To calculate collision risk, an analysis of the rotor-swept-height (RSH) was conducted based on the specifications of the Vestas V110-2.0/2.2 turbine model. The rotor-swept-height is defined as the height range that turbine blades will pass through when a turbine is active. The V110-2.0/2.2 turbine model has a RSH of 40 to 150 m above ground level. Based on the percentage of birds flying within the RSH, the percentage of birds flying, the frequency of observations and the mean use of observations, a collision risk index can be generated to identify which species or species groups will be at a relatively higher risk of collision than others.

Each calculation is detailed in Table 3.

Table 3: Avian Use Study Data Analysis Methods

Value[(a)]	Calculation Method
flocks observed	sum of all flocks (a group of 1 or more individuals)
individuals observed	sum of all observations of a species or group
mean use	individuals observed / sum of AUS plot sampling events
% composition	(individuals observed of species *x* / individuals observed of all species) × 100
% frequency	[(sum of AUS plot sampling events with occurrence of species *x*) / sum of AUS plot sampling events] × 100
airborne flocks	sum of flocks (a group of 1 or more individuals) observed flying
airborne birds	sum of individuals of each species or group observed flying

Table 3: Avian Use Study Data Analysis Methods

Value[(a)]	Calculation Method
mean flight height	{sum of [(minimum flight height of flock + maximum flight height of flock) / 2 × airborne birds in flock]} / airborne birds
% birds flying	(airborne birds / individuals observed) × 100
% flying below the rotor-swept-height	[sum of species (max. flying height <40 m)/sum of species (flying)] × 100
% flying within the rotor-swept-arc	[sum of species (range of min. to max. flying height partly between 40 m and 150 m)/sum of species (flying)] × 100
% flying above the rotor-swept-height	[sum of species (min. flying height >150 m)/sum of species (flying)] × 100
collision risk index	(mean use) × (frequency) x (% birds flying) × (% flying within the rotor-swept-height)

(a) All calculations were conducted on an individual species and species group basis.

AUS = Avian Use Study;% = percent

3.9 Incidental Observations

Incidental wildlife observations, including mammals, amphibians, and unusual concentrations of birds, birds exhibiting unusual behaviour, active bird nests, and species of concern observed while traveling in or within 1 km of the Project Area were recorded opportunistically. Species of concern were identified as those listed federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2016), the *Species At Risk Act* (SARA 2016), or provincially by AEP (ASRD 2012).

4.0 RESULTS

4.1 Wildlife Database Review

The FWMIS results provided by Emily Herdman from AEP identified historical observations of 15 species of special concern within a 2 km buffer of the Project Area. Appendix A describes each species and their provincial and federal status.

4.2 Winter Bird Survey

To document avian species presence within the Project Area during the winter, an early winter bird survey was conducted on January 21 and 22, 2016, and a late winter bird survey was conducted on February 24 to 26, 2016, by an experienced wildlife biologist. Due to the later start of winter 2015/2016, Golder consulted with AEP to have the timeframe for ‘early winter’ extended to January 31.

Each winter wildlife survey was conducted over approximately eight hours, under typical weather conditions for the region, with temperatures ranging from -12°C to 11°C, and clear to overcast skies. Twenty-six point counts were completed during the early winter survey and 39 were completed during the late winter survey period.

Table 4 includes all the observations made during each winter bird survey. Of the species observed during the winter wildlife surveys, none are listed provincially (ASRD 2012) and/or federally (COSEWIC 2016).

Table 4: Winter Bird Survey Observations, 2016

Species	Number of Individuals		Habitat Types
	Early Winter Survey	Late Winter Survey	
black-billed magpie	17	28	cultivated cropland, deciduous forest, mixedwood forest, modified pasture, native grassland, shrubland
black-capped chickadee	5	14	deciduous forest, shrubland
Canada goose	0	177	cultivated cropland, deciduous forest, modified pasture, shrubland
common raven	8	10	cultivated cropland, deciduous forest, man-made waterbody, wetland/drainage
common redpoll	91	87	cultivated cropland, deciduous forest, mixedwood forest, shrubland
great-horned owl	2	0	deciduous forest
hairy woodpecker	0	3	deciduous forest
house sparrow	0	10	deciduous forest
pine grosbeak	5	1	deciduous forest
rock dove	0	14	cultivated cropland, deciduous forest
rough-legged hawk	0	1	modified pasture
Total	**128**	**345**	

4.3 Sharp-tailed Grouse Survey

The sharp-tailed grouse survey was conducted in 2016 between April 11 to 20 and April 29 to May 13. The first round was in conjunction with a Richardson's ground squirrel survey. Fifty-nine quarter sections (approximately 64 ha) were surveyed within the Project Area with a focus on native prairie, native pasture, and tame pasture or hay. Weather conditions during the survey consisted of temperatures ranging from -3°C to 27°C, light winds, and a few clouds.

One lek was found during the surveys; however, the lek and associated 500 m setback are located outside the Project Area. The lek consisted of six adult birds (12 U 443071E 5807268N) (Figure 1). Active sharp-tailed grouse leks have a recommended set back distance of 500 m (ESRD 2013b). While other sharp-tailed grouse were observed during the survey in quarter sections SE-6-40-13, NE-31-39-13, and SW-1-40-15, no additional leks were observed within the Project Area. Sharp-tailed grouse were also observed incidentally during the AUS in quarter sections SW-33-39-14 and NE-36-39-14.

4.4 Richardson's Ground Squirrel Survey

The Richardson's ground squirrel survey was conducted between April 16 to 19, 2016. Twenty-seven (27) plots were surveyed from the road within the Project Area (Figure 2). Weather conditions during the survey consisted of temperatures ranging from 1°C to 27°C, with mostly calm to light winds, and a few clouds.

Richardson's ground squirrels were observed at 18 of the 27 plots. A total of 64 individuals were observed in four habitat types (Table 5).

Table 5: 2016 Richardson's Ground Squirrel Observations – Halkirk 2

Habitat Type	Number of Richardson's Ground Squirrel Observations
cultivated cropland	17
hayland	1
modified pasture	11
native pasture	35
TOTAL	**64**

4.5 Spring Bat Migration Study

During May 2016, eight bat detectors were deployed at six locations within the Project Area (Figure 2). Due to a variety of technical issues, including battery failure, a severed cable and a malfunctioning microphone, not all detectors functioned each night (Table 4). Data were collected in the Project Area over a total of 330 detector nights during the spring bat migration period of 2016.

4.5.1 All Species Combined

Over the entire survey period, a total of 623 bat passes (1.89 bat passes/night) were recorded (Table 6). This level of bat activity falls in the low end of the range of bat activity reported at other wind power facilities in southern Alberta (i.e., 0.78 to 14.81 bat passes / detector night; Baerwald and Barclay 2009).

Table 6: Bat Activity by Night: Spring 2016 – Halkirk 2

Night	Detector Effort[a]	Species[b]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
Apr 28	2	-		-	-	1	1	-	-	-	2	1.00
Apr 29	8	-	1	1	-	2	-	-	-	3	7	0.88
Apr 30	8	-		6	-	3	-	-	-	1	10	1.25
May 01	8	1	1	2	2	18	1	-	-	-	25	3.13
May 02	8	-		3	-	5	-	-	-	1	9	1.13
May 03	8	-	6	4	-	16	3	2	-	2	33	4.13
May 04	8	2	4	6	1	17	2	-	3	4	39	4.88
May 05	8	1	2	5	-	9	1	-	-	5	23	2.88
May 06	8	-	2	4	-	10	-	-	-	-	16	2.00
May 07	8	3	3	5	-	4	-	-	-	-	15	1.88
May 08	8	-	2	4	-	2	-	-	-	-	8	1.00
May 09	8	-		1	-		-	-	-	-	1	0.13
May 10	8	-	2	3	-	1	3	-	-	-	9	1.13
May 11	8	-	1	2	-	2	-	-	2	-	7	0.88
May 12	8	-		3	-		-	1	-	-	4	0.50
May 13	8	-	2	3	-	3	-	-	1	-	9	1.13
May 14	8	2	1	4	3	5	1	-	1	4	21	2.63
May 15	8	-	4	3	-	7	-	-	1	1	16	2.00
May 16	8	-	2	4	-	14	-	-	1	-	21	2.63
May 17	8	-	3	9	6	16	-	1	5	-	40	5.00
May 18	8	1	5	2	1	16	-	-	1	2	28	3.50
May 19	8	-	-	-	-	3	-	-	-	-	3	0.38
May 20	6	-	-	-	-	-	-	-	-	-	-	0.00
May 21	6	-	-	-	-	-	-	-	-	-	-	0.00
May 22	6	-	1	1		2	-	-	-	1	5	0.83
May 23	6	-	-	1	25	7	2	-	-	-	35	5.83
May 24	6	1	2	-		12	2	-	-	1	18	3.00

Table 6: Bat Activity by Night: Spring 2016 – Halkirk 2

Night	Detector Effort[a]	Species[b]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
May 25	8	-	4	5	4	13	1	-	2	-	29	3.63
May 26	8	1	5	8	9	25	2	-	8	5	63	7.88
May 27	8	-	-	2	4	7	2	-	3	-	18	2.25
May 28	8	1	1	-	-	3	-	-	-	1	6	0.75
May 29	8	-	-	-	-	1	-	-	-	-	1	0.13
May 30	8	-	-	-	-	-	-	-	-	-	-	0.00
May 31	7	-	1	2	1	4	-	-	-	2	10	1.43
June 01	7	-	1	2	1	12	-	-	-	2	18	2.57
June 02	7	1	-	1	-	4	-	-	2	-	8	1.14
June 03	7	-	1	6	3	4	-	-	1	-	15	2.14
June 04	7	1	1	4	3	2	4	-	1	-	16	2.29
June 05	7	-	-	3	1		1	-	-	-	5	0.71
June 06	7	1	3	3		6	-	-	-	1	14	2.00
June 07	7	-	1	3	2	3	2	-	1	-	12	1.71
June 08	7	-	-	-	1	2	-	-	-	-	3	0.43
June 09	7	-	-	-	-	1	-	-	-	-	1	0.14
June 10	7	-	-	-	-	-	-	-	-	-	-	0.00
June 11	3	-	-	-	-	-	-	-	-	-	-	0.00
June 12	2	-	-	-	-	-	-	-	-	-	-	0.00
Total	**330**	**16**	**62**	**115**	**67**	**262**	**28**	**4**	**33**	**36**	**623**	**1.89**

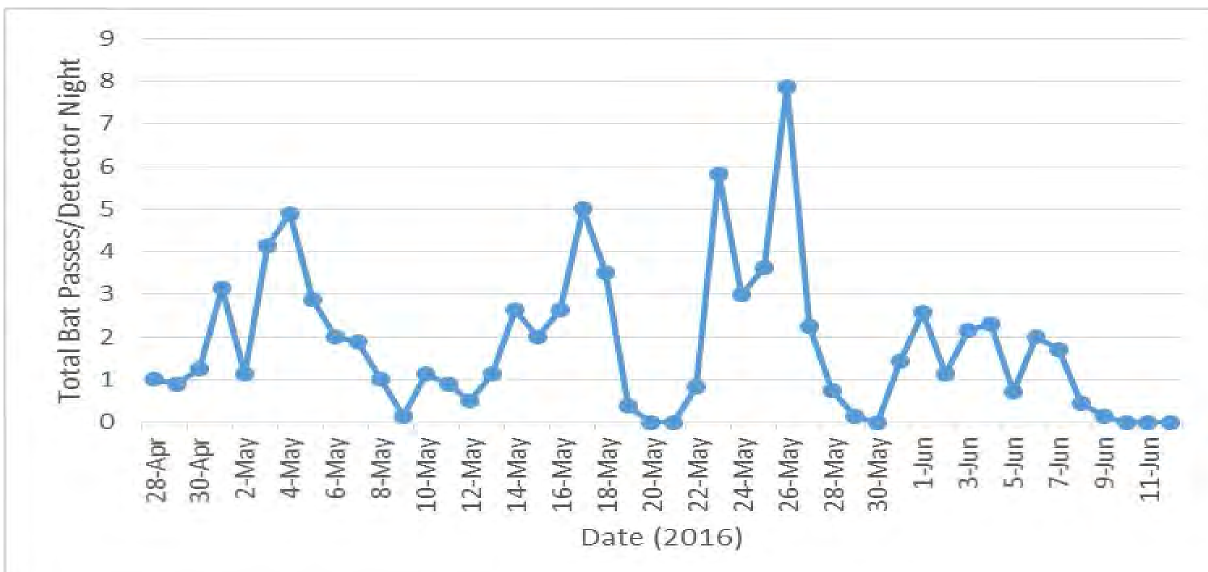
[a] Detector effort = number of deployed bat detectors that were functional during the entire survey period (i.e., April 28 to June 12, 2014).

[b] Bat species: hoary (*Lasiurus cinereus*), silver-haired (*Lasionycteris noctivagans*), unidentifiable Myotis species, big-brown (*Eptesicus fuscus*), low freq. (includes hoary, silver-haired, and big brown), high freq. (includes myotis species and red (*Lasiurus borealis*)), unknown (definitely a bat species, but not identifiable due to recording quality).

Bats may migrate along landscape features that form natural north-south corridors such as forest edges, ridge lines, streams and valleys (Lausen et al. 2008). Most of the Project Area is characterized by open, flat, cultivated land, agricultural/pasture, modified pasture and native prairie (Figure 1). However, landscape features including the Battle River valley located north of the Project Area and the Paintearth Creek and associated coulees located south of the Project Area and their associated coulees, draws, and native habitat are considered to be higher potential habitat for bat species. While a lack of landscape features may exist within the Project Area, landscape features within the vicinity (i.e., 2 km buffer of the Project Area) may contribute to the levels of bat activities detected in the Project Area.

The highest levels of bat activity were recorded on May 26, 2016 (63 individuals or 7.88 bat passes / detector), May 23, 2016 (35 individual or 5.83 bat passes / detector), and May 17, 2016 (40 individuals or 5.00 bat passes / detector) (Figure 3). During these peaks in detection, the most common species were hoary bats and “low frequency” bats (which may include hoary bat, silver-haired bat, and/or big brown bat) (Table 6). Figure 3 shows the variation in overall bat activity recorded during the 2016 spring migration period.

Figure 3: Bat Activity by Night: Spring 2016



Results of the bat surveys indicate that multiple bat species passed through, and/or use the Project Area. Based on recorded echolocation signatures, four species of bats were positively identified, including big brown bat, silver-haired bat, hoary bat, and red bat, the latter three of which are listed provincially as “sensitive” based on their susceptibility to mortality associated with wind power facilities (ASRD 2012). Since echolocation calls could not always be identified to the species level, an additional five species groups were identified including:

- big brown / silver-haired;
- *Myotis* species, which most likely includes western small-footed bat (listed as “sensitive” provincially [ASRD 2012]), long-legged bat, and little brown bat (listed as “secure” provincially (ASRD 2012), but listed as “endangered” federally and is on Schedule 1 of *the Species at Risk Act* due to large population declines in the eastern part of its range as a result of White-nose Syndrome (COSEWIC 2016; Species at Risk Public Registry 2016);

- high frequency, which may include various species of *Myotis* and red bat;
- low frequency, which may include hoary bat, silver-haired bat, and big brown bat; and
- unknown bats, which include calls that could clearly be identified as a bat, but could not be identified to species or species group due to recording quality or because the characteristic frequency fell between 30 and 35 kHz.

Overall, bats in the low frequency and big brown/silver-hair species groups were the most commonly detected categories during the spring migration monitoring period (Figure 4, Figure 5).

Figure 4: Total Activity of Low Frequency Bats by Night: Spring 2016

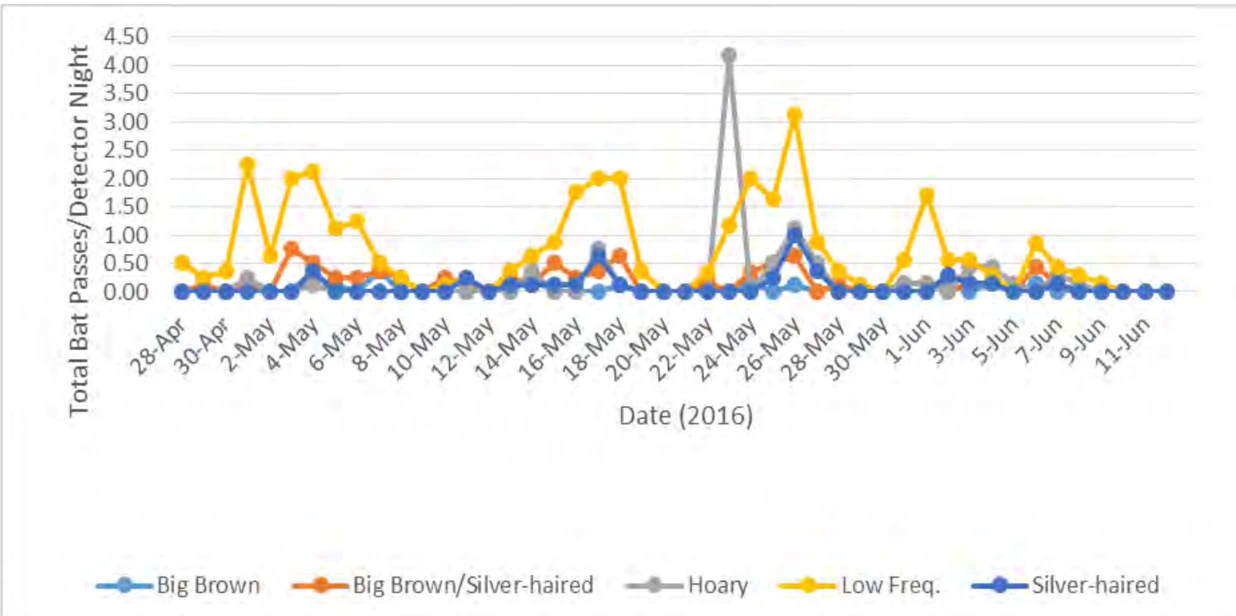
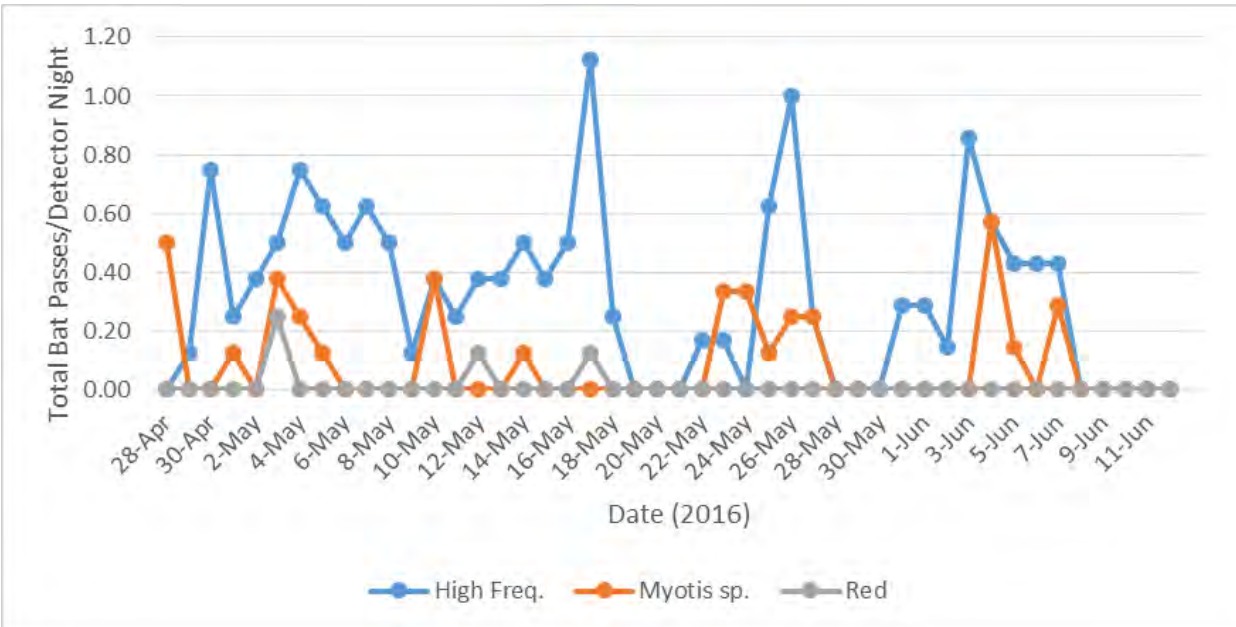


Figure 5: Total Activity of High Frequency Bats by Night: Spring 2016



4.5.2 Migratory Species

Migratory species such as silver-haired, hoary and red bats are the species primarily involved in fatalities associated with wind power facilities in Alberta (Lausen et al. 2008). Overall, about 10.8% of bat passes were identified as hoary bats, 5.3% as silver-haired bats and 0.6% as red bats. Red bats are uncommon in Alberta (Smith 1993; Van Zyll de Jong 1985). They were detected at one of the eight detector locations during the spring migration period, for a total of 4 bat passes (Table 7). Although red bat activity may be underestimated if the high frequency category includes some red bats, this species is likely present in low numbers in the Project Area and therefore at relatively lower risk of collision fatalities compared to silver-haired and hoary bats.

Baerwald and Barclay (2009) found no clear relationship between activity of migratory bats recorded at ground level and fatality rates observed at nine wind power facilities in southern Alberta, but did find a relationship between fatality rates and bat activity levels recorded at heights of 30 m. Therefore, estimates of migratory bat fatality can be made based on 30 m high acoustic data. Two detectors, CPHB02M and CPHB05M, were deployed at a 30 m height in the Project Area and can be used to better understand risk of migratory bat fatality rates for the Project.

Table 7: Bat Activity by Detector: Spring 2016 – Halkirk 2

Detector	Total Detector Effort	Species/Species Groups[b]									All Species/Species Groups	
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown	Total	Passes per Detector Night
CPHB01G	44	-	9	13	-	26	5	-	2	2	57	1.30
CPHB02M[c]	44	-	4	4	7	16	-	-	5	-	36	0.82
CPHB03G	45	3	6	8	-	40	2	-	1	11	71	1.58
CPHB04G	43	3	14	19	1	21	15	-	3	4	80	1.86
CPHB05M[c]	38	-	3	5	5	16	1	-	-	-	30	0.79
CPHB06G	44	6	1	33	11	67	3	-	9	7	137	3.11
CPHB07G	32	2	13	17	37	51	1	-	10	2	133	4.16
CPHB08G	40	2	12	16	6	25	1	4	3	10	79	1.98
Total	**330**	**16**	**62**	**115**	**67**	**262**	**28**	**4**	**33**	**36**	**623**	**1.89**

[a] Detector effort = number of nights with functional detectors. All detector nights (i.e., 330) are used to calculate the total detector effort used to calculate passes per detector night for all species/species groups.

[b] Bat species: hoary (*Lasiurus cinereus*), silver-haired (*Lasionycteris noctivagans*), unidentifiable Myotis species, big-brown (*Eptesicus fuscus*), low freq. (includes hoary, silver-haired, and big brown), high freq. (includes myotis species and red (*Lasiurus borealis*)), unknown (definitely a bat species, but not identifiable due to recording quality or because the characteristic frequency fell between 30 and 35 kHz).

[c] Detector deployed at 30 m height.

4.5.3 Activity by Detector

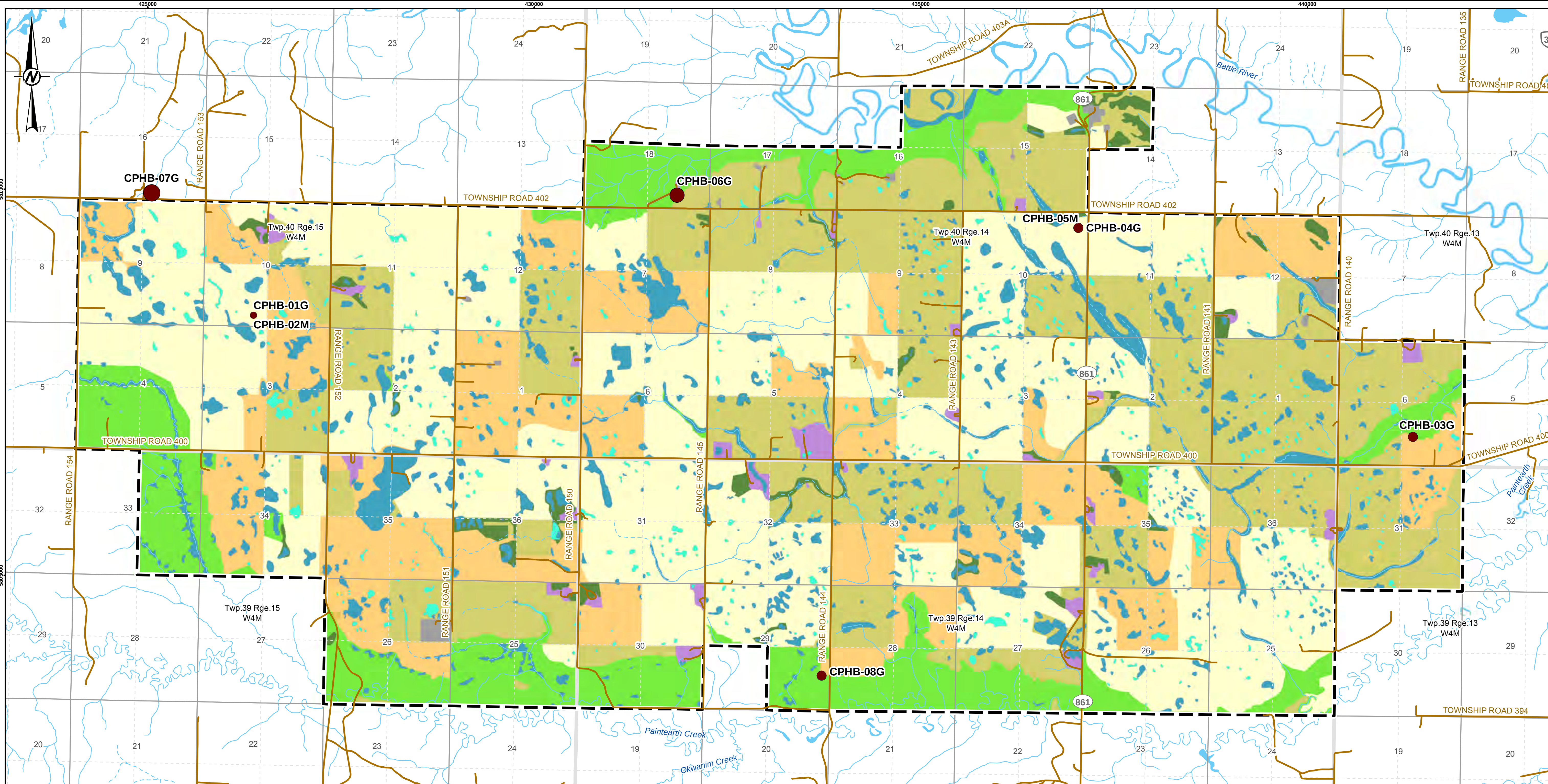
The average number of bat passes recorded per detector night ranged from 0.79 to 1.98 depending on the detector location (Table 7; Figure 6). Baerwald and Barclay (2009) suggest that detection rates may be higher at heights of 30 m, but the opposite pattern was found in the Project Area. Bat activity levels were lower at the raised detectors (CPHB02M and CPHB05M) compared to the corresponding paired detectors at ground level (CPHB01G and CPHB04G). Activity levels were greatest at the detectors located 2 m above the ground on the north east side and north central side of the Project Area (i.e., CPHB06G and CPHB07G; Figure 1).

4.6 Fall Bat Migration Study

During fall 2016, eight bat detectors were deployed at the six locations within the Project Area used for the spring bat migration study (Figure 2). Due to a variety of technical issues (i.e., battery failure, cattle knocking detectors over), not all detectors functioned each night (Table 10). Data were collected in the Project Area over a total of 678 detector nights during the fall bat migration period of 2016.

4.6.1 All Species Combined

Over the entire survey period, a total of 2,480 bat passes (3.66 bat passes/detector night) were recorded (Table 10). This level of bat activity falls in the lower end of the range of bat activity reported at other wind power facilities in southern Alberta (i.e., 0.78 to 14.81 bat passes/detector night; Baerwald and Barclay 2009).



LEGEND

PROJECT AREA

MEAN SPRING BAT PASSES PER DETECTOR NIGHT

- < 1
- 1.01 - 1.5
- 1.51 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- > 3.5

ROAD/HIGHWAY

WATERCOURSE

INDEFINITE WATERCOURSE

LAND COVER A,B

- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

0 2 4

1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	JS
PREPARED	AB
REVIEWED	CS
APPROVED	JM

NOTE(S)

A LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
B STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

SPRING BAT ACTIVITY AT DETECTORS IN THE PROJECT AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	6

Table 8: Bat Activity by Night: Fall 2016 – Halkirk 2

Night	Detector Effort[(a)]	Species[(b)]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
Jul-13	2	-	5	8	-	1	4	-	4	-	22	11.00
Jul-14	8	-	1	3	-	2	9	-	2	-	17	2.13
Jul-15	7	1	-	7	-	4	11	-	1	-	24	3.43
Jul-16	7	2	-	4	1	-	2	-	3	-	12	1.71
Jul-17	7	1	-	6	1	1	1	-	1	-	11	1.57
Jul-18	7	1	4	7	1	3	1	-	4	-	21	3.00
Jul-19	7	-	4	9	-	3	2	-	1	-	19	2.71
Jul-20	7	-	6	2	1	1	3	-	2	-	15	2.14
Jul-21	7	-	8	16	4	10	10	-	7	5	60	8.57
Jul-22	7	-	6	208	2	21	5	-	1	2	245	35.00
Jul-23	5	2	6	7	2	11	10	-	7	1	46	9.20
Jul-24	6	6	12	18	2	31	7	-	5	-	81	13.50
Jul-25	6	2	3	12	1	15	6	-	1	1	41	6.83
Jul-26	6	1	7	5	-	14	4	-	2	1	34	5.67
Jul-27	7	1	5	6	-	11	2	-	3	3	31	4.43
Jul-28	7	2	4	4	2	18	6	-	1	-	37	5.29
Jul-29	7	2	11	47	4	25	3	1	3	5	101	14.43
Jul-30	5	7	5	10	9	18	8	-	3	1	61	12.20
Jul-31	5	-	2	5	-	10	7	1	2	1	28	5.60
Aug-01	6	4	7	14	5	9	5	-	1	1	46	7.67
Aug-02	6	-	4	7	-	14	9	-	-	-	34	5.67
Aug-03	6	2	6	6	1	8	15	-	-	1	39	6.50
Aug-04	8	5	12	23	4	27	7	2	7	-	87	10.88
Aug-05	8	4	-	10	4	29	10	-	6	4	67	8.38
Aug-06	8	7	12	11	5	25	10	2	2	3	77	9.63
Aug-07	8	5	4	5	4	9	7	4	5	1	44	5.50
Aug-08	8	4	5	5	12	20	6	-	10	3	65	8.13

Table 8: Bat Activity by Night: Fall 2016 – Halkirk 2

Night	Detector Effort[(a)]	Species[(b)]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
Aug-09	8	3	7	17	13	13	4	-	2	-	59	7.38
Aug-10	7	3	6	9	3	8	10	1	1	1	42	6.00
Aug-11	5	1	4	5	4	13	7	1	1	-	36	7.20
Aug-12	5	3	7	15	2	22	9	2	6	-	66	13.20
Aug-13	7	2	7	14	1	19	9	3	6	1	62	8.86
Aug-14	6	1	4	13	1	6	4	1	-	3	33	5.50
Aug-15	7	-	1	17	3	11	6	4	-	1	43	6.14
Aug-16	7	3	7	17	-	7	6	1	1	-	42	6.00
Aug-17	7	1	14	5	-	8	3	-	2	-	33	4.71
Aug-18	6	3	1	18	-	5	7	-	-	2	36	6.00
Aug-19	6	1	7	19	3	11	7	-	-	1	49	8.17
Aug-20	6	2	7	19	3	15	3	4	6	1	60	10.00
Aug-21	8	-	9	24	8	16	3	2	3	4	69	8.63
Aug-22	8	-	12	4	2	15	1	-	4	-	38	4.75
Aug-23	8	-	2	7	-	9	3	-	-	-	21	2.63
Aug-24	8	1	1	27	2	10	2	-	1	2	46	5.75
Aug-25	8	2	3	14	-	5	1	-	-	-	25	3.13
Aug-26	8	-	1	9	4	12	3	1	-	1	31	3.88
Aug-27	8	1	2	3	-	5	1	-	2	-	14	1.75
Aug-28	8	1	-	3	-	-	-	-	-	-	4	0.50
Aug-29	7	-	4	5	-	2	-	1	2	-	14	2.00
Aug-30	6	-	1	6	-	3	-	-	-	-	10	1.67
Aug-31	6	3	13	7	5	29	-	-	17	-	74	12.33
Sep-01	6	3	1	13	-	1	6	-	2	-	26	4.33
Sep-02	6	-	-	1	-	2	-	-	1	-	4	0.67
Sep-03	6	-	-	-	1	-	-	-	-	-	1	0.17
Sep-04	6	-	-	1	-	-	-	-	-	-	1	0.17

Table 8: Bat Activity by Night: Fall 2016 – Halkirk 2

Night	Detector Effort[(a)]	Species[(b)]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
Sep-05	6	-	1	-	-	2	-	-	-	-	3	0.50
Sep-06	6	-	-	4	1	-	-	-	-	1	6	1.00
Sep-07	7	1	2	4	-	12	1	-	2	-	22	3.14
Sep-08	7	-	2	-	-	4	-	-	1	-	7	1.00
Sep-09	7	-	5	2	3	10	1	-	3	-	24	3.43
Sep-10	6	-	2	-	2	7	-	-	1	-	12	2.00
Sep-11	6	-	-	-	-	-	-	-	-	-	0	0.00
Sep-12	6	-	-	1	-	-	-	-	-	-	1	0.17
Sep-13	8	-	1	-	-	6	-	-	-	-	7	0.88
Sep-14	8	1	2	6	-	8	1	-	2	1	21	2.63
Sep-15	8	1	5	-	-	5	2	-	-	-	13	1.63
Sep-16	8	-	4	1	-	7	-	-	7	-	19	2.38
Sep-17	8	1	-	-	-	2	-	1	-	-	4	0.50
Sep-18	8	-	6	-	-	3	-	-	-	-	9	1.13
Sep-19	8	-	-	-	-	-	-	-	-	-	0	0.00
Sep-20	8	-	2	-	-	-	-	-	-	-	2	0.25
Sep-21	8	2	-	-	-	1	-	-	3	-	6	0.75
Sep-22	8	-	-	-	-	-	-	-	-	-	0	0.00
Sep-23	8	-	-	-	-	1	-	-	1	-	2	0.25
Sep-24	8	-	-	-	-	4	-	-	-	-	4	0.50
Sep-25	8	-	3	-	-	1	-	-	-	-	4	0.50
Sep-26	8	1	1	-	-	2	-	-	-	-	4	0.50
Sep-27	8	-	-	-	-	1	1	-	-	2	4	0.50
Sep-28	8	-	-	-	-	1	-	-	-	-	1	0.13
Sep-29	8	-	-	-	-	-	-	-	-	-	0	0.00
Sep-30	8	-	-	-	-	1	-	-	-	-	1	0.13
Oct-1	8	-	-	-	-	-	-	-	-	-	0	0.00

Table 8: Bat Activity by Night: Fall 2016 – Halkirk 2

Night	Detector Effort[(a)]	Species[(b)]									Total	Passes per Detector
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown		
Oct-2	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-3	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-4	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-5	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-6	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-7	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-8	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-9	8	-	-	-	-	-	-	-	-	-	0	0.00
Oct-10	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-11	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-12	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-13	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-14	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-15	7	-	-	-	-	-	-	-	-	-	0	0.00
Oct-16	7	-	-	-	-	-	-	-	-	-	0	0.00
Total	**678**	**100**	**296**	**775**	**126**	**665**	**271**	**32**	**161**	**54**	**2480**	**3.66**

(a) Detector effort = number of deployed bat detectors that were functional during the entire survey period (i.e., July 13 to October 16, 2016).

(b) Bat species: hoary (*Lasiurus cinereus*), silver-haired (*Lasionycteris noctivagans*), unidentifiable Myotis species, big-brown (*Eptesicus fuscus*), low freq. (includes hoary, silver-haired, and big brown), high freq. (includes myotis species and red (*Lasiurus borealis*)), unknown (definitely a bat species, but not identifiable due to recording quality).

Note: Does not include bat passes that were filtered out as noise using a bat data filter. The error rate for missed bats for data analysed in 2016 was 5.7%. Calculated as [(bat passes filtered out as noise)/(bat passes filtered out as noise + sum of bat passes)×100].

Landscape features within the vicinity (i.e., 2 km buffer of the Project Area) such as the Battle River valley and the Paintearth Creek and their associated coulees, draws, and native habitat may contribute to the levels of bat activity detected in the Project Area, as discussed in Section 4.5.1. The highest levels of bat activity were recorded on July 22, 2016 (245 individuals or 35.00 bat passes/detector night), July 24 (81 individuals or 13.50 bat passes/detector night), and July 29, 2016 (101 individuals or 14.43 bat passes/detector night) (Figure 7). These data suggest three possible bat detection peaks. Baseline studies of bat activity in central and southern Alberta generally report one or two peaks of bat activity (e.g., Golder 2010a,b; Golder 2014). During the peaks in detection the most common species were "high frequency" bats (which may include various species of *Myotis* and red bat) and "low frequency bats" (which may include hoary bat, silver-haired bat, and/or big brown bat) (Table 10). Figure 7 shows the variation in overall bat activity recorded during the 2016 fall migration period.

Results of the bat surveys indicated that multiple bat species passed through, and/or utilize the Project Area during the fall migration period. Based on recorded echolocation signatures, four species of bats were positively identified, including big brown bat, silver-haired bat, hoary bat, and red bat, the latter three of which are listed provincially as "sensitive" based on their susceptibility to mortality associated with wind power facilities (ASRD 2012). Since echolocation calls could not always be identified to the species level, an additional five species groups were identified including big brown/silver-haired, *Myotis* species, high frequency, low frequency and unknown bats, as described in Section 4.5.1.

Overall, bats in the high frequency and low frequency species groups were the most commonly detected categories during the fall migration monitoring period. Peak migration for hoary bats tends to be earlier than that of silver-haired bats with hoary bat migration peaking in August and silver-haired bats peaking in August or early September (Lausen 2008). Therefore, the first peak in low frequency bat detection may generally represent hoary bat migration and the second peak in activity may represent silver-haired bat migration. This is supported by the data because confirmed recordings of hoary bats peak on July 30 and August 8 and 9, 2016 (Figure 8). Confirmed recordings of silver-haired bats peak on August 31, 2016 (Figure 8).

The high frequency species group peaked in detection on July 22, 2016 (Figure 9). *Myotis* species peaked in detection on August 2, 2016 and were consistently detected at higher rates than red bats, which peaked in detection on August 20, 2016 (Figure 9). In general, the total number of low frequency bats were detected at higher rates than the total number of high frequency bats.

Figure 7: Bat Activity by Night: Fall 2016

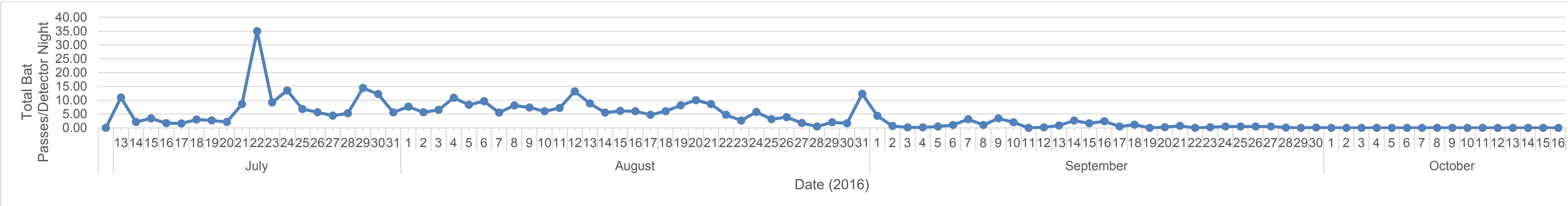


Figure 8: Total Activity of Low Frequency Bats by Night: Fall 2016

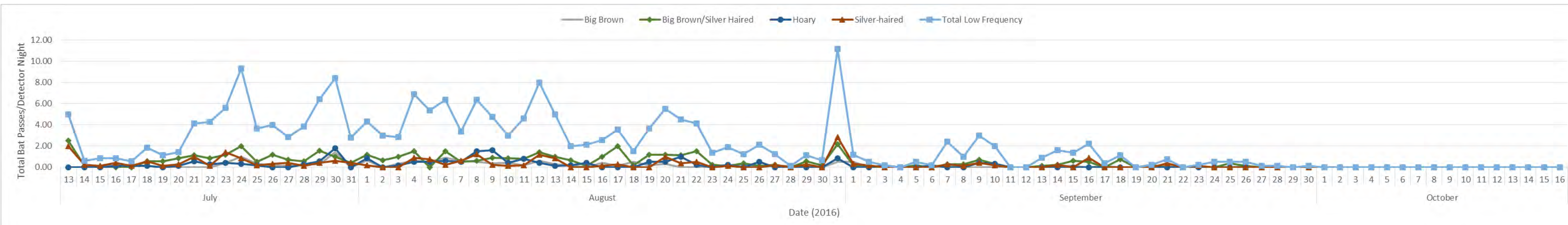
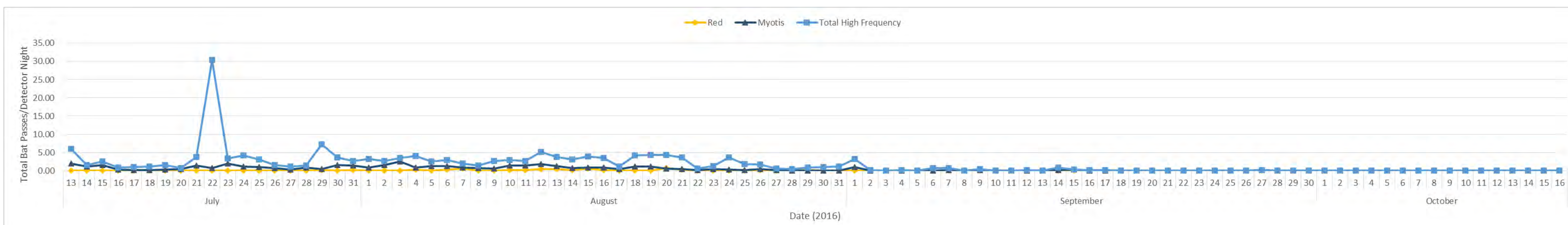


Figure 9: Total Activity of High Frequency Bats by Night: Fall 2016



4.6.2 Migratory Species

Migratory species such as silver-haired, hoary and red bats are the species primarily involved in fatalities associated with wind power facilities in Alberta (Lausen et al. 2008). Overall, a small percentage of these species were identified within the Project Area. Specifically, approximately 6.5% of bat passes were identified as silver-haired bats, 5.1% as hoary bats, and 1.3% as red bats. Red bats are uncommon in Alberta (Smith 1993; Van Zyll de Jong 1985). They were detected at all eight of the detector locations during the fall migration period for a total of 32 bat passes (Table 11). Although red bat activity may be underestimated if the high frequency category includes some red bats, this species is likely present in low numbers in the Project Area and therefore at relatively lower risk compared to silver-haired and hoary bats.

Baerwald and Barclay (2009) found no clear relationship between activity of migratory bats recorded at ground level and fatality rates observed at nine wind power facilities in southern Alberta, but did find a relationship between fatality rates and bat activity levels recorded at heights of 30 m. Therefore, estimates of migratory bat fatality can be made based on 30 m high acoustic data. Two detectors, CPHB02M and CPHB05M, were deployed at a 30 m height in the Project Area and can be used to better understand risk of migratory bat fatality rates for the Project.

The AEP *Bat Mitigation Framework* (ESRD 2013c) recommends calculating a precautionary estimate of migratory bat passes by grouping low frequency observations with those of hoary, silver-haired and red bats collected from August 1 to September 10. Approximately 85% of the identified bats at detectors CPHB02M and CPHB05M (i.e., deployed at a 30 m height) were classified as potentially migratory. Therefore, all of the unknown bat passes (i.e., 1) were also classified as migratory. As a result, a total of 168 migratory bat passes, or 2.75 bat passes/detector night were detected at the detectors deployed at a 30 m height. Bat detectors located in closest proximity to the Battle River and associated draws and coulees and to the Paintearth Creek and associated coulees, which contain a tributary to the Battle River, had the highest migratory bat activity levels. It is anticipated that proximity to these habitat features contributes to the higher levels of bat activity recorded during the fall migration monitoring.

4.6.3 Activity by Detector

The average number of bat passes recorded per detector night ranged from 1.00 to 7.16 depending on the detector location (Table 11). Baerwald and Barclay (2009) suggest that detection rates may be higher at heights of 30 m. The opposite pattern was found in the Project Area during the fall migration monitoring period, considering all species/species groups. Total bat activity levels were lower at the raised detector CPHB01G compared to the corresponding paired detector CPHB02M, and the same pattern was observed at the raised detector CPHB04G compared to the corresponding paired detector CPHB05M. However, detection rates were higher at heights of 30 m when considering only migratory bat species/species groups during the migratory period (i.e., August 1 to September 30) (Table 11). Total bat activity levels at raised detectors CPHB02M and CPHB05M were higher than their corresponding paired detectors CPHB01G and CPHB04G, respectively.

Activity levels were the greatest during the fall bat monitoring survey at detectors located 2 metres above the ground in the northernmost portion of the Project Area (i.e., CPHB07G and CPHB06G) and in the southernmost portion of the Project Area (i.e., CPHB08G) (Figure 10). Detectors CPHB07G and CPHB06G are in closest proximity to the Battle River and associated draws and valley. Detector CPHB08G is located in closest proximity to the Paintearth Creek which contains a tributary to the Battle River. It is anticipated that proximity to these habitat features may contribute to the higher levels of bat activity recorded during the fall bat migration monitoring.

Table 9: Bat Activity by Detector: Fall 2016 -– Halkirk 2

Detector	Total Detector Effort (Migratory Detector Effort)[a]	Species/Species Groups[b]									All Species/Species Groups		Migratory Species/Species Groups[c]	
		Big Brown	Big Brown / Silver-haired	High Freq.	Hoary	Low. Freq.	Myotis sp.	Red	Silver-haired	Unknown	Total	Passes per Detector Night	Total	Passes per Detector Night
CPHB01G	95 (41)	1	21	47	1	35	25	1	3	6	140	1.47	51	1.24
CPHB02M[d]	80 (28)	5	8	13	6	33	1	2	11	1	80	1.00	41	1.46
CPHB03G	81 (38)	11	16	85	8	69	7	12	26	7	241	2.98	114	3.00
CPHB04G	88 (36)	3	41	41	5	60	44	1	2	3	200	2.27	87	2.42
CPHB05M[d]	81 (33)	6	9	10	25	73	1	2	41	0	167	2.06	127	3.85
CPHB06G	96 (41)	46	63	129	37	220	140	9	30	13	687	7.16	203	4.95
CPHB07G	77 (31)	8	47	336	10	37	2	2	15	14	471	6.12	59	1.90
CPHB08G	80 (33)	20	91	114	34	138	51	3	33	10	494	6.18	175	5.30
Total	**678 (281)**	**100**	**296**	**775**	**126**	**665**	**271**	**32**	**161**	**54**	**2480**	3.66	857	3.05

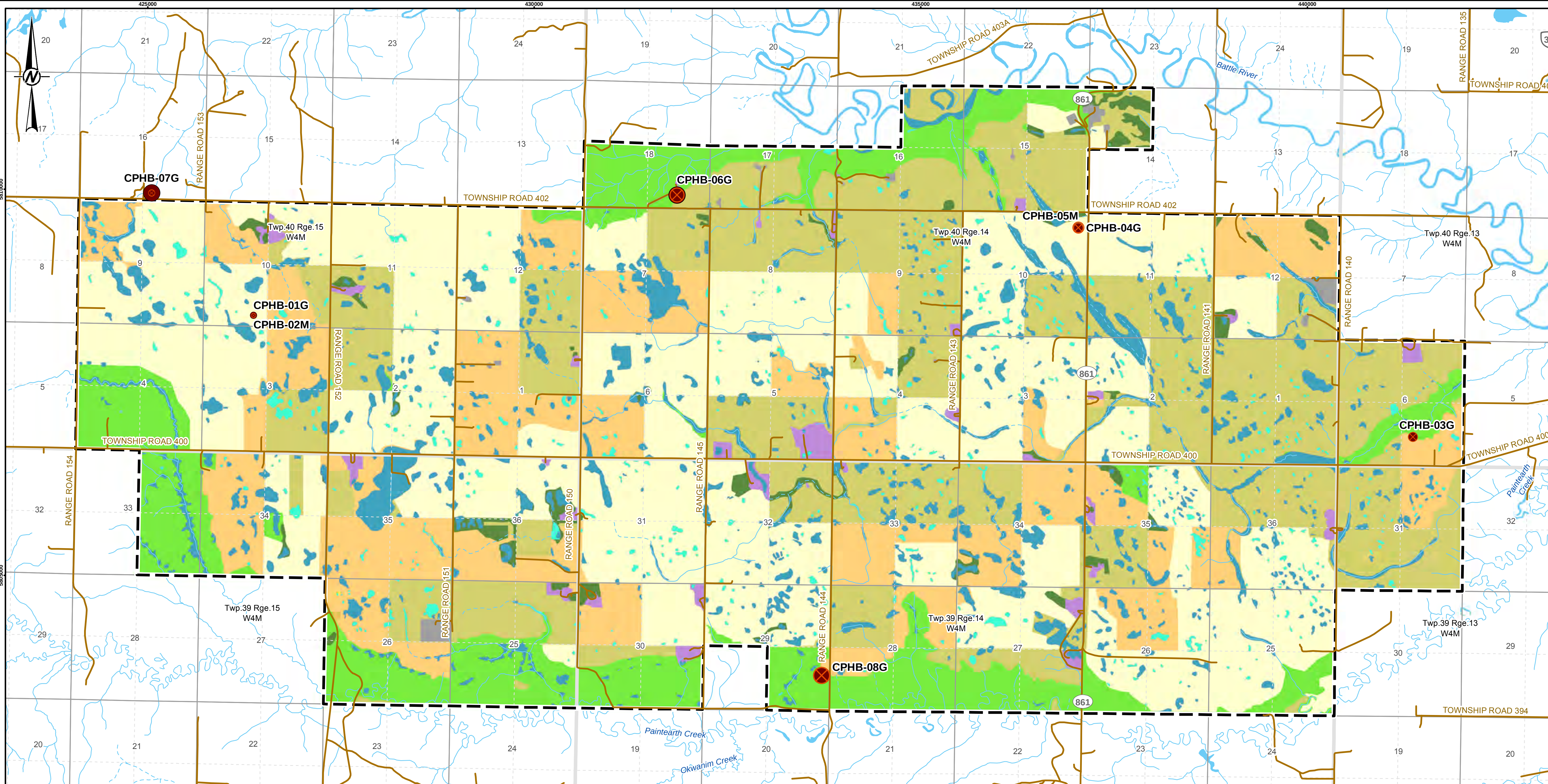
[a] Detector effort = number of nights with functional detectors. All detector nights (i.e., 678) are used to calculate the total detector effort used to calculate passes per detector night for all species/species groups. Migratory detector effort is calculated from August 1 to September 10 as per the Bat Mitigation Framework (ESRD 2013c) and this value (i.e., 281) is used to calculate passes per detector night for migratory species/species groups.

[b] Bat species: hoary (*Lasiurus cinereus*), silver-haired (*Lasionycteris noctivagans*), unidentifiable Myotis species, big-brown (*Eptesicus fuscus*), low freq. (includes hoary, silver-haired, and big brown), high freq. (includes myotis species and red (*Lasiurus borealis*)), unknown (definitely a bat species, but not identifiable due to recording quality or because the characteristic frequency fell between 30 and 35 kHz).

[c] Migratory species/species groups include big brown/silver haired, hoary, low frequency, red, and silver-haired and unknown.

[d] Detector deployed at 30 m height.

Note: Does not include bat passes that were filtered out as noise using a bat data filter. The error rate for missed bats for data analysed in 2016 was 5.7%. Calculated as [(bat passes filtered out as noise)/(bat passes filtered out as noise + sum of bat passes)×100].



LEGEND

PROJECT AREA

MEAN MIGRATORY BAT PASSES PER DETECTOR NIGHT

- < 1.5
- 1.51 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- > 5.01

MEAN BAT PASSES PER DETECTOR NIGHT

- < 1.0
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- > 5.01

ROAD/HIGHWAY

WATERCOURSE

INDEFINITE WATERCOURSE

LAND COVER [A,B]

- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

0 2 4

1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	JS
PREPARED	AB
REVIEWED	CS
APPROVED	JM

NOTE(S)

[A]LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.

[B]STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

FALL BAT ACTIVITY AT DETECTORS IN THE PROJECT AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

PATH: I:\2015\1543760\Mapping\MXD\Wildlife\Final\1543760_Fall_Bat_Activity_Rev0.mxd PRINTED ON: 2017-01-27 AT: 1:11:35 PM

4.7 Raptor Nest Survey

During June 7 to12 and June 21 to 28, 2016 raptor nest searches were conducted within the Project Area and a 1 km buffer surrounding the Project Area in conjunction with rounds one and two of the BBS. Active nests searches included four red-tailed hawk nests and two Swainson's hawk nests (Figure 1; Table 10). Seven red-tailed hawk nests, and two Swainson's hawk nest were incidentally observed during the 2016 wildlife surveys (Figure 1; Table 10).

Table 10: Raptor Nest Locations: Summer 2016 – Halkirk 2

Species[(a)]	Location (Zone 12U, NAD 83)		Surrounding Habitat
	Easting	Northing	
red-tailed hawk	439434	5809277	Modified pasture in treed area
red-tailed hawk	429425	5806539	Cultivated cropland in treed area
red-tailed hawk	427284	5806403	Cultivated cropland in treed area near wetland
red-tailed hawk	438632	5806445	Wetland
red-tailed hawk	425757	5806486	Modified pasture near farmyard
red-tailed hawk	424102	5809576	Cultivated cropland in treed area near wetland
red-tailed hawk	428560	5807375	Cultivated cropland in treed area
red-tailed hawk	424909	5805737	Native pasture in treed area
red-tailed hawk	438864	5809638	Hayland and modified pasture in treed area
red-tailed hawk	4345378	5803327	In coulee, along Paintearth Creek in treed area
red-tailed hawk	426040	5808957	Cultivated cropland in treed area
Swainson's hawk	440350	5806376	Cultivated cropland in treed area
Swainson's hawk	428954	5806335	Cultivated cropland in treed area
Swainson's hawk	430028	5807347	Cultivated cropland in treed area
Swainson's hawk	438753	5805152	Modified pasture

(a) Species in *italics* and **bold** = provincially (ASRD 2012) or federally (COSEWIC 2016) listed.

4.8 Breeding Bird Survey

A total of 85 BBS plots were completed in 2016 between June 7 – 12 (Round 1) and June 21-24, 26 and 28 (Round 2) to augment the bird information gathered from the AUS plot surveys (Figure 1). During the BBS, 807 observations of 36 bird species were identified (Table 11). The most common species observed during the BBS plots were clay-coloured sparrow, savannah sparrow, and red-winged blackbird (Table 11).

Table 11: Breeding Birds Observed by Habitat: Summer 2016 – Halkirk 2

Species[(a)]	Cultivated/ Cropland (n=18)	Deciduous Forest (n=16)	Dugout (n=2)	Hayland (n=12)	Modified Forest (n=4)	Modified Pasture (n=16)	Native Pasture (n=17)	Tame Pasture (n=7)	Wetland/ Drainage n=26	Grand Total n=
alder flycatcher									3	3
American goldfinch	3	7		3	1		4	1	4	23
American redstart							1			1

Table 11: Breeding Birds Observed by Habitat: Summer 2016 – Halkirk 2

Species[(a)]	Cultivated/ Cropland (n=18)	Deciduous Forest (n=16)	Dugout (n=2)	Hayland (n=12)	Modified Forest (n=4)	Modified Pasture (n=16)	Native Pasture (n=17)	Tame Pasture (n=7)	Wetland/ Drainage n=26	Grand Total n=
American robin	6	5		1		2			4	18
Baird's sparrow							1			1
barn swallow	1					2	4		7	14
black-capped chickadee		1					1			2
Brewer's blackbird	3						2		12	17
cedar waxwing	2	7		2		5	8		6	30
clay-coloured sparrow	29	17		9	2	31	24	11	17	140
cliff swallow									8	8
common grackle									3	3
common yellowthroat	1								10	11
eastern kingbird	1	1				5	1	1		9
eastern phoebe									2	2
gray catbird	1	5				2	1		8	17
horned lark	16		2	1						19
house wren	6	6		1	2	4	4		4	27
Le Conte's sparrow	1								1	2
least flycatcher		3				1			2	6
mountain bluebird						2				2
Nelson's sparrow									1	1
red-winged blackbird	26	3		4		4			68	105
rose-breasted grosbeak									1	1
savannah sparrow	52	6	3	8		26	10	20	11	136
song sparrow	1								7	8

Table 11: Breeding Birds Observed by Habitat: Summer 2016 – Halkirk 2

Species[(a)]	Cultivated/ Cropland (n=18)	Deciduous Forest (n=16)	Dugout (n=2)	Hayland (n=12)	Modified Forest (n=4)	Modified Pasture (n=16)	Native Pasture (n=17)	Tame Pasture (n=7)	Wetland/ Drainage n=26	Grand Total n=
Sprague's pipit						1	4			5
Tennessee warbler									1	1
tree swallow				1		3	4		3	11
veery		2								2
vesper sparrow	31	3		3		15	9	2	8	71
western meadowlark	12			6	1	14	8	15	5	61
yellow warbler	5	8		2		3	4	1	10	33
yellow-bellied sapsucker		2								2
yellow-headed blackbird									14	14
yellow-rumped warbler		1								1
Grand Total	**197**	**77**	**5**	**41**	**6**	**120**	**90**	**51**	**220**	**807**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

n= number

Note: Birds flying were attributed to the habitat over which they flew.

4.9 Avian Use Study

Twenty-eight AUS plots were established within the Project Area in 2016 for the spring, summer, and fall seasons. Details of each plot are provided in Figure 2.

4.9.1 Spring Surveys

Surveys consisted of 20-minute monitoring periods of bird activity within each plot. Each AUS plot was surveyed twice (morning and afternoon) each round, resulting in 224 plot visits conducted, which equates to approximately 75 hours of direct observation.

During the spring 2016 AUS surveys, a total of 13,618 birds were observed, including 1,243 flocks (Table 12). Overall, waterfowl were the most commonly observed species group (7,738 individuals/292 flocks), followed by passerines (5,422 individuals/777 flocks).

Table 12: Species and Species Groups observed during the Avian Use Study: Spring 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
Grouse and Allies	**1**	**2**
sharp-tailed grouse	1	2
Gulls, Terns and Allies	**12**	**46**
Franklin's gull	11	45
unidentified gull	1	1
Near Passerines	**5**	**6**
downy woodpecker	1	1
hairy woodpecker	1	1
northern flicker	2	3
unidentified *Picoides*	1	1
Passerines	**777**	**5,422**
American crow	149	485
American robin	26	73
American tree sparrow	28	88
barn swallow	5	9
black-billed magpie	119	159
unidentified blackbird	4	8
black-capped chickadee	19	27
blue jay	5	5
Brewer's blackbird	3	10
brown-headed cowbird	1	1
chipping sparrow	1	1
clay-coloured sparrow	10	11
common raven	51	72
common redpoll	4	6
European starling	33	92
horned lark	41	180
house sparrow	1	10
Lapland longspur	30	863
mountain bluebird	3	8
unidentified passerine	6	131
red-winged blackbird	26	52
savannah sparrow	43	62
snow bunting	47	2,905
song sparrow	5	6
unidentified sparrow	1	2
Sprague's pipit	2	2
Swainson's thrush	1	1
tree swallow	10	14
vesper sparrow	59	80
western meadowlark	44	59

Table 12: Species and Species Groups observed during the Avian Use Study: Spring 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
Pigeons and Doves	**28**	**90**
mourning dove	4	5
rock dove	24	85
Raptors	**78**	**87**
American kestrel	2	2
bald eagle	3	3
broad-winged hawk	1	2
gyrfalcon	1	1
unidentified hawk	2	2
merlin	1	1
northern harrier	40	45
red-tailed hawk	18	20
rough-legged hawk	7	7
Swainson's hawk	1	2
turkey vulture	2	2
Shorebirds	**33**	**44**
killdeer	20	27
willet	5	9
Wilson's snipe	7	7
unidentified yellowlegs	1	1
Waterbirds	**17**	**183**
American coot	1	1
great blue heron	2	2
sandhill crane	14	180
Waterfowl	**292**	**7,738**
American wigeon	14	52
blue-winged teal	4	5
cackling goose	1	6
Canada goose	108	1,532
canvasback	1	1
common goldeneye	8	12
unidentified dabbler	1	10
unidentified duck	4	10
gadwall	5	6
unidentified goose	2	50
greater white-fronted goose	12	1,073
green-winged teal	9	25
mallard	82	171
northern pintail	18	197
northern shoveler	7	12
unidentified scaup	1	1
snow goose	10	4,508

Table 12: Species and Species Groups observed during the Avian Use Study: Spring 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
unidentified swan	2	17
tundra swan	3	50
Total	**1,243**	**13,618**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

4.9.1.1 Avian Species Relative Abundance and Richness

During the spring 2016 avian use surveys, the average number of individual birds observed at each AUS plot was 81.06 individuals/plot, and the total number of avian species observed was 64 (Table 13).

Table 13: Survey Effort, Mean Use, Total Species, and Avian Richness: Spring 2016 – Halkirk 2

Year	Season	Survey Rounds	Number of Plot Visits	Mean Use	Number of Species	Avian Richness (Average Number of Species / Plot Visit)
2016	Spring	3	168	81.06	64	5.54

Waterfowl were observed most frequently compared to any other species group, followed by passerines (Table 14).

Table 14: Mean Use, Composition, and Frequency of Occurrence of Species Groups: Spring 2016 – Halkirk 2

Species Group	Mean Use[(a)]	Composition[(b)] (%)	Frequency[(c)] (%)
Waterfowl	46.06	56.82	61.90
Passerines	32.27	39.81	98.21
Waterbirds	1.09	1.34	8.93
Pigeons and Doves	0.54	0.66	16.07
Raptors	0.52	0.64	38.10
Gulls, Terns and Allies	0.27	0.34	5.95
Shorebirds	0.26	0.32	15.48
Near Passerines	0.04	0.04	2.98
Grouse and Allies	0.01	0.01	0.60
Total	**81.06**	**100.00**	**100.00**

(a) Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

(b) Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

(c) Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

Fourteen waterfowl species were observed during the spring surveys, with the most abundant being snow goose at 26.83 individuals per AUS plot visit, followed by Canada goose at 9.12 individuals per AUS plot visit and greater white-fronted goose at 6.39 individuals per AUS plot visit (Table 15).

Twenty-seven passerine species were observed, with the most abundant being snow bunting at 17.29 individuals per AUS plot, Lapland longspur at 5.14 individuals per AUS plot visit, American crow at 2.89 individuals per AUS plot visit and horned lark at 1.07 individuals per AUS plot visit.

Ten raptor species were observed, with northern harrier being the most common at 0.27 individuals per AUS plot visit.

Thirteen listed species observed during the spring AUS surveys were American kestrel, bald eagle, barn swallow, broad-winged hawk, great blue heron, green-winged teal, northern harrier, northern pintail, pileated woodpecker, sandhill crane, sharp-tailed grouse, Sprague's pipit, and Swainson's hawk (Table 12). Of these listed species, Sprague's pipit (Schedule 1, Threatened) is the only species listed under the SARA (COSEWIC 2016).

Table 15: Mean Use, Composition, and Frequency of Occurrence: Spring 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
snow goose	26.83	33.10	5.36
snow bunting	17.29	21.33	16.67
Canada goose	9.12	11.25	39.88
greater white-fronted goose	6.39	7.88	4.76
Lapland longspur	5.14	6.34	14.29
American crow	2.89	3.56	58.33
northern pintail	1.17	1.45	8.93
horned lark	1.07	1.32	18.45
sandhill crane	1.07	1.32	7.14
mallard	1.02	1.26	29.76
black-billed magpie	0.95	1.17	51.19
unidentified passerine	0.78	0.96	3.57
European starling	0.55	0.68	19.05
American tree sparrow	0.52	0.65	13.69
rock dove	0.51	0.62	13.69
vesper sparrow	0.48	0.59	24.40
American robin	0.43	0.54	14.29
common raven	0.43	0.53	23.81
savannah sparrow	0.37	0.46	20.24
western meadowlark	0.35	0.43	20.83
American wigeon	0.31	0.38	6.55
red-winged blackbird	0.31	0.38	14.29
unidentified goose	0.30	0.37	1.19
tundra swan	0.30	0.37	1.79
Franklin's gull	0.27	0.33	5.36
northern harrier	0.27	0.33	20.24
black-capped chickadee	0.16	0.20	10.12
killdeer	0.16	0.20	11.31
green-winged teal	0.15	0.18	4.17
red-tailed hawk	0.12	0.15	10.71
unidentified swan	0.10	0.12	1.19

Table 15: Mean Use, Composition, and Frequency of Occurrence: Spring 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
tree swallow	0.08	0.10	5.95
clay-coloured sparrow	0.07	0.08	5.36
common goldeneye	0.07	0.09	3.57
northern shoveler	0.07	0.09	2.98
Brewer's blackbird	0.06	0.07	1.19
unidentified dabbler	0.06	0.07	0.60
unidentified duck	0.06	0.07	2.38
house sparrow	0.06	0.07	0.60
barn swallow	0.05	0.07	2.98
unidentified blackbird	0.05	0.06	2.38
mountain bluebird	0.05	0.06	1.19
willet	0.05	0.07	2.98
cackling goose	0.04	0.04	0.60
common redpoll	0.04	0.04	2.38
gadwall	0.04	0.04	1.79
rough-legged hawk	0.04	0.05	4.17
song sparrow	0.04	0.04	2.98
Wilson's snipe	0.04	0.05	3.57
blue jay	0.03	0.04	2.98
blue-winged teal	0.03	0.04	1.79
mourning dove	0.03	0.04	2.38
bald eagle	0.02	0.02	1.79
northern flicker	0.02	0.02	1.19
American coot	0.01	0.01	0.60
American kestrel	0.01	0.01	1.19
broad-winged hawk	0.01	0.01	0.60
brown-headed cowbird	0.01	0.01	0.60
canvasback	0.01	0.01	0.60
chipping sparrow	0.01	0.01	0.60
downy woodpecker	0.01	0.01	0.60
great blue heron	0.01	0.01	1.19
unidentified gull	0.01	0.01	0.60
gyrfalcon	0.01	0.01	0.60
hairy woodpecker	0.01	0.01	0.60
unidentified hawk	0.01	0.01	1.19
merlin	0.01	0.01	0.60
unidentified *Picoides*	0.01	0.01	0.60
unidentified scaup	0.01	0.01	0.60
sharp-tailed grouse	0.01	0.01	0.60
unidentified sparrow	0.01	0.01	0.60
Sprague's pipit	0.01	0.01	1.19
Swainson's hawk	0.01	0.01	0.60
Swainson's thrush	0.01	0.01	0.60

Table 15: Mean Use, Composition, and Frequency of Occurrence: Spring 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
turkey vulture	0.01	0.01	1.19
unidentified yellowlegs	0.01	0.01	0.60
Total	**81.06**	**100.00**	**100.00**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

(b) Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

(c) Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

(d) Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

4.9.1.2 Flight Height

During the entire AUS, 705 flocks composed of 6,614 birds were observed flying through the AUS plots (Table 16 and 17). No species group was observed mostly within the RSH. Species with the highest percentage of observations in the RSH were common goldeneye, northern pintail, and snow goose. Of these species, only northern pintail is listed (provincially listed as sensitive by AEP) (ASRD 2012). Gulls, terns and allies, pigeons and doves, and shorebirds were never observed flying within the RSH.

Table 16: Flight Height Characteristics by Species Group: Spring 2016 – Halkirk 2

Species Group	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(a)]		
					Below (%)	Within (%)	Above (%)
Gulls, Terns and Allies	42	8	100.00	11.37	100.00	0.00	0.00
Passerines	4,551	419	89.17	14.72	95.76	4.24	0.00
Pigeons and Doves	77	19	87.50	8.45	100.00	0.00	0.00
Raptors	76	69	87.36	15.55	80.26	19.74	0.00
Shorebirds	20	14	95.24	11.70	100.00	0.00	0.00
Waterbirds	166	13	91.71	21.71	86.75	13.25	0.00
Waterfowl	1,682	163	24.45	34.07	65.87	34.13	0.00
Total	**6,614**	**705**	**53.30**	**19.72**	**87.84**	**12.16**	**0.00**

(a) Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

Table 17: Flight Height Characteristic by Species: Spring 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
American crow	208	113	45.41	11.68	94.23	5.77	0.00
American kestrel	2	2	100.00	6.25	100.00	0.00	0.00
American robin	42	9	71.19	13.36	100.00	0.00	0.00
American tree sparrow	64	15	91.43	2.14	100.00	0.00	0.00
American wigeon	13	4	27.08	16.96	69.23	30.77	0.00
bald eagle	2	2	66.67	14.00	100.00	0.00	0.00

Table 17: Flight Height Characteristic by Species: Spring 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
barn swallow	9	5	100.00	4.39	100.00	0.00	0.00
black-billed magpie	99	74	71.22	7.29	92.93	7.07	0.00
unidentified blackbird	8	4	100.00	9.25	100.00	0.00	0.00
blue jay	2	2	66.67	12.75	100.00	0.00	0.00
Brewer's blackbird	10	3	100.00	1.80	100.00	0.00	0.00
cackling goose	6	1	100.00	22.50	100.00	0.00	0.00
Canada goose	524	68	37.75	19.06	88.17	11.83	0.00
common goldeneye	10	7	83.33	31.50	20.00	80.00	0.00
common raven	56	38	86.15	25.91	82.14	17.86	0.00
common redpoll	6	4	100.00	17.50	100.00	0.00	0.00
unidentified duck	8	3	80.00	26.38	75.00	25.00	0.00
European starling	77	26	83.70	9.75	97.40	2.60	0.00
Franklin's gull	42	8	100.00	11.37	100.00	0.00	0.00
unidentified goose	50	2	100.00	11.50	100.00	0.00	0.00
great blue heron	2	2	100.00	13.25	100.00	0.00	0.00
greater white-fronted goose	113	5	12.94	17.65	84.96	15.04	0.00
green-winged teal	6	2	24.00	12.17	100.00	0.00	0.00
gyrfalcon	1	1	100.00	13.00	100.00	0.00	0.00
unidentified hawk	1	1	50.00	15.50	100.00	0.00	0.00
horned lark	138	20	82.63	10.20	100.00	0.00	0.00
killdeer	18	12	100.00	11.39	100.00	0.00	0.00
Lapland longspur	763	29	88.41	15.37	87.55	12.45	0.00
mallard	118	50	72.84	13.06	93.22	6.78	0.00
merlin	1	1	100.00	5.50	100.00	0.00	0.00
mountain bluebird	7	2	87.50	10.50	100.00	0.00	0.00
mourning dove	2	1	66.67	2.50	100.00	0.00	0.00
northern harrier	43	39	95.56	15.17	76.74	23.26	0.00
northern pintail	158	10	80.61	37.42	15.19	84.81	0.00
northern shoveler	1	1	8.33	2.00	100.00	0.00	0.00
unidentified passerine	131	6	100.00	6.85	100.00	0.00	0.00
red-tailed hawk	17	15	85.00	21.94	70.59	29.41	0.00
red-winged blackbird	13	5	28.26	5.15	100.00	0.00	0.00
rock dove	75	18	88.24	8.61	100.00	0.00	0.00
rough-legged hawk	5	5	71.43	9.60	100.00	0.00	0.00
sandhill crane	164	11	92.13	21.81	86.59	13.41	0.00
savannah sparrow	3	2	42.86	0.67	100.00	0.00	0.00
snow bunting	2,886	42	100.00	16.06	97.68	2.32	0.00
snow goose	608	5	15.17	56.16	47.37	52.63	0.00
unidentified sparrow	2	1	100.00	1.00	100.00	0.00	0.00
Swainson's hawk	2	1	100.00	3.50	100.00	0.00	0.00

Table 17: Flight Height Characteristic by Species: Spring 2016 – Halkirk 2

Species[a]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[b]		
					Below (%)	Within (%)	Above (%)
Swainson's thrush	1	1	100.00	10.00	100.00	0.00	0.00
unidentified swan	17	2	100.00	17.47	100.00	0.00	0.00
tree swallow	14	10	100.00	7.46	100.00	0.00	0.00
tundra swan	50	3	100.00	37.75	62.00	38.00	0.00
turkey vulture	2	2	100.00	13.25	100.00	0.00	0.00
vesper sparrow	2	1	10.00	1.00	100.00	0.00	0.00
western meadowlark	10	7	31.25	2.00	100.00	0.00	0.00
willet	1	1	100.00	9.00	100.00	0.00	0.00
Wilson's snipe	1	1	50.00	20.00	100.00	0.00	0.00
Total	**6,614**	**705**	**53.30**	**19.72**	**87.84**	**12.16**	**0.00**

[a] Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

[b] Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

4.9.1.3 Collision Risk Index

Collision risk indices were derived from abundance and flight behaviour (see Table 3 for equation). Collision risk index values should be regarded as a relative index of the potential likelihood of turbine collisions, for comparing across species and species groups, and not a definitive measure of probability of turbine collisions. However, when comparing across species and species groups, it should be noted that the collision risk index does not account for differences in behaviour other than flight characteristics (Strickland et al. 2001).

Based on the collision risk index derived from data collected during the spring AUS, assuming an RSH of 40 to 150 m, the species group at greatest risk of turbine collision within the Project Area was waterfowl (2.379), followed by passerines (1.199) (Table 18).

Table 18: Mean Collision Risk Index by Species Group: Spring 2016 – Halkirk 2

Species Group	Mean Use	Frequency (%)	Flying (%)	Flying Within RSH (%)	Collision Risk Index
Waterfowl	46.06	61.90	24.45	34.13	2.379
Passerines	32.27	98.21	89.17	4.24	1.199
Raptors	0.52	38.10	87.36	19.74	0.034
Waterbirds	1.09	8.93	91.71	13.25	0.012
Gulls, Terns and Allies	0.27	5.95	100.00	0.00	0.000
Pigeons and Doves	0.54	16.07	87.50	0.00	0.000
Shorebirds	0.26	15.48	95.24	0.00	0.000
All Species Combined	**81.06**	**100.00**	**53.30**	**12.16**	**5.252**

Of the positively identified species, Canada goose (0.162), had the highest collision risk index, followed by snow goose (0.115), Lapland longspur (0.081), and northern pintail (0.072) (Table 19). Listed species with a non-zero collision risk index include northern pintail, northern harrier, and sandhill crane (Table 19).

Table 19: Mean Collision Risk Index by Species: Spring 2016 - Halkirk 2

Species[a]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
Canada goose	9.12	39.88	37.75	11.83	0.162
snow goose	26.83	5.36	15.17	52.63	0.115
Lapland longspur	5.14	14.29	88.41	12.45	0.081
northern pintail	1.17	8.93	80.61	84.81	0.072
snow bunting	17.29	16.67	100.00	2.32	0.067
American crow	2.89	58.33	45.41	5.77	0.044
black-billed magpie	0.95	51.19	71.22	7.07	0.024
common raven	0.43	23.81	86.15	17.86	0.016
mallard	1.02	29.76	72.84	6.78	0.015
northern harrier	0.27	20.24	95.56	23.26	0.012
sandhill crane	1.07	7.14	92.13	13.41	0.009
greater white-fronted goose	6.39	4.76	12.94	15.04	0.006
red-tailed hawk	0.12	10.71	85.00	29.41	0.003
American wigeon	0.31	6.55	27.08	30.77	0.002
common goldeneye	0.07	3.57	83.33	80.00	0.002
European starling	0.55	19.05	83.70	2.60	0.002
tundra swan	0.30	1.79	100.00	38.00	0.002
American kestrel	0.01	1.19	100.00	0.00	0.000
American robin	0.43	14.29	71.19	0.00	0.000
American tree sparrow	0.52	13.69	91.43	0.00	0.000
bald eagle	0.02	1.79	66.67	0.00	0.000
barn swallow	0.05	2.98	100.00	0.00	0.000
unidentified blackbird	0.05	2.38	100.00	0.00	0.000
blue jay	0.03	2.98	66.67	0.00	0.000
Brewer's blackbird	0.06	1.19	100.00	0.00	0.000
cackling goose	0.04	0.60	100.00	0.00	0.000
common redpoll	0.04	2.38	100.00	0.00	0.000
unidentified duck	0.06	2.38	80.00	25.00	0.000
Franklin's gull	0.27	5.36	100.00	0.00	0.000
unidentified goose	0.30	1.19	100.00	0.00	0.000
great blue heron	0.01	1.19	100.00	0.00	0.000
green-winged teal	0.15	4.17	24.00	0.00	0.000
gyrfalcon	0.01	0.60	100.00	0.00	0.000
unidentified hawk	0.01	1.19	50.00	0.00	0.000
horned lark	1.07	18.45	82.63	0.00	0.000
killdeer	0.16	11.31	100.00	0.00	0.000
merlin	0.01	0.60	100.00	0.00	0.000

Table 19: Mean Collision Risk Index by Species: Spring 2016 - Halkirk 2

Species[(a)]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
mountain bluebird	0.05	1.19	87.50	0.00	0.000
mourning dove	0.03	2.38	66.67	0.00	0.000
northern shoveler	0.07	2.98	8.33	0.00	0.000
unidentified passerine	0.78	3.57	100.00	0.00	0.000
red-winged blackbird	0.31	14.29	28.26	0.00	0.000
rock dove	0.51	13.69	88.24	0.00	0.000
rough-legged hawk	0.04	4.17	71.43	0.00	0.000
savannah sparrow	0.37	20.24	42.86	0.00	0.000
unidentified sparrow	0.01	0.60	100.00	0.00	0.000
Swainson's hawk	0.01	0.60	100.00	0.00	0.000
Swainson's thrush	0.01	0.60	100.00	0.00	0.000
unidentified swan	0.10	1.19	100.00	0.00	0.000
tree swallow	0.08	5.95	100.00	0.00	0.000
turkey vulture	0.01	1.19	100.00	0.00	0.000
vesper sparrow	0.48	24.40	10.00	0.00	0.000
western meadowlark	0.35	20.83	31.25	0.00	0.000
willet	0.05	2.98	100.00	0.00	0.000
Wilson's snipe	0.04	3.57	50.00	0.00	0.000
All Species Combined	**81.06**	**100.00**	**53.30**	**12.16**	**5.252**

(a) Species in *italics* and **bold** = provincially (ASRD 2012) or federally listed by SARA (COSEWIC 2016).

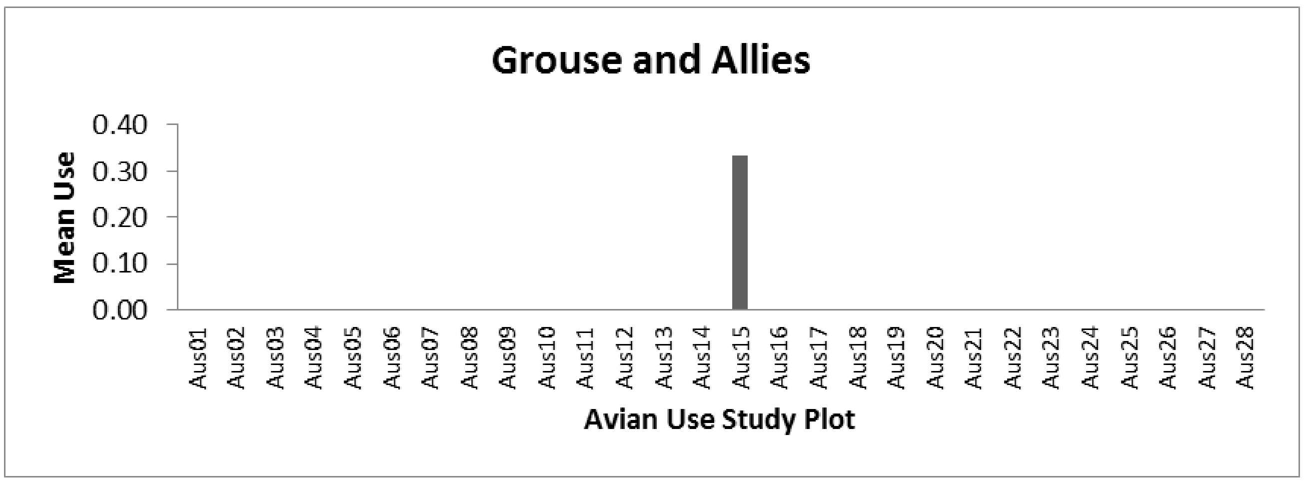
4.9.1.4 Spatial Use

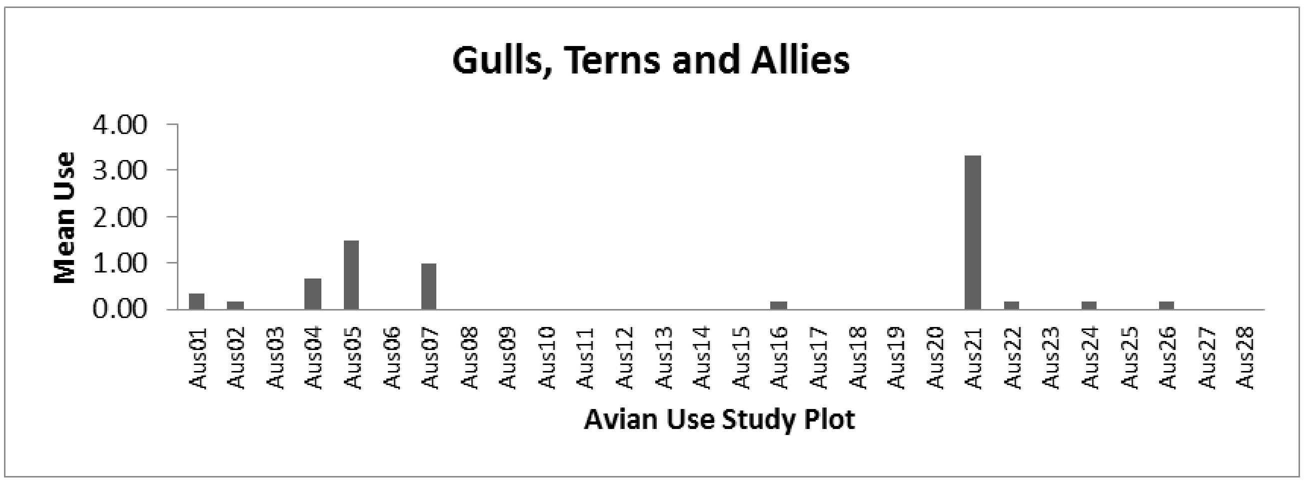
Only passerines were observed at all AUS plots during the spring migration (Figure 11). Plots with the highest numbers of birds observed included AUS20 (600.00 individuals/plot visit), AUS21 (354.83 individuals/plot visit), AUS14 (180.67 individuals/plot visit), and AUS11 (129.33 individuals/plot visit).

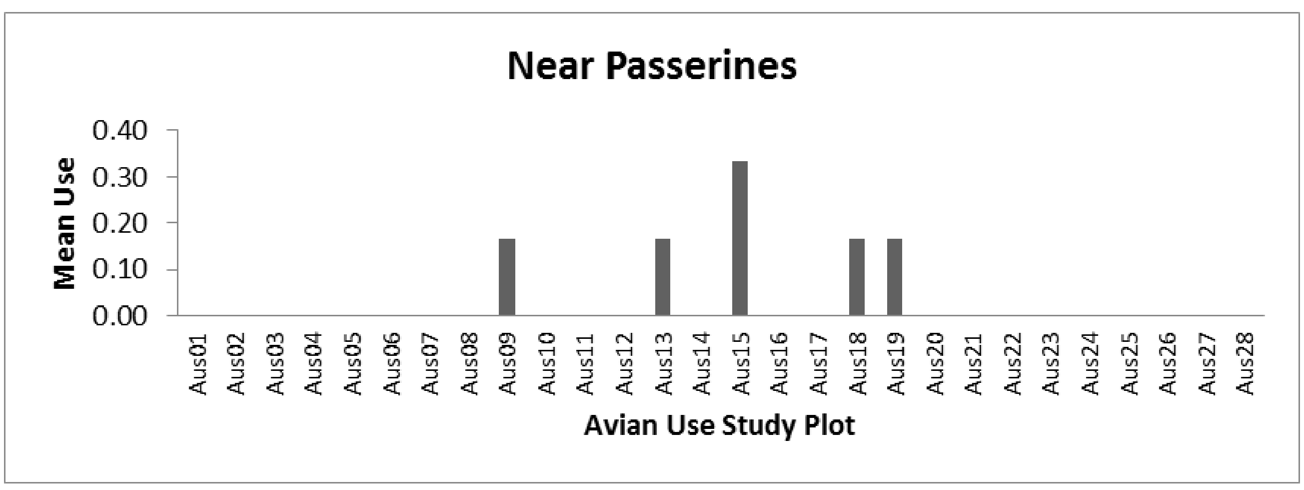
Plots AUS20 and AUS21 are located in the west section of the Project Area and observations at these plots consisted primarily of waterfowl and passerines (Figure 11). Plot AUS20 consisted primarily of waterfowl (589.50 individuals/plot visit) and passerines (5.33 individuals/plot visit) and plot AUS21 had mostly waterfowl (294.83 individuals/plot visit) followed by passerines (54.67 individuals/plot visit) (Figure 11).

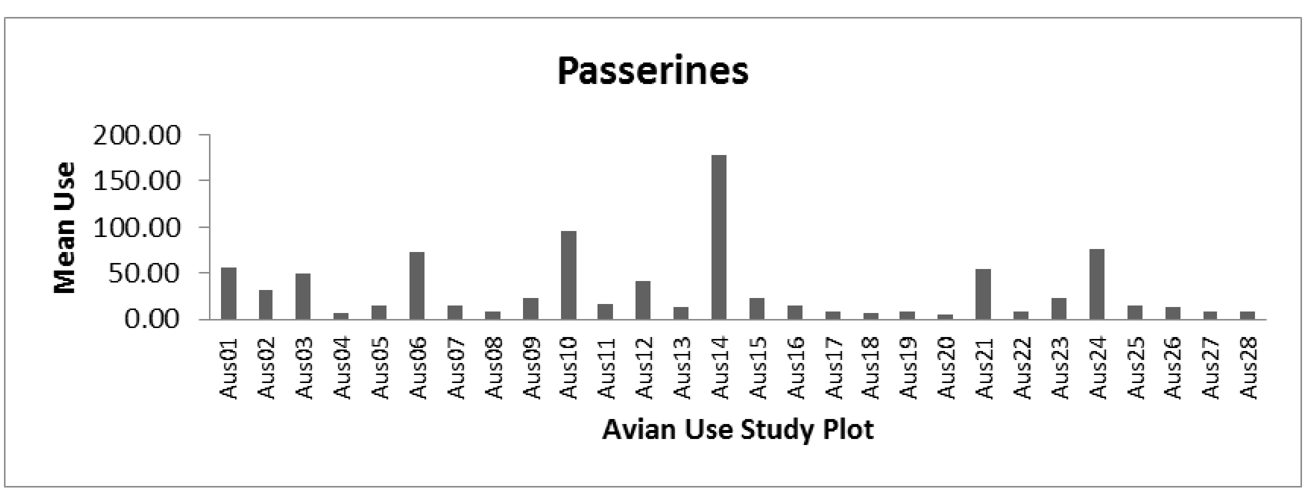
AUS14 and AUS11 are located in the southwest section of the Project Area. Observations at Plot AUS14 consisted primarily of passerines (178.00 individuals/plot visit) and plot AUS11 had mostly waterfowl (109.33 individuals/plot visit) (Figure 11).

Figure 11: Mean Use by Avian Use Study Plot: Spring 2016 – Halkirk 2









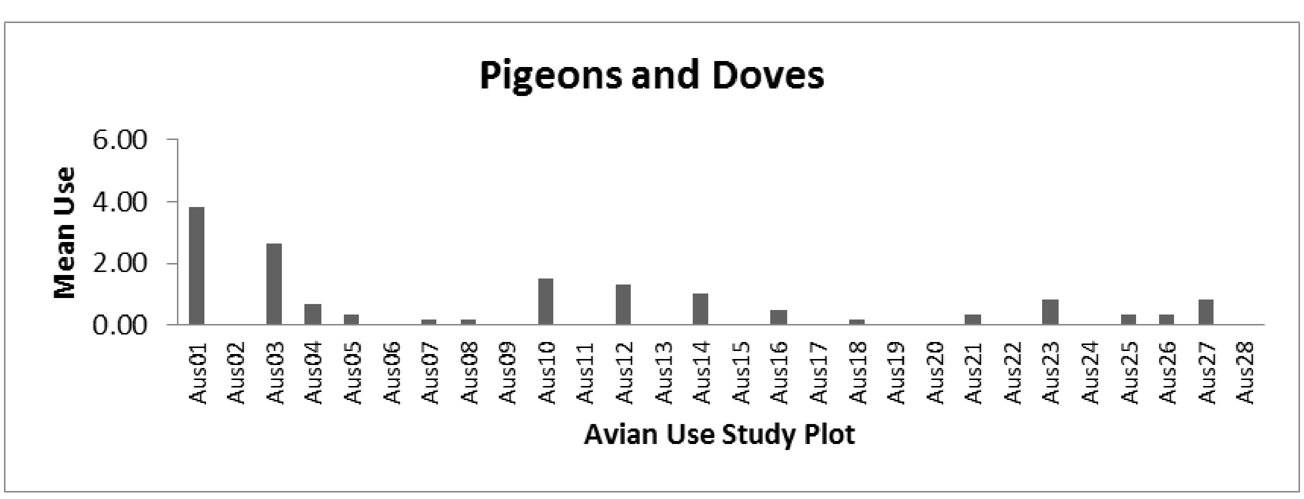
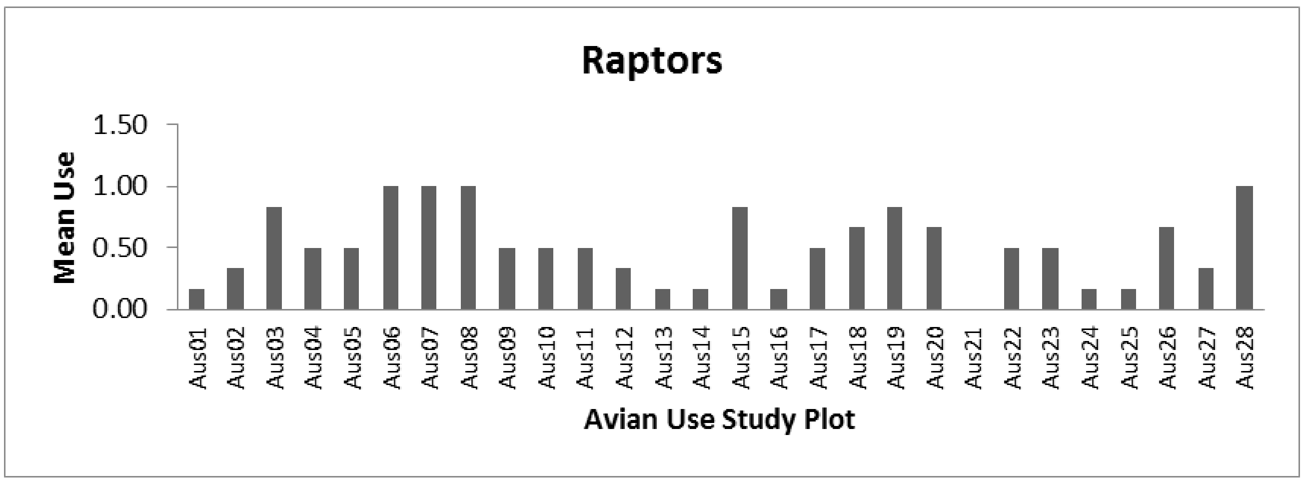
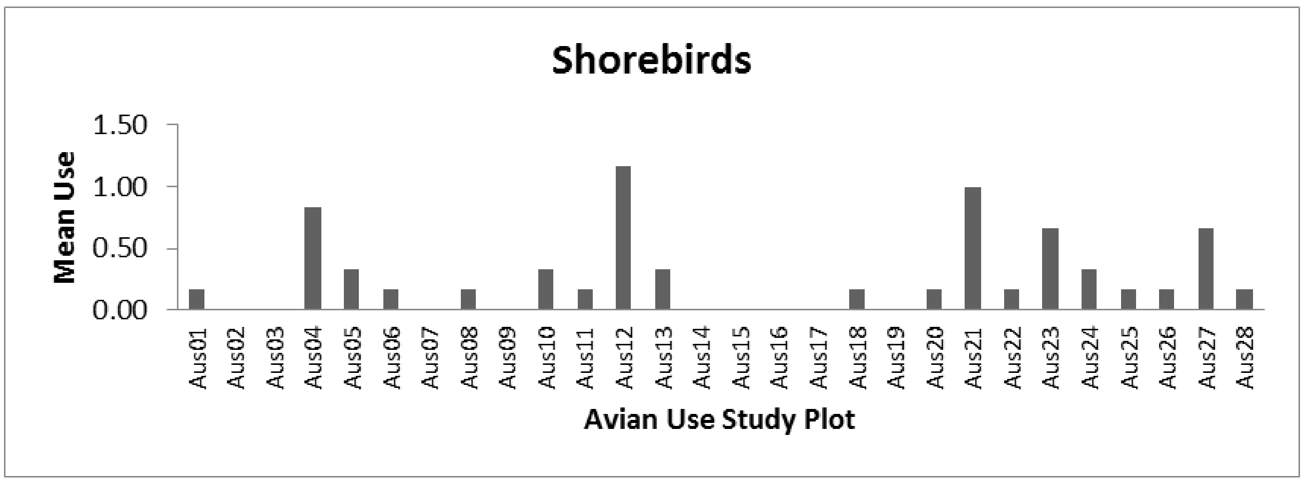
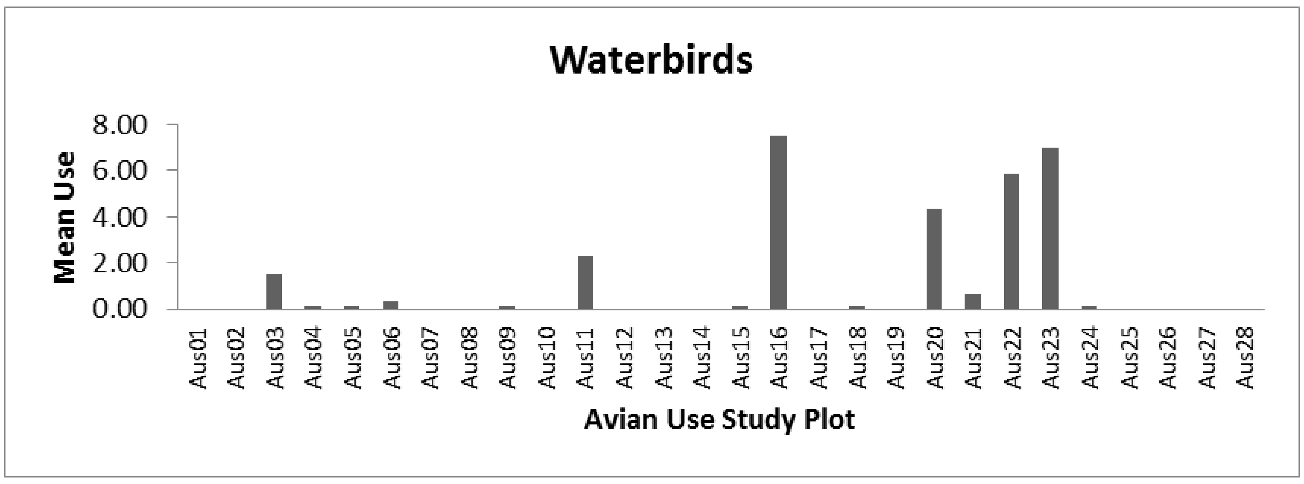
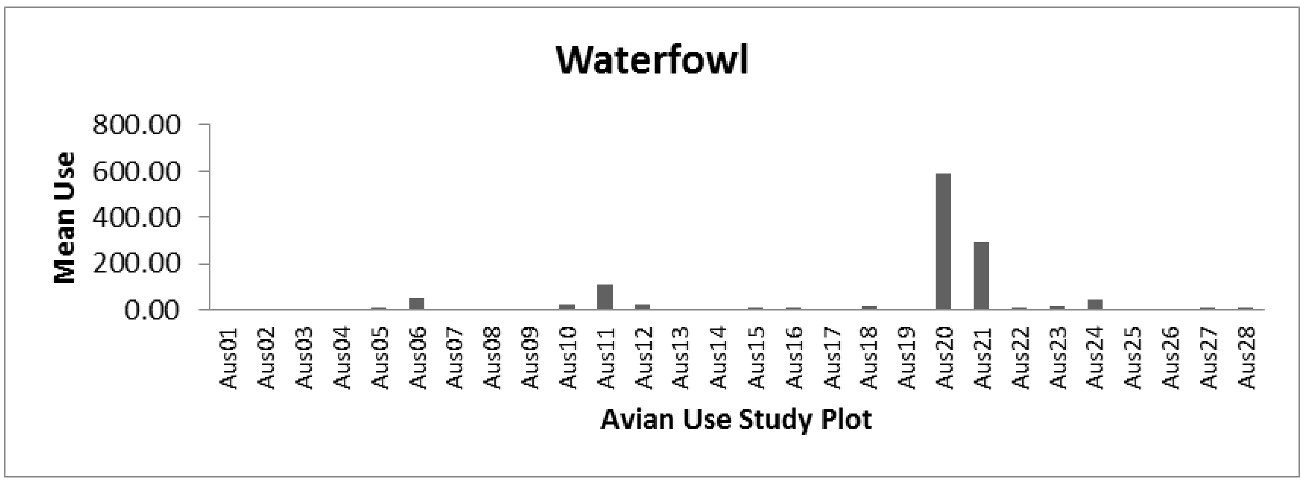


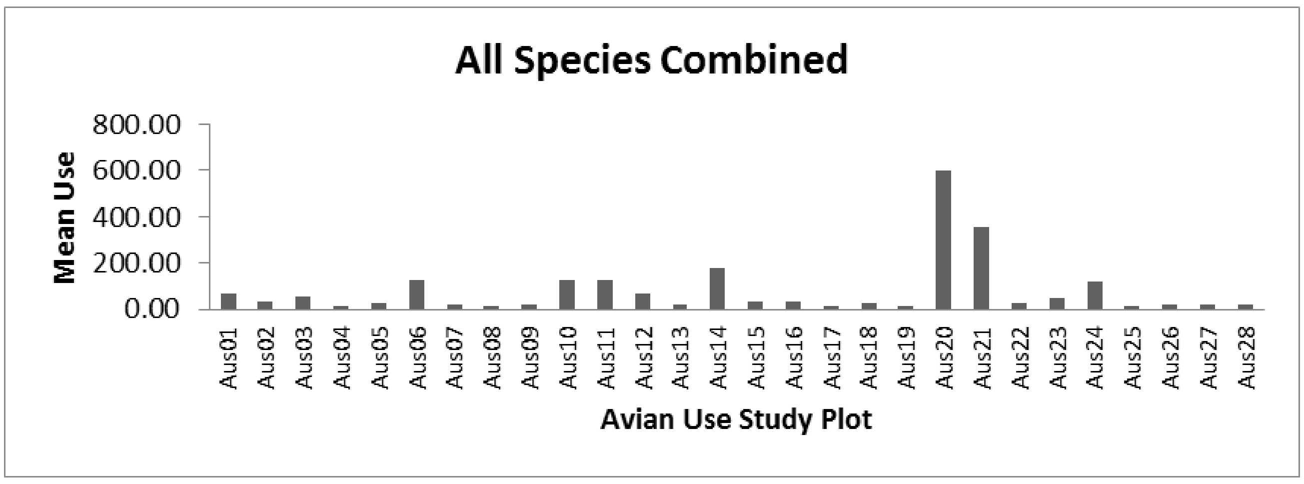
Figure 11: Mean Use by Avian Use Study Plot: Spring 2016 – Halkirk 2 (continued)







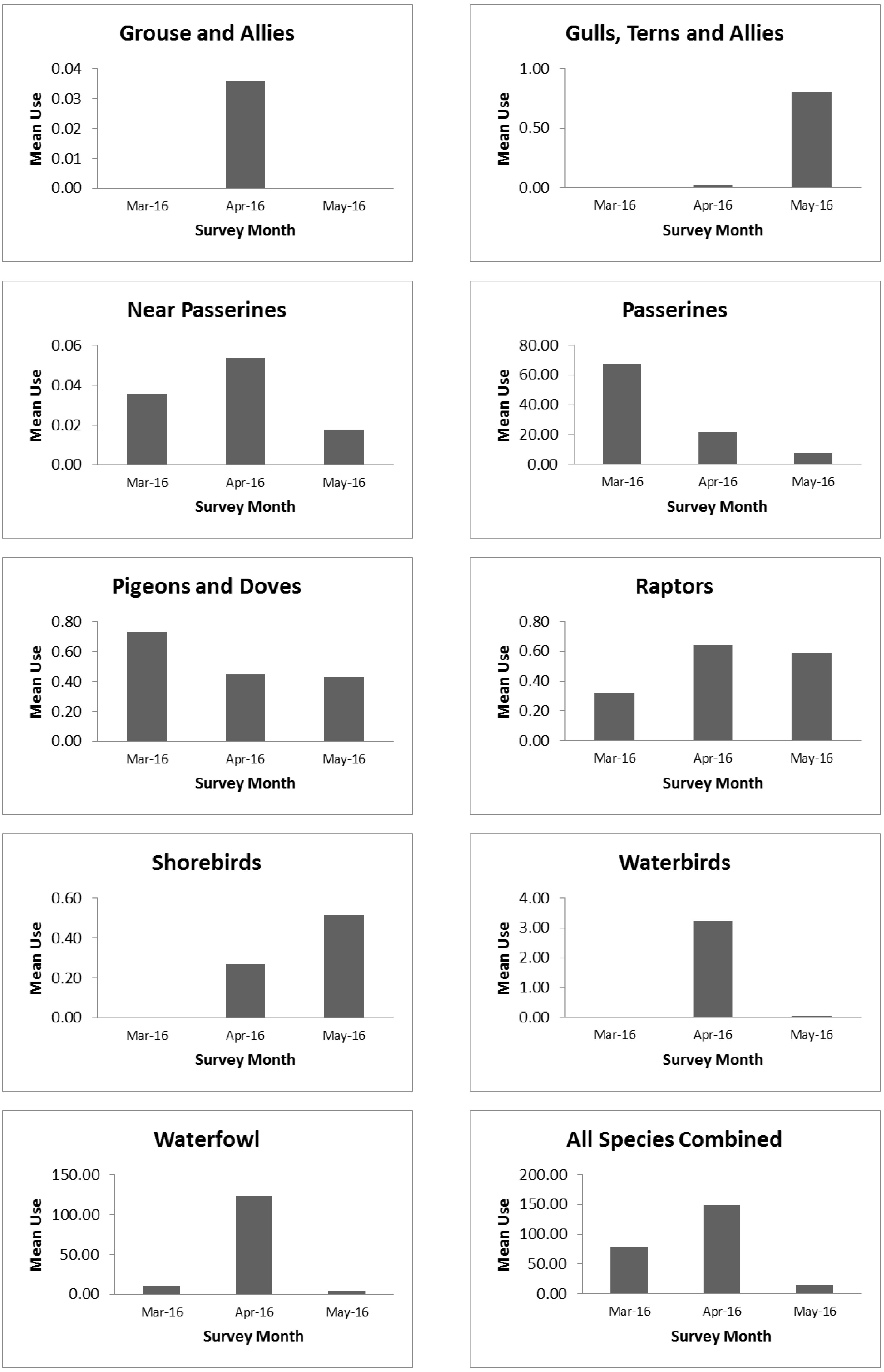




4.9.1.5 Temporal Use

Overall, the average number of birds observed per site visit was the greatest during April 2016 (Figure 12). One contributing factor was that waterfowl had a higher mean use in April, than any other spring 2016 survey month. This was primarily due to large numbers of snow goose (4,428), Canada goose (1,103), and greater white-fronted goose (1,073) observed in that month.

Figure 12: Avian Mean Use by Survey Month: Spring 2016 – Halkirk 2



4.9.2 Summer Surveys

Surveys consisted of 20-minute monitoring periods of bird activity within each plot. Each AUS plot was surveyed twice (morning and afternoon) each round, resulting in 112 plot visits conducted, which equates to approximately 37.33 (37) hours of direct observation.

During the summer 2016 AUS surveys, a total of 2,623 birds were observed, composed of 1,187 flocks (Table 20). Overall, passerines were the most commonly observed species group (2,147 individuals/947 flocks), followed by raptors (115 individuals/101 flocks).

Table 20: Species and Species Groups observed during the Avian Use Study: Summer 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
Grouse and Allies	**2**	**2**
gray partridge	2	2
Gulls, Terns and Allies	**19**	**106**
black tern	2	3
Franklin's gull	15	101
unidentified gull	2	2
Near Passerines	**13**	**13**
hairy woodpecker	1	1
northern flicker	10	10
pileated woodpecker	1	1
yellow-bellied sapsucker	1	1
Passerines	**947**	**2,147**
American crow	128	211
American goldfinch	32	60
American robin	35	36
barn swallow	11	23
black-billed magpie	70	181
unidentified blackbird	9	167
black-capped chickadee	3	4
Brewer's blackbird	6	41
brown thrasher	1	1
brown-headed cowbird	15	49
cedar waxwing	37	76
chipping sparrow	1	2
clay-coloured sparrow	100	134
cliff swallow	3	215
common grackle	1	1
common raven	18	30
common yellowthroat	10	11
eastern kingbird	11	12
eastern phoebe	1	2
European starling	23	158
gray catbird	14	14

Table 20: Species and Species Groups observed during the Avian Use Study: Summer 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
horned lark	15	19
house wren	24	28
lark sparrow	1	1
least flycatcher	4	4
loggerhead shrike	1	1
unidentified passerine	22	43
red-winged blackbird	44	223
savannah sparrow	82	104
song sparrow	7	9
unidentified sparrow	14	17
spotted towhee	6	7
Sprague's pipit	8	8
tree swallow	13	42
veery	3	3
vesper sparrow	107	140
warbling vireo	3	3
western meadowlark	35	36
yellow warbler	28	29
yellow-headed blackbird	1	2
Pigeons and Doves	**23**	**79**
mourning dove	5	5
rock dove	18	74
Raptors	**101**	**115**
unidentified accipiter	1	1
American kestrel	2	2
golden eagle	1	1
unidentified hawk	3	5
merlin	1	1
northern harrier	27	32
red-tailed hawk	47	53
Swainson's hawk	19	20
Shorebirds	**21**	**26**
killdeer	4	8
marbled godwit	2	3
spotted sandpiper	2	2
willet	1	1
Wilson's snipe	12	12
Waterbirds	**29**	**43**
American coot	4	7
American white pelican	2	9
great blue heron	6	6
sora	17	21

Table 20: Species and Species Groups observed during the Avian Use Study: Summer 2016 – Halkirk 2

Species[a]	Flocks	Individuals
Waterfowl	**32**	**92**
blue-winged teal	3	5
bufflehead	1	2
Canada goose	3	6
unidentified dabbler	2	15
unidentified duck	6	12
gadwall	2	2
green-winged teal	2	3
mallard	12	46
northern shoveler	1	1
Total	**1,187**	**2,623**

[a] Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

4.9.2.1 Avian Species Relative Abundance and Richness

During the summer 2016 AUS, the average number of individual birds observed at each AUS plot was 23.42 individuals/plot, and the total number of avian species observed was 68 (Table 21).

Table 21: Survey Effort, Mean Use, Total Species, and Avian Richness: Summer 2016 – Halkirk 2

Year	Season	Survey Rounds	Number of Plot Visits	Mean Use	Number of Species	Avian Richness (Average Number of Species / Plot Visit)
2016	Summer	2	112	23.42	68	8.15

Compared to any other species group, passerines were observed in the largest numbers and were the most frequently observed (Table 22).

Table 22: Mean Use, Composition, and Frequency of Occurrence of Species Groups: Summer 2016 – Halkirk 2

Species Group	Mean Use[a]	Composition[b] (%)	Frequency[c] (%)
Passerines	19.17	81.85	100.00
Raptors	1.03	4.38	65.18
Gulls, Terns and Allies	0.95	4.04	16.07
Waterfowl	0.82	3.51	16.07
Pigeons and Doves	0.71	3.01	17.86
Waterbirds	0.38	1.64	21.43
Shorebirds	0.23	0.99	17.86
Near Passerines	0.12	0.50	10.71
Grouse and Allies	0.02	0.08	1.79
Total	**23.42**	**100.00**	**100.00**

[a] Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

[b] Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

[c] Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

Thirty-seven passerine species were positively identified during the summer surveys, with the most abundant being red-winged blackbird at 1.99 individuals per AUS plot visit, cliff swallow at 1.92 individuals per AUS plot visit, and American crow at 1.88 individuals per AUS plot visit (Table 23).

Six raptor species were observed, with red-tailed hawk being the most common at 0.47 individuals per AUS plot visit.

Seven waterfowl species were observed during the summer surveys, with the most abundant being mallard at 0.41 individuals per AUS plot visit.

Seventeen listed species observed during the summer 2016 AUS surveys were American kestrel, American white pelican, bald eagle, barn swallow, black tern, common yellowthroat, eastern phoebe, golden eagle, great blue heron, green-winged teal, least flycatcher, loggerhead shrike, northern harrier, pileated woodpecker, sora, Sprague's pipit and Swainson's hawk. Of these listed species, loggerhead shrike and Sprague's pipit are the only species listed under SARA (Schedule 1, Threatened) (COSEWIC 2016).

Table 23: Mean Use, Composition, and Frequency of Occurrence: Summer 2016 – Halkirk 2

Species[a]	Mean Use[b]	Composition[b] (%)	Frequency[c] (%)
red-winged blackbird	1.99	8.50	33.93
cliff swallow	1.92	8.20	2.68
American crow	1.88	8.04	66.96
black-billed magpie	1.62	6.90	43.75
unidentified blackbird	1.49	6.37	7.14
European starling	1.41	6.02	14.29
vesper sparrow	1.25	5.34	70.54
clay-coloured sparrow	1.20	5.11	68.75
savannah sparrow	0.93	3.96	58.93
Franklin's gull	0.90	3.85	12.50
cedar waxwing	0.68	2.90	31.25
rock dove	0.66	2.82	13.39
American goldfinch	0.54	2.29	25.00
red-tailed hawk	0.47	2.02	40.18
brown-headed cowbird	0.44	1.87	12.50
mallard	0.41	1.75	6.25
unidentified passerine	0.38	1.64	16.96
tree swallow	0.38	1.60	9.82
Brewer's blackbird	0.37	1.56	5.36
American robin	0.32	1.37	25.89
western meadowlark	0.32	1.37	25.00
northern harrier	0.29	1.22	22.32
common raven	0.27	1.14	16.07
yellow warbler	0.26	1.11	23.21
house wren	0.25	1.07	21.43
barn swallow	0.21	0.88	9.82
sora	0.19	0.80	15.18
Swainson's hawk	0.18	0.76	15.18
horned lark	0.17	0.72	13.39
unidentified sparrow	0.15	0.65	12.50
unidentified dabbler	0.13	0.57	0.89

Table 23: Mean Use, Composition, and Frequency of Occurrence: Summer 2016 – Halkirk 2

Species[a]	Mean Use[b]	Composition[b] (%)	Frequency[c] (%)
gray catbird	0.13	0.53	10.71
unidentified duck	0.11	0.46	5.36
eastern kingbird	0.11	0.46	9.82
Wilson's snipe	0.11	0.46	10.71
common yellowthroat	0.10	0.42	8.93
northern flicker	0.09	0.38	8.04
American white pelican	0.08	0.34	1.79
song sparrow	0.08	0.34	6.25
killdeer	0.07	0.30	3.57
Sprague's pipit	0.07	0.30	7.14
American coot	0.06	0.27	3.57
spotted towhee	0.06	0.27	5.36
Canada goose	0.05	0.23	1.79
great blue heron	0.05	0.23	5.36
black-capped chickadee	0.04	0.15	2.68
blue-winged teal	0.04	0.19	2.68
unidentified hawk	0.04	0.19	2.68
least flycatcher	0.04	0.15	3.57
mourning dove	0.04	0.19	4.46
black tern	0.03	0.11	1.79
green-winged teal	0.03	0.11	1.79
marbled godwit	0.03	0.11	1.79
veery	0.03	0.11	2.68
warbling vireo	0.03	0.11	2.68
American kestrel	0.02	0.08	1.79
bufflehead	0.02	0.08	0.89
chipping sparrow	0.02	0.08	0.89
eastern phoebe	0.02	0.08	0.89
gadwall	0.02	0.08	1.79
gray partridge	0.02	0.08	1.79
unidentified gull	0.02	0.08	1.79
spotted sandpiper	0.02	0.08	1.79
yellow-headed blackbird	0.02	0.08	0.89
unidentified accipiter	0.01	0.04	0.89
brown thrasher	0.01	0.04	0.89
common grackle	0.01	0.04	0.89
golden eagle	0.01	0.04	0.89
hairy woodpecker	0.01	0.04	0.89
lark sparrow	0.01	0.04	0.89
loggerhead shrike	0.01	0.04	0.89
merlin	0.01	0.04	0.89
northern shoveler	0.01	0.04	0.89

Table 23: Mean Use, Composition, and Frequency of Occurrence: Summer 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
pileated woodpecker	0.01	0.04	0.89
willet	0.01	0.04	0.89
yellow-bellied sapsucker	0.01	0.04	0.89
Total	**23.42**	**100.00**	**100.00**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

(b) Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

(c) Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

(d) Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

4.9.2.2 Flight Height

During the summer 2016 AUS, 455 flocks composed of 1,283 birds were observed flying through the AUS plots (Table 24 and 25). Only one species group, waterbirds, was observed mostly within the RSH (64.29%). Species mostly observed in the RSH were American white pelican, black tern, cliff swallow, and golden eagle. Of these species, American white pelican, black tern, and golden eagle are listed (provincially listed as sensitive by AEP) (ASRD 2012). Near passerines, and pigeons and doves, were never observed flying within the RSH.

Table 24: Flight Height Characteristics by Species Group: Summer 2016 – Halkirk 2

Species Group	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(a)]		
					Below (%)	Within (%)	Above (%)
Gulls, Terns and Allies	103	17	100.00	12.94	82.52	17.48	0.00
Near Passerines	2	2	33.33	6.75	100.00	0.00	0.00
Passerines	981	308	58.05	10.77	79.20	20.80	0.00
Pigeons and Doves	39	12	51.32	8.72	100.00	0.00	0.00
Raptors	92	80	80.00	17.65	80.43	19.57	0.00
Shorebirds	16	11	100.00	13.38	93.75	6.25	0.00
Waterbirds	14	7	63.64	33.71	35.71	64.29	0.00
Waterfowl	36	18	40.00	14.79	97.22	2.78	0.00
Total	**1,283**	**455**	**60.52**	**11.77**	**80.44**	**19.56**	**0.00**

(a) Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

Table 25: Flight Height Characteristic by Species: Summer 2016 – Halkirk 2

Species[a]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[b]		
					Below (%)	Within (%)	Above (%)
unidentified accipiter	1	1	100.00	12.50	100.00	0.00	0.00
American crow	141	81	67.46	7.66	100.00	0.00	0.00
American goldfinch	49	25	92.45	8.43	100.00	0.00	0.00
American kestrel	2	2	100.00	16.50	100.00	0.00	0.00
American robin	7	6	41.18	7.86	100.00	0.00	0.00
American white pelican	9	2	100.00	45.00	0.00	100.00	0.00
barn swallow	23	11	100.00	6.07	100.00	0.00	0.00
black tern	3	2	100.00	18.00	33.33	66.67	0.00
black-billed magpie	53	25	32.92	5.58	100.00	0.00	0.00
unidentified blackbird	145	6	86.83	5.91	100.00	0.00	0.00
blue-winged teal	2	1	40.00	20.00	100.00	0.00	0.00
Brewer's blackbird	21	2	51.22	4.50	100.00	0.00	0.00
brown thrasher	1	1	100.00	2.00	100.00	0.00	0.00
brown-headed cowbird	18	6	36.73	3.83	100.00	0.00	0.00
Canada goose	4	2	100.00	20.13	100.00	0.00	0.00
cedar waxwing	65	29	89.04	9.78	100.00	0.00	0.00
clay-coloured sparrow	14	10	29.17	1.50	100.00	0.00	0.00
cliff swallow	215	3	100.00	24.19	6.98	93.02	0.00
common raven	19	13	86.36	16.58	89.47	10.53	0.00
unidentified duck	12	6	100.00	16.79	91.67	8.33	0.00
eastern kingbird	8	7	66.67	6.13	100.00	0.00	0.00
European starling	69	15	43.67	4.03	100.00	0.00	0.00
Franklin's gull	98	13	100.00	12.60	84.69	15.31	0.00

Table 25: Flight Height Characteristic by Species: Summer 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
gadwall	1	1	50.00	5.50	100.00	0.00	0.00
golden eagle	1	1	100.00	50.00	0.00	100.00	0.00
gray catbird	1	1	50.00	1.50	100.00	0.00	0.00
great blue heron	5	5	83.33	13.40	100.00	0.00	0.00
green-winged teal	2	1	66.67	5.00	100.00	0.00	0.00
unidentified gull	2	2	100.00	22.00	50.00	50.00	0.00
unidentified hawk	5	3	100.00	27.50	40.00	60.00	0.00
killdeer	7	3	100.00	10.64	100.00	0.00	0.00
loggerhead shrike	1	1	100.00	1.50	100.00	0.00	0.00
mallard	15	7	32.61	13.00	100.00	0.00	0.00
marbled godwit	2	1	100.00	10.00	100.00	0.00	0.00
merlin	1	1	100.00	6.00	100.00	0.00	0.00
northern flicker	2	2	33.33	6.75	100.00	0.00	0.00
northern harrier	30	25	93.75	9.53	96.67	3.33	0.00
unidentified passerine	42	21	100.00	13.23	95.24	4.76	0.00
red-tailed hawk	35	31	66.04	19.93	80.00	20.00	0.00
red-winged blackbird	33	16	15.28	4.24	100.00	0.00	0.00
rock dove	39	12	52.70	8.72	100.00	0.00	0.00
savannah sparrow	3	3	9.38	1.50	100.00	0.00	0.00
song sparrow	1	1	25.00	1.50	100.00	0.00	0.00
unidentified sparrow	11	9	64.71	4.09	100.00	0.00	0.00
spotted sandpiper	2	2	100.00	3.25	100.00	0.00	0.00
Swainson's hawk	17	16	85.00	23.62	64.71	35.29	0.00
tree swallow	33	9	78.57	9.14	100.00	0.00	0.00

Table 25: Flight Height Characteristic by Species: Summer 2016 – Halkirk 2

Species[a]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[b]		
					Below (%)	Within (%)	Above (%)
vesper sparrow	8	7	16.67	1.38	100.00	0.00	0.00
willet	1	1	100.00	25.00	100.00	0.00	0.00
Wilson's snipe	4	4	100.00	22.00	75.00	25.00	0.00
Total	**1,283**	**455**	**60.52**	**11.77**	**80.44**	**19.56**	**0.00**

[a] Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

[b] Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

4.9.2.3 Collision Risk Index

Collision risk indices were derived from abundance and flight behaviour (see Table 3 for equation). Collision risk index values should be regarded as a relative index of the potential likelihood of turbine collisions, for comparing across species and species groups, and not a definitive measure of probability of turbine collisions. However, when comparing across species and species groups it should be noted that the collision risk index does not account for differences in behaviour other than flight characteristics (Strickland et al. 2011).

Based on the collision risk index derived from data collected during the summer AUS, assuming an RSH of 40 to 150 m, the species group at greatest risk of turbine collision within the Project Area was passerines (2.314), followed by raptors (0.105) (Table 26).

Table 26: Mean Collision Risk Index by Species Group: Summer 2016 – Halkirk 2

Species Group	Mean Use	Frequency (%)	Flying (%)	Flying Within RSH (%)	Collision Risk Index
Passerines	19.17	100.00	58.05	20.80	2.314
Raptors	1.03	65.18	80.00	19.57	0.105
Waterbirds	0.38	21.43	63.64	64.29	0.034
Gulls, Terns and Allies	0.95	16.07	100.00	17.48	0.027
Shorebirds	0.23	17.86	100.00	6.25	0.003
Waterfowl	0.82	16.07	40.00	2.78	0.001
Near Passerines	0.12	10.71	33.33	0.00	0.000
Pigeons and Doves	0.71	17.86	51.32	0.00	0.000
All Species Combined	**23.42**	**100.00**	**60.52**	**19.56**	**2.773**

Of the positively identified species, cliff swallow (0.048), had the highest collision risk index, followed by red-tailed hawk (0.025), Franklin's gull (0.017), and Swainson's hawk (0.008) (Table 27). Listed species with a non-zero collision risk index include Swainson's hawk, northern harrier, and American white pelican (Table 27).

Table 27: Mean Collision Risk Index by Species: Summer 2016 - Halkirk 2

Species[(a)]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
cliff swallow	1.92	2.68	100.00	93.02	0.048
red-tailed hawk	0.47	40.18	66.04	20.00	0.025
Franklin's gull	0.90	12.50	100.00	15.31	0.017
Swainson's hawk	0.18	15.18	85.00	35.29	0.008
common raven	0.27	16.07	86.36	10.53	0.004
unidentified passerine	0.38	16.96	100.00	4.76	0.003
Wilson's snipe	0.11	10.71	100.00	25.00	0.003
northern harrier	0.29	22.32	93.75	3.33	0.002
American white pelican	0.08	1.79	100.00	100.00	0.001
unidentified hawk	0.04	2.68	100.00	60.00	0.001
unidentified accipiter	0.01	0.89	100.00	0.00	0.000
American crow	1.88	66.96	67.46	0.00	0.000
American goldfinch	0.54	25.00	92.45	0.00	0.000
American kestrel	0.02	1.79	100.00	0.00	0.000
American robin	0.32	25.89	41.18	0.00	0.000
barn swallow	0.21	9.82	100.00	0.00	0.000
black tern	0.03	1.79	100.00	66.67	0.000
black-billed magpie	1.62	43.75	32.92	0.00	0.000
unidentified blackbird	1.49	7.14	86.83	0.00	0.000
blue-winged teal	0.04	2.68	40.00	0.00	0.000
Brewer's blackbird	0.37	5.36	51.22	0.00	0.000
brown thrasher	0.01	0.89	100.00	0.00	0.000
brown-headed cowbird	0.44	12.50	36.73	0.00	0.000
Canada goose	0.05	1.79	100.00	0.00	0.000
cedar waxwing	0.68	31.25	89.04	0.00	0.000
clay-coloured sparrow	1.20	68.75	29.17	0.00	0.000
unidentified duck	0.11	5.36	100.00	8.33	0.000
eastern kingbird	0.11	9.82	66.67	0.00	0.000
European starling	1.41	14.29	43.67	0.00	0.000
gadwall	0.02	1.79	50.00	0.00	0.000
golden eagle	0.01	0.89	100.00	100.00	0.000
gray catbird	0.13	10.71	50.00	0.00	0.000
great blue heron	0.05	5.36	83.33	0.00	0.000
green-winged teal	0.03	1.79	66.67	0.00	0.000
unidentified gull	0.02	1.79	100.00	50.00	0.000
killdeer	0.07	3.57	100.00	0.00	0.000
loggerhead shrike	0.01	0.89	100.00	0.00	0.000
mallard	0.41	6.25	32.61	0.00	0.000
marbled godwit	0.03	1.79	100.00	0.00	0.000
merlin	0.01	0.89	100.00	0.00	0.000

Table 27: Mean Collision Risk Index by Species: Summer 2016 - Halkirk 2

Species[(a)]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
northern flicker	0.09	8.04	33.33	0.00	0.000
red-winged blackbird	1.99	33.93	15.28	0.00	0.000
rock dove	0.66	13.39	52.70	0.00	0.000
savannah sparrow	0.93	58.93	9.38	0.00	0.000
song sparrow	0.08	6.25	25.00	0.00	0.000
unidentified sparrow	0.15	12.50	64.71	0.00	0.000
spotted sandpiper	0.02	1.79	100.00	0.00	0.000
tree swallow	0.38	9.82	78.57	0.00	0.000
vesper sparrow	1.25	70.54	16.67	0.00	0.000
willet	0.01	0.89	100.00	0.00	0.000
All Species Combined	**23.42**	**100.00**	**60.52**	**19.56**	**2.773**

[(a)] Species in *italics* and **bold** = provincially (ASRD 2012) or federally listed by SARA (COSEWIC 2016).

4.9.2.4 Spatial Use

Only passerines were observed at all AUS plots during the summer (Figure 13). Plots AUS28 and AUS 10 had the highest relative use compared to all other AUS plots (Figure 13). This was primarily due to relatively high numbers of observed passerines at both plot locations as compared to all other AUS plots. The reason for this large number of passerines observed at plot AUS 28 (63.25 individuals/AUS plot visit) was primarily one large flock of cliff swallows. The large number of passerines observed at plot AUS 10 (43.50 individuals/AUS plot visit) was primarily due to a large flock of unidentified blackbirds.

Raptors were observed in all but one AUS plot (AUS 27). They were observed in the highest numbers at AUS 23 (2.25 individuals/AUS plot visit) and AUS 04 (2.25 individuals/AUS plot visit) compared to other AUS plots.

Figure 13: Mean Use by Avian Use Study Plot: Summer 2016 – Halkirk 2

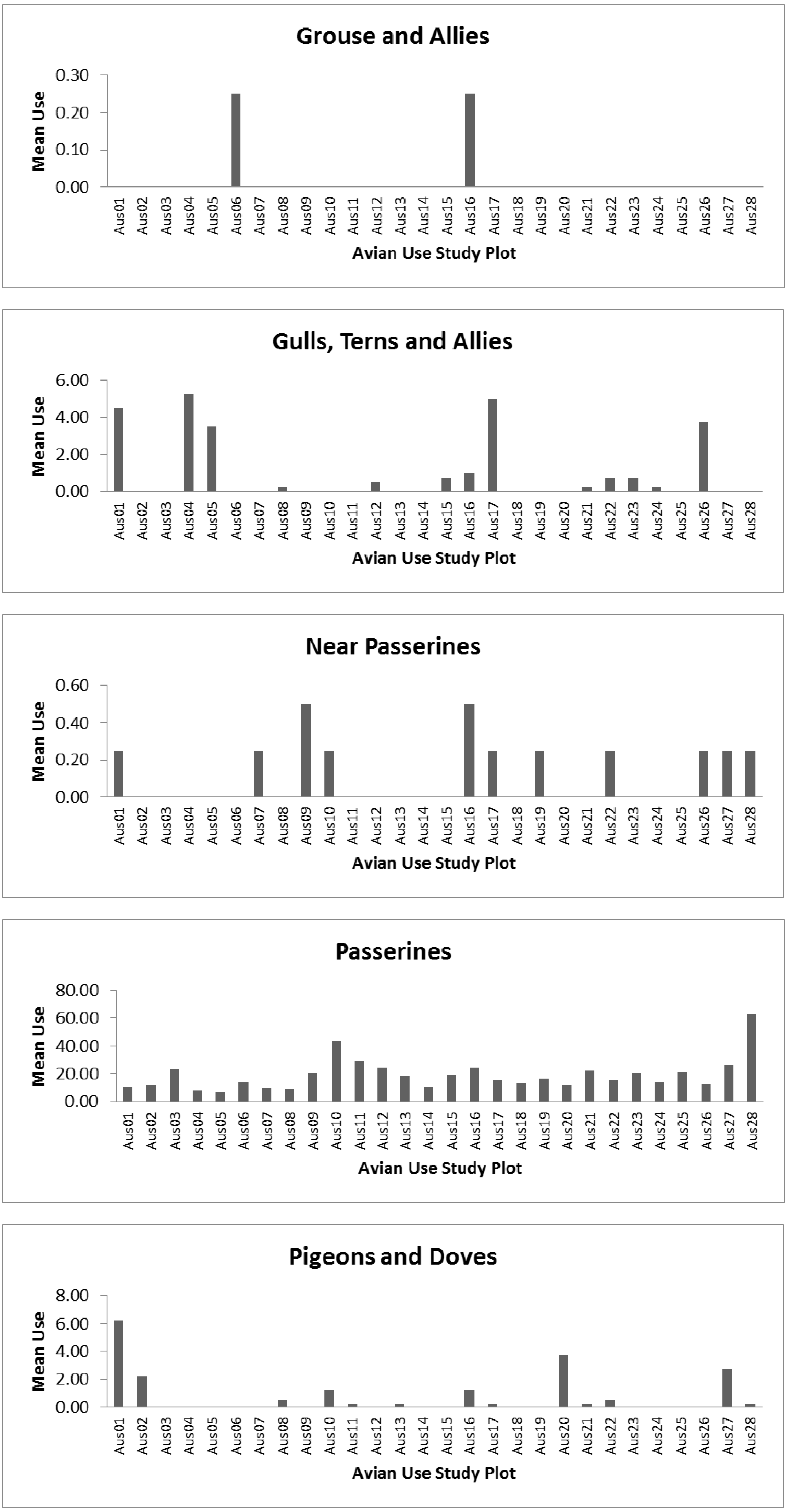
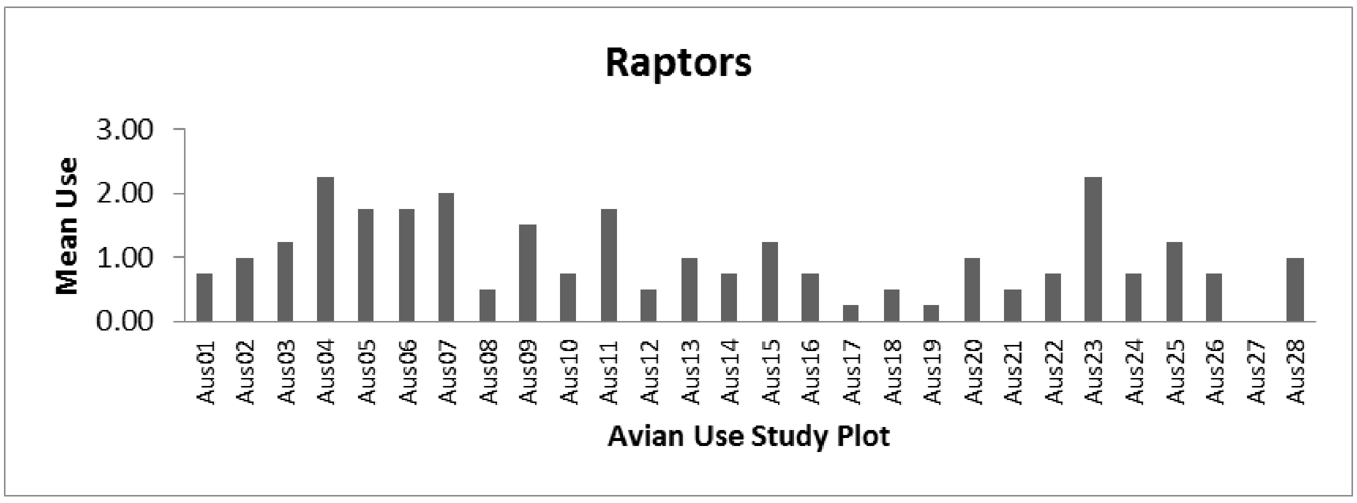
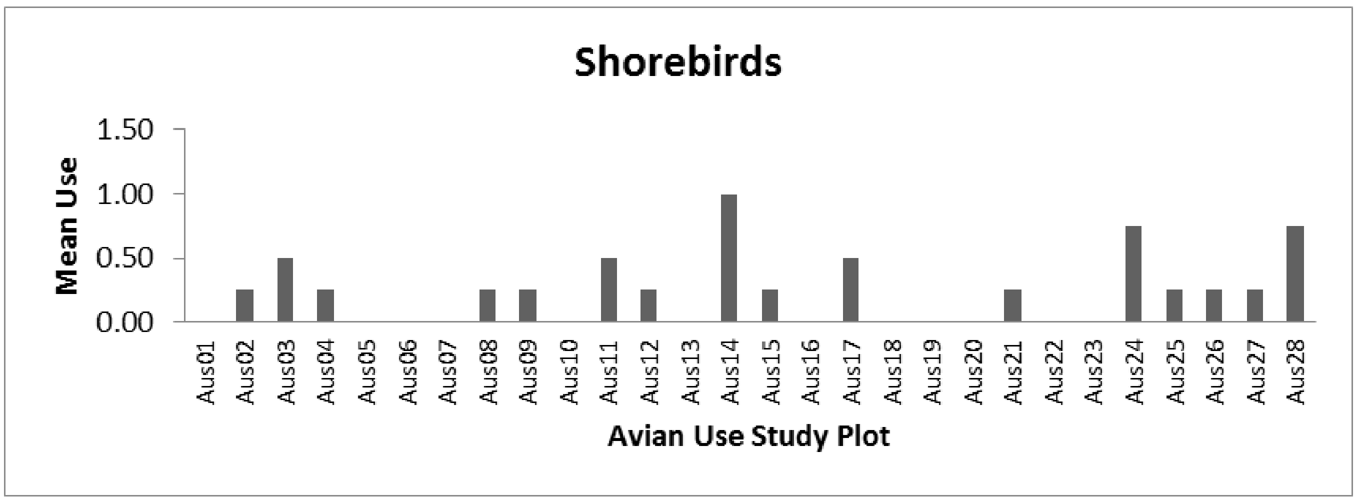
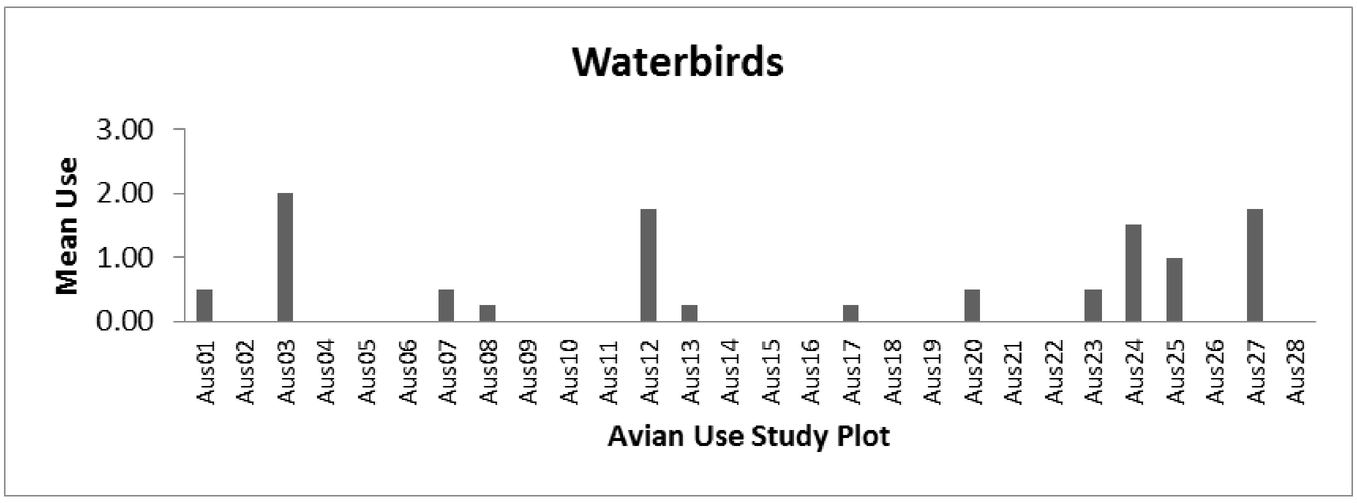
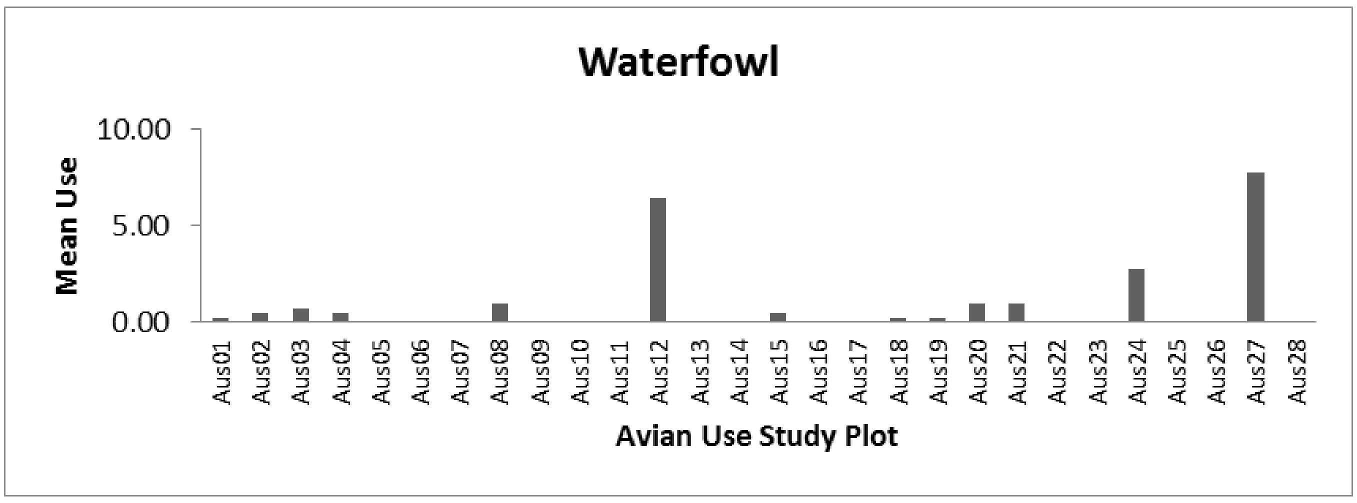


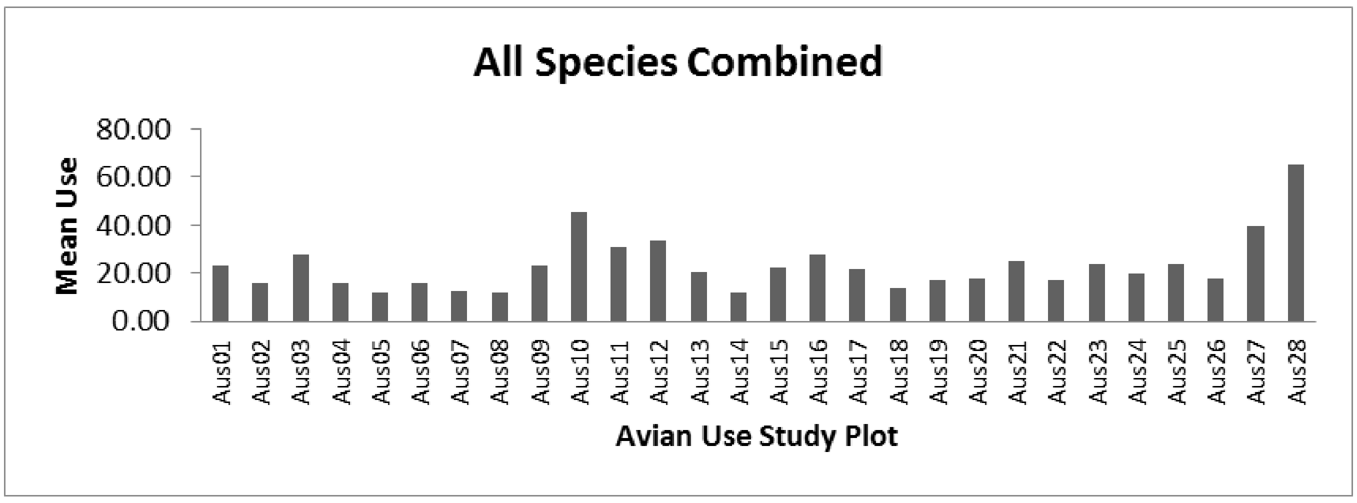
Figure 13: Mean Use by Avian Use Study Plot: Summer 2016 – Halkirk 2 (continued)







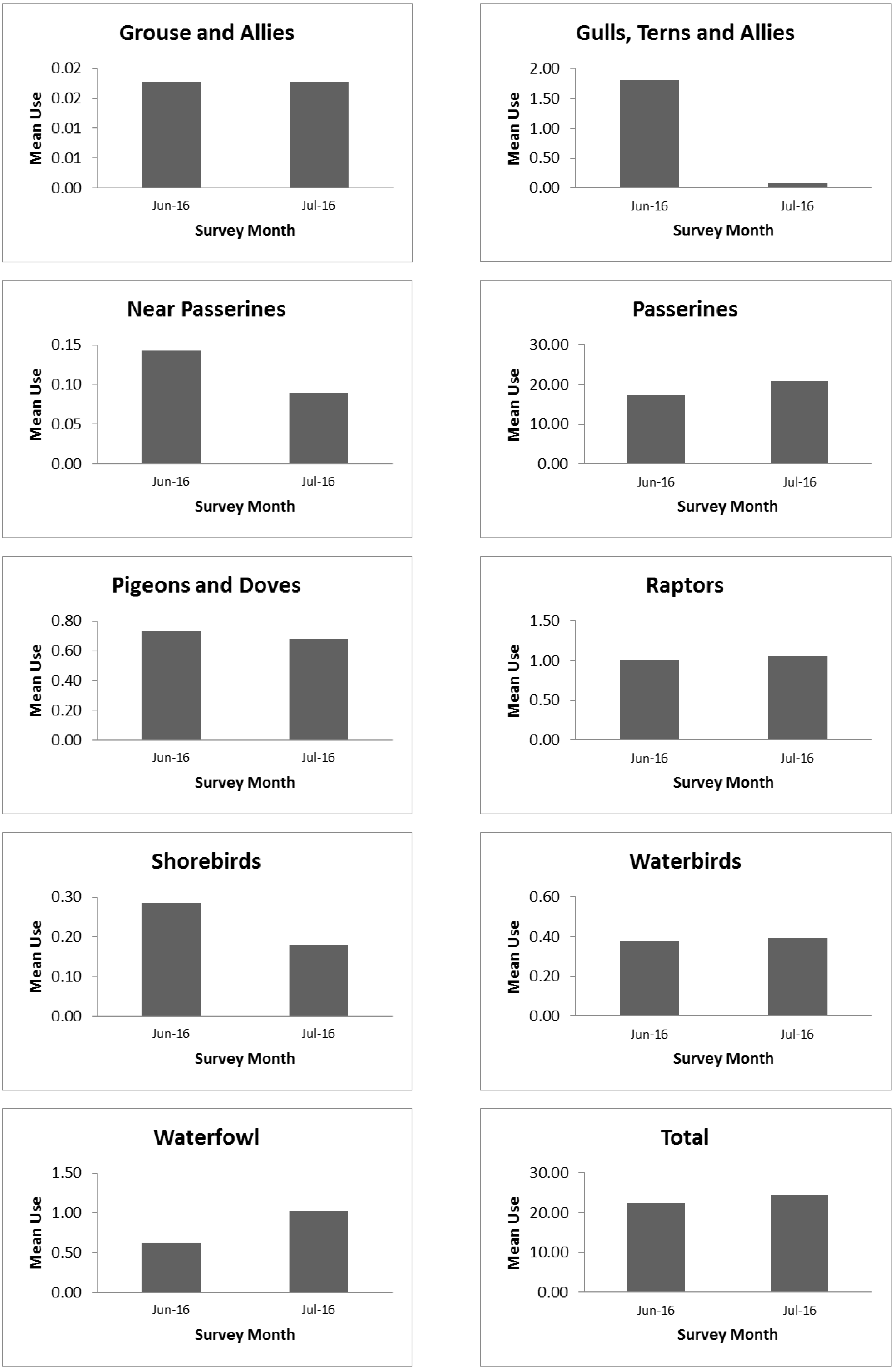




4.9.2.5 Temporal Use

As expected for a breeding season AUS, relative plot use over these two months remained relatively consistent among most species groups (Figure 14). Relative plot use varied slightly between June (22.41 individuals/AUS plot visit) and July (24.43 individuals/AUS plot visit).

Figure 14: Avian Mean Use by Survey Date: Summer 2016 – Halkirk 2



4.9.3 Fall Surveys

Surveys consisted of 20-minute monitoring periods of bird activity within each plot. Each AUS plot was surveyed twice (morning and afternoon) each round, resulting in 167 plot visits conducted, which equates to approximately 56 hours of direct observation. One afternoon visit at plot AUS 17 during round three was not completed, resulting in a total 167 plot visits conducted rather than 168.

During the fall 2016 AUS surveys, a total of 11,677 birds were observed, composed of 1,018 flocks (Table 28). Overall, waterfowl were the most commonly observed species group (8,165 individuals/234 flocks), followed by passerines (2,739 individuals/541 flocks) (Table 28).

Table 28: Species and Species Groups observed during the Avian Use Study: Fall 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
Grouse and Allies	**2**	**9**
gray partridge	1	5
sharp-tailed grouse	1	4
Gulls, Terns and Allies	**1**	**2**
unidentified tern	1	2
Near Passerines	**16**	**16**
belted kingfisher	1	1
downy woodpecker	1	1
hairy woodpecker	2	2
northern flicker	5	5
pileated woodpecker	5	5
unidentified woodpecker	1	1
yellow-bellied sapsucker	1	1
Passerines	**541**	**2,739**
American crow	66	444
American goldfinch	9	14
American pipit	1	40
American robin	15	55
American tree sparrow	3	6
barn swallow	13	45
black-billed magpie	110	259
unidentified blackbird	18	221
black-capped chickadee	13	26
blue jay	5	5
cedar waxwing	4	8
clay-coloured sparrow	5	10
common raven	65	105
common yellowthroat	1	1
unidentified corvid	5	5
eastern kingbird	9	22
European starling	21	558
gray catbird	6	7

Table 28: Species and Species Groups observed during the Avian Use Study: Fall 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
horned lark	7	76
house wren	2	2
Lapland longspur	5	69
mountain bluebird	2	5
unidentified passerine	67	574
pine siskin	1	4
savannah sparrow	5	6
Say's phoebe	1	1
song sparrow	2	2
unidentified sparrow	45	105
spotted towhee	2	2
tree swallow	3	4
vesper sparrow	13	23
western meadowlark	12	15
white-crowned sparrow	1	2
white-throated sparrow	1	2
yellow warbler	1	1
yellow-headed blackbird	2	15
Pigeons and Doves	**25**	**152**
mourning dove	7	11
rock dove	18	141
Raptors	**173**	**205**
American kestrel	1	1
bald eagle	1	1
great horned owl	1	1
unidentified hawk	16	16
merlin	1	1
northern harrier	44	50
prairie falcon	1	1
unidentified raptor	3	5
red-tailed hawk	69	88
rough-legged hawk	6	6
sharp-shinned hawk	2	2
Swainson's hawk	27	32
turkey vulture	1	1
Shorebirds	**6**	**21**
killdeer	4	17
unidentified yellowlegs	2	4
Waterbirds	**20**	**368**
American coot	3	9
great blue heron	1	1
sandhill crane	13	355

Table 28: Species and Species Groups observed during the Avian Use Study: Fall 2016 – Halkirk 2

Species[(a)]	Flocks	Individuals
sora	3	3
Waterfowl	**234**	**8,165**
American wigeon	6	182
Canada goose	108	2,335
unidentified dabbler	3	85
unidentified duck	13	163
gadwall	6	40
unidentified goose	3	150
greater white-fronted goose	46	2,368
green-winged teal	3	15
mallard	20	404
northern pintail	5	42
northern shoveler	1	4
snow goose	17	2,365
unidentified teal	2	10
tundra swan	1	2
Total	**1,018**	**11,677**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

4.9.3.1 Avian Species Relative Abundance and Richness

During the fall 2016 AUS, the average number of individual birds observed at each AUS plot was 69.92 individuals/plot, and the total number of avian species observed was 68 (Table 21).

Table 29: Survey Effort, Mean Use, Total Species, and Avian Richness: Fall 2016 – Halkirk 2

Year	Season	Survey Rounds	Number of Plot Visits	Mean Use	Number of Species	Avian Richness (Average Number of Species / Plot Visit)
2016	Fall	3	167	69.92	68	4.04

Compared to any other species group, waterfowl were observed in the largest numbers and passerines were most frequently observed (Table 30).

Table 30: Mean Use, Composition, and Frequency of Occurrence of Species Groups: Fall 2016 – Halkirk 2

Species Group	Mean Use[(a)]	Composition[(b)] (%)	Frequency[(c)] (%)
Waterfowl	48.89	69.92	52.69
Passerines	16.40	23.46	94.01
Waterbirds	2.20	3.15	10.78
Raptors	1.23	1.76	68.86
Pigeons and Doves	0.91	1.30	13.17
Shorebirds	0.13	0.18	3.59
Near Passerines	0.10	0.14	9.58
Grouse and Allies	0.05	0.08	1.20
Gulls, Terns and Allies	0.01	0.02	0.60
Total	**69.92**	**100.00**	**99.40**

(a) Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

(b) Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

(c) Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

Ten waterfowl species were observed during the fall 2016 surveys, with the most abundant being greater white-fronted goose at 14.18 individuals per AUS plot visit, and snow goose at 14.16 individuals per AUS plot visit (Table 31).

Thirty-two passerine species were positively identified during the fall surveys, with the most abundant being European starling at 3.34 individuals per AUS plot visit, American crow at 2.66 individuals per AUS plot visit, and black-billed magpie at 1.55 individuals per AUS plot visit.

Eleven raptor species were observed, with red-tailed hawk being the most common at 0.53 individuals per AUS plot visit.

Twenty listed species observed during the fall 2016 AUS surveys were American kestrel, bald eagle, barn swallow, common yellowthroat, great blue heron, green-winged teal, northern harrier, northern pintail, pileated woodpecker, prairie falcon, sandhill crane, sharp-tailed grouse, sora and Swainson's hawk. Of these listed species, none are species listed under SARA (COSEWIC 2016).

Table 31: Mean Use, Composition, and Frequency of Occurrence: Fall 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
greater white-fronted goose	14.18	20.28	19.16
snow goose	14.16	20.25	7.19
Canada goose	13.98	20.00	34.13
unidentified passerine	3.44	4.92	29.94
European starling	3.34	4.78	12.57
American crow	2.66	3.80	29.94
mallard	2.42	3.46	7.19
sandhill crane	2.13	3.04	6.59

Table 31: Mean Use, Composition, and Frequency of Occurrence: Fall 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
black-billed magpie	1.55	2.22	45.51
unidentified blackbird	1.32	1.89	8.38
American wigeon	1.09	1.56	2.99
unidentified duck	0.98	1.40	7.19
unidentified goose	0.90	1.28	1.80
rock dove	0.84	1.21	9.58
common raven	0.63	0.90	31.74
unidentified sparrow	0.63	0.90	26.35
red-tailed hawk	0.53	0.75	35.33
unidentified dabbler	0.51	0.73	1.80
horned lark	0.46	0.65	3.59
Lapland longspur	0.41	0.59	2.99
American robin	0.33	0.47	8.38
northern harrier	0.30	0.43	23.95
barn swallow	0.27	0.39	7.78
northern pintail	0.25	0.36	2.99
American pipit	0.24	0.34	0.60
gadwall	0.24	0.34	2.99
Swainson's hawk	0.19	0.27	14.97
black-capped chickadee	0.16	0.22	7.78
vesper sparrow	0.14	0.20	7.78
eastern kingbird	0.13	0.19	5.39
unidentified hawk	0.10	0.14	9.58
killdeer	0.10	0.15	2.40
green-winged teal	0.09	0.13	1.20
western meadowlark	0.09	0.13	7.19
yellow-headed blackbird	0.09	0.13	1.20
American goldfinch	0.08	0.12	5.39
mourning dove	0.07	0.09	4.19
clay-coloured sparrow	0.06	0.09	2.99
unidentified teal	0.06	0.09	1.20

Table 31: Mean Use, Composition, and Frequency of Occurrence: Fall 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
American coot	0.05	0.08	1.80
cedar waxwing	0.05	0.07	2.40
American tree sparrow	0.04	0.05	1.80
gray catbird	0.04	0.06	3.59
rough-legged hawk	0.04	0.05	3.59
savannah sparrow	0.04	0.05	2.99
blue jay	0.03	0.04	2.99
unidentified corvid	0.03	0.04	2.99
gray partridge	0.03	0.04	0.60
mountain bluebird	0.03	0.04	1.20
northern flicker	0.03	0.04	2.99
pileated woodpecker	0.03	0.04	2.99
unidentified raptor	0.03	0.04	1.80
northern shoveler	0.02	0.03	0.60
pine siskin	0.02	0.03	0.60
sharp-tailed grouse	0.02	0.03	0.60
sora	0.02	0.03	1.80
tree swallow	0.02	0.03	1.80
unidentified yellowlegs	0.02	0.03	1.20
American kestrel	0.01	0.01	0.60
bald eagle	0.01	0.01	0.60
belted kingfisher	0.01	0.01	0.60
common yellowthroat	0.01	0.01	0.60
downy woodpecker	0.01	0.01	0.60
great blue heron	0.01	0.01	0.60
great horned owl	0.01	0.01	0.60
hairy woodpecker	0.01	0.02	1.20
house wren	0.01	0.02	1.20
merlin	0.01	0.01	0.60
prairie falcon	0.01	0.01	0.60
Say's phoebe	0.01	0.01	0.60
sharp-shinned hawk	0.01	0.02	1.20
song sparrow	0.01	0.02	1.20
spotted towhee	0.01	0.02	1.20
unidentified tern	0.01	0.02	0.60
tundra swan	0.01	0.02	0.60
turkey vulture	0.01	0.01	0.60
white-crowned sparrow	0.01	0.02	0.60
white-throated sparrow	0.01	0.02	0.60
unidentified woodpecker	0.01	0.01	0.60

Table 31: Mean Use, Composition, and Frequency of Occurrence: Fall 2016 – Halkirk 2

Species[(a)]	Mean Use[(b)]	Composition[(b)] (%)	Frequency[(c)] (%)
yellow warbler	0.01	0.01	0.60
yellow-bellied sapsucker	0.01	0.01	0.60
Total	**69.92**	**100.00**	**99.40**

[(a)] Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

[(b)] Mean Use = Mean (average) number of individuals of the species / species group observed per plot visit during a 20-minute observation event.

[(c)] Composition = Proportion of all AUS observations that were of the species / species group (in percentage).

[(d)] Frequency = Proportion of AUS plot surveys in which the species / species group was observed (in percentage).

% = percent

4.9.3.2 Flight Height

During the fall 2016 AUS, 665 flocks composed of 8,395 birds were observed flying through the AUS plots (Table 32; Table 33). Only two species groups, waterbirds and waterfowl, were observed mostly within the RSH (68.99% and 62.88% respectively). Species mostly observed in the RSH were greater white-fronted goose, sandhill crane, and snow goose. Of these species, only sandhill crane is listed (provincially listed as sensitive by AEP) (ASRD 2012). Grouse and allies, gulls, terns, and allies, near passerines, and pigeons and doves, were never observed flying within the RSH.

Table 32: Flight Height Characteristics by Species Group: Fall 2016 – Halkirk 2

Species Group	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(a)]		
					Below (%)	Within (%)	Above (%)
Grouse and Allies	4	1	44.44	5.50	100.00	0.00	0.00
Gulls, Terns and Allies	2	1	100.00	15.00	100.00	0.00	0.00
Near Passerines	4	4	50.00	9.00	100.00	0.00	0.00
Passerines	1,610	317	60.19	9.29	97.95	2.05	0.00
Pigeons and Doves	130	17	86.09	7.90	100.00	0.00	0.00
Raptors	154	127	75.86	14.14	85.06	14.94	0.00
Shorebirds	11	3	52.38	12.86	100.00	0.00	0.00
Waterbirds	316	10	88.76	36.41	31.01	68.99	0.00
Waterfowl	6,164	185	75.53	40.15	37.12	62.88	0.00
Total	**8,395**	**665**	**72.46**	**33.04**	50.57	49.43	0.00

[(a)] Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

Table 33: Flight Height Characteristic by Species: Fall 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
American crow	162	38	36.82	9.12	99.38	0.62	0.00
American goldfinch	14	9	100.00	7.21	100.00	0.00	0.00
American kestrel	1	1	100.00	8.00	100.00	0.00	0.00

Table 33: Flight Height Characteristic by Species: Fall 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
American pipit	40	1	100.00	8.00	100.00	0.00	0.00
American robin	30	8	55.56	11.77	100.00	0.00	0.00
American tree sparrow	6	3	100.00	1.92	100.00	0.00	0.00
American wigeon	50	3	27.47	11.06	100.00	0.00	0.00
bald eagle	1	1	100.00	17.50	100.00	0.00	0.00
barn swallow	28	12	62.22	7.00	100.00	0.00	0.00
black-billed magpie	154	64	61.35	5.72	100.00	0.00	0.00
unidentified blackbird	166	14	75.11	8.69	100.00	0.00	0.00
black-capped chickadee	6	3	31.58	3.08	100.00	0.00	0.00
blue jay	2	2	100.00	6.75	100.00	0.00	0.00
Canada goose	1,696	91	72.70	31.15	52.06	47.94	0.00
cedar waxwing	6	3	75.00	6.33	100.00	0.00	0.00
clay-coloured sparrow	2	1	20.00	1.50	100.00	0.00	0.00
common raven	72	44	77.42	17.30	72.22	27.78	0.00
unidentified corvid	3	3	60.00	12.50	100.00	0.00	0.00
unidentified dabbler	60	2	70.59	10.50	100.00	0.00	0.00
unidentified duck	116	9	71.60	13.39	100.00	0.00	0.00
eastern kingbird	9	3	40.91	2.67	100.00	0.00	0.00
European starling	134	8	24.01	4.90	100.00	0.00	0.00
unidentified goose	150	3	100.00	37.50	36.67	63.33	0.00
great blue heron	1	1	100.00	1.50	100.00	0.00	0.00
greater white-fronted goose	1,907	41	80.57	35.69	37.49	62.51	0.00
green-winged teal	4	1	26.67	8.00	100.00	0.00	0.00
hairy woodpecker	1	1	50.00	5.50	100.00	0.00	0.00
unidentified hawk	6	7	37.50	12.67	83.33	16.67	0.00
horned lark	56	3	76.71	7.91	100.00	0.00	0.00

Table 33: Flight Height Characteristic by Species: Fall 2016 – Halkirk 2

Species[a]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[b]		
					Below (%)	Within (%)	Above (%)
killdeer	8	2	47.06	13.94	100.00	0.00	0.00
Lapland longspur	64	4	92.75	6.71	100.00	0.00	0.00
mallard	287	15	71.04	11.33	97.91	2.09	0.00
mourning dove	6	3	60.00	6.17	100.00	0.00	0.00
northern flicker	2	2	66.67	6.25	100.00	0.00	0.00
northern harrier	43	38	87.76	4.08	100.00	0.00	0.00
northern pintail	34	3	80.95	14.47	100.00	0.00	0.00
northern shoveler	4	1	100.00	10.50	100.00	0.00	0.00
unidentified passerine	555	58	97.54	12.39	97.84	2.16	0.00
pileated woodpecker	1	1	100.00	18.00	100.00	0.00	0.00
pine siskin	4	1	100.00	5.50	100.00	0.00	0.00
prairie falcon	1	1	100.00	5.50	100.00	0.00	0.00
unidentified raptor	5	3	100.00	62.00	20.00	80.00	0.00
red-tailed hawk	66	50	75.00	15.31	84.85	15.15	0.00
rock dove	124	14	87.94	7.98	100.00	0.00	0.00
rough-legged hawk	4	4	66.67	11.50	75.00	25.00	0.00
sandhill crane	315	9	91.30	36.52	30.79	69.21	0.00
savannah sparrow	3	2	60.00	1.50	100.00	0.00	0.00
sharp-shinned hawk	1	1	50.00	2.50	100.00	0.00	0.00
sharp-tailed grouse	4	1	100.00	5.50	100.00	0.00	0.00
snow goose	1,845	14	78.01	61.99	4.07	95.93	0.00
unidentified sparrow	60	19	61.22	3.85	100.00	0.00	0.00
Swainson's hawk	25	20	78.13	20.80	72.00	28.00	0.00
unidentified teal	9	1	90.00	3.50	100.00	0.00	0.00
unidentified tern	2	1	100.00	15.00	100.00	0.00	0.00
tree swallow	4	3	100.00	5.38	100.00	0.00	0.00
tundra swan	2	1	100.00	12.50	100.00	0.00	0.00

Table 33: Flight Height Characteristic by Species: Fall 2016 – Halkirk 2

Species[(a)]	Airborne Birds	Airborne Flocks	% Birds Flying	Mean Flight Height (m)	Relation to Rotor-Swept-Height for Proposed (V110-2.0/2.2) Turbine[(b)]		
					Below (%)	Within (%)	Above (%)
turkey vulture	1	1	100.00	5.50	100.00	0.00	0.00
vesper sparrow	14	8	60.87	2.07	100.00	0.00	0.00
western meadowlark	1	1	11.11	1.00	100.00	0.00	0.00
yellow-headed blackbird	15	2	100.00	5.00	100.00	0.00	0.00
unidentified yellowlegs	3	1	75.00	10.00	100.00	0.00	0.00
Total	**8,395**	**665**	**72.46**	**33.04**	**50.57**	**49.43**	**0.00**

(a) Species in *italics* and **bold** = provincially listed species of special status (ASRD 2012) or federally listed species of special status (COSEWIC 2016).

(b) Based on rotor-swept height (RSH) of 40 to 150 m above ground level for the Vestas V110-2.0/2.2 turbine model.

% = percent; m = metres

4.9.3.3 Collision Risk Index

Collision risk indices were derived from abundance and flight behaviour (see Table 3 for equation). Collision risk index values should be regarded as a relative index of the potential likelihood of turbine collisions, for comparing across species and species groups, and not a definitive measure of probability of turbine collisions. However, when comparing across species and species groups it should be noted that the collision risk index does not account for differences in behaviour other than flight characteristics (Strickland et al. 2001).

Based on the collision risk index derived from data collected during the fall AUS, assuming an RSH of 40 to 150 m, the species group at greatest risk of turbine collision within the Project Area was waterfowl (12.236), followed by passerines (0.190) (Table 34).

Table 34: Mean Collision Risk Index by Species Group: Fall 2016 – Halkirk 2

Species Group	Mean Use	Frequency (%)	Flying (%)	Flying Within RSH (%)	Collision Risk Index
Waterfowl	48.89	52.69	75.53	62.88	12.236
Passerines	16.40	94.01	60.19	2.05	0.190
Waterbirds	2.20	10.78	88.76	68.99	0.145
Raptors	1.23	68.86	75.86	14.94	0.096
Grouse and Allies	0.05	1.20	44.44	0.00	0.000
Gulls, Terns and Allies	0.01	0.60	100.00	0.00	0.000
Near Passerines	0.10	9.58	50.00	0.00	0.000
Pigeons and Doves	0.91	13.17	86.09	0.00	0.000
Shorebirds	0.13	3.59	52.38	0.00	0.000
All Species Combined	**69.92**	**99.40**	**72.46**	**49.43**	**24.896**

Of the positively identified species, Canada goose (1.663), had the highest collision risk index, followed by greater white-fronted goose (1.368), and snow goose (0.762) (Table 35). Listed species with a non-zero collision risk index include sandhill crane and Swainson's hawk (Table 35).

Table 35: Mean Collision Risk Index by Species: Fall 2016 - Halkirk 2

Species[(a)]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
Canada goose	13.98	34.13	72.70	47.94	1.663
greater white-fronted goose	14.18	19.16	80.57	62.51	1.368
snow goose	14.16	7.19	78.01	95.93	0.762
sandhill crane	2.13	6.59	91.30	69.21	0.088
common raven	0.63	31.74	77.42	27.78	0.043
unidentified passerine	3.44	29.94	97.54	2.16	0.022
red-tailed hawk	0.53	35.33	75.00	15.15	0.021
unidentified goose	0.90	1.80	100.00	63.33	0.010
Swainson's hawk	0.19	14.97	78.13	28.00	0.006
mallard	2.42	7.19	71.04	2.09	0.003
American crow	2.66	29.94	36.82	0.62	0.002
unidentified hawk	0.10	9.58	37.50	16.67	0.001
American goldfinch	0.08	5.39	100.00	0.00	0.000
American kestrel	0.01	0.60	100.00	0.00	0.000
American pipit	0.24	0.60	100.00	0.00	0.000
American robin	0.33	8.38	55.56	0.00	0.000
American tree sparrow	0.04	1.80	100.00	0.00	0.000
American wigeon	1.09	2.99	27.47	0.00	0.000
bald eagle	0.01	0.60	100.00	0.00	0.000
barn swallow	0.27	7.78	62.22	0.00	0.000
black-billed magpie	1.55	45.51	61.35	0.00	0.000
unidentified blackbird	1.32	8.38	75.11	0.00	0.000
black-capped chickadee	0.16	7.78	31.58	0.00	0.000
blue jay	0.03	2.99	100.00	0.00	0.000
cedar waxwing	0.05	2.40	75.00	0.00	0.000
clay-coloured sparrow	0.06	2.99	20.00	0.00	0.000
unidentified corvid	0.03	2.99	60.00	0.00	0.000
unidentified dabbler	0.51	1.80	70.59	0.00	0.000
unidentified duck	0.98	7.19	71.60	0.00	0.000
eastern kingbird	0.13	5.39	40.91	0.00	0.000
European starling	3.34	12.57	24.01	0.00	0.000
great blue heron	0.01	0.60	100.00	0.00	0.000
green-winged teal	0.09	1.20	26.67	0.00	0.000
hairy woodpecker	0.01	1.20	50.00	0.00	0.000
horned lark	0.46	3.59	76.71	0.00	0.000
killdeer	0.10	2.40	47.06	0.00	0.000
Lapland longspur	0.41	2.99	92.75	0.00	0.000

Table 35: Mean Collision Risk Index by Species: Fall 2016 - Halkirk 2

Species[a]	Mean Use	Frequency (%)	Birds Flying (%)	Flying Within RSH (%)	Collision Risk Index
mourning dove	0.07	4.19	60.00	0.00	0.000
northern flicker	0.03	2.99	66.67	0.00	0.000
northern harrier	0.30	23.95	87.76	0.00	0.000
northern pintail	0.25	2.99	80.95	0.00	0.000
northern shoveler	0.02	0.60	100.00	0.00	0.000
pileated woodpecker	0.03	2.99	100.00	0.00	0.000
pine siskin	0.02	0.60	100.00	0.00	0.000
prairie falcon	0.01	0.60	100.00	0.00	0.000
unidentified raptor	0.03	1.80	100.00	80.00	0.000
rock dove	0.84	9.58	87.94	0.00	0.000
rough-legged hawk	0.04	3.59	66.67	25.00	0.000
savannah sparrow	0.04	2.99	60.00	0.00	0.000
sharp-shinned hawk	0.01	1.20	50.00	0.00	0.000
sharp-tailed grouse	0.02	0.60	100.00	0.00	0.000
unidentified sparrow	0.63	26.35	61.22	0.00	0.000
unidentified teal	0.06	1.20	90.00	0.00	0.000
unidentified tern	0.01	0.60	100.00	0.00	0.000
tree swallow	0.02	1.80	100.00	0.00	0.000
tundra swan	0.01	0.60	100.00	0.00	0.000
turkey vulture	0.01	0.60	100.00	0.00	0.000
vesper sparrow	0.14	7.78	60.87	0.00	0.000
western meadowlark	0.09	7.19	11.11	0.00	0.000
yellow-headed blackbird	0.09	1.20	100.00	0.00	0.000
unidentified yellowlegs	0.02	1.20	75.00	0.00	0.000
All Species Combined	**69.92**	**99.40**	**72.46**	**49.43**	**24.896**

[a] Species in *italics* and **bold** = provincially (ASRD 2012) or federally listed by SARA (COSEWIC 2016).

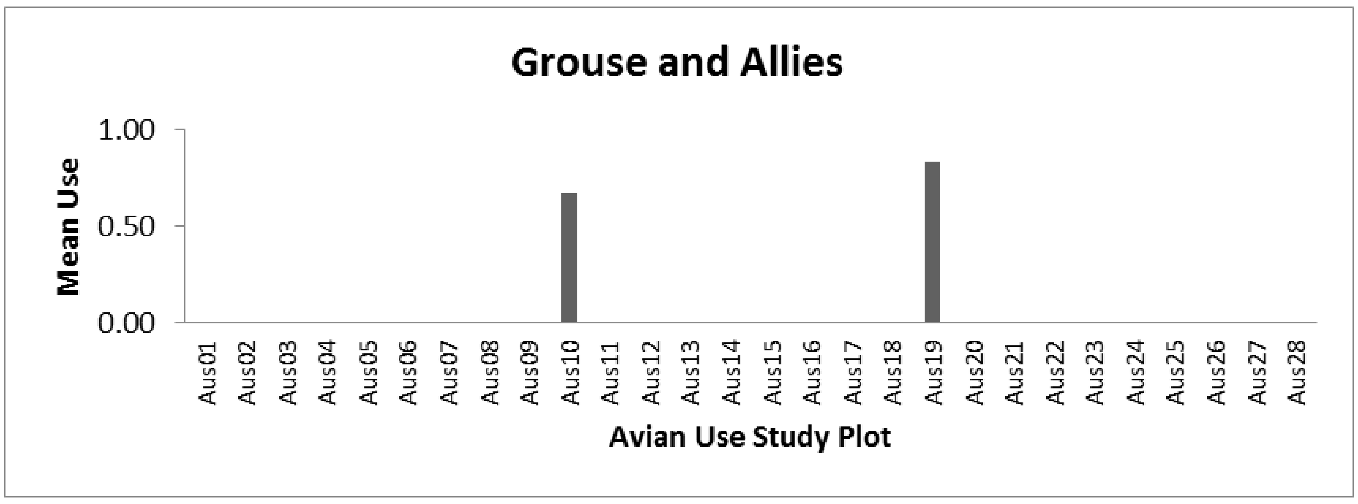
4.9.3.4 Spatial Use

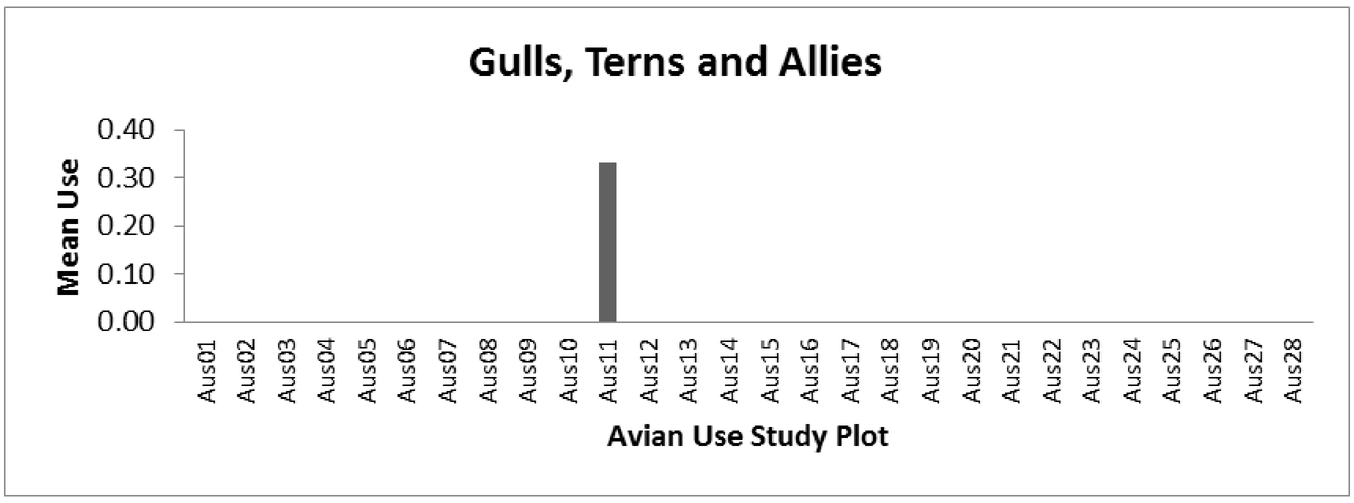
Passerines were observed at all AUS plots during the fall migration (Figure 15). Plots AUS 11 and AUS 20 had the highest relative use compared to all other AUS plots (Figure 15). This was primarily due to relatively high numbers of observed waterfowl at both plot locations as compared to all other AUS plots.

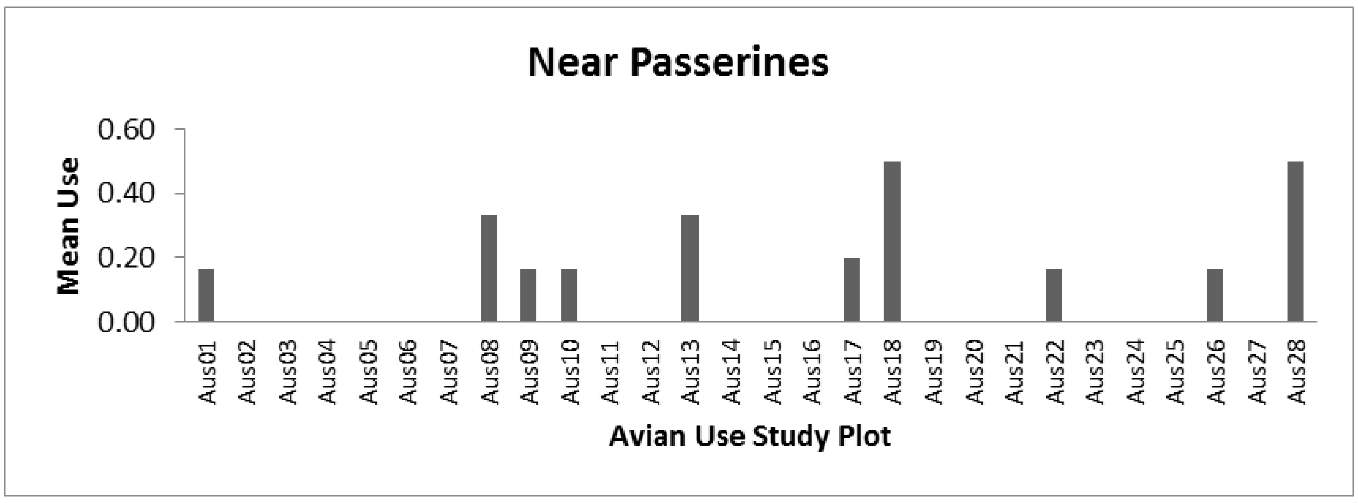
Waterfowl were observed in highest numbers at AUS 11 (180.67 individuals/AUS plot visit) compared to other AUS plots, but AUS 20 and AUS 27 also had relatively high numbers. The large number of waterfowl observed at AUS 11 was primarily due to two large flocks of greater white-fronted geese.

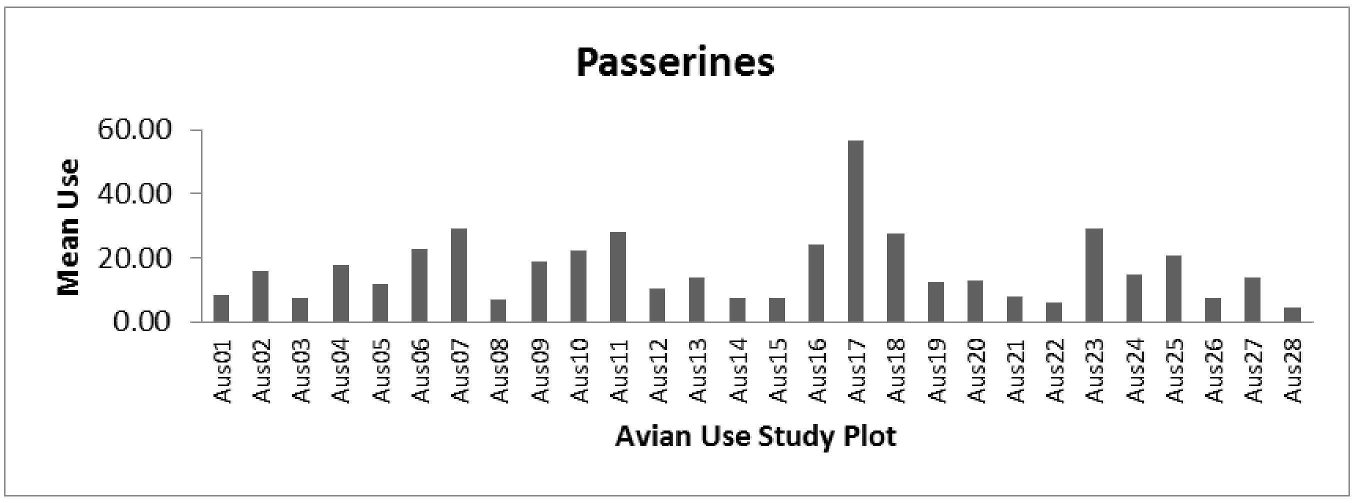
Passerines were observed in relatively high numbers at AUS 17, compared to other AUS plots (Figure 15). The reason for this large number of passerines observed at plot AUS 17 (56.80 individuals/AUS plot visit) is primarily one large flock of European starlings.

Figure 15: Mean Use by Avian Use Study Plot: Fall 2016 – Halkirk 2









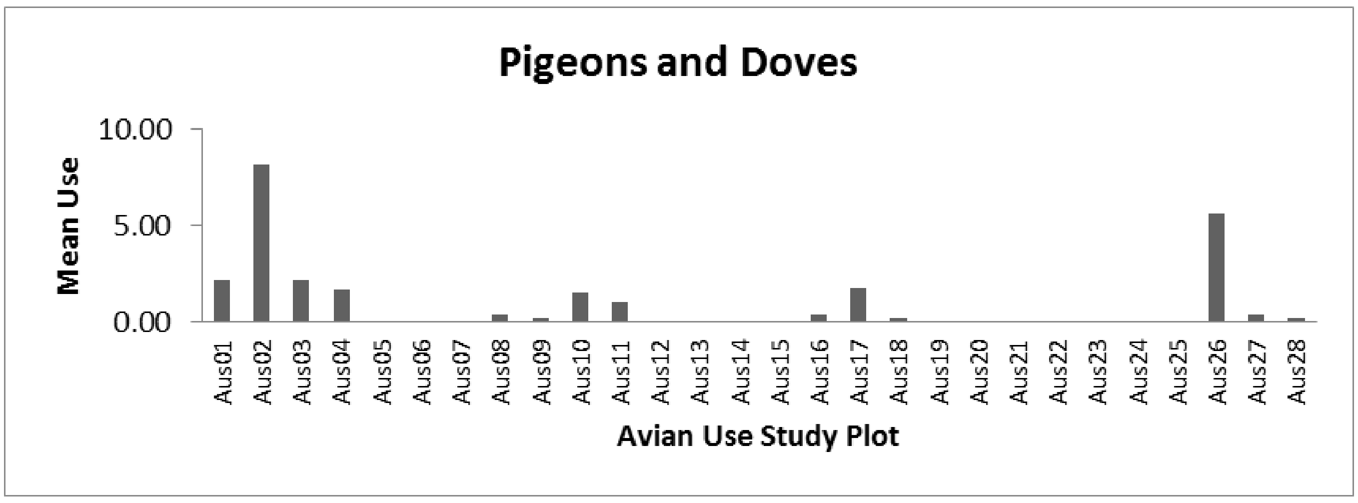
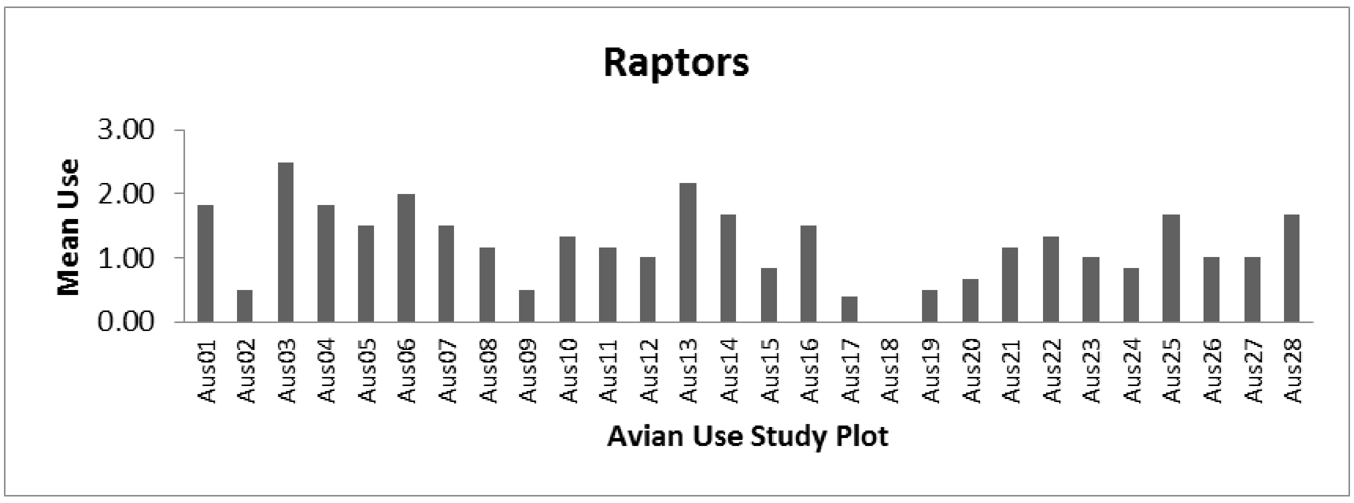
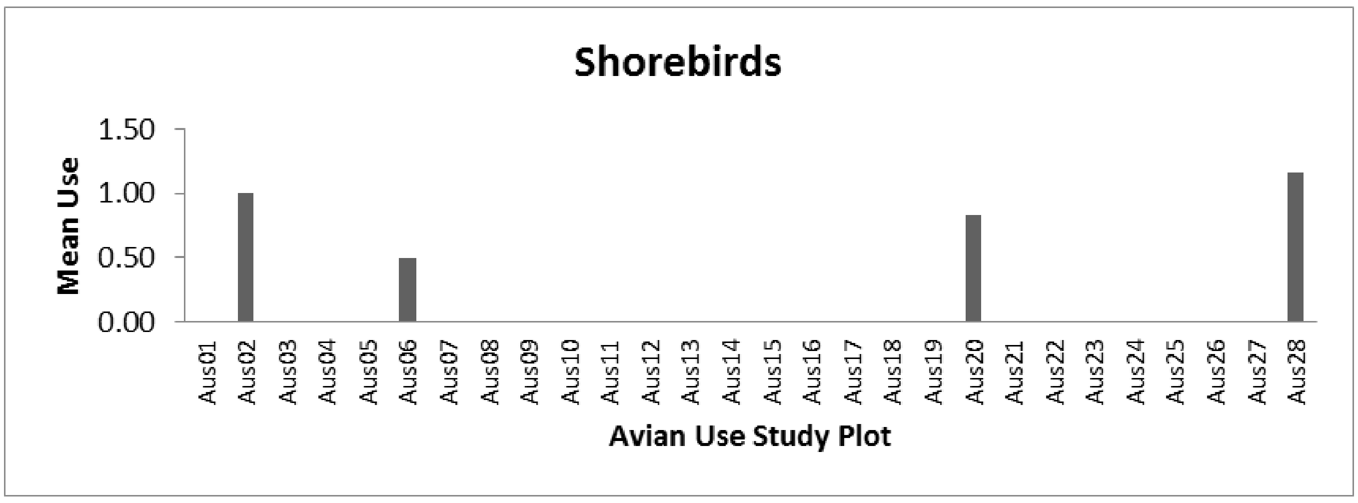
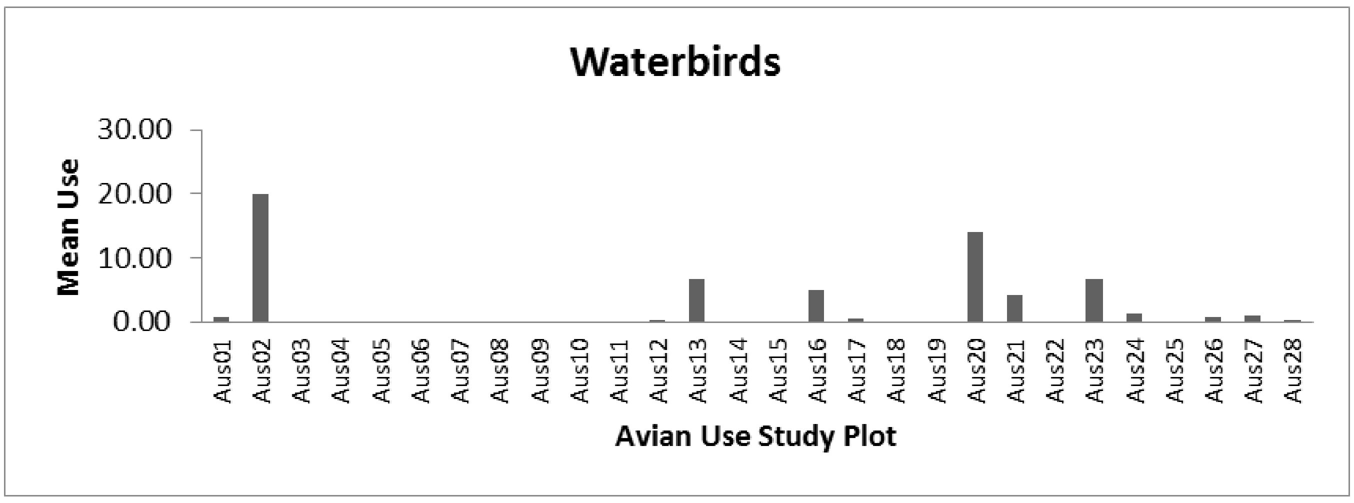
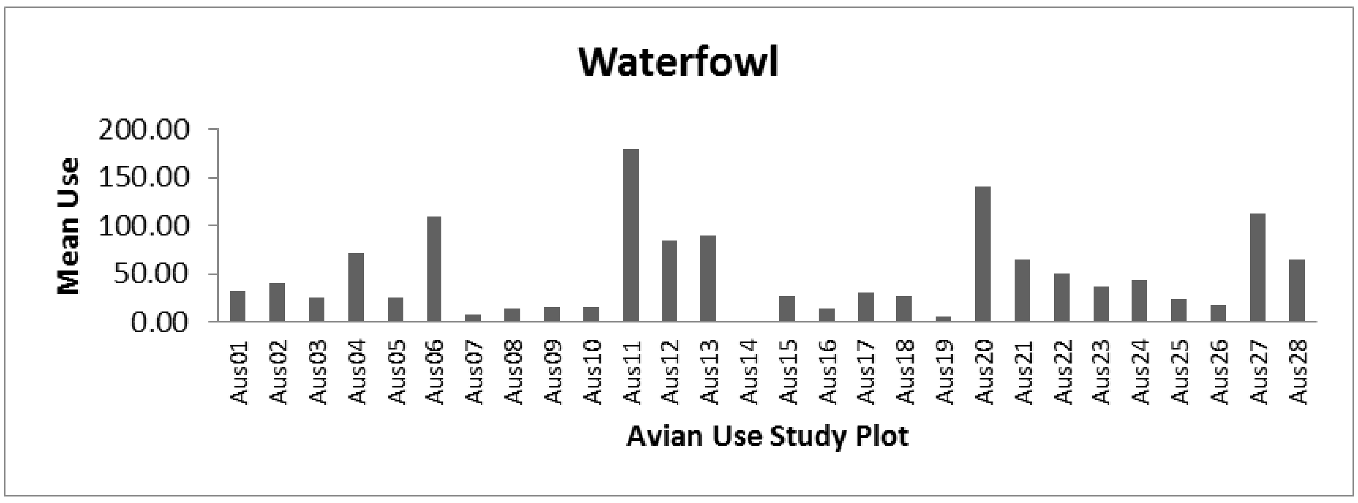


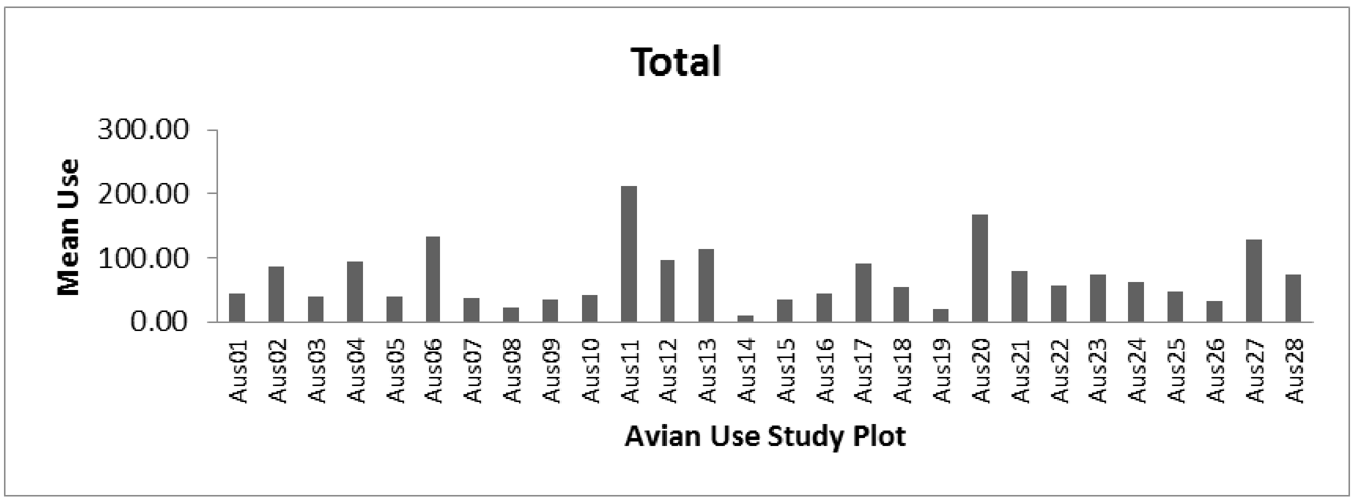
Figure 15: Mean Use by Avian Use Study Plot: Fall 2016 – Halkirk 2 (continued)











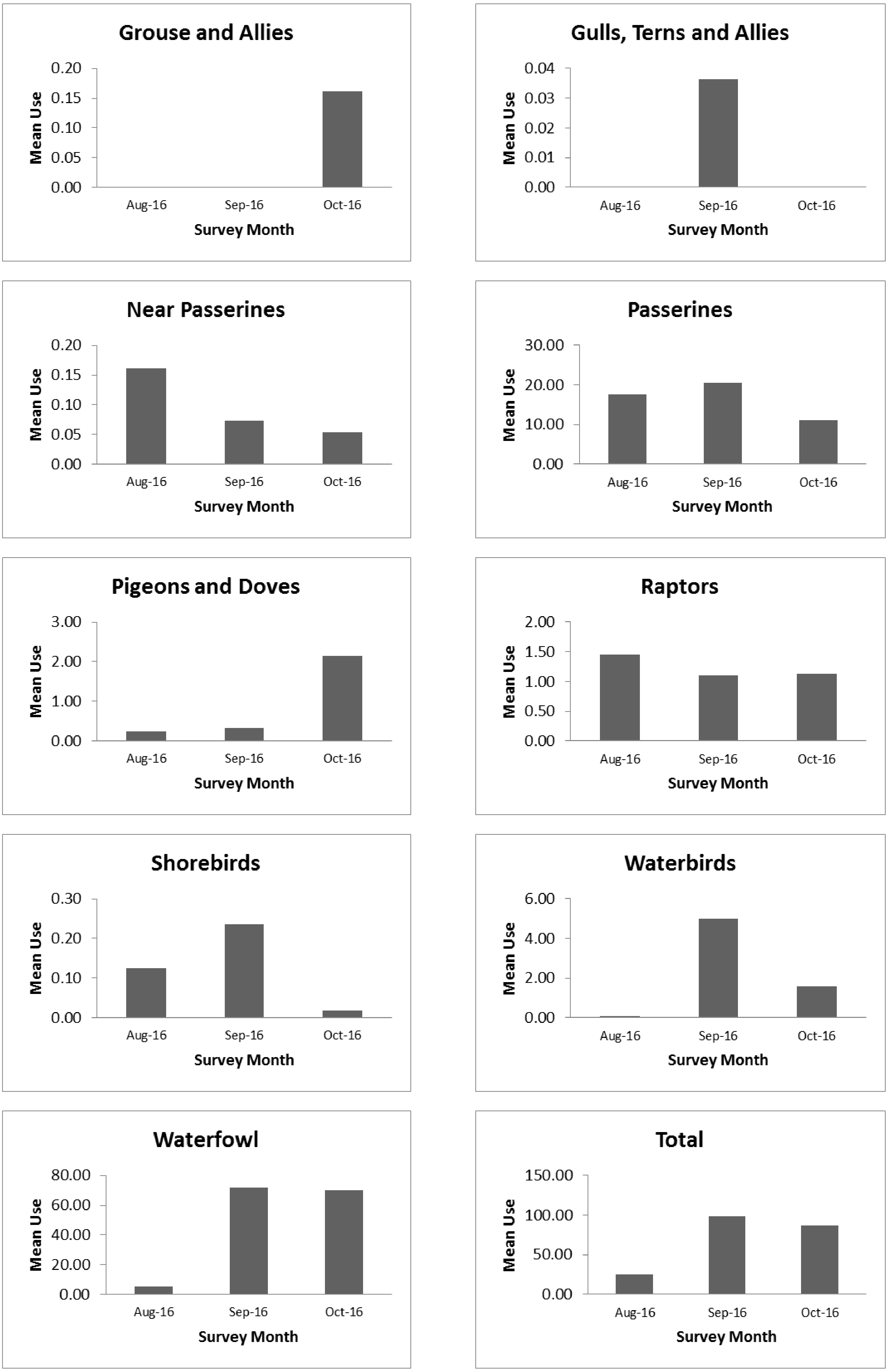
4.9.3.5 Temporal Use

Near passerines, passerines, and raptors, all show a decline in relative plot use over the fall migration season (Figure 16). However, waterfowl show an increase in relative plot use over the fall migration season, peaking in September 2016 (71.69 individuals/AUS plot visit). This high number of relative plot use by waterfowl is the primary contributor to the high relative plot use overall in September and October 2016 (98.91 individuals/AUS plot visit and 86.55 individuals/AUS plot visit, respectively), which corresponds to the latter half of the fall bird migration season (Figure 16).

4.10 Incidental Observations

All incidental wildlife sightings were noted during each wildlife survey. Incidental wildlife observations of species of special concern made within the Project Area are presented in Table A-1 in Appendix A.

Figure 16: Avian Mean Use by Survey Date: Fall 2016 – Halkirk 2



5.0 SPECIES OF SPECIAL CONCERN

Following field data collection, observations of provincially and federally listed species found during the 2016 wildlife surveys were summarized. The results of a FWMIS search within a 2 km buffer of the Project Area were used to provide additional listed species records. Species of special concern with the potential to occur in the Project Area, but which were not confirmed during field surveys or the FWMIS search, were also compiled and are presented in Table A-1 in Appendix A. The list of potential species is not exhaustive, but highlights species that might occasionally occur within the Project Area based on breeding ranges or migratory potential (COSEWIC 2012; COSEWIC 2013; Engley and Norton 2001; Russell and Bauer 2000; Scobie 2002; FAN 2007; Smith 1993).

6.0 SUMMARY

6.1 Wildlife Database Review

The Project Area falls within a sharp-tailed grouse range and sensitive raptor range for prairie falcon. Fourteen bird species of concern (including raptors) and one mammal species of concern (Franklin's ground squirrel) have been observed historically within the Project Area and 2 km buffer.

6.2 Winter Bird Survey

During the winter bird surveys conducted in 2016 on January 21 and 22 and February 24, 25 and 26, 473 individual birds and 11 species were observed. The most common species observed were common redpoll, black-billed magpie and Canada goose.

6.3 Sharp-tailed Grouse Survey

One lek was found during the sharp-tailed grouse survey conducted on May 11, 2016. The lek was found outside the Project Area, and the associated 500 m setback does not overlap with Project Area (12 U 443071E 5807268N).

6.4 Richardson's Ground Squirrel Survey

The Richardson's ground squirrel survey was conducted between April 16 and 19, 2016. Richardson's ground squirrels were observed at 18 of 27 plots. A total of 64 individuals were observed in the cultivated cropland, hayland, modified pasture, and native pasture habitat types.

6.5 Spring Bat Migration Study

Bat activity monitoring was conducted in the Project Area in 2016 from April 28 or 29 through June 9, 10, 11 or 12 to monitor the peak spring migration period for bats, as per the recommendations outlined in Lausen et al. (2008). Eight bat detectors were deployed at six locations in the Project Area.

Overall bat activity levels recorded within the Project Area were low (1.89 bat passes/detector night) compared to levels recorded at other wind power facilities in southern Alberta (i.e., 0.78 to 14.81 bat passes/detector night; Baerwald and Barclay 2009).

Results indicate that multiple bat species passed through, and/or used the Project Area. Four species of bats were positively identified, including big brown bat, silver-haired bat, hoary bat, and red bat, the latter three of which are listed provincially as "sensitive" based on their susceptibility to mortality associated with wind power facilities (ASRD 2012). Because echolocation calls could not always be positively identified to the species level, an additional five species groups were identified including: big brown/silver-haired, *Myotis* species, high frequency, low frequency, and unknown bats. Bats in the low frequency and big brown/silver-haired species groups were the most commonly detected categories or species during the spring migration monitoring period.

Bat activity varied throughout the monitoring period with three identified bat detection peaks occurring on May 17, May 23, and May 26, 2016. During these peaks in detection, the most common species were hoary bats and “low frequency” bats (which may include hoary bat, silver-haired bat, and/or big brown bat).

Migratory species such as silver-haired, hoary and red bats are the species primarily involved in fatalities associated with wind power facilities in Alberta (Lausen et al. 2008). Overall, 10.8% of bat passes were identified as hoary bats, 5.3% as silver-haired bats, and 0.6% as red bats. Bat activity levels were found to be lowest at raised detectors compared to corresponding paired detectors at ground level. The AEP Bat Mitigation Framework (ESRD 2013c) indicates that migratory bat species are more frequently killed by wind power developments in Alberta during fall migration.

6.6 Fall Bat Migration Study

Bat activity monitoring was conducted in 2016 in the Project Area from July 13 or 14 through October 16 to monitor the peak fall migration period for bats, as per the recommendations outlined in Lausen et al. (2008). Eight bat detectors were deployed at six locations in the Project Area, including two detectors raised to a height of 30 m and each paired with a ground-level detector.

Overall bat activity levels recorded within the Project Area were in the low range (3.66 bat passes/detector night) compared to levels recorded at other wind power facilities in southern Alberta (i.e., 0.78 to 14.81 bat passes/detector night; Baerwald and Barclay 2009).

Results indicate that multiple bat species passed through, and/or utilize the Project Area. Four species of bats were positively identified, including big brown bat, silver-haired bat, hoary bat, and red bat, the latter three of which are listed provincially as “sensitive” based on their susceptibility to mortality associated with wind power facilities (ASRD 2012). Because echolocation calls could not always be positively identifying to the species level, an additional five species groups were identified including: big brown/silver haired, Myotis, high frequency, low frequency and unknown bats. Bats in the high frequency species group and silver-haired bats were the most commonly detected categories during the fall migration monitoring period.

Bat activity varied throughout the monitoring period, with peaks in detection identified on July 22, 24, and 29, 2016. During these peaks in detection, the most common species were high frequency bats (which may include various species of *Myotis* and red bat) and low frequency bats (which may include hoary bat, silver-haired bat, and/or big brown bat).

Migratory species such as silver-haired, hoary and red bats are the species primarily involved in fatalities associated with wind power facilities in Alberta (Lausen et al. 2008). About 6.5% of bat passes were identified as silver-haired bats, 5.1% as hoary bats, and 1.3% as red bats. Following the approach recommended in the AEP *Bat Mitigation Framework* (ESRD 2013c), an estimated 168 migratory bat passes, or 2.75 bat passes/detector night were detected at the detectors deployed at a 30 m height. Consequently, the Project Area is rated as having “potentially high risk” of bat fatalities (ESRD 2013c) based on the framework’s classification because the migratory bat activity documented within the Project Area is greater than 2 migratory bat passes/detector night. Bat detectors located in closest proximity to the Battle River and associated draws and coulees and to the Paintearth Creek and associated coulees, which contain a tributary to the Battle River, had the highest migratory bat activity levels. It is anticipated that proximity to these habitat features contributes to the higher levels of bat activity recorded during the fall migration monitoring.

6.7 Raptor Nest Survey

A raptor nest search of the Project Area and a 1 km buffer of the Project Area was conducted in 2016 in conjunction with rounds one and two of the BBS during June 7-12 and June 21-24, 26, 28. Active nests found included four red-tailed hawk nests, and two Swainson’s hawk nests. Eight other active raptor nests were incidentally observed during 2016 wildlife surveys. These were an additional seven red-tailed hawk nests, and one Swainson’s hawk nest.

6.8 Breeding Bird Survey

During the BBS, completed in 2016 on June 7-12 and June 21-24, 26, 28. 2,375 individual birds of 78 species were observed. The most common species observed were clay coloured sparrow, savannah sparrow and red-winged blackbird, sparrow, red-winged blackbird.

6.9 Avian Use Study

6.9.1 Spring

During the 2016 spring AUS, 84 avian species were observed, and the most common species groups observed were waterfowl and waterbirds. Of the twenty-eight AUS plots, the plots with the largest numbers of birds observed were AUS 20, AUS 21, AUS 14 and AUS 11.

Plots AUS 20 and AUS 21 are located in the west section of the Project Area. Both plots consisted primarily of waterfowl. The most abundant species observed at AUS 20 and AUS 21 was snow goose which is a species common to the region during migration. The high relative numbers of individuals observed at both of these plots were primarily due to the high numbers of waterfowl observed. Waterfowl were mostly observed using the cultivated cropland as a staging area at this two plots. These staging areas resulted in a relatively larger number of birds observed compared to other AUS plots.

Plot AUS 11 is located in the southwest section of the Project Area and consisted primarily of waterfowl. The most abundant species observed was Canada goose. Waterfowl were mostly observed using a dugout and cultivated cropland as a staging area. This staging area resulted in a relatively larger number of birds observed compared to most other AUS plots.

Plot AUS 14 is located in the southwest section of the Project Area. Plot AUS 14 consisted primarily of passerines and the most abundant species observed was snow bunting. No obvious habitat or topographical features at AUS 14 suggest a reason for the relatively larger numbers of birds observed compared to most other AUS plots.

The high relative numbers of individuals observed at AUS 20, AUS 21, and AUS 11 were primarily due to high numbers of waterfowl. One reason for the relatively large number of birds observed compared to other AUS plots was due to waterfowl staging areas at AUS 11, AUS 20, and AUS 06. Species observed in the spring included high numbers snow goose, Canada goose, and snow bunting. All three of these species are common to the region during migration.

6.9.2 Summer

During the 2016 summer AUS, 68 avian species were observed, and the most common species groups observed were passerines and raptors. The largest numbers of birds observed were at plots AUS 28, AUS 10, and AUS 27.

Plots AUS 27 is located in the northeast section of the Project Area. Observation at this plot consisted primarily of passerines. The most abundant species observed at AUS 27 were red-winged blackbirds. These individuals were observed in the wetlands with extensive cattails within this plot. This wetland habitat with extensive cattails resulted in a relatively larger number of birds observed compared to other AUS plots.

Plot AUS 28 is located in the northeast section of the Project Area and observations at this plot consisted primarily of passerines. The most abundant species was cliff swallow. The relatively larger number of birds observed compared to most other AUS plots was due to a breeding colony of cliff swallows present under a bridge in this plot.

Plot AUS 10 is located in the northwest section of the Project Area. The high relative numbers of individuals observed at this plot was primarily due to the high numbers of passerine species observed. Many unidentified blackbird species were observed at AUS 10. No obvious habitat or topographical features at these plots suggest a reason for the relatively larger numbers of birds observed compared to most other AUS plots.

The high relative numbers of individuals observed at AUS 28, AUS 10, and AUS 27 were primarily due to high numbers of passerines. One reason for the relatively large number of birds observed compared to other AUS plots was due to wetland habitat at AUS 27 and a cliff swallow breeding colony at AUS 28. Species observed in the summer included high numbers red-winged blackbirds, cliff swallows, and other blackbird species. All three of these are common to the region during migration.

6.9.3 Fall

During the 2016 fall AUS, 68 avian species were observed, and the most common species groups observed were waterfowl and passerines. The plots with the largest numbers of birds observed were AUS 11, AUS 20, AUS 06, AUS 27, and AUS 13.

Plot AUS 11 is located in the southwest section of the Project Area and observations at this plot consisted primarily of waterfowl. Greater white-fronted goose and Canada goose were the most abundant species observed at this plot. Waterfowl were mostly observed using a dugout and cultivated cropland as a staging area. This staging area resulted in a relatively larger number of birds observed compared to other AUS plots.

Plot AUS 13 is located in the southwest section of the Project Area and observations at this plot consisted primarily of waterfowl. Greater white-fronted goose and Canada goose were the most abundant species observed at this plot. This plot was located at the bottom of a coulee and many waterfowl were observed flying through the plot. This coulee feature resulted in a relatively larger numbers of birds observed compared to most other AUS plots.

Plot AUS 20 is located centrally in the Project Area and observations at this plot consisted primarily of waterfowl. The most abundant species observed at this plot were snow goose and greater white-fronted goose. Waterfowl were mostly observed using the cultivated cropland as a staging area. This staging area resulted in a relatively larger number of birds observed compared to most other AUS plots.

Plots AUS 06 is located in the northeast section of the Project Area and observations at this plot consisted primarily of waterfowl. The most abundant species at this plot was greater white-fronted goose. Waterfowl were observed using cultivated cropland as a staging area. This plot is also located overlooking a coulee where a number of birds in flight were observed. This coulee and staging area resulted in a relatively larger number of birds observed compared to most other AUS plots.

AUS 27 is located in the northeast section of the Project Area and observations at this plot primarily consisted of waterfowl. The most abundant species at plot AUS 27 was snow goose. No obvious habitat or topographical features at these plots suggest a reason for the relatively larger numbers of birds observed compared to most other AUS plots.

The high relative numbers of individuals observed at AUS 11, AUS 20, AUS 06, AUS 27 and AUS 13 were primarily due to high numbers of waterfowl. The relatively larger number of birds observed compared to other AUS plots was due to waterfowl staging areas at AUS 11, AUS 20, AUS 06 and waterfowl flying through coulees at AUS 13 and AUS 06. Waterfowl observed included high numbers Canada goose, greater-white fronted goose and snow goose. All three of these species are common to the region during migration.

7.0 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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https://golderassociates.sharepoint.com/sites/10018g/multiple user/master_ee_working_file/appendices/appendix_e_wildlife_baseline/1543760_halkirk2_wildlife_baseline.docx

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APPENDIX A

Historical and Incidental Wildlife Observations

Taxonomic Group	Common Name	Latin Name	Provincial Status[(a)]	Federal Status – Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[(b)]	*Species at Risk Act* Registry[(c)]	Associated Habitat	Historical Observation in Project Area[(d)]	Observed During 2016 Field Surveys [(e)]
Amphibian / Reptiles	plains garter snake	*Thamnophis radix*	Sensitive	-	-	Near wetlands in prairie and farmland areas, dispersing into adjacent terrestrial habitat	No	Yes
	red-sided garter snake	*Thamnophis sirtalis*	Sensitive	-	-	Margins of wetlands, rivers and other bodies of water.	No	No
	western toad	*Anaxyrus boreas*	Sensitive	Not Active	Schedule 1: Special Concern	Permanent waterbodies	No	No
Birds	American bittern (f)	*Botaurus lentiginosus*	Sensitive	-	-	In marshes where it hides in grasses	No	No
	American green-winged teal	*Anas crecca*	Sensitive	-	-	Shallow marshes, flooded fields or on mudflats	Yes	Yes
	American kestrel	*Falco sparverius*	Sensitive	-	-	Open areas with short ground vegetation and sparse trees	Yes	Yes
	American white pelican	*Pelecanus erythrorhynchos*	Sensitive	Not At Risk	-	Roosts on sandbars and small low islands	No	Yes
	Baird's sparrow	Ammodramus bairdii	Sensitive	Special Concern	-	Breeds in native mixed-grass and fescue prairie. Some hayfield or pastures.	No	Yes
	bald eagle	*Haliaeetus leucocephalus*	Sensitive	Not At Risk	-	Usually nests near tree-lined fish-bearing lakes and rivers	Yes	Yes
	Baltimore oriole	*Icterus galbula*	Sensitive	-	-	Open woodland, forest edge, river banks, and small groves of trees.	No	No
	barn swallow	*Hirundo rustica*	Sensitive	Threatened	-	Open areas including agricultural fields, over open water such as lakes and ponds.	Yes	Yes
	bay-breasted warbler (f)	Setophaga castanea	Sensitive	-	-	Breeds in boreal spruce and fir forest	No	
	black tern	*Chlidonias niger*	Sensitive	Not At Risk	-	Nests on marshy ponds	No	Yes
	black-crowned night heron	*Nycticorax nycticorax*	Sensitive	-	-	Wetlands	No	No
	black-necked stilt	Himantopus mexicanus	Sensitive	-	-	Flooded lowlands, or shallow lagoons. Human-maintained wetlands such as sewage ponds or flooded pastures.	No	No
	black-throated green warbler(f)	Setophaga virens	Sensitive	-	-	Boreal coniferous forest and transitional coniferous-deciduous forest	No	No
	bobolink	Dolichonyx oryzivorus	Sensitive	Threatened	-	Large fields with a mixture of grasses and broad-leaved plants, hayfields and meadows.	No	No
	Brewer's sparrow	Spizella breweri	Sensitive	-	-	Depend almost exclusively on the sagebrush ecosystem when breeding.	No	No
	broad-winged hawk(f)	*Buteo platypterus*	Sensitive	-	-	Nest in tall trees	No	Yes
	brown creeper	*Certhia americana*	Sensitive	-	-	Mature coniferous forests	No	No
	Canada warbler(f)	*Wilsonia canadensis*	Sensitive	Threatened	Schedule 1: Threatened	Thick stands of willow and alder along streams and dense shrubs and bushes in swamps near the forest edge	No	No
	Cape May warbler(f)	*Dendroica tigrina*	Sensitive	-	-	Mature coniferous forests where spruce budworms are abundant	No	No
	caspian tern	*Sterna caspia*	Sensitive	Not At Risk	-	Permanent waterbodies and wetlands	No	No
	common nighthawk	*Chordeiles minor*	Sensitive	Threatened	Schedule 1: Threatened	Open or semi-open areas in a variety of areas	No	No
	common yellowthroat	*Geothlypis trichas*	Sensitive	-	-	Marshes, streamside thickets, wet meadows and other wetlands	Yes	Yes
	eastern phoebe	*Sayornis phoebe*	Sensitive	-	-	Found along streams or man-made structures	No	Yes
	Forster's tern	*Sterna forsteri*	Sensitive	Data Deficient	-	Open water and in marshes	No	No
	golden eagle	*Aquila chrysaetos*	Sensitive	Not At Risk	-	Usually in mountainous areas near bogs or cliff edges	No	Yes
	great blue heron	*Ardea herodias*	Sensitive	-	-	Fish-bearing inland waterbodies	No	Yes
	great gray owl	*Strix nebulosa*	Sensitive	Not At Risk	-	Coniferous, deciduous and mixedwood areas, usually near muskegs, marshes and wet meadows	No	No
	great-crested flycatcher	*Myiarchus crinitus*	Sensitive	-	-	Deciduous, mixedwood areas and edge of clearings	No	No
	horned grebe	*Podiceps auritus*	Sensitive	Special Concern	-	Nests on marshy ponds and winters on deep open water	No	No
	least flycatcher	*Empidonax minimus*	Sensitive	-	-	Semi-open woodlands, orchards and shrubby fields	Yes	Yes
	lesser scaup	*Aythya affinis*	Sensitive	-	-	Lakes and ponds	No	Yes
	loggerhead shrike (Prairie population)	*Lanius ludovicianus excubitorides*	Sensitive	Threatened	Schedule 1: Threatened	Open habitat including;: grasslands, sagebrush stands, pastures, agricultural area and thinly wooded areas with small trees	No	Yes
	northern goshawk	*Accipiter gentilis*	Sensitive	Not At Risk	-	In forests where clearings or wetlands provide open areas	No	No
	northern harrier	*Circus cyaneus*	Sensitive	Not At Risk	-	Open fields, savannas, meadows and marshes	Yes	Yes
	northern pintail	*Anas acuta*	Sensitive	-	-	Freshwater ponds and marshes	No	Yes
	olive-sided flycatcher(d)	Contopus cooperi	May Be At Risk	Threatened	Schedule 1: Threatened	Coniferous forests, at forest edges and openings, such as meadows and ponds.	No	No

Taxonomic Group	Common Name	Latin Name	Provincial Status[a]	Federal Status – Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[b]	*Species at Risk Act* Registry[c]	Associated Habitat	Historical Observation in Project Area[d]	Observed During 2016 Field Surveys [e]
	osprey	*Pandion haliaetus*	Sensitive	-	-	Usually nests near tree-lined fish-bearing lakes and rivers	No	No
	peregrine falcon	*Falco peregrinus*	At Risk	Special Concern	Schedule 1: Special Concern	Nests on cliff edges or man-made structures	No	No
	pied-billed grebe	*Podilymbus podiceps*	Sensitive	-	-	On ponds, bays and other open water close to aquatic vegatation	No	Yes
	pileated woodpecker	*Drycopus pileatus*	Sensitive	-	-	Older, mature dense canopy forest, mixed and deciduous woods with large dead and dying trees	Yes	Yes
	piping plover	Charadrius melodus	At Risk	Endangered	Schedule 1: Endangered		No	No
	prairie falcon	Falco mexicanus	Sensitive	Not At Risk	-	Breeding habitats include grasslands, shrubsteppe desert, areas of mixed shrubs and grasslands that supports abundant ground squirrel or pika populations.	No	Yes
	purple martin	Progne subis	Sensitive	-	-	Forage over towns, cities, parks, open fields, dunes, streams, wet meadows, beaver ponds, and other open areas	No	No
	red knot(f)	Calidris canutus	May Be At Risk	Endangered	Schedule 1: Endangered	Breeds in drier tundra areas, such as sparsely vegetated hillsides	No	No
	rusty blackbird (f)	*Euphagus carolinus*	Sensitive	Special Concern	Schedule 1: Special Concern	Nests in trees near bogs within boreal forests	No	No
	sandhill crane	*Grus canadensis*	Sensitive	-	-	Nests in open meadows and winters in marshes or farmland	Yes	Yes
	sedge wren	*Cistothorus plantensis*	Sensitive	Not At Risk	-	Nests in dense tall sedges and grasses in wet meadow, hayfields, and marshes	No	No
	sharp-tailed grouse	*Tympanuchus phasianellus*	Sensitive	-	-	Aspen parklands, open grasslands or brushlands	Yes	Yes
	short-eared owl	*Asio flammeus*	May Be At Risk	Special Concern	Schedule 1: Special Concern	Roosts on the ground among weeds and grass	No	Yes
	sora	*Porzana caroline*	Sensitive	-	-	Wetlands	Yes	Yes
	Sprague's pipit	*Anthus spragueii*	Sensitive	Threatened	Schedule 1: Threatened	Large blocks of native grassland and native pasture	Yes	Yes
	Swainson's hawk	*Buteo swainsoni*	Sensitive	-	-	Grasslands in open country	Yes	Yes
	trumpeter swan	*Cygnus buccinator*	At Risk	Not At Risk	-	Small to medium size shallow lakes	No	No
	upland sandpiper	*Bartramia longicauda*	Sensitive	-	-	Grassy fields with open patches	No	Yes
	western grebe	*Aechmophorus occidentalis*	Sensitive	Special Concern	-	Nests on lakes with marshy vegetation and winters on open lakes	No	No
	western tanager	*Piranga ludoviciana*	Sensitive	-	-	Open coniferous and mixedwood forests	No	No
	western wood-pewee	*Contopus sordidulus*	Sensitive	-	-	Open woodlands, along forest edges and in riparian woodlands	No	No
	white-faced ibis(d)	Plegadis chihi	Sensitive	-	-	Freshwater wetlands dominated by cattail and bulrush	No	No
	white-winged scoter	*Melanitta fusca*	Sensitive	-	-	Nests on ground in dense tangled vegetation or in spruce woods	No	No
	whooping crane	*Grus americana*	At Risk	Endangered	Schedule 1: Endangered	Breeds in freshwater marshes and prairies	No	No

Historical Wildlife Species of Concern With the Potential to Occur in the Project Area and Wildlife Species of Concern Incidentally Observed During the 2016 Field Surveys

Taxonomic Group	Common Name	Latin Name	Provincial Status[a]	Federal Status – Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[b]	*Species at Risk Act* Registry[c]	Associated Habitat	Historical Observation in Project Area[d]	Observed During 2016 Field Surveys [e]
Mammals	American Badger	*Taxidea taxus*	Sensitive	Special Concern	-	Non-forested grasslands	No	No
	Franklin's ground squirrel	*Spermophilus franklinii*	Undetermined	-	-	grassland	Yes	No
	hoary bat	*Lasiurus cinereus*	Sensitive	-	-	High forest cover, appear to prefer coniferous stands	No	Yes
	little brown myotis	Myotis lucifugus	Secure	Endangered	Schedule 1: Endangered	Forested areas, rocky outcrops	No	No
	long-legged bat	Myotis volans	Undetermined	-	-	Forested areas, rocky outcrops	No	No
	northern myotis	Myotis septentrionalis	May Be At Risk	Endangered	Schedule 1: Endangered	Forested areas adjacent to rocky outcrops or badland landscapes	No	No
	eastern red bat	*Lasiurus borealis*	Sensitive	-	-	Coniferous and deciduous forests and is often found near open grassy areas	No	No
	red bat	*Lasiurus borealis*	Sensitive	-	-	Forests, forest edges and hedgerows. Roosting in in deciduous or coniferous trees.		Yes
	silver-haired bat	*Lasionycteris noctivagans*	Sensitive	-	-	Forested areas	No	Yes
	thirteen-Lined Ground Squirrel	*Spermophilus tridecemlineatus*	Undetermined	-	-	grassland	No	Yes
	western small-footed bat	Myotis ciliolabrum	Sensitive	-	-	rocky outcrops or badland landscapes	No	No

(a) ASRD 2012.
(b) COSEWIC 2016.
(c) SARA 2016.
(d) AEP 2016.
(e) Observed during the 2016 field surveys.
(f) Potentially found in the Project area during spring and fall migrations
- = No status.

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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APPENDIX F

Historical Resource Act Approval

Alberta Culture and Tourism

HRA Number: 4941-16-0008-002

February 08, 2017

Historical Resources Act Approval

Proponent: Capital Power

9th Floor EPCOR Tower, 10423-101 St NW, Edmonton, AB T5H 0E9

Contact: Jeff Sansom

Agent: Golder Associates Ltd.

Contact: Vincent Balls

Project Name: **Halkirk II Wind Project (Version 10B Layout)**

Project Components: Wind Power

Application Purpose: Amendment to Project Submitted Previously

Requesting HRA Approval / Requirements

Historical Resources Act approval is granted for the activities described in this application and its attached plan(s)/sketch(es) subject to Section 31, "a person who discovers an historic resource in the course of making an excavation for a purpose other than for the purpose of seeking historic resources shall forthwith notify the Minister of the discovery." The chance discovery of historical resources is to be reported to the contacts identified within "Standard Requirements under the Historical Resources Act: Reporting the Discovery of Historic Resources."

Martina Purdon
Head, Regulatory Approvals &
Information Management

Lands Affected: Additional Lands

Proposed Development Area:

MER	RGE	TWP	SEC	LSD List
4	14	39	35	1,2,4-8,12
4	14	39	32	1,4-8
4	14	39	34	1,4-12,15,16
4	14	39	33	3-6,11-14
4	14	39	31	1,2,5-10,12-16
4	14	40	4	4,5,9-12
4	14	40	6	1-4,6,10-11,14
4	14	40	7	1-5,12

(continued)

4	14	40	8	1-8
4	14	40	3	1-4,10-12,14,15
4	14	39	25	3-14
4	14	39	30	15,16
4	14	39	27	12-14
4	14	39	36	1-4
4	13	39	31	2-4,7,10,15,16
4	14	39	26	1,3,5-9,12,13,15,16
4	14	39	28	5,6,9,12,13,16
4	15	39	26	11,13,14
4	15	39	34	1-3,5-8,10,12,13,15
4	13	40	6	1,2
4	15	39	36	8,9,13,16
4	14	40	9	5
4	14	40	10	1-3,5,6,11,12,14-16
4	15	40	3	1-7,10-12,14
4	14	40	15	3,5-12,14,15
4	15	40	2	9,10,15,16
4	15	40	9	1-3,5-8
4	15	40	1	1-8,11-15
4	15	40	4	1,8-10,13-16
4	15	40	10	3-6,12,13
4	15	40	12	2-4,6,9,11,12,14-16
4	15	40	11	1,2,8-14
4	15	39	35	2-10,16
4	14	40	5	1-4
4	14	40	11	13
4	14	39	27	15,16

Documents Attached:

Document Name	Document Type
Topo relief map	Illustrative Material

Alberta Culture and Tourism

STANDARD REQUIREMENTS UNDER THE *HISTORICAL RESOURCES ACT*: REPORTING THE DISCOVERY OF HISTORIC RESOURCES

If development proponents and/or their agents become aware of historic resources during the course of development activities, they are required, under Section 31 of the *Historical Resources Act*, to report these discoveries to the Heritage Division of Alberta Culture and Tourism. This requirement applies to all activities in the Province of Alberta.

1.0 REPORTING THE DISCOVERY OF ARCHAEOLOGICAL RESOURCES

The discovery of archaeological resources is to be reported to Eric Damkjar, Head, Archaeology, at 780-431-2346 (toll-free by first dialing 310-0000) or eric.damkjar@gov.ab.ca.

2.0 REPORTING THE DISCOVERY OF PALAEONTOLOGICAL RESOURCES

The discovery of palaeontological resources is to be reported to Dan Spivak, Head, Resource Management, Royal Tyrrell Museum of Palaeontology, at 403-820-6210 (toll-free by first dialing 310-0000) or dan.spivak@gov.ab.ca.

3.0 REPORTING THE DISCOVERY OF HISTORIC PERIOD SITES

The discovery of historic structures to be reported to Ronald Kelland, Acting Manager, Historic Places Research and Designation Program, at 780-431-2334 (toll-free by first dialing 310-0000) or ronald.kelland@gov.ab.ca. Please note that some historic structure sites may also be considered Aboriginal traditional use sites.

4.0 REPORTING THE DISCOVERY OF ABORIGINAL TRADITIONAL USE SITES

The discovery of any Aboriginal traditional use site that is of a type listed below is to be reported to Valerie Knaga, Director, Aboriginal Heritage Section, at 780-431-2371 (toll-free by first dialing 310-0000) or valerie.k.knaga@gov.ab.ca.

Aboriginal Traditional Use sites considered by Alberta Culture and Tourism to be historic resources under the *Historical Resources Act* include:

Historic cabin remains;
Historic cabins (unoccupied);
Cultural or historical community camp sites;

Ceremonial sites/Spiritual sites;
Gravesites;
Historic settlements/Homesteads;
Historic sites;
Oral history sites;
Ceremonial plant or mineral gathering sites;
Historical Trail Features; and,
Sweat/Thirst/Fasting Lodge sites

5.0 FURTHER SALVAGE, PRESERVATIVE OR PROTECTIVE MEASURES

If previously unrecorded historic resources are discovered, proponents may be ordered to undertake further salvage, preservative or protective measures or take any other actions that the Minister of Alberta Culture and Tourism considers necessary.

APPENDIX G

Post Construction Monitoring and Mitigation Plan

February 2017

POST-CONSTRUCTION MONITORING AND MITIGATION PLAN

Halkirk 2 Wind Power Project

Submitted to:
Capital Power Corporation
EPCOR Tower, Suite 1200
10423 101 Street NW
Edmonton, AB T5H0E9

REPORT

Project Number: 1543760

Golder Associates

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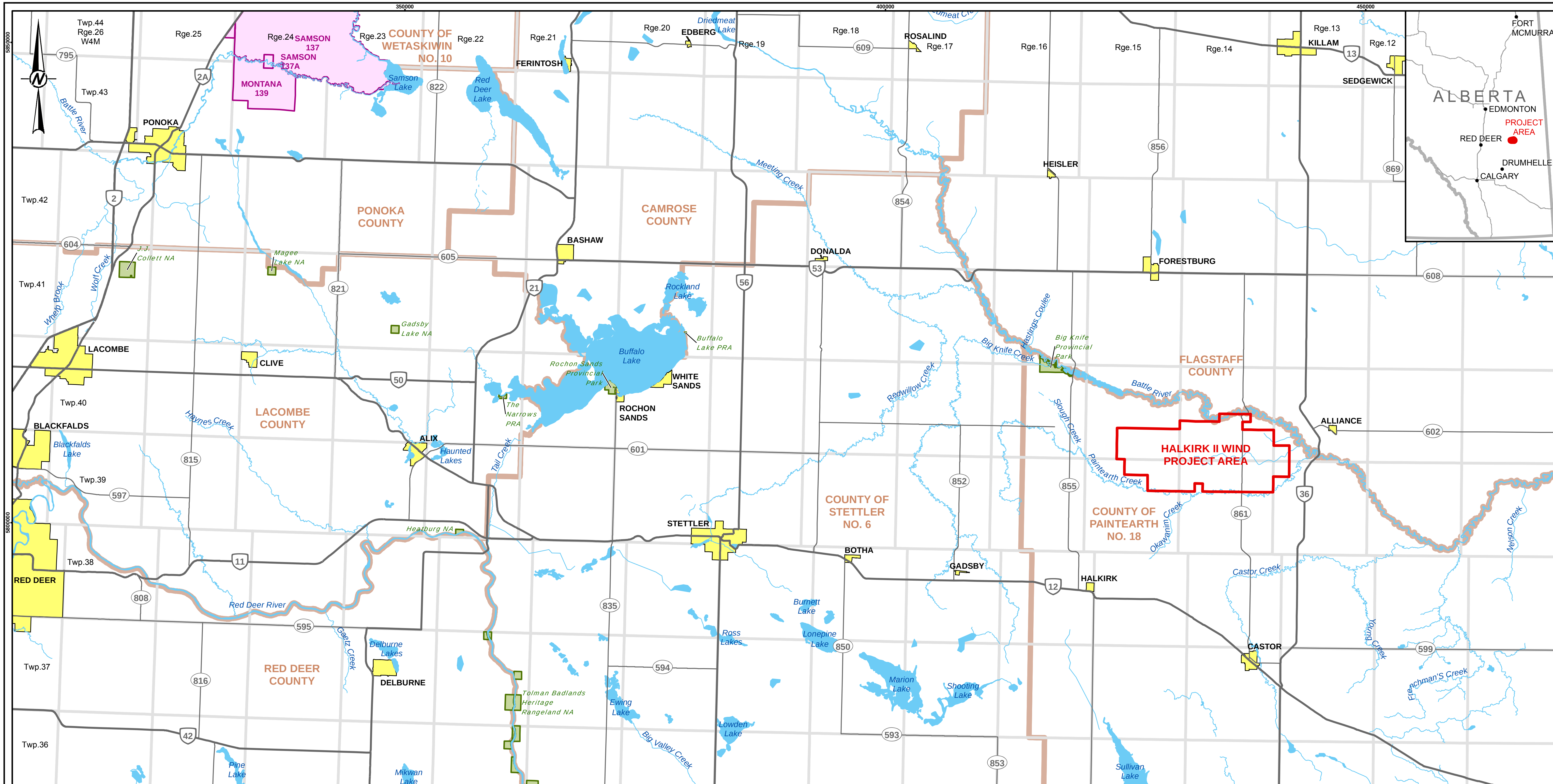
1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Capital Power Corporation (Capital Power) to prepare a Post-Construction Monitoring and Mitigation Plan (PCMMP) for their proposed Halkirk 2 Wind Power Project (the Project) located within the County of Paintearth and Flagstaff County, approximately 12 kilometres (km) northeast of Halkirk, Alberta. The Project is located within portions of Townships 39 and 40, Ranges 13, 14 and 15, W4M (Figure 1). The Project will consist of 74 Vestas V110 2.0 megawatt (MW) wind turbines, for a total installed nameplate capacity of 148 MW. The project will also include access roads, an underground electrical collector system, and a substation.

The PCMMP describes the proposed post construction monitoring activities and mitigation measures Capital Power proposes to implement during construction and operation of the Project and focuses on understanding direct impacts to birds and bats over a three-year period, as detailed within the following sections.

The PCMMP accompanies the submission of the Environmental Evaluation, as per requirements identified in *The Approach* section of the updated Alberta Environment and Parks (AEP) *Wildlife Directive for Alberta Wind Energy Projects* (the Directive), dated January 27, 2017 (AEP 2017). Ultimately, the Environmental Evaluation will support Capital Power's application to the Alberta Utilities Commission (AUC) for a permit to construct and a licence to operate the Project.

This PCMMP follows the recommendations outlined in the Directive, the Canadian Wildlife Service's (CWS's) Wind Turbines and Birds: A Guidance Document for Environmental Assessment (CWS 2007a), and the Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (CWS 2007b).



LEGEND

- PROJECT AREA
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- WATERCOURSE
- INDIAN RESERVE
- MUNICIPAL BOUNDARY
- PARK / PROTECTED AREA
- POPULATED PLACE
- WATERBODY

REFERENCE(S)

1. PARKS AND PROTECTED AREAS OBTAINED FROM ALBERTA PARKS, GOVERNMENT OF ALBERTA.
2. OTHER ALBERTA DIGITAL BASE DATA MAY BE OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED, ALTALIS LTD.© GOVERNMENT OF ALBERTA 2016. ALL RIGHTS RESERVED. OR IHS ENERGY INC.

PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-01-27
DESIGNED	CS
PREPARED	SK
REVIEWED	CS
APPROVED	JM

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

REGIONAL AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	1

2.0 POST CONSTRUCTION MONITORING

The post-construction monitoring program has been designed to document direct effects of Project operations on wildlife, primarily birds and bats, by duplicating pre-construction inventory surveys and conducting mortality searches. The post-construction monitoring program will assess the effectiveness of mitigation efforts and determine whether additional or modified mitigation measures are warranted.

Post-construction monitoring for the Project will be carried out during the first three years of Project operation, and will consist of the following:

- duplication of select pre-construction wildlife inventory surveys;
- weekly bird and bat mortality searches at one-third of the turbines (25 of the 74 turbines), between March 1 and October 30. The same plots will be used for both bird and bat mortality searches;
- three searcher efficiency trials each season (i.e., spring, summer and fall) for each search technician;
- three scavenger impact trials, equally spaced out (i.e., early, middle and late), during each season; and
- preparation and submission of annual reports that document the results of the searches and total mortality of birds and bats within the search areas.

Prior to starting the post-construction monitoring program, wildlife research and collection permits will be obtained and discussions with AEP area biologists will be completed, if necessary.

2.1 Duplication of Pre-Construction Wildlife Inventory Surveys

Select pre-construction baseline wildlife inventory surveys will be duplicated during the first two years of operation, as part of the post-construction monitoring program, to assess the potential wildlife displacement, due to the Project. A subset of the pre-construction baseline wildlife inventory surveys will be conducted, which will provide data for comparison between pre- and post-construction wildlife inventories.

Proposed post-construction wildlife inventory surveys will include the following:

- bat surveys;
- breeding bird surveys; and
- Avian Use Surveys.

No Project infrastructure will be sited within the setback distances of any sensitive species features (e.g., sharp-tailed grouse leks) identified during the pre-construction surveys, and all turbines will be sited in agricultural/pasture land, cultivated land, or modified pasture land cover types, which provide low suitability habitat for most wildlife species, particularly for species of special concern. Consequently, specific post-construction surveys for sensitive species are not proposed the Project.

2.1.1 Bat Surveys

Bat monitoring will follow recommendations within the Alberta Bat Action Team (ABAT) endorsed Post-Construction Wind Energy Protocol for Bats (Barclay and Baerwald 2015) for two years of post-construction monitoring. The protocol calls for annual acoustic monitoring during periods of peak bat activity as observed during the pre-construction surveys. It is recommended that acoustic monitoring be completed with fatality monitoring activities and at the same detector sites used during the pre-construction monitoring.

Eight AnaBat® bat detection / recording units will be set-up, using the same configuration as for pre-construction monitoring. Four bat detector units will be set-up on the two meteorological towers, with two detectors positioned 2 m above ground and two detectors 30 m above ground. The remaining four bat detectors will be positioned approximately 2 m above ground and affixed to the same vertical structures (e.g., fence posts, trees or shrubs) used during pre-construction monitoring, if available.

Bat activity (i.e., high frequency auditory signals) will be digitally recorded by the AnaBat® SD1 onto compact flash one gigabite (1 GB) memory cards. The memory cards will be downloaded during weekly maintenance checks of the AnaBat® units.

Data analysis methods will be consistent with the methods used during pre-construction monitoring. Analyses will consist of a tally of all bat ‘passes’, and assigning the passes to bat species or species group based on characteristics of the echolocation recording (Lausen 2008). A bat ‘pass’ will be attributed to a bat flying through the detection radius of the bat detector. Because an individual bat may be recorded making multiple passes, the data presented will be a measure of bat activity in the vicinity of the bat detectors, not a direct measure of the numbers of bats within or passing through the Project Area/region.

2.1.2 Breeding Bird Surveys

Breeding bird surveys (BBS) will be conducted twice during the breeding season, for two years of post-construction monitoring. The two annual survey rounds will be a minimum of 10 days apart and will follow the protocol used for the pre-construction BBS, which is a standardized BBS point count method adapted from the North American Breeding Bird Survey (Ralph 1993) and the Sensitive Species Inventory Guidelines for grassland birds (AEP 2013).

Each point count will be conducted from one half hour before sunrise through until 10 a.m. Each point-count will consist of a five-minute survey; habitat type, and all birds heard and/or seen will be recorded within a 100 m radius of the plot centre.

A total of 85 BBS plots were established in previous pre-construction monitoring programs; a subset of these BBS plots will be sampled during the post-construction monitoring period. Representative post-construction BBS survey plots will be selected in areas of native habitat, where species of special concern were observed during the pre-construction BBS.

2.1.3 Avian Use Surveys

Avian use surveys (AUS) will be conducted monthly during the spring, summer and fall, for two years of post-construction monitoring. The AUS will follow the protocol used for pre-construction AUS, which is similar to protocols used at numerous other wind power developments throughout North America (Golder 2001, 2005, 2010a,b; Johnson et al. 2003; Erickson et al. 1999; Erickson et al. 2000; Strickland et al. 2001; Strickland et al. 2003).

A total of 28 circular AUS plots were established during the pre-construction surveys; a subset of these AUS plots will be sampled during the post-construction monitoring program. Representative post-construction AUS survey plots will be selected based on actual turbine locations and the collision mortality indices calculated during the pre-construction environmental evaluation.

All birds observed within or flying over the 800 m radius plot will be recorded during 20-minute sample events, twice daily at each location (morning and afternoon), during three survey rounds in the spring, two survey rounds in the summer, and three survey rounds in the fall. Each observation will be assigned a unique observation number, and will consist of species (or species group), number of individuals, sex and age class, distance from plot centre (first observed and closest), altitude above-ground (first observed, lowest, and highest), activity, and habitat(s) (observed in or flying over).

2.2 Bird and Bat Mortality

Bird and bat mortality monitoring will be conducted by experienced wildlife biologists, as defined by the Directive, during the first three years of Project operation. Mortality monitoring will consist of weekly searches around 25 of the 74 turbines, coupled with searcher efficiency and scavenger impact trials. Only birds and bats found within the search plots (i.e., assumed to have been killed as a result of a collision with the turbines) will be used to estimate mortality rates. If incidental mortalities are found (i.e., mortality related to traffic collisions and/or found outside of search area) they will be recorded and reported, but not used to estimate annual turbine collision mortality.

The primary objectives of the mortality monitoring are to estimate avian and bat mortality rates across the entire Project footprint and to determine whether the estimated mortality is lower, similar, or higher than the average mortality rates observed at other regional projects with similar wildlife habitat features. The mortality analysis will consider the following three factors:

- Number of annual avian and bat mortalities per turbine, per megawatt, and across the Project;
- Disproportionate representation of a particular species; and
- Comparison to existing data on wind farm mortality.

Mortality monitoring consists of short-term intensive surveys involving standardized carcass searches and bias trials for searcher efficiency and carcass removal, conducted by trained biologists. The overall Project fatality estimation is based on the number of carcasses found during carcass searches conducted under operating turbines. Both the probability that a carcass persists on-site long enough to be detected by searchers (carcass persistence) and the ability of searchers to detect carcasses (searcher efficiency) can lead to imperfect detection of carcasses during standardized searches. Consequently, mortality monitoring will include (1) standardized carcass searches to monitor potential injuries or fatalities associated with Project operation; (2) searcher efficiency trials to assess observer efficiency in finding carcasses; and (3) carcass removal trials to assess seasonal, site-specific carcass persistence time. Annual fatality rates will then be calculated by correcting for the bias (i.e., underestimation) due to searcher efficiency and scavenging rates by using an equation that accounts for the number of turbines searched, the carcass persistence, and searcher efficiency.

2.2.1 Mortality Searches

The survey protocols described below may be adapted for the second and third year of monitoring, based on the first and second year survey results.

Prior to starting the post-construction mortality monitoring program, wildlife research and collection permits will be obtained from CWS and AEP, as required.

2.2.1.1 Turbine Selection

As required by the Directive, mortality search plots will be established at one-third of the turbine locations (i.e., at 25 of the 74 turbines). The 25 turbines selected for mortality surveys will be used for both the bird and bat mortality monitoring, and will be surveyed for all three years of the post-construction monitoring program. The 25 turbine locations (Figure 2) were selected using a stratified random selection method, allowing for representation of all habitat types and including a mix of footprint edge and internal turbines (AEP 2017).

The following criteria were used to select turbines for mortality searches:

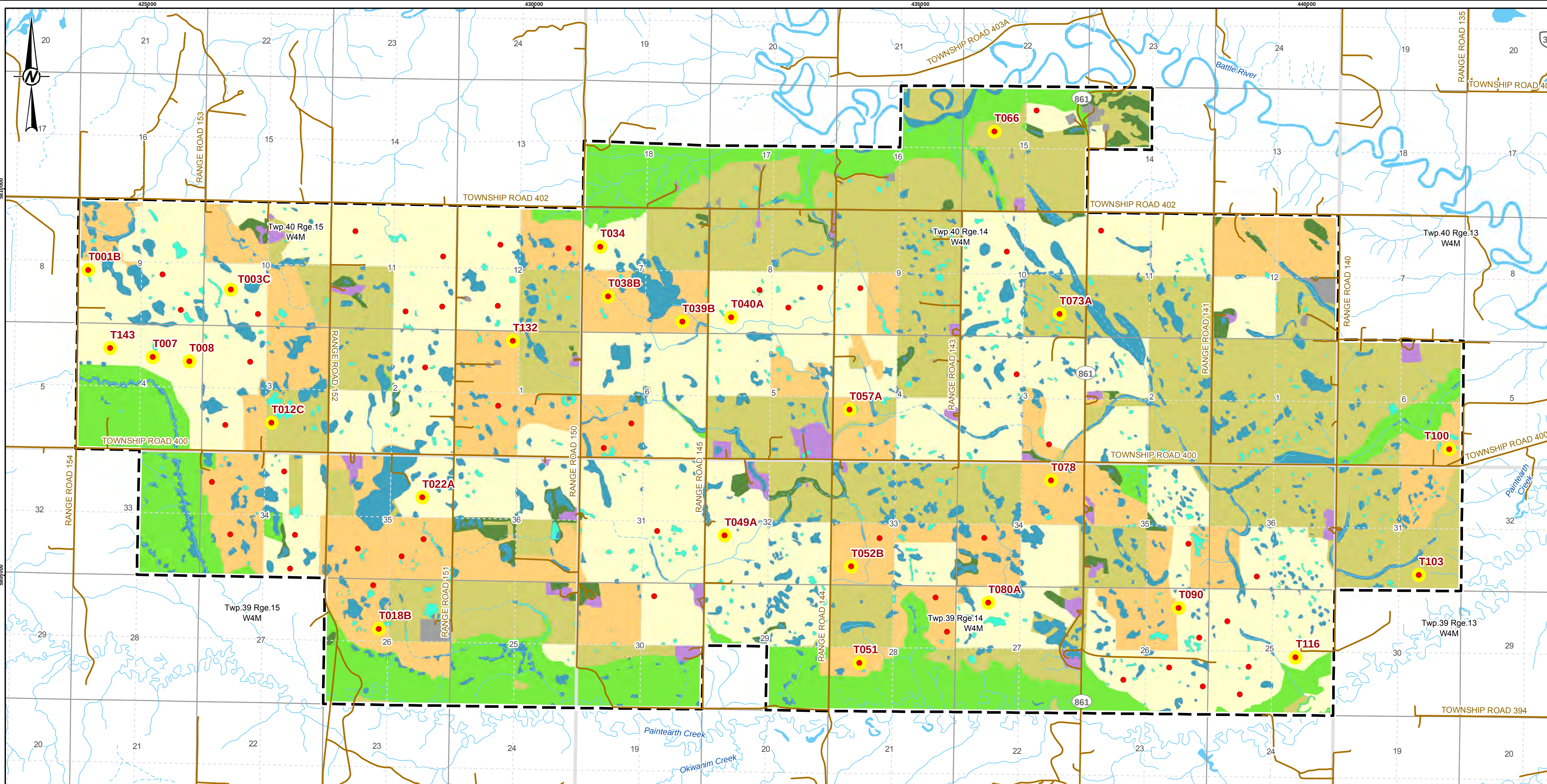
- Proximity to natural features such as coulees and large permanent waterbodies;
- Land cover type placement of turbine (e.g., agricultural/cultivated, modified pasture); and
- Proximity to baseline survey locations where high abundance of bats and/or birds were observed.

Land use cover types in the Project Area includes approximately 77% lands modified for agricultural purposes (i.e., agricultural/pasture, cultivated land, modified pasture), 12% native prairie, 8% wetlands, and a variety of other cover types including wooded at 1%, and miscellaneous developed areas. All permanent turbine locations were placed in modified land cover types for a total footprint disturbance of 13.0 ha. The majority of this footprint (i.e., 63%) occurs in cultivated land and 32% of the turbine footprint occurs in modified pasture. Consequently, stratifying the 25 turbines selected for mortality searches by habitat is difficult, as no natural habitats are affected by the turbine footprints. Therefore, representative turbine locations on cultivated land and modified pasture were selected.

Turbines were selected based on proximity to baseline AUS and bat survey plots so that baseline abundance levels could be correlated with post-construction mortality data, if any. In addition, the spring and fall AUS survey results were given slightly more weighting than the summer AUS survey results, as bird abundance was an order of magnitude higher for spring and fall than for summer (i.e., 13,618 and 11,677 birds in spring and fall, respectively and 2,623 birds in summer).

The turbine selection was first based on proximity of turbines to high abundance survey locations for AUS and bats, as mortality rates would be expected to be highest in these areas. Turbines were then selected based on habitat, and some turbines were selected where mortality is expected to be lower so that a more representative effect of the Project could be determined.

Table 1 lists the turbines selected for post-construction mortality searches and provides a description of criteria used to justify turbine selection.



LEGEND

- PROJECT AREA
- TURBINE SELECTED FOR POST-CONSTRUCTION MORTALITY SEARCHES
- TURBINE NOT SELECTED FOR POST-CONSTRUCTION MORTALITY SEARCHES
- ROAD/HIGHWAY
- WATERCOURSE
- INDEFINITE WATERCOURSE

LAND COVER [A,B]

- AGRICULTURAL/PASTURE
- CULTIVATED LAND
- MODIFIED PASTURE
- NATIVE PRAIRIE
- DEVELOPED
- FARM YARD / RURAL RESIDENTIAL
- WOODED
- WETLAND PERMANENCE CLASS I-II
- WETLAND PERMANENCE CLASS III-V

0 2 4

1:50,000 KILOMETRES

CLIENT

Capital Power

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-02-23
DESIGNED	CS
PREPARED	CH
REVIEWED	CS
APPROVED	JVC

NOTE(S)

[A] LAND COVER TYPES MAY BE DESKTOP OR FIELD VERIFIED.
[B] STEWART AND KANTRUD (1971) WETLAND CLASSIFICATION SYSTEM. ALBERTA ENVIRONMENT AND SUSTAINABLE RESOURCE DEVELOPMENT. 2015. ALBERTA WETLAND CLASSIFICATION SYSTEM. WATER POLICY BRANCH, POLICY AND PLANNING DIVISION, EDMONTON, AB.

REFERENCE(S)

1. ALBERTA TOWNSHIP SYSTEM, HYDROGRAPHY AND TRANSPORTATION BASE DATA © GOVERNMENT OF ALBERTA 2015. ALL RIGHTS RESERVED.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

HALKIRK 2 WIND PROJECT

TITLE

TURBINES SELECTED FOR POST-CONSTRUCTION MORTALITY SEARCHES

PROJECT NO.	CONTROL	REV.	FIGURE
1543760		0	2

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25mm

Table 1: Criteria and Selected Turbines for Post-Construction Mortality Searches

Turbines Selected for Mortality Searches	Criteria
T038B, T039B, T040A, T073A	Turbines in close proximity to a substantial waterbody and AUS plots 21 and 27.
T007, T008, T018B, T066, T100, T103, T116, T143	Turbines in close proximity to coulee system/native prairie and AUS plots 11 and 06.
T001B, T003C, T034, T051	Turbines in close proximity to bat detector locations with relatively higher bat passes and turbine T03C is also near a red-tailed hawk nest.
T012C, T022A, T049A, T052B, T057A, T078, T080A, T090, T132	Turbines representative of habitat and overall spatial distribution with some in proximity to native prairie.

2.2.1.2 Sample Size and Search Plot

Mortality searches will be conducted at the selected 25 turbines using one of two search pattern methodologies, a linear search pattern or a spiralling rope search pattern. Linear search patterns consist of traversing through a square shaped plot in a systematic manner along equally spaced transects. The spiralling rope pattern uses a length of rope, acting as the radius of a circular-like plot, which winds around the base of the turbine during the survey creating an equally spaced spiral transect. In each search pattern methodology, transects will be spaced a maximum of 7 m apart. The habitat type, vegetation, and terrain features will determine which methodology will be followed at each plot. In general, spirals are more efficient, but linear transects may be beneficial in cropland where vegetation could hinder the use of a rope to guide transects (Barclay and Baerwald 2015). Capital Power will also manage the vegetation, where feasible, within the mortality search plots, to increase searcher efficiency.

Based on the turbine height of 150 m from the tip of blade to the ground, the square linear search pattern plots will measure 150 m x 150 m (2.25 ha) and are to be centered around the base of the turbine. Plot boundaries will then be oriented with the four cardinal directions. The spiralling rope search pattern plot will extend starting at 75 m from the base of the turbine (approximately 1.77 ha). Using this methodology, the plot boundary and transects are dictated by the continuous loss of rope as it winds around the turbine. Both the linear and spiral pattern plot dimensions meet the minimum survey area of half the maximum height of the turbine, required by the Directive.

2.2.1.3 Search Method

Searches will be initiated as soon after sunrise as possible (Barclay and Baerwald 2015). The transects will be walked, as suggested by Barclay and Baerwald, at an approximate pace of 2.4 to 3.0 kilometres per hour (km/hr) (typical walking pace is 5 km/hr on broken ground) while searching 3.5 m on either side for bird and bat carcasses, or evidence of scavenged carcasses.

All carcasses, or evidence of carcasses, will be photographed in the position found, geo-referenced using a hand-held global positioning system (GPS), collected (conditional on permit approval), and recorded on a plot specific mortality search datasheet. For each carcass found, data recorded will include the unique carcass identification number, turbine plot number, observer, date and time collected, species, sex (when possible), age class (when possible), location in reference to nearest turbine, distance to and identity of other nearby structures (i.e., fence, power-line, substation), distance from observer at moment of detection, visibility class of where each carcass was found, carcass condition, and any comments indicating the suspected cause or time of death. Each carcass will be classified according to condition criteria outlined in Table 2.

All carcasses will be collected in plastic bags, labelled, and frozen for future use during searcher efficiency or scavenger impact trials, and/or delivery to an appropriate agency for necropsy, as dictated by the appropriate CWS and AEP collection permits.

Table 2: Carcass Classification Descriptions

Carcass Condition Class	Carcass Description
Intact	A carcass that is completely intact, is not badly decomposed, and shows little or no sign of being fed upon by a predator or scavenger.
Scavenged	An entire carcass showing signs of being fed upon by a predator or scavenger or a dismembered carcass (portions) in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.).
Feather Spot	Ten or more feathers at one location indicating predation or scavenging. If only feathers are found, ten or more total feathers or two or more primaries must be discovered to consider the observation a casualty.

Source: Young et al. 2003.

Upon completion of the plot search, the searcher will record the end time, document any incidental wildlife observations they made during the search, and then move to the next search plot to begin a new search.

2.2.1.4 Schedule and Frequency

Bird and bat mortality associated with turbine collisions has been found to vary with time of year, with the spring and fall migratory periods being times when the largest amounts of mortality are observed (CWS 2007a). Post-construction monitoring is required from March 1 to October 30 (AEP 2017), which includes the periods of peak spring (May and June) and fall (August and September) migration for the Project, corresponding with the highest levels of observed mortality associated with turbine collisions. Little to no mortality is observed during the winter months.

According to the Directive, surveys are required at each location on a weekly basis, between March 1 and October 30, for all three years of post-construction monitoring. This calculates to 35 surveys per year or a total of 105 surveys over the course of the three years.

2.2.2 Searcher Efficiency

Searcher efficiency may be influenced by several factors, including, but not limited to, habitat type, vegetation height, observer experience, observer fatigue, and lighting conditions. Searcher efficiency trials are necessary to adjust the number of carcasses found during searches, allowing for correction of detection biases (CWS 2007b). Efficiency trials will coincide with the standardized mortality searches by placing pre-marked Efficiency Trial Carcasses (ETC) within the search areas. The efficiency trials will be conducted on an ongoing basis during each search season (spring, summer, fall), and in distinct habitat types.

A total of 20 bat carcasses or surrogates are recommended per searcher during each season, or 100 carcasses in total depending on the situation (Barclay and Baerwald 2015).

Efficiency trials will be conducted in a blind manner, whereby the searchers do not know they are being tested (Young et al. 2003; Barclay and Baerwald 2015). During each site visit, one of the study members will be designated as the Efficiency Trial Supervisor (ETS) in charge of distributing the ETC throughout the search plots designated for other members of the search team. The ETC will be marked to distinguish from other carcases and typically, 5 to 10 ETC will be deployed during each trial. The ETS will record the location and number of all ETC deployed on a standardized searcher efficiency datasheet, for subsequent recovery should they be overlooked during the mortality search/efficiency trials. Immediately following the day of sampling, the ETS will determine if any ETC were overlooked by the search team, and collect them prior to leaving the Project area. The team member designated as the ETS will change between successive visits, so that all search team members are subject to efficiency trials during each season. As lighting conditions also influence carcass detection, cloud cover estimates will be recorded during each trial, and an attempt will be made to conduct trials in both overcast and clear conditions.

Searcher efficiency (SE) represents the probability of an observer to detect ETC, and is calculated as:

SE = # ETC detected / # ETC deployed

CWS and AEP research permits will be required for the collection and acquisition (if required) of ETC. Pending salvage permit approval, fresh or frozen carcasses collected during the mortality searches may be used as ETC. If there is a shortage of bat carcasses, dark mice, dark gerbils, or darkly feathered one-day old chicks are considered suitable surrogates.

Searchers

Search crews will consist of experienced wildlife biologists, as defined by the Directive. Search personnel will be provided with on-the-job training in the various tasks associated with the mortality plot searches, including plot layout, transect establishment, consistent search pacing, GPS and compass use, mortality documentation, and safe work practices.

Search personnel will be trained in the identification of specific sensitive wildlife species (e.g., Sprague’s pipit, loggerhead shrike, short-eared owl), as they will be required to document incidental observations of these species during the course of the search programs. Training in the recognition of the sensitive species will include on-the-job training, listening to recordings of the species specific vocalization, and reference field-guide review.

Search personnel will be trained in the efficiency trial methodology so that they can assist with the efficiency trials of fellow search personnel and function as the ETS during alternate efficiency trials. The ETS training will consist of ETC deployment, documentation, and follow-up ETC recovery as detailed above.

2.2.3 Scavenger Impacts

Scavenger impact trials are necessary to adjust the number of carcasses found during mortality searches, allowing for correction of scavenger biases. Scavenger impact trials will be conducted approximately three times during each survey season to account for scavenger density changes (Barclay and Baerwald 2015). By determining the length of time taken for scavengers to completely remove the carcass, the total mortality count estimate will be adjusted.

Each scavenger impact trial will consist of placing 12 carcasses or surrogates (fresh or thawed) of different species within pre-selected scavenger impact plots located within the study area and recording the carcass details on a standardized scavenger impact datasheet (Barclay and Baerwald 2015). The scavenger impact trial plots will be located within representative habitat outside the mortality search plots, to prevent possible confusion with turbine related mortality. Each scavenger impact trial will last up to 15 days, in which time the scavenger impact trial carcasses will be monitored continuously with remote wildlife cameras and/or inspected on days when search crews are on site, or until completely removed by scavengers. At the end of the trial (i.e., after the 15 days), any remaining trial carcasses will be removed. An attempt will be made to use species normally occurring in the study area during the scavenger impact trials, as domestic species (i.e., chicken) may be more palatable and/or easily detected by scavengers. Pending salvage permit approval, fresh carcasses found during the mortality searches may be used as scavenger impact trial carcasses.

2.2.4 Fatality Estimates

Results of searcher efficiency and scavenger efficiency trials will be incorporated into the fatality estimates using the Huso (2010) estimator. The Huso estimator is the most common and most recommended by AEP (Barclay and Baerwald 2015).

2.2.5 Post-Construction Reporting

At the completion of each year of the bird and bat mortality monitoring, an annual report will be prepared that includes:

- detailed survey protocols and data analysis methodology;
- raw data, using the appropriate FWMIS datasheet for each turbine;
- results of searcher efficiency and scavenger trials;
- the uncorrected fatality rate for bats and birds expressed as number of mortalities/turbine/year and mortalities/megawatt/year;
- the corrected fatality rate/turbine/year and corrected mortalities/megawatt/year based on Huso (2010) or Shoenfeld (2004);
- a summary of species killed;
- results of pre-construction and post-construction wildlife surveys;
- a comparison of the pre- and post-construction survey results;
- a comparison of the estimated fatality rates from pre-construction surveys and the fatality rates from post-construction surveys for birds and bats; and
- a statement of Compliance with the Directive and signature of lead biologist.

The annual post-construction monitoring report will be submitted to the AUC for review.

3.0 POST CONSTRUCTION MITIGATION

Due to thoughtful planning and Project design, it is anticipated that operational mitigation will not be required. However, if required, the effectiveness of such mitigation measures on reducing bird and/or bat mortality will be assessed through an operational mitigation study, which will be conducted in conjunction with the post-construction monitoring program. Turbines selected for operational mitigation (i.e., the experimental group) will be located throughout the Project, including a mix of footprint edge and internal turbines. It is expected that an operational mitigation study with experimental and control turbines will reduce the influence of annual bat/bird activity variability on the assessment of operational mitigation measures. Carcass searchers will not be informed of the ongoing operational mitigation study nor which specific turbines are included, to avoid any potential bias in search effort at experimental or control turbines during the study.

Results of the operational mitigation study, if required, will be included in the annual post-construction monitoring report and will be submitted to the AUC for review. Capital Power will consult with the AUC (and AEP, as appropriate) to determine whether additional or different mitigation measures are warranted and whether the three-year post-construction monitoring program is satisfactory.

4.0 CLOSURE

This PCMMP is intended to fulfill the requirements of the updated AEP *Wildlife Directive for Alberta Wind Energy Projects*, dated January 27, 2017 (AEP 2017).

The PCMMP includes the duplication of select pre-construction surveys, bird and bat mortality searches (including searcher efficiency and scavenger trials), and reporting commitments. After completion of the proposed 3-year mortality monitoring program, the results will be assessed by Capital Power, the AUC, and AEP to determine that wildlife mortalities are at acceptable levels and the program can be concluded.

Because of the rapid development of the wind energy industry in Alberta and the large amount of data still being collected, the body of knowledge on impacts to birds and bats from wind energy development is continually growing. Accordingly, Capital Power will consult with AUC/AEP during the post-construction monitoring phase for regular dialogue and feedback with provincial biologists.

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